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Corrective Measures Evaluation Report for Material Disposal Area G, Consolidated Unit 54-013(b)-99, at Technical Area 54, Revision 3

Prepared by the Environmental Programs Directorate

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September 2011

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EXECUTIVE SUMMARY

This report documents the corrective measures evaluation (CME) conducted for Material Disposal Area (MDA) G, Consolidated Unit 54-013(b)-99, located within Area G, at Los Alamos National Laboratory's Technical Area 54 (TA-54). MDA G comprises all subsurface pits, trenches, and shafts located within the disposal units. The low-level waste disposal units are regulated by the U.S. Department of Energy (DOE).

Area G includes all Resource Conservation Recovery Act–permitted surface units and all other operational buildings or structures at TA-54. MDA G is located within the boundary of Area G. This CME is part of a comprehensive, integrated approach to remediation and closure of all subsurface units at Area G.

The goal of the CME is to recommend a corrective measures alternative for closure of the solid waste management units (SWMUs) at Consolidated Unit 54-013(b)-99 and to address releases from the SWMUs in accordance with the Compliance Order on Consent (the Consent Order). The performance assessment and composite analysis for Area G will establish the technical requirements for closure needed to meet the performance objectives for radiological protection of the public from radionuclides disposed of at the site. These technical requirements will be incorporated into the design of the final remedy during the corrective measures implementation phase of the project.

Retrievably stored transuranic (TRU) waste will be removed before the implementation of the preferred remedy. If DOE determines that removal of portions of the retrievable TRU waste is unsafe for workers or is cost prohibitive relative to risk reduction benefits, DOE may propose incorporating this waste into the corrective actions at MDA G through regulatory options available per DOE Order 435.1.

Subsurface volatile organic compound (VOC) vapor plumes are present in the vadose zone at MDA G. The sources of VOC vapors at MDA G are thought to be associated with mixed wastes disposed in the pits and shafts at the site, with VOCs being a component of the waste rather than a primary waste form.

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.

A conceptual site model (CSM) was developed to evaluate primary and secondary release mechanisms from the source areas (pits and shafts). The CSM evaluates the exposure pathways and potential risks. The remedial action objectives (RAOs) for these source areas 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.
- Prevent the creation of contaminated leachate by restricting the infiltration of water into the waste.

In order to complete the CME, treatment technologies were identified and screened for applicability to the sources of contamination present at MDA G. Applicable technologies were then combined into corrective measures alternatives to address the RAOs for MDA G. 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 pits 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 by providing a soil medium to hold infiltrated water until it is removed by evaporation from the surface and transpiration through vegetation. The alternative also includes constructing and operating a soil-vapor extraction (SVE) system to remove VOCs from the subsurface in order to prevent the downward migration of these VOCs to the groundwater. Performance monitoring and institutional controls will be included to ensure that 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 G that couples vapor monitoring in the vadose zone near the disposal units with regional aquifer monitoring 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) G, Consolidated Unit 54-013(b)-99, at Los Alamos National Laboratory (LANL or the Laboratory). MDA G subsurface disposal units are located within the boundaries of Area G at Technical Area 54 (TA-54) (Figures 1.0-1 and 1.0-2). This CME is developed and submitted pursuant to the 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 solid waste management units (SWMUs) or areas of concern (AOCs).

The Laboratory is divided into numerous TAs based upon facility operations. Several of the TAs include MDAs where waste was previously disposed. MDA G comprises all subsurface pits, trenches, and shafts located within the boundary of Area G. Included in the definition of MDA G is Consolidated Unit 54-013(b)-99. Consolidated Unit 54-013(b)-99 contains nine SWMUs: 54-013(b), 54-014(b), 54-014(c), 54-014(d), 54-015(k), 54-017, 54-018, 54-019, and 54-020. One SWMU [54-013(b)] is aboveground. The remaining eight SWMUs [54-014(b), 54-014(c), 54-014(d), 54-015(k), 54-017, 54-018, 54-019, and 54-020] are subsurface. These SWMUs were used for the disposal of low-level radioactive waste (LLW), radioactively contaminated infectious waste, asbestos-contaminated material, and polychlorinated biphenyls (PCBs). Consolidated Unit 54-013(b)-99 also includes subsurface units used for the retrievable storage of transuranic (TRU) waste. The subsurface units and SWMU 54-013(b), which compose MDA G, are collocated with units regulated by the Resource Conservation Recovery Act (RCRA) and LLW disposal units. The LLW disposal units are regulated by the DOE.

Area G waste disposal units are identified in Figure 1.0-3. Area G includes all operating RCRA-permitted surface units and all other operational buildings or structures at TA-54. MDA G is located within the boundary of Area G.

The definitions above are used when referencing MDA G and Area G throughout the CME report.

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.

The regulatory framework at MDA G is complex. The Laboratory's ongoing management of hazardous and mixed wastes in permitted surface container storage units at Area G is regulated by the New Mexico Environment Department (NMED) under a Hazardous Waste Facility Permit (HWFP) issued pursuant to the New Mexico Hazardous Waste Act (HWA). There are seven outdoor container storage units (CSUs) and two indoor CSUs that will be closed under the Laboratory's HWFP to facilitate corrective action at MDA G.

The Consent Order addresses corrective action for the hazardous component of wastes disposed of in SWMUs and regulated units at MDA G. The Consent Order fulfills the corrective action requirements in Sections 3004(u) and (v) and 3008(h) of the federal RCRA; Sections 74-4-4(A)(5)(h) and (i), 74-4-4.2(B), and 7-7-10(E) of the HWA; and the federal and state implementing regulations in the Code of Federal Regulations, Title 40 (40 CFR) Part 264, Subpart F, and the New Mexico Administrative Code (NMAC), Section 20.6.2.3103, respectively. The integration of the Consent Order with the HWFP is described in Section III.W of the Consent Order. The Consent Order is the sole enforceable instrument for corrective action relating to the Laboratory except as provided in Section III.W.1.

The requirements of the Consent Order do not apply to radionuclides, including but not limited to source, special nuclear, or byproduct material as defined in the Atomic Energy Act of 1954 (AEA), as amended, or the radioactive portion of mixed waste. Historic and operating LLW disposal units and TRU waste storage units are exclusively regulated by the DOE under the AEA. DOE's authority to regulate nuclear safety is governed by the provisions of 10 CFR Parts 830 through 835. Pursuant to these regulations, DOE is required to review and approve all activities and work related to radionuclides, including activities and work under the Consent Order. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with DOE policy and Section III.A of the Consent Order.

The regulated units at MDA G are a small subset of the SWMUs. A "regulated unit" is defined in 40 CFR 264.90(a)(2) as "any landfill, surface impoundment, waste pile or land treatment facility that received wastes after July 26, 1982 or that certified closure after July 26, 1983." Closure under Subpart F of Parts 264 and 265 for regulated units is prescriptive, including design requirements for caps for land disposal units and postclosure care (including cap maintenance and groundwater monitoring). The U.S. Environmental Protection Agency (EPA) recognized that complex sites, such as MDA G, are potentially subject to two different sets of RCRA requirements that apply to a single release if both regulated units and SWMUs have contributed to the release. To avoid unnecessary impediments to cleanups while ensuring that both SWMUs and regulated units are cleaned up in a manner that is protective of human health and the environment, 40 CFR 264.110(c) provides EPA and authorized states such as New Mexico with the discretion to prescribe alternative requirements for closure. MDA G meets the requirements for the application of 40 CFR 264.110(c) for the following reasons:

- MDA G has two regulated units situated among eight subsurface SWMUs, and both types of units have likely contributed to the releases indentified during site investigation.
- The alternative closure and postclosure requirements for MDA G are set out in the Consent Order, which is an "enforceable document" as defined in 40 CFR 270.1(c)(7).

Two source areas are addressed in this CME:

- the MDA G SWMUs and regulated units (pits and shafts)
- the vadose zone

Remediation and closure of MDA G requires integration of solutions that address waste and regulatory issues specific to MDA G. To achieve remediation and closure requires use of recent and historical characterization data as the basis for defining the nature and extent of contamination at MDA G. The CME report identifies and evaluates appropriate technologies that manage potential unacceptable future risk from MDA G. Finally, this CME report screens and evaluates alternatives based on known performance data that have demonstrated the technologies' abilities to meet regulatory threshold and balancing criteria and recommends an alternative as the proposed remedy.

This CME report is organized according to the Consent Order requirements. Table 1.0-1 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 G and the MDA G 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 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 G subsurface units. Section 5 also includes a discussion of the Consent Order evaluation criteria process used for screening and evaluating the available treatment technologies as well as the recommended corrective measures alternatives. Section 6 presents the identification and screening of technologies. The corrective measures alternatives are developed from the retained technologies identified and described in section 7. Section 7 also presents the screening of these alternatives against the four threshold criteria identified in Section VII.D.4.a of the Consent Order. Alternatives that pass the threshold criteria are further evaluated 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 gives an account of historical investigation at MDA G. Appendix C provides the contaminant screening method for subsurface soil vapors, describes their distributions, and 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 a summary of DOE's requirements for radioactive waste management. Appendix G provides the cost estimates for the corrective measures alternatives identified and carried through section 7. Appendixes H through J present preliminary design information for potential corrective measures, including a multilayer RCRA 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. MDAs H and J are located approximately 500 ft and 1000 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 MDA L.

Mesita del Buey is a 100- to 140-ft-high finger-shaped mesa that trends southeast. The elevation of Mesita del Buey ranges from 6750 to 6670 ft at Area G. 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).

Area G is a 63-acre (25-ha) fenced site, containing 333 active and inactive waste disposal units, that lies within the boundaries of TA-54 (Figure 1.0-2). Area G contains 35 pits, 294 shafts, and 4 trenches. The regulatory category of each disposal unit is shown in Table 2.0-1 and Figure 1.0-3. Consolidated Unit 54-013(b)-99 is located within Area G and consists of nine inactive SWMUs: 54-013 (b), 54-014 (b), 54-014(c), 54-014 (d), 54-015(k), 54-017, 54-018, 54-019, and 54-020. Table 2.0-2 identifies and describes each SWMU, including the type of waste managed or stored. There are eight inactive MDA G subsurface SWMUs that comprise 32 pits, 196 shafts, 4 trenches, and retrievable TRU waste in corrugated metal pipes overlying Pit 29. These disposal units range from 8 ft to 65 ft (2.4 to 20 m) below the original ground surface.

The following subsections provide a summary of site information. Further information about current site conditions at MDA G is described in detail in the approved investigation work plan (LANL 2004, 087833, pp. 14−21) and report (LANL 2005, 090513), the approved supplemental sampling investigation work plan (LANL 2006, 094803), the MDA G investigation report (IR) (LANL 2005, 090513, pp. 9, 11−16) and addendum (LANL 2007, 096110, p. 1), and the annual periodic monitoring reports for pore gas (e.g., LANL 2010, 108496). These documents describe the site and include information on the disposal units, waste inventories, characterization activities, analytical results from sampling, and assessments of potential present-day risks to human health and the environment.

2.1 Site History

Wastes historically disposed of at MDA G included operational and nonroutine wastes, plus demolition debris. Operational wastes consisted of a wide range of materials including compactable trash (e.g., paper, cardboard, and plastic), rubber, glass, disposable protective clothing, solidified powders and ash, animal tissue, and suspect radioactive waste. Nonroutine waste included classified waste, uranium chips from Laboratory shops, and pieces of heavy equipment such as dump trucks. Demolition debris included equipment and scrap metal, demolition debris, soil, concrete, asphalt, asbestos, and PCB-contaminated materials.

The nature of the waste disposed of at MDA G has changed over the facility's lifetime. Waste that under current definitions is considered to be TRU was disposed of at the facility through 1970. Since then, the vast majority of TRU waste generated at the Laboratory has been segregated and retrievably stored for permanent disposal at the Waste Isolation Pilot Plant (WIPP), although small amounts of TRU waste were disposed of at MDA G between 1971 and 1979.

Mixed wastes have also been historically disposed of at MDA G. A mixed waste is a waste that contains both hazardous waste subject to the HWA and RCRA, and source, special nuclear or byproduct material subject to the AEA. Waste that under current definitions qualifies as mixed low-level waste (MLLW) was placed in MDA G pits and shafts through 1985. Mixed TRU waste was routinely disposed of at MDA G before 1971; smaller quantities of mixed TRU waste were disposed of between 1971 and 1979. Since 1986, when the EPA affirmed its authority over the regulation of the hazardous component of MLLW, the

vast majority of MLLW has been segregated from LLW and sent off-site for treatment and/or disposal. Small amounts of MLLW were inadvertently placed in a single pit and shaft between 1986 and 1990. No mixed waste has been disposed of at MDA G since 1990. In addition to LLW, MDA G was previously authorized to dispose of low-level contaminated-PCB solid waste.

MDA G contains 229 inactive subsurface waste management units (Figure 1.0-3). Tables 2.1-1 through 2.1-3 summarize the operational history, unit dimensions, waste volumes, and description of waste received at each pit, trench, and shaft at MDA G (LANL 2005, 090513, pp. 53−55).

On a volume basis, most of the waste at MDA G has been placed in the pits. Before the mid-1990s, the waste was typically placed into the pits in lifts; each layer of waste was covered with uncontaminated crushed tuff and compacted using heavy equipment. Most waste placed in pits was packaged in plastic bags and cardboard boxes. The waste packaging requirements and disposal pit operations used before the mid-1990s are generally expected to confer structural stability to the pits. Layering waste and crushed tuff and compacting these layers with heavy equipment effectively filled void spaces within the waste and provided an even, consolidated surface for the disposal of more waste. The result has been infrequent and minor cases of settlement; no significant subsidence has been observed at Area G.

To more efficiently use the available pit disposal capacity, disposal procedures were modified in the mid-1990s. Since that time, all waste other than bulk soils and debris is required to be placed in metal containers before disposal. The containers used to date have included steel drums, B-25 waste containers, compactor boxes, and transportainers. These containers are stacked in the disposal units to maximize usage of the available disposal capacity. Bulk materials are placed directly in the disposal pits and may be used to fill void spaces between and within waste containers.

The waste disposed in the shafts is generally placed in small metal cans or 30- to 85-gal. drums, depending upon the nature of the waste. The packages are lowered into the shafts and stacked on top of one another. Crushed tuff may be added as backfill around the waste packages, thereby reducing void spaces in the disposal units. In general, backfilling the disposal shafts is expected to adequately stabilize the waste. However, isolated instances of subsidence near the shafts have been observed during the 50-yr history of the facility.

During active operations (i.e., when waste was being received), the pits and trenches remained open to the atmosphere and the shafts were covered and locked with steel lids after disposal. When active operations ceased, any remaining capacity of the pits, shafts, and trenches was filled with clean crushed tuff. Portions of the waste disposal units at MDA G have been covered with asphalt, and much of the surface, above the MDA G subsurface units, is currently being used for the active storage of RCRA MLLW and TRU waste (LANL 1992, 007669, pp. 5−179).

As discussed above, the Consent Order addresses corrective action for the hazardous component of wastes disposed of in SWMUs and regulated units at MDA G. The requirements of the Consent Order do not apply to radionuclides, which are solely within the DOE's regulatory authority.

2.2 Area G Inventory

The information in Tables 2.1-1 and 2.1-3 provides a summary of the disposal inventory for the pits and shafts, respectively.

Pre-1970 TRU waste is assumed to contain hazardous constituents (LANL 2004, 087833, pp. G-3−G-9). Waste disposal records indicate that significant portions of the TRU waste generated at the Laboratory after 1970 are mixed with hazardous constituents. The mixed TRU waste consists of combustible and noncombustible fractions. Combustible waste includes items such as rags, plastic, paper, and rubber.

Examples of noncombustible waste include glass, scrap metal, graphite, salts, and equipment such as glove boxes. Other categories or types of waste that were generated include cement paste generated when treated liquid waste or sludges were solidified in cement before disposal, chemical treatment sludge, and PCB-contaminated waste.

Additionally, 12 disposal shafts contain PCB-contaminated waste that would be classified as Toxic Substances Control Act (TSCA) waste.

2.3 Site Description

2.3.1 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 G 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 composed of the Carjo loam, the Hackroy loam, and the Seaby loam. At Area G, natural or undisturbed surficial soil cover is limited as a result of disposal unit construction.

Canyon bottoms (i.e., Cañada del Buey and Pajarito Canyon) near Area G 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 G, Cañada del Buey has experienced a period of accretion, and eroded soils from Area G, as well as other areas at TA-54, have been deposited on the canyon bottom and along stream banks. Potentially, these soils may be redistributed downstream during storm runoff events.

2.3.2 Subsurface Geology

A brief description of the site-specific geology at MDA G is summarized in this section. A generalized stratigraphic column for the east end of MDA G is shown in Figure 2.3-1. Appendix E, section E-2, describes the sitewide geology for the entire TA-54 site. North-south cross-sections in the vicinity of MDA G are shown in Figures E-2.1-2, E-2.1-7, and E-2.1-8.

The facilities and disposal pits of MDA G are sited 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 thickness of Bandelier Tuff deposits ranges from 175 to 350 ft at MDA G. These tuffs overlie a 650- to 775-ft-thick sequence of volcanic rocks that make up the Cerros del Rio volcanic series. This volcanic series is dominated by lava flows that range in composition from basalt (Tb4) to dacite (Tvt2b) (Appendix E, section E-2.1). A variety of volcanic lithologies are intercalated with the lavas, including flow breccias, cinder deposits, scoria, phreatomagmatic deposits, and interflow sediments. Cuttings from boreholes at TA-54 and exposed cinder vents nearby indicate that a number of volcanic centers occur in the vicinity. A possible basaltic conduit that fed upper-level lava flows was intersected by well R-22 at the eastern end of MDA G (Appendix E). 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 G. Sitewide borehole data indicate that the Puye Formation is underlain by the Miocene Chamita Formation (Tcar) of the Santa Fe Group. The Chamita Formation consists of variably calcite-cemented sands, silty sands, and gravels. Miocene basaltic lavas are intercalated with the Chamita Formation.

At MDA G, the top of regional saturation occurs at a depth of about 900 ft in the Cerros del Rio volcanic series. Thus, the top of the regional aquifer beneath MDA G is made up of 30 to 100 ft of fractured lavas (Figure E-2.1-12) that overlie porous Pliocene and Miocene sedimentary deposits. East of MDA G, the regional water table is within sedimentary rocks of the Totavi Lentil and Chamita Formation.

2.3.3 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 Storm Water 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.

2.3.4 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 G, 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 2.3-2 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 below the root zone 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). If these conditions are maintained over long time frames, 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 of several hundred years to several thousand years are predicted under

disturbed and undisturbed conditions, respectively (Stauffer et al. 2005, 097432). Adsorbing waterborne constituents will migrate more slowly. Vapor-phase contaminants may migrate more quickly than waterborne contaminants, as described in Appendix C. The CSM for contaminant migration through the unsaturated zone at TA-54 is presented in detail in Appendix E of 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 at three boreholes adjacent to disposal units near the center and south-central portions of MDA G. The data indicate average volumetric moisture contents within the Tshirege units ranging from 1.5% to 10% and within the Otowi member reaching 11.5 %. Similar moisture content ranges were reported in the MDA G IR for boreholes extending down to 700 ft below ground surface (bgs) (LANL 2005, 090513), as described in Appendix B of this report. These moisture content values are low, given that the porosity of the tuffs are in the 40% to 50% range, and for fully saturated conditions, the volumetric moisture content is equivalent to the porosity. At these moisture contents, the fractures beneath MDA G are expected to be predominantly dry, and pore water is expected to reside within the tuff matrix. During infiltration events, limited flow may occur temporarily along the fractures (Soll and Birdsell 1998, 070011). Higher volumetric moisture contents and percolation rates are expected under paved areas because of a lack of ET (Newman et al. 2005, 099163). The paved areas are thought to be permeable enough to allow water infiltration sufficient to sustain the observed percolation rates. A comparison of moisture profiles measured with neutron probes within and adjacent to an open pit found significantly wetter conditions within the disposal pit. For example, volumetric moisture contents in the pit ranged from 8% to 12% compared with 1% to 6% in the adjacent area (LANL 1997, 056384). 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 G. Borehole 54-25105, the deepest borehole to date at MDA G, was drilled to a depth of 700 ft bgs and did not encounter perched groundwater (LANL 2005, 090513). Regional wells drilled in areas next to MDA G (R-21, R-22, R-32, R-39, R-41, R-49, and R-57) also did not encounter perched-intermediate groundwater. Perched-intermediate groundwater occurs in wells R-55 and R-23/R-23i, located 2500 and 3600 ft (0.75 and 1.1 km) east and southeast of MDA G, respectively (LANL 2003, 079601; Kleinfelder 2006, 092495). Perched-intermediate groundwater also occurs in wells R-40/40i and R-37, both located approximately 5900 ft (1.8 km), northwest of MDA G (LANL 2009, 106432). This water is thought to be localized beneath the canyon floor and to result from infiltration along the adjacent canyon, which has a large drainage area.

2.3.5 Regional Aquifer Hydrology and Groundwater Monitoring Network

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 G, the regional water-table elevation is approximately 5810 ft amsl or approximately 900 ft (300 m) below the ground surface. Figure 2.3-3 shows the TA-54 ground monitoring network.

As with the conditions observed elsewhere beneath the Pajarito Plateau, the regional aquifer beneath MDA G 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 (Table E-3.1-3), and (2) a lack of vertical propagation of pumping drawdown caused by pumping tests and municipal water supply pumping (Tables E-3.1-1 and E-3.1-2).

The vertical stratification of the regional aquifer is also demonstrated by the well 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 G, the shallow portion of the regional aquifer is located within the Cerros del Rio lavas, and the deeper portion is located within the underlying sediments (Appendix E). 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 (Appendix E).

The water-table map of the regional aquifer beneath the Pajarito Plateau is presented in Appendix E, Figure E-3.3-1. The map is based on monthly-averaged water-level data from February 2011 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 G (e.g., R-57 and R-55). 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. The regional water table is observed within the Cerros del Rio lavas beneath MDA G and in the underlying sediments to the west, north, and east of MDA G (Appendix E, Figures E-2.1-2, E-2.1-7, and E-2.1-8).

The structure of the regional aquifer flow near MDA G is represented in greater detail by a series of water-table (piezometric) maps presented in Appendix E (Figures E-3.3-2 through E-3.3-6). The water-level contour maps in Figures E-3.3-2, E-3.3-3, and E-3.3-4 incorporate information from the shallowest screens in the regional aquifer at the monitoring wells; the three different maps represent alternative conceptual models related to uncertainties associated with (1) the lateral continuity of the shallow aquifer flow and (2) the R-41 water-level data. The water-table map in Figure E-3.3-2 ignores the water level at R-41, assuming that the well is drilled through a hydrogeologic zone with limited lateral extent within the lavas that is hydraulically disconnected from the aquifer; as a result, the lavas near R-41 are locally unsaturated, and the R-41 observation is not representative of the general structure of the groundwater flow in the shallow portion of the regional aquifer. The map in Figure E-3.3-3 takes into account the water level at R-41 but assumes that there is a vertical barrier impacting the shallow aquifer flow between R-57 and R-22 (R-41 as well) associated potentially with a fault structure and/or volcanic vents. Analysis presented in Figure E-3.3-4 also takes into account the water level at R-41 but assumes that there is a lateral disconnection in the shallow aquifer flow between R-57 and R-41 due to the lateral extent of the lavas along the top of the regional aquifer beneath MDA G (Figure E-2.1-8).

The water-level contour maps in Figures E-3.3-5 and E-3.3-6 incorporate information from the deeper screens in the regional aquifer at the monitoring wells with more than one screen; both maps take into account the R-41 water-level data. Figure E-3.3-5 does not make any assumptions related to discontinuities in the deep aquifer flow. Figure E-3.3-6 assumes that there is a vertical barrier impacting the shallow aquifer flow between R-57 and R-22 (R-41 as well) associated potentially with a fault structure and/or volcanic vents (a conceptual model similar to the one implemented for the shallow aquifer flow in Figure E-3.3-3).

Groundwater flow in the upper part of the regional aquifer beneath MDA G appears to be substantially impacted by the Cerros del Rio lavas (Appendix E, Figures E-2.1-2, E-2.1-7, and E-2.1-8). These lavas are more than 150 ft thick beneath the regional water table (Appendix E, Figure E-2.1-12). 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 hydraulic interconnection of the fractures and interbedded sediments. The permeability of the intact lava matrix is expected to be quite low. Because of local fracture properties, there might be local zones within the lavas (laterally and vertically) with relatively high and relatively low groundwater flows. For example, high-permeability fractures and interbedded sediments can lead to relatively high local groundwater flow velocities and preferential contaminant migration though the phreatic zone. Low-permeability zones or zones with fractures hydraulically disconnected from the phreatic zone may appear to be unsaturated; for example, a similar zone may have been observed near R-41 and this conceptual uncertainty is represented in the water-table map presented in Figure E-3.3-2. 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 Pajarito 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 (Appendix E, Figure E-3.3-1).

The groundwater flow in the regional aquifer beneath MDA G is predominantly from northwest to southeast. The direction of the potential contaminant transport in the regional aquifer is expected to follow the hydraulic gradients along the regional water table, although fractures or interbedded sediments may cause permeability anisotropy that could lead to deviations from the predominant flow direction. In the area downgradient from MDA G, the direction of the regional aquifer flow is believed to be dominantly towards the southeast based on regional water-table maps. However, there is some uncertainty about the flow regime where regional groundwater exits the lavas and merges with the groundwater flow in the more permeable sediments of the Totavi Lentil to the east and north. This type of conceptual uncertainty is reflected in the water-table map presented in Figure E-3.3-4 (discussed above). This transition between lavas and Totavi sediments at the regional water table occurs near the eastern boundary of MDA G (Appendix E, Figure E-2.1-12). The transitional nature of the water table at the interface between the lavas and Totavi Lentil sediments is probably reflected by the relatively low water level observed at R-41 (Appendix E, Figure E-3.3-2). The water-table map in Figure E-3.3-4 suggests there may be a local component of regional groundwater flow to the north near the northeast corner of MDA G.

Based on the existing hydrogeological information (Appendix E, Table E-3.1-2), most of the monitoring wells located near MDA G (R-21, R-56, R-32, R-49, and R-57) have been observed to respond to the water-supply pumping at wells PM-2 and PM-4. In contrast, the monitoring wells R-22 and R-41 do not appear to respond to the water-supply pumping at PM-2 and PM-4. However, this is somewhat surprising considering the proximity of R-57 and R-41/R-22. The lack of pumping response in the deep screens at R-22 may indicate the presence of localized heterogeneities (low permeable zones, faulting, volcanic vents, etc.) in the regional aquifer between R-57 and R-41/R-22. This type of conceptual uncertainty is reflected in the water-table maps presented in Appendix E, Figures E-3.3-3 and E-3.3-6 (discussed above).

The complexity and uncertainty in the groundwater flow directions are discussed in Appendix E.

The regional monitoring-well network around MDA G 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 of MDA G. The monitoring network includes single-screen wells (R-21, R-41, R-39, R-23) and multiscreen wells (R-32, R-49, R-57). In the wells downgradient from MDA G, the uppermost screen is placed as close to the water table as possible to monitor the first arrival of contaminants in the aquifer. In the multiscreen wells, the lower screen(s) 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 G 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 G are either unconfined or partially confined (Appendix E, Table E-3.1-1): for example, uppermost screens at R-32, R-41, R-57, R-49, and R-39. This suggests that the uppermost 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; Appendix E, Table E-3.1-4): for example, R-32 screen 2, R-49 screen 1, R-57 screen 1, R-22 screen 1, and R-39 screen 1.

2.3.6 Historical Preservation and Archaeology

Known archaeological sites exist in the immediate vicinity of Area G. The site has been thoroughly characterized for archaeological sites and structures that may be subject to historical preservation restrictions (LANL 1992, 007669). The exact locations of existing archaeological sites are not identified in this report to protect the cultural resources.

2.4 Summary of Previous Investigations

MDA G has been the subject of several site investigations and two SVE pilot studies (LANL 2009, 105112). The first investigation was conducted in 1985, following receipt of a Compliance Order from the New Mexico Environmental Improvement Division (NMEID, now NMED). A Phase I RCRA facility investigation (RFI) was conducted at MDA G between 1993 and 1995. A Consent Order site investigation was concluded in 2007. All three investigations are summarized in the following sections and in the approved IR (LANL 2005, 090513) and addendum to the IR (LANL 2007, 096110). These investigations composed a comprehensive approach to characterizing potential releases of hazardous wastes and hazardous constituents from all subsurface disposal units at Area G. NMED ultimately approved the IR (NMED 2007, 096716). Relevant data, figures, and tables from these investigations are included in Appendix B, and the key findings from these studies are summarized below.

The IR addendum (LANL 2007, 096110) concluded that the hazardous constituents in the subsurface of MDA G pose no potential unacceptable present-day risk or dose to human health or the environment.

2.4.1 Summary of 1985 Physical Investigations

In 1985, the Laboratory received a Compliance Order from NMEID that addressed numerous waste management issues at the Laboratory (NMEID 1985, 075885, pp. 1–9). An investigation in and around MDA G was performed and focused on six tasks outlined in the 1985 Compliance Order. The results and outcomes of these six tasks are described in a hydrogeologic assessment of Areas G and L in TA-54 (IT Corporation 1987, 076068, pp. 6-2–6-7).

2.4.2 Summary of Phase I RFI

In 1993, 1994, and 1995, ambient-air, channel-sediment, surface-flux, and subsurface-core samples were collected at MDA G during a Phase I RFI. In addition, pore-gas samples have been collected since 1985. The results of these previous investigations are summarized in the historical investigation report of the approved work plan for MDA G (LANL 2004, 087833, Appendix B, pp. B-5–B-18) and included in Appendix B, section B-2.0 of this CME report. The key findings from these studies are summarized below:

- In channel sediments, cadmium, tritium, plutonium-238, plutonium-239, and americium-241 were detected above background values (BVs). These results indicated that migration of contaminants from Area G via surface flow and sediment transport may have occurred.
- In ambient-air samples, elevated levels of tritium, plutonium-238, plutonium-239, and americium-241 were detected during routine monitoring in 2002. These results showed potential transport of contaminants via air dispersion and wind.
- Surface-flux measurements for vapors were taken at several locations across the mesa top and sides at Area G. Vapor fluxes for tritium and several volatile organic compounds (VOCs) were observed (e.g., 1,1,1-trichloroethane [TCA], trichloroethene [TCE], perchloroethene [PCE], and Freon). These results indicated diffusion of subsurface vapors releasing to the atmosphere.
- A total of 125 borehole soil and tuff samples were collected in 19 boreholes over depths of approximately 38.5 to 150 ft bgs. Forty-three chemicals of potential concern (COPCs), including metals, radionuclides, PCBs, semivolatile organic compounds (SVOCs), and VOCs, were identified from these samples because either detections or detection limits exceeded BVs or the constituents were detected but had no BVs. Metals had very low frequencies of detection above BVs, suggesting limited mobility in the subsurface. Most radionuclides had very low frequencies of detection (2 or fewer), suggesting limited mobility in the subsurface. Tritium was detected above BV in most samples; Americium-241 and uranium-235 had multiple detections. Detections of PCBs, SVOCs, and VOCs were also infrequent and sporadic. The interpretation of these data indicates limited mobility by liquid-phase transport away from the disposal units.
- Pore-gas monitoring data for MDA G indicate that VOCs and tritium are present in pore gas. Trichloroethane was the dominant VOC detected. Pore-gas data indicate that VOCs and tritium had been released into the tuff beneath the disposal units (LANL 2005, 090513, p. 4).

2.4.3 Summary of Consent Order Investigations

Two investigations were conducted under the Consent Order at MDA G: a 2005 site investigation (LANL 2005, 090513) and a 2007 supplemental investigation (LANL 2007, 096110).

2.4.3.1 2005 Site Investigation

Field investigations conducted in 2005 at MDA G under the Consent Order are reported in the MDA G IR (LANL 2005, 090513) and summarized in Appendix B, section B-3.1 of this CME report. Under this investigation, 39 boreholes were drilled in accordance with the approved MDA G work plan (LANL 2004, 087833). These boreholes were drilled and sampled to characterize underlying stratigraphy (37 of the 39 boreholes) or to determine whether perched water was present (2 of the 39 boreholes). Core samples in and adjacent to fractures were collected and analyzed for target analytes. In addition, a risk assessment was conducted that concluded surface and subsurface contamination did not pose an unacceptable risk to human health and the environment based on current site use.

The soil and rock sample results indicated a number of inorganic and organic chemicals were detected at trace levels beneath the former disposal units and were consistent with the results obtained during the Phase I RFI. All inorganic chemicals detected above BVs during the 2005 study were generally less than five times the BV. In addition, all inorganic chemicals detected at levels greater than BVs were in samples from intervals containing clay-filled fractures and were at levels less than the soil BV, which was considered to be a more representative metric for comparison (LANL 2005, 090513). The interpretation of these results indicates little if any migration of metals and other inorganic chemicals from the disposal units.

The only organic compounds detected in core samples were trace levels of several dioxin and furan congeners. Pore-gas sampling was also conducted under the 2005 investigation. After drilling activities concluded, pore-gas samples were collected at the depth of the nearest adjacent disposal unit and at total depth (TD). Results confirmed the presence of VOCs, consisting primarily of chlorinated VOCs, in the vadose zone beneath MDA G. The dominant subsurface vapor contaminant was TCA. Tritium was also detected in pore gas. The highest tritium concentrations were detected in samples from locations in the eastern and south-central portions of MDA G.

Ambient air was sampled in and beneath structures within and adjacent to MDA L during 2004 to determine the impact of vapor intrusion into buildings (LANL 2005, 092591, Appendix K). Multiple analytes were measured in the samples. All concentrations for individual analytes were below the American Conference of Governmental Industrial Hygienists threshold limit values (TLVs) and the Occupational Safety and Health Administration permissible exposure limits (PELs). Many of the analytes detected in the samples have similar toxicological properties; therefore, the additive effect of the analyte mixture was also considered. No TLVs or PELs were exceeded for mixed samples (LANL 2005, 092591). Because subsurface vapor-phase VOC concentrations at MDA L exceed those at MDA G, the results from the MDA L analysis represent a conservative estimate of potential vapor intrusion at MDA G.

Naturally occurring and anthropogenic radionuclides were confirmed at levels above BVs in soil and rock samples collected beneath MDA G. The anthropogenic radionuclides detected sporadically across the site included americium-241, plutonium-238, plutonium-239, and strontium-90.

Subsurface samples collected to a depth of 700 ft (210 m) beneath the MDA G subsurface units did not identify perched water zones.

2.4.3.2 2007 Supplemental Site Investigation

Field investigations conducted in 2007 at MDA G under the Consent Order are reported in the addendum to the MDA G IR (LANL 2007, 096110) and summarized in Appendix B, section B-3.2 of this CME report. Four boreholes were extended to define the vertical extent of VOC pore-gas contamination. Validated analytical results collected during pore-gas monitoring of these boreholes confirm the presence of VOCs and tritium in vapor samples. The addendum concluded that the additional data supported the risk assessment presented in the 2005 IR that the site did not pose a potential unacceptable risk to human health or the environment. The vertical distribution of VOC and tritium concentrations indicated no current threat of groundwater contamination, but the fiscal year 2007 periodic monitoring report (LANL 2007, 101771) recommended future pore-gas monitoring. The pore-gas sampling data supported the adequacy of the existing subsurface vapor-monitoring network to track contaminants in pore gas (LANL 2007, 101771).

2.4.4 Summary of SVE Pilot Studies

NMED requested that the Laboratory conduct pilot tests to determine the effectiveness of SVE to remove VOCs from the vadose zone (NMED 2007, 098446). Two active in situ SVE pilot studies have been conducted at MDA G to evaluate the effectiveness of SVE technology for remediating the subsurface VOC vapor plumes and to provide design, operational, and cost information necessary for evaluating SVE as a remedial alternative during the CME. The first study was conducted during the summer of 2008; the second study was conducted in the spring of 2010.

The 2008 SVE pilot study was conducted adjacent to the disposal shaft field located west of Building 54-0412 (Figures 2.4-1 and 2.4-2) and included a shallow active extraction test, a deep active extraction test, and a passive monitoring period. Results of the 2008 SVE pilot study determined that active SVE is a viable technology for removing vapor-phase VOCs from the subsurface at MDA G. Approximately 278 lb (126 kg) of VOCs was removed from the Tshirege Member during the 30-d active shallow-extraction phase of the pilot study, with TCA making up approximately 75% of the recovered VOC mass. Using data collected from the pilot study, the two-dimensional numerical analysis estimated the radii of influence (ROIs) to be approximately 150 ft (45 m) for the shallow-extraction interval and approximately 50 ft (15 m) for the deep-extraction interval.

At the direction of NMED (NMED 2009, 107044), a supplemental SVE pilot study was conducted at MDA G at the same location as the 2008 SVE pilot study (Figure 2.4-3). The objectives of the supplemental pilot study were (1) to determine the capabilities and optimal design for a full-scale active SVE system at MDA G and (2) to further demonstrate that active SVE has the potential to be an effective part of remediation of hazardous constituents at MDA G. The 2010 SVE pilot test was designed to target the permeable zones identified in the Tshirege Member of the Bandelier Tuff, the contacts between the stratigraphic units, and any permeable layers in the geologic column. It was also designed to assess the ability of major stratigraphic units, such as the Cerro Toledo unit and Otowi Member, to act as either a barrier to contaminant migration or as an effective extraction interval. Results and conclusions of the pilot study are detailed in “Report for Supplemental Soil-Vapor Extraction Pilot Test at Material Disposal Area G, Technical Area 54” (LANL 2010, 109657).

The results of the 2010 SVE pilot test further demonstrated that active SVE has the potential be an effective remedial technology for removing VOCs from the subsurface at MDA G. Discrete permeability values measured during the pilot study were within the ranges of values considered feasible for implementation of SVE. Similarly, the pressure responses measured during the step tests indicated an ROI large enough for SVE to be implementable and cost effective at the MDA G site, depending on cleanup levels. The tests further show that an effective ROI can be achieved using vacuums and air-flow rates achievable with equipment typically used for SVE, although safety considerations associated with use of higher vacuums than previously tested would need to be addressed.

2.4.5 Status of Pore-Gas Monitoring

Pore-gas monitoring activities have been conducted at MDA G since 1985 to characterize VOC and tritium concentrations present in the vadose zone beneath MDA G. Quarterly pore-gas monitoring began in 1990 after EPA issued Module VIII of the Laboratory’s HWFP, which included requirements for quarterly pore-gas sampling at MDA G 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 monitoring activities are implemented annually in accordance with the revised long-term vapor-monitoring plan, provided as part of the MDA G CME Plan (LANL 2007, 098608), and a subsequent table of revised pore-gas monitoring locations, approved by NMED (Shen 2008, 103907).

Pore-gas monitoring activities at MDA G currently include field screening 121 completed sampling ports in 20 pore-gas monitoring boreholes and 1 open borehole. VOC and tritium samples are collected from 41 sampling ports within each of the 20 completed boreholes and from the open borehole. Pore-gas monitoring borehole locations are presented in Table 2.4-1 and shown in Figure 2.4-4.

VOC and tritium samples are collected from sampling ports within each monitoring borehole corresponding to the greatest depth of the adjacent disposal unit, and from the TD of the borehole.

Because sampling methods and resulting data quality have changed substantially over the years, pore-gas data before 1996 were not subject to the current quality assurance/quality control (QA/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 G have shown that VOCs are the primary RCRA-regulated vapor-phase constituents in the subsurface at MDA G. The nature and extent of the VOCs are discussed in section 3.2.4 and Appendix C.

2.4.6 Summary of Canyons Investigations

Sediment, surface water, and groundwater data are collected as part of the canyons investigations. These data are very useful at helping determine whether SWMUs (particularly those with outfall/mesa slope aspects) have contamination or release histories that manifest in the canyon floor and whether they are at levels that represent potentially unacceptable human-health risk or adverse ecological affects. These data are presented in canyons IRs. For MDA G, potential releases are discussed within this and previous documents (LANL 2005, 090513) that address nature and extent from the subsurface units that constitute MDA G.

The data from adjacent canyons, specifically Pajarito Canyon and Cañada del Buey, are used to address potential impacts from Area G (as distinguished from MDA G) on shallow surface media including sediment, surface water, alluvial groundwater, and biota. The possible impact of releases from Area G on sediment in Pajarito Canyon was evaluated using data collected from sediment investigation reaches upcanyon and downcanyon from Area G (LANL 2009, 106939). These sediment data indicate no potential impacts from Area G in canyon-bottom sediments. The spatial distribution of COPCs indicates that TA-09, TA-18, and possibly TA-16 are the main sources of mobile contaminants in surface water and groundwater in Pajarito Canyon. Biota investigations for the segment of Pajarito Canyon adjacent to Area G also indicate no adverse affects.

The possible impact of releases from MDA G on sediment in Cañada del Buey was evaluated using data collected from several sediment investigation reaches upcanyon and downcanyon from MDA G (LANL 2009, 107497). Based on their spatial distribution, MDA G is a potential source for several COPCs in Cañada del Buey sediment, including low levels of radionuclides, inorganic chemicals, and PCBs. In Cañada del Buey, the activities of americium-241, plutonium-238, and plutonium-239/240, as well as the concentrations of PCBs (specifically Aroclor-1248) are highest in upcanyon reaches from MDA G. The concentrations of several inorganic chemicals, including aluminum and antimony, have their highest concentrations in downcanyon reaches of MDA G. Concentrations of COPCs associated with MDA G decrease rapidly downcanyon from the upper reaches and are either not detected or are not present at concentrations above sediment BVs above NM 4 and White Rock. The absence of confirmed contaminants in the lower reaches indicates that contaminants released from MDA G have had little to no off-site impact and that MDA G is not a recognizable source of contaminants for White Rock or the Rio Grande. No alluvial groundwater is known to be present along the reaches adjacent to MDA G, and only occasional stormwater flow is present.

2.5 Status of Groundwater Monitoring

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 G. The monitoring well network at MDA G 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 2.3-3).

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 2.3-3). 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 2.5-1 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 G include wells R-21, R-22, R-23i, R-23, R-32, R-39, R-41, R-49, R-55, R-55i, R-56, and R-57. Table 2.5-2 shows the monitoring frequency and analyte suites specified for the active screens in these 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 G or other sources at TA-54 (LANL 2009, 106939). Further evaluation of existing groundwater data in the MDA G area is included in section 3.2.5 of this report.

The regional monitoring-well network downgradient of MDA G is a redundant system that is designed to provide reliable detection of potential contaminants reaching the regional aquifer. The wells are located both near the facility boundary and at more distal locations along the dominant regional flow direction as well as along potential local flow directions to the northeast. Because of the difficulties associated with monitoring groundwater in lavas beneath MDA G, the network is made up of two-screen wells with an upper well screen placed as close to the water table as possible to monitor the first arrival of contaminants in the aquifer and a lower screen placed in permeable aquifer sediments to monitor the primary groundwater pathways downgradient of the facility. The monitoring wells located immediately downgradient of MDA G (R-41, R-57, R-49, and R-39) are screened in sections of the regional aquifer that appear to be the best locations for monitoring potential contaminants; therefore, no additional monitoring wells are necessary to complete the network. The design of these wells includes at least one well screen that is placed in relatively high permeable sediments close to the regional water table (Appendix E, section E-2.1).

Hydrogeologic data also suggest that the screened regional-aquifer zones at the monitoring wells near MDA G are either unconfined or partially confined. This suggests that the upper well screens and the regional water table are potentially hydraulically connected. At R-41, the relatively low water level and the lack of cross-well pumping responses lead to uncertainties related to (1) the groundwater flow direction in the regional aquifer along the water table near R-41, and (2) the hydraulic connection of the deep

saturated zone tapped by R-41 with the rest of aquifer. Various hydrogeological conceptual models to explain the R-41 water-level data are discussed in Appendix E.

3.0 SITE CONDITIONS

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

3.1 Surface Conditions

Temporary structures to support ongoing waste management activities are present at Area G, including structures over many of the subsurface disposal units at MDA G. A very limited portion of the area is undisturbed. The surface of Area G consists of asphalt-paved roads and storage pads, graded roads, buildings, utilities, stormwater drainages, shaft caps, and vegetated pit and trench covers (Figure 3.1-1).

3.2 Subsurface Conditions

3.2.1 Subsurface Utilities

The location of subsurface utilities is shown in Figure 3.1-1. Utilities include electricity and communication lines, potable water, fire water, and sewer.

3.2.2 Disposal Pits

The disposal pits range in depth from 8 to 65 ft and are unlined (Table 2.1-1). After a pit was filled, it was covered with approximately 3 ft of crushed tuff and a nominal 4 in. of topsoil. Native grasses were seeded in the topsoil.

3.2.3 Disposal Shafts

The disposal shafts range in diameter from 1 to 8 ft and are up to 65 ft deep (Table 2.1-3). Shafts are lined or unlined, depending on the type of waste they contain. Typically, a shaft was filled with waste to within 3 ft of the ground surface. Once it was determined that a shaft would no longer receive waste, it was backfilled with crushed tuff and plugged with approximately 3 ft of concrete, slightly rounded at the surface to form a dome.

3.2.4 Nature and Extent of Vadose Zone Contaminants

Subsurface VOC vapor plumes are present in the vadose zone at MDA G. The sources of VOC vapors at MDA G are thought to be associated with mixed wastes disposed in the pits and shafts at the site, with VOCs being a component of the waste rather than a primary waste form. The VOCs are not expected to be present in the waste disposal units as solvents in a liquid phase. The source may be ongoing because VOC vapors are emanating from mixed wastes contained in drums or other containers that limit their rate of escape.

The VOC vapor plumes differ across the site in terms of the constituents and concentrations of VOCs of which they are composed (LANL 2010, 108496). An important aspect of vapor migration is that vapors are transported predominantly by vapor-phase diffusion throughout the Bandelier Tuff units; in the dry environment present at MDA G, 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).

A two-tiered-method screening evaluation was developed to identify vapor-phase VOCs that could potentially affect groundwater at concentrations exceeding applicable cleanup levels. The screening evaluation is described in Appendix C and summarized below.

- The Tier I screening 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 screening level is exceeded for a given VOC, the Tier II screen is applied. The Tier I screening method is consistent with screening performed in the pore-gas periodic monitoring reports.
- The Tier II method 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 tiered approach presented in Appendix C identified four VOC COPCs in these plumes, TCA, TCE, 1,1-dichlorethylene (1,1-DCE), and PCE. Further data analysis was performed on contaminant concentration data for these four VOCs, including spatial and temporal analyses. The analysis identifies three comingled plume areas across MDA G.

- An eastern plume is present near Pits 1 through 5 that has concentrations of TCA, TCE, 1,1-DCE, and PCE that exceed Tier II screening values. This area is considered to be an ongoing source for VOC vapors, although concentrations may be declining, because concentrations remain higher than the Tier II screening values some 40 to 50 yr after disposal units in this area were closed.
- A central plume is present near Pit 6 where concentrations of TCE exceed the Tier II screening value. This area is considered to be a potentially ongoing source of limited extent for TCE vapors.
- A western plume is present near Pits 29 and 33 where concentrations of TCE exceed its Tier II screening value and near Pit 29 where TCA exceeds its screening value. This area is considered to be a potentially ongoing source of limited extent for TCE and TCA vapors.

Appendix C provides present-day mass estimates for TCA and TCE of 211 kg and 79 kg, respectively, accounting for both vapor and liquid phases. Approximately 95% of the mass of the TCA and TCE in these three plumes is within the Tshirege Member of the Bandelier Tuff, and 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 C. Decreasing concentrations and masses are present in deeper units.

Inorganic chemicals, including metals, perchlorate, and nitrate, were disposed of at MDA G. These constituents migrate as waterborne constituents, and their transport is controlled by unsaturated water flow rates. As noted above, infiltration rates are low in the unsaturated zone beneath MDA G, generally less than 1 mm/yr. In addition, many metals adsorb onto mineral surfaces, causing them to migrate more slowly than the water phase. The sources of inorganic chemicals at MDA G are thought to be associated

with mixed wastes disposed in the pits and shafts at the site. Inorganic chemicals were detected during the Phase I RFI work (section 2.4.2) and the 2005 site investigation (section 2.4.3.1) in core samples collected beneath and adjacent to the base of disposal pits and shafts at MDA G. The two studies showed consistent results. All inorganic chemicals detected above BVs during the 2005 study were generally less than five times the BV. In addition, all inorganic chemicals detected at levels greater than BVs were in samples from intervals containing clay-filled fractures and were at levels less than the soil BV, which was considered to be a more representative metric for comparison (LANL 2005, 090513). These results indicate little, if any, migration of metals and other inorganic chemicals from the disposal units.

3.2.5 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 G on 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 G (Appendix D). The MDA G network wells include the following upgradient and downgradient regional wells: R-21, R-22, R-23, R-23i, R-32, R-38, R-39, R-41, R-49, R-55, R-55i, R-56, and R-57 (Figure 2.3-3). 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 most of these wells, with the exception of newly completed wells R-55, R-55i, R-56, and R-57, which are currently undergoing characterization sampling. For this report, data are available for two sampling events for R-55i and R-57, and for three events for R-55 and R-56.

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 QA/QC 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 G:

- Inorganic constituents in samples collected from active monitoring wells: total dissolved solids (at R-23), aluminum (at R-32), iron (at R-32), and manganese (at R-23, R-32, and R-55i)
- Inorganic constituents in samples collected from inactive screens in R-22 and R-32: iron (at R-22 screens 1, 2, 4, and 5, and R-32 screen 3), lead (R-22 screen 3), and manganese (at R-22 screens 1, 2, 3, 4, and 5, and R-32 screen 3)
- Organic constituents in samples collected from active monitoring wells: benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene (at R-55 screen 2), benzene (at R-38), and bis(2-ethylhexyl)phthalate (at R-23, R-32, and R-38)
- Organic constituents in samples collected from inactive screens in wells R-22: benzo(a)pyrene, benzo(b)fluoranthene, and pentachlorophenol (at R-22 screen 5); 4-methylphenol (at R-22 screen 4); and phenol (at R-22 screens 4 and 5)

The conditions under which these exceedances occurred are explained in Appendix D. The majority of the constituents listed above are associated with the first year of sampling following well completion or redevelopment, or with samples collected from screens that subsequently have been plugged and abandoned or rehabilitated. The organic constituents are not persistent after the first few rounds of sampling at a well, or they are detected only sporadically and near their respective detection limits. Well R-23 is located considerably downgradient of MDA G in Pajarito Canyon, and no exceedances of standards have occurred in wells closer to MDA G. Therefore, the results of the screening and evaluation conducted in Appendix D indicate that there is no compelling evidence that contaminants present in the vadose zone below MDA G have migrated to regional groundwater in wells downgradient of MDA G. 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 3.2.4. 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.

TA-54 monitoring network wells, including those specific to MDA G, will continue to be sampled on a quarterly basis, consistent with the 2010 IFGMP (LANL 2010, 109830). Additional monitoring of water levels and geochemistry will enhance the understanding of the relationship between organic contaminants and observations in groundwater.

4.0 CONCEPTUAL SITE MODEL FOR MDA G

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 G are shown pictorially in Figure 4.0-1. The MDA G CSM was used to support risk-based decision-making and as an aid in identifying potential remedial alternatives.

A schematic diagram of the CSM that displays the release mechanisms from the sources (the disposal pits and shafts) to potential receptors and the potential risk is shown in Figure 4.0-2.

The CSM diagram describes whether the exposure pathways are complete under current and future site conditions. The future scenario includes the removal of domes, utilities, and existing asphalt pads, as required by RCRA closure at the conclusion of all waste removal operations. The future scenario conservatively assumes that institutional controls are not maintained and no remedy is implemented. Current and future risks are also qualitatively evaluated for the purpose of the CME.

4.1 Primary Sources of Contamination

The primary sources of buried waste at MDA G are the disposal pits and shafts. Area G has been used as the Laboratory's primary radioactive disposal facility since 1957. Hazardous and mixed wastes were disposed of in pits and shafts at MDA G until 1990 (section 2.1). The hazardous constituents disposed of at MDA G included metals, inorganic chemicals, VOCs, SVOCs, asbestos, and PCBs. For the purposes of this CME report, the CSM is concerned with the transport and risks associated with the hazardous constituents.

4.2 Primary Release Mechanisms

Five primary release mechanisms for the waste from the pits and shafts are identified (Figure 4.0-2). These are (1) release of waste into subsurface soils by biointrusion and leaching, (2) volatilization of VOCs to become soil vapor, (3) excavation into the waste, (4) biointrusion, surface erosion, and subsidence 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.

Biointrusion into the waste has the potential to spread contaminants into subsurface soils or to the surface 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 (Tierney and Foxx 1987, 006669). Burrow depths for ants and small mammals are generally less than 3.3 ft (1 m), although a small fraction of burrows extend to 6.6 ft (2 m) (Tierney and Foxx 1987, 006669). The crushed tuff covering the pits and shafts is subject to biointrusion, and the rooting and burrow depths cited are similar to the estimated crushed tuff thickness that currently covers the pit waste at the site. Shallow rooting plants and animal burrows are present in unpaved areas of MDA G. Under current cover maintenance, the site is periodically mowed during the growing season, deeper-rooted plants (shrubs and trees) are removed, animal burrows are filled, and animal populations are controlled to minimize this pathway. Areas of the site that are currently covered with asphalt are less susceptible to biointrusion. Under the future conditions assumed in the CSM, which include removal of pavement and loss of cover maintenance, deeper-rooted plant communities and larger animal populations may be established.

Leaching of waste constituents into the subsurface soils beneath and adjacent to the pits and shafts potentially began during waste disposal. During disposal, open pits collected precipitation and runoff; therefore, leaching rates were probably elevated compared with rates following pit closure. Because the shafts were routinely covered during disposal, and they have a much smaller surface area, collection of precipitation and runoff was probably minimal during disposal. Following pit/shaft closure, leaching of contaminants by water that infiltrates into the disposal units continues. Leach rates in covered units are currently expected to be controlled by infiltration rates, which are estimated to be 10 mm/yr or less in disturbed or paved areas and less than 1 mm/yr in vegetated areas (section 2.3.4). Leach rates in paved areas will decrease following asphalt removal as part of RCRA closure. Investigation data indicate little if any migration of metals and other inorganic chemicals due to leaching from the disposal units (section 3.2.4. of this report and LANL 2005, 090513).

The source of VOC vapors in the subsurface at MDA G is thought to be associated with mixed wastes that have VOCs as a component of the waste rather than as a primary waste form. Volatilization of uncontainerized VOCs likely occurred predominantly into soil vapor during and soon after disposal in the pits and shafts. Volatilization from containers is believed to still occur in the pits and shafts because soil-vapor concentrations remain elevated, especially on the eastern end of MDA G (section 3.2.4). The source may still be ongoing because containers limit the rate at which vapors can escape into the surrounding fill. Volatilization of VOCs present in the waste will affect soil vapor located in fill material within the disposal units before diffusing further to subsurface soil vapor.

The third primary release mechanism is excavation, which would take place through the crushed tuff covering the pits and some shafts. However, shafts having a 3-ft concrete cover may be less susceptible to excavation. Exposure by excavation is a function of the volume and depth of waste excavated and will depend largely upon site access. Excavation into wastes is currently prohibited by site controls, but lack of these controls in the future may increase the potential for this release mechanism.

Erosion is another primary release mechanism that can expose waste. Rills and gullies sometimes form in the crushed tuff cover at the site. However, the interim cover currently has sufficient thickness to prevent waste exposure though erosion. In addition, as part of site maintenance, the interim cover is repaired if affected by erosion. Much of the site is currently covered with asphalt, which limits erosion in those areas. In the future, without site controls, erosion could degrade the cover. For the most part, surface erosion will result in a gradual thinning of the crushed tuff cover 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; French et al. 2008, 106890).

Subsidence of the waste within the disposal units has the potential to expose wastes. Evidence of waste settling has been observed at the site and repaired as part of cover maintenance, although waste exposure due to subsidence has not occurred. In the future without site controls, subsidence will have greater potential to expose waste.

Exposure of the waste by cliff retreat is not currently observed, because the disposal units are set back from the mesa edge. Cliff retreat and seismic events are potential release mechanisms that may expose wastes over time (Appendix E).

4.3 Secondary Sources of Contamination

Two secondary sources, subsurface soils and soil vapor, are generated directly from primary release mechanisms (Figure 4.0-2). Direct release of waste from the pits and shafts to surface soils is not included as a secondary source because it is assumed that solid wastes were successfully disposed of into the disposal units rather than spilled and left at the surface. However, surface soils are included as a secondary source because migration of contaminants from subsurface soils to surface soils can occur through biointrusion, volatilization, excavation, erosion, and subsidence (via upward movement through the soil column).

4.4 Secondary Release Mechanisms

Several secondary release mechanisms can further spread contaminants from secondary sources toward potential receptors (Figure 4.0-2). For surface soils, these mechanisms are (1) stormwater runoff and erosion, (2) volatilization/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 and vapor diffusion of VOCs, (3) 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. Erosion, excavation, and biointrusion affect migration for contaminants mixed with surface and subsurface soils, much like the primary release mechanism for waste described above.

Currently, limited contaminant transport by stormwater runoff and erosion of surface soils may occur at MDA G. For example, perimeter soil sampling results in 2006 showed heavy metals below the regional statistical reference level (RSRL) in 478 out of 483 measurements; only zinc and antimony exceeded the RSRL, each in a single sample, and their concentrations were below industrial and occupational screening limits. These pathways are more likely to be complete in unpaved areas than in paved areas because pavement prevents migration of surface soils. These pathways will become even more viable after asphalt is removed and if cover maintenance is stopped.

Volatilization and vapor diffusion of VOCs can occur in both surface soils and in subsurface soils with subsequent migration in soil vapor. VOCs in 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 within Mesita del Buey. 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 2.4.2). 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 (Appendix C). In addition, air flow within the basalt may also contribute to migration of vapor-phase VOCs.

Vapor-phase VOCs originating from the pits and shafts are spread in soil vapor in the vadose zone; pore-gas data indicate VOC plumes from the surface to depths of approximately 200 to 250 ft (Appendix C). There appear to be three main plumes: an eastern plume near Pits 1 through 5, a central plume near Pit 6, and a western plume near Pits 29 and 33 (section 3.2.4 and Appendix C). Surface-flux measurements showed releases of contaminants to the surface across the site, with the greatest fluxes measured at the eastern side of MDA G (Trujillo et al. 1998, 058242). Vapor-phase diffusion from the pits and shafts impacts air and may potentially impact regional groundwater in the future. The future impact to groundwater is not known because of uncertainty related to vapor transport in the basalt.

Leaching of contaminants from the disposal units and downward migration by percolating water will continue at a slow rate because of infiltrating water at the site, as discussed in section 4.2. Travel times due to 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, assuming uniform groundwater flow in the subsurface (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. Absorbing constituents, like metals, have longer travel times than adsorbing constituents. Both vadose zone and regional groundwater data indicate that this release mechanism to groundwater is currently incomplete for both inorganic and organic chemicals.

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 (Figure 4.0-2).

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 if pathways are complete through exposure routes such as inhalation,

ingestion, or dermal contact. The air pathway from surface soils includes releases both to outside air and 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 and in the CSM (Figure 4.0-2). The future risk scenario includes removal of buildings, domes, and the existing asphalt pavement that covers some of the disposal units, and the loss of institutional controls.

Under current conditions, several transport pathways are considered to be complete or potentially complete.

- Based on field data, the stormwater runoff, erosion of surface soil/sediment, and wind pathways are complete. The risk from exposure is very low because current surface and subsurface contaminant levels do not pose an unacceptable risk to human health (LANL 2005, 090513; LANL 2007, 098644).
- The air pathway (volatilization/vapor diffusion) is complete for VOCs. However, based on the low vapor fluxes emitted at the surface (Trujillo et al. 1998, 058242) and a low risk from exposure to ambient air (LANL 2005, 090513), the current risk from exposure, including vapor intrusion into buildings, is very low.
- The completeness of the biointrusion pathway differs with depth because density of plant roots and animal burrows decreases with depth (section 4.2). It is considered to be complete for surface soils and potentially complete for subsurface soils and wastes. Site maintenance, such as mowing, removal of deeper-rooting plants, and pest control, minimizes biointrusion, which helps to keep the risk from exposure very low. The thickness of the interim cover helps to minimize exposure.
- The excavation pathway is considered to be potentially complete for site workers for surface soils and subsurface soils. However, excavation directly into the waste is considered to be an incomplete pathway because of current site controls. The risk from exposure is very low because of site maintenance and operational controls. For the general public, the excavation pathway is not complete.
- Erosion and subsidence directly into the waste are potentially complete pathways based on the development of erosional rills and gullies and site settling. The thickness of the interim cover and cover maintenance help to minimize exposure. Exposure risk is considered to be very low.
- The vapor transport pathway to groundwater from volatilization of shaft and pit waste is potentially complete, but the current risk to the groundwater resource itself is considered to be very low. There is uncertainty related to vapor transport mechanisms through the Cerros del Rio basalt to groundwater. In addition, the vapor and groundwater data do not clearly indicate a release of VOCs from MDA G to the groundwater (Appendix C).
- All other pathways (leaching and diffusion/volatilization of contamination in subsurface soils to groundwater and cliff retreat/seismic events) are currently considered to be incomplete.

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

- Stormwater runoff and erosion of surface soil/sediment remain complete pathways. In the future, sediment and surface-water concentrations may increase after removal of the buildings, site covers, and pavement, resulting in a low future risk from exposure.
- The air pathway (volatilization/vapor diffusion) remains complete for VOCs. Air concentrations in the future may increase after removal of the asphalt covers and pavement at the site, elevating the risk from exposure to outside air from very low (the current risk) to low. Decontamination and decommissioning (D&D) of all structures during preclosure of MDA G will limit potential future vapor intrusion into buildings.
- Wind remains a complete pathway for exposure to dust. The future risk of this pathway is considered to increase from very low to low because surface-soil concentrations may increase without site controls.
- The potential for excavation into surface soils, subsurface soils, and waste increases in the future if people inadvertently enter the site. Exposure risks range from low/medium for surface soils to medium for subsurface soils and waste because concentrations closer to the waste are assumed to be higher. The assumed future medium exposure risk is based on uncertainty related to the inventory and concentrations of hazardous constituents in the waste.
- The completeness of the biointrusion pathway also differs with depth under future conditions because of the decreasing density of plant roots and animal burrows with depth. Under the future scenario, the pathway is considered to be complete for surface soils and subsurface soils, and potentially complete for wastes. The site is periodically mowed to reduce combustible loading when needed, but plants are generally left in place to limit erosion. Under the future conditions assumed in the CSM, which includes loss of cover maintenance, deeper-rooting plant communities and larger animal populations may be established. Exposure risks range from low/medium for surface soils to medium for subsurface soils and waste. The assumed future medium exposure risk is based on uncertainty related to the inventory and concentrations of hazardous constituents in the waste.
- Leaching of water-soluble contaminants from subsurface soils to groundwater is considered to be a potentially complete future pathway. However, completion of the pathway is expected to occur over a long time frame (e.g., several hundred to several thousand years), because of low infiltration rates across the mesa top, 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.
- Uncertainties are associated with transport of vapor-phase contaminants through the basalt; therefore, there are uncertainties about the potential of vapor-phase diffusion to impact groundwater in the future. For this reason, the future pathway is considered to be potentially complete. Vapor-phase concentrations of four VOCs (TCA, TCE, PCE, and 1,1-DCE) exceed the Laboratory-proposed Tier II screening value (Appendix C). Because of uncertainty associated with this pathway, it is ranked as a future very low to medium risk to the groundwater resource.
- The future human health and ecological receptor risks from exposure to contaminated groundwater (due to vapor-phase transport of contaminants to groundwater) are considered to be low. The groundwater exposure location for receptors is not likely to occur within the bounds of Area G. Therefore, the concentrations of any contaminants reaching groundwater in the future will decrease because of dilution, dispersion, and attenuation before reaching a groundwater well. It is unlikely that groundwater would be extracted from a location having significant VOC concentrations.

- Erosion and subsidence may result in a potentially complete pathway to the waste. 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.
- Exposure of waste from cliff retreat and seismic activities may result in a potentially complete pathway. The disposal units are located a minimum of 50 ft from the mesa edge and are not expected to be impacted by cliff retreat for more than 10,000 yr (Broxton and Eller 1995, 058207; Reneau and Raymond 1995, 054709, and Appendix E of this report), which results in a very low future risk from exposure.

4.7 Remedial Action Objectives

The remedial action objectives (RAOs) address exposure pathways with the potential for medium and high risk from exposure. Based on the CSM, the RAOs for MDA G 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; and
- 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.

The final RAO is defined to address uncertainty related to potential leachate production from the unlined pits and shafts at MDA G. 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.

5.0 CORRECTIVE ACTIONS AND CLOSURE REQUIREMENTS

The MDA G subsurface units are subject to a CME as outlined in the Consent Order. The LLW disposal units are subject to closure requirements under DOE Order 435.1, including long-term performance objectives for radiological protection of the public. DOE closure requirements for the LLW disposal units are addressed in Appendix F. The operating CSUs are subject to closure under the Laboratory's HWFP rather than corrective action under the Consent Order. As discussed in section 1.0 above, there are also regulated units at MDA G, which are a small subset of the MDA G SWMUs. The regulated units are subject to corrective action under the Consent Order pursuant to the alternative closure requirements in 40 CFR 264.110(c).The closure requirements for the permitted and interim-status aboveground CSUs and the regulated units are discussed below.

5.1 Permitted and Interim-Status Container Storage Units

The closure performance standards for the permitted and interim-status aboveground CSUs include minimizing the need for further maintenance, controlling any postclosure escape of hazardous waste or constituents to the extent necessary to protect human health and the environment, and complying with applicable regulatory standards.

There are nine permitted CSUs currently operating on the surface of Area G. They include seven large asphalt pads (Pads 1, 3, 5, 6, 9, 10, and 11) with storage domes and two buildings (54-8 and 54-33). These CSUs include both permitted and interim-status units, depending upon their operational dates, although all are incorporated in the HWFP and are therefore subject to the 40 CFR 264, Subpart G and I closure standards. These surface units must be closed before subsequent closure activities for the MDA G subsurface SWMUs and regulated units may be completed under the Consent Order. The proposed permit contains detailed closure plans for the surface units, including the removal of the storage structures and the asphalt pads, and sampling and analysis procedures for the underlying soil. If the remaining soil cannot be demonstrated to be decontaminated to the levels contained in the closure plans, further closure activities for these units may be coordinated with the closure activities undertaken for corrective action at MDA G by the Consent Order as described in the proposed permit.

5.2 Regulated Units and Solid Waste Management Units

Pit 29 and Shaft 124 are regulated units. Pit 29 is 600 ft long and 30 ft deep and received nonliquid waste. Shaft 124 is 6 ft in diameter and 65 ft deep and was used for disposal of solid radioactive wastes but included approximately 1 ft^3 of hazardous wastes made up of organic liquids and vials. Shafts 145 and 146 are interim-status container storage shafts. Shafts 145 and 146 are identical in construction, consisting of 6-ft-diameter shafts augured to a depth of 60 ft. The shafts served as containment systems for the containerized mixed waste stored in each shaft. As discussed in section 1.0 above, regulated units will be closed under alternative closure requirements established under the Consent Order rather than the closure requirements of 40 CFR 264 Subparts G and N. The alternative closure requirements will be established using the CME process for MDA G contained in Section VII.D of the Consent Order. Upon NMED's selection of the remedy for MDA G, the Laboratory will prepare and submit a corrective measures implementation (CMI) plan. The CMI plan will fulfill the requirements for a closure plan and postclosure plan for the regulated units, as specified in 40 CFR Part 264, Subparts G and N.

5.3 Media Cleanup Standards

The cleanup and screening levels described in Section VIII of the Consent Order (Table 5.3-1) were followed in this CME to determine the recommended corrective measures alternative. 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 that are described below.

5.3.1 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.

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

5.3.2 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 NMAC), and the 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) (Table 5.3-1). 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 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 the 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.

5.3.3 Surface Water

No permanent surface water is present at MDA G, and MDA G 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 G.

5.3.4 Pore Gas

The Consent Order does not specifically address cleanup standards, screening levels, or other regulatory criteria for pore gas. 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 G, 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 C-1.0-1, Appendix C).

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 C using recently reported soil-vapor monitoring data from MDA G. 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 should be performed.

- The Tier I screening 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 screening level is exceeded for a given VOC, the Tier II screen is applied. The Tier I screening method is consistent with screening performed in the pore-gas periodic monitoring reports.

- The Tier II method 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.

5.4 Toxic Substances Control Act

PCBs are managed under the TSCA. The TSCA gives the EPA the authority to develop, implement, and enforce regulations concerning the use, manufacture, cleanup, and disposal of PCBs.

5.5 Consent Order CME Requirements

The purpose of the CME is to identify and evaluate potential remedial alternatives for MDA G. 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 G 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 5.5.1 and 5.5.2. Figure 5.5-1 presents a flow chart of the selection process used to determine the recommended corrective measures alternative.

5.5.1 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 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.

5.5.2 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 G. 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 G 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/section1/list-of-tables.html.

For wastes disposed at MDA G, 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.

The majority of waste disposed at MDA G was LLW. Pre-1970 TRU and MLLW were disposed at MDA G, but extensive liquid hazardous waste was not disposed at MDA G. Although there is a vapor-phase VOC plume in the subsurface of MDA G, there is not a discrete source of liquid VOCs in the pits or shafts. The screening of technologies is focused on (1) containment, in situ treatment, excavation/retrieval, or ex situ treatment of the hazardous waste component of the MLLW in the pits and shafts and (2) in situ treatment of the VOC plume in the vadose zone.

6.2 Screening of Technologies

Corrective action guidance from EPA (1994, 095975, p. 58) and DOE (1993, 073487, pp. 4-51-4-52) requires that potential corrective measures technologies be screened 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 G 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 operations and maintenance (O&M) requirements 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 G 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 G 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 G. However, this technology has been demonstrated primarily with groundwater contamination and its applicability with 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 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 can 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 G 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 will otherwise be evaporated or transpired from the subsurface. Such trapped moisture could induce transport of contaminants to the groundwater. As maintaining low moisture content is a desirable feature for MDA G, 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 transport of contaminants to the groundwater. Additionally, because of the size of the cap required to cover the pits/impoundments and shafts, the potential exists for significant cracking, thus limiting its 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 protects only 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 G.

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 as 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 successfully used 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 G.

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 in 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 G. However, compacted clay layers can be incorporated into multilayer cover designs considered for MDA G.

Compacted clay cover technology was not retained.

Multilayer Cover (RCRA Cover)

This technology was evaluated even though the regulated units at MDA G 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 the 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 2003, 097902). 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 in this area was conducted by the Laboratory at a test site approximately 1 mi from MDA G (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 2.3-2). 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, 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 in order 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 G exceeds the Tier II screening limit, indicating that an active technology is preferred in order to reduce 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 G. 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 G 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.

Soil-Vapor Extraction

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 two SVE pilot studies conducted at MDA G in 2008 and 2010 (LANL 2009, 105112; LANL 2010, 109657) 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 likely, and where waste is near the surface and of a

homogeneous waste form (EPA 2002, 102739, p. 1). 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. Because of the heterogeneous nature of the waste at MDA G, 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 pits and shafts ranges from 8 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 boxes, drums, and cans, subsurface heating would not enhance the extractability of the source contaminants. VOCs are already readily extractable given the highly fractured subsurface where air readily travels through the mesa. Therefore, application of this technology at MDA G would provide minimal benefit.

Thermal treatment technologies were not retained.

6.2.3 Excavation/Retrieval Technologies

The potential for excavating/retrieving materials at MDA G 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

Excavation is the primary option for removing waste from the MDA G subsurface units. Waste in the larger disposal areas (i.e., pits) of MDA G would require large-scale soil moving and excavating equipment (remotely operated, if necessary), grappling devices, and containerization tools to safely remove the waste from the subsurface.

Trench excavation techniques are a viable option for removing some of the shaft waste at MDA G. The MDA G shafts could be accessed by excavating a large trench alongside the shafts, thereby making waste removal possible. This technology has already been used at MDA G to excavate trenches to a depth of 65 ft.

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 G extend to a depth of 65 ft, and there is significant uncertainty 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 G 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 be accomplished only 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. The older shafts are known to have not been containerized. Therefore, the safety hazards of working in the narrow shafts eliminate this technology as a viable technology for the shafts at MDA G.

Waste container retrieval technology was not retained.

6.2.4 Ex Situ Treatment Technologies

If excavated, MDA G waste materials and/or contaminated media will require characterization to determine whether the waste material meets the waste acceptance criteria (WAC) of the appropriate treatment, storage, and disposal 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 G 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 would require 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 the construction of a RCRA landfill. A new RCRA landfill would require 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. This delay impacts the Consent Order corrective action requirements.

An 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 treatment, storage, or disposal 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 removing waste or become a disposal unit).

A CAMU would require 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. This delay impacts the Consent Order corrective action requirements.

An 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, the Waste Isolation Pilot Plant (WIPP), Energy Solutions in Clive, Utah, and other approved facilities. The off-site disposal option is readily available and applicable to MDA G 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 G

Technologies considered applicable for MDA G 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 pits and shafts at MDA G:

- 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 G:

- Physical Treatment—SVE

6.3.3 Excavation/Retrieval Technologies

The following technology is suitable for removal of the waste in the pits and shafts at MDA G:

- Excavation

6.3.4 Waste Management and Disposal

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

- 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 were carried forward from section 6. The corrective measures alternatives are

- Alternative 1—No Action
- Alternative 2A—Multilayer Cover, SVE, and Institutional Controls
- Alternative 2B— ET Cover, SVE, and Institutional Controls
- Alternative 3—Excavation, SVE, and Institutional Controls

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

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

The Laboratory's TRU Waste Disposition Project will retrieve, characterize, package, and ship both the aboveground TRU and the retrievable belowground TRU waste. The aboveground TRU includes the waste in drums and fiberglass-reinforced plywood boxes that are currently stored throughout Area G in domes. The retrievable belowground TRU waste is located in: Pit 29 (corrugated metal pipes); Pit 9; Trenches A–D; Shafts 200−232 (33 shafts); Shafts 262−266 (tritium torpedoes); and Shafts 302−306 (hot cell liners). All waste operations are required to be completed before implementing the final remedy for MDA G.

Before implementing the final remedy, seven outdoor hazardous waste CSUs and two indoor CSUs must undergo closure per the Laboratory HWFP (Figure 7.1-1). The closure plan for each CSU is documented in the HWFP. The closure requirements include the removal of all hazardous waste residues and constituents, including the removal and disposition of CSU structures; review of the operating history and potential contamination assessments for all underlying storage pads; removal of the storage pads, plus 6 in. of the underlying soil/base course; and completion of the sampling and analysis plan developed for the closure. D&D may be performed for individual structures as necessary to support waste management consolidation or corrective action activities before initiating the final closure of a CSU. These D&D activities require a Class 1 permit modification with prior approval from NMED for structure removal.

- Pad 1 is an irregularly shaped asphalt pad that is approximately 358 ft long and 213 ft wide (approximately 76,000 ft^2). The pad currently has two existing structures associated with it: building 412, which is the Decontamination and Volume Reduction System (DVRS) facility, and the Mobile Visual Examination and Repackaging (MOVER) transportainer with support trailer. The DVRS is 60 ft × 220 ft (13,200 ft^2) and is used for storage and volume reduction of bulky mixed waste. The MOVER is a 10 × 40 ft transportainer unit that contains a glovebox used to visually examine and repackage the contents of high-activity TRU waste drums. Dome 226 was previously located on this pad but underwent D&D in October 2009. Building 412 and the MOVER will undergo D&D, and Pad 1 will undergo closure before the implementation of the final remedy for MDA G.
- Pad 3 is an asphalt pad that measures 339 ft long × 50 ft wide (approximately 17,000 ft^2). The pad currently has one structure associated with it, Dome 48, which is 50 ft × 285 ft (14,300 ft^2) and used for storage of hazardous waste in solid and liquid form. Dome 48 will undergo D&D, and Pad 3 will undergo closure before the implementation of the final remedy for MDA G.
- Pad 5 is a consolidated CSU. This CSU includes asphalt Pad 5, which measures 850 ft long × 224 ft wide (approximately 190,000 ft^2); Pad 7, measuring 200 ft long × 64 ft wide; and Pad 8, measuring 150 ft long × 95 ft wide. There are 10 structures associated with the permitted unit: 2 domes and 8 sheds. Storage Domes 49 and 224 and the sheds are used for the storage of hazardous waste. Dome 49 is 60 ft × 440 ft (26,400 ft^2), and Dome 224 is 60 ft × 110 ft (6600 ft^2). Storage sheds 144, 145, 146, and 177 are 30 ft^2, and storage sheds 1027, 1028, 1029, and 1041 are 207 ft^2, each a prefabricated steel structure. All structures will undergo D&D, and Pad 5 will undergo closure before the implementation of the final remedy for MDA G.

- Pad 6 is an asphalt pad that measures 633 ft long × 99 ft wide (approximately 62,700 ft^2). The two structures associated with the permitted unit, Domes 153 and 283, are each used for the storage of hazardous waste in both liquid and solid form. Dome 153 is 60 ft × 326 ft (19,600 ft^2), and Dome 283 is 60 ft by 260 ft (15,600 ft^2). All structures will undergo D&D, and Pad 6 will undergo closure before the implementation of the final remedy for MDA G.
- Pad 9 is an asphalt pad that measures 570 ft long × 275 ft wide (approximately 158,000 ft^2). There are four dome structures associated with the permitted unit used for the storage of hazardous waste in both liquid and solid form. Domes 229, 230, 231, and 232 are each 89 ft × 246 ft (22,000 ft^2). The domes will undergo D&D, and Pad 9 will undergo closure before the implementation of the final remedy for MDA G.
- Pad 10 is an asphalt pad that measures 350 ft long × 250 ft wide (approximately 89,600 ft^2). Transuranic waste characterization trailers are situated on the permitted unit, and hazardous waste containers are stored near or in the trailers for staging associated with the waste characterization. The hazardous waste storage activities involve the following structures: trailers 54-0438 and 54-0457 (which house the superhigh-efficiency neutron coincidence counter); trailer 54-0497 (which houses the real-time radiography system #2); trailers 54-0498 and 54-0506 (which house two high-efficiency neutron counters); trailers 54-0545, 54-0546, 54-0483, and 54-1059; trailer 54-0365 (office); and shed 54-XXX1 (the X's are part of the shed identifier). Trailers 54-0365, 54-0483, 54-1059, and shed 54-XXX1 have never stored hazardous waste. All structures will undergo D&D, and Pad 10 will undergo closure before the implementation of the final remedy for MDA G.
- Pad 11 is an asphalt pad that is approximately 478 ft long × 137 ft wide (approximately 65,500 ft^2). The pad currently has one structure associated with it, Dome 375, which is 100 ft × 300 ft (30,000 ft^2) and is used for storage of hazardous waste both in liquid and solid form. Dome 375 will undergo D&D, and Pad 11 will undergo closure before the implementation of the final remedy for MDA G.
- Storage shed 8 is an indoor hazardous waste CSU. The permitted unit is a steel-framed building with a concrete floor, which sits on a concrete supporting pad. The building is 40 ft × 16 ft (64 ft^2). Storage shed 8 will undergo closure (including D&D) before the implementation of the final remedy for MDA G.
- Building 33 is an indoor hazardous waste CSU. The permitted unit is a storage dome with an attached concrete-block building, both of which sit on a concrete pad. The dome is 50 ft × 157 ft (7,850 ft^2). The concrete block building is 40 ft × 34 ft (1,360 ft^2). Building 33 will undergo closure before the implementation of the final remedy for MDA G

If the sampling and analysis required by the closure plans reveal that residual hazardous waste constituents are present above decontamination verification levels in the soil beneath the pads, further closure activities will be implemented in coordination with the corrective action activities at Area G through alternative closure requirements contained in the HWFP. Other on-site structures not included in the permit, including transportainers and sheds, will undergo D&D before the final action for MDA G.

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 5.3. 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 measures alternatives for MDA G 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 migration of VOCs in 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, one multilayer cover (Appendix H) will be installed over MDA G (Figure 7.3-1). The area of the cover would be approximately 51 acres. The conceptual multilayer cover design (Figure 7.3-2) and construction consists of (from the ground surface to the top)

- site preparation of the existing soil surface, which includes 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% and 5%.

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

- Installation of 18 SVE boreholes (Figure 7.3-3), each to a depth of approximately 150 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 60 to 150 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA G to provide effective extraction of VOC vapors but where drilling access is not impeded by the disposal pits and shafts.
- Installation of six SVE boreholes (Figure 7.3-3) into the Cerro Toledo (Qct unit) to approximately 200 ft bgs. These boreholes will be screened within the Qct unit (180 to 200 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 further downward migration of VOC vapors in the vadose zone.

- Six portable, skid-mounted SVE units will be cycled between the extraction boreholes during operations. Each SVE unit will utilize a 15-horsepower (hp) blower motor, providing up to 200 standard cubic feet per minute (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 2.4.4). An additional two SVE units, similar to those described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction boreholes in the upper units are projected to provide a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft2 for each borehole. Extraction boreholes in the Qct unit are expected to provide a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft2. Borehole spacing will target the vapor plume areas but may be impacted by the inability to drill through the pits and shafts.

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 yr. 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 yr. Pore-gas monitoring will be performed to evaluate the performance of the SVE system. Maintenance activities will be performed to address erosion and 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 J. Because of the uncertainty associated with continuing releases of VOCs at the site, a long period of active SVE will be performed to remove as much VOC mass as possible. The opportunity will then be provided for VOC concentrations to rebound if a continuing release is present. Active SVE will be conducted at an extraction borehole for 90 d. After 90 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring at select pore-gas monitoring wells will be performed at the end of each 90-d operational period. 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 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 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, one ET cover (Appendix I) will be installed over MDA G (Figure 7.3-1). The area of the cover would be approximately 51 acres. The conceptual ET cover design (Figure 7.3-5) and construction consists of (from the ground surface to the top)

- 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.

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

- Installation of 18 SVE boreholes (Figure 7.3-3), each to a depth of approximately 150 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 60 to 150 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA G to provide effective extraction of VOC vapors but where drilling access is not impeded by the disposal pits and shafts.
- Installation of six SVE boreholes (Figure 7.3-3) into the Cerro Toledo (Qct unit) to approximately 200 ft bgs. These boreholes will be screened within the Qct unit (180 to 200 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 further downward migration of VOC vapors in the vadose zone.
- Six portable, skid-mounted SVE units will be cycled between the 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 2.4.4). An additional two SVE units, similar to those described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction boreholes in the upper units are projected to provide a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction boreholes in the Qct unit are expected to provide a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2. Borehole spacing will target the vapor plume areas but may be impacted by the inability to drill through the pits and shafts.

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 yr. 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 yr. 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 and 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 increasing erosion resistance by adding gravel surface amendments; enhancing or limiting plant growth and types for transpiration by varying depths of enriched soil; modifying the size of the ET reservoir layer above the waste layer by varying the depths of the primary crushed-tuff ET layer; or preventing 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 J. Because of the uncertainty associated with continuing releases of VOCs at the site, a long period of active SVE will be performed to remove as much VOC mass as possible. The opportunity will then be provided for VOC concentrations to rebound if a continuing release is present. Active SVE will be conducted at an extraction borehole for 90 d. After 90 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring at select pore-gas monitoring wells will be performed at the end of each 90-d operational period. 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 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.

7.3.3.2 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 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 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 3: Excavation, SVE, and Institutional Controls

Under this alternative, the shafts and the pits will be excavated. Excavation of the pits and shafts will be accomplished using standard excavation methods. However, the excavation will be performed within an enclosure to control releases and to provide weather protection for the excavation. The original units were excavated with nearly vertical side walls with an entry ramp on both sides. The remediation activities may employ the same manner of excavation, with nearly vertical slopes (1-ft horizontal to 6-ft vertical) (Figure 7.3-6). Portions of these excavations may be used to access the shaft excavations or as a staging area. The estimated volume of excavated materials is provided in Appendix G. Confirmatory sampling will be conducted to ensure that all contaminated material has been removed from the excavations.

Some waste may be classified as newly generated TRU waste. This waste was not included in the original permit of the WIPP facility, and a permit modification may be required for disposal at WIPP.

A summary of activities for excavation of the pits and shafts includes the following:

- construction of moveable excavation enclosures with supplied air and high-efficiency particulate air filters to control releases and for weather protection;
- 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 within the original excavation of any environmental media meeting industrial SSLs and then backfilling to grade; and
- off-site shipment and disposal of wastes that do not meet industrial SSLs.

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

- Installation of 18 SVE boreholes (Figure 7.3-3), each to a depth of approximately 150 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 60 to 150 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA G to provide effective extraction of VOC vapors but where drilling access is not impeded by the disposal pits and shafts.
- Installation of six SVE boreholes (Figure 7.3-3) into the Cerro Toledo (Qct unit) to approximately 200 ft bgs. These boreholes will be screened within the Qct unit (180 to 200 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 further downward migration of VOC vapors in the vadose zone.

- Six portable, skid-mounted SVE units will be cycled between the 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 2.4.4). An additional two SVE units, similar to those described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction boreholes in the upper units are projected to provide a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction boreholes in the Qct unit are expected to provide a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2. Borehole spacing will target the vapor plume areas but may be impacted by the inability to drill through the pits and shafts.

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.

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 180 d. After 180 d of extraction, the SVE system will be moved to another extraction borehole. Performance monitoring will provide important information on the effectiveness of the removal of the VOC plume and determine if additional SVE operation is needed.

7.3.4.1 Protection of Human Health and the Environment

Excavation of the pits and shafts will remove source material.

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.

7.3.4.2 Attainment of Media Cleanup Standards

Wastes will be excavated from the pits and shafts to a level that meets industrial SSLs. Investigative sampling has indicated that soil concentrations beneath the pits 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.

7.3.4.3 Control of Source and Releases

Excavation of the pits and shafts will remove source material.

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

This alternative eliminates 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.

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.

8.0 EVALUATION OF ALTERNATIVES AGAINST REMEDIAL ALTERNATIVE EVALUATION CRITERIA

Corrective measures alternatives appropriate for MDA G were screened against the Consent Order threshold criteria 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 G

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 relatively short time frame (i.e., approximately 2 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.

The risk of traffic accidents associated with the remedy is generally considered a function of total miles of travel for the project vehicles. Based on an average accident rate for large trucks of 2.3 fatal accidents per 100 million mi (DOT 2002, 097082, p. 2), or 2.3×10^{-8} fatal accidents per mi, and approximately 1.3 million truck transport miles (Appendix G) on public roads for delivery of project resources, the overall incident rate for fatal traffic accidents for the project would be less than 1.

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 $1,039,000. The capital cost for installation of the multilayer cover is estimated to be $58,723,000. Total capital costs for installation of the SVE and monitoring systems are estimated to be $2,357,000. Annual SVE operational and monitoring costs are estimated to be $1,600,000. The total O&M costs for SVE and the multilayer cover are estimated to be $6,739,000.

The indirect capital costs are estimated to be $130,825,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $6,819,000, which includes professional management and contingency.

The total PV cost is estimated to be $213,128,000 (Table 8.2-1). Assumptions and cost estimates are provided in Appendix G.

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. 2000, 069673; Dwyer 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 relatively short time frame (i.e., approximately 2 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 ET cover construction.

The risk of vehicle traffic accidents associated with implementation of the remedy is generally considered a function of total miles of travel for the project vehicles. Based on an average fatal accident rate per vehicle miles for large trucks of 2.3 fatal accidents per 100 million mi (DOT 2002, 097082, p. 2), and approximately 853,000 truck transport miles (Appendix G) on public roads for delivery of project resources, an overall incident rate for fatal traffic accidents for the project would be less than 1.

SVE equipment is commercially available and extraction boreholes can be constructed within a 6-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 $1,039,000. The capital cost for installation of the ET cover is estimated to be $ 52,561,000. Total capital costs for installation of the SVE and monitoring systems are estimated to be $2,357,000. Annual SVE operational and monitoring costs are estimated to be $1,600,000. The total O&M costs for SVE and the ET cover are estimated to be $6,739,000.

The indirect capital costs are estimated to be $113,371,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $6,819,000, which includes professional management and contingency.

The total PV cost is estimated to be $186,503,000 (Table 8.2-2). Assumptions and cost estimates are provided in Appendix G.

8.2.4 Alternative 3: Excavation, SVE, and Institutional Controls

This alternative is described in section 7.3.4.

8.2.4.1 Long-Term Reliability and Effectiveness

Removal of the waste in the pits 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 this uncertainty by restricting site access.

8.2.4.2 Reduction of Toxicity, Mobility, or Volume

The removal of waste in the pits 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.

8.2.4.3 Short-Term Effectiveness

Based on previous excavation projects at the Laboratory (e.g., MDA B and North Ancho Canyon), 220 yd^3 per d is the estimated productivity rate for waste excavation and removal from MDA G. At this rate, the excavation, segregation, analysis, treatment, and disposal activities will be completed over a 30-yr time frame using 250 work days per yr. Clean fill will be imported from TA-61, or other borrow pits, to backfill the excavation.

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. Excavation activities will be performed within enclosures to minimize short-term risks.

Potential accidents resulting from excavation and associated waste handling include industrial hazards/accidents, fires with release of hazardous materials, explosions and associated releases of radioactive materials, spills of hazardous and radioactive materials, inadvertent exposures to penetrating radiation, and transportation accidents.

The risk to the public from all activities, except potential fire and explosions and on-site/off-site transportation, is negligible. The risk of vehicle traffic accidents associated with implementation of the remedy is generally considered a function of total miles of travel for the project vehicles. Based on an average fatal accident rate per vehicle miles for large trucks of 2.3 fatal accidents per 100 million mi, (DOT 2002, 097082, p. 2), and approximately 162.5 million truck transport miles (Appendix G) on public roads, an overall incident rate for fatal traffic accidents for the project would be between 3 and 4 fatalities.

SVE equipment is commercially available and extraction boreholes can be constructed within a 6-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 the waste.

8.2.4.4 Implementability

The pits 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. Following excavation of waste, no maintenance is required.

One significant challenge of this alternative is ensuring the permitted off-site disposal facilities can receive all the various waste streams.

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 $1,039,000. The total capital costs for installation of the SVE and monitoring systems are estimated to be $1,994,000. The total capital costs for the excavation of the pits and shafts are estimated to be $8,993,000,000; of which $7,106,000,000 is estimated for disposal of waste materials.

Annual SVE operational and monitoring costs are estimated to be $1,600,000. A 3-yr O&M time frame is assumed for the SVE system for a total O&M cost of $4,800,000.

The indirect capital costs are estimated to be $17,735,000,000, which includes design of the alternative as well as professional management and contingency. Indirect O&M costs are estimated to be $5,218,000, which includes professional management and contingency.

The total PV cost is estimated to be $29,112,000,000 (Table 8.2-3). Assumptions and cost estimates are provided in Appendix G.

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 G. 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 G

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 3, 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.

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 2B, ET cover with SVE and institutional controls, is rated higher, 3, than Alternative 2A, multilayer cover with SVE and institutional controls, which is rated 2.

9.1.2 Reduction of Toxicity, Mobility, or Volume

Alternative 3, 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.

Each type of cover provides similar performance. Therefore, Alternatives 2A, multilayer cover with SVE and institutional controls, and 2B, ET cover with SVE and institutional controls, are rated equally, 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, including highway fatalities. For this reason, Alternative 3, excavation with SVE and institutional controls, is rated lowest (rating = 1 on a 1 to 5 scale).

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 with SVE and institutional controls, and 2B, ET cover 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 as 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. Because Alternative 3, excavation with SVE and institutional controls, includes excavation of all waste materials, it is rated the lowest, 1.

Since each type of cover has similar design and construction requirements shown to be implementable, Alternatives 2A, multilayer cover with SVE and institutional controls, and 2B, ET cover with SVE and institutional controls, are rated equally, 3.

9.1.5 Cost

Alternative 1, no action, has no cost, so it is rated the highest (rating = 5, on a1 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 the disposal of the waste. Because Alternative 3, excavation with SVE and institutional controls, includes excavation of all waste materials and has the highest cost, it is rated the lowest, 1.

Since each type of cover has similar cost requirements and excavation is not required, Alternatives 2A, multilayer cover with SVE and institutional controls, and 2B, ET cover with SVE and institutional controls, are rated equally, 3.

9.2 Selection of Recommended Corrective Measure

Based on the alternative evaluation, the recommended alternative for MDA G 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 pits 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 relatively short time frame (i.e., approximately 2 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 6-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 pits, 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 CSM is shown in Figure 9.2-1.

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 G. The design does not include the requirements for closing the LLW units as defined by DOE Order 435.1, which are described in Appendix F. The DOE Order 435.1 performance objectives may influence the final design of the ET cover by increasing the thickness of the various layers. However, the final design for the ET cover will satisfy both Consent Order and DOE Order 435.1 performance objectives.

The design process will include the following.

ET Cover

One ET cover will be installed over MDA G (Figure 7.3-1). The area of the cover will be approximately 51 acres. 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, with minimal slopes, 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

- 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 30-yr maintenance period 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 G soil based on design infiltration events identified above;

- identifying the seed mixture to be used and 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; and
- satisfying DOE Order 435.1 performance objectives.

SVE

The results and conclusions of the SVE pilot tests conducted at MDA G in 2008 and 2010 (LANL 2009, 105112; LANL 2010, 109657) determined that SVE is a viable technology for removing VOCs from the subsurface at MDA G. A conceptual SVE design (Appendix J) includes the following principal assumptions and components:

- Installation of 18 SVE boreholes (Figure 7.3-3), each to a depth of approximately 150 ft bgs within the lower reaches of unit Qbt 1g (Figure 7.3-4). The boreholes will be screened from 60 to 150 ft bgs, where the majority of the VOC mass is located. The boreholes will be spaced across MDA G to provide effective extraction of VOC vapors but where drilling access is not impeded by the disposal pits and shafts.
- Installation of six SVE boreholes (Figure 7.3-3) into the Cerro Toledo (Qct unit) to approximately 200 ft bgs. These boreholes will be screened within the Qct unit (180 to 200 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 further downward migration of VOC vapors in the vadose zone.
- Six portable, skid-mounted SVE units will be cycled between the 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 2.4.4). An additional two SVE units, similar to those described above, will be used to cycle between the extraction boreholes in the Qct unit.
- Extraction boreholes in the upper units are projected to provide a 125-ft ROI, providing an effective area of extraction of approximately 49,000 ft^2 for each borehole. Extraction boreholes in the Qct unit are expected to provide a 150-ft ROI, providing an effective area of extraction of approximately 70,650 ft^2. Borehole spacing will target the vapor plume areas but may be impacted by the inability to drill through the pits and shafts.

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 G 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 ET 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 G 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 discussion with NMED. Additional information and specifications for the surface treatment is provided in Appendix I.

10.2.2 Cover Soil

The performance of the ET cover relies on its thickness, materials, and placement. The ET cover for MDA G 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 I.

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 I.

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 I.

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 J.

10.3.1 Long-Term Monitoring Requirements

Groundwater monitoring of the regional aquifer will be conducted in accordance with requirements in the Laboratory's HWFP.

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

The coupled monitoring network for MDA G 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 the pits and 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 to keep Northern New Mexico stakeholders and other interested parties regularly informed of project activities and progress at MDA G.

11.0 SCHEDULE FOR COMPLETION OF ACTIVITIES

The Consent Order requires that a schedule for completion of activities be submitted in the CME report. Activities leading to completion of the remedy include planning, design, and construction of the ET cover and planning, design, installation, testing, and operation of the SVE system and monitoring systems. Several milestones for completion of the corrective measure at MDA G 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 implementation of the preferred remedy. 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 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. NMED will provide an opportunity for a public hearing that may extend the public comment period.
- Based upon the Laboratory's preferred remedy in the CME, the Laboratory will request to submit a CMI plan within 18 mo after NMED selects a final remedy. The 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 as necessary to NMED to perform D&D of existing structures for the aboveground CSUs.
- The aboveground CSUs will be closed, and retrievably stored TRU will be removed before the CMI plan is implemented.
- The corrective measure will be implemented and a remedy completion report submitted according to the schedule in the CMI plan. Following approval of the CMI plan, construction of the Laboratory's preferred remedy is expected to take 2 yr.
- Active SVE and pore-gas monitoring will occur as discussed in Appendix J.

- 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 HWFP.

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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Trujillo, V., R. Gilkeson, M. Morgenstern, and D. Krier, June 1998. "Measurement of Surface Emission Flux Rates for Volatile Organic Compounds at Technical Area 54," Los Alamos National Laboratory report LA-13329, Los Alamos, New Mexico. (Trujillo et al. 1998, 058242)

Wilson, C.J., K.J. Crowell, and L.J. Lane, September 2005. "Surface Erosion Modeling for the Repository Waste Cover at Los Alamos National Laboratory Technical Area 54, Material Disposal Area G," Los Alamos National Laboratory document LA-UR-05-7771, Los Alamos, New Mexico. (Wilson et al. 2005, 092034)

12.2 Map Data Sources

Hypsography, 20- and 100-ft 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

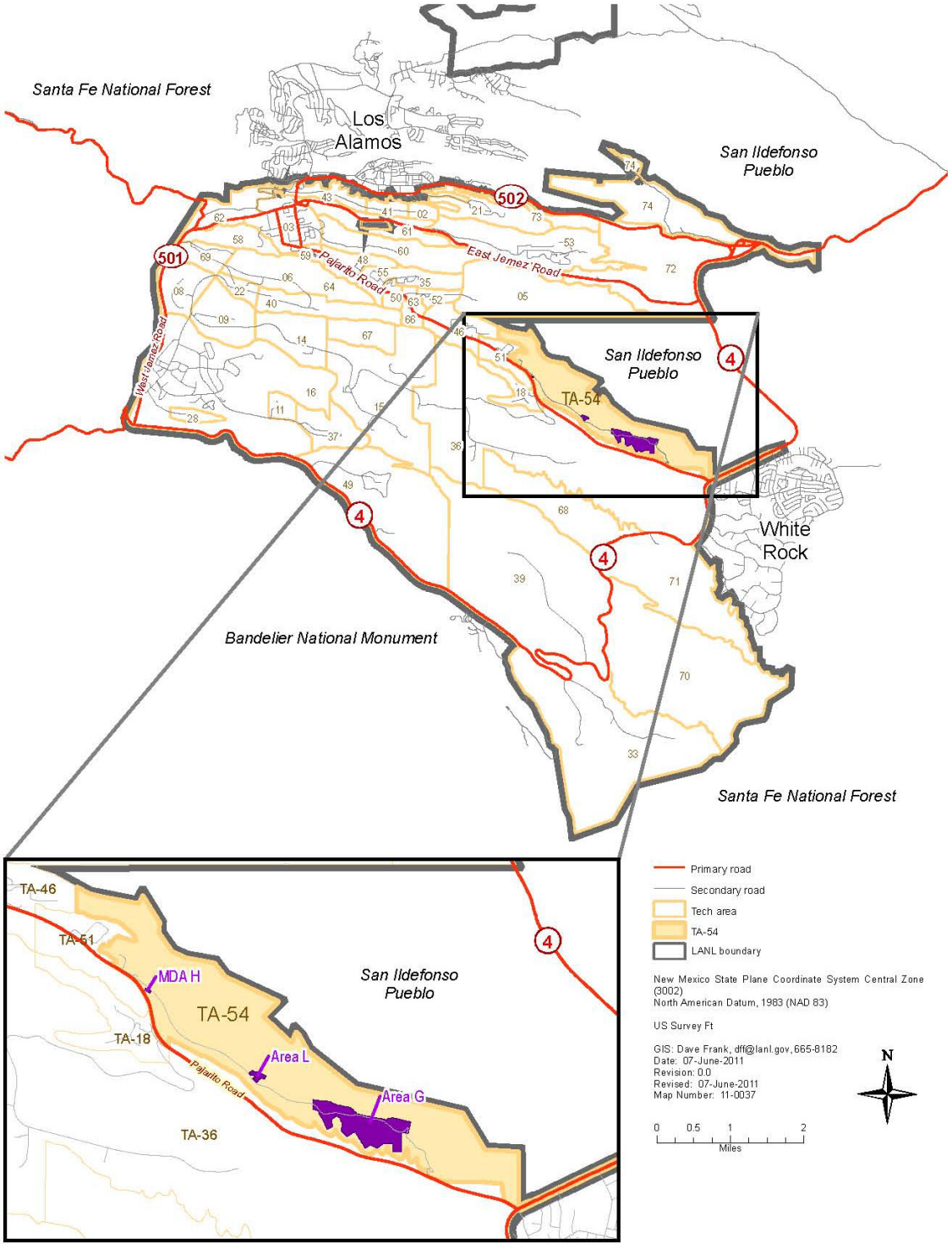


Figure 1.0-1 Location of Area G in TA-54 with respect to Laboratory TAs and surrounding landholdings

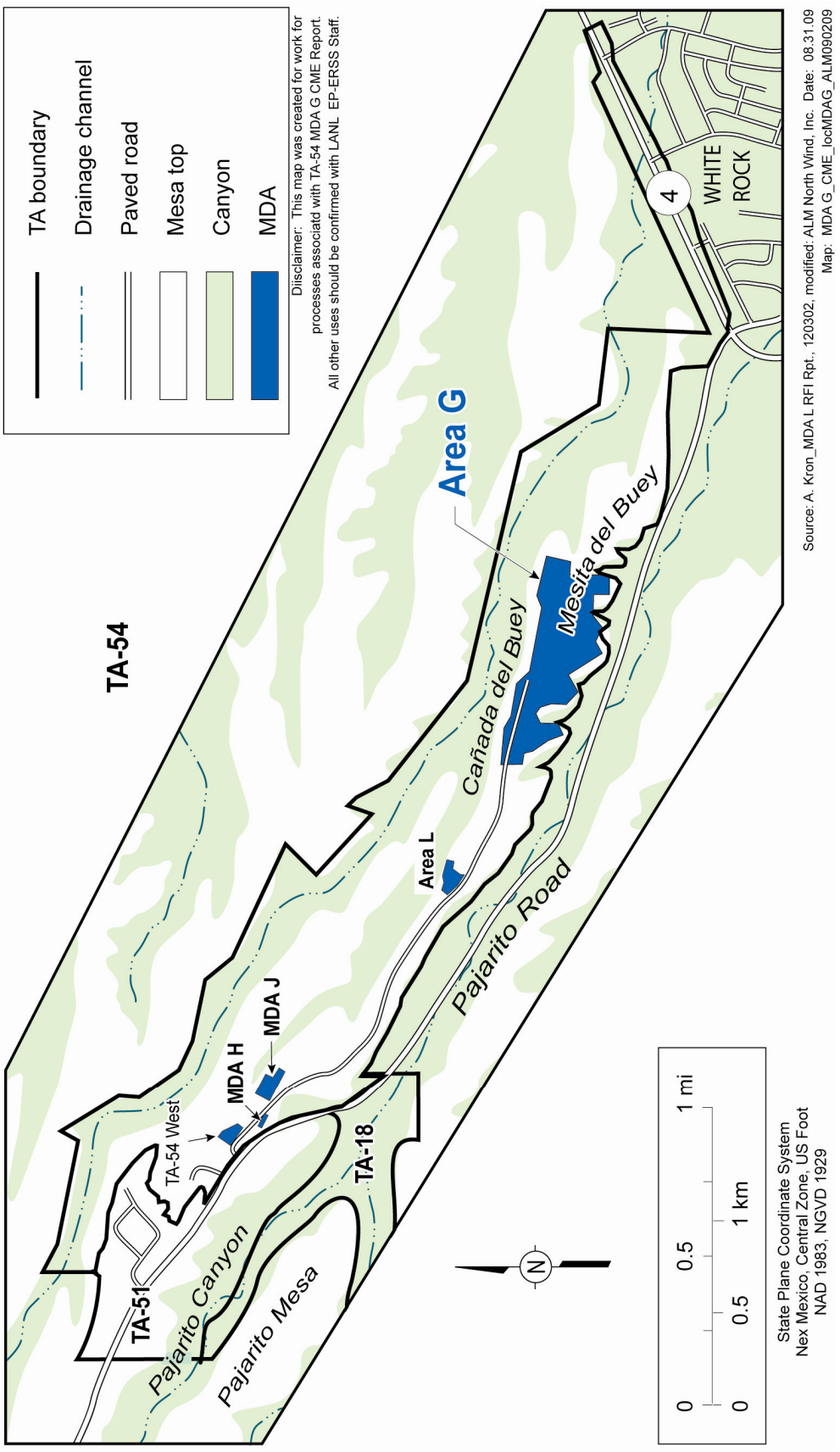


Figure 1.0-2 Location of Area G in TA-54

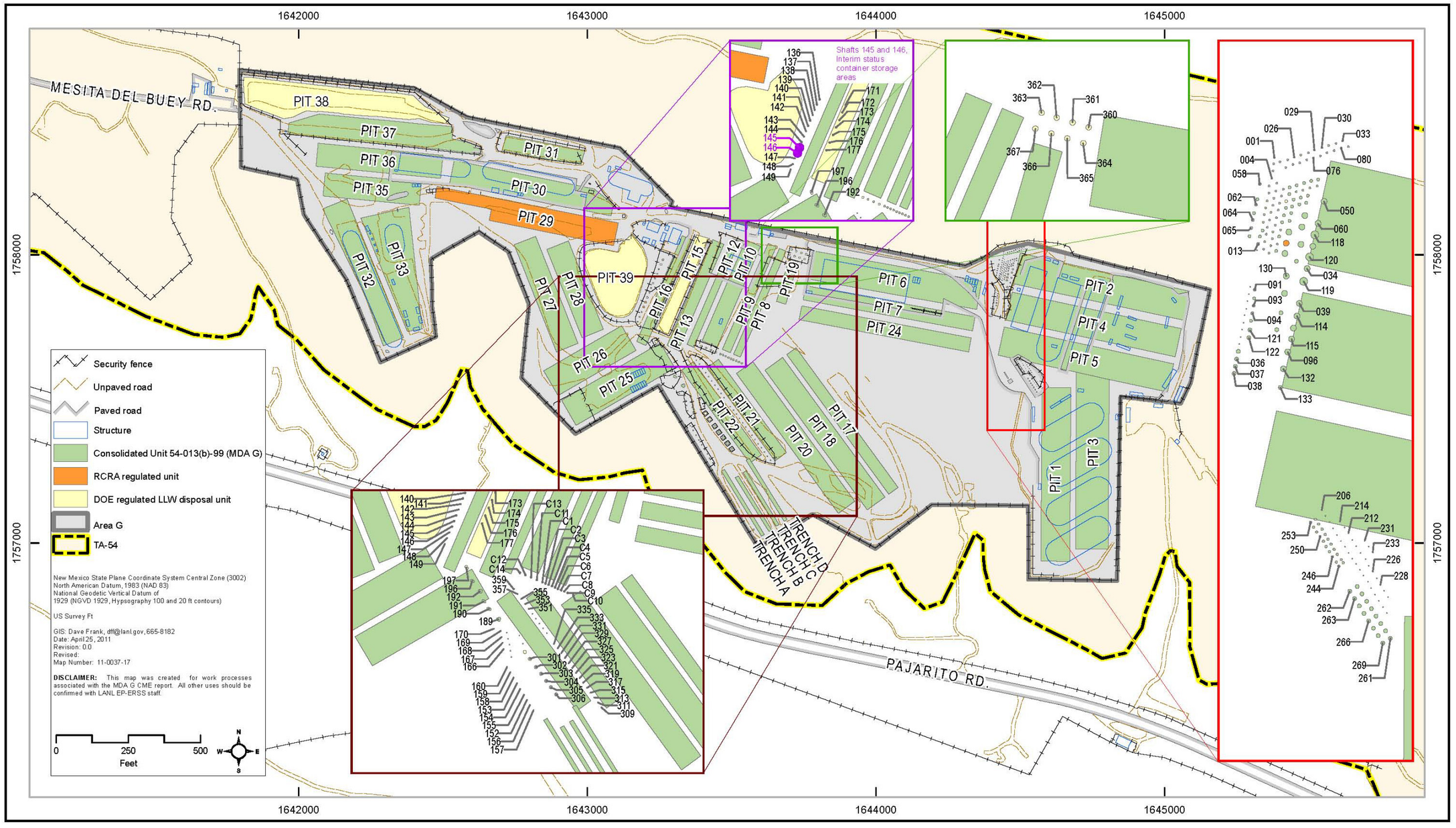


Figure 1.0-3 Area G waste disposal units

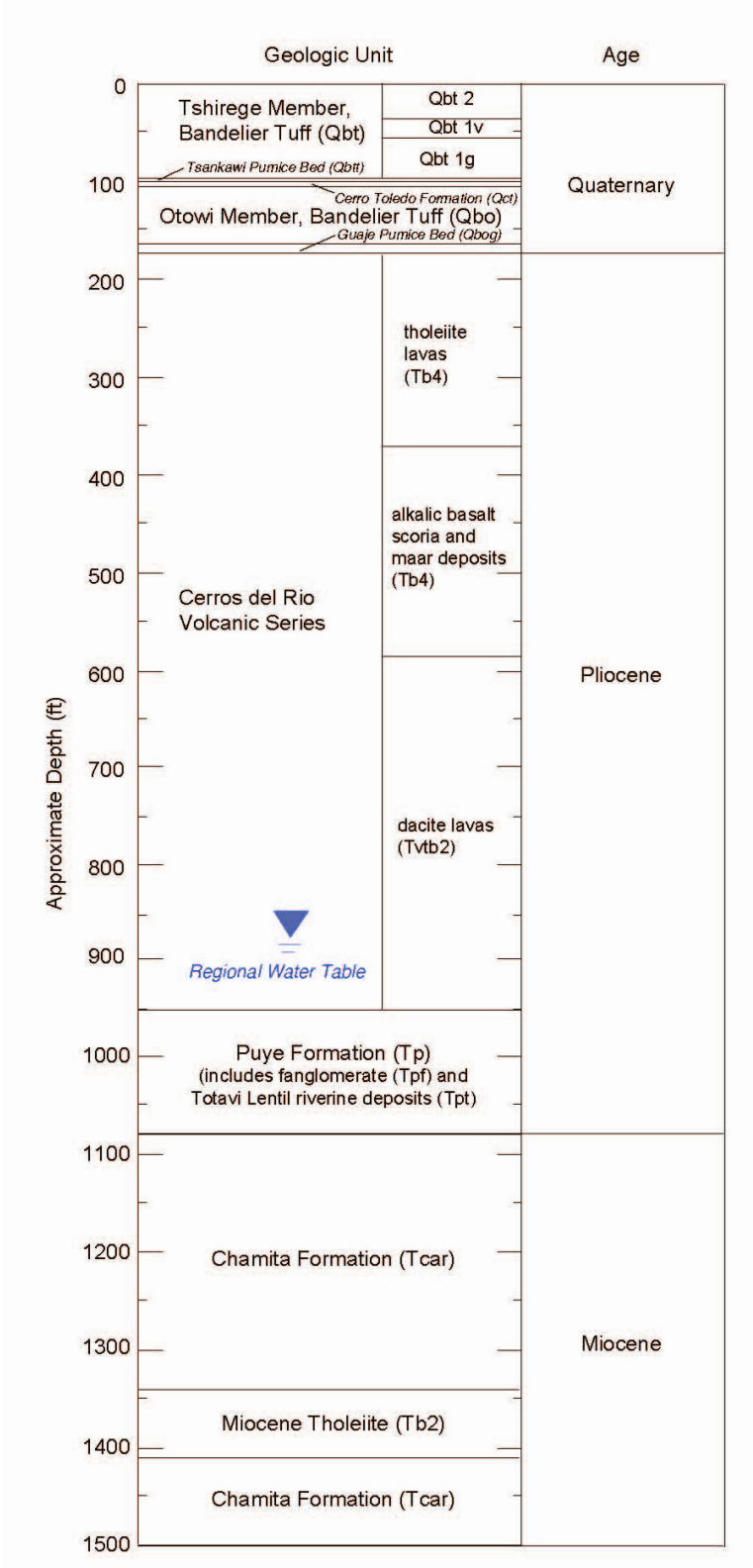


Figure 2.3-1 Generalized stratigraphic column for MDA G. Approximate depths to geologic contacts are shown for the east end of MDA G.

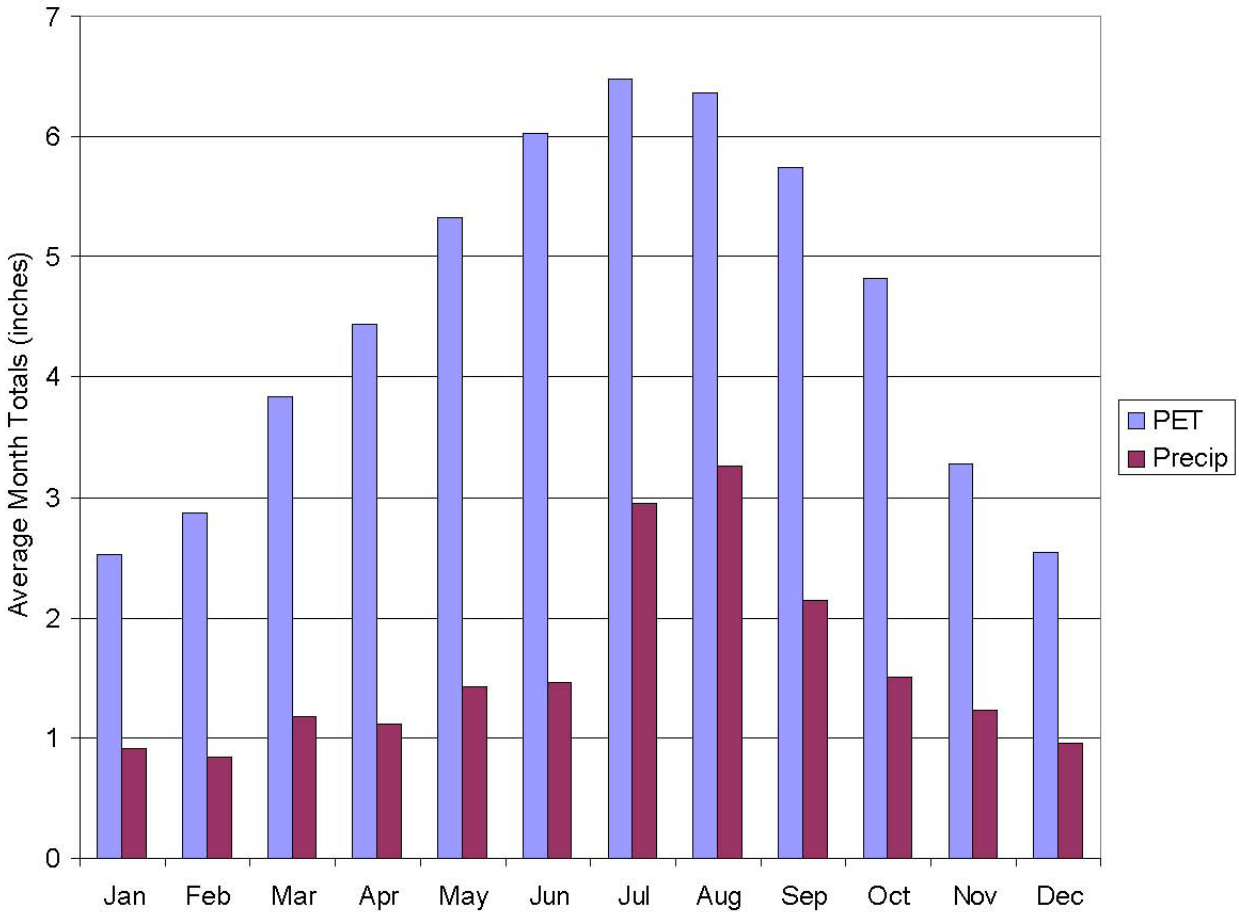


Figure 2.3-2 Climate's demand for water (potential evapotranspiration [PET]) versus supply of water (precipitation) for Los Alamos, New Mexico

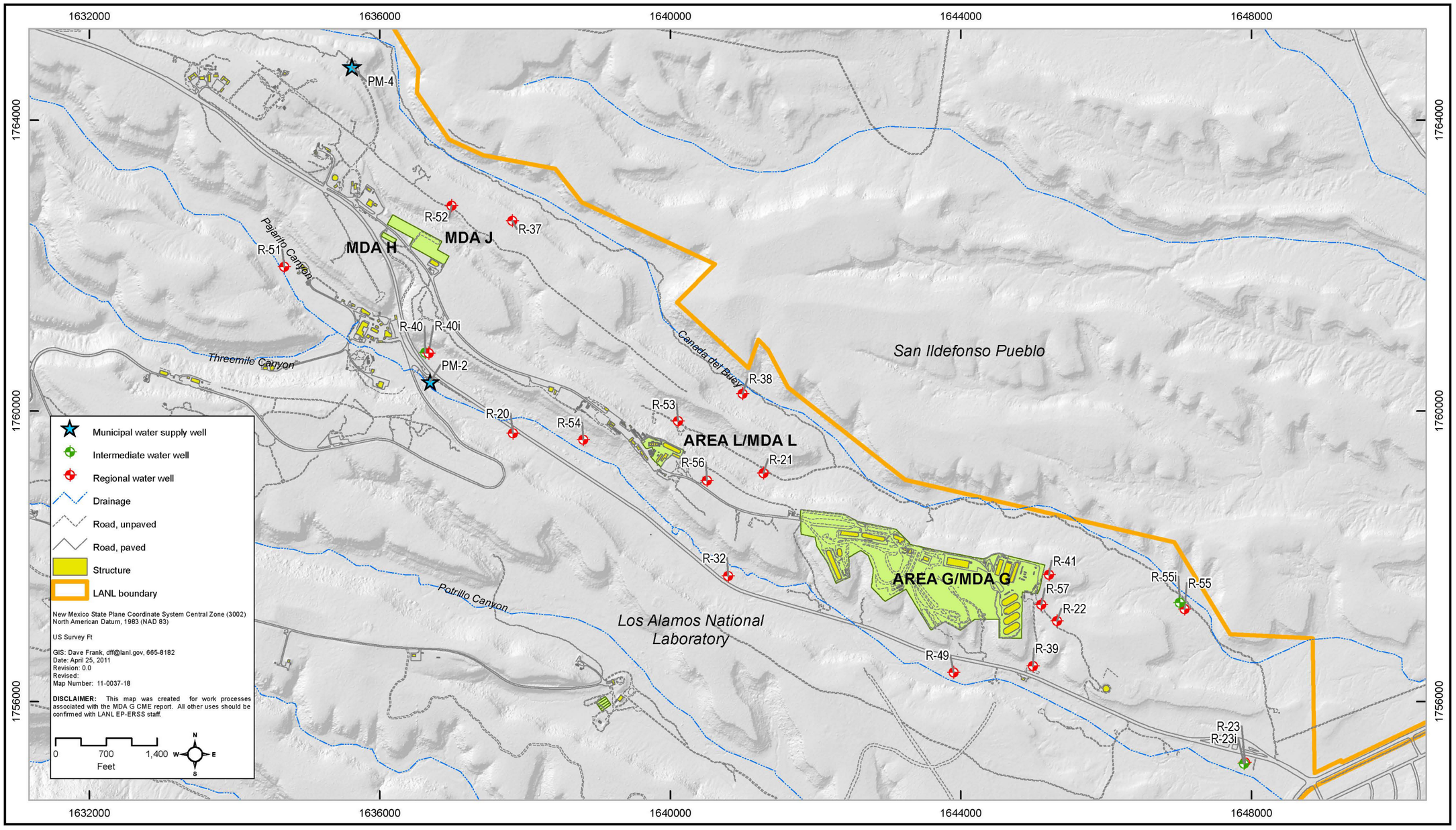


Figure 2.3-3 TA-54 groundwater-monitoring network, also showing water-supply wells

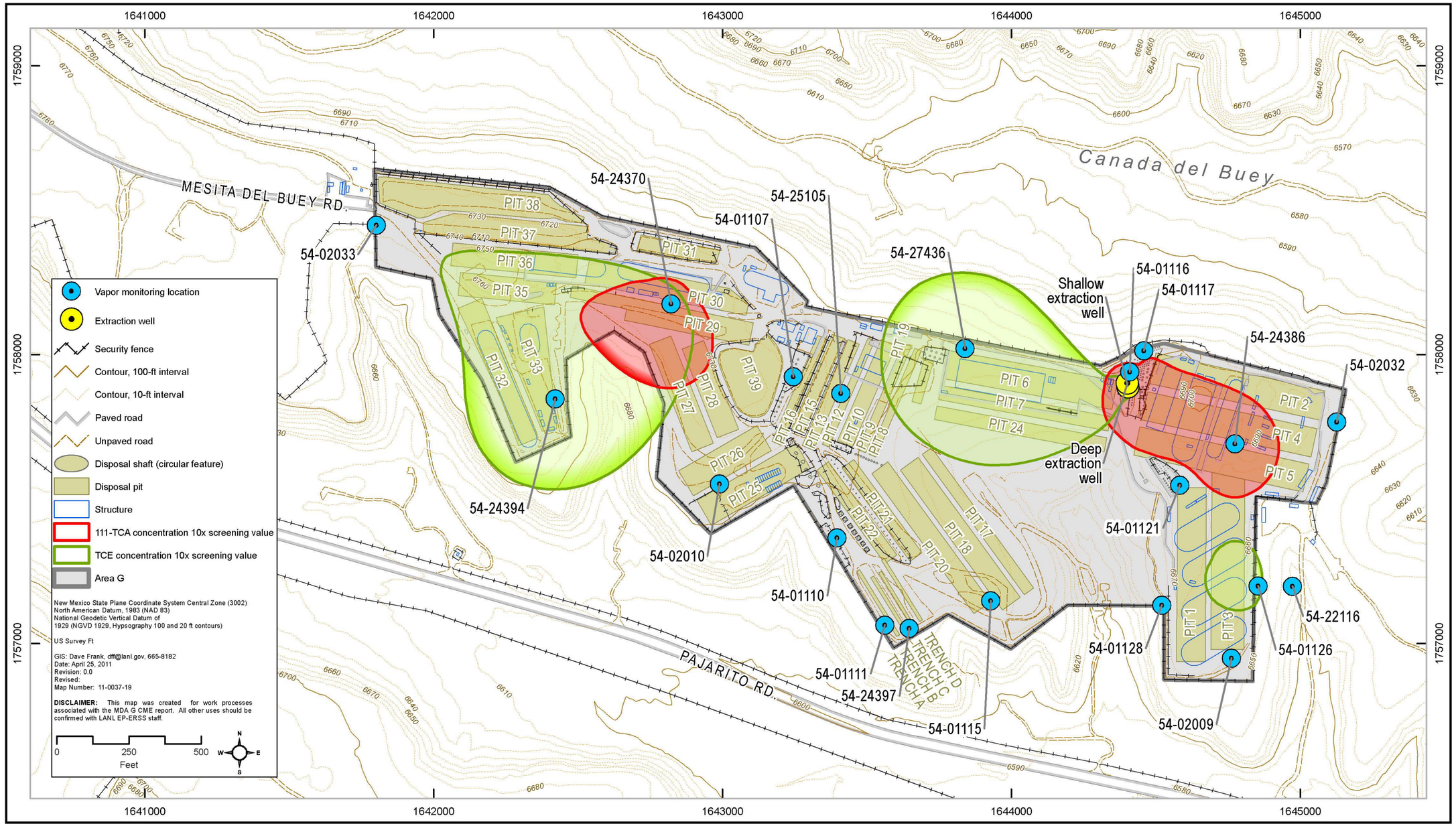


Figure 2.4-1 2008 MDA G SVE pilot test location

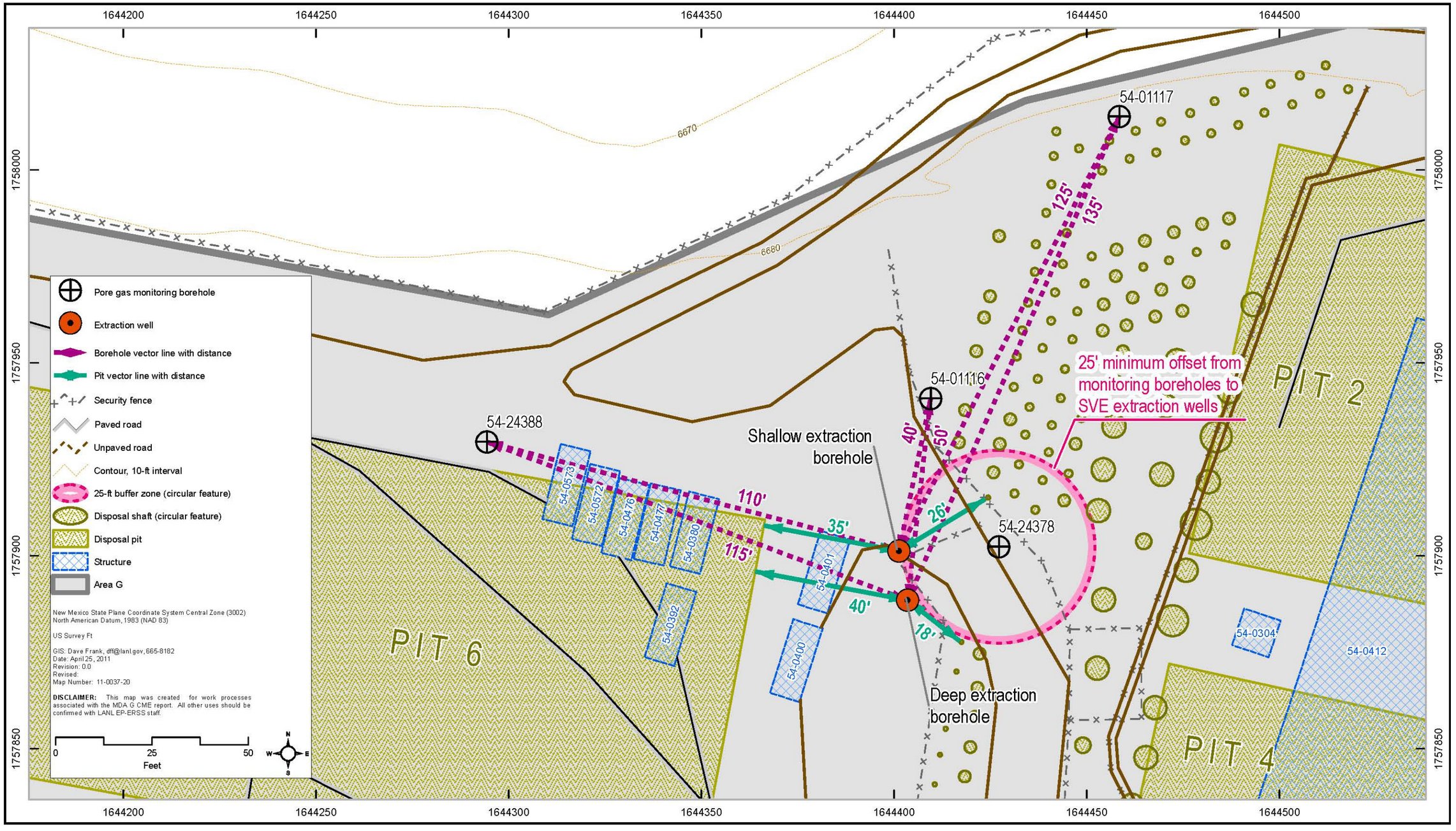


Figure 2.4-2 2008 MDA G SVE pilot test extraction and monitoring borehole locations

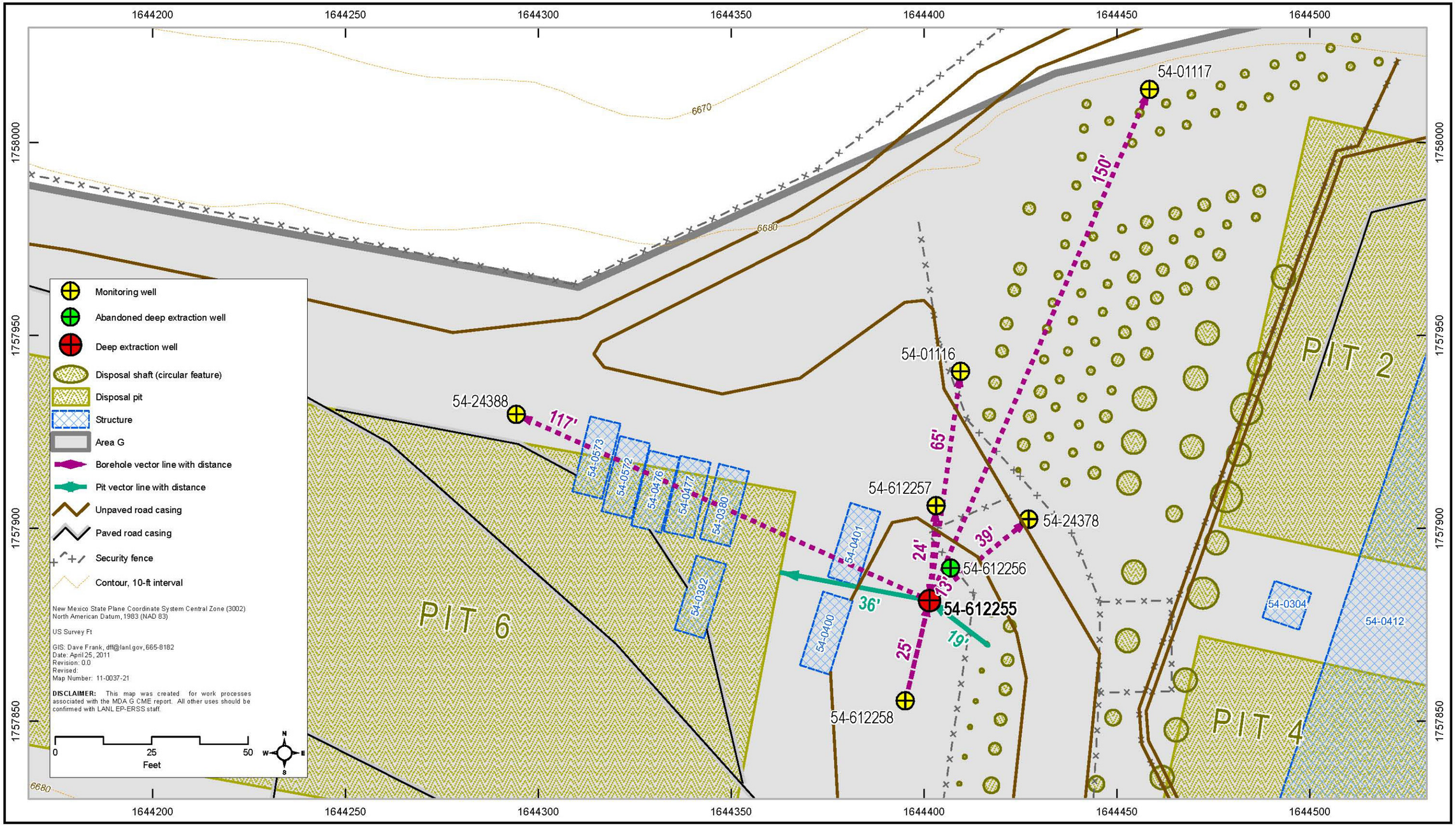


Figure 2.4-3 2010 MDA G SVE pilot test extraction and monitoring borehole locations

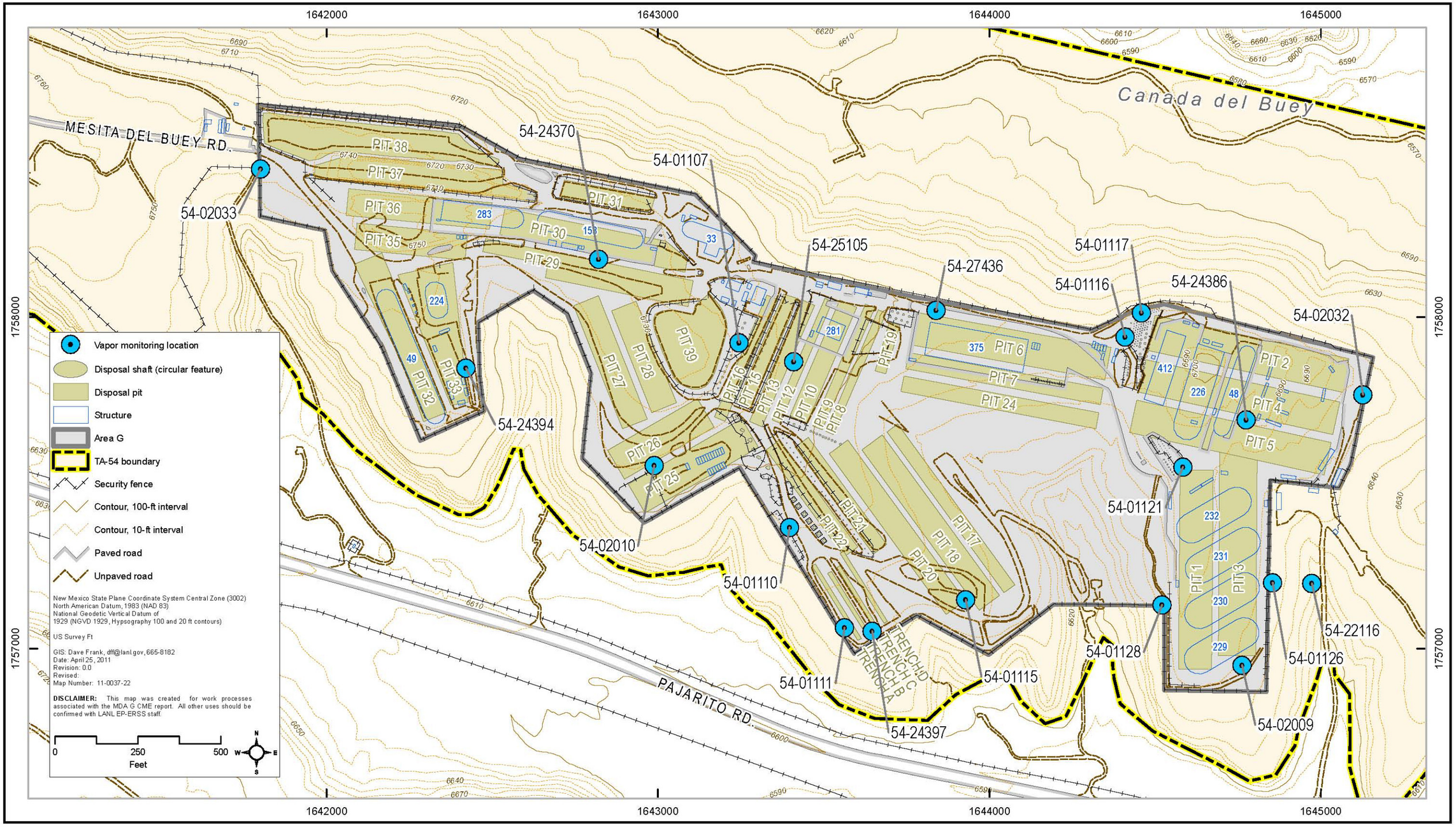


Figure 2.4-4 MDA G pore-gas monitoring borehole locations

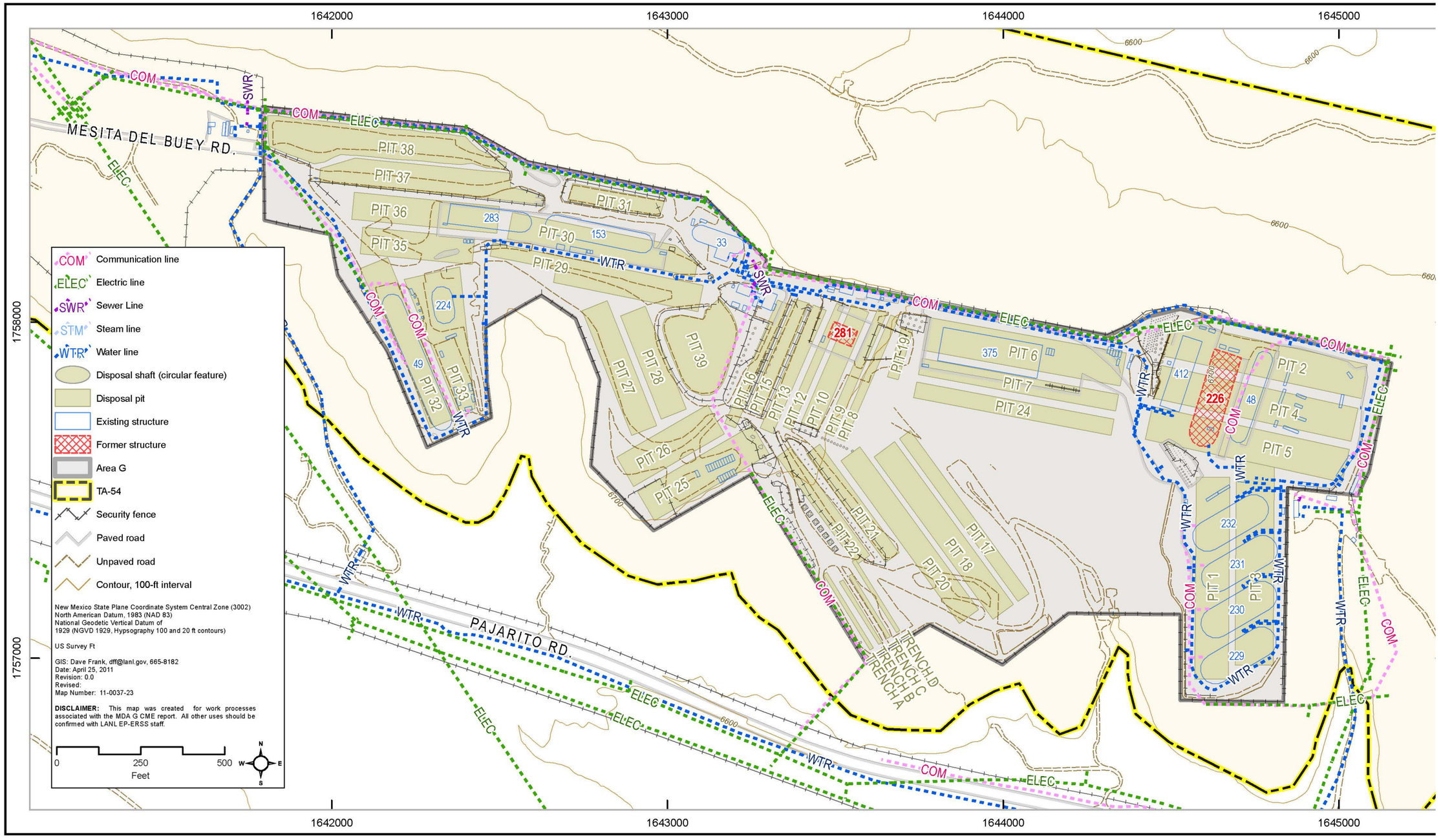
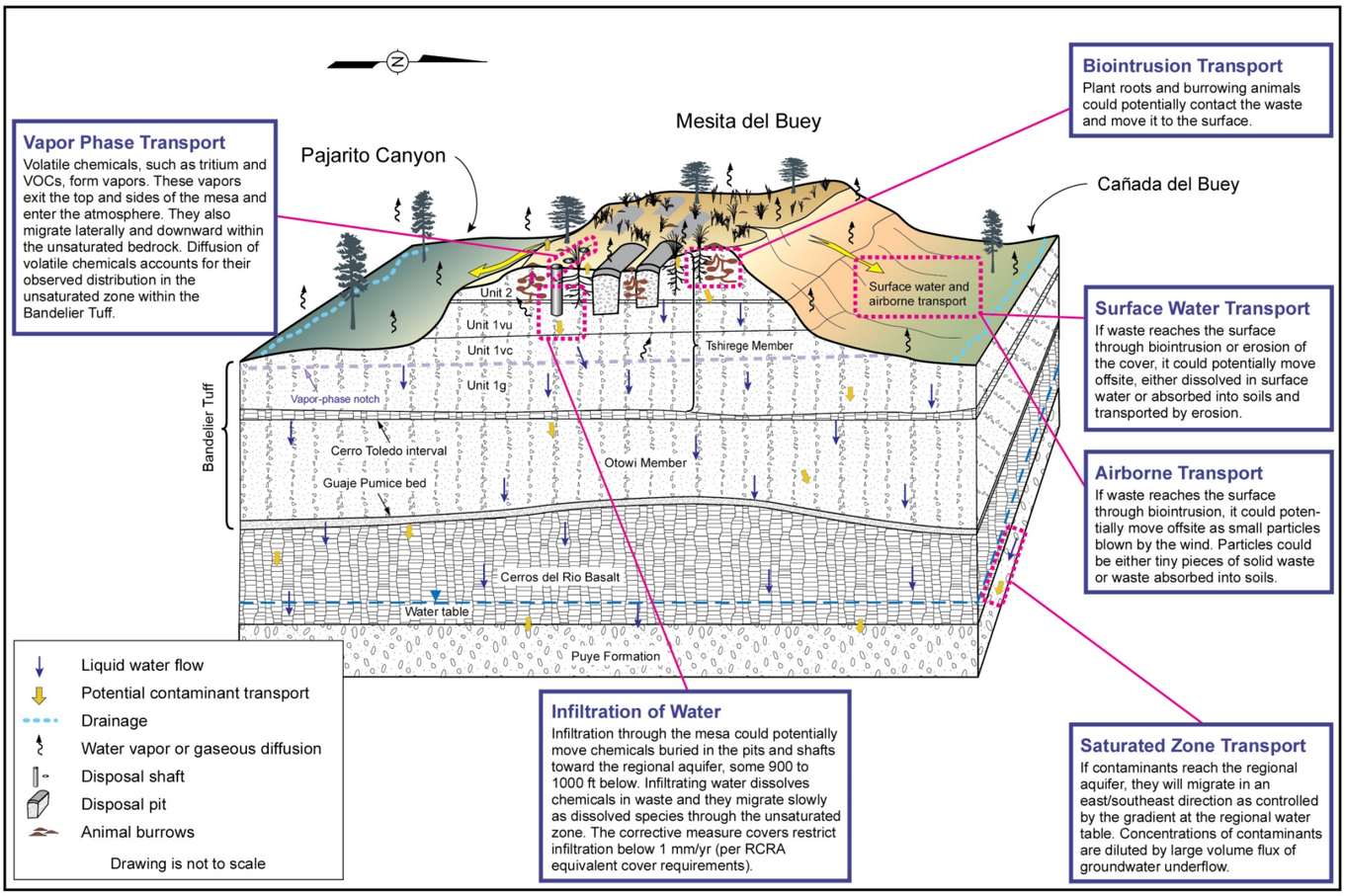
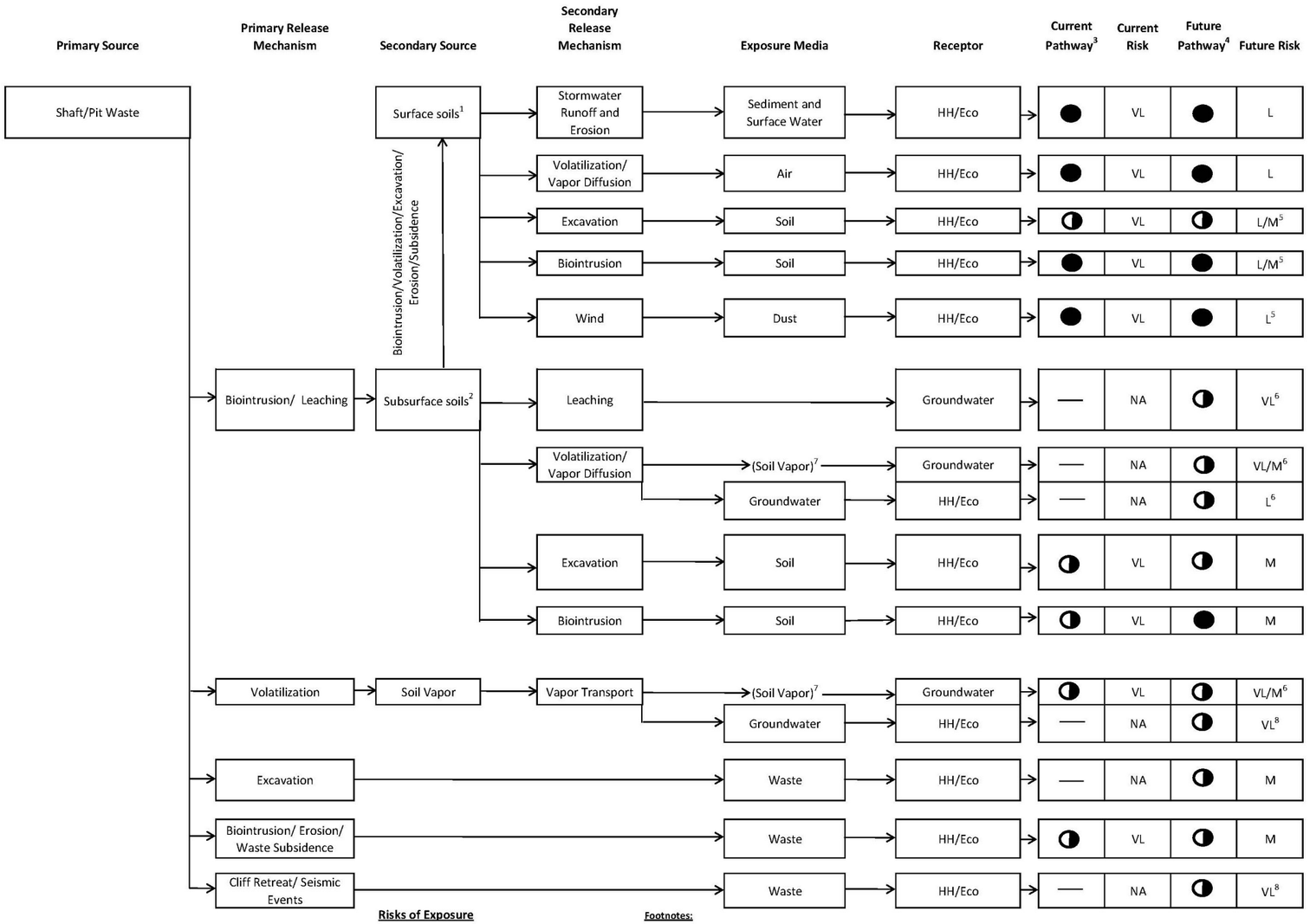


Figure 3.1-1 Surface structures and subsurface utilities at Area G



J. Tauxe, 062101 after A. Kron_Rev. for F2.3-1, MDA H RS, 122001, RLM_Rev. for MDA H CMS Rpt., 051403, cf; modified 101507, ptm; modified 041211, ptm

Figure 4.0-1 Hydrogeologic conceptual site model for Area G



Exposure Pathways

● = Complete pathway

◑ = Potentially complete pathway

— = Incomplete pathway

Notes:

HH = Human Health
Eco = Ecological

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 no remedy implemented and no institutional controls.

[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. 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

[6] = There is uncertainty associated with the contaminant transport to groundwater.

[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 shaft waste at MDA G

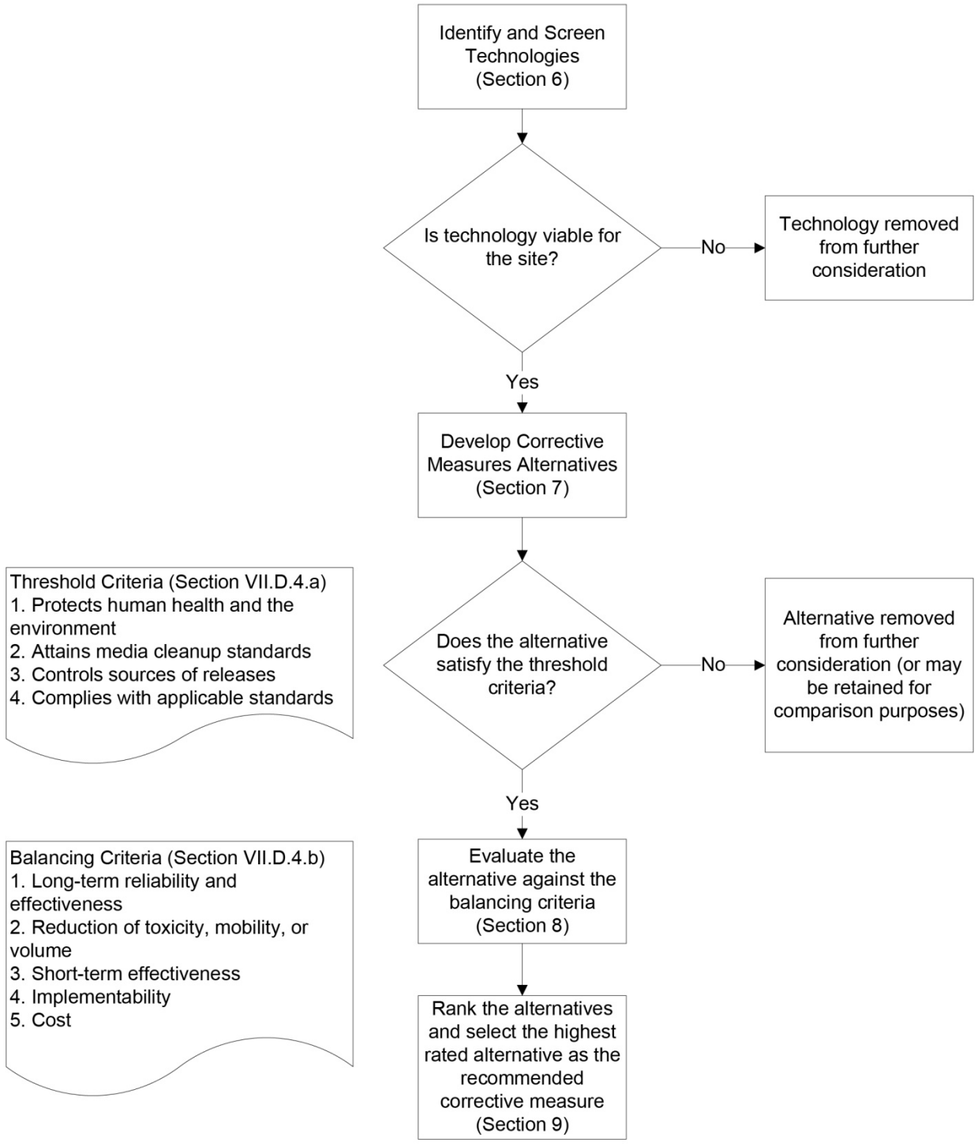


Figure 5.4-1 The selection process for the preferred corrective measures alternative

Figure 7.1-1 Site layout of MDA G

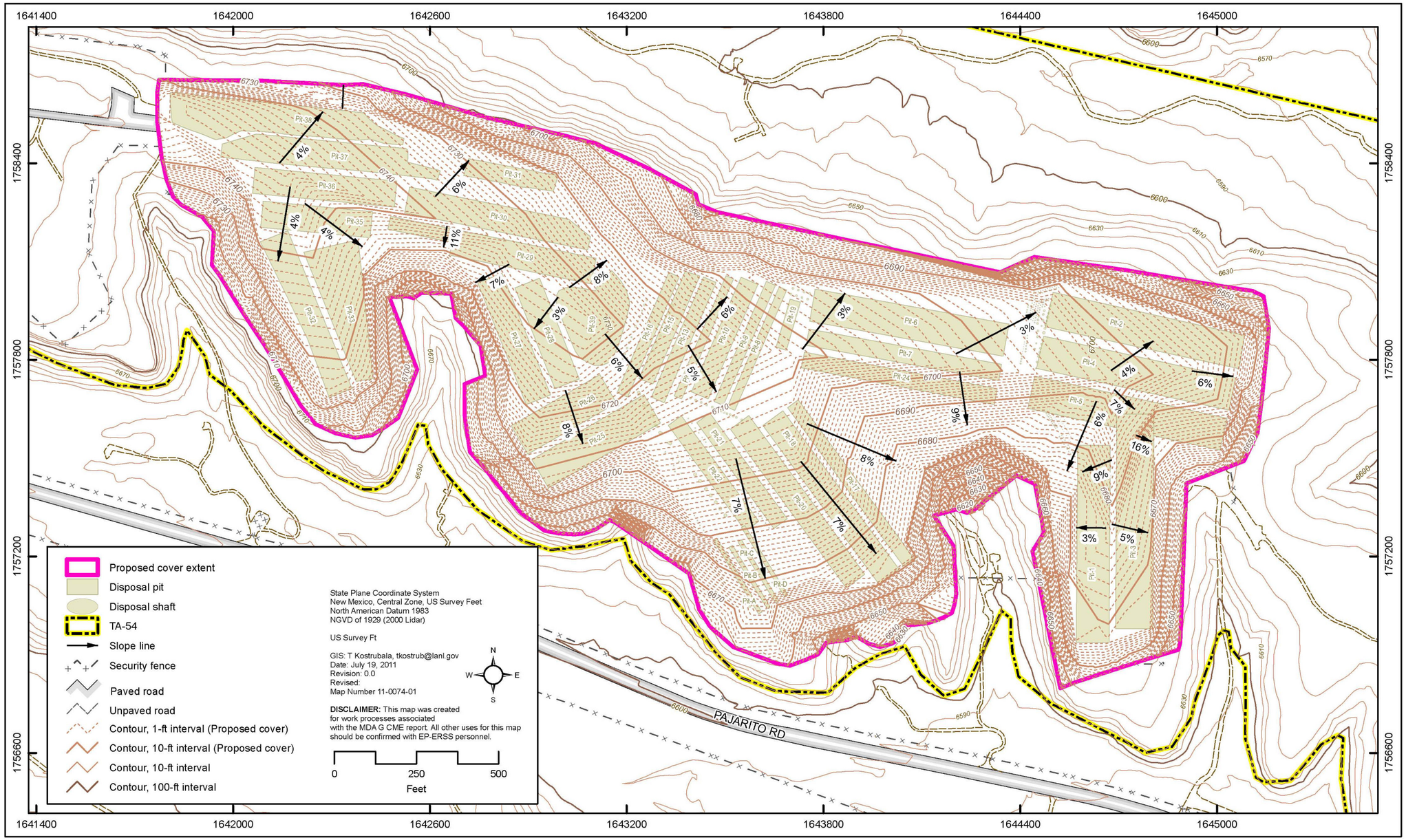


Figure 7.3-1 Conceptual cover layout for Alternatives 2A and 2B

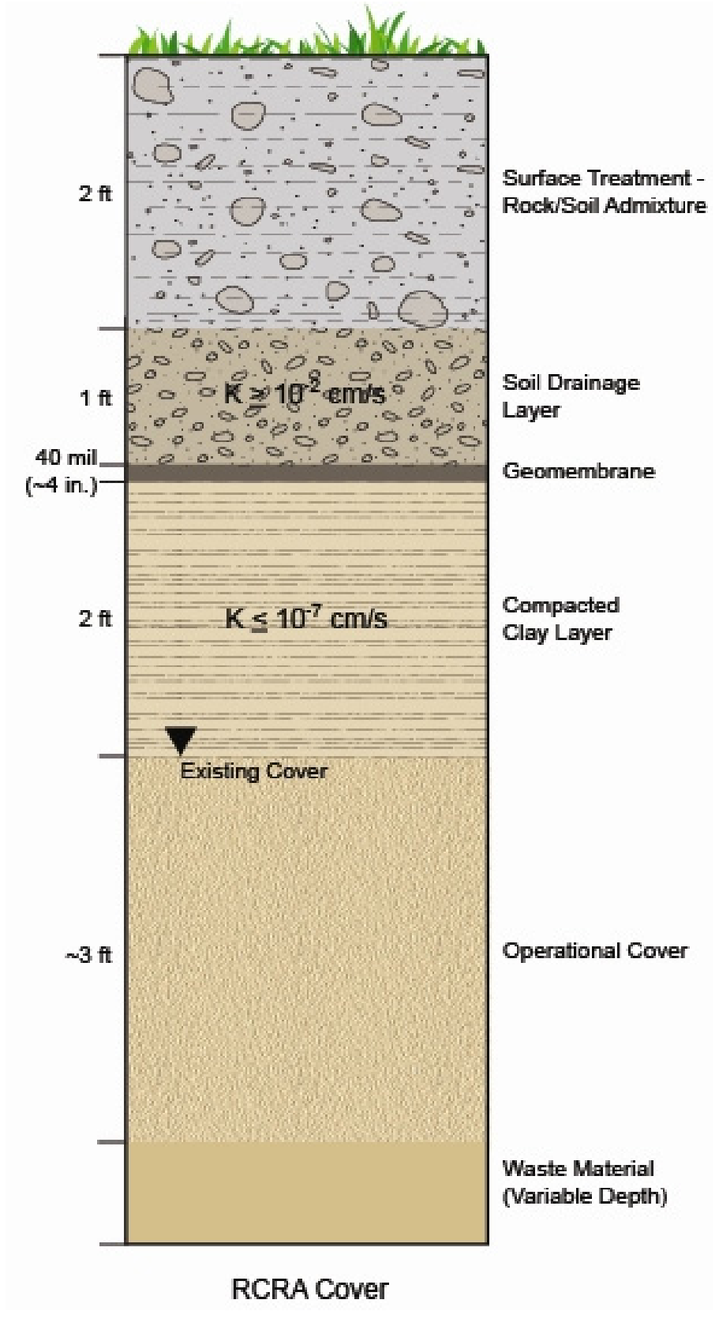


Figure 7.3-2 Cross-section of RCRA cover

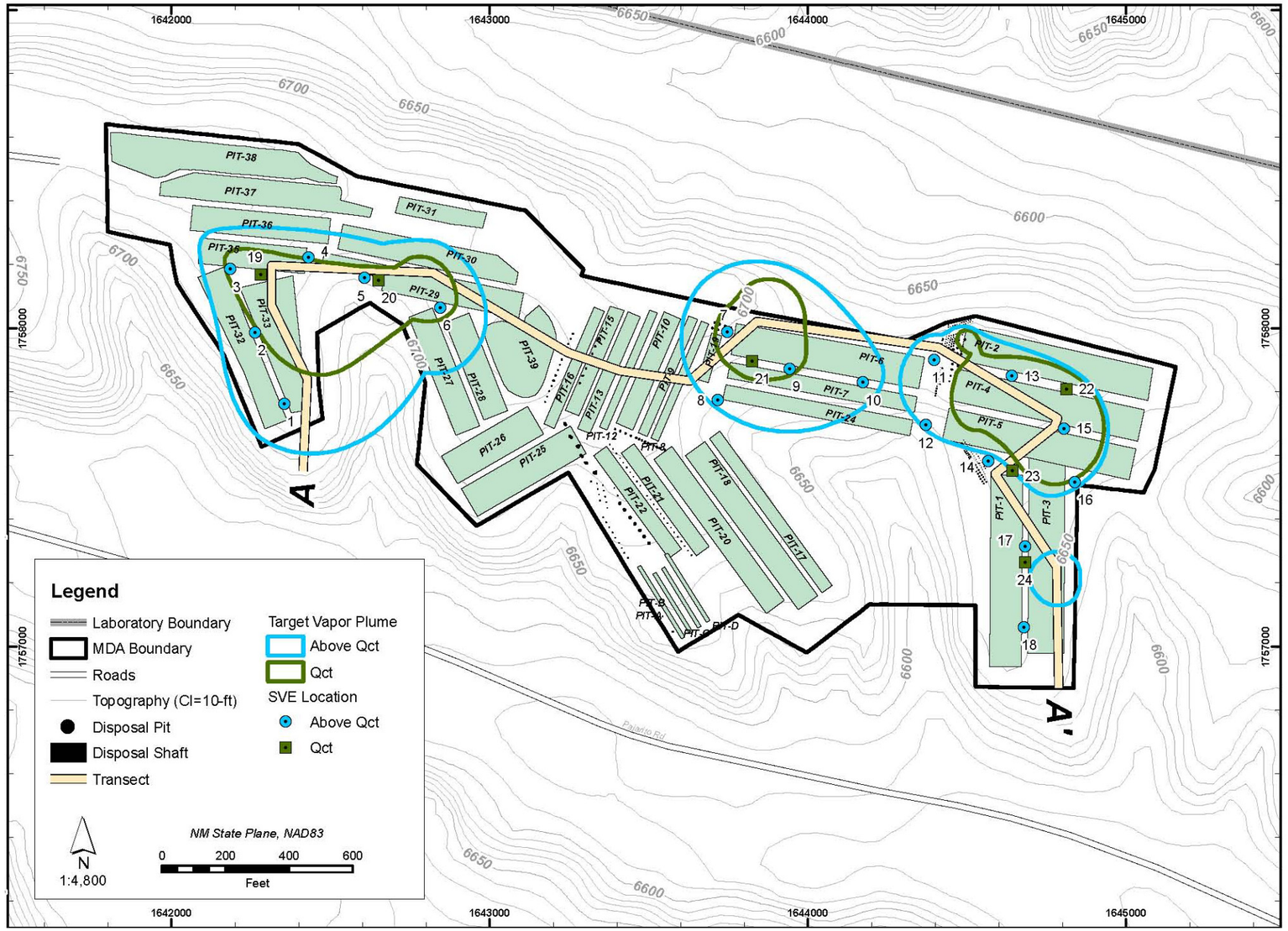


Figure 7.3-3 SVE layout for Alternatives 2A and 2B

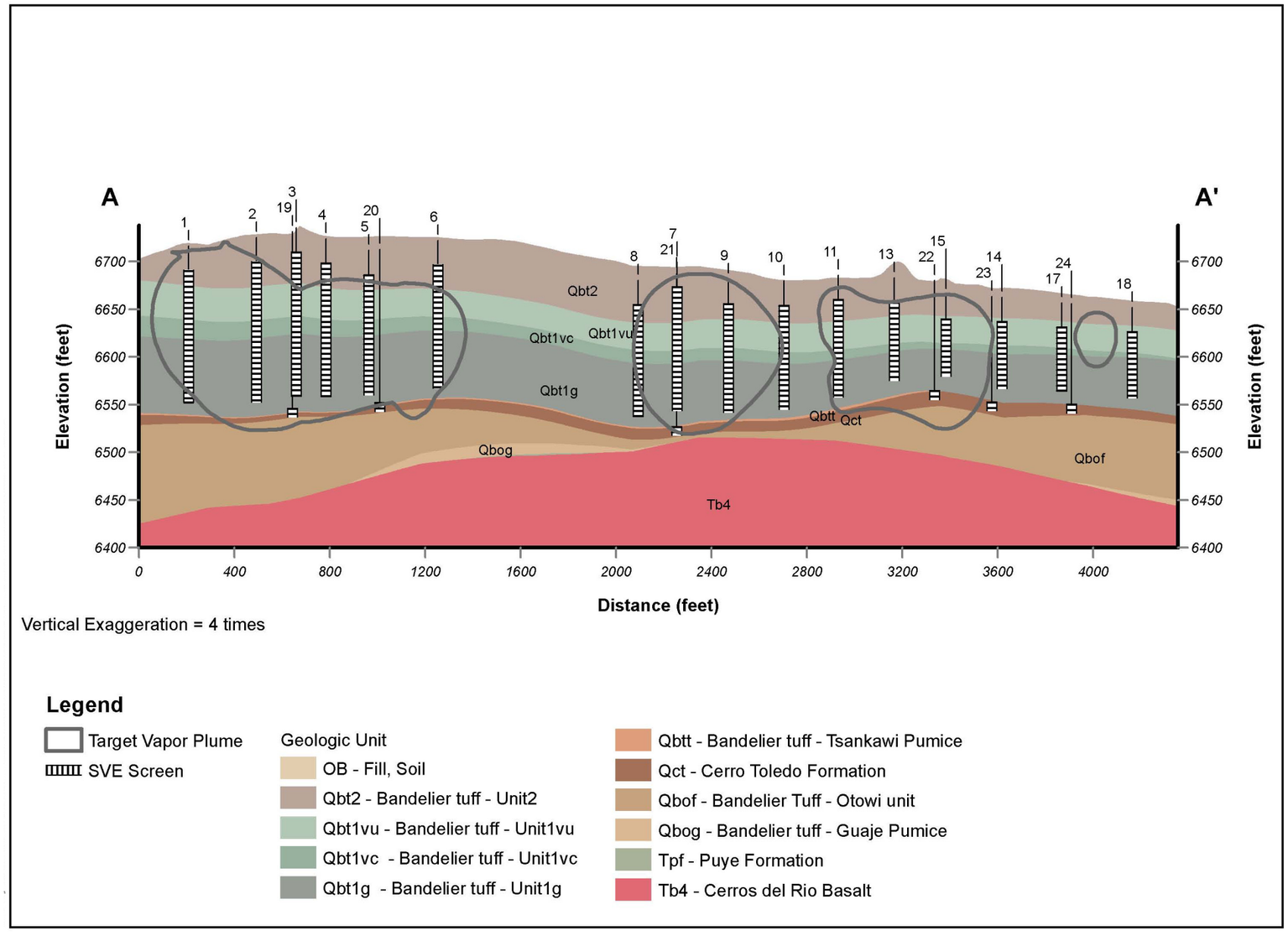


Figure 7.3-4 SVE cross-section

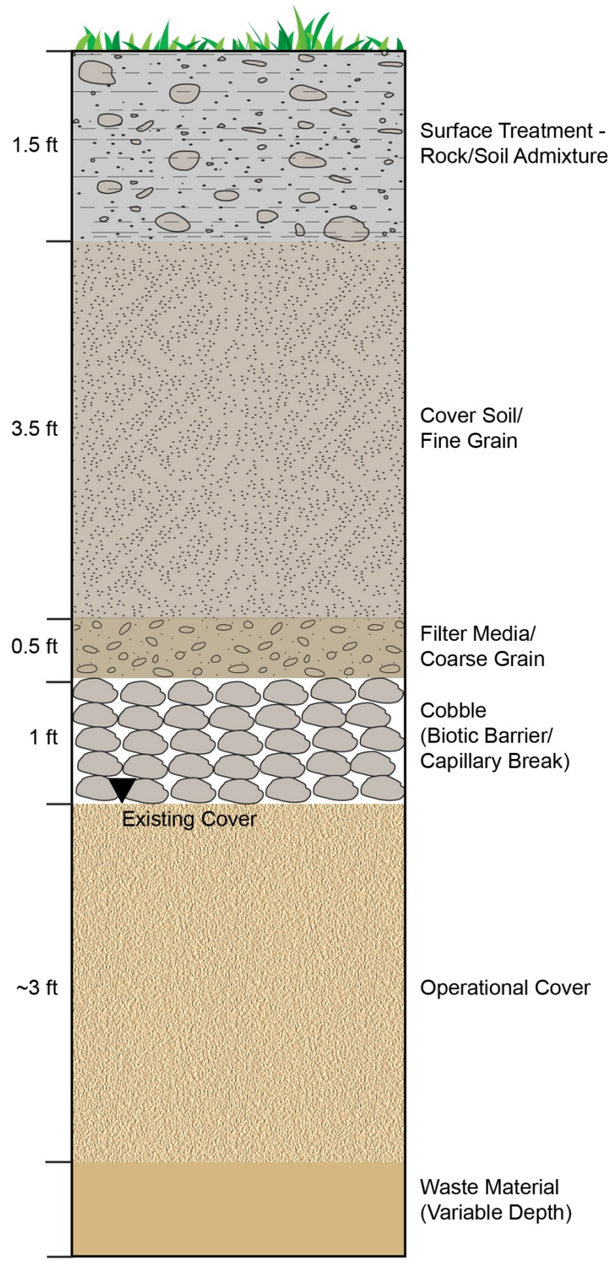


Figure 7.3-5 Cross-section of ET cover

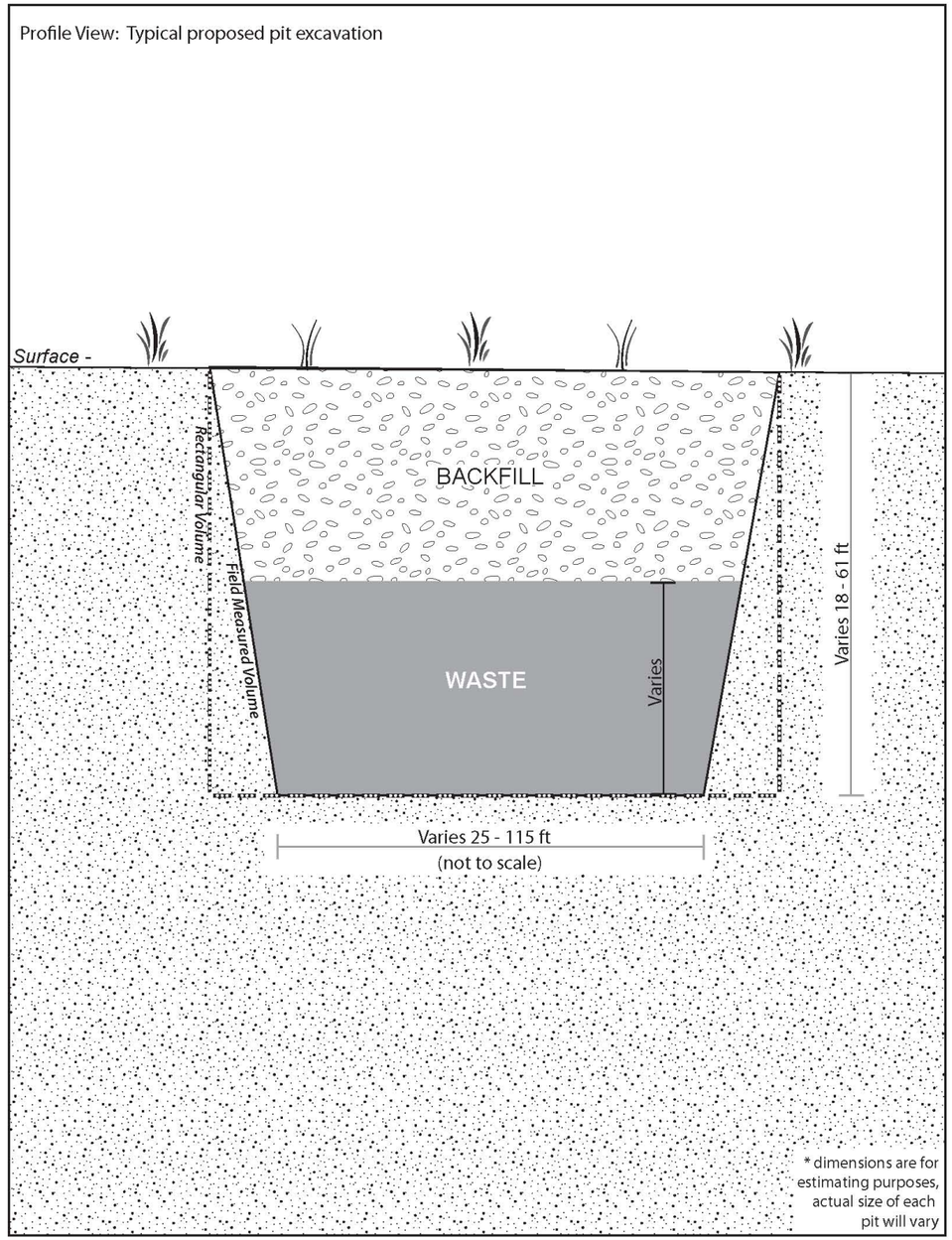


Figure 7.3-6 Typical cross-section of pits excavation

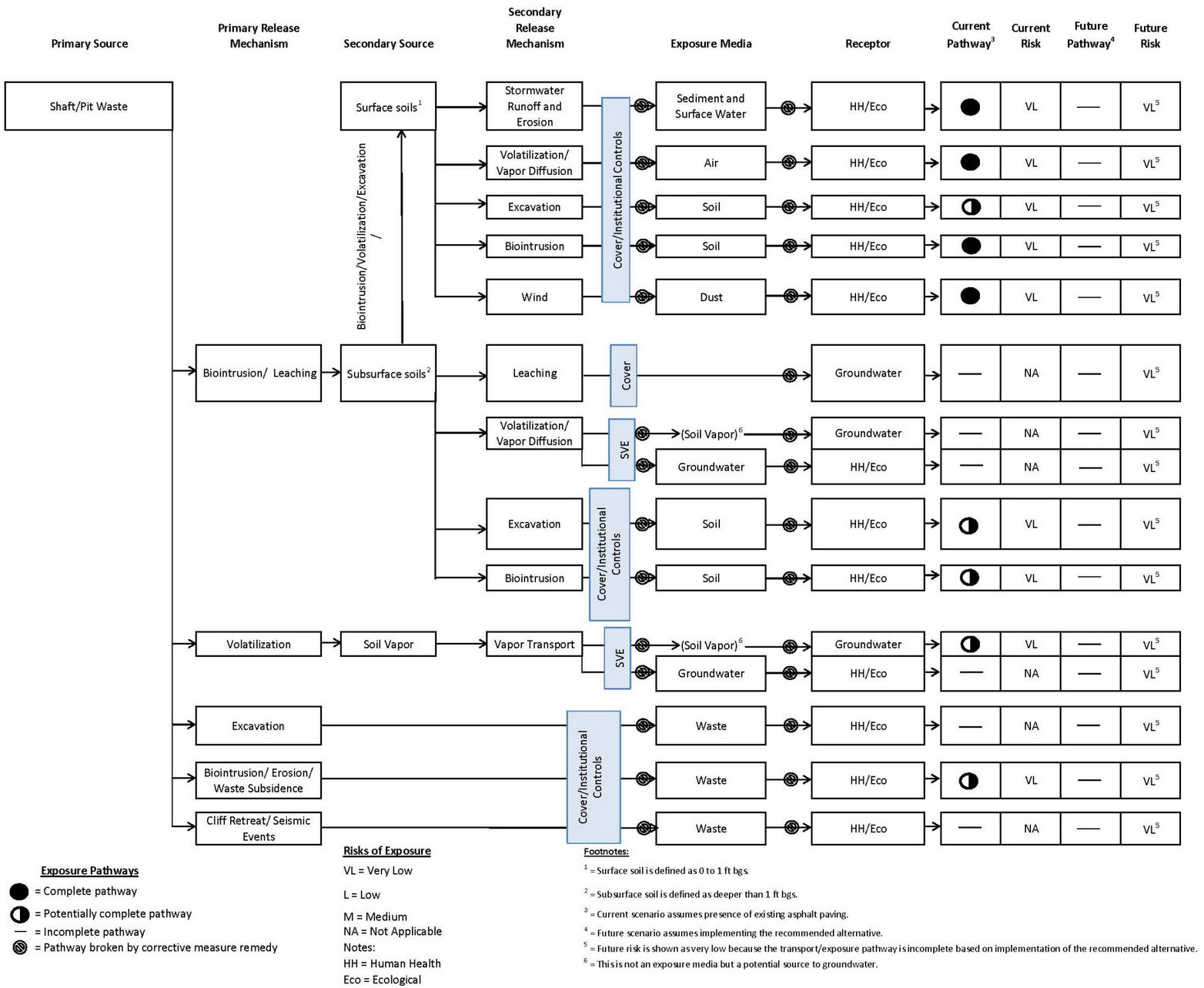


Figure 9.2-1 Refined conceptual site model for pit and shaft wastes

Table 1.0-1
Crosswalk with Consent Order Requirements

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section or Other Source
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 5 through 9
3	1. A description of the location, status, and current use of the site.	VII.D.2	Sections 1 and 2
4	2. A description of the history of site operations and the history of releases of contaminants.	VII.D.2	Section 2
5	3. A description of site surface conditions.	VII.D.2	Sections 2 and 3
6	4. A description of site subsurface conditions.	VII.D.2	Sections 2 and 3
7	5. A description of on- and off-site contamination in all affected media.	VII.D.2	Sections 2, 3, and Appendix B
8	6. An identification and description of all sources of contaminants.	VII.D.2	Sections 2, 3 and Appendix B
9	7. An identification and description of contaminant migration pathways.	VII.D.2	Section 4
10	8. An identification and description of potential receptors.	VII.D.2	Section 4
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	Section 6
13	11. Remedial alternative pilot or bench scale testing results.	VII.D.2	Section 2 and Appendix B
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	Sections 7, 8, and 9
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	Section10
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 7, 8 and 9

Table 1.0-1 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section or Other Source
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 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. 4. Comply with applicable standards for management of waste.	VII.D.4.a	Section 7
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 1.0-1 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section or Other Source
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 PV. 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 2.0-1
Area G Waste Unit Categories

	MDA G, Consolidated Unit 54-013(b)-99, Closure Requirements Defined under Corrective Action		Area G Waste Disposal Units		Closure Requirements Defined by Operating Permit[a]
	Corrective Action Disposal Units	**Retrievable TRU Waste[b]**	**LLW Disposal Units[b]**	**LLW/Retrievable TRU Waste Storage Units**	**CSUs**
Unit	Pits 1–8, 10, 12, 13, 16–22, 24–28, 30–33, and 35–37 Shafts C1–C10, C12, C13, 1–20, 22, 24–96, 99–112, 114, 115, 118–123, 125–136, 138–140, 150–160, 189–192, and 196 **Total Pits = 30** **Total Shafts =159** Regulated Units Pit 29 Shaft 124 RCRA CSUs: Shafts 145 and 146 **Total Pits = 1** **Total Shafts = 3**	TRU waste in corrugated metal pipes Trenches A–D Shafts 200–233 **Total Pits = 1** **Total Shafts = 34** **Total Trenches = 4**	Pit 15 Pits 38 and 39 Shafts 21, 23, 97, 137, 141–144, 147–149, 161–177, 197, 300, 301, 307, 308, 360–367, 369, and 370 Shafts C11, C14, 321, 323, 325, 327, 329, 331, 333, 335, 339, 341, 343, 345, 347, 349, 351, 355, and 357 Shafts 309, 311, 313, 315, 317, 319, 337, 353, and 359 **Total Pits = 3** **Total Shafts =71**	Shafts 235, 236–243,[c] 246–253,[c] 262–266, and 302–306 **Total Shafts = 27**	Surface CSUs Pad 1 (54-226 and 54-412) Pad 3 (54-48) Pads 5, 7, and 8 (54-49, 54-224, 54-144, 54-145, 54-146, 54-177, 54-1027, 54-1028, 54-1030, and 54-1041) Pad 6 (54-153 and 54-283) Pad 9 (54-229, 54-230, 54-231, and 54-232) Pad 10 (formerly Pads 2 and 4) Pad 11 (54-375)[d] 54-8 54-33

Note: Shaded area indicates units addressed in this CME report.

[a] Associated buildings in parentheses with exception of Pad 10.

[b] Regulated by DOE under the AEA.

[c] Removed in 2009.

[d] Included in RCRA permit application renewal.

Table 2.0-2
Consolidated Unit 54-013(b)-99 SWMUs

SWMU	Description
SWMU 54-013(b)	SWMU 54-013(b) was a vehicle monitoring/decontamination area located in the central portion of Area G on the surface of Pit 19. The area was used to decontaminate trucks and TRU waste drums but is no longer in use.
SWMU 54-014(b)	SWMU 54-014(b) consists of Pit 9, an inactive disposal pit measuring 30 ft wide × 400 ft long × 20 ft deep. From 1974 to 1978, Pit 9 received retrievable TRU. When filled, the pit was covered with 3.3 ft of consolidated crushed tuff and 4 in. of topsoil and reseeded with native grasses. The TRU wastes in Pit 9 will be retrieved and processed for disposal at WIPP.
SWMU 54-014(c)	SWMU 54-014(c) consists of retrievable TRU waste storage shafts 200 through 233, located in the northeastern quadrant of Area G, TA-54. The shafts each measure 1 ft in diameter and 18 ft deep and are lined with concrete. Some of the shafts began receiving TRU waste in 1978 and were closed between 1979 and 1987. The shafts were used for wastes that required special packaging (primarily tritium), special handling (e.g., highly active metals), or segregation. When filled, the shafts typically were filled with waste to within 3 ft of the ground surface, backfilled with crushed tuff, and covered with a concrete dome. The TRU wastes in these shafts will be retrieved and processed for disposal at WIPP.
SWMU 54-014(d)	SWMU 54-014(d) consists of retrievable TRU waste storage trenches A, B, C, and D, which are located in the south-central portion of TA-54's Area G. These trenches began receiving TRU in 1974. Trenches A, B, and C vary in size from 219 ft to 262.5 ft long × 13 ft wide × 6 ft to 8 ft deep. Trench D is 60 ft long × 13 ft wide × 6 ft deep. The TRU waste placed in these trenches was packaged in 30-gal. containers inside concrete casks. When filled, the trenches were backfilled with 3.3 ft of crushed tuff followed by 4 in. of topsoil. The surface was reseeded with native grasses. The TRU wastes in these trenches will be retrieved and processed for disposal at WIPP.
SWMU 54-015(k)	SWMU 54-015(k) consists of a layer of retrievable TRU waste in cement-filled sections of corrugated pipe located inside a mound of fill material that was placed on top of inactive Pit 29 in the northeast quadrant of TA-54's Area G. These TRU wastes will be retrieved and processed for disposal at WIPP.
SWMU 54-017	SWMU 54-017 consists of inactive disposal pits 1 through 8, 10, 12, 13, 16 through 22, and 24. Pits 1 through 8, 10, 12, 13, 16 through 22, and 24 were operational between 1959 and 1980 and received radioactive, mixed, and nonretrievable TRU wastes in the form of wing tanks, dry boxes, building debris, sludge drums, lab waste, contaminated soil, D&D waste, filter plenums, and uranium. Pits 1 through 8, 10, 12, 13, 16 through 22, and 24 are located in the eastern portion of Area G with volumes ranging from 1371 to 56,759 yd^3. When filled, the pits were covered with 3.3 ft of consolidated crushed tuff and 4 in. of topsoil and reseeded with native grasses.
SWMU 54-018	SWMU 54-018 consists of disposal pits 25 through 33 and 35 through 37. Only Pit 29 (although no longer in use) is considered a regulated unit until RCRA closure is certified and approved by NMED. Pits 25 through 28 and 30 through 36 were operational between 1979 and 1980 and received radioactive, mixed, and TRU-contaminated waste in the form of reactor control rods, D&D waste, contaminated soil, transformers, glove boxes, asbestos, and lab waste and range in volume from 20,957 to 59,930 yd^3. Pit 29 operated until 1986. Pit 37 operated from 1990 to 1997 and primarily received circuit boards and contaminated soil. When filled, the pits were covered with 3.3 ft of consolidated crushed tuff and 4 in. of topsoil and reseeded with native grasses.

Table 2.0-2 (continued)

SWMU	Description
SWMU 54-019	SWMU 54-019 consists of disposal shafts 1 through 20, 24 through 34, 38 through 92, 96, 109 through 112, and 150. These shafts, which were operational between 1966 and 1980, received LLW and hazardous and mixed waste. The shafts range in size from 1 ft to 6 ft in diameter and 25 ft to 60 ft deep and are located primarily in the northeast quadrant of Area G. Disposal shafts typically were filled with waste to within 3 ft of the ground surface, backfilled with crushed tuff, and covered with a concrete dome.
SWMU 54-020	SWMU 54-020 consists of disposal shafts C1 through C10, C12, C13, 22, 35 through 37, 93 through 95, 99 through 108, 114, 115, 118 through 136, 138 through 140, 151 through 160, 189 through 192, and 196. These shafts were operational between 1970 and the early 1990s. Only Shaft 124 (although no longer in use) is considered active until RCRA closure is certified and approved by NMED. The shafts contain one or a combination of the following waste types: PCB residues, LLW, hazardous, and mixed waste. The shafts range in size from 1 ft to 8 ft in diameter and 25 ft to 65 ft deep and are located throughout the eastern portion of Area G. Disposal shafts were typically filled with waste to within 3 ft of the ground surface, backfilled with crushed tuff, and covered with a concrete dome.

Table 2.1-1
MDA G Subsurface Disposal Unit Information for Pits

Pit No.[a]	Operational Period	Dimensions (length × width × depth)	Rectangular Vol. of Pit (yd^3)	Field Meas. Pit Vol. (yd^3)	Vol. of Waste in Pit (yd^3)	Waste Description
1	Jan 1959–Apr 1961	616 ft × 113 ft × 20 ft	51,561	37,080	5529	Wing tanks from Kirtland Air Force Base, dry boxes, “normal trash.” Pit used to burn combustibles
2	Apr 1961–Jul 1963	618 ft × 104 ft × 26 ft	61,892	42,911	6407	Classified Bendix waste, 55-gal. drums, property numbers, D-38, hot dirt
3	Jun 1963–Mar 1966	655 ft × 115 ft × 33 ft	92,064	56,759	9473	Misc. material, lumber, pipe, 55-gal. drums, D&D, D-38, Bendix classified waste, soil from TA-10–Bayo Canyon
4	Jan 1966–Dec 1967	600 ft × 110 ft × 34 ft	83,111	44,950	8212	D&D, graphite, wooden boxes, D-38, 55-gal. drums, classified Bendix waste, property numbers. Burning trench along south wall of pit
5	Jan 1967–Mar 1974	600 ft × 100 ft × 29 ft	64,444	41,258	6624	Scrap material, D&D, graphite hoppers, sludge drums (possibly aqueous solution from TA-50), property numbers
6	Jan 1970–Aug 1972	600 ft × 113 ft × 26 ft	65,289	43,933	6696	Misc. scrap, wood, D&D. Covered with topsoil from TA-1 with up to 20 pCi/g Pu contamination

Table 2.1-1 (continued)

Pit No.[a]	Operational Period	Dimensions (length × width × depth)	Rectangular Vol. of Pit (yd^3)	Field Meas. Pit Vol. (yd^3)	Vol. of Waste in Pit (yd^3)	Waste Description
7	Mar 1974–Oct 1975	600 ft × 50 ft × 30 ft	33,333	17,101	4343	Low-level TRU-contaminated waste. Replaced Pit 17 for low-level TRU-contaminated waste in 1974. Covered with topsoil from TA-1 with up to 20 pCi/g Pu contamination
8	Sep 1971–May 1974	400 ft × 25 ft × 25 ft	9259	6528	2311	55 gal. drums of sludge from H-7 and nonretrievable TRU waste also drums from TA-50 (aqueous and nonretrievable TRU)
9	Nov 1974–Nov 1979	400 ft × 30 ft × 20 ft	8889	9027	na[b]	Drums and fiberglass crates containing retrievable TRU wastes (>10 nCi/g Pu-239 or U-233 or >100 nCi/g Pu-238). Bottom of pit is paved
10	May 1979–Mar 1980	380 ft × 57 ft × 27 ft	21,660	15,549	4016	Building debris, lab wastes, sludge drums (from TA-50 dewatering, possibly aqueous)
12	Sep 1971–Dec 1975	400 ft × 25 ft × 25 ft	9259	7303	2363	Nonretrievable TRU waste. Originally contained retrievable TRU, but was transferred to Pit 9 (30 55-gal. drums)
13	Nov 1976–Sep 1977	400 ft × 42 ft × 28 ft	17,422	12,107	1931	Uranium, mixed fission products, mixed activation products. Uranium fission products and induced activity wastes
16	Sep 1971–Aug 1975	400 ft × 25 ft × 25 ft	9259	8081	2235	Crates and drums containing uranium-contaminated wastes
17	Aug 1972–Mar 1974	600 ft × 46 ft × 24 ft	24,533	17,399	4962	Low-level Pu TRU <10 nCi/g. Misc. scrap wastes, crates, filter plenums
18	Feb 1978–Aug 1979	600 ft × 75 ft × 40 ft	66,667	46,685	12,358	Contaminated dirt, lab wastes, noncompactible waste, D&D, drums
19	Nov 1975–Aug 1979	153 ft × 30 ft × 18 ft	3060	1371	na	Asbestos and carcinogens, plastic layer placed in bottom
20	Nov 1975–Oct 1977	600 ft × 71 ft × 36 ft	56,800	37,454	14,899	Lab waste, oil, sludge drums, trash, contaminated dirt
21	Aug 1972–Dec 1974	402 ft × 56 ft × 26 ft	21,678	13,328	3607	Uranium, classified material, boxes, drums, scrap metal
22	Sep 1976–Mar 1978	413 ft × 56 ft × 33 ft	28,268	17,690	3744	Filter plenum, sludge drums (possibly aqueous from TA-50), lab waste, graphite fuel rods, contaminated dirt
24	Jul 1975–Nov 1976	600 ft × 58 ft × 30 ft	38,667	23,388	7327	Graphite, lab wastes, 22 truck loads of soil. Uranium, tritium, mixed fission products, and mixed activation products

Table 2.1-1 (continued)

Pit No.[a]	Operational Period	Dimensions (length × width × depth)	Rectangular Vol. of Pit (yd^3)	Field Meas. Pit Vol. (yd^3)	Vol. of Waste in Pit (yd^3)	Waste Description
25	Jan 1980–May 1981	395 ft × 103 ft × 39 ft	58,767	47,000	6530	Reactor control rods, D&D, scrap Drums, lab wastes, test drums, PCB-contaminated waste forms
26	Feb 1984–Feb 1985	310 ft × 100 ft × 36 ft	41,333	22,209	4312	Building debris, TRU culverts, asbestos, alpha box soil, lumber, PCBs
27	May 1981–Jul 1982	400 ft × 80 ft × 46 ft	54,519	26,946	7441	Laboratory waste, contaminated soil and pipe, D&D, PCBs, and unknown chemical waste
28	Dec 1981–Apr 1983	330 ft × 83 ft × 40 ft	40,578	21,381	4422	Barium nitrate, PCB soil, lab waste, property numbers, transformers, clay pipes, building debris, uranium graphite
29	Oct 1984–Oct 1986	658 ft × 80 ft × 50 ft	97,481	45,795	9784	TRU cement paste (recoverable), D&D soil, glove boxes, plywood boxes (4 ft × 4 ft × 8 ft), asbestos, PCBs, and unknown chemical waste
30	Oct 1988–Jun 1990	568 ft × 39 ft × 35 ft	28,716	42,843	13,464	Asbestos, PCBs, and unknown chemical waste
31	Jun 1990–Mar 2003	280 ft × 52 ft × 25 ft	13,481	na	2702	Asbestos, mixed fission products, and mixed activation products.
32	Nov 1985–Aug 1987	518 ft × 74 ft × 51 ft	72,405	36,364	5367	PCB asphalt, transformers, contaminated soil, glove boxes, 4 ft × 4 ft × 8 ft plywood boxes, capacitors, building debris
33	Nov 1982–Jul 1984	425 ft × 115 ft × 40 ft	72,407	59,930	7776	Beryllium in stainless steel, lab waste, building debris, asbestos, noncompactible trash, PCBs, and unknown chemical waste
35	Jun 1987–Feb 1988	363 ft × 83 ft × 40 ft	44,636	20,957	3361	Trash, 4 ft × 4 ft × 8 ft plywood boxes, asbestos, lab waste, PCBs, and unknown chemical waste
36	Jan 1988–Dec 1988	435 ft × 83 ft × 43 ft	57,501	28,057	4491	4 ft × 4 ft × 8 ft plywood boxes, compactable nonnuclear. trash, rubble, building waste, beryllium, and PCB soil (<200 ppm)
37	Apr 1990–Apr 1997	731 ft × 83 ft × 61 ft	137,076	57,213	24,299	Ultrahigh-Temperature Reactor Experiment reactor vessel and stack, asbestos, PCBs, and unknown chemical waste

[a] Does not include LLW pits 15, 38, and 39.

[b] na = Not available.

Table 2.1-2
MDA G Subsurface Disposal Unit Information for Trenches

Trench No.	Operational Period	Dimensions (length × width × depth)	Waste Description
A	1974	262.5 ft × 12.75 ft × 8 ft	Heat source Pu-238 (80% Pu-238, 16% Pu-239, 3% Pu-239, 1% other) in casks from (1) radiolytic heating, (2) radiolytic gas formation, and (3) radiation emitting from waste. Average of 18 g Pu-238 per cask, with max 40 g Pu-238
B	1974–1977	218.75 ft × 12.75 ft × 8 ft	
C	1977–1981	218.75 ft × 12.75 ft × 10 ft (est.)	
D	1981–1985	250 ft × 12.75 ft × 10 ft (est.)	

Table 2.1-3
MDA G Subsurface Disposal Unit Information for Shafts

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
1	1966–1967	2/25	N[a]	78.4	63	Cell trash, irradiated metal, animal tissue
2	1966–1967	2/25	N	78.4	42	DU[b] chips, animal tissue, irradiated Pu cell waste
3	1966–1967	2/25	N	78.4	35	Pu-contaminated Na and metal, neutron generators
4	1967–1968	2/25	N	78.4	44	U-contaminated metal, U-238 samples, DU
5	1967–1968	2/25	N	78.4	29	DU, tritium-contaminated materials, U-238-contaminated metal
6	1967–1968	2/25	N	78.4	21	Tritium-contaminated materials, U-235
7	1967–1968	2/25	N	78.4	52	Animal tissue, PTC waste, tritium DU
8	1968–1969	2/25	N	78.4	na[c]	Pu cell waste, animal tissue, end boxes
9	1968–1969	2/25	N	78.4	70	Hot cell waste, Pu cell waste, Experimental Breeder Reactor (EBR) II waste, fuel elements
10	1969	2/25	N	78.4	54	Animal tissue, Pu-239 waste, U-contaminated chemicals
11	1967–1969	3/25	N	176.5	72	PeeWee waste and trash, U-235 cell waste, graphite
12	1966–1970	3/25	N	176.5	83	Cell waste, Rover waste, tritium
13	1966–1970	3/25	N	176.5	122	Animal tissue, EBR hardware, reactor parts
14	1966–1969	1/25	CMP[d]	19.7	na	U-235 vermiculite, neutralized solution HCL + U-235
15	1969–1970	1/25	CMP	19.7	8	Tritium in H_3PO_4, hot cell waste
16	1969	1/25	CMP	19.7	4	Tritium
17	1970–1974	1/25	CMP	19.7	1	Tritium pump, U-235 in Na
18	1970–1973	1/25	CMP	19.7	13	Neutralized Na, Cs-137 + Ba-140
19	1971–1974	1/25	CMP	19.7	3	Pu-239 solution, reacted Pu-239
20	1974–1975	1/25	CMP	19.7	8	Sorbed Pu-239 solution
22	1980–1993	1/25	CMP	19.7	7	Radioactive sources
24	1969–1970	2/25	N	78.4	44	Animal tissue, DU, unloaded fuel elements

Table 2.1-3 (continued)

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
25	1969–1971	2/25	N	78.4	45	DU, U-238 residue, U-238 contaminated metal
26	1969–1970	2/25	N	78.4	56	Hot cell trash, fuel elements, DU-contaminated metal
27	1970	2/25	N	78.4	13	Irradiated material, DU-contaminated material
28	1970	2/25	N	78.4	14	LA notebooks, U-235 residues
29	1970–1971	2/25	N	78.4	24	Thermocouple waste, U-235 residue
30	1970–1971	2/25	N	78.4	11	Animal tissue, Pu-239 hot cell waste
31	1970–1971	2/25	N	78.4	47	DU
32	1970–1971	2/25	N	78.4	33	Los Alamos Molten Plutonium Reactor Experiment II (LAMPRE-II) lines and valves, animal tissue, irradiated stainless steel
33	1970–1971	2/25	N	78.4	15	Pu-239 hot cell waste
34	1970–1972	6/60	N	1709.2	932	U-contaminated oil
35	1971–1985	3/40	N	282.9	125	Hot cell wastes, animal tissues, herbicide containers, fission products
36	1970–1985	3/40	N	282.9	198	Hot cell wastes, spallation products
37	1970–1985	3/40	N	282.9	198	Animal and chemical wastes
38	1970–1974	3/40	N	282.9	69	Rover reactor parts, LAMPRE-II tank
39	1970–1973	6/60	N	1709.2	537	Tritium-contaminated equipment
40	1971	2/25	N	78.4	28	Animal tissue
41	1971–1972	2/25	N	78.4	71	Animal tissue, graphite
42	1972	2/25	N	78.4	56	Animal tissue, U-contaminated metal
43	1971–1972	2/25	N	78.4	43	U-contaminated metal, DU
44	1971–1972	2/25	N	78.4	61	Animal tissue, Pu-239-contaminated vermiculite, DU with graphite
45	1971–1972	2/25	N	78.4	70	Pu-contaminated steel, U-235 residues
46	1972	2/25	N	78.4	38	Animal tissue, Pu-239-contaminated steel
47	1972	2/25	N	78.4	32	Animal tissue, contaminated metal, fuel waste (no vol.)
48	1972	2/25	N	78.4	19	Hot cell trash, fuel waste (no vol.)
49	1972	2/25	N	78.4	21	Animal tissue
50	1974–1976	6/60	N	1709.2	581	Tritium (1110 Ci)
51	1975	2/25	N	78.4	52	Hot cell waste
52	1975–1976	2/25	N	78.4	6	Pu, U, mixed fission products, mixed activation products, hot cell wastes
53	1975–1976	2/25	N	78.4	3	Mixed fission products, cell wastes, Pu-239, U-235
54	1976	2/25	N	78.4	6	Mixed fission products, cell trash
55	1976–1977	2/25	N	78.4	20	Hot cell trash

Table 2.1-3 (continued)

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
56	1977	2/25	N	78.4	11	Cell waste, contaminated parts from Size Reduction Lab
57	1977	2/25	N	78.4	8	Hot cell waste
58	1972–1973	3/25	N	176.5	88	Hot cell waste, DU
59	1973–1974	6/60	N	1709.2	120	Tritium-contaminated steel, tools, and waste
60	1972–1974	3/25	N	176.5	128	Oil contaminated with U-235, Pu-239
61	1973–1974	3/25	N	176.5	143	Beryllium waste, U-238-contaminated metal, animal tissue
62	1976	3/25	N	176.5	141	Animal tissue, Pu-238, P-32
63	1976	3/25	N	176.5	28	DU, residues
64	1976–1977	3/25	N	176.5	32	Animal wastes, U-235
65	1976–1977	3/25	N	176.5	123	Classified U wastes, targets, animal tissue
66	1976–1979	3/25	N	176.5	25	Animal tissue
67	1977	2/25	N	78.4	48	Targets, cell trash
68	1977	2/25	N	78.4	23	Cell trash, classified notebooks
69	1977	2/25	N	78.4	20	Air conditioning parts from recovery
70	1975–1976	6/60	N	1709.2	917	Contaminated oil
71	1978	2/25	N	78.4	31	No description
72	1972–1973	2/25	N	78.4	61	Irradiated stainless steel, hot cell waste trash
73	1973	2/25	N	78.4	43	Hot cell trash
74	1973	2/25	N	78.4	69	Pu-239 waste
75	1973	2/25	N	78.4	61	Pu-238 waste, cell trash
76	1973–1974	2/25	N	78.4	75	Hot cell trash
77	1973–1974	2/25	N	78.4	33	Hot cell trash, Pu-239 hot cell trash
78	1974–1975	2/25	N	78.4	46	Cell wastes, reactor wastes, irradiated box ends
79	1974–1975	2/25	N	78.4	46	Hot cell waste, irradiated metal
80	1975–1976	2/25	N	78.4	25	Sodalime, Ta-182 chips, animal tissue
81	1976	2/25	N	78.4	na	Animal tissue (12 boxes)
82	1978	3/25	N	176.5	1	Trash, chemical wastes
83	1978	3/25	N	176.5	44	Animal tissue, DU
84	1978	3/25	N	176.5	17.3	Trash from Size Reduction Lab, cell trash
85	1978	3/25	N	176.5	12	Neutralized Na Dowanol, cell trash
86	1977	3/25	N	176.5	22	Spallation products, classified materials
87	1977	2/25	N	78.4	23	Cell wastes
88	1977	2/25	N	78.4	18	Cell wastes
89	1977–1978	2/25	N	78.4	12	Animal tissue (5 boxes), cell waste
90	1978	2/25	N	78.4	25	DU, hot cell trash

Table 2.1-3 (continued)

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
91	1977–1978	3/50	N	353.4	54	Spallation products, animal waste, cell trash, trash cans
92	1977–1978	3/50	N	353.4	60	Spallation products, uranyl-nitrate in HNO3
93	1978–1984	3/50	N	353.4	139	Spallation products, fuel elements, cell waste, animal tissues
94	1978–1984	3/50	N	353.4	29	Hot cell waste, DU, control rods
95	1984	3/50	N	353.4	142	Cell wastes, animal tissues
96	1977–1979	6/50	N	1413.6	438	Uranium-contaminated oil, niobium, zirconium, chlorides, aluminum shell
99	1983–1984	3/60	N	424.1	189	Hot cell wastes, animal tissue, machine parts
100	1983	3/60	N	424.1	3	Hot cell waste, target and stinger
101	1980–1981	3/60	N	424.1	75	Spallation products, hot cell waste
102	1982–1983	3/60	N	424.1	184	No description
103	1981–1982	3/60	N	424.1	118	Hot cell waste, spent fuel elements
104	1982	3/60	N	424.1	10	Uranium chips, scrap metal
105	1982–1983	3/60	N	424.1	2	Animal tissue
106	1980–1981	3/60	N	424.1	69	Spallation products, hot cell waste
107	1978–1981	3/60	N	424.1	27	Hot trash, animal tissue, chemical waste
108	1980–1982	3/60	N	424.1	230	Spallation products, solvent, animal tissue
109	1980	2/60	N	188.5	83	Spallation products, trash cans
110	1979	3/60	N	424.1	128	Spallation products, animal tissue, mixed combustible trash
111	1979–1980	2/60	N	188.5	134	Cell waste, spallation products, niobium and tantalum perchloride
112	1978–1979	3/60	N	424.1	149	Classified pieces, animal waste, cell waste, spallation products
114	1979–1982	6/60	N	1696.5	981	Shielding blocks, graphite design assembly
115	1979–1982	6/60	N	1696.5	539	Hot trash, tritium scrap
118	1983–1984	8/62	N	3267.3	461	Vials
119	1983	8/62	N	3116.5	549	DU chips, hydrocarbons, HF leach solids
120	1983–1984	8/63	N	3116.6	531	Shielding blocks, graphite design assembly
121	1984–1985	4/60	N	753.9	245	Animal tissue, cell trash
122	1984–1985	4/60	N	753.9	258	Hot cell waste, waste cans
123	1984	6/60	N	1696.5	516	DU chips and turnings, firing residue
124	1984–1991	6/65	N	1837.7	491	Vials, organics
125	1984	6/65	N	1837.7	597	DU chips and turnings
126	1985–1987	6/65	N	1837.7	781	Meson and hot cell waste
127	1985	6/65	N	1837.7	484	DU chips and turnings, U3 08 oil and wax
128	1985–1986	6/65	N	1837.7	417	Animal tissue, mustargen

Table 2.1-3 (continued)

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
129	1986	3/65	N	459.4	136	Mixed spallation products
130	1986–1987	6/65	N	1837.7	1110	DU chips, metal trash
131	1987–1995	6/65	N	1837.7	438	Activated shielding
132	1987–1993	6/65	N	1837.7	634	Classified material
133	1986–1987	4/65	N	816.8	96	Spallation products, hot cell waste
134	1986	3/65	N	459.4	239	Animal tissue
135	1986–1987	3/65	N	459.4	219	Animal tissue
136	1986–1995	6/65	N	1837.7	50	Low-level tritium
138	1987–1989	4/60	N	753.9	191	Animal tissue
139	1987–1988	4/60	N	753.9	308	Hot cell waste
140	1987–1991	6/61	N	1724.7	869	Animal tissue
150	1976–1979	6/60	CMPAC[e]	1696.5	86	Low-level tritium
151	1979–1986	3/60	CMPAC	424.1	131	Low-level tritium
152	1980–1983	3/60	CMPAC	424.1	147	Tritium scrap, tubing, hardware
153	1983–1984	3/60	CMPAC	424.1	12	Contaminated pump, property numbers
154	1984–1986	3/65	CMPAC	459.4	135	High-level tritium, molecular sieves
155	1988–1989	3/65	CMPAC	459.4	137	High-level tritium
156	1986–1987	3/45	CMPAC	318.2	59	Dry box trash, molecular sieves
157	1987–1988	3/45	CMPAC	318.2	88	Tritium
158	1989–1998	2/45	CMPAC	141.2	78	High-level tritium
159	1989	2/45	CMPAC	141.2	12	High-level tritium
160	1990–1993	2/45	CMPAC	141.2	89	High-level tritium
189	1987–1988	8/65	N	3267.3	1743	Los Alamos Meson Physics Facility (LAMPF) activated shielding (triple shaft)
190	1983–1984	8/65	N	3267.3	1077	Scrap metal
191	1984–1986	8/65	N	3267.3	1470	LAMPF scrap metal, graphite target (double shaft)
192	1987–1989	8/65	N	3267.3	1537	LAMPF scrap metal (triple shaft)
196	1989–1993	6/53	N	2997.5	2050	LAMPF inerts
200	1980–1981	1/18	SPI[f]	56.5	44	Hot cell wastes
201	1978–1979	1/18	SPI	56.5	39	Hot cell wastes
202	1980	1/18	SPI	56.5	43	Hot cell wastes
203	1980	1/18	SPI	56.5	43	Hot cell wastes
204	1978–1979	1/18	SPI	56.5	38	Hot cell wastes, fuel cans
205	1980	1/18	SPI	56.5	45	Hot cell wastes, trash, fuel cans
206	1980–1981	1/18	SPI	56.5	67	Cell trash and fuel sample
207	1981	1/18	SPI	56.5	48	Cell trash, fuel cells
208	1981	1/18	SPI	56.5	48	Hot cell trash, waste
209	1981	1/18	SPI	56.5	48	Hot cell paint, trash

Table 2.1-3 (continued)

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
210	1981	1/18	SPI	56.5	48	Hot cell trash
211	1981	1/18	SPI	56.5	48	Hot cell trash
212	1980	1/18	SPI	56.5	75	LAMPF fuel vessel
213	1981	1/18	SPI	56.5	30	Hot cell wastes, trash
214	1982	1/18	SPI	56.5	30	Hot cell wastes
215	1982	1/18	SPI	56.5	30	Hot cell trash
216	1982	1/18	SPI	56.5	30	Hot cell wastes
217	1982	1/18	SPI	56.5	30	Hot cell wastes
218	1982	1/18	SPI	56.5	30	Hot cell wastes
219	1983	1/18	SPI	56.5	30	Hot cell wastes
220	1983	1/18	SPI	56.5	30	Hot cell wastes
221	1983	1/18	SPI	56.5	30	Hot cell wastes
222	1983	1/18	SPI	56.5	30	Hot cell wastes
223	1983	1/18	SPI	56.5	30	Hot cell wastes
224	1985	1/18	SPI	56.5	4	Hot cell wastes
225	1984	1/18	SPI	56.5	4	Hot cell wastes
226	1984	1/18	SPI	56.5	4	Hot cell wastes
227	1984	1/18	SPI	56.5	4	Hot cell wastes
228	1987	1/18	SPI	56.5	1	Hot cell wastes
229	1984	1/18	SPI	56.5	5	Hot cell wastes
230	1984	1/18	SPI	56.5	4	Hot cell wastes
231	1985	1/18	SPI	56.5	4	Hot cell wastes
232	1987	1/18	SPI	56.5	1	Hot cell wastes
233	na	1/18	SPI	56.5	na	Hot cell wastes
C1	na	6/60	N	1696.5	221	PCBs (no liquids)
C2	na	6/60	N	1696.5	357	PCBs (no liquids)
C3	na	6/60	N	1696.5	339	PCBs (no liquids)
C4	na	6/60	N	1696.5	385	PCBs (no liquids)
C5	na	6/60	N	1696.5	258	PCBs (no liquids)
C6	na	6/60	N	1696.5	449	PCBs (no liquids)
C7	na	6/60	N	1696.5	512	PCBs (no liquids)
C8	na	6/60	N	1696.5	498	PCBs (no liquids)

Table 2.1-3 (continued)

Shaft No.	Operational Period	Diameter/ Depth (ft)	Lining	Shaft Volume (ft^3)	Waste Volume (ft^3)	Waste Description
C9	na	6/60	N	1696.5	406	PCBs (no liquids)
C10	1984–1985	6/60	N	1696.5	534	PCBs (no liquids)
C12	1986–1990	6/65	N	1696.5	588	PCBs (no liquids)
C13	1987–1995	6/65	N	1696.5	1060	PCBs (no liquids)

Note: Does not include LLW shafts.
[a] N = No.
[b] DU = Depleted uranium.
[c] na = Not available.
[d] CMP = Corrugated metal pipe.
[e] CMPAC = Corrugated metal pipe asphalt coated.
[f] SPI = Steel pipe insert.

Table 2.4-1
MDA G Subsurface Pore-Gas Monitoring Locations

Borehole ID	VOC and Tritium Sampling Port Depth Intervals (ft bgs)
54-01107	20 (19–21), 44.5 (43.5–45.5), **56.5 (55.5–57.5)**, 74 (73–75), 91 (90–92), **100 (99–101)**
54-01110	20 (19–20), 48 (47–49), **60 (59–61)**, 70 (69–71), 85 (84–86), **90 (89–91)**
54-01111	**20 (19–21)**, 39.5 (38.5–40.5), 50 (49–51), 70 (69–71), 78 (77–79), 100 (99–101), **139 (138–140)**
54-01115[a]	7 (6–8), 26 (25–27), **40 (39–41)**, 53 (52–54), 63 (62–64), **68 (67–69)**
54-01116	**22.5 (20–25)**, 42.5 (40–45), 67.5 (65–70), 82.5 (80–85), 97.5 (95–100), 132.5 (130–135), 151.5 (149–154), 165 (162.5–167.5), **187.8 (185.3–190.3)**
54-01117[b]	**20 (20),** 31.5 (31.5), 55 (55), 73 (73), 82 (82), **85 (85)**
54-01117[c]	**20 (18.5–22.5)**, 42.5 (40–45), 67.5 (65–70), 82.5 (80–85), 97.5 (95–100), 132.5 (130–135), 150 (147.5–152.5), 159.5 (157–162), **179.8 (177.3–182.3)**
54-01121	**20 (19–21)**, 26 (25–27), 61.5 (60.5–62.5), 70 (69–71), 76 (75–77), 98 (97–99), **121 (120–122)**
54-01126[a]	7 (6–8), 17 (16–18), 28 (27–29), **35 (34–36)**, 42 (41–43), **49 (48–50)**
54-01128[a]	7.5 (6.5–8.5), 15(14–16), **20 (19–21)**, 30 (29–31), **39 (38–40)**
54-02009	**37 (34.5–39.5)**, 62 (59.5–64.5), 79 (76.5–81.5) **92 (89.5–94.5)**
54-02010	**30 (27.5–32.5)**, 53 (51.5–55.5), **95 (92.5–97.5)**
54-02032	**20 (20)**, 60 (60), 100 (100), 130 (130), **156 (156)**
54-02033	20 (20), **60 (60)**, 100 (100), 160 (160), 200 (200), 220 (220), 260 (260), **277 (277)**
54-22116[d]	28 (27–29), 46 (45–47), 64 (63–65), 82 (81–83), 100 (99–101), 118 (117–119), 136 (135–137), 154 (153–155), **172 (171–173), 190 (189–191),** 208 (207-209), 226 (225–227), 244 (243–245), 262 (261–263), **280 (279–281)**
54-24370	**40 (35–45)**, 72.5 (67.5–77.5), 120 (115–125), 174.7 (169.7–179.7), 200 (195–205), **243.7 (238.7–248.7)**
54-24386	**40 (37.5–42.5)**, 83 (80.5–85.5), 117 (114.5–119.5), 135 (132.5–137.5), **195 (192.5–197.5)**
54-24394	**50 (45–55)**, 100 (95–105), 150 (145–155), 192.5 (187.5–197.5), 245.25 (240.25–250.25), **300.5 (295.5–305.5)**
54-24397	**50 (45–55)**, 90 (85–95), 130 (125–135), 165 (160–170), 188 (183–193), **239.75 (234.75–244.3)**
54-25105[e]	**485 (485–701)**
54-27436	**45 (40–50)**, 70 (65–75), 115 (110–120), 163 (158–168), **185 (180–190)**

Note: Depths highlighted in bold denote intervals where VOC and tritium samples are to be collected.

[a] Borehole location is an angled borehole. Port depth and interval is depth below ground surface.

[b] Borehole depth represents old port intervals before redrilling and installation of new depths.

[c] Borehole location redrilled during the reporting time frame (May and June of 2008).

[d] Borehole location is horizontal borehole. Port depths and intervals are length from borehole head.

[e] Open borehole.

Table 2.5-1
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 2.5-2
2010 Interim Monitoring Plan for Wells in the TA-54 Monitoring Group

Well	TAL Metals[a]	VOC + TICs[b]	SVOC + TICs[b]	Pesticides	PCB[c]	HEXP[d]	Dioxins/Furans	RAD[e]	Low-Level Tritium[f]	Gen. Inorganics[g]	Perchlorate	Stable Isotopes[h]	Field Parameters[i]
Wells downgradient of MDA G													
R-22 screen 1	TBD[j]	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
R-22 screens 2 through 5	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
R-23i[k] piezometer (port 1)	Q	Q	S	–[l]	–	S	–	A	S	Q	S	A	Q
R-23i[k] screen 1 (port 2)	Q	Q	S	–	–	S	–	A	S	Q	S	A	Q
R-23i[k] screen 2 (port 3)	Q	Q	S	–	–	S	–	A	S	Q	S	A	Q
R-23[k]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	A	Q
R-39	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-41 screen 1	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-41 screen 2	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-49 screen 1	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-49 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-55 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-55 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-57 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-57 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
Wells downgradient of MDA H													
R-20 screen 1[m]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-20 screen 2[m]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q

Table 2.5-2 (continued)

Well	TAL Metals[a]	VOC + TICs[b]	SVOC + TICs[b]	Pesticides	PCB[c]	HEXP[d]	Dioxins/Furans	RAD[e]	Low-Level Tritium[f]	Gen. Inorganics[g]	Perchlorate	Stable Isotopes[h]	Field Parameters[i]
R-37 screen 1	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-37 screen 2	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-40i[n]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-40 screen 1[n]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-40 screen 2[m]	Q	Q	Q	A	A	A	A	A	Q	Q	Q	S	Q
R-52 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-52 screen 2	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
Wells downgradient of MDA L													
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-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[m]	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-54 screen 2[m]	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

Table 2.5-2 (continued)

Well	TAL Metals[a]	VOC + TICs[b]	SVOC + TICs[b]	Pesticides	PCB[c]	HEXP[d]	Dioxins/Furans	RAD[e]	Low-Level Tritium[f]	Gen. Inorganics[g]	Perchlorate	Stable Isotopes[h]	Field Parameters[i]
Wells upgradient of MDAs G, H, and L													
R-51 screen 1	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	S	Q
R-51 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 high-explosives 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 target analyte list (TAL) metals, plus boron, molybdenum, silicon dioxide, strontium, tin, and uranium.

[b] VOC = Volatile organic compounds; SVOC = semivolatile organic compounds; TICs = tentatively identified compounds.

[c] PCB = Polychlorinated biphenyl (compound).

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

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

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

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

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

[i] Field parameters include pH, turbidity, specific conductance, dissolved oxygen, and temperature at all locations. Oxidation-reduction potential (ORP) will be measured if a flow-through cell is used. Alkalinity (ALK) will be measured for all samples either in the field or at the on-site Earth and Environmental Sciences (EES-14) laboratory.

[j] TBD = to be determined.

[k] In the 2010 IFGMP (LANL 2010, 109830, Table 5.4-1), wells R-23 and R-23i are assigned to "General Surveillance Monitoring Locations." These wells are included in Table 2.5-2 above because they are relevant downgradient wells.

[l] — = This analytical suite is not scheduled to be collected at this location.

[m] 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.

[n] 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

Table 5.2-1
Summary of Regulatory Criteria and Cleanup Levels

Media	Regulatory Standard
Groundwater*	– NMWQCC standards – Safe Drinking Water Act standards – EPA regional tap water screening levels (SLs)
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 Technologies

Area	No Action	Containment Technologies	In Situ Treatment	Excavation
Pits and Shafts Exposure pathways of concern include • direct exposure to waste via erosion, biointrusion, waste subsidence, 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 and 2B – Source area SVE	Alternative 3 – Excavation of pits and shafts with off-site disposal
Vadose Zone Exposure pathway includes • volatilization of VOCs from waste or volatilization/vapor diffusion from contaminated subsurface soils with vapor transport through pore gas to groundwater	Alternative 1 No action	n/a*	Alternative 3 – Source area SVE	n/a

Note: Pore-gas monitoring and institutional controls will be implemented in conjunction with all technologies other than no-action technology.

* 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 pits and 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. 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 3 Waste excavation, SVE, and institutional controls	• Waste from the pits and shafts 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 cleanup 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 pits and shafts 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.

* Human health and the environment.

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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	$215,055	$796,072	$28,204			$1,039,331	10,250	LF	$101
		Fencing Total						**$1,039,331**			
	RCRA Cover										
		Site Prep	$332,536	$135,521	$66,958	$2,396		$537,410	1	LS	$537,410
		Cover Prep	$628,799	$4,306,660	$473,734			$5,409,193	61,387	CY	$88
		Compacted Clay (2 ft)	$5,206,285	$13,938,264	$6,436,802			$25,581,351	162,914	CY	$157
		Geomembrane (40 mil HDPE)	$1,017,163	$3,261,562	$298,008			$4,576,734	51	AC	$89,740
		Drainage Layer (1 ft)	$839,904	$3,445,897	$631,533			$4,917,334	82,197	CY	$60
		Cover Soil/Surface Treatment (2 ft)	$2,232,352	$6,807,405	$1,855,179			$10,894,936	162,914	CY	$67
		Cover Armoring	$760,938	$229,199	$16,812			$1,006,949	4840	CY	$208
		Vegetation	$178,371	$5,537,305	$82,696			$5,798,372	51	AC	$113,694
		RCRA Cover Total						**$58,722,278**			
	SVE										
		SVE Unit				$561,247		$561,247	8	EA	$70,156
		Extraction Boreholes & SVE Installation	$1,096,897	$139,955	$25,028	$170,427		$1,432,307	24	EA	$59,679
		Monitoring Borehole Conversions	$163,885	$55,271	$10,165	$36,960		$266,281	4	EA	$66,570
		Monitoring Borehole Conversions 600'	$68,626	$26,344	$2,026			$96,995	1	EA	$96,995
		SVE Total						**$2,356,831**			
	Distributable										
		Distributables Total	$6,190,861	$436,808				**$6,627,668**			
	O&M										
		Active SVE Operation (3 yr)				$3,350,304		$3,350,304	3	YR	$1,116,768
		Active SVE Monitoring (3 yr)				$479,306		$479,306	3	YR	$159,769
		Rebound SVE Monitoring (3 yr)				$970,595		$970,595	3	YR	$323,532
		Subsurface VOC Vapor Monitoring				$1,493,472		$1,493,472	27	YR	$55,314
		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						**$6,738,601**			

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				$16,013,993		$16,013,993			
		Professional Management	$48,287,292					$48,287,292			
		Contingency					$66,523,695	$66,523,695			
		Indirect Total						**$130,824,980**			
	Indirect O&M										
		Professional Management	$2,299,652					$2,299,652			
		Contingency				$4,519,127		$4,519,127			
		Indirect O&M Total						**$6,818,778**			
		Total Costs 2A Multilayer (RCRA) Cover, SVE, Institutional Controls						**$213,128,468**			

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 G. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix G. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix G. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix G. 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 G 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	$215,055	$796,072	$28,204			$1,039,331	10,250	LF	$101
		Fencing Total						**$1,039,331**			
	ET Cover										
		Site Prep	$332,536	$135,521	$66,958	$2,396		$537,410	1	LS	$537,410
		Cover Prep	$628,799	$4,306,660	$473,734			$5,409,193	61,387	CY	$88
		Biobarrier (1 ft)	$178,812	$3,892,424	$285,510			$4,356,746	82,197	CY	$53
		Filter Layer (0.5 ft)	$306,278	$3,125,558	$312,647			$3,744,483	41,140	CY	$91
		Fine-Grained Cover Layer (3.5 ft)	$1,285,737	$20,203,493	$1,975,572			$23,464,802	287,980	CY	$81
		Cover Soil/Surface Treatment (1.5 ft)	$1,674,244	$5,105,527	$1,391,367			$8,171,138	123,420	CY	$66
		Cover Armoring	$760,938	$229,199	$16,812			$1,006,949	4840	CY	$208
		Vegetation	$178,371	$5,537,305	$82,696			$5,798,372	51	AC	$113,694
		TDR Moisture Monitoring	$7,566	$64,167				$71,733	1	LS	$71,733
		ET Cover Total						**$52,560,826**			
	SVE										
		SVE Unit				$561,247		$561,247	8	EA	$70,156
		Extraction Boreholes & SVE Installation	$1,096,897	$139,955	$25,028	$170,427		$1,432,307	24	EA	$59,679
		Monitoring Borehole Conversions	$163,885	$55,271	$10,165	$36,960		$266,281	4	EA	$66,570
		Monitoring Borehole Conversions 600'	$68,626	$26,344	$2,026			$96,995	1	EA	$96,995
		SVE Total						**$2,356,831**			
	Distrib.										
		Distributables Total	$3,379,065	$238,419				**$3,617,483**			
	O&M										
		Active SVE Operation (3 yr)				$3,350,304		$3,350,304	3	YR	$1,116,768
		Active SVE Monitoring (3 yr)				$479,306		$479,306	3	YR	$159,769
		Rebound SVE Monitoring (3 yr)				$970,595		$970,595	3	YR	$323,532
		Subsurface VOC Vapor Monitoring				$1,493,472		$1,493,472	27	YR	$55,314
		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						**$6,738,601**			

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				$13,877,515		$13,877,515			
		Professional Management	$41,845,131					$41,845,131			
		Contingency					$57,648,557	$57,648,557			
		Indirect Total						**$113,371,203**			
	Indirect O&M										
		Professional Management	$2,299,652					$2,299,652			
		Contingency					$4,519,127	$4,519,127			
		Indirect O&M Total						**$6,818,778**			
Total Costs 2B ET Cover, SVE, Institutional Controls								**$186,503,053**			

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 G. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix G. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix G. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix G. 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 G 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 3

	Item Description		Labor Cost	Material Cost	Equipment Cost	Subcontractor Cost	Other Costs	Gross Cost	Parametric Quantity	Parametric Unit	Parametric Cost
Alt.3	**Excavation, SVE, and, Institutional Controls**										
Direct Costs	Site Fencing										
		Site Fencing	$215,055	$796,072	$28,204			$1,039,331	10,250	LF	$101
		Fencing Total						**$1,039,331**			
	SVE										
		SVE Unit				$561,247		$561,247	8	EA	$70,156
		Extraction Boreholes & SVE Installation	$1,096,897	$139,955	$25,028	$170,427		$1,432,307	24	EA	$59,679
		SVE Total						**$1,993,554**			
	Excavation										
		Excavation Site Prep (including enclosures)	$194,142,849	$135,521	$634,696	$539,038,504		$733,951,569	1	LS	$733,951,569
		Excavation Shafts (1)	$7,108,617	$27,658	$3,881,276		$176,251	$11,193,802	73,008	CY	$153
		Excavation Shafts (2)	$1,113,845	$5,339	$715,481		$33,719	$1,868,383	11,849	CY	$158
		Excavation Shafts (3)	$923,286	$3,183	$496,328		$20,508	$1,443,305	10,153	CY	$142
		Excavation Shafts (4)	$1,700,131	$7,830	$979,510		$59,237	$2,746,707	18,854	CY	$146
		Excavation Shafts (5)	$2,397,187	$12,436	$1,441,405		$78,389	$3,929,417	24,683	CY	$159
		Excavation Shafts (6)	$2,124,727	$11,704	$1,206,326		$67,438	$3,410,194	20,913	CY	$163
		Backfill of Shafts (1)	$1,585,578	$50,481	$611,012			$2,247,072	75,110	CY	$30
		Backfill of Shafts (2)	$254,102	$4,738	$97,920			$356,759	12,037	CY	$30
		Backfill of Shafts (3)	$215,977	$2,005	$83,228			$301,210	10,231	CY	$29
		Backfill of Shafts (4)	$400,205	$2,645	$154,221			$557,072	18,958	CY	$29
		Backfill of Shafts (5)	$533,621	$14,992	$205,634			$754,247	25,278	CY	$30
		Backfill of Shafts (6)	$457,392	$22,352	$176,259			$656,003	21,667	CY	$30
		Disposal of Waste Shafts (1)	$5,133,617	$2,179,235	$522,081	$4,111,327	$971,603	$12,917,863	2103	CY	$6,143
		Disposal of Waste Shafts (2)	$464,167	$196,856	$47,215	$370,436	$91,805	$1,170,479	188	CY	$6,226
		Disposal of Waste Shafts (3)	$196,981	$82,887	$20,244	$156,625	$38,252	$494,989	79	CY	$6,266
		Disposal of Waste Shafts (4)	$261,158	$110,516	$26,663	$206,186	$160,658	$765,180	105	CY	$7,287
		Disposal of Waste Shafts (5)	$1,456,677	$618,198	$148,065	$1,170,399	$275,415	$3,668,753	595	CY	$6,166
		Disposal of Waste Shafts (6)	$343,712		$19,069	$1,292,764		$1,655,545	227	CY	$7,293
		Disposal RCRA Wast Shafts (6)	$172,914	$72,526	$17,837	$135,657	$38,252	$437,186	68	CY	$6,429
		Excavation of Pit (MLLW)	$261,445,616	$421,336	$53,816,369	$444,891	$2,754,683	$318,882,895	1,020,464	CY	$312
		Excavation of Pit (MLLW + TRU)	$124,635,335	$194,170	$24,735,430		$1,236,206	$150,801,140	470,789	CY	$320
		Backfill of Pit (MLLW Grouping)	$21,542,079	$15,255,748	$8,301,369			$45,099,197	1,020,464	CY	$44
		Backfill of Pit (MLLW & TRU Grouping)	$9,938,395	$7,387,202	$3,829,820			$21,155,417	470,789	CY	$45
		Disposal of Waste Pit (MLLW)	$1,477,947,726	$627,274,178	$150,213,707	$1,190,598,529	$277,908,948	$3,723,943,089	605,426	CY	$6,151
		Disposal of Waste Pit (MLLW + TRU)	$2,085,045,887	$273,493,464	$147,226,087	$745,445,481	$109,691,639	$3,360,902,558	383,498	CY	$8,764
		Confirmatory Sampling	$41,072,628		$55,120	$536,395,396		$577,523,143	88,862	EA	$6,499
		Equipment Decon	$1,204,798	$3,234,016				$4,438,815	1	LS	$4,438,815
		Revegetation	$178,371	$5,537,305	$82,696			$5,798,372	51	AC	$113,694
		Excavation Total						**$8,993,070,362**			

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
	Distrib.										
		Distributables	$2,214,964,189	$156,282,633				$2,371,246,822			
	O&M										
		Active SVE Operations (3 yr)				$3,350,304		$3,350,304	3	YR	$1,116,768
		Active SVE Monitoring (3 yr)				$479,306		$479,306	3	YR	$159,769
		Rebound SVE Monitoring (3 yr)				$970,595		$970,595	3	YR	$323,532
		O&M Total						**$4,800,204**			
Indirect Costs	Indirect Capital Costs										
		Design				$992,666,263		$992,666,263			
		Professional Management	$7,041,423,065					$7,041,423,065			
		Contingency					$9,700,719,697	$9,700,719,697			
		Indirect Total						$17,734,809,025			
	Indirect O&M										
		Professional Management	$1,878,319					$1,878,319			
		Contingency					$3,339,261	$3,339,261			
		Indirect O&M Total						**$5,217,580**			
		Total Cost for 3 Excavation, SVE, Institutional Controls						**$29,112,176,879**			

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 G. Material costs are products necessary to complete the specific tasks in the detailed cost estimate in Appendix G. Equipment costs are the mechanized and/or hand tools needed to complete the specific tasks in the detailed cost estimate in Appendix G. Subcontract costs are a lump sum costs, usually based on past history, to complete the specific tasks in the detailed cost estimate in Appendix G. 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 G 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 Rating 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
Screening 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 obtained.	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**

Table 9.1-2 (continued)

Alternative	Balancing Criteria	Rating Justification	Rating
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 Alternative 3, which includes excavation.	2
	Reduction of Toxicity, Mobility, or Volume	SVE will reduce volume and downward mobility of VOCs. The multilayer cover reduces infiltration, therefore reducing mobility. This alternative is comparable to Alternative 2B but is rated lower than Alternative 3, which includes excavation.	3
	Short-Term Effectiveness	This alternative is comparable to Alternative 2B but is rated higher than Alternative 3, which includes excavation because of the risks associated with excavation and waste handling.	4
	Implementability	This alternative uses standard construction techniques. This alternative is comparable to Alternative 2B but is rated higher than Alternative 3, which includes 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 Alternative 3, which includes excavation because of its additional costs for excavation and waste handling.	3
	Total		**15**

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, Alternative 3 is rated higher.	3
	Reduction of Toxicity, Mobility, or Volume	SVE will reduce volume and downward mobility of VOCs. The ET cover reduces infiltration, therefore reducing mobility. This alternative is comparable to Alternative 2A but is rated lower than Alternative 3, which includes excavation.	3
	Short-Term Effectiveness	This alternative is comparable to Alternative 2A but is rated higher than Alternative 3, which includes excavation because of the risks associated with excavation and waste handling.	4
	Implementability	This alternative uses standard construction techniques. This alternative is comparable to Alternative 2A but is rated higher than Alternative 3, which includes 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 Alternative 3, which includes excavation because of its additional costs for excavation and waste handling.	3
	Total		**16**

Table 9.1-2 (continued)

Alternative	Balancing Criteria	Rating Justification	Rating
Alternative 3 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
AD	Associate Director (tax)
AEA	Atomic Energy Act
ALARA	as low as reasonably achievable
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
B&K	Brüel and Kjær
bgs	below ground surface
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	decontamination and decommissioning
DCA	dichloroethane
DCE	dichloroethylene (also dichloroethene)
DL	detection limit
DO	dissolved oxygen
DOE	Department of Energy (U.S.)
DVRS	Decontamination and Volume Reduction System
EBR	Experimental Breeder Reactor

EPA	Environmental Protection Agency (U.S.)
ET	evapotranspiration
FEHM	Finite Element Heat and Mass transfer code
FLUTe	Flexible Liner Underground Technologies
FV	fallout value
FY	fiscal year
G&A	general and administrative (tax)
GAC	granular activated carbon
GBIR	Groundwater Background Investigation Report
gpd	gallons per day
gpm	gallons per minute
HDPE	high-density polyethylene
HELP	Hydrologic Evaluation of Landfill Performance (EPA infiltration model)
HH	human health
HH&E	human health and environment
HI	hazard index
hp	horsepower
HWA	Hazardous Waste Act (New Mexico)
HWFP	Hazardous Waste Facility Permit
IFGMP	Interim Facility-Wide Groundwater Monitoring Plan
IR	investigation report
JMVF	Jemez Mountain volcanic field
LAMPF	Los Alamos Meson Physics Facility
LANL	Los Alamos National Laboratory
LDR	land disposal restriction
LLW	low-level radioactive waste
Ma	million years ago
MCL	maximum contaminant level
MDA	material disposal area
MDL	method detection limit
meq	millaequivalent(s)
MLLW	mixed low-level waste
MOVER	Mobile Visual Examination and Repackaging
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
NMEID	New Mexico Environmental Improvement Division (New Mexico Environment Department before 1991)
NMGRT	New Mexico gross receipts tax
NMWQCC	New Mexico Water Quality Control Commission
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
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)
PEL	permissible exposure limit (OSHA)
PET	potential evapotranspiration
PETN	pentaerythritol tetranitrate
PLS	pure live seed
PMR	periodic monitoring report
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
RH	remote handling

ROI	radius of influence
RPF	Records Processing Facility
RSRL	regional statistical reference level
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)
TATB	triaminotrinitrobenzene
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TD	total depth
TDR	time-domain reflectometer
TDS	total dissolved solids
TEDE	total effective dose equivalent
TIC	tentatively identified compound
TKN	total Kjeldahl nitrogen
TLV	threshold limit value (American Conference of Governmental Industrial Hygienists)
TOC	total organic carbon
TOCP	tri-ortho-cresyl-phosphate
TRU	transuranic
TSCA	Toxic Substances Control Act
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

Historical Investigations

B-1.0 INTRODUCTION

This appendix provides additional information for Phase I Resource Conservation and Recovery Act facility investigation (RFI) activities and investigations under the Compliance Order on Consent (the Consent Order) conducted for Material Disposal Area (MDA) G. It also summarizes site-specific studies of typical Los Alamos National Laboratory (the Laboratory or LANL) rooting depths (i.e., biointrusion), predicted contaminant breakthrough times to groundwater, and near-surface hydrologic behavior at MDA G.

B-2.0 PHASE I RFI ACTIVITIES

In 1993, 1994, and 1995, samples were collected at MDA G during the Phase I RFI. In addition, pore-gas samples have been collected since 1985. The results of these previous investigations are summarized in the historical investigation report of the approved investigation work plan for MDA G (LANL 2004, 087833, Appendix B, pp. B-5–B-18).

During the Phase I RFI, the following samples were collected and analyzed:

- 59 surface channel sediment samples in surrounding canyons
- 156 core samples from 10 vertical boreholes and 10 angled boreholes in the mesa
- 142 tritium surface-flux samples
- 281 (including field duplicates) volatile organic compound (VOC) surface-flux samples consisting of 227 ambient-air samples for tritium and 16 ambient-air samples for VOCs
- 48 subsurface pore-gas samples for VOCs
- 13 subsurface pore-gas samples for tritium

In the channel sediments, six metals, including beryllium, cadmium, cobalt, mercury, selenium, and silver, were retained as chemicals of potential concern (COPCs) because of either elevated concentrations or detection limits above background values (BVs). Five radionuclides, including tritium, cobalt-60, plutonium-238, plutonium-239, and americium-241, were detected in channel sediment samples: all were above BVs, except cobalt-60, for which a BV has not been established (LANL 1998, 059730, pp. 44–45). Therefore, these radionuclides were also identified as COPCs (Figure B-2.0-1). Methoxychlor(4, 4'-) was the only organic chemical detected in sediment and was also identified as a COPC. The channel sediment sampling data are shown in Figure B-2.0-2.

In the ambient-air samples, slightly elevated to elevated levels of radionuclides (i.e., tritium, plutonium-238, plutonium-239, americium-241, and various uranium isotopes) as well as two VOCs (i.e., acetone, and methanol) were detected (Tables B-2.0-1 and B-2.0-2). Locations of the ambient-air sampling stations are shown in Figure B-2.0-3.

Tritium and four VOCs, specifically, methylene chloride; 1,1,1-trichloroethane (TCA); tetrachloroethene (PCE); and 1,1,2-trichlorotrifluoroethane (Freon-113) were detected in surface flux-gas samples (Eklund 1995, 056033, pp. 3-9, 3-18, 4-2–4-9, and 4-12). Locations of tritium high-flux areas are shown in Figure B-2.0-4, and tritium and VOC surface flux chamber sampling locations are shown in Figure B-2.0-5.

VOC surface flux was measured across Area G in two surveys conducted in August 1993 and August 1994 using a surface flux chamber and EMFLUX surface adsorbent cartridges (Figure B-2.0-6). Details of the surface flux chamber investigations are reported in Eklund (1995, 056033, pp. iv–7-1).

Details of the EMFLUX surface adsorbent cartridges investigations are presented in reports prepared by Quadrel Services (1993, 063868, pp. 9–11; 1994, 063869, pp. 3-21) and Trujillo et al. (1998, 058242, pp. 18–21). During the summers of 1993 and 1994, tritium flux was measured at 142 locations on and near the surface of Area G (Eklund 1995, 056033, pp. 3-11–3-17) (Figure B-2.0-6). Sixteen VOCs were detected in 1993 mesa-top surface flux studies: acetone, benzene, carbon disulfide, carbon tetrachloride, chloroform, chloromethane, 1,1-dichloroethane (DCA), 1,1-dichloroethene (DCE), methylene chloride, PCE, toluene, TCA, trichloroethene (TCE), trichlorofluoromethane (Freon-11), Freon-113, and xylenes. Slightly fewer (i.e., 10) VOCs were detected in the 1994 samples: acetone, DCA, DCE, methylene chloride, PCE, toluene, TCA, TCE, Freon-113, and xylenes.

Additionally, in 1994, 16 ambient-air samples were collected for 8 d at two sampling locations along the northern perimeter of Area G. Surface flux and ambient-air sampling results indicated that VOCs and tritium were being released into the atmosphere from the subsurface (LANL 2005, 090513, p. 4).

Borehole soil and tuff core samples identified 43 COPCs, including one anion (cyanide); eight metals (antimony, cadmium, mercury, molybdenum, selenium, silver, thallium, and vanadium); 12 radionuclides (i.e., ,tritium, cobalt-60, strontium-90, cesium-137, europium-152, thorium-230, uranium-234, uranium-235, uranium-238, plutonium-238, plutonium-239, and americium-241); and 22 organic compounds (acetone, aldrin, Aroclor-1254, benzene, benzo(a)pyrene, benzo(g,h,i)perylene, bis(2 ethylhexyl)phthalate, 2-butanone, butylbenzylphthalate, gamma-chlordane, di-n-butylphthalate, di-n-octylphthalate, ethylbenzene, heptachlor epoxide, methylene chloride, 2-methylnaphthalene, naphthalene, pyrene, PCE, toluene, 1,2,4-trimethylbenzene, and total xylenes). Figures B-2.0-7, B-2.0-8, and B-2.0-9 show the locations and data for the above-listed COPCs.

The pore-gas monitoring data for MDA G indicate VOCs are COPCs in pore gas. TCA is the dominant VOC detected. The highest TCA concentration measured was 167 ppmv. Table B-2.0-3 presents the detected VOCs in pore-gas samples from MDA G subsurface units between 1999 and 2002, with borehole sampling locations shown in Figure B-2.0-10.

In 2003, 13 subsurface pore-gas samples were collected and analyzed for tritium from two boreholes, 54-01110 and 54-01111, located next to the tritium disposal shafts. A review and analysis of the data indicate that tritium has been released into the tuff beneath the disposal units (LANL 2005, 090513, p. 4). Table B-2.0-4 summarizes the pore-gas tritium results for these two boreholes (LANL 2004, 087833, Appendix B, p. B-75).

B-3.0 CONSENT ORDER INVESTIGATION ACTIVITIES

B-3.1 2005 Activities

Field investigations conducted in 2005 at MDA G under the Consent Order are reported in the MDA G investigation report (LANL 2005, 090513). During this investigation, 39 boreholes (Figure B-3.1-1) were drilled in accordance with the approved MDA G work plan (LANL 2004, 087833). In 2005, the Consent Order required pore-gas monitoring during the site investigations for all MDAs and a long-term pore-gas monitoring plan for each MDA. The Consent Order required that drilling continue a minimum of 25 ft (8 m) below the deepest detected VOC contamination zone, based on head-space field screening. Thirty-seven shallow boreholes were drilled using a hollow-stem auger rig either to refusal or to the target depth specified in the work plan. Per the Consent Order, another deep borehole was drilled with an air-rotary rig to determine whether perched water was present. This borehole was abandoned at 556 ft (169 m) when drilling problems prevented further advancement the target depth of 700 ft (213 m). A replacement borehole was drilled next to the target depth.

Continuous cores were collected from the 37 shallow boreholes to characterize the stratigraphy beneath the site. Core samples were analyzed for target analyte list (TAL) metals, cyanide, nitrates, explosive compounds, dioxins, furans, perchlorate, VOCs, and radionuclides. The sampling, which focused on fracture characterization, included the collection of fracture fill material and surrounding intact tuff (Table B-3.1-1). Geotechnical and geochemical samples were collected from the deep boreholes to measure chloride-ion concentration, matric potential, and moisture content. Pore-gas samples for tritium and VOCs were collected to evaluate the nature and extent of vapor-phase VOCs and tritium in pore gas beneath MDA G.

The soil and tuff sampling results indicated a number of inorganic and organic chemicals (Plates B-1 and B-2, respectively) were detected at trace levels beneath the former disposal units and were consistent with the results obtained during the Phase I RFI. The only organic compounds detected in core samples were trace levels of several dioxin and furan congeners. The inorganic chemicals detected above BVs did not show any discernable patterns or trends to indicate a release from the historical subsurface waste units at MDA G.

Naturally occurring and anthropogenic radionuclides were confirmed at levels above BVs in soil and rock samples collected beneath MDA G. The anthropogenic radionuclides detected sporadically across the site included americium-241, plutonium-238, plutonium-239, and strontium-90. Naturally occurring radionuclides detected above BVs included thorium isotopes, uranium-234, uranium-235, and uranium-238 (Plate B-3).

Pore-gas samples were collected in the boreholes at the depth nearest to the disposal unit and at the total depth of the borehole. The pore-gas sample results confirmed the presence of VOCs, consisting primarily of chlorinated VOCs, in the vadose zone beneath MDA G. Data collected during the Phase I RFI, quarterly monitoring events, and the 2005 investigation indicate the highest VOC concentrations are beneath the eastern and south-central portions of MDA G and are limited at depth by the Cerros del Rio basalt at approximately 630 ft (192 m). The dominant subsurface vapor contaminant is TCA. Tritium was also detected in pore gas. The highest tritium concentrations were detected in samples from locations in the eastern and south-central portions of MDA G, coinciding with the highest vapor concentrations of VOCs (Tables B-3.1-2 and B-3.1-3).

Subsurface samples collected to a depth of 700 ft (210 m) beneath the MDA G subsurface units did not identify perched water zones. Gravimetric moisture analyses showed moisture levels ranging from 0.2% to 27.2% by weight (Table B-3.1-4). Laboratory matric potential readings confirmed all samples collected beneath MDA G contained moisture levels below saturation. Perched groundwater was not detected in the 39 boreholes, including the deep borehole completed to 700 ft (210 m). Perched groundwater is unconfined and separated from an underlying main body of groundwater by an unsaturated zone. Not finding perched groundwater, however, does not preclude the possibility of concentrated preferential flow, including lateral flow.

B-3.2 2007 Supplemental Site Investigation

A supplemental investigation was conducted in 2007 at MDA G that focused primarily on additional pore-gas sampling (LANL 2007, 101771). The Laboratory extended four existing boreholes ([BH] 2 [location 54-24361], BH-10 [location 54-24370], BH-26 [location 54-24386], and BH-34 [location 54-24394], shown in Figure B-3.1-1), to define the vertical extent of VOC pore-gas contamination (LANL 2007, 096110, p. v). Table B-3.2-1 summarizes a typical sampling port construction. Also, during this investigation, an existing borehole, BH-37 (location 54-24397), was extended to determine the vertical profile of tritium concentrations in the vapor phase at this location.

The 2007 pore-gas sampling confirmed the results of the Phase I RFI, previous quarterly monitoring, and the 2005 investigation: the highest VOC concentrations are beneath the eastern portions of MDA G. VOC concentrations are highest in the Tshirege Member of the Bandelier Tuff and decrease markedly in the underlying stratigraphic units. The lowest VOC concentrations are found in the deepest unit sampled, the Cerros del Rio basalt. TCA is the dominant subsurface VOC vapor contaminant in the eastern and central portions of MDA G, while TCE is dominant VOC in the western portions of MDA G (Table B-3.2-2). Tritium is only detected in BH-37, with concentrations peaking at 50 ft (15 m) below ground surface (bgs) near the base of the nearby tritium shafts, and decreases to total depth of 239.75 ft (73 m) bgs (Table B-3.2-3).

Validated analytical results of samples collected during pore-gas monitoring in fiscal year (FY) 2007 confirm the presence of VOCs and tritium in the subsurface. Analyses of samples collected periodically since 1997 from four pore-gas locations show stable or decreasing VOC concentrations. The vertical distribution of VOC and tritium concentrations indicated that there is no current threat of groundwater contamination, but the FY2007 periodic monitoring report (LANL 2007, 101771) recommended future pore-gas monitoring. The pore-gas sampling data supported the adequacy of the existing subsurface vapor-monitoring network to track contaminants in pore gas (LANL 2007, 101771).

B-4.0 MDA G SITE-SPECIFIC STUDIES

B-4.1 Rooting Depth Study

Deep rooted plants may provide a pathway for the release of waste from an area like MDA G into the environment. A field study was completed to determine rooting depths of plants collected from four canyon areas within the Laboratory: Pajarito, Potrillo, Mesita del Buey, and Mortandad Canyons (Tierney and Foxx 1987, 006669). The study was performed to obtain data on the root structures of native species common to the Laboratory. Root samples were collected from 22 different plant specimens. The majority of the plants had been found on low-level waste sites in the past. In general, the greatest observed biomass of the roots of all trees, shrubs, and forbs was located in the upper 6 ft of soil (Tierney and Fox 1987, 006669, p. 14). Roots of immature specimens were also found within 6 ft of the surface (Tierney and Fox 1987, 006669, p. 14). Of the three tree species examined, roots for piñon pine and one-seed juniper were found to extend to depths greater than 18 ft in fractured tuff (Tierney and Fox 1987, 006669, p. 15).

B-4.2 Near-Surface Hydrologic Properties at MDA G Study

For this study, 26 shallow cores were collected from various areas within MDA G: in the pits, next to the pits, in non-pit areas, under asphalt, under unpaved areas, and within vegetated areas (Newman et al. (2005, 099163). The samples were then analyzed for near-surface (3.3 to 6.6 ft bgs) hydrogeologic conditions.

Results of the study indicate substantial evaporation occurs in unpaved locations at MDA G, and little evaporation occurs in paved locations. The measured average gravimetric water content percentage in the top 1 m under the paved areas was 11% versus 5% in the unpaved areas. The total estimated flux was 0.46 cm/yr under the paved areas versus 0.073 cm/yr under the unpaved areas. No significant differences were found in the hydrogeologic variables examined for the covered pit areas and adjacent areas. Downward flux estimates show significant differences between the unpaved active disposal areas and the undisturbed vegetated areas west of MDA G. The total flux was estimated to be 0.14 cm/yr in active, unpaved areas and 0.072 cm/yr in the undisturbed vegetated area.

B-4.3 Groundwater Breakthrough Modeling Study for MDA G Performance Assessment

A numerical model was formulated to estimate the travel time of contaminant transport to the groundwater beneath MDA G (Stauffer et al. 2005, 097432). This groundwater pathway model assumes that the infiltration rate through the future cover will be similar to that observed on the undisturbed mesa top. Infiltration rates greater than 10 mm/yr (0.39 in./yr) are typically assumed to be an upper bound associated with disturbed sites; therefore, the groundwater transport model considers this infiltration rate and lower infiltration rates as determined by Newman et al. (2005, 099163), and described in section B-3.2. Infiltration rates of 2 to 10 mm/yr (0.079 to 0.39 in./yr) increase the possibility for breakthrough at the regional aquifer within 1000 yr. However, these infiltration rates are considered to be high for the site that will be under a cover (e.g., evapotranspiration or vegetative) in the future.

For the highest infiltration rate modeled (i.e., 10 mm/yr [0.39 in./yr]), near the eastern disposal shafts, the predicted contaminant breakthrough for nonsorbing species starts at 500 yr and peaks around 750 yr (Stauffer et al. 2005, 097432). This is the shortest resulting breakthrough time modeled. Other modeled infiltration rates result in breakthrough starting thousands of years later. Because the thickness of the Bandelier Tuff increases at the site from east to west and the differences in the disposal units' depths, breakthrough occurs more quickly on the eastern end of the site than on the western end.

B-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.

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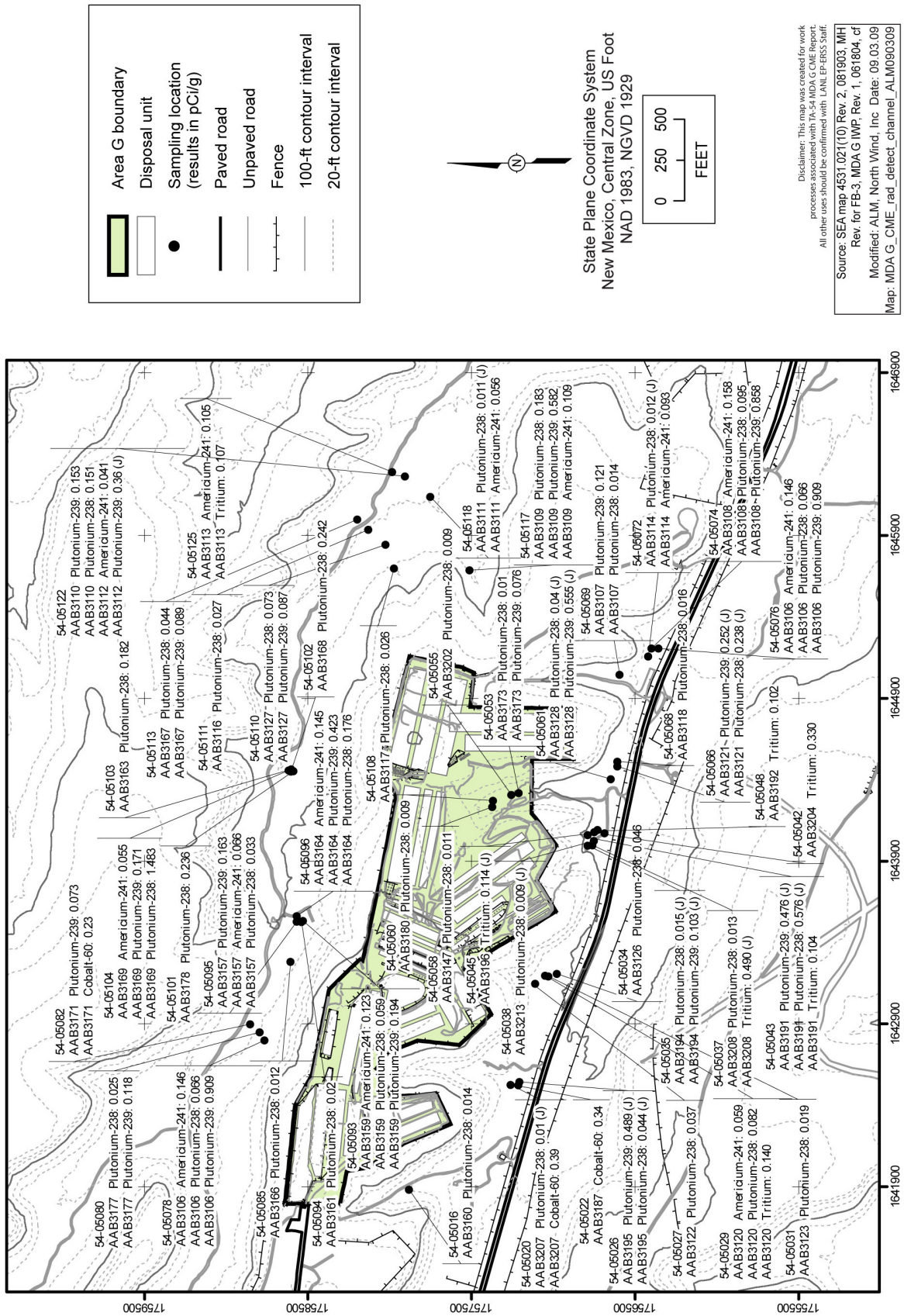


Figure B-2.0-1 Radionuclides detected above BVs in Area G channel sediments during Phase I RFI sampling

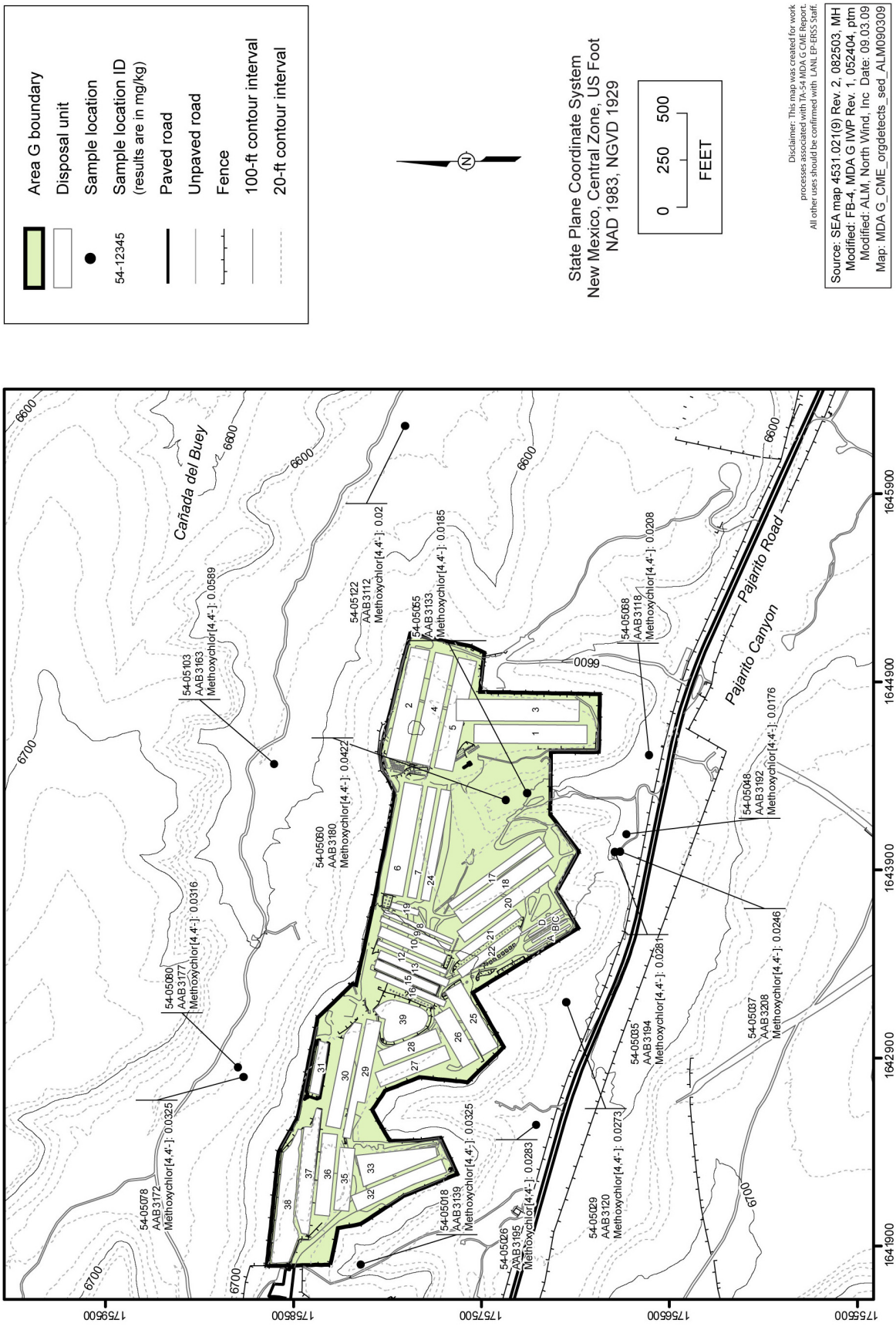


Figure B-2.0-2 Organic chemicals detected in channel sediments at Area G during Phase I RFI sampling

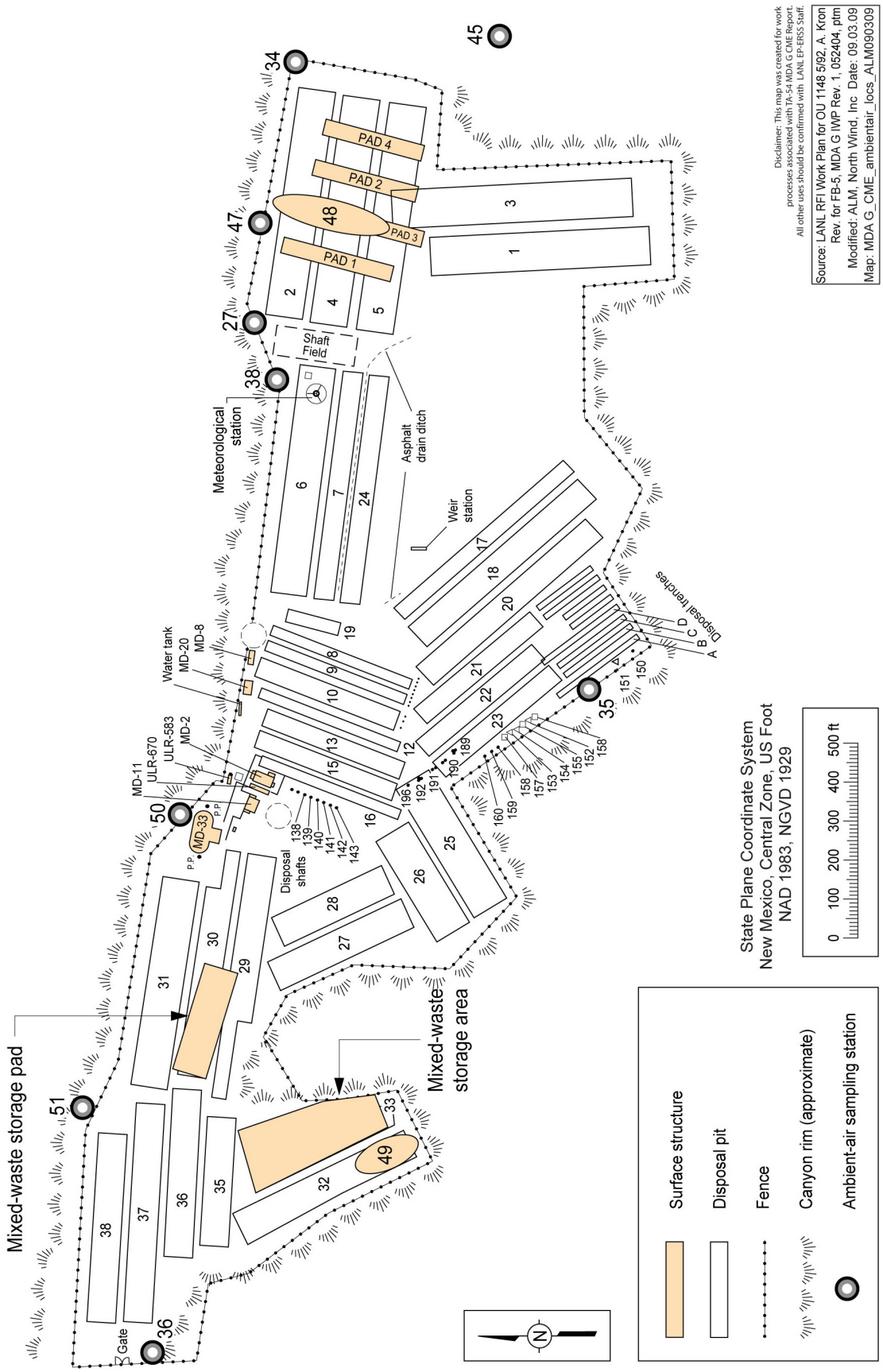


Figure B-2.0-3 Locations of ambient-air sampling stations at Area G

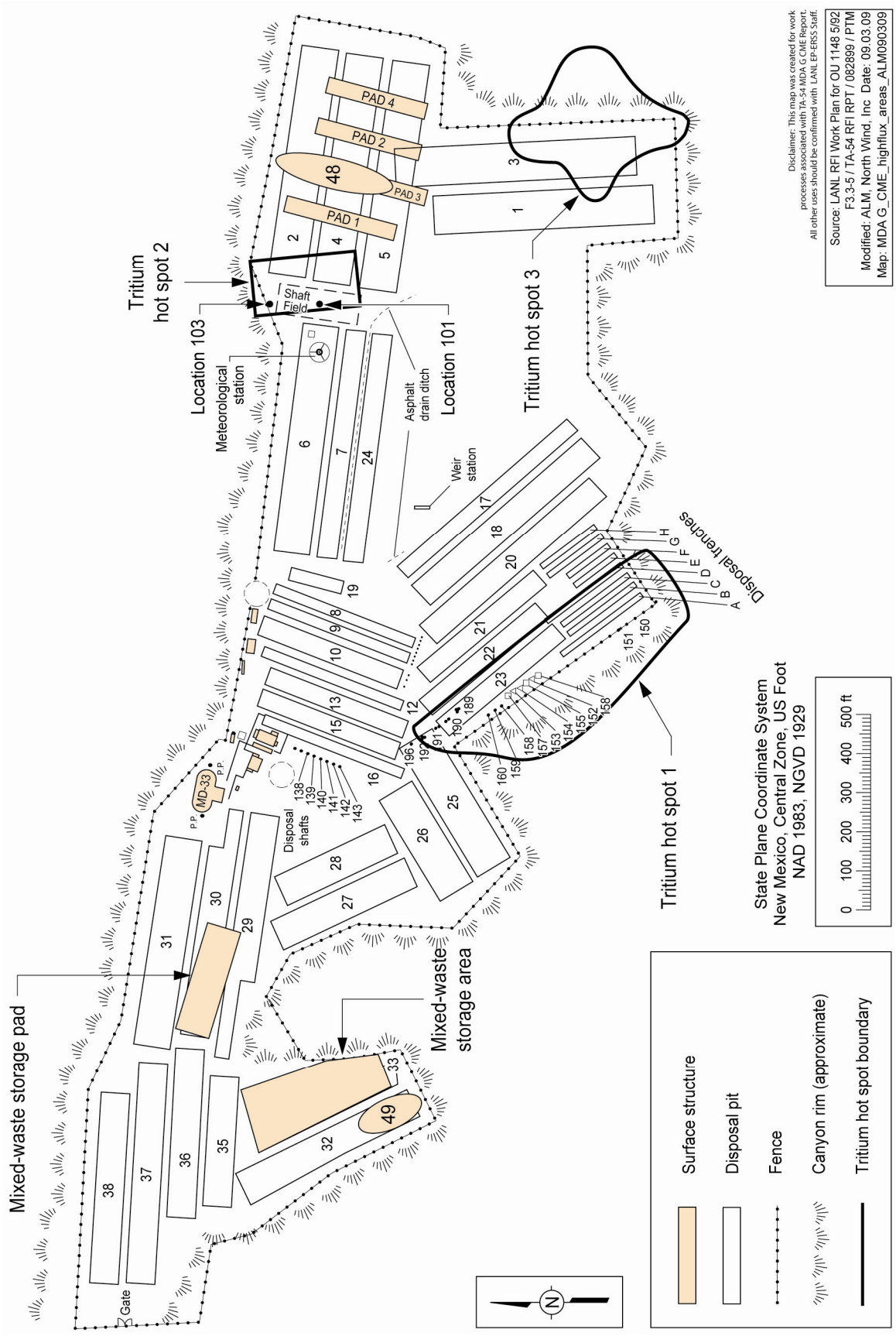


Figure B-2.0-4 Locations of high tritium surface-flux areas at Area G during 1993–1994 survey

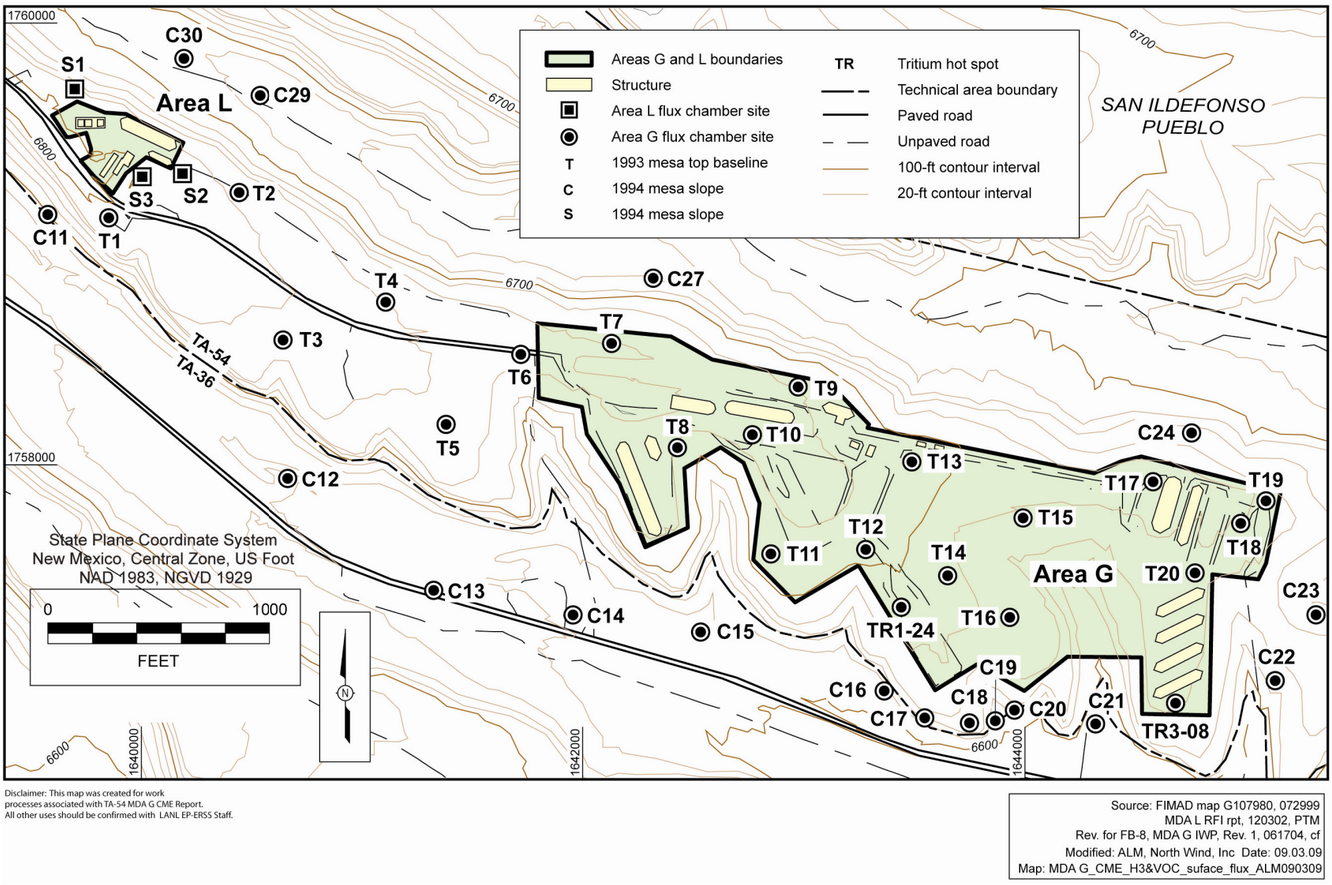


Figure B-2.0-5 Tritium and VOC surface flux chamber sampling locations at Areas G and L

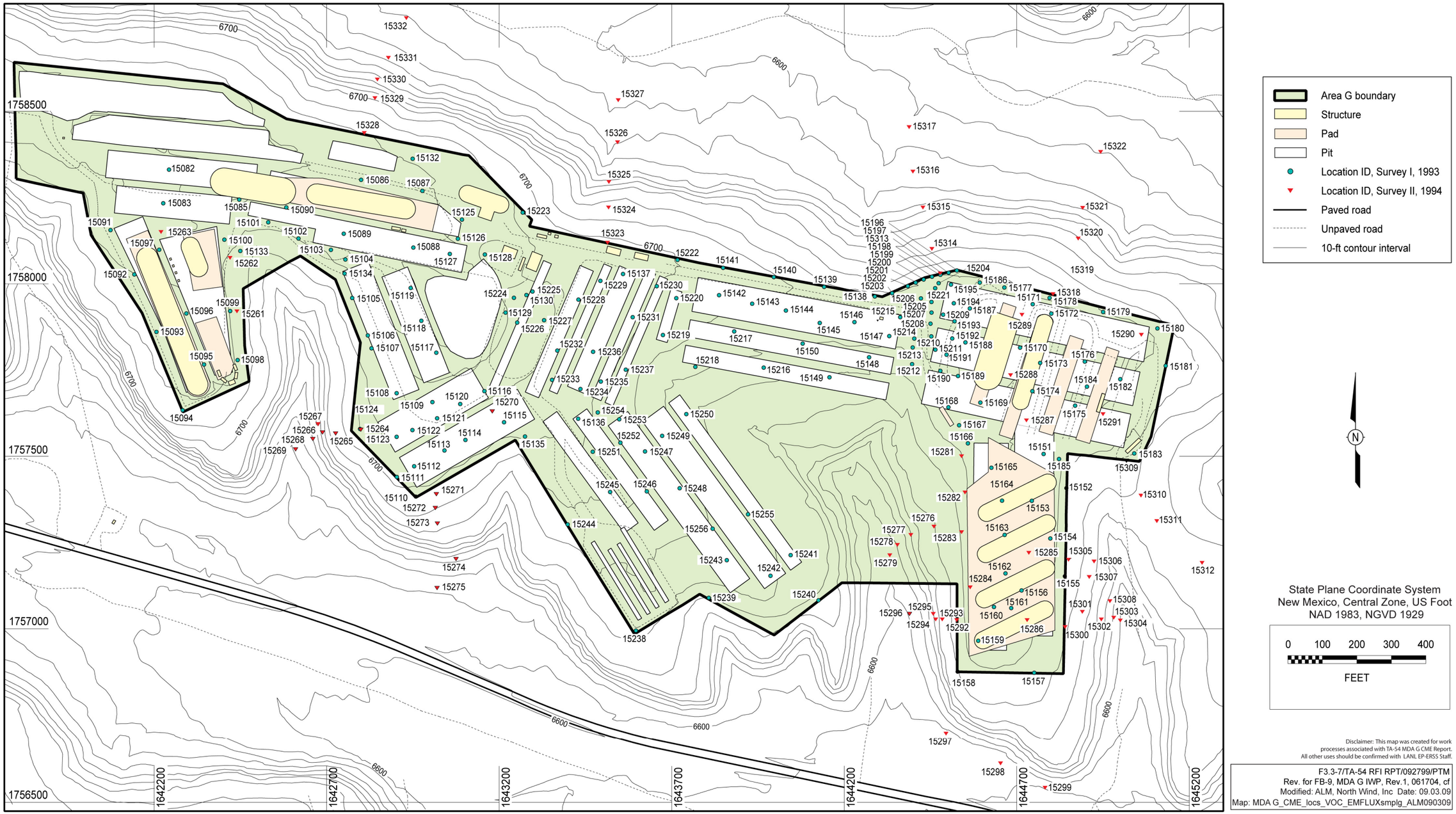


Figure B-2.0-6 VOC EMFLUX surface flux sampling locations at Area G for 1993–1994 survey

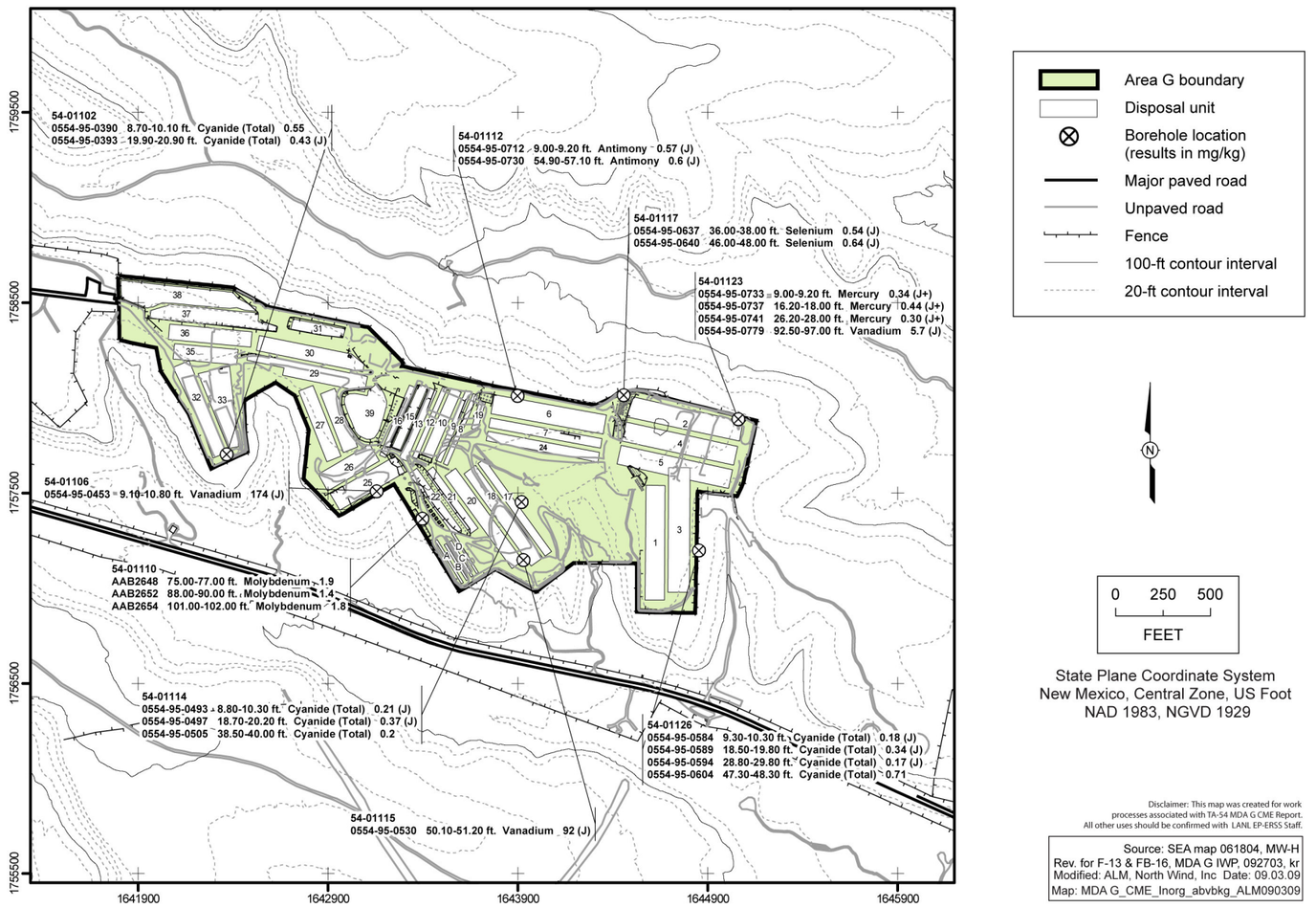
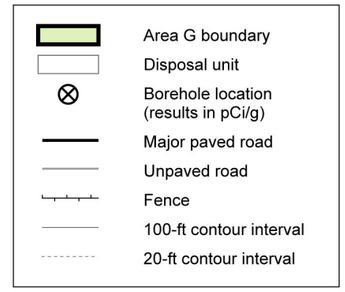
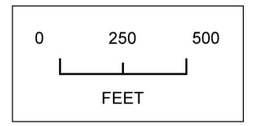


Figure B-2.0-7 Inorganic chemicals detected above BVs in subsurface tuff at MDA G during Phase I RFI sampling





State Plane Coordinate System
New Mexico, Central Zone, US Foot
NAD 1983, NGVD 1929

Disclaimer: This map was created for work processes associated with TA-54 MDA G CME Report. All other uses should be confirmed with LANL EP-ERSS Staff.

Source: SEA map 4531.021(6) Rev. 3, 090903, MH
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Rev. for F2.4-9, MDA G CME rpt, 090908, ptm
Modified: ALM, North Wind, Inc Date: 09.03.09
Map: MDA G_CME_Subsurf_Rad_ALM090309

Figure B-2.0-8 Radionuclides detected above BVs in subsurface tuff at MDA G during Phase I RFI sampling

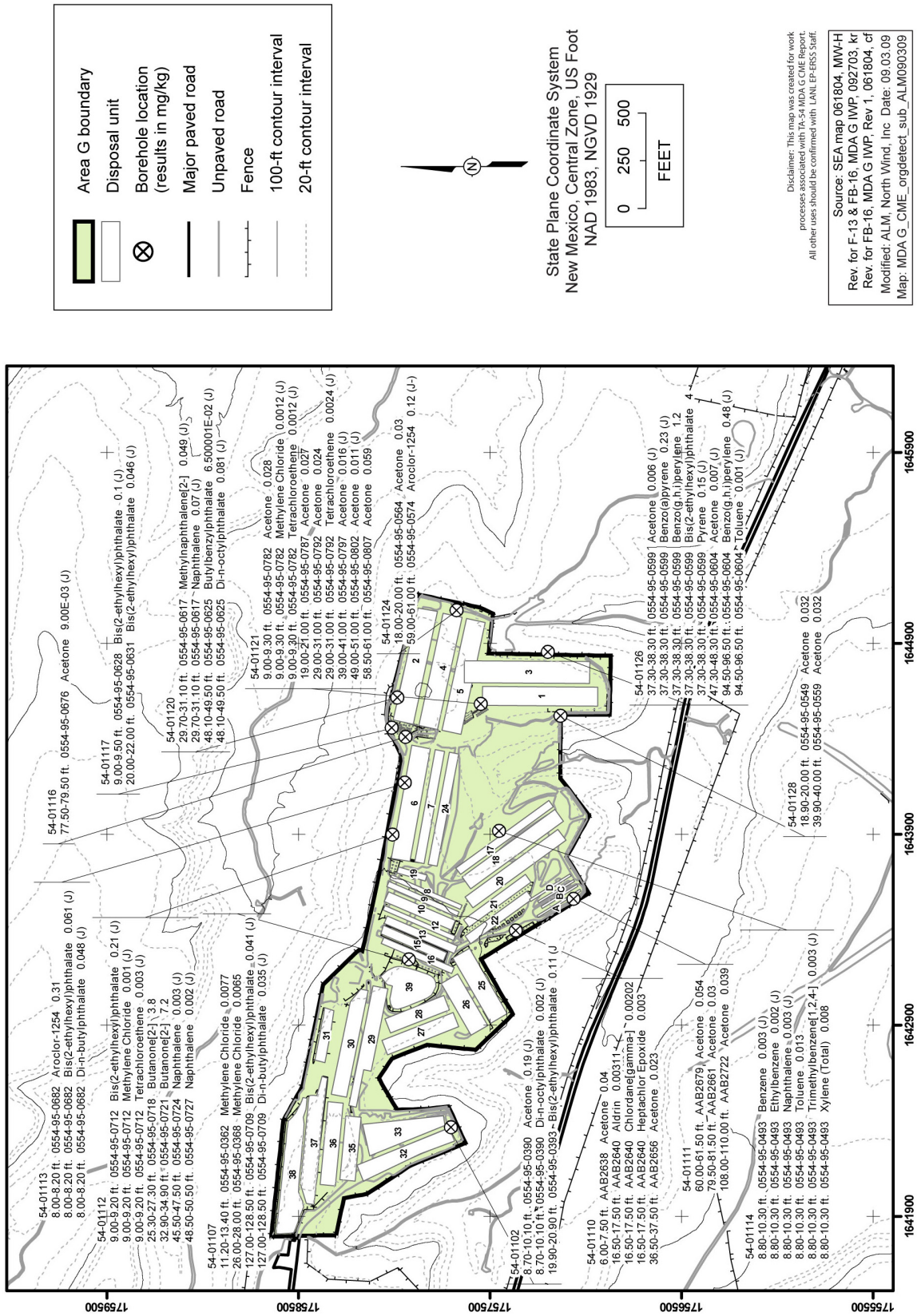

Figure B-2.0-9 Organic chemicals detected in subsurface tuff at MDA G during Phase I RFI sampling

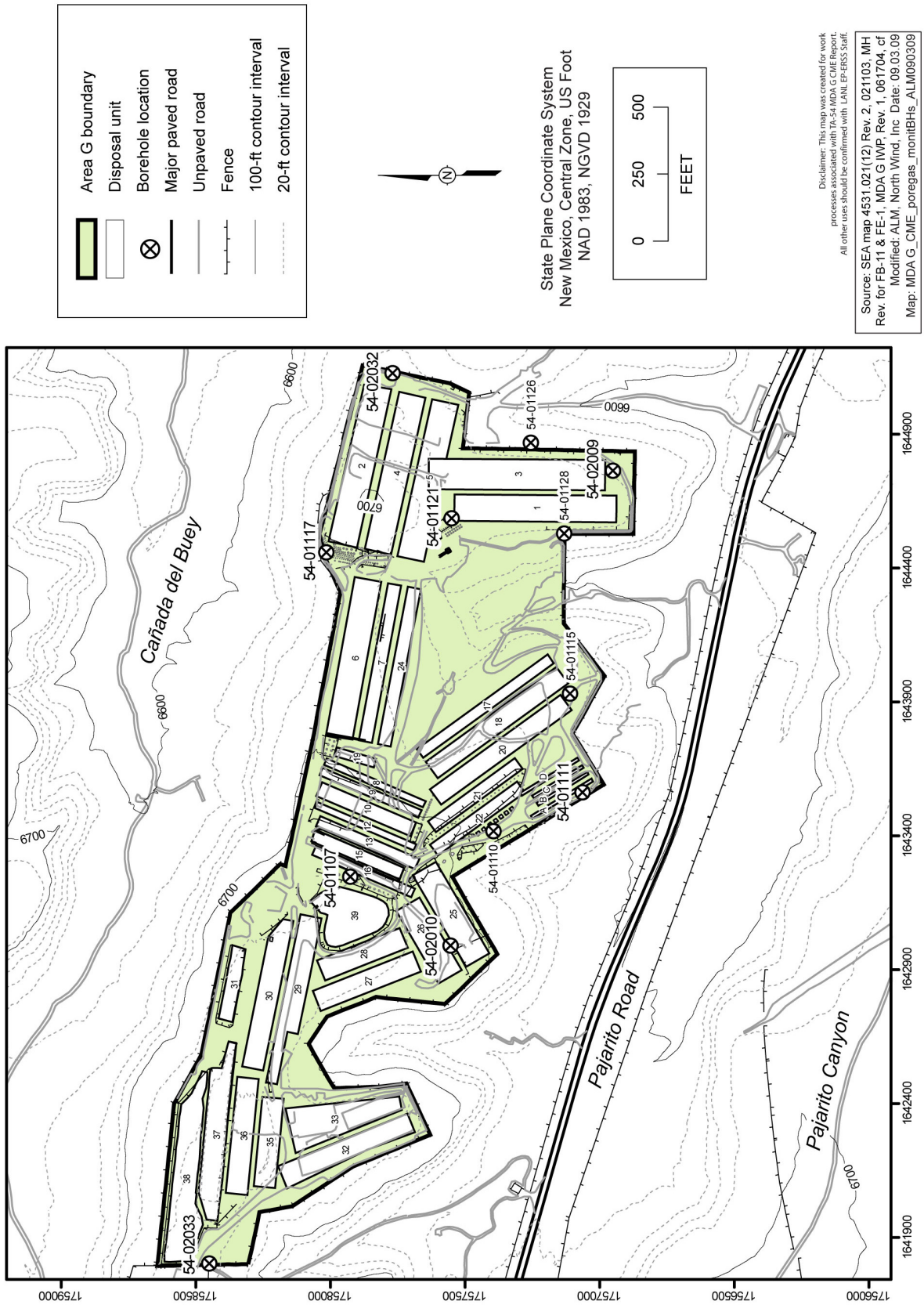

Figure B-2.0-10 MDA G pore-gas monitoring borehole locations (through 2002)

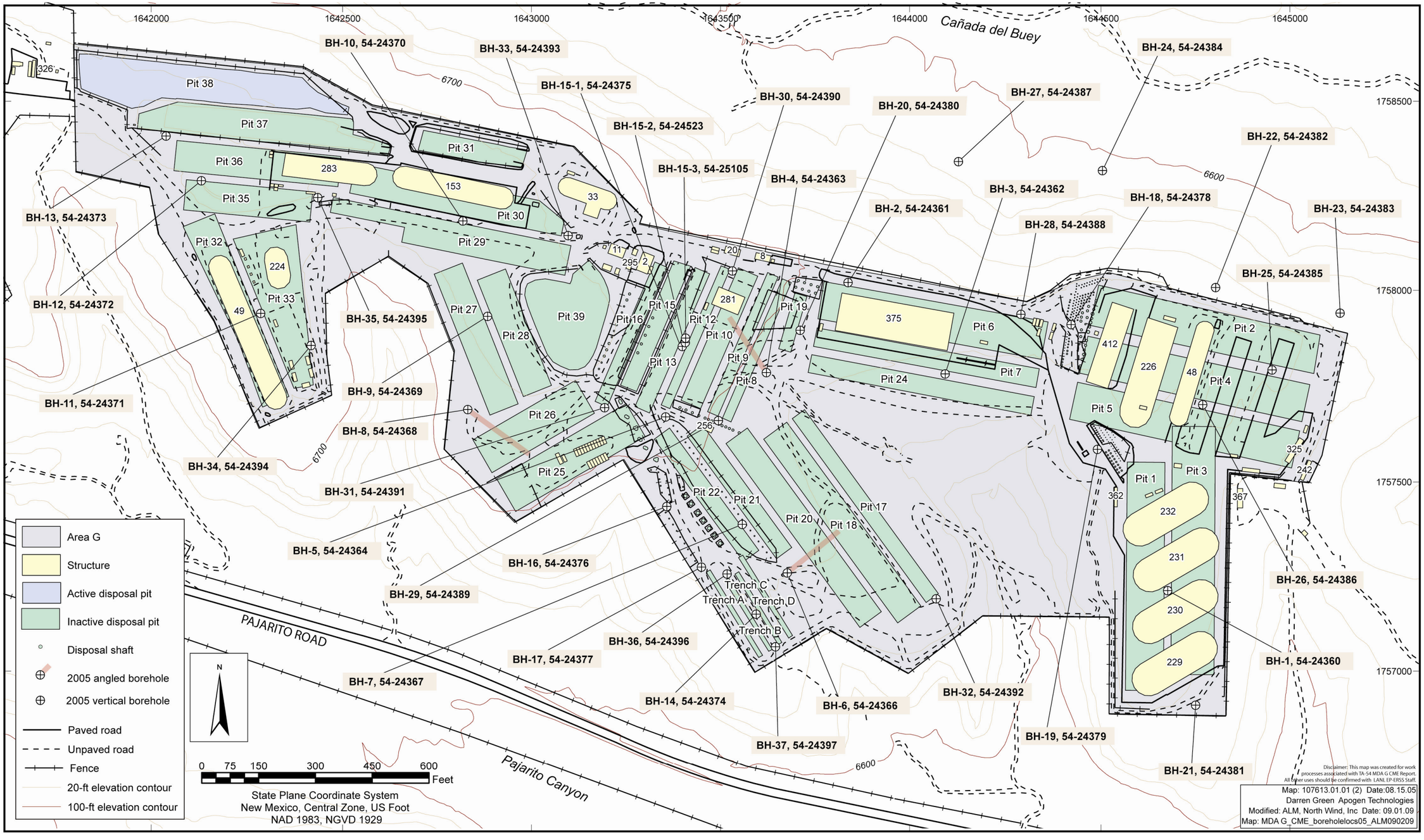

Figure B-3.1-1 Boreholes drilled during the 2005 MDA G investigation

Table B-2.0-1
Average Concentrations of VOCs in Ambient Air from SUMMA Canisters Collected at Area G during Phase I RFI

Analyte	Area G Location 1 Average Concentration		Area G Location 2 Average Concentration	
	ppb	mg/m^3	ppb	mg/m^3
Acetone	0.75	0.0018	0.56	0.0013
Benzaldehyde	—*	—	0.045	0.00020
Benzene	0.079	0.00025	0.12	0.00038
Carbon tetrachloride	0.019	0.00012	0.017	0.00011
Chlorodifluoromethane	0.20	0.00072	—	—
Chloromethane	0.13	0.00028	0.11	0.00024
Dichlorodifluoromethane	0.12	0.00058	0.085	0.00042
Freon 113	0.024	0.00018	0.017	0.00013
Methanol	8.1	0.011	0.48	0.00063
Toluene	0.19	0.00071	0.20	0.00076
TCA	0.20	0.0011	0.029	0.00016
Trichlorofluoromethane	0.084	0.00047	0.04	0.00023
Xylene	0.075	0.00033	0.13	0.00055

Note: Data were corrected for seasonal variability.

* — = The VOC was detected in less than four samples.

Table B-2.0-2
Range of 2001 Ambient-Air Concentrations Measured at Area G and at Regional Air Stations

Analyte	Area G Air Stations		Regional Air Stations	
	Lowest Annual Average (Station Number)	Highest Annual Average (Station Number)	Lowest Annual Average	Highest Annual Average
Plutonium-238	0.0 aCi/m^3* (35)	3.2 aCi/m^3 (34)	0.0 aCi/m^3	0.1 aCi/m^3
Plutonium-239	0.1 aCi/m^3 (36)	25.1 aCi/m^3 (34)	0.0 aCi/m^3	0.6 aCi/m^3
Americium-241	0.0 aCi/m^3 (35,36)	66.6 aCi/m^3 (34)	0.0 aCi/m^3	0.1 aCi/m^3
Uranium-234	10.6 aCi/m^3 (36)	48.0 aCi/m^3 (45)	10.0 aCi/m^3	31.8 aCi/m^3
Uranium-235	0.2 aCi/m^3 (36)	3.1 aCi/m^3 (45)	0.1 aCi/m^3	2.9 aCi/m^3
Uranium-238	16.4 aCi/m^3 (36)	50.7 aCi/m^3 (45)	7.4 aCi/m^3	31.2 aCi/m^3

* aCi indicates attocuries (10–8 curie).

Table B-2.0-3
Frequency of Detected Organic Chemicals in MDA G Pore-Gas Samples from 1999 to 2002

Analyte	Number of Analyses	Number of Detects	Concentration Range* (ppbv)	Frequency of Detects
Acetone	46	7	[1]–[57000]	7/46
Acetonitrile	32	1	0.6–[11000]	1/32
Acetophenone	13	0	[50]–[500]	0/13
Acrolein	32	1	[1.2]–[5700]	1/32
Acrylonitrile	32	0	[1.2]–[5700]	0/32
Benzene	48	6	[0.48]–[2300]	6/48
Benzonitrile	13	0	[50]–[500]	0/13
Benzyl Chloride	39	0	[0.48]–[2300]	0/39
Bromodichloromethane	46	1	[0.48]–[2300]	1/46
Bromoform	46	0	[0.48]–[2300]	0/46
Bromomethane	48	0	[0.48]–[2300]	0/48
Butadiene[1,3-]	46	0	[0.48]–[2300]	0/46
Butane[n-]	32	10	[0.49]–[2300]	10/32
Butanol[1-]	46	2	[1]–[5700]	2/46
Butanone[2-]	46	3	[1.2]–[5700]	3/46
Butene[1-]	13	2	[3.7]–[102]	2/13
Butene[cis-2-]	13	6	0.8–[50]	6/13
Butene[trans-2-]	13	3	4.4–[50]	3/13
Carbon Disulfide	46	1	[0.48]–[2300]	1/46
Carbon Tetrachloride	48	6	[0.48]–[2300]	6/48
Chloro-1,3-butadiene[2-]	13	0	[5]–[50]	0/13
Chloro-1-propene[3-]	32	0	[0.48]–[2300]	0/32
Chlorobenzene	48	0	[0.48]–[2300]	0/48
Chlorodibromomethane	46	1	[0.48]–[2300]	1/46
Chlorodifluoromethane	41	8	[0.4]–[2300]	8/41
Chloroethane	48	6	[0.48]–[2300]	6/48
Chloroform	48	13	[0.5]–[2300]	13/48
Chloromethane	48	1	[0.84]–[5700]	1/48
Cyclohexane	46	6	[0.5]–[5700]	6/46
Cyclohexanone	13	0	[50]–[500]	0/13
Cyclopentane	13	1	1.4–[50]	1/13
Cyclopentene	12	0	[5]–[50]	0/12
Decane[n-]	19	0	[0.48]–[2300]	0/19
Dibromoethane[1,2-]	39	1	[0.48]–[2300]	1/39
Dibromomethane	19	1	[0.48]–[2300]	1/19
Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	39	2	[0.48]–[2300]	2/39
Dichlorobenzene[1,2-]	48	0	[0.48]–[2300]	0/48

Table B-2.0-3 (continued)

Analyte	Number of Analyses	Number of Detects	Concentration Range* (ppbv)	Frequency of Detects
Dichlorobenzene[1,3-]	48	0	[0.48]–[2300]	0/48
Dichlorobenzene[1,4-]	48	0	[0.4]–[2300]	0/48
Dichlorodifluoromethane	39	28	6–[2300]	28/39
Dichloroethane[1,1-]	48	44	0.26–6100	44/48
Dichloroethane[1,2-]	48	7	[0.48]–[2300]	7/48
Dichloroethene[1,1-]	48	43	[0.49]–14000	43/48
Dichloroethene[cis-1,2-]	48	8	0.4–[2300]	8/48
Dichloroethene[trans-1,2-]	46	2	[0.48]–[2300]	2/46
Dichloropropane[1,2-]	48	2	[0.48]–[2300]	2/48
Dichloropropane[1,3-]	1	0	[10]–[10]	0/1
Dichloropropene[cis-1,3-]	48	0	[0.48]–[2300]	0/48
Dichloropropene[trans-1,3-]	48	0	[0.48]–[2300]	0/48
Diethyl Ether	32	0	[1.2]–[5700]	0/32
Dimethylbutane[2,2-]	13	4	1.8–[50]	4/13
Dimethylbutane[2,3-]	13	0	[5]–[50]	0/13
Dimethylpentane[2,3-]	13	2	0.2–[50]	2/13
Dioxane[1,4-]	27	0	[3.4]–[1400]	0/27
Dodecane[n-]	19	0	[0.48]–[2300]	0/19
Ethanol	27	5	[3.4]–18000	5/27
Ethyl Acrylate	13	0	[50]–[500]	0/13
Ethyl Tert-Butyl Ether	13	0	[50]–[500]	0/13
Ethylbenzene	48	0	[0.48]–[2300]	0/48
Ethyltoluene[4-]	5	0	[29]–[1300]	0/5
Hexachlorobutadiene	48	4	[0.48]–[2300]	4/48
Hexane	46	4	0.4–[2300]	4/46
Hexanone[2-]	46	0	[1.2]–[5700]	0/46
Hexene[cis-3-]	13	0	[5]–[50]	0/13
Hexene[trans-2-]	13	0	[5]–[50]	0/13
Isobutane	13	7	2.4–297	7/13
Isooctane	13	1	0.2–[50]	1/13
Isopentane	13	8	[5]–[50]	8/13
Isoprene	13	0	[5]–[50]	0/13
Isopropylbenzene	32	0	[0.48]–[2300]	0/32
Methacrylonitrile	13	0	[50]–[500]	0/13
Methanol	46	6	[6.3]–[110000]	6/46
Methyl Methacrylate	13	0	[50]–[500]	0/13
Methyl Tert-Butyl Ether	46	0	[1.2]–[5700]	0/46
Methyl-1-butene[3-]	13	1	0.4–[50]	1/13

Table B-2.0-3 (continued)

Analyte	Number of Analyses	Number of Detects	Concentration Range* (ppbv)	Frequency of Detects
Methyl-1-pentene[2-]	13	0	[5]–[50]	0/13
Methyl-1-pentene[4-]	13	0	[5]–[50]	0/13
Methyl-2-butene[2-]	13	2	[0.6]–[50]	2/13
Methyl-2-pentanone[4-]	46	0	[1.2]–[5700]	0/46
Methylcyclohexane	13	4	0.9–[50]	4/13
Methylcyclopentane	13	7	1.4–[50]	7/13
Methylene Chloride	48	20	[0.49]–48000	20/48
Methylheptane[2-]	13	0	[5]–[50]	0/13
Methylheptane[3-]	13	0	[5]–[50]	0/13
Methylhexane[2-]	13	0	[5]–[50]	0/13
Methylhexane[3-]	13	0	[0.4]–[50]	0/13
Methylpentane[2-]	13	5	0.5–[50]	5/13
Methylpentane[3-]	13	5	1.9–[50]	5/13
Methylstyrene[alpha-]	32	0	[0.48]–[2300]	0/32
Naphthalene	19	1	[0.48]–2700	1/19
n-Heptane	46	1	[0.48]–[2300]	1/46
Nitrobenzene	13	0	[50]–[500]	0/13
Nitropropane[2-]	13	1	0.5–[500]	1/13
Nonane[1-]	32	0	[0.48]–[2300]	0/32
Octane[n-]	32	0	[0.48]–[2300]	0/32
Pentane	32	7	[0.1]–[5700]	7/32
Pentene[1-]	13	0	[1]–[50]	0/13
Pentene[cis-2-]	13	0	[5]–[50]	0/13
Pentene[trans-2-]	13	0	[5]–[50]	0/13
Pinene[alpha-]	13	0	[5]–[50]	0/13
Pinene[beta-]	13	1	[5]–120	1/13
Propanol[2-]	27	4	0.4–4500	4/27
Propionitrile	13	0	[50]–[500]	0/13
Propylbenzene[1-]	32	0	[0.48]–[2300]	0/32
Propylene	27	6	[3.4]–[1400]	6/27
Styrene	48	2	[0.48]–[2300]	2/48
Tetrachloroethane[1,1,2,2-]	48	0	[0.48]–[2300]	0/48
Tetrachloroethene	48	43	0.41–[2300]	43/48
Tetrahydrofuran	27	0	[3.4]–[1400]	0/27
Toluene	48	10	0.1–[2300]	10/48
Trichloro-1,2,2-trifluoroethane[1,1,2-]	48	33	2.1–15000	33/48
Trichlorobenzene[1,2,4-]	48	3	[0.48]–[2300]	3/48
Trichloroethane[1,1,1-]	48	48	7.5–167000	48/48

Table B-2.0-3 (continued)

Analyte	Number of Analyses	Number of Detects	Concentration Range* (ppbv)	Frequency of Detects
Trichloroethane[1,1,2-]	48	5	[0.48]–[2300]	5/48
Trichloroethene	48	39	0.37–3600	39/48
Trichlorofluoromethane	39	25	11–[2300]	25/39
Trimethylbenzene[1,2,4-]	48	0	[0.1]–[2300]	0/48
Trimethylbenzene[1,3,5-]	48	0	[0.48]–[2300]	0/48
Trimethylpentane[2,3,4-]	13	0	[5]–[50]	0/13
Undecane[n-]	19	0	[0.48]–[2300]	0/19
Vinyl acetate	46	1	0.81–[5700]	1/46
Vinyl Chloride	48	0	[0.48]–[2300]	0/48
Xylene (Total)	21	0	[0.48]–[2000]	0/21
Xylene[1,2-]	48	1	[0.48]–[2300]	1/48
Xylene[1,3-]	13	0	[5]–[50]	0/13
Xylene[1,3-]+Xylene[1,4-]	14	0	[0.49]–[2300]	0/14

* Square brackets indicate method detection limits.

Table B-2.0-4
2003 Pore-Gas Tritium Results for
MDA G Borehole Locations 54-01110 and 54-01111

Borehole	Sample ID	Depth (ft bgs)	Tritium (pCi/L)*	Qualifier
54-01110	MD54-03-50390	20	1.80E+07	J+
54-01110	MD54-03-50391	48	2.10E+07	J+
54-01110	MD54-03-50392	60	5.00E+05	J+
54-01110	MD54-03-50393	70	8.20E+05	J+
54-01110	MD54-03-50394	85	1.04E+08	J+
54-01110	MD54-03-50395	90	1.62E+08	J+
54-01111	MD54-03-50396	20	2.71E+08	J+
54-01111	MD54-03-50397	39.5	3.81E+07	J+
54-01111	MD54-03-50398	50	9.24E+07	J+
54-01111	MD54-03-50399	70	4.60E+09	J+
54-01111	MD54-03-50403	70	4.39E+08	J+
54-01111	MD54-03-50400	78	1.18E+10	J+
54-01111	MD54-03-50402	100	5.06E+09	J+
54-01111	MD54-03-50401	139	4.85E+08	J+

* Tritium pore-vapor concentrations have been corrected for silica gel bound water (Marczak 2009, 106500).

Table B-3.1-1
Fracture Sample Summary for Boreholes at MDA G

Borehole ID	Borehole Location	Sample ID	Media Code	Begin Depth (ft)	End Depth (ft)	Sample Description	Notes
BH 3	54-24362	MD54-05-57887	Qbt 2	35	40	Fracture (38–40 ft) filled with clay	Sample represents base of closest disposal unit
		MD54-05-57894					Duplicate of MD54-05-57887
BH 4	54-24363	MD54-05-57896	Qbt 2	42.8	45.2	Clay-filled fracture	Did not collect a paired sample above fracture because a sample was collected at 31.8–35.4 ft
BH 9	54-24369	MD54-05-57960	Qbt 2	65	70	2–3-mm-thick clay-filled fracture	Sample represents base of closest disposal unit
		MD54-05-57967					Duplicate of MD54-05-57967
BH 15	54-24375	MD54-05-58014	Qbt 2	62	64	Tuff sample collected above fracture	Paired fracture sample
		MD54-05-58015		64	65	1–2-mm-thick mud-filled fracture	
BH 25	54-24385	MD54-05-58103	Qbt 2	30	35	Fracture (31.8–32.0 ft) filled with 0.1 mm clay coating	Sample represents base of closest disposal unit
		MD54-05-58110					Duplicate of MD54-05-58103
BH 26	54-24386	MD54-05-58117	Qbt 2	56	58	Tuff sample collected above fracture	Paired fracture sample
		MD54-05-58118		58	59	2-mm-thick silt-filled fracture	
BH 30	54-24390	MD54-05-58149	Qbt 2	56	57	Fracture from 56–57 ft	Not enough material in core barrel to collect sample above the fracture
		MD54-05-58150	Qbt 1v	93	94	Tuff sample collected above fracture	Paired fracture sample
		MD54-05-58151		94	95	1–2-mm-thick clay-filled fracture	
BH 34	54-24394	MD54-05-58186	Qbt 2	50	55	Fracture (50–55 ft) filled with 3-mm-thick clay and organic material	Did not collect sample above fracture because a sample was collected at 40–45 ft
		MD54-05-58187	Qbt 1v	100	102	Tuff sample collected above fracture	Paired fracture sample

Table B-3.1-2
VOCs Detected in 2005 Pore-Gas Samples Collected from MDA G Subsurface Units

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24361	30–32	MD54-05-60283	Chloroform	234
			Dichloroethane[1,1-]	688
			Dichloroethene[1,1-]	436
			Tetrachloroethene	9490
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	3140 (J)*
			Trichloroethane[1,1,1-]	14700
			Trichloroethene	53700
	138–140	MD54-05-60282	Chloroform	381
			Dichloroethane[1,1-]	1130
			Dichloroethene[1,1-]	832
			Tetrachloroethene	3320
			Toluene	267
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1460 (J)*
			Trichloroethane[1,1,1-]	13600
			Trichloroethene	29000
54-24362	35–37	MD54-05-60285	Carbon Tetrachloride	32.0
			Chloroform	100
			Dichlorodifluoromethane	2400
			Dichloroethane[1,1-]	260
			Dichloroethene[1,1-]	330
			Styrene	45.0
			Tetrachloroethene	1100
			Toluene	400
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1200
			Trichloroethane[1,1,1-]	8200
			Trichloroethene	6500
			Trichlorofluoromethane	130
	135–137	MD54-05-60284	Acetone	64.1 (J)*
			Chloroform	151
			Dichloroethane[1,1-]	526
			Dichloroethene[1,1-]	753
			Methylene Chloride	55.5
			Styrene	51.1
			Tetrachloroethene	1150
			Toluene	324
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	3060 (J+)*

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24362 (continued)	135–137	MD54-05-60284	Trichloroethane[1,1,1-]	10900
			Trichloroethene	5260
			Trichlorofluoromethane	286
54-24363	12–250	MD54-05-60286	Toluene	240
			Carbon Disulfide	2.9
			Chloroform	5.2
			Dichlorodifluoromethane	13
			Dichloroethane[1,1-]	11
			Dichloroethene[1,1-]	46
			Styrene	10
			Butanone[2-]	5
			Tetrachloroethene	96
			Acetone	70
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	120
			Trichloroethane[1,1,1-]	900
			Trichloroethene	45
			Trichlorofluoromethane	6.6
			Xylene[1,3-]+Xylene[1,4-]	8.4
54-24364	65–67	MD54-05-60289	Dichloroethane[1,1-]	129
			Dichloroethene[1,1-]	384
			Dichloropropane[1,2-]	25.9
			Methylene Chloride	29.9
			Tetrachloroethene	1760
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1840 (J)*
			Trichloroethane[1,1,1-]	5340
			Trichloroethene	2850
			Trichlorofluoromethane	225
	130–132	MD54-05-60288	Acetone	102
			Dichloroethane[1,1-]	105
			Dichloroethene[1,1-]	384
			Dichloropropane[1,2-]	42.0
			Methylene Chloride	45.1
			Tetrachloroethene	1290
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1300 (J)*
			Trichloroethane[1,1,1-]	4040
			Trichloroethene	1830
			Trichlorofluoromethane	180

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24366	12–250	MD54-05-60290	Trichloroethane[1,1,1-]	29
			Acetone	17
			Toluene	20
54-24367	30–32	MD54-05-60293	Dichloroethane[1,1-]	259
			Dichloroethene[1,1-]	396
			Styrene	63.9
			Tetrachloroethene	481
			Toluene	527
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	2070 (J+)*
			Trichloroethane[1,1,1-]	13100
			Trichloroethene	1290
			Trichlorofluoromethane	399
	153–155	MD54-05-60292	Dichloroethane[1,1-]	809
			Dichloroethene[1,1-]	2540
			Styrene	111
			Tetrachloroethene	881
			Toluene	1170
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	6360 (J+)*
			Trichloroethane[1,1,1-]	31600
			Trichloroethene	2420
			Trichlorofluoromethane	483
54-24368	95–97	MD54-05-60295	Dichlorodifluoromethane	310
			Dichloroethane[1,1-]	660
			Dichloroethene[1,1-]	1900
			Styrene	160
			Tetrachloroethene	290
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	7100
			Trichloroethane[1,1,1-]	42000
			Trichloroethene	480
			Trichlorofluoromethane	770
	192–194	MD54-05-60294	Dichlorodifluoromethane	390
			Dichloroethane[1,1-]	430
			Dichloroethene[1,1-]	1600
			Propanol[2-]	210
			Styrene	500
			Tetrachloroethene	280
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	4000
			Trichloroethane[1,1,1-]	22000

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24368 (continued)	192–194	MD54-05-60294	Trichloroethene	470
			Trichlorofluoromethane	820
54-24369	65–67	MD54-05-61743	Dichlorodifluoromethane	2800
			Dichloroethane[1,1-]	2800
			Dichloroethene[1,1-]	4800
			Tetrachloroethene	3600
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	18000
			Trichloroethane[1,1,1-]	120000
			Trichloroethene	3200
			Trichlorofluoromethane	2500
	184–186	MD54-05-61742	Dichlorodifluoromethane	1000
			Dichloroethane[1,1-]	490
			Dichloroethene[1,1-]	1100
			Tetrachloroethene	500
			Toluene	140
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	3800
			Trichloroethane[1,1,1-]	20000
			Trichloroethene	500
			Trichlorofluoromethane	780
54-24370	37–39	MD54-05-60299	Dichlorodifluoromethane	10400
			Dichloroethene[1,1-]	2730
			Dichloroethene[cis-1,2-]	388
			Tetrachloroethene	1020
			Toluene	791
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	48300 (J+)*
			Trichloroethane[1,1,1-]	92700
			Trichloroethene	12400
			Trichlorofluoromethane	10100
	148–150	MD54-05-60298	Dichlorodifluoromethane	12400
			Dichloroethane[1,1-]	6880
			Dichloroethene[1,1-]	3290
			Dichloroethene[cis-1,2-]	396
			Methylene Chloride	312
			Styrene	179
			Tetrachloroethene	624
			Toluene	1130
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	33700 (J+)*
			Trichloroethane[1,1,1-]	65400

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24370 (continued)	148–150	MD54-05-60298	Trichloroethene	6980
			Trichlorofluoromethane	7300
54-24371	40–42	MD54-05-61745	Butanone[2-]	72.0
			Chloroform	100
			Dichlorodifluoromethane	730
			Dichloroethane[1,1-]	760
			Dichloroethene[1,1-]	290
			Methyl-2-pentanone[4-]	29.0
			Styrene	120
			Tetrachloroethene	460
			Toluene	4400
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	12000
			Trichloroethane[1,1,1-]	9100
			Trichloroethene	2400
			Trichlorofluoromethane	1300
	141–143	MD54-05-61744	Acetone	46.0
			Butanone[2-]	84.0
			Chloroform	92.0
			Dichlorodifluoromethane	690
			Dichloroethane[1,1-]	720
			Dichloroethene[1,1-]	330
			Methyl-2-pentanone[4-]	28.0
			Methylene Chloride	17.0
			Styrene	100
			Tetrachloroethene	410
			Toluene	4400
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	5900
			Trichloroethane[1,1,1-]	7500
			Trichloroethene	2600
			Trichlorofluoromethane	1200
54-24372	55–57	MD54-05-61747	Acetone	30.0
			Butanone[2-]	28.0
			Dichlorodifluoromethane	180
			Dichloroethane[1,1-]	25.0
			Dichloroethene[1,1-]	38.0
			Methyl-2-pentanone[4-]	10.0
			Styrene	90.0
			Tetrachloroethene	190

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24372 (continued)	55–57	MD54-05-61747	Toluene	1800
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	130
			Trichloroethane[1,1,1-]	970
			Trichloroethene	200
			Trichlorofluoromethane	360
	185–187	MD54-05-61746	Acetone	21.0
			Butanone[2-]	22.0
			Dichlorodifluoromethane	86.0
			Dichloroethane[1,1-]	25.0
			Dichloroethene[1,1-]	47.0
			Methyl-2-pentanone[4-]	10.0
			Methylene Chloride	57.0
			Styrene	95.0
			Tetrachloroethene	180
			Toluene	1400
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	63.0
			Trichloroethane[1,1,1-]	750
			Trichloroethene	210
			Trichlorofluoromethane	150
			Xylene[1,3-]+Xylene[1,4-]	7.40
54-24373	65–67	MD54-05-60305	Acetone	128
			Butanone[2-]	3.83
			Chloroform	9.76
			Dichlorodifluoromethane	939
			Dichloroethane[1,1-]	13.8
			Dichloroethene[1,1-]	31.7
			Dichloropropane[1,2-]	55.4
			Methylene Chloride	149
			Tetrachloroethene	94.9
			Toluene	3.50
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	605
			Trichloroethane[1,1,1-]	1200
			Trichloroethene	69.8
			Trichlorofluoromethane	1460
	187–189	MD54-05-60304	Acetone	28.5
			Dichlorodifluoromethane	203
			Dichloroethene[1,1-]	5.55
			Dichloropropane[1,2-]	9.24

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24373 (continued)	187–189	MD54-05-60304	Methylene Chloride	25.0
			Tetrachloroethene	18.3
			Toluene	4.90
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	115
			Trichloroethane[1,1,1-]	229
			Trichloroethene	10.2
			Trichlorofluoromethane	270
54-24374	10–12	MD54-05-60306	Dichloroethane[1,1-]	117
			Methylene Chloride	41.7
			Tetrachloroethene	217
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	4290 (J)*
			Trichloroethane[1,1,1-]	8720
			Trichloroethene	193
			Trichlorofluoromethane	101
	139–141	MD54-05-60307	Acetone	228
			Dichloroethane[1,1-]	93.0
			Dichloroethene[1,1-]	365
			Dichloropropane[1,2-]	69.3
			Methylene Chloride	29.5
			Tetrachloroethene	183
			Toluene	32.0
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1990 (J)*
			Trichloroethane[1,1,1-]	5180
			Trichloroethene	274
			Trichlorofluoromethane	101
54-24375	30–32	MD54-05-60309	Dichloroethane[1,1-]	485
			Dichloroethene[1,1-]	1470
			Tetrachloroethene	11500
			Toluene	181
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	9190 (J)*
			Trichloroethane[1,1,1-]	43100
			Trichloroethene	1130
			Trichlorofluoromethane	500
	157–159	MD54-05-60308	Dichloroethane[1,1-]	380
			Dichloroethene[1,1-]	1820
			Methylene Chloride	104
			Tetrachloroethene	11500
			Toluene	162

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24375 (continued)	157–159	MD54-05-60308	Trichloro-1,2,2-trifluoroethane[1,1,2-]	8420 (J)*
			Trichloroethane[1,1,1-]	36000
			Trichloroethene	1400
			Trichlorofluoromethane	511
54-24376	35–37	MD54-05-60311	Dichloroethane[1,1-]	129
			Dichloroethene[1,1-]	246
			Styrene	93.7
			Tetrachloroethene	149
			Toluene	565
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1230 (J+)*
			Trichloroethane[1,1,1-]	6000
			Trichloroethene	258
			Trichlorofluoromethane	78.6
	158–160	MD54-05-60310	Acetone	49.9
			Butanone[2-]	5.89
			Dichloroethane[1,1-]	64.7
			Dichloroethene[1,1-]	166
			Methyl-2-pentanone[4-]	16.4
			Styrene	119
			Tetrachloroethene	74.6
			Toluene	1020
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	421 (J+)*
			Trichloroethane[1,1,1-]	2340
			Trichloroethene	161
			Trichlorofluoromethane	33.7
54-24377	45–47	MD54-05-60313	Dichloroethane[1,1-]	76.9
			Dichloroethene[1,1-]	234
			Methylene Chloride	12.8
			Styrene	123
			Tetrachloroethene	122
			Toluene	603
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1380 (J+)*
			Trichloroethane[1,1,1-]	3540
			Trichloroethene	215
			Trichlorofluoromethane	73.0
	150–152	MD54-05-60312	Acetone	57.0
			Butanone[2-]	9.43
			Dichloroethane[1,1-]	48.5

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24377 (continued)	150–152	MD54-05-60312	Dichloroethene[1,1-]	178
			Methyl-2-pentanone[4-]	19.2
			Methylene Chloride	8.33
			Styrene	145
			Tetrachloroethene	67.8
			Toluene	1280
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	758 (J+)*
			Trichloroethane[1,1,1-]	2020
			Trichloroethene	134
			Trichlorofluoromethane	43.2
			Xylene[1,3-]+Xylene[1,4-]	13.0
54-24378	30–32	MD54-05-60315	Dichloroethane[1,1-]	7280
			Dichloroethene[1,1-]	5550
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	22200 (J)*
			Trichloroethane[1,1,1-]	464000
			Trichloroethene	4080
	136–138	MD54-05-60314	Dichloroethane[1,1-]	12900
			Dichloroethene[1,1-]	13900
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	28300 (J)*
			Trichloroethane[1,1,1-]	709000
			Trichloroethene	7520
54-24379	20–22	MD54-05-60317	Dichloroethane[1,1-]	1460
			Dichloroethene[1,1-]	3650
			Tetrachloroethene	664
			Toluene	279
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	375 (J)*
			Trichloroethane[1,1,1-]	32700
			Trichloroethene	1240
	144–146	MD54-05-60316	Dichloroethane[1,1-]	6070
			Dichloroethene[1,1-]	15100
			Tetrachloroethene	2030
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1530 (J)*
			Trichloroethane[1,1,1-]	98200
			Trichloroethene	4780
54-24380	20–22	MD54-05-60319	Chloroform	1850
			Dichloroethane[1,1-]	295
			Dichloroethene[1,1-]	396
			Tetrachloroethene	813

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24380 (continued)	20–22	MD54-05-60319	Toluene	128
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	2990 (J+)*
			Trichloroethane[1,1,1-]	14700
			Trichloroethene	3440
			Trichlorofluoromethane	163
	155–157	MD54-05-60318	Chloroform	683
			Dichloroethane[1,1-]	445
			Dichloroethene[1,1-]	753
			Methylene Chloride	79.8
			Styrene	76.6
			Tetrachloroethene	813
			Toluene	716
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	2990 (J+)*
			Trichloroethane[1,1,1-]	16900
			Trichloroethene	4030
			Trichlorofluoromethane	236
54-24381	15–17	MD54-05-60321	Dichloroethane[1,1-]	1660
			Dichloroethene[1,1-]	3800
			Tetrachloroethene	949
			Toluene	309
			Trichloroethane[1,1,1-]	54500
			Trichloroethene	462
	143–145	MD54-05-60320	Dichloroethane[1,1-]	1780
			Dichloroethene[1,1-]	5150
			Tetrachloroethene	746
			Toluene	377
			Trichloroethane[1,1,1-]	51300
			Trichloroethene	537
54-24382	28–29	MD54-05-60323	Chloroform	57.0
			Dichloroethane[1,1-]	950
			Dichloroethene[1,1-]	1100
			Ethanol	59.0 (J)*
			Tetrachloroethene	310
			Trichloroethane[1,1,1-]	8400
			Trichloroethene	90.0
	107–109	MD54-05-60322	Acetone	83.0 (J)*
			Butanone[2-]	8.50
			Chloroform	8.60

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24382 (continued)	107–109	MD54-05-60322	Dichloroethane[1,1-]	180
			Dichloroethane[1,2-]	9.00
			Dichloroethene[1,1-]	170
			Methylene Chloride	5.30
			n-Heptane	8.90
			Propanol[2-]	47.0
			Styrene	400
			Tetrachloroethene	37.0
			Toluene	44.0
			Trichloroethane[1,1,1-]	1100
			Trichloroethene	18.0
			Vinyl Chloride	2.90
			Xylene[1,3-]+Xylene[1,4-]	15.0
54-24383	10–11	MD54-05-60324	Acetone	23.0 (J)*
			Butanol[1-]	13.0
			Butanone[2-]	4.30
			Dichloroethane[1,1-]	7.60
			Dichloroethene[1,1-]	13.0
			Ethyltoluene[4-]	13.0
			Styrene	8.10
			Trichloroethane[1,1,1-]	80.0
			Trimethylbenzene[1,2,4-]	10.0
			Xylene[1,3-]+Xylene[1,4-]	13.0
	107–109	MD54-05-60359	Acetone	27.0 (J)*
			Butanone[2-]	2.80
			Dichloroethane[1,1-]	52.0
			Dichloroethene[1,1-]	95.0
			Propanol[2-]	8.90
			Styrene	220
			Tetrachloroethene	44.0
			Toluene	30.0
			Trichloroethane[1,1,1-]	440
			Trichloroethene	12.0
			Xylene[1,3-]+Xylene[1,4-]	8.40
54-24384	10–12	MD54-05-60327	Acetone	58.0 (J)*
			Dichloroethane[1,1-]	4.40
			Dichloroethene[1,1-]	9.20
			Propanol[2-]	77.0

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24384 (continued)	10–12	MD54-05-60327	Styrene	130
			Toluene	32.0
			Trichloroethane[1,1,1-]	68.0
			Trichloroethene	47.0
			Xylene[1,3-]+Xylene[1,4-]	12.0
	65–67	MD54-05-60326	Acetone	112
			Dichloroethane[1,1-]	113
			Dichloroethene[1,1-]	285
			Hexane	5.64
			Methyl-2-pentanone[4-]	16.8
			Tetrachloroethene	42.0
			Toluene	10.2
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	60.5
			Trichloroethane[1,1,1-]	1960
			Trichloroethene	41.9
			Xylene[1,3-]+Xylene[1,4-]	16.5
54-24385	30–32	MD54-05-60329	Dichloroethane[1,1-]	3880
			Dichloroethene[1,1-]	5550
			Tetrachloroethene	5630
			Toluene	162
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1070 (J+)*
			Trichloroethane[1,1,1-]	65400
			Trichloroethene	859
	134–136	MD54-05-60328	Dichloroethane[1,1-]	5660
			Dichloroethene[1,1-]	8320
			Tetrachloroethene	4880
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1070 (J+)*
			Trichloroethane[1,1,1-]	70900
			Trichloroethene	1130
54-24386	35–37	MD54-05-60331	Dichloroethane[1,1-]	4040
			Dichloroethene[1,1-]	4750
			Tetrachloroethene	1150
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	996 (J+)*
			Trichloroethane[1,1,1-]	98200
			Trichloroethene	1020
	156–158	MD54-05-60330	Dichloroethane[1,1-]	33200
			Dichloroethene[1,1-]	59400
			Tetrachloroethene	5490

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24386 (continued)	156–158	MD54-05-60330	Trichloro-1,2,2-trifluoroethane[1,1,2-]	5440 (J+)*
			Trichloroethane[1,1,1-]	447000
			Trichloroethene	8590
54-24387	10–11	MD54-05-60333	Acetone	51.0 (J)*
			Butanone[2-]	5.50
			Dichloroethene[1,1-]	5.00
			Ethyltoluene[4-]	13.0
			Styrene	16.0
			Toluene	7.80
			Trichloroethane[1,1,1-]	41.0
			Trichloroethene	20.0
			Trimethylbenzene[1,2,4-]	23.0
			Trimethylbenzene[1,3,5-]	5.50
			Xylene[1,2-]	5.80
			Xylene[1,3-]+Xylene[1,4-]	14.0
	80–82	MD54-05-60332	Acetone	123
			Butanone[2-]	9.43
			Dichloroethane[1,1-]	5.66
			Dichloroethene[1,1-]	7.53
			Ethanol	9.04
			Hexane	7.75
			Methyl-2-pentanone[4-]	9.83
			Toluene	13.9
			Trichloroethane[1,1,1-]	65.4
			Trichloroethene	29.0
			Trimethylbenzene[1,2,4-]	4.91
			Xylene[1,3-]+Xylene[1,4-]	20.8
54-24388	25–27	MD54-05-60335	Dichloroethane[1,1-]	2180
			Dichloroethene[1,1-]	2810
			Tetrachloroethene	2030
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	5590 (J)*
			Trichloroethane[1,1,1-]	125000
			Trichloroethene	2850
	129–131	MD54-05-60334	Dichloroethane[1,1-]	2670
			Dichloroethene[1,1-]	5150
			Tetrachloroethene	1970
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	7350 (J)*

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24388 (continued)	129–131	MD54-05-60334	Trichloroethane[1,1,1-]	125000
			Trichloroethene	4190
54-24389	20–22	MD54-05-60337	Acetone	13.0 (J)*
			Butanone[2-]	15.0
			Carbon Tetrachloride	16.0
			Chloroform	21.0
			Dichlorodifluoromethane	22.0
			Dichloroethane[1,1-]	28.0
			Dichloroethene[1,1-]	82.0
			Methyl-2-pentanone[4-]	7.90
			Styrene	85.0
			Tetrachloroethene	630
			Toluene	1200
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	320
			Trichloroethane[1,1,1-]	1700
			Trichloroethene	460
			Trichlorofluoromethane	12.0
			Xylene[1,3-]+Xylene[1,4-]	6.60
	147–149	MD54-05-60336	Acetone	35.0 (J)*
			Butanone[2-]	28.0
			Carbon Tetrachloride	23.0
			Chloroform	42.0
			Dichlorodifluoromethane	110
			Dichloroethane[1,1-]	92.0
			Dichloroethene[1,1-]	310
			Methyl-2-pentanone[4-]	14.0
			Methylene Chloride	27.0
			Styrene	70.0
			Tetrachloroethene	920
			Toluene	2600
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	590
			Trichloroethane[1,1,1-]	3700
			Trichloroethene	1100
			Trichlorofluoromethane	57.0
54-24390	30–32	MD54-05-60339	Dichloroethane[1,1-]	2180
			Dichloroethene[1,1-]	3250
			Tetrachloroethene	1360
			Toluene	365

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24390 (continued)	30–32	MD54-05-60339	Trichloro-1,2,2-trifluoroethane[1,1,2-]	21400 (J)*
			Trichloroethane[1,1,1-]	142000
	158–160	MD54-05-60338	Dichloroethane[1,1-]	1420
			Dichloroethene[1,1-]	3680
			Tetrachloroethene	2370
			Toluene	678
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	19100 (J)*
			Trichloroethane[1,1,1-]	109000
			Trichloroethene	644
54-24391	25–27	MD54-05-60341	Dichloroethane[1,1-]	324
			Dichloroethene[1,1-]	325
			Styrene	97.9
			Tetrachloroethene	2780
			Toluene	377
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1530 (J+)*
			Trichloroethane[1,1,1-]	22400
			Trichloroethene	140
			Trichlorofluoromethane	432
	165–167	MD54-05-60340	Dichloroethane[1,1-]	186
			Dichloroethene[1,1-]	475
			Styrene	72.4
			Tetrachloroethene	949
			Toluene	829
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1150 (J+)*
			Trichloroethane[1,1,1-]	7630
			Trichloroethene	193
			Trichlorofluoromethane	376
54-24392	25–27	MD54-05-60343	Acetone	13.0 (J)*
			Butanone[2-]	12.0
			Dichlorodifluoromethane	20.0
			Dichloroethane[1,1-]	14.0
			Dichloroethene[1,1-]	40.0
			Methyl-2-pentanone[4-]	6.40
			Styrene	60.0
			Tetrachloroethene	140
			Toluene	880
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	31.0
			Trichloroethane[1,1,1-]	580

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24392 (continued)	25–27	MD54-05-60343	Trichloroethene	150
			Trichlorofluoromethane	12.0
			Xylene[1,3-]+Xylene[1,4-]	4.60
	144–146	MD54-05-60342	Acetone	36.0 (J)*
			Butanone[2-]	18.0
			Carbon Disulfide	4.50
			Chloroform	10.0
			Dichlorodifluoromethane	100
			Dichloroethane[1,1-]	35.0
			Dichloroethene[1,1-]	170
			Methyl-2-pentanone[4-]	8.20
			Methylene Chloride	4.80
			Styrene	66.0
			Tetrachloroethene	210
			Toluene	970
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	190
			Trichloroethane[1,1,1-]	1300
			Trichloroethene	220
			Trichlorofluoromethane	51.0
			Xylene[1,3-]+Xylene[1,4-]	14.0
54-24393	35–37	MD54-05-60345	Chlorodifluoromethane	3890
			Chloroform	29.3
			Dichlorodifluoromethane	1930
			Dichloroethane[1,1-]	190
			Dichloroethene[1,1-]	174
			Styrene	59.6
			Tetrachloroethene	305
			Toluene	414
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	4370 (J)*
			Trichloroethane[1,1,1-]	4420
			Trichloroethene	156
			Trichlorofluoromethane	1120
			Xylene[1,3-]+Xylene[1,4-]	60.8
	156–158	MD54-05-60344	Chlorodifluoromethane	2050
			Chloroform	18.1
			Dichlorodifluoromethane	2080
			Dichloroethane[1,1-]	194
			Dichloroethene[1,1-]	317

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24393 (continued)	156–158	MD54-05-60344	Methylene Chloride	13.9
			Styrene	15.8
			Tetrachloroethene	393
			Toluene	226
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	4440 (J)*
			Trichloroethane[1,1,1-]	4800
			Trichloroethene	193
			Trichlorofluoromethane	1240
54-24394	50–52	MD54-05-61749	Chloroform	150
			Dichlorodifluoromethane	1100
			Dichloroethane[1,1-]	1600
			Dichloroethene[1,1-]	930
			Tetrachloroethene	640
			Toluene	95.0
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	21000
			Trichloroethane[1,1,1-]	18000
			Trichloroethene	32000
			Trichlorofluoromethane	2200
	163–165	MD54-05-61748	Chloroform	120
			Dichlorodifluoromethane	1900
			Dichloroethane[1,1-]	960
			Dichloroethene[1,1-]	740
			Methylene Chloride	46.0
			Tetrachloroethene	580
			Toluene	120
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	9200
			Trichloroethane[1,1,1-]	13000
			Trichloroethene	12000
			Trichlorofluoromethane	2500
54-24395	40–42	MD54-05-60349	Bromodichloromethane	26.1
			Chloroform	73.2
			Dichlorodifluoromethane	1580
			Dichloroethane[1,1-]	48.5
			Methylene Chloride	11.8
			Tetrachloroethene	183
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	5280 (J)*
			Trichloroethane[1,1,1-]	4360
			Trichloroethene	134
			Trichlorofluoromethane	3870

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24395 (continued)	170–172	MD54-05-60349	Acetone	112
			Bromodichloromethane	23.4
			Chloroform	48.8
			Dichlorodifluoromethane	1090
			Dichloroethane[1,1-]	34.4
			Dichloropropane[1,2-]	18.0
			Methanol	301
			Methylene Chloride	30.9
			Tetrachloroethene	149
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	2680 (J)*
			Trichloroethane[1,1,1-]	2560
			Trichloroethene	172
			Trichlorofluoromethane	2250
54-24396	10–12	MD54-05-60351	Acetone	126
			Dichloroethane[1,1-]	80.9
			Dichloroethene[1,1-]	242
			Dichloropropane[1,2-]	24.5
			Methylene Chloride	16.7
			Tetrachloroethene	156
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1530 (J)*
			Trichloroethane[1,1,1-]	4470
			Trichloroethene	231
			Trichlorofluoromethane	61.8
	131–133	MD54-05-60350	Acetone	109
			Dichloroethane[1,1-]	166
			Dichloroethene[1,1-]	674
			Dichloropropane[1,2-]	32.3
			Methylene Chloride	34.7
			Tetrachloroethene	291
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	2530 (J)*
			Trichloroethane[1,1,1-]	7090
			Trichloroethene	537
			Trichlorofluoromethane	157
54-24397	15–17	MD54-05-60353	Acetone	209
			Butanone[2-]	7.37
			Dichloroethane[1,1-]	36.0
			Dichloroethene[1,1-]	119

Table B-3.1-2 (continued)

Borehole Location	Depth (ft)	Sample ID	Analyte	Result (µg/m³)
54-24397 (continued)	15–17	MD54-05-60353	Dichloropropane[1,2-]	17.1
			Methylene Chloride	10.1
			Tetrachloroethene	94.9
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1380 (J+)*
			Trichloroethane[1,1,1-]	2290
			Trichloroethene	80.6
			Trichlorofluoromethane	44.4
	125–127	MD54-05-60352	Acetone	147
			Butanone[2-]	7.37
			Dichloroethane[1,1-]	44.5
			Dichloroethene[1,1-]	214
			Dichloropropane[1,2-]	20.3
			Methylene Chloride	11.1
			Tetrachloroethene	81.3
			Toluene	13.6
			Trichloro-1,2,2-trifluoroethane[1,1,2-]	1150 (J+)*
			Trichloroethane[1,1,1-]	2400
			Trichloroethene	107
			Trichlorofluoromethane	67.4
54-24523	485–700	MD54-05-60366	Acetone	71.2
			Butanone[2-]	5.89
			Toluene	7.53

* Data qualifier definitions are included in Appendix A.

Table B-3.1-3
Tritium Detected in 2005 Pore-Gas Samples Collected from MDA G

Borehole Location	Depth (ft)	Sample ID	Result*	Units
54-24361	30–32	MD54-05-61531	26,348	pCi/L
	138–140	MD54-05-61530	7372	pCi/L
54-24362	35–37	MD54-05-61533	56,407	pCi/L
	135–137	MD54-05-61532	54,716	pCi/L
54-24363	12–14	MD54-05-61534	48,251	pCi/L
54-24364	65–67	MD54-05-61537	11,656	pCi/L
	130–132	MD54-05-61536	11,824	pCi/L
54-24366	12–14	MD54-05-61538	72,696	pCi/L
54-24367	30–31	MD54-05-61541	191,464	pCi/L
	153–155	MD54-05-61540	14,564	pCi/L
54-24368	95–97	MD54-05-61543	3757	pCi/L
	192–194	MD54-05-61542	7241	pCi/L
54-24369	65–67	MD54-05-61545	27,214	pCi/L
	184–186	MD54-05-61544	6788	pCi/L
54-24371	40–42	MD54-05-61549	8256	pCi/L
	141–143	MD54-05-61548	13,460	pCi/L
54-24372	55–57	MD54-05-61551	12,062	pCi/L
	185–187	MD54-05-61550	10,406	pCi/L
54-24373	65–67	MD54-05-60305	9159	pCi/L
	187–189	MD54-05-60304	3007	pCi/L
54-24374	10–12	MD54-05-61555	7,151,180	pCi/L
	139–141	MD54-05-61554	357,367	pCi/L
54-24375	30–32	MD54-05-61557	14,557	pCi/L
	157–159	MD54-05-61556	4726	pCi/L
54-24376	158–160	MD54-05-61558	46,766	pCi/L
54-24377	150–152	MD54-05-61560	31,117	pCi/L
54-24378	30–32	MD54-05-61563	7,746,915	pCi/L
	136–138	MD54-05-61562	2,500,041	pCi/L
54-24379	20–22	MD54-05-61565	8518	pCi/L
	144–146	MD54-05-61564	56,704	pCi/L
54-24380	20–22	MD54-05-61567	5289	pCi/L
	155–157	MD54-05-61566	4739	pCi/L
54-24381	15–17	MD54-05-61569	10,575	pCi/L
	143–145	MD54-05-61568	8046	pCi/L
54-24382	28–29	MD54-05-61571	5129	pCi/L
	107–109	MD54-05-61570	13,291	pCi/L
54-24383	10–11	MD54-05-60325	4194	pCi/L

Table B-3.1-3 (continued)

Borehole Location	Depth (ft)	Sample ID	Result*	Units
54-24384	10–12	MD54-05-60327	11,593	pCi/L
	65–67	MD54-05-60326	981	pCi/L
54-24385	30–32	MD54-05-61577	883,169	pCi/L
	134–136	MD54-05-61576	32,526	pCi/L
54-24386	35–37	MD54-05-61579	15,465,802	pCi/L
	156–158	MD54-05-61578	384,049	pCi/L
54-24387	10–11	MD54-05-60333	5873	pCi/L
54-24388	25–27	MD54-05-61583	276,187	pCi/L
54-24389	20–22	MD54-05-61584	13,678	pCi/L
	147–149	MD54-05-61585	7110	pCi/L
54-24390	30–32	MD54-05-61587	12,172	pCi/L
	158–160	MD54-05-61586	4194	pCi/L
54-24391	25–27	MD54-05-61589	9420	pCi/L
	165–167	MD54-05-61588	14,860	pCi/L
54-24392	25–27	MD54-05-61591	12,381	pCi/L
	144–146	MD54-05-61590	8595	pCi/L
54-24393	35–37	MD54-05-61593	3379	pCi/L
54-24394	163–165	MD54-05-61594	2535	pCi/L
54-24396	131–133	MD54-05-61598	30,035	pCi/L
54-24397	15–17	MD54-05-61601	2,936,902	pCi/L
54-25105	485–700	MD54-05-61604	11,588	pCi/L

* Tritium pore-vapor concentrations have been corrected for silica gel bound water (Marczak 2009, 106500).

Table B-3.1-4
Gravimetric Moisture Content and Matric
Potential in Samples Collected from MDA G at BH 54-25423

Sample Number	Sample Depth (ft)	Matrix	Gravimetric Moisture Content (%, g/g)	Matric Potential (bars)
MD54-05-59235	11.5	Qbt 2	3.0	8.0
MD54-05-59237	22.0	Qbt 2	4.5	1.3
MD54-05-59239	32.0	Qbt 2	2.1	2.9
MD54-05-59241	42.0	Qbt 2	4.8	6.0
MD54-05-59243	52.0	Qbt 2	6.4	2.0
MD54-05-59245	62.0	Qbt 2	2.4	4.0
MD54-05-59248	82.0	Qbt 1v	5.3	3.4
MD54-05-59250	92.0	Qbt 1vc	10.0	2.7
MD54-05-59252	102.0	Qbt 1g	10.8	5.0
MD54-05-59253	107.0	Qbt 1g	5.7	2.8
MD54-05-59255	117.0	Qbt 1g	5.4	2.9
MD54-05-59256	122.0	Qbt 1g	4.0	3.3
MD54-05-59258	142.0	Qbt 1g	6.4	3.0
MD54-05-59260	157.0	Qbt 1g	8.3	2.9
MD54-05-59261	162.0	Qbt 1g	7.8	2.1
MD54-05-59262	167.0	Qbt 1g	7.6	1.5
MD54-05-59264	177.0	Qct	6.1	2.4
MD54-05-59265	182.0	Qct	9.3	1.4
MD54-05-59266	185.0	Qct	7.3	4.9
MD54-05-59268	197.0	Qbog	27.2	0.6
MD54-05-59270	207.0	Tb4	0.4	48.0
MD54-05-59310	210.0	Tb4	1.2	3.7
MD54-05-59272	217.0	Tb4	2.7	19.6
MD54-05-59273	222.0	Tb4	2.1	2.1
MD54-05-59274	227.0	Tb4	0.7	7.9
MD54-05-59275	232.0	Tb4	0.5	14.8
MD54-05-59276	237.0	Tb4	0.2	95.1
MD54-05-59277	242.0	Tb4	0.4	27.6
MD54-05-59278	247.0	Tb4	2.1	50.6
MD54-05-59279	254.5	Tb4	0.9	7.3
MD54-05-59281	265.0	Tb4	0.2	15.1
MD54-05-59282	271.5	Tb4	1.4	5.5
MD54-05-59283	276.2	Tb4	0.8	15.7
MD54-05-59284	281.3	Tb4	2.1	1.1
MD54-05-59285	286.4	Tb4	0.7	11.6
MD54-05-59286	291.3	Tb4	1.6	2.4

Table 3.1-4 (continued)

Sample Number	Sample Depth (ft)	Matrix	Gravimetric Moisture Content (%, g/g)	Matric Potential (bars)
MD54-05-59287	296.1	Tb4	3.1	3.3
MD54-05-59289	301.1	Tb4	3.0	5.0
MD54-05-59288	301.5	Tb4	0.8	4.9
MD54-05-59291	316.7	Tb4	5.2	4.4
MD54-05-59292	321.8	Tb4	5.2	1.5
MD54-05-59293	326.9	Tb4	0.8	4.9
MD54-05-59294	331.6	Tb4	1.8	2.4
MD54-05-59295	336.0	Tb4	0.7	4.3
MD54-05-59296	341.9	Tb4	1.0	3.5
MD54-05-59297	346.8	Tb4	0.7	3.1
MD54-05-59298	351.0	Tb4	0.6	2.3
MD54-05-59299	356.9	Tb4	0.7	6.0
MD54-05-59301	366.9	Tb4	0.8	8.8
MD54-05-59302	371.4	Tb4	0.7	8.2
MD54-05-59303	376.1	Tb4	0.6	12.2
MD54-05-59304	381.3	Tb4	0.8	21.7
MD54-05-59305	386.7	Tb4	0.5	12.6
MD54-05-59306	391.6	Tb4	1.0	3.5
MD54-05-59307	396.7	Tb4	0.6	32.7
MD54-05-59308	401.4	Tb4	0.6	8.3
MD54-05-59309	407.0	Tb4	0.6	6.9
MD54-05-59311	436.5	Tb4	0.6	6.3
MD54-05-59312	456.7	Tb4	0.6	8.7
MD54-05-59313	482.3	Tb4	5.4	335.0
MD54-05-59314	494.0	Tb4	7.5	22.7
MD54-05-59315	545.0	Tb4	11.3	3.2

Table B-3.2-1
Summary of MDA G Supplemental Investigation
Pore-Gas Sampling Port Construction

Borehole ID	Sample Port Depths in ft (Unit Sampled)					
BH-2b (54-27436)	45 (Qbt 2)	70 (Qbt 1v)	115 (Qbt 1g)	163 (Qbo)	185 (Tb 4)	—*
BH-10 (54-24370)	40 (Qbt 2)	72.5 (Qbt 1v)	120 (Qbt 1g)	174.7 (Qct)	200 (Qbo)	243.7 (Tb 4)
BH-26 (54-24386)	40 (Qbt 2)	83 (Qbt 1g)	117 (Qct)	135 (Qbo)	195 (Tb 4)	—
BH-34 (54-24394)	50 (Qbt 2)	100 (Qbt 1v)	150 (Qbt 1g)	192.5 (Qct)	245.25 (Qbo)	300.5 (Tb 4)
BH-37 (54-24397)	50 (Qbt 1v)	90 (Qbt 1g)	130 (Qbt 1g)	165 (Qct)	188 (Qbo)	239.75 (Tb 4)

* — = Sixth sampling port not necessary.

Table B-3.2-2
MDA G Supplemental Investigation VOC Pore-Gas Results

Sample ID	Location ID	Depth Interval (ft)	Acetone	Butanone[2-]	Carbon Disulfide	Chlorodifluoromethane	Chloroethane	Chloroform	Cyclohexane	Dichlorodifluoromethane	Dichloroethane[1,1-]
MD54-07-75257	54-24370	35–45	—*	—	—	—	—	660	—	13000	15000
MD54-07-75258	54-24370	67.5–77.5	—	—	—	—	—	740	—	17000	18000
MD54-07-75259	54-24370	115–125	—	—	—	—	—	510	—	19000	12000
MD54-07-75260	54-24370	169.5–180	—	—	120	—	93	160	—	13000	4000
MD54-07-75262	54-24370	195–205	—	—	—	—	—	—	—	15000	3400
MD54-07-75261	54-24370	237.5–249.5	—	—	—	—	—	—	—	1500	240
MD54-07-75263	54-24386	37.5–42.5	—	—	2100	—	—	—	—	—	36000
MD54-07-75264	54-24386	80.5–86	—	—	1200	—	—	—	—	—	32000
MD54-07-75266	54-24386	115–120	2600	—	1300	—	—	—	—	—	32000
MD54-07-75265	54-24386	130–136	—	—	620	—	—	—	—	—	17000
MD54-07-75267	54-24386	191–201	—	—	—	—	—	—	—	—	1900
MD54-07-75268	54-24394	45–55	—	—	190	—	—	—	—	1400	2300
MD54-07-75269	54-24394	95–105	—	—	—	—	—	140	340	1500	1700
MD54-07-75270	54-24394	145–154.8	—	—	—	—	—	130	270	1900	1200
MD54-07-75271	54-24394	190–195	—	—	—	130	—	110	210	2200	760
MD54-07-75272	54-24394	240–250	—	—	—	140	—	71	150	2200	390
MD54-07-75273	54-24394	296.5–306.5	—	—	3.9	14	—	4.5	15	220	39
MD54-07-75251	54-27436	40–50	—	—	—	—	—	—	—	—	1100
MD54-07-75252	54-27436	65–75	—	—	—	—	—	—	—	—	1100
MD54-07-75253	54-27436	110–120	—	—	—	—	—	360	—	400	1200
MD54-07-75254	54-27436	160–166	—	—	—	—	—	330	—	290	940
MD54-07-75255	54-27436	180–191.5	20	4.6	—	—	—	34	27	64	130

Table B-3.2-2 (continued)

Sample ID	Location ID	Depth Interval (ft)	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Methylene Chloride	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane
MD54-07-75257	54-24370	35–45	5100	470	—	1900	—	44000	170000	21000	14000
MD54-07-75258	54-24370	67.5–77.5	7000	700	—	2100	—	50000	190000	26000	15000
MD54-07-75259	54-24370	115–125	6400	620	420	1500	—	39000	120000	16000	12000
MD54-07-75260	54-24370	169.5–180	4300	270	430	690	—	22000	53000	6000	7100
MD54-07-75262	54-24370	195–205	4900	280	460	740	—	23000	54000	6300	7900
MD54-07-75261	54-24370	237.5–249.5	630	15	37	120	170	2400	4900	560	800
MD54-07-75263	54-24386	37.5–42.5	41000	—	—	6500	—	4700	790000	6400	—
MD54-07-75264	54-24386	80.5–86	46000	—	—	6100	1200 (J)	4000	640000	7900	—
MD54-07-75266	54-24386	115–120	56000	—	—	5900	4700	2800	400000	8300	—
MD54-07-75265	54-24386	130–136	33000	—	—	3400	—	1600	240000	4800	—
MD54-07-75267	54-24386	191–201	3400	—	—	440	—	200	23000	600	—
MD54-07-75268	54-24394	45–55	1100	—	280	540	—	73000	32000	83000	3300
MD54-07-75269	54-24394	95–105	1100	—	—	450	—	28000	22000	30000	2600
MD54-07-75270	54-24394	145–154.8	1100	—	74	470	—	13000	16000	17000	2800
MD54-07-75271	54-24394	190–195	990	—	60	480	—	9000	13000	9400	3100
MD54-07-75272	54-24394	240–250	980	—	58	380	—	6000	9100	4200	3000
MD54-07-75273	54-24394	296.5–306.5	180	—	—	45	—	470	880	290	250
MD54-07-75251	54-27436	40–50	860	—	—	10000	—	1500	21000	190000	—
MD54-07-75252	54-27436	65–75	910	—	—	7300	—	1400	20000	130000	—
MD54-07-75253	54-27436	110–120	730	—	230	3900	—	910	16000	56000	—
MD54-07-75254	54-27436	160–166	680	—	100	1300	—	440	10000	21000	—
MD54-07-75255	54-27436	180–191.5	230	—	10	160	—	120	1700	1800	31

Note: All values are reported in $\mu g/m^3$.

* — = Concentration ($\mu g/m^3$) was below the method detection limit for the analyte.

Table B-3.2-3
MDA G Supplemental
Investigation Tritium Pore-Gas Results

Borehole ID	Sample Depth Interval (ft)	Sample ID	Result (pCi/L)*
BH-37 (54-24397)	45–55	MD54-07-75283	8,960,000
	84–95	MD54-07-75284	1,072,000
	125–135	MD54-07-75285	540,000
	160–168	MD54-07-75286	107,800
	194–192	MD54-07-75287	205,600
	232.5–244	MD54-07-75288	3500

* Tritium pore-vapor concentrations have been corrected for silica gel bound water (Marczak 2009, 106500).

Appendix C

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

C-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) G. 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 (PMRs) for vapor-sampling activities at the Los Alamos National Laboratory (the Laboratory) (e.g., LANL 2010, 108496) and is 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 G. Therefore, a two-tiered screening approach is applied at MDA G to further identify vapor-phase VOCs and vadose-zone concentrations that could potentially affect groundwater at concentrations exceeding applicable cleanup levels (Figure C-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 G (LANL 2010, 108496). 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 C-2.0 using soil-vapor data collected during fiscal year (FY) 2009 and FY2010 and presented in the MDA G PMRs for vapor-sampling activities for those two years (LANL 2010, 108496; LANL 2011, 111729). The results of the two-tiered screening process identified four VOCs of potential concern: 1,1-dichloroethylene (DCE), perchloroethene (PCE), 1,1,1-trichloroethane (TCA), and trichloroethene (TCE). In addition, Tier II screening concentrations are calculated for all VOCs that were detected at MDA G from the last five sampling events. In section C-3.0, the characteristics of the four VOCs within the subsurface vapor plume at MDA G are summarized based on their 2009 distributions and their behavior with time. Section C-4.0 briefly describes the VOC transport mechanisms at MDA G.

C-2.0 SCREENING METHODOLOGY

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

As part of ongoing 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 G if the soil-vapor concentration were in equilibrium with groundwater according to Henry's law partitioning. The equilibrium between air and water concentrations is described by the following equation:

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

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 New Mexico Environment Department (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:

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

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

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

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

S = 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 C-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 C-2.1-1 presents the calculated concentrations of contaminants in soil vapor corresponding to groundwater SLs for the Tier 1 screening. Tables C-2.1-2 and C-2.1-3 present the results of the Tier I screen for the FY 2009 and FY2010 soil-vapor data collected at MDA G, respectively (LANL 2010, 108496) (LANL 2011, 111729). Five VOCs were identified with the Tier I screen in FY2009, and nine VOCs were identified in FY2010.

C-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 C-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. If contaminants reach the water table of the regional aquifer, they will mix with the clean groundwater flowing under ambient flux conditions, and contaminants will be diluted. The resulting contaminant concentration in the groundwater will therefore be 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}):

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

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:

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

where

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

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 C-2.2-1, C-2.2-2, and C-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 G in the free air and water phases, respectively. The values for the air diffusion coefficients were estimated using the EPA calculator (http://www.epa.gov/athens/learn2model/part-two/onsite/estdiffusion-ext.html) . These coefficients can be modified to account for diffusion through a porous medium using the following equation (Millington and Quirk 1961, 110521):

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

$$D_{wp} = D_w n^{4/3} \quad \textbf{Equation C-2.2-5}$$

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 C-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:

$$C_{wt}^w = \frac{C_{wt}^g}{H} \quad \textbf{Equation C-2.2-6}$$

where H is the dimensionless Henry's law constant. Henry's law constant depends on the properties of the VOC (e.g., its volatility) 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:

$$F_{dg} = \frac{C_{wt}^a}{C_{aq}^w} = \frac{2Hd_a}{d_m} \quad \textbf{Equation C-2.2-7}$$

where the mixing zone depth is calculated as

$$d_m = \sqrt{\frac{2d_a D_{wp}}{kI}} \quad \textbf{Equation C-2.2-8}$$

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:

$$F_{dg} = \frac{C_{vz}^a}{C_{aq}^w} = \frac{2Hd_a\left[1+\frac{d_{vz}}{Hd_a D_{ap}}\sqrt{\frac{kId_a D_{wp}}{2}}\right]}{d_m} \quad \textbf{Equation C-2.2-9}$$

where d_{vz} is the vertical distance between the vapor 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), and C_{vz}^a is the source vapor 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 (~250 m; the basalt section of the vadose zone is about 200 m), and available time for contaminant migration through the vadose zone (approximately 20 to 50 yr). Equation C-2.2-9 takes into account the impact of the vapor-contaminant concentration at the water table on the diffusive flux of the vapor-phase contaminants 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 in the liquid phase at the water table, which will decrease the contaminant concentration in the vapor phase adjacent to the regional water table (the fractionation between the vapor and liquid-phase concentrations at the water table interface is assumed to be at steady-state and controlled by the Henry's law constant). 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 G, and the source length is considered to be on the order of 60 m The source length is based in part on spatial analyses of the observed concentrations presented in section C-3.1, particularly, the TCE data at the eastern end of MDA G, which indicates that the TCE concentration decreases rapidly over a short horizontal distance. In addition, the 60-m source length is double the 30-m length assumed for the TCE and TCE plumes at MDA L (LANL 2011, 205756). A larger source length was assumed to be reasonable for the large surface areas of the pits at MDA G compared with the shaft clusters present at MDA L. As a result, Equation C-2.2-9 is modified accordingly:

$$F_{dg} = \frac{d_a}{L} \frac{2Hd_a\left[1+\frac{d_{vz}}{Hd_aD_{ap}}\sqrt{\frac{kId_aD_{wp}}{2}}\right]}{d_m} \qquad \textbf{Equation C-2.2-10}$$

Equations C-2.2-1 and C-2.2-10 are used to calculate the dilution factors for various VOCs at MDA G migrating in the water and vapor phases, respectively. 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 G are presented in Table C-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 identified five VOCs as COPCs in FY2009 and nine in FY2010 (Tables C-2.1-2 and C-2.1-3). These nine VOCs are analyzed using the Tier II methodology for the pore water and vapor migration, as demonstrated in Table C-2.2-1, which uses the maximum concentration for the nine constituents measured during the FY2009 and FY2010 vapor sampling. The table summarizes the information about the regional aquifer, vadose zone, and contaminants applied in the Tier II analysis to solve Equations C-2.2-1 and C-2.2-10 for these nine VOCs. The method presented in Table C-2.2-1 was used to define the Tier II SLs for all VOC constituents detected at the site over the last five sampling rounds, as compiled in Table C-2.1-1. Based on the obtained SLs, four chemicals are COPCs after the Tier II analysis: 1,1-DCE; PCE; TCA; and TCE, as shown in Tables C-2.2-1,C-2.1-2, and C-2.1-3.

C-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 C-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 C-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, although no numerical modeling is applied here. Some or all of these types of analyses might be performed depending on the vapor-plume characteristics.

C-3.0 CHARACTERISTICS OF THE SUBSURFACE VAPOR PLUME

This section investigates the characteristics of the VOC vapor plumes at MDA G. Four VOCs were identified as having the potential to impact groundwater during the Tier II screen based on a combined analysis of the FY2009 and FY2010 vapor data (Tables C-2.1-2, C-2.1-3, and C-2.2-1): 1,1-DCE; PCE; TCA; and TCE. According to the screening process (Figure C-1.0-1), additional data and uncertainty analysis for these constituents are warranted.

The data are interpreted using two methods. First, the FY2009 distributions of soil-vapor concentrations for the VOCs are assessed in section C-3.1. In addition, the FY2009 contaminant masses for TCA and TCE in the subsurface beneath MDA G 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, a summary of the time-history concentration data for the four VOCs (1,1-DCE, PCE, TCA, and TCE) that exceed their Tier II screening values is presented in section C-3.2. The time histories illustrate concentrations trends that are used to draw conclusions about the time-dependent nature of the sources. Data available from 1997 through the FY2009 sampling event are used.

These analyses are augmented with a summary of FY 2010 data.

C-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 G. These estimates are calculated using soil-vapor data collected from vapor monitoring wells shown in Figure 2.4-4 of the corrective measures evaluation (CME) and based on vapor-sampling data gathered during the fourth quarter FY2009 sampling at MDA G (LANL 2010, 108496). A combination of analytical data and field SVs for TCA and TCE concentrations gathered at approximately 130 ports in 20 pore-gas monitoring boreholes and one open borehole are used in the analyses (Table 2.4-1 of the CME). For the other two constituents, analytical data from 42 ports in 20 pore-gas monitoring boreholes and one open borehole are used.

The distributions and mass estimates for TCA and TCE were developed as part of the supplemental SVE pilot test conducted at MDA G in May 2010 (LANL 2010, 109657) and are summarized below. The TCA and TCE mass estimates include distributions in three phases: soil vapor, dissolved into pore water, and adsorbed onto solid media, based on chemical partitioning. The mathematical approach and assumptions used to estimate the total VOC mass are included in the MDA G supplemental SVE pilot test report

(LANL 2010, 109657). The same approach is also presented in the MDA L CME report, Rev. 2 (LANL 2011, 205756). The Tier II screening criteria presented in section C-2.2 were developed after the data analysis was developed for the supplemental SVE test. Multiples of the Tier I screening criteria (e.g., 10, 20, and 30 times the Tier I criteria) are used for many of the figures and in the discussion that follows. More figures of plume distribution relative to the Tier II screening levels are presented in Appendix J.

The method estimates the TCA and TCE contaminant mass contained within a volume defined by 10 times the Tier I vapor-phase concentration SV (Table C-3.1-1). The vapor concentrations equivalent to 10 times the Tier I screening limits are 423,000 µg/m^3 for TCA and 20,000 µg/m^3 for TCE (LANL 2010, 108496). These values are less than the calculated Tier II SVs of 745,000 µg/m^3 and 51,270 µg/m^3 for TCA and TCE, respectively, presented in Table C-2.1-1, and a lower estimated mass would be calculated using the Tier II threshold values.

C-3.1.3 Summary of Current VOC Distributions

This section includes several illustrations of the modeled three-dimensional 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 C-3.1-1 and C-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 location of the section line used to produce orthogonal cross-sections through the VOC plume centers for viewing vertical extents of each plume. Figures C-3.1-3 and C-3.1-4 present the east-west cross-section through each plume.

Figure C-3.1-1 shows two areas where elevated TCA concentrations exist: a western area located near Pits 29 and 30, and an eastern area near Pits 2, 4, and 5. These areas are defined by one or two vapor-monitoring wells with maximum concentrations of approximately 20 times the Tier I SV. The highest TCA concentrations are located at the eastern side of MDA G.

Figure C-3.1-2 shows three areas of elevated TCE concentrations: a western area located near Pit 33, a central area near Pit 6, and a southeastern area near Pit 3. The TCE distribution is not particularly similar to that of TCA. Maximum concentrations in excess of 30 times the Tier I SV of 2000 µg/m^3 are present in the three areas. The highest TCE concentrations are located at the western side of MDA G.

Figures C-3.1-3 and C-3.1-4 show the TCA and TCE plumes, respectively, in cross-section. The TCA and TCE plumes are ellipsoidal in shape with vertical extents being greater than lateral extents. 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 G.

Mass estimates were calculated for the current plume distributions depicted in Figures C-3.1-1 through C-3.1-4 (LANL 2010, 109657) and are presented in Table C-3.1-1. 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 values. The estimated subsurface VOC masses are 211 kg and 79 kg for TCA and TCE, respectively. Despite the greater overall extent of the TCE plumes, the overall mass of TCE is just over one-third of that determined for TCA because the estimates are based on screening values rather than absolute concentrations. The breakdown of mass by geology reiterates that approximately 93% and 95% of the masses of TCA and TCE, respectively, are within the Tshirege Member of the Bandelier Tuff. The breakdown of mass according to geologic strata may be used to help guide the placement and length of screened intervals in extraction boreholes for maximizing the removal efficiency of the system (e.g., see Appendix J).

Figure C-3.1-5 provides a map view of the overlapping plume extents for TCA and TCE based on a contour interval of 10 times the respective Tier I SV for each compound. The TCA and TCE plumes are, for the most part, not collocated so any SVE remedial actions may need to cover multiple areas across MDA G.

DCE(1,1-) and PCE were identified in the Tier II screen in addition to TCA and TCE. The Tier II SLs presented in Table C-2.1-2 are compared with the pore gas concentrations reported in the FY2009 and FY2010 vapor PMRs (LANL 2010, 108496; LANL 2011, 111729) and show that these two constituents exceed their Tier II SVs only in limited areas. DCE(1,1-) exceeded its Tier II SV at two monitoring boreholes at the eastern side of MDA G near Pits 1 through 5: 54-24386 and 54-01121. PCE exceeded its Tier II SV at one monitoring borehole, 54-24370, in the west-central portion of MDA G near Pits 29 and 30 in FY2010.

C-3.2 Time-History Analyses of Soil-Vapor Concentrations

Time-history soil-vapor concentration data for the four VOCs identified during the Tier II screen (TCA; 1,1-DCE; TCE; and PCE,) were reviewed to discern concentration trends with time. This review included analytical data from 20 vapor-monitoring boreholes at MDA G from 1997 through 2009. The period of record for some of these boreholes is, however, much shorter because several of the boreholes were installed between 2002 and 2005.

C-3.2.1 Eastern Plume Area Near Pits 1 Through 5

As noted above, the three VOCs (TCA, 1,1-DCE, and TCE) have exceeded the Tier II SVs at the eastern side of MDA G near Pits 1 through 5 during 2009 and 2010. PCE has not exceeded its Tier II SV in this area, but its concentrations are elevated above Tier I SVs. The data from eight vapor-monitoring boreholes located in this area indicate that concentrations at this location are either generally decreasing or are variable, showing no clear trend. Two possible exceptions to this observation are at the shallowest ports in boreholes 54-24386 (37 ft) and 54-01121 (19 ft). However, these trends are uncertain because they are based on only five and four data points, respectively, and pore-gas data are naturally variable (ASTM 2006, 110404). Because concentrations remain elevated for the four VOCS some 40 to 50 yr after disposal units in this area were closed, this area is considered to be a potentially ongoing source for VOC vapors, although the concentrations may be declining. However, the maximum concentrations of TCA and TCE shown in Figures C-3.1-3 and C-3.1-4 occur at depths below the disposal pits and shafts. This indicates that the highest concentration areas in the plumes are related to releases that occurred in the past rather than from ongoing releases. Lower concentrations of TCA and TCE vapors present at depths near the pits and shafts indicate that TCA and TCE source/release concentrations have declined.

The concentrations and mass of TCA near the SVE pilot test area west of Pits 2 and 4 was evaluated using field-screening data from 2008 (just before the 2008 extraction test) and routine monitoring data in 2009. This analysis is presented in the report for the supplemental SVE pilot test (LANL 2010, 109657). The analysis showed that the maximum TCA concentration within the 2008 pilot test area decreased from over 30 times the Tier I SV before the test to between 20 and 25 times the SV 10 mo after the test. In addition, the TCA mass in the affected area remained reduced by approximately 44% compared with the pretest mass over the same period. This result indicates that although the TCA source may be continuing in this area, the SVE pilot test had a long-term impact within the radius of influence of the extraction well in terms of decreasing the mass and the maximum concentration of the TCA vapor plume.

C-3.2.2 Central Plume Area Near Pit 6

TCE exceeded the Tier II SV at the center of MDA G near Pit 6 at vapor-monitoring borehole 54-27436 in 2009 and 2010. The three other VOCs have not exceeded their SVs at this location. The TCE data from this monitoring borehole indicates decreasing concentrations at the shallowest port (40 ft based on

four data points) and potentially increasing concentrations at the deepest port (180 ft based on five data points). These trends are again considered to be uncertain because they are based on only few data points, and pore-gas data are variable (ASTM 2006, 110404). This area is considered to be a potentially ongoing source of limited extent for TCE vapors.

C-3.2.3 Western Plume Area Near Pits 29 and 33

TCA exceeded its Tier II SV at the western end of MDA G near Pit 29 at vapor monitoring borehole 54-24370 in 2009; PCE exceeded its Tier II SV at this location in 2010. In addition, TCE exceeded its Tier II SV near Pit 29 at vapor-monitoring borehole 54-24370 and near Pit 33 at borehole 54-24394 in both 2009 and 2010. However, 1,1-DCE has not exceeded its SV at this location. The TCA and TCE data from these two monitoring boreholes indicate variable concentrations with no clear trend. This area is considered to be a potentially ongoing source with limited extent for TCA, TCE, and PCE vapors.

C-4.0 VAPOR TRANSPORT AT MDA G

The sources of VOC vapors at MDA G are thought to be associated with mixed wastes disposed of in the pits and shafts at the site, with VOCs being a component of the waste rather than a primary waste form. The VOCS are not expected to be present in the waste disposal units as solvents in a liquid phase. The source may be ongoing because VOC vapors are emanating from mixed wastes contained in drums or other containers that limit their rate of escape. Volatilization of VOCs present in the waste will affect soil vapor located in fill material within the disposal units before diffusing further to subsurface soil vapor outside of the disposal units.

The conceptual model for vapor transport at MDA G is that VOCs in the 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. Under natural conditions, the shape and growth of the plume are diffusion-driven in the tuff units. Vapor-phase diffusion is a relatively rapid process, which, under existing conditions (low infiltration rates), is faster than unsaturated water flow at MDA G and accounts for the observed migration to depth of VOCs in soil vapor within the Bandelier Tuff (Stauffer et al. 2005, 090537). 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.

Topography is an important control on vapor transport at MDA G. 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 vapor 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 (Trujillo et al. 1998, 058242). Asphalt, which currently covers part of the site, decreases this mechanism somewhat because it partially blocks the diffusive transport of VOC vapors from exiting at the surface (Stauffer et al. 2005, 090537). Diffusive gradients also spread vapor-phase contaminants downward toward the regional aquifer. Shallow vapors will tend to diffuse out of the mesa at the surface, while deeper vapors may transport downward.

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. In addition, air flow within the basalt may contribute to migration of vapor-phase VOCs. Open, interconnected air pathways probably occur between the top of the Cerros del Rio volcanic series and the regional aquifer beneath MDA G (see Appendix E). 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 at MDA G (see section 2.4.4), vapors were extracted near the higher-concentration area west of Pits 2, 4 and 5. This removal of higher concentration vapors can slow subsequent vapor transport away from the source areas or even reverse gradients toward the extraction boreholes following SVE.

C-5.0 RESULTS

This appendix presents a two-tiered, risk-based screening approach to identify VOCs that could potentially impact the regional aquifer (Figure C-1.0-1). The screening approach is demonstrated using recently reported soil-vapor monitoring data from MDA G. As part of this screen, nine VOC COPCs were identified using the Tier I screen based on FY2009 and FY2010 data; four VOC COPCs were identified using the Tier II screen. These four VOCs are TCA, TCE, 1,1-DCE, and PCE. Also, MDA G–specific Tier II SVs for soil-vapor concentrations were developed to use in future comparison of soil-vapor data.

Further data analyses, including spatial and temporal analyses, were performed on contaminant concentration data for the four VOCs identified during the Tier II screening process. The analysis identifies three comingled plume areas across MDA G.

- An eastern plume present near Pits 1 through 5 has concentrations of TCA, TCE, and 1,1-DCE that exceed Tier II SVs. This area is considered to be a potentially ongoing source of VOC vapors. However, the SVE pilot test conducted in 2008 had a long-term impact within the radius of influence of the extraction well in terms of decreasing the mass and the maximum concentration of the TCA vapor plume (LANL 2010, 109657).
- A central plume near Pit 6 has concentrations of TCE that exceed the Tier II SV. This area is considered to be a potentially ongoing source of limited extent for TCE vapors.
- A western plume near Pits 29 and 33 has concentrations of TCE, TCA, and PCE that exceed their respective Tier II SVs. This area is considered to be a potentially ongoing source of limited extent for TCE, TCA, and PCE vapors.

The sources of VOC vapors at MDA G are thought to be associated with mixed wastes disposed in the pits and shafts at the site, with VOCs being a component of the waste rather than a primary waste form. They are not expected to be present as a liquid phase. The source may be ongoing because VOC vapors are emanating from mixed wastes contained in drums or other containers that limit their rate of escape.

The mass distributions of TCA and TCE were calculated, and most mass (93% and 95% for TCA and TCE, respectively) is located within the Tshirege Member of the Bandelier Tuff. However, uncertainty is associated with the vapor-phase transport of contaminants through the Cerros del Rio basalts toward the regional aquifer.

C-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

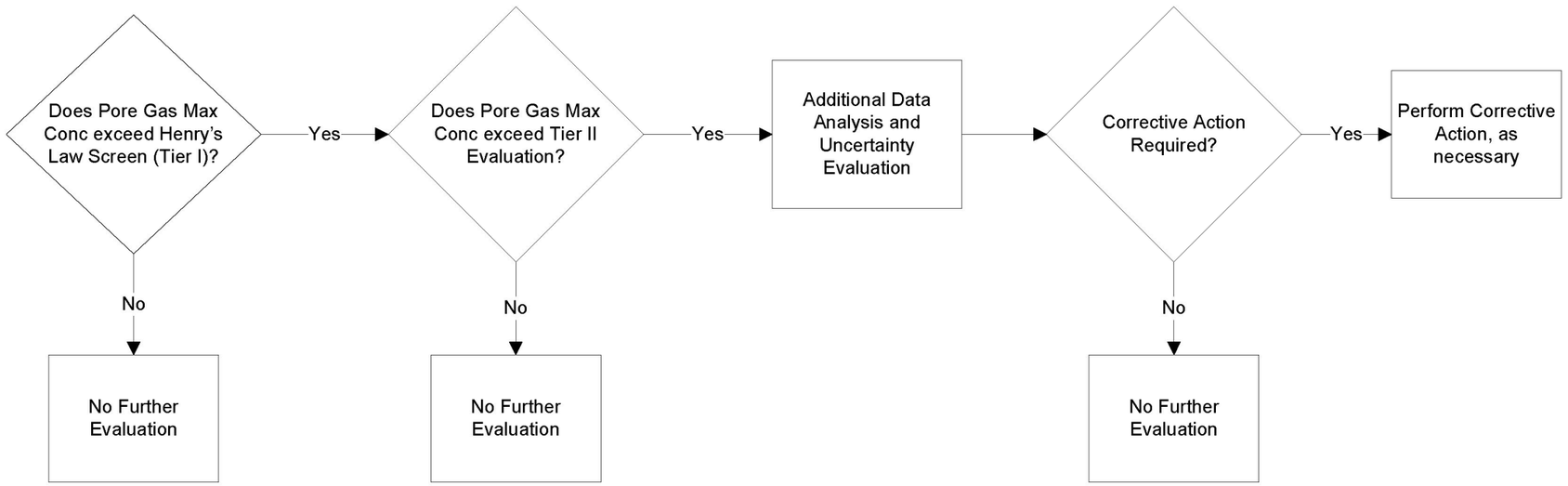
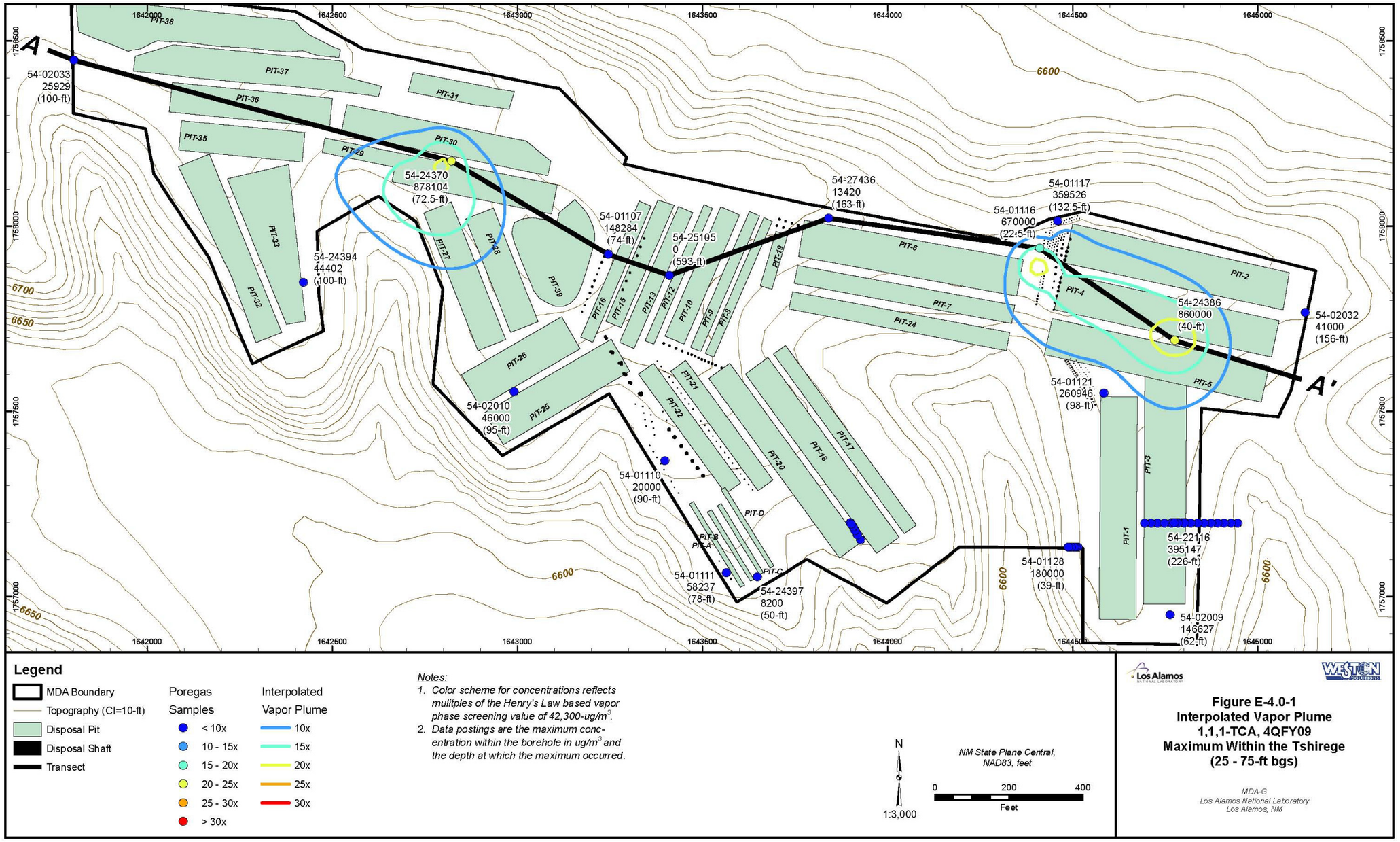


Figure C-1.0-1 Two-tiered screening method to identify vapor-phase VOCs that could potentially affect groundwater



Legend

- MDA Boundary
- Topography (CI=10-ft)
- Disposal Pit
- Disposal Shaft
- Transect

Poregas Samples	Interpolated Vapor Plume
< 10x	10x
10 - 15x	15x
15 - 20x	20x
20 - 25x	25x
25 - 30x	30x
> 30x	

Notes:

1. *Color scheme for concentrations reflects mulitples of the Henry's Law based vapor phase screening value of 42,300-ug/m^3.*
2. *Data postings are the maximum concentration within the borehole in ug/m^3 and the depth at which the maximum occurred.*

N

1:3,000

NM State Plane Central, NAD83, feet

0 200 400

Feet

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Figure E-4.0-1
Interpolated Vapor Plume
1,1,1-TCA, 4QFY09
Maximum Within the Tshirege
(25 - 75-ft bgs)

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Los Alamos, NM

Figure C-3.1-1 Interpolated vapor plume for TCA at MDA G based on fourth quarter FY2009 data, maximum concentration within the Tshirege (25 to 75 ft below ground surface [bgs])

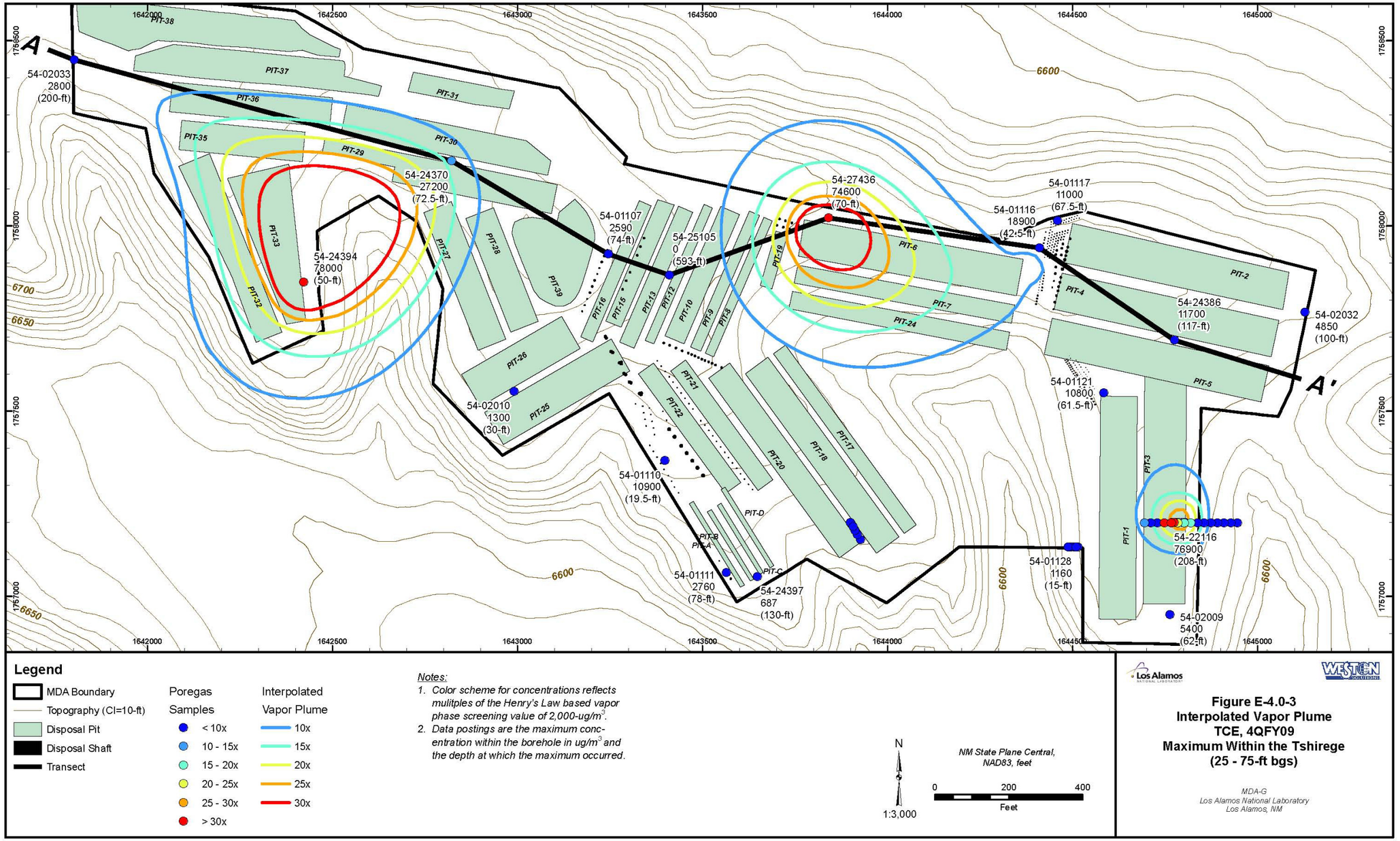


Figure C-3.1-2 Interpolated vapor plume for TCE at MDA G based on fourth quarter FY2009 data, maximum concentration within the Tshirege (25 to 75 ft bgs)

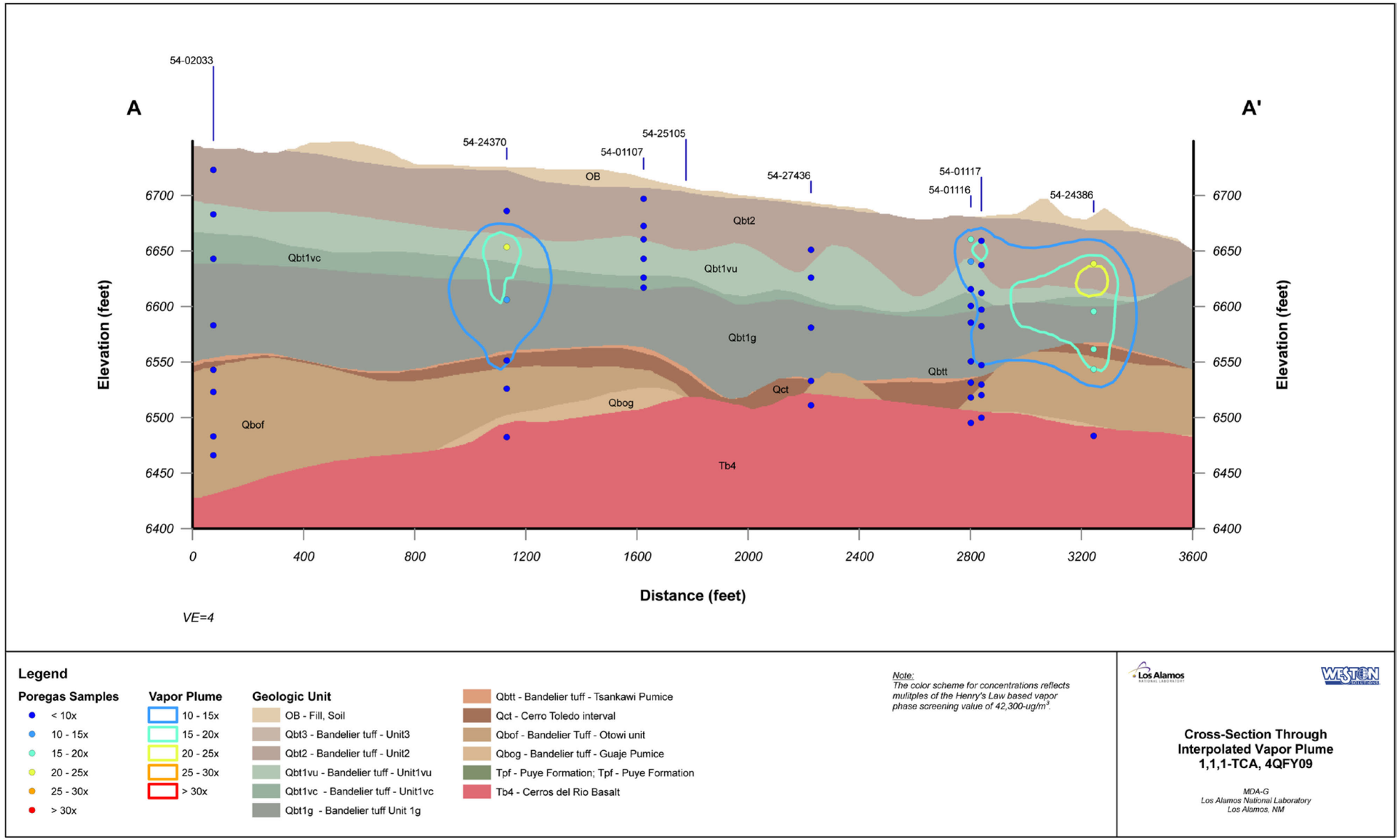
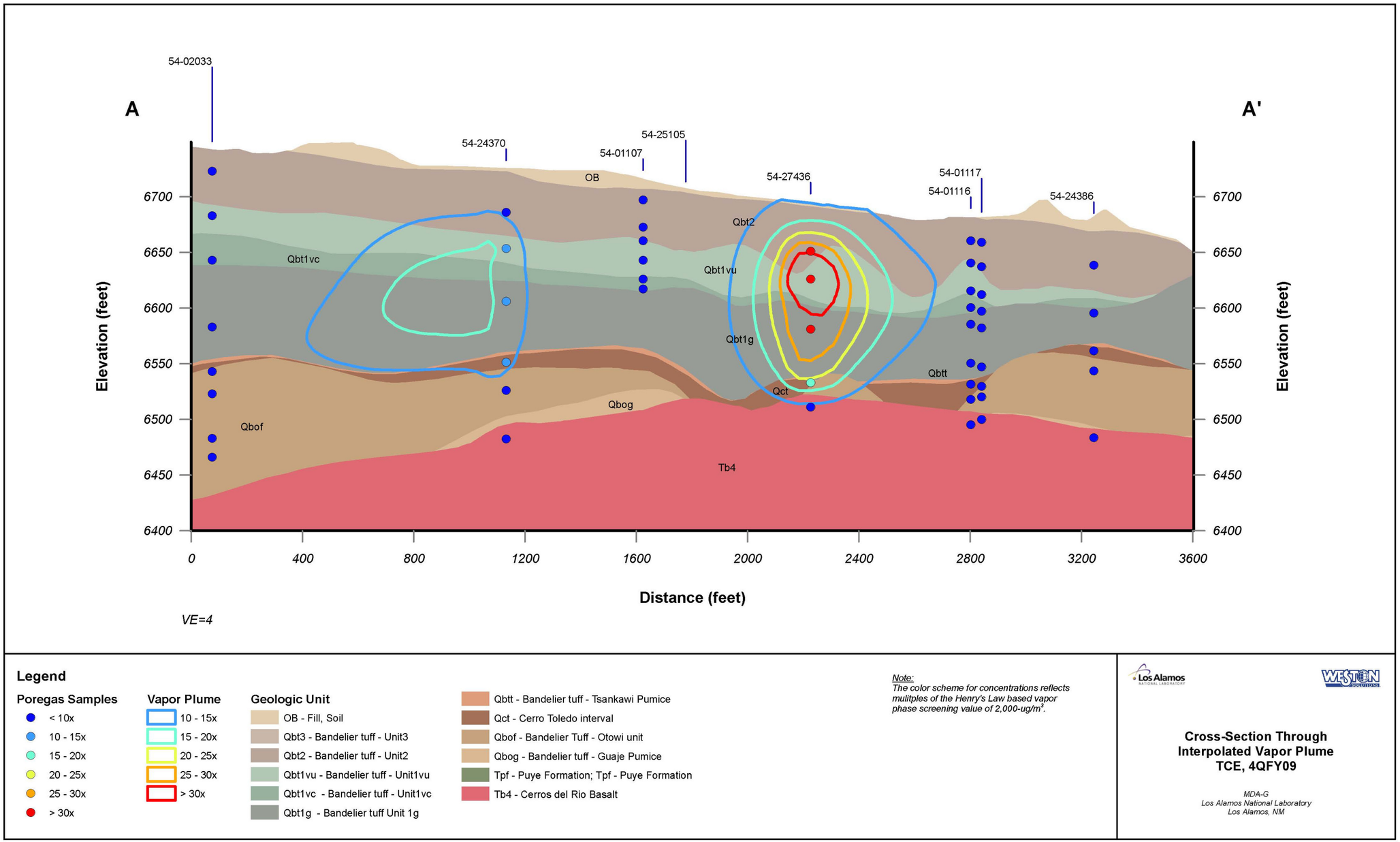


Figure C-3.1-3 East-west cross-section through interpolated vapor plume for TCA at MDA G based on fourth quarter FY2009 data



Legend

Poregas Samples
- < 10x
- 10 - 15x
- 15 - 20x
- 20 - 25x
- 25 - 30x
- > 30x

Vapor Plume
- 10 - 15x
- 15 - 20x
- 20 - 25x
- 25 - 30x
- > 30x

Geologic Unit
- OB - Fill, Soil
- Qbt3 - Bandelier tuff - Unit3
- Qbt2 - Bandelier tuff - Unit2
- Qbt1vu - Bandelier tuff - Unit1vu
- Qbt1vc - Bandelier tuff - Unit1vc
- Qbt1g - Bandelier tuff Unit 1g
- Qbtt - Bandelier tuff - Tsankawi Pumice
- Qct - Cerro Toledo interval
- Qbof - Bandelier Tuff - Otowi unit
- Qbog - Bandelier tuff - Guaje Pumice
- Tpf - Puye Formation; Tpf - Puye Formation
- Tb4 - Cerros del Rio Basalt

Note:
The color scheme for concentrations reflects mulitples of the Henry's Law based vapor phase screening value of 2,000-ug/m^3.

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Cross-Section Through Interpolated Vapor Plume TCE, 4QFY09

MDA-G
Los Alamos National Laboratory
Los Alamos, NM

Figure C-3.1-4 East-west cross-section through interpolated vapor plume for TCE at MDA G based on fourth quarter FY2009 data

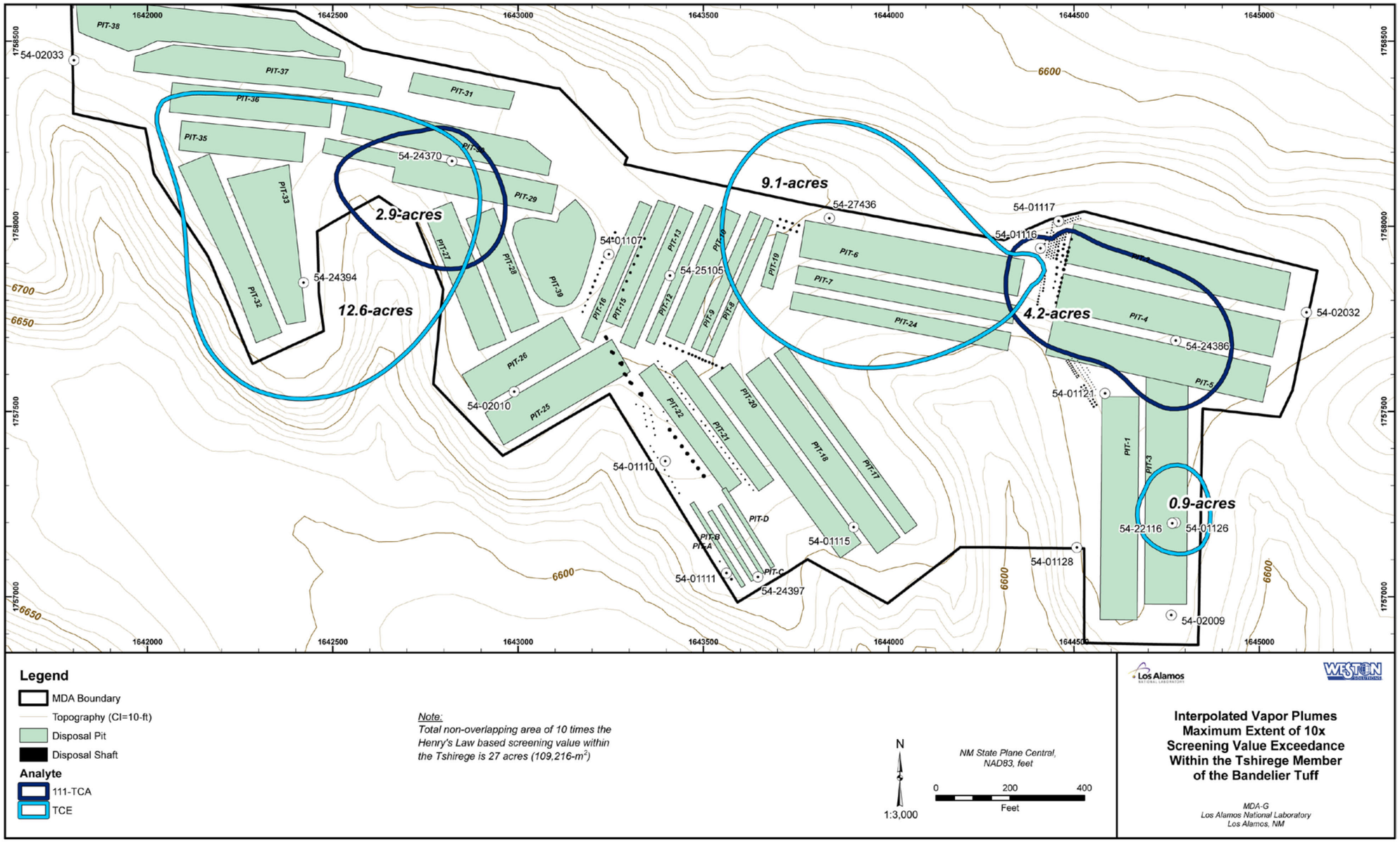

Figure C-3.1-5 Overlapping extents of 10 times Tier I SV contours for interpolated vapor plumes for TCA and TCE at MDA G based on fourth quarter FY2009 data. Plotted contour values shown are 423,000 µg/m^3 and 20,000 µg/m^3 for TCA and TCE, respectively.

Table C-2.1-1
Henry's Law Constants, Groundwater SLs, and the
Laboratory-Recommended Tier I and Tier II Vapor-Phase Screening Concentrations for MDA G

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 G Specific Tier II Calculated Pore-Gas Screening Concentrations (µg/m^3)
Acetone	0.0016	22,000	EPA regional SL	35,200	1.32×10^6
Benzene	0.228	5	EPA MCL	1140	1.86×10^4
Butadiene[1,3-]	3	0.018	EPA regional SL	54	552
Butanone[2-]	0.0023	7100	EPA regional SL	16,330	6.12×10^5
Carbon Disulfide	0.59	1000	EPA regional SL	590,000	2.09×10^7
Carbon Tetrachloride	1.1	5	EPA MCL	5500	3.94×10^4
Chlorodifluoromethane	1.7	100,000	EPA regional SL	170,000,000	2.54×10^9
Chloroform	0.15	100	NMWQCC	15,000	4.02×10^5
Cyclohexane	6.1	13,000	EPA regional SL	79,300,000	2.62×10^8
Dichlorodifluoromethane	14	390	EPA regional SL	5,460,000	1.63×10^7
Dichloroethane[1,1-]	0.23	25	NMWQCC	5750	9.86×10^4
Dichloroethene[1,1-]	1.1	5	NMWQCC	5500	3.12×10^4
Dichloroethene[1,2-]	0.048	5	EPA MCL	240	9000
Dichloroethene[cis-1,2-]	0.17	70	EPA MCL	11,900	2.54×10^5
Ethanol	na[b]	na	na	na	na
Ethylbenzene	0.323	700	EPA MCL	226,100	3.48×10^6
Ethyltoluene[4-]	na	na	na	na	na
Hexane	74	880	EPA regional SL	65,120,000	1.81×10^8
Methanol	0.00019	18,000	EPA regional SL	3420	1.28×10^5
Methylene Chloride	0.13	5	EPA MCL	650	1.57×10^4
n-Heptane	na	na	na	na	na
Propylene	na	na	na	na	na
Tetrachloroethene	0.72	5	EPA MCL	3600	3.75×10^4
Toluene	0.272	750	NMWQCC	204,000	3.23×10^6
Trichloro-1,2,2-trifluoroethane[1,1,2-]	22	59,000	EPA regional SL	1,298,000,000	3.98×10^9
Trichloroethane[1,1,1-]	0.705	60	NMWQCC	42,300	7.45×10^5
Trichloroethane[1,1,2-]	0.034	5	EPA MCL	170	1.51×10^5
Trichloroethene	0.4	5	EPA MCL	2000	5.13×10^4

Table C-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 G Specific Tier II Calculated Pore-Gas Screening Concentrations (µg/m³)
Trichlorofluoromethane	4	1300	EPA regional SL	5,200,000	1.98×10^7
Trimethylbenzene[1,2,4-]	0.25	15	EPA regional SL	3750	7.87×10^4
Trimethylbenzene[1,3,5-]	0.36	370	EPA regional SL	133,200	6.75×10^4
Xylene[1,2-]	0.213	1400	EPA regional SL	298,200	6.46×10^6
Xylene[1,3-]+Xylene[1,4-]	0.27	10,000[c]	EPA MCL	2,700,000	4.01×10^7

Notes: Tier 1 screening concentration is the calculated concentration in pore gas exceeding groundwater standard derived from the denominator of Equation C-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 C-2.2-1 and C-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 C-2.1-2
Screening of VOCs Detected during FY2009 in Pore Gas at MDA G

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	54	35,200	0.0015	No	No
Butanone[2-]	15	16,330	0.00092	No	No
Carbon Disulfide	8	590,000	0.000014	No	No
Chlorodifluoromethane	330	170,000,000	0.0000019	No	No
Chloroform	270	15,000	0.018	No	No
Cyclohexane	12,000	79,300,000	0.00015	No	No
Dichlorodifluoromethane	7200	5,460,000	0.0013	No	No
Dichloroethane[1,1-]	41,000	5750	7.1	Yes	No
Dichloroethene[1,1-]	49,000	5500	8.9	Yes	Yes
Ethanol	8.1	na[b]	na	n/a[c]	n/a[c]
Methanol	270	3420	0.079	No	No
Methylene Chloride	380	650	0.58	No	No
Tetrachloroethene	21,000	3600	5.8	Yes	No
Toluene	450	204,000	0.0022	No	No
Trichloro-1,2,2-trifluoroethane[1,1,2-]	140,000	1,298,000,000	0.00011	No	No

Table C-2.1-2 (continued)

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
Trichloroethane[1,1,1-]	860,000	42,300	20	Yes	Yes
Trichloroethene	78,000	2000	39	Yes	Yes
Trichlorofluoromethane	13,000	5,200,000	0.0025	No	No

Notes: Calculated concentrations in pore gas corresponding to groundwater SLs derived from denominator of Equation 3.0-3. SV derived from Equation 3.0-3.

[a] If the SV is less than 1, then the concentration of the VOC in pore gas does not exceed the groundwater screening level. The VOC is not a threat to groundwater if the SV is less than 1.

[b] na = Not available

[c] n/a = Not applicable.

Table C-2.1-3
Screening of VOCs Detected during FY2010 in Pore Gas at MDA G

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	140	34,880	0.004	No	No
Benzene	35	1140	0.031	No	No
Butanol[1-]	1200	1332	0.9	No	No
Chlorodifluoromethane	260	170,000,000	0.0000015	No	No
Chloroform	810	12,000	0.0675	No	No
Cyclohexane	4200	79,300,000	0.000053	No	No
Dichlorobenzene[1,2-]	860	46,470	0.019	No	No
Dichlorodifluoromethane	11,000	5,530,000	0.002	No	No
Dichloroethane[1,1-]	35,000	5750	6.1	Yes	No
Dichloroethane[1,2-]	340	240	1.4	Yes	No
Dichloroethene[1,1-]	33,000	5500	6	Yes	Yes
Dichloroethene[cis-1,2-]	46,000	11,900	3.9	Yes	No
Ethanol	430	na[b]	na	n/a[c]	n/a
Ethyltoluene[4-]	52	na	na	n/a	n/a
Methylene Chloride	1900	650	2.9	Yes	No
Tetrachloroethene	220,000	3600	61	Yes	Yes
Toluene	220	204,000	0.001	No	No
Trichloro-1,2,2-trifluoroethane[1,1,2-]	140,000	1,298,000,000	0.00011	No	No

Table C-2.1-3 (continued)

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
Trichloroethane[1,1,1-]	720,000	42,300	17	Yes	No
Trichloroethane[1,1,2-]	600	170	3.5	Yes	No
Trichloroethene	1,600,000	2000	800	Yes	Yes
Trichlorofluoromethane	3000	5,200,000	0.00058	No	No
Trimethylbenzene[1,2,4-]	62	3750	0.017	No	No
Xylene[1,3-]+Xylene[1,4-]	66	167,400	0.00039	No	No

Notes: Calculated concentrations in pore gas corresponding to groundwater SLs derived from denominator of Equation 3.0-3.
Screening value derived from Equation 3.0-3.

[a] If the screening value is less than 1, then the concentration of the VOC in pore gas does not exceed the groundwater screening level. The VOC is not a threat to ground water if the screening value is less than 1.

[b] na = Not available.

[c] n/a = Not applicable.

Table C-2.2-1
Tier II Analysis of Chemicals Failing the Tier I Analysis Based on Maximum FY2009 and FY2010 Concentrations

Parameters	Symbol	Unit	Dichloroethane [1,1-]	Dichloroethane [1,2-]	Dichloroethene [1,1-]	Dichloroethene [cis-1,2-]	Methylene Chloride	Tetrachloroethene	Trichloroethane [1,1,1-]	Trichloroethane [1,1,2-]	Trichloroethene
Source Properties											
Screening Level (SL) / Maximum Contaminant Level (MCL)		µg/L	25	5	5	70	5	5	60	60	5
Contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vz}	µg/m^3	41000	340	49000	46000	1900	220000	860000	600	1600000
Henry's law coefficient (dimensionless)	H	-	0.23	0.048	1.1	0.17	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	178	7	45	271	15	306	1220	18	4000
Distance from the vadose zone source to the water table	d_{vz}	m	250	250	250	250	250	250	250	250	250
Source length along the regional groundwater flow direction	L	m	60	60	60	60	60	60	30	30	30
Aquifer											
Hydraulic conductivity in the regional aquifer	k	m/d	1	1	1	1	1	1	1	1	1
Hydraulic gradient in the regional aquifer	I	m/m	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Considered aquifer thickness (e.g. screen length of a monitoring well)	d_a	m	3	3	3	3	3	3	3	3	3
Darcy velocity	v	m/d	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Pore-Water-Phase Migration											
Infiltration rate through the vadose zone	R	m/a	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
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	4.11E-04	4.11E-04	4.11E-04
Regional aquifer flux (unit length perpendicular to the groundwater flow)	q_{aq}	m^2/d	3.00E-02	3.00E-02	3.00E-02	3.00E-02	3.00E-02	3.00E-02	3.00E-02	3.00E-02	3.00E-02
Contaminant flux from the vadose-zone source to the water table under steady-state	q_{ssw}	m/d*µg/m^3	2.44	0.10	0.61	3.71	0.20	4.19	16.71	0.24	54.79
Aquifer mixing zone	d_m	m	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Dilution factor	F_{dw}	-	37.50	37.50	37.50	37.50	37.50	37.50	74.00	74.00	74.00
Contaminant concentration in the aquifer within the mixing zone	C^w_{aq}	µg/L	4.75	0.19	1.19	7.22	0.39	8.15	16.48	0.24	54.05
Screening level: acceptable contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vzMAX}	µg/m^3	215625	9000	206250	446250	24375	135000	3130200	150960	148000
COPC of concern based on pore-water migration? [yes/no]	-	yes/no	no	no	no	no	no	yes	no	no	yes
Gas-Phase Migration											
Diffusion coefficient of contaminants in air	D_a	m^2/d	0.7258	0.7258	0.7430	0.7603	0.8640	0.4346	0.5616	0.5616	0.5962
Diffusion coefficient of contaminants in the vadose zone	D_{ap}	m^2/d	0.0377	0.0377	0.0386	0.0395	0.0449	0.0226	0.0292	0.0292	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

Table C-2.2-1 (continued)

Parameters	Symbol	Unit	Dichloroethane [1,1-]	Dichloroethane [1,2-]	Dichloroethene [1,1-]	Dichloroethene [cis-1,2-]	Methylene Chloride	Tetrachloroethene	Trichloroethane [1,1,1-]	Trichloroethane [1,1,2-]	Trichloroethene
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
Porosity	n	-	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
Contaminant concentration in the vadose zone at the water table under steady state	C^g_{wt}	$\mu g/m^3$	6538	13	23597	5892	215	57713	266889	13	341169
Contaminant concentration in the aquifer at the water table under steady state	c^w_{wt}	$\mu g/m^3$	28426	270	21452	34658	1655	80157	378566	375	852922
Contaminant flux from the vadose-zone source to the water table under steady-state	q_{ssg}	$m/d*\mu g/m^3$	5	0	4	6	0	15	69	0	156
Aquifer mixing zone (only due to diffusion; if dispersion is included the contaminant flux will increase)	d_m	m	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Dilution factor	F_{dg}	-	3.9	3.4	6.2	3.6	3.1	7.5	12.4	8.7	10.3
Contaminant concentration in the aquifer within the mixing zone	C^w_{aq}	µg/L	10.40	0.10	7.85	12.68	0.61	29.33	69.26	0.07	156.04
Sceeening level: acceptable contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vzMAX}	$\mu g/m^3$	98547	17222	31212	2.54E+05	15692	37504	745022	524965	51268
COPC of concern based on air-phase migration? [yes/no]	-	yes/no	no	no	yes	no	no	yes	yes	no	yes

Note: ppm=mg/kg=mg/L=g/m3 (w); ppb = µg/kg = µg/L = mg/m3 (w); µg/kg = µg/m3 (a).
density of air ~ $1kg/m^3$.
density of water ~ 1kg/L.

Table C-3.1-1
Total Contaminant Mass (kg) of TCA and TCE
Exceeding 10 Times the Tier I Vapor-Phase SL

Analyte	Tshirege Only	Below Tshirege	Total
TCA	195	16	211
TCE	75	4	79

Source: LANL 2010, 109657.

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 2.5-1; Figure 2.3-3). 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-47i" (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 5^{th} and 95^{th} 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 5.3.2 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

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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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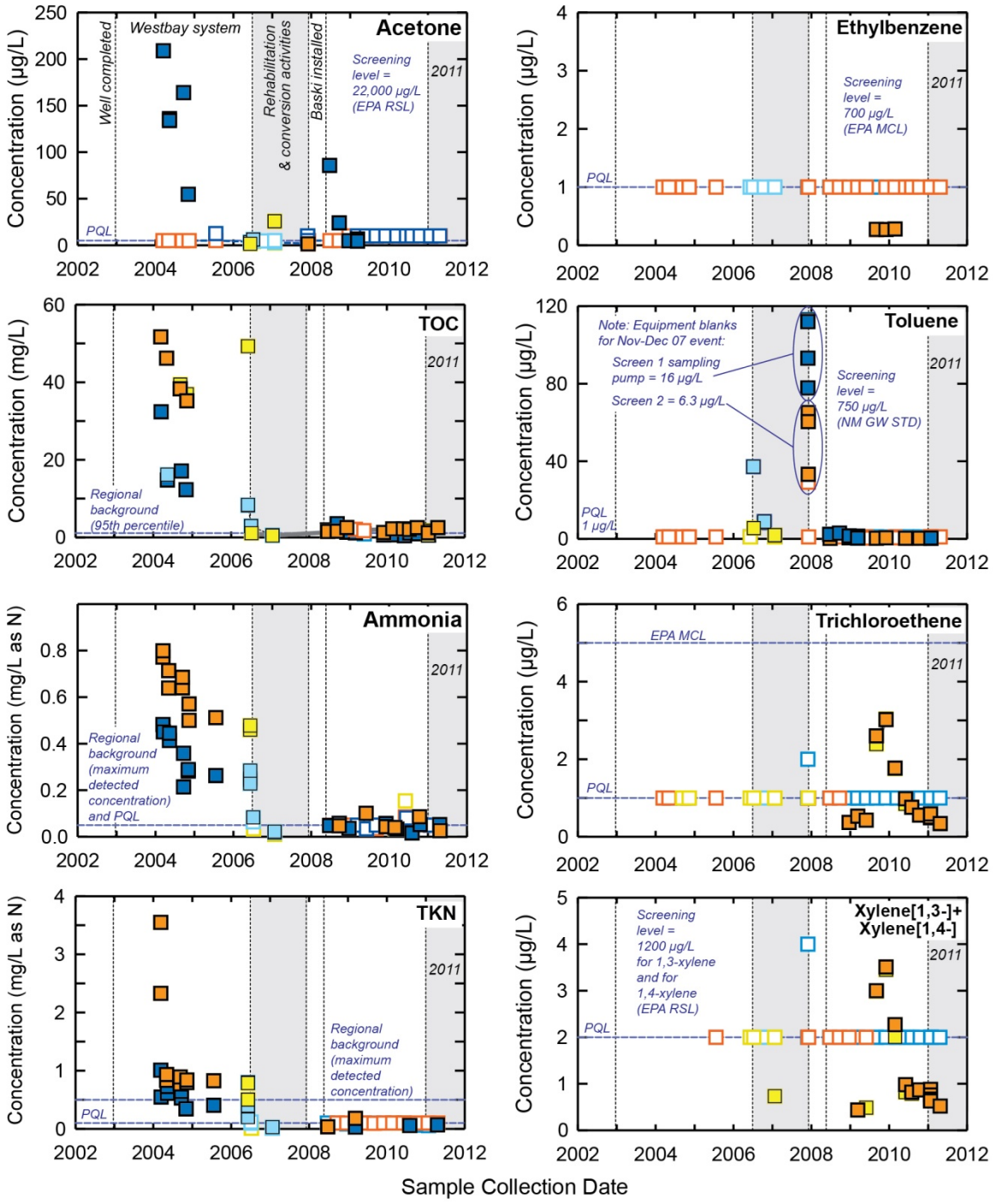


	Screen 1	Screen 2
Primary sample	Detect / Nondetect	Detect / Nondetect
Field duplicate or redevelopment sample	Detect / Nondetect	Detect / Nondetect
Data source: LANL water-quality database		

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

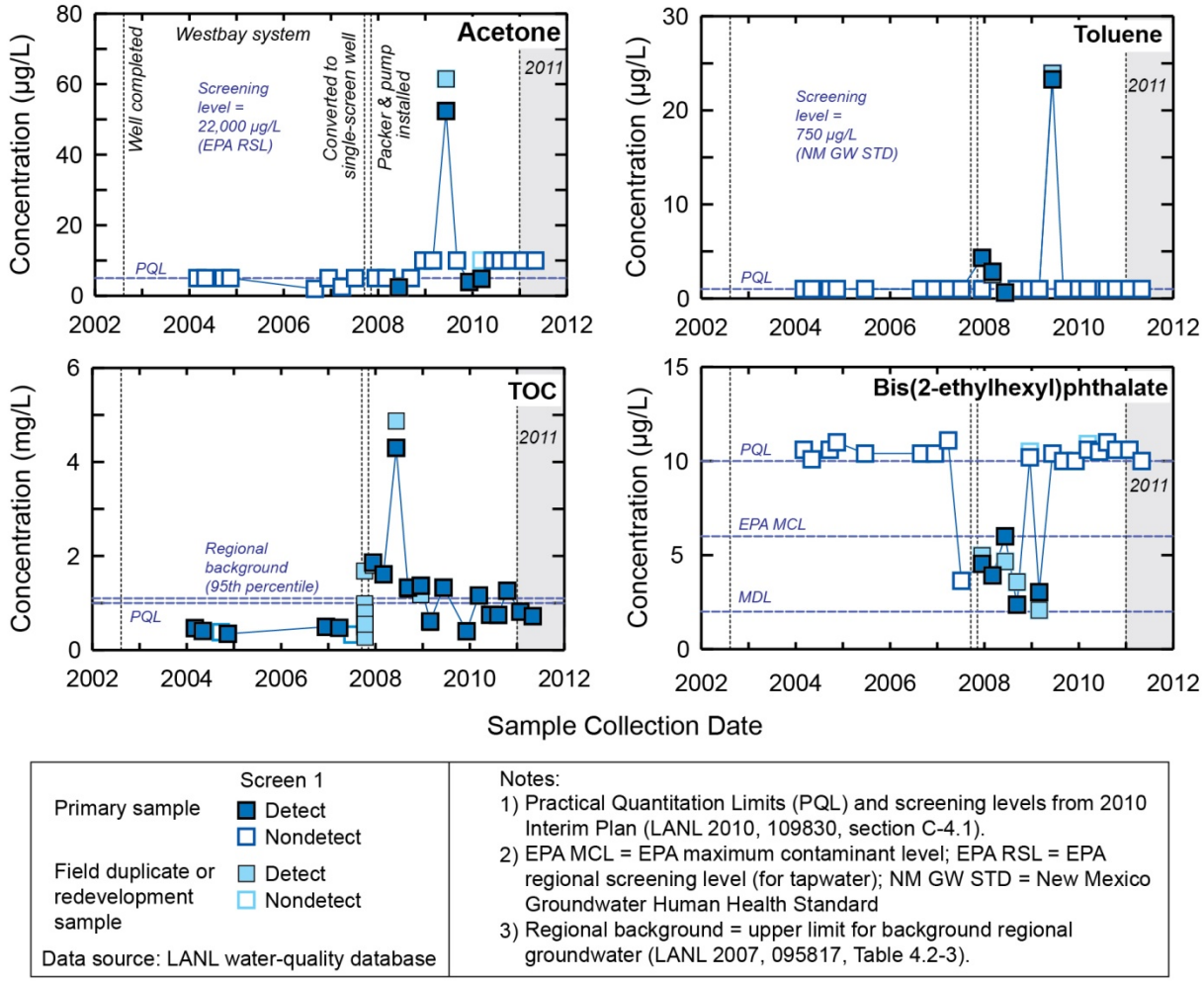
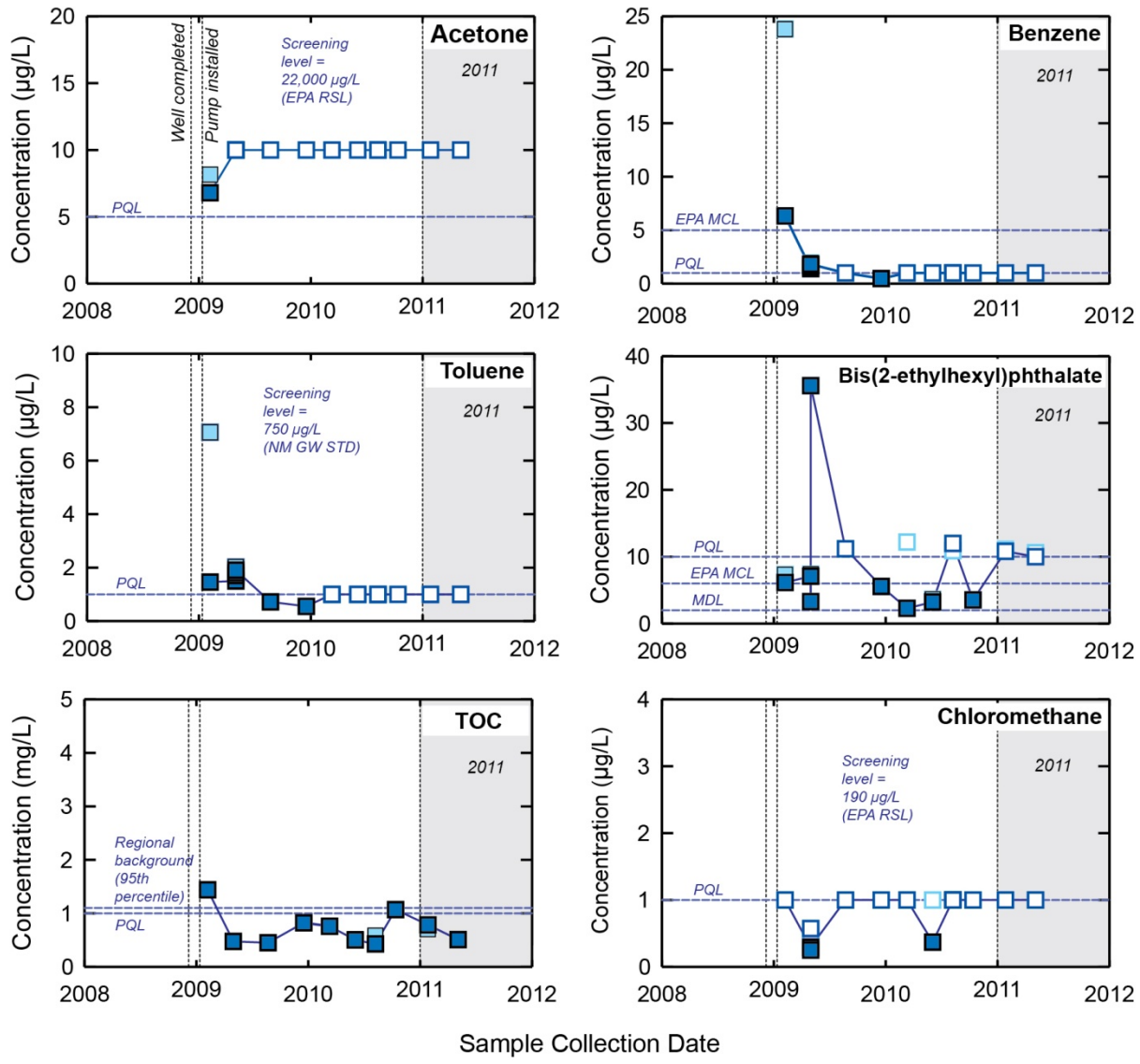


Figure D-3.6-1 Concentration trends for selected organic chemicals and indicators of residual organic drilling products in R-32



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-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	—
Silicon Dioxide	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.

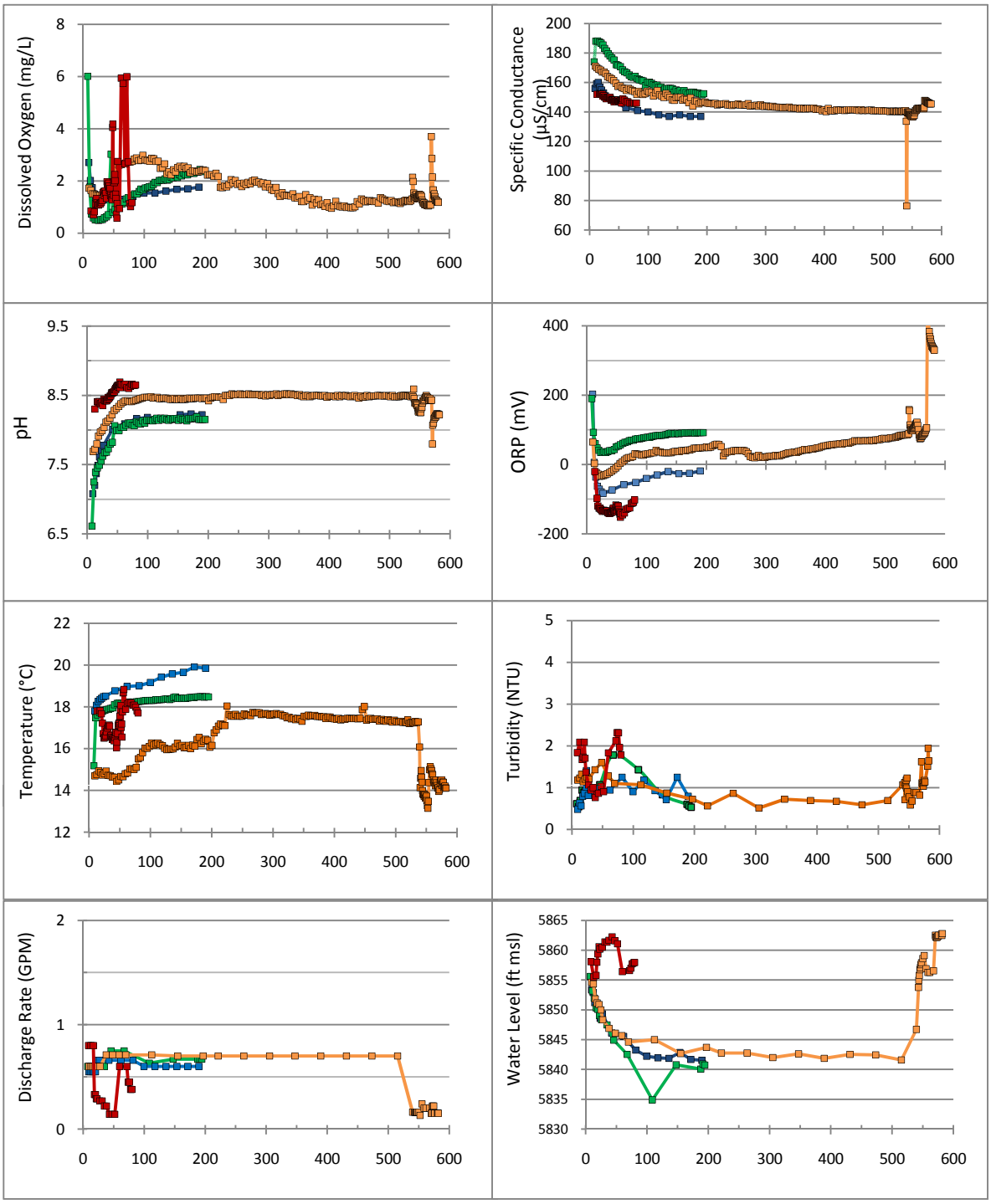
Attachment D-1

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

Figure D2-R20-1. **Time-series plots of field parameters monitored during purging of R-20 screen 1 (port P1A)**

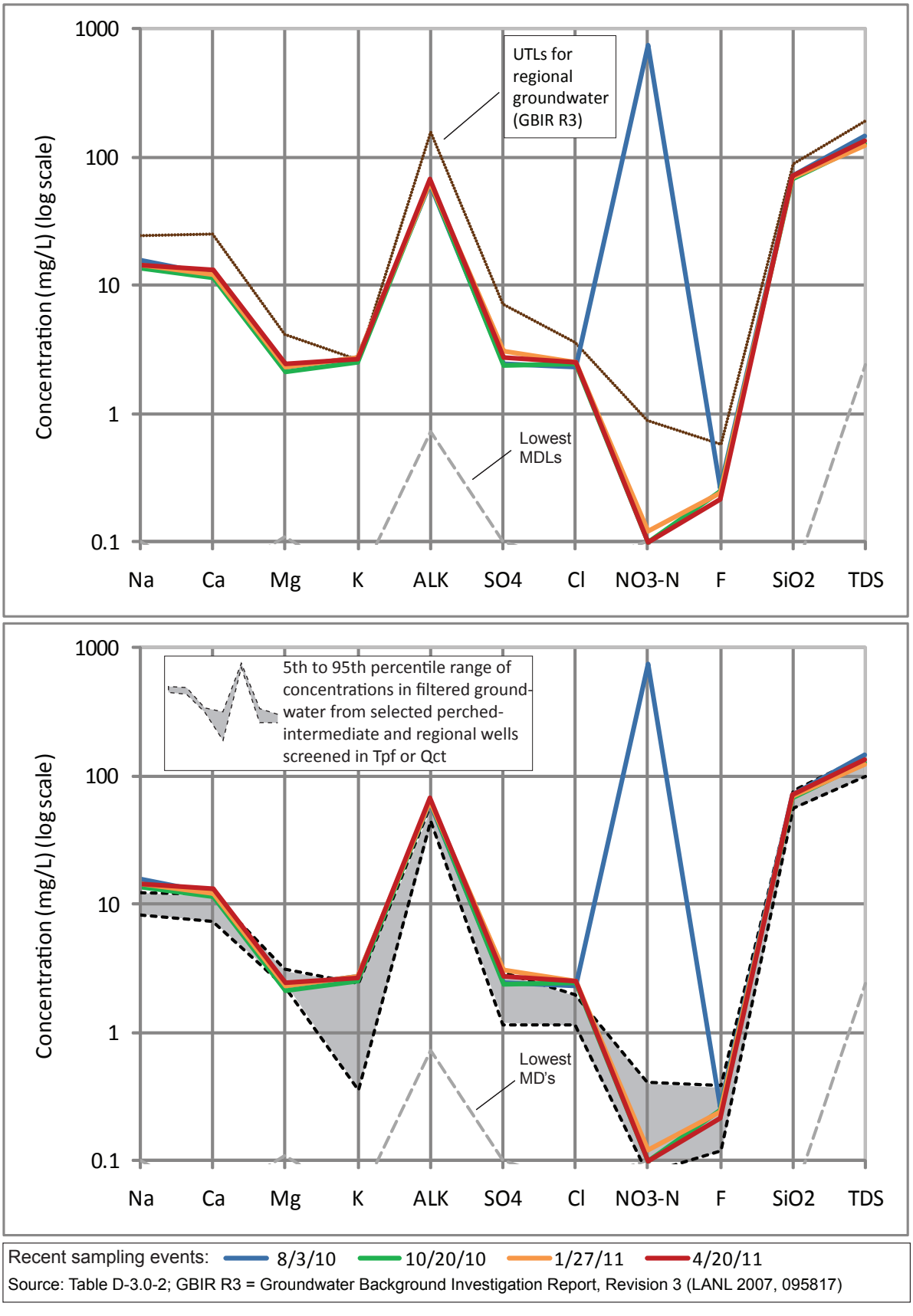


Figure D2-R20-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-20 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

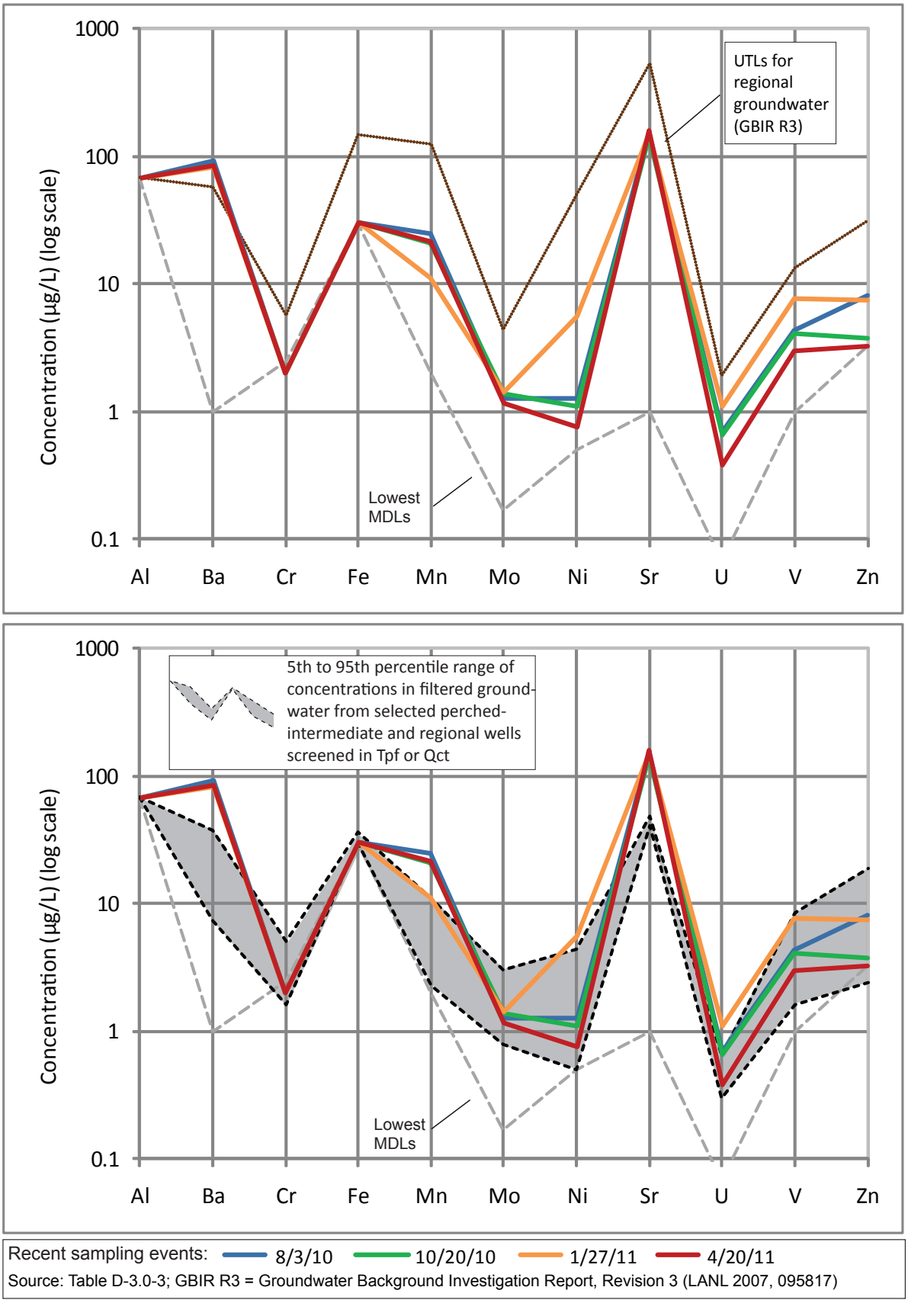
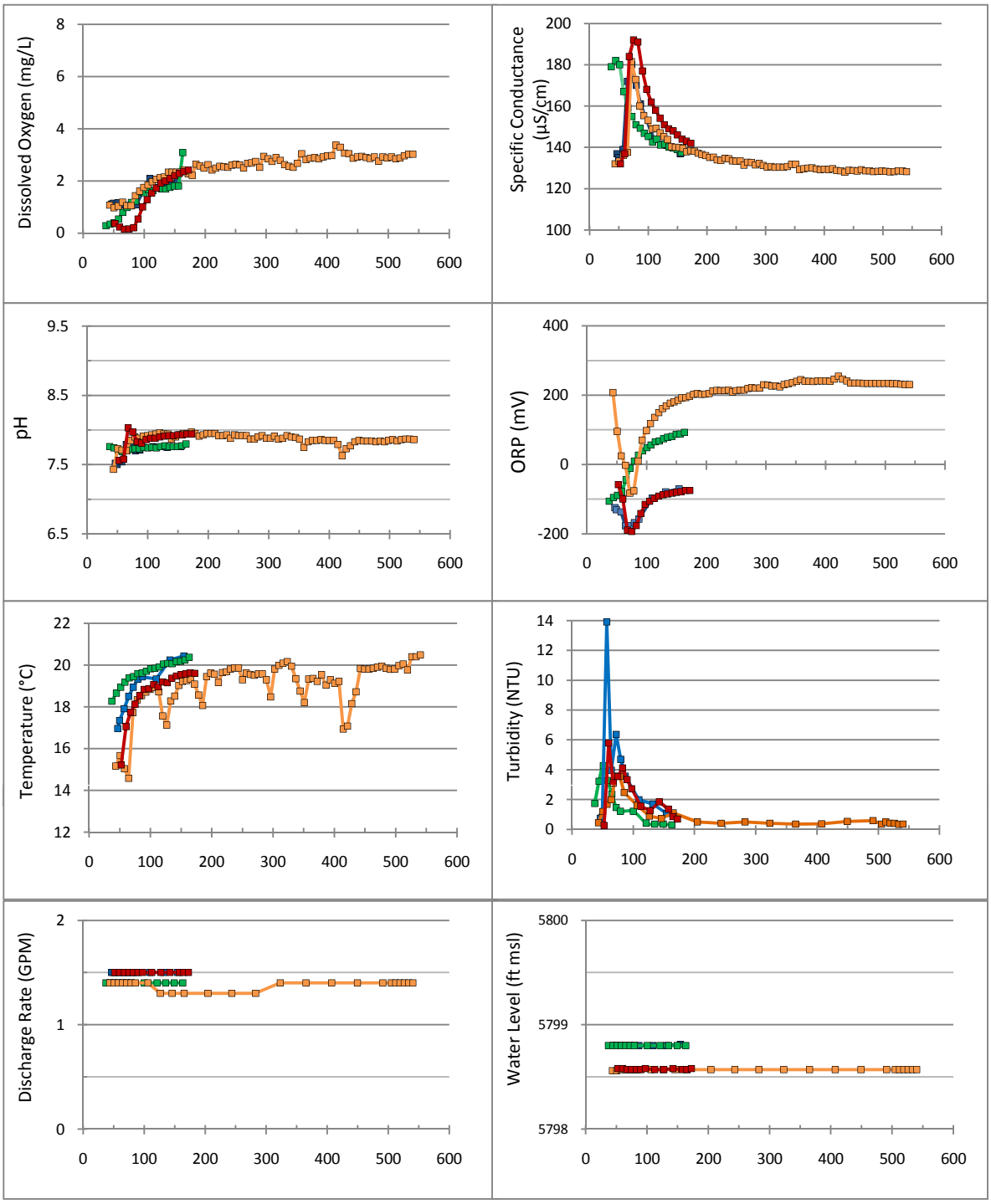


Figure D2-R20-3. Concentrations of trace metals in filtered groundwater from well R-20 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows"background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-20 screen 2 (port P2A), port depth 1147 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R20-4. Time-series plots of field parameters monitored during purging of R-20 screen 2 (port P2A)

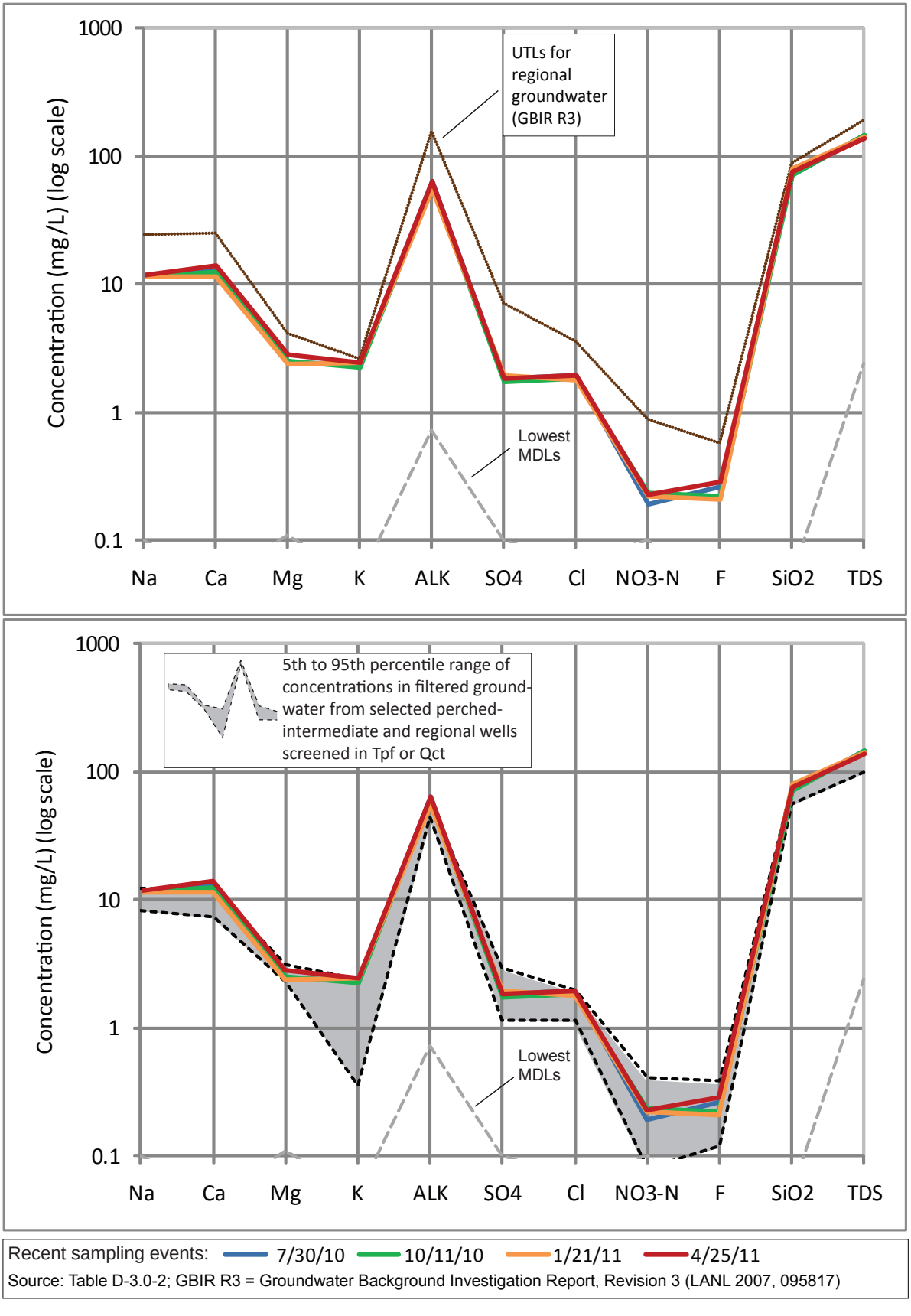


Figure D2-R20-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-20 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

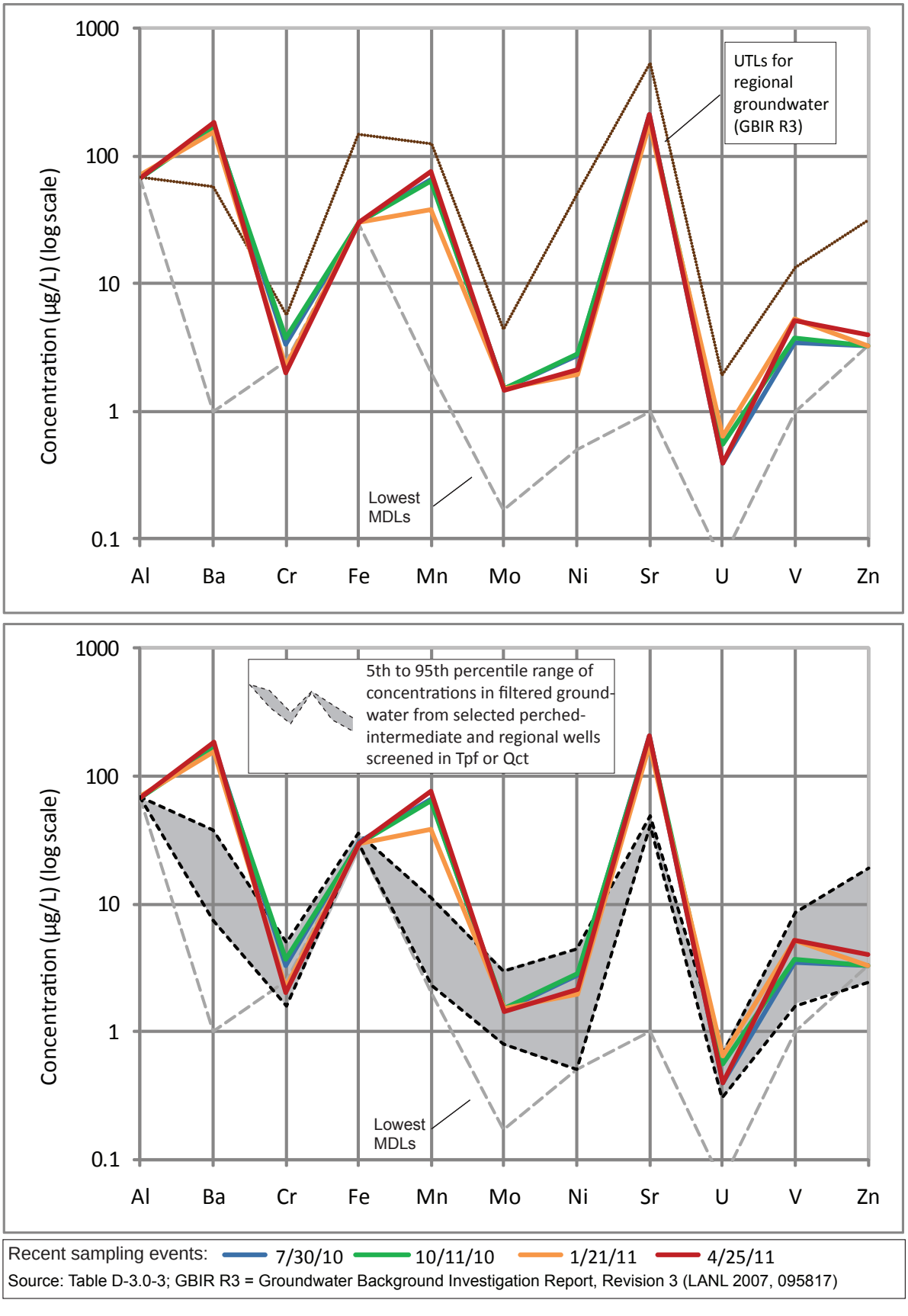
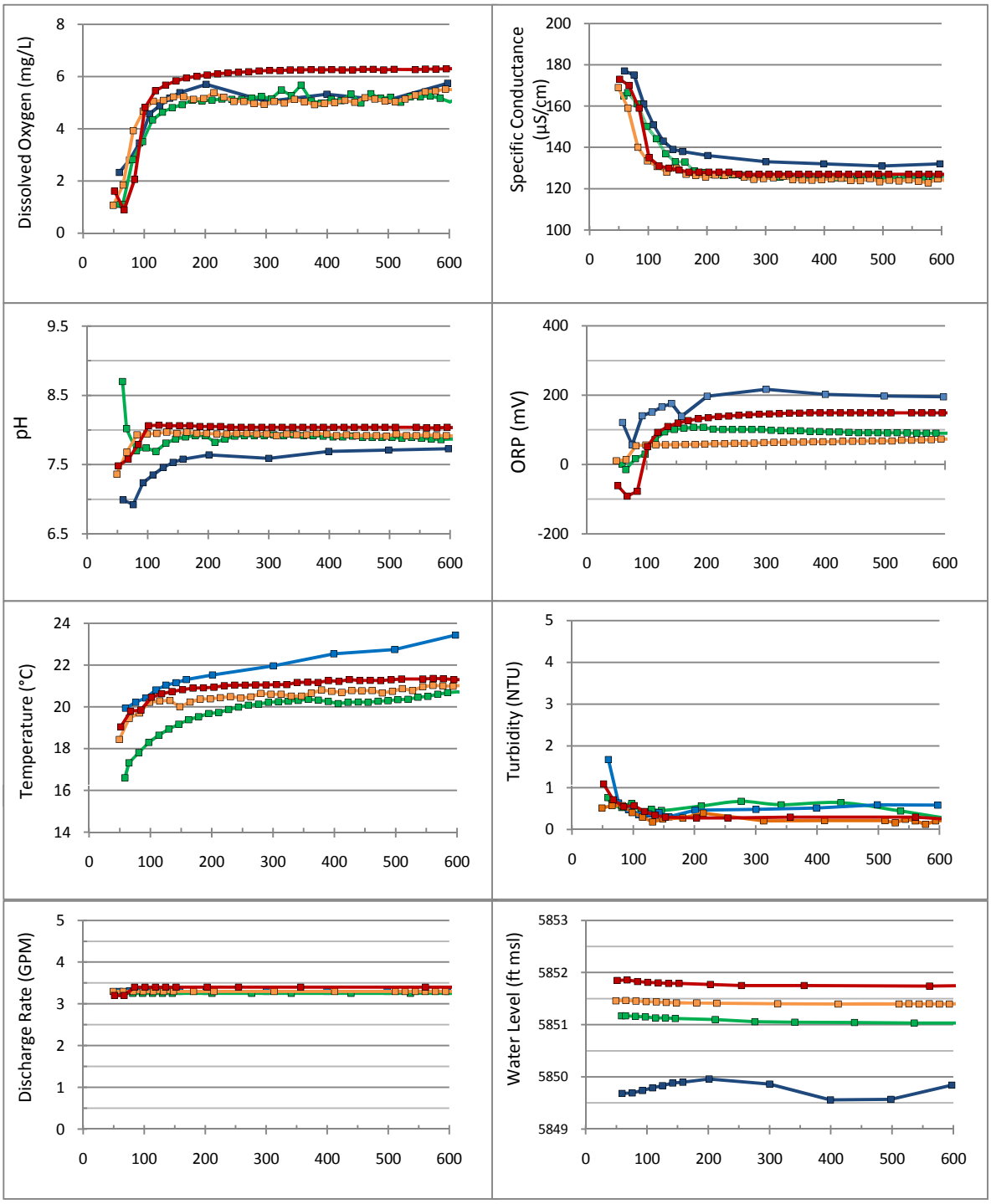


Figure D2-R20-6. Concentrations of trace metals in filtered groundwater from well R-20 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-21 (single screen), port depth 889 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R21-1. Time-series plots of field parameters monitored during purging of R-21 (single screen)

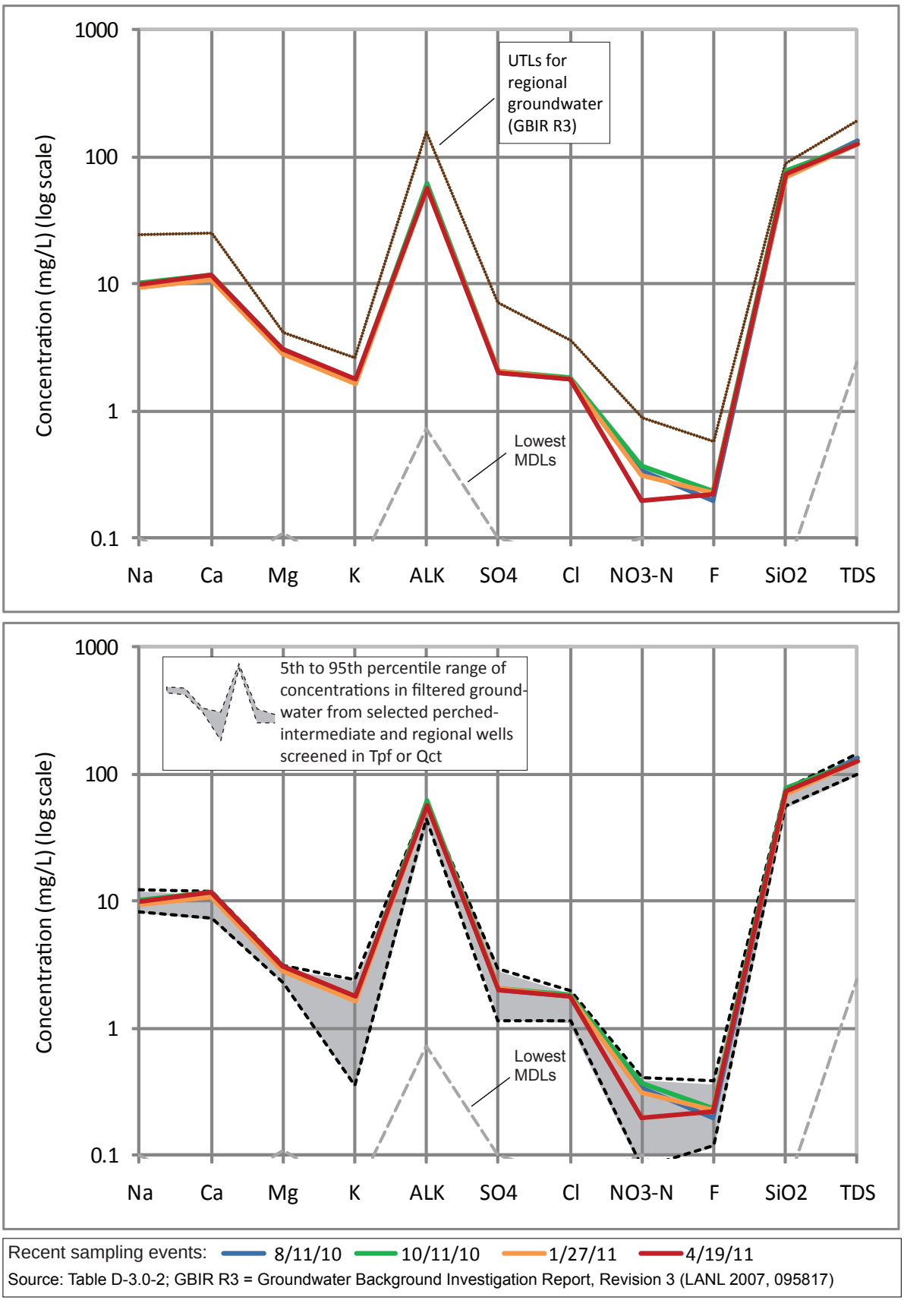


Figure D2-R21-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-21 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

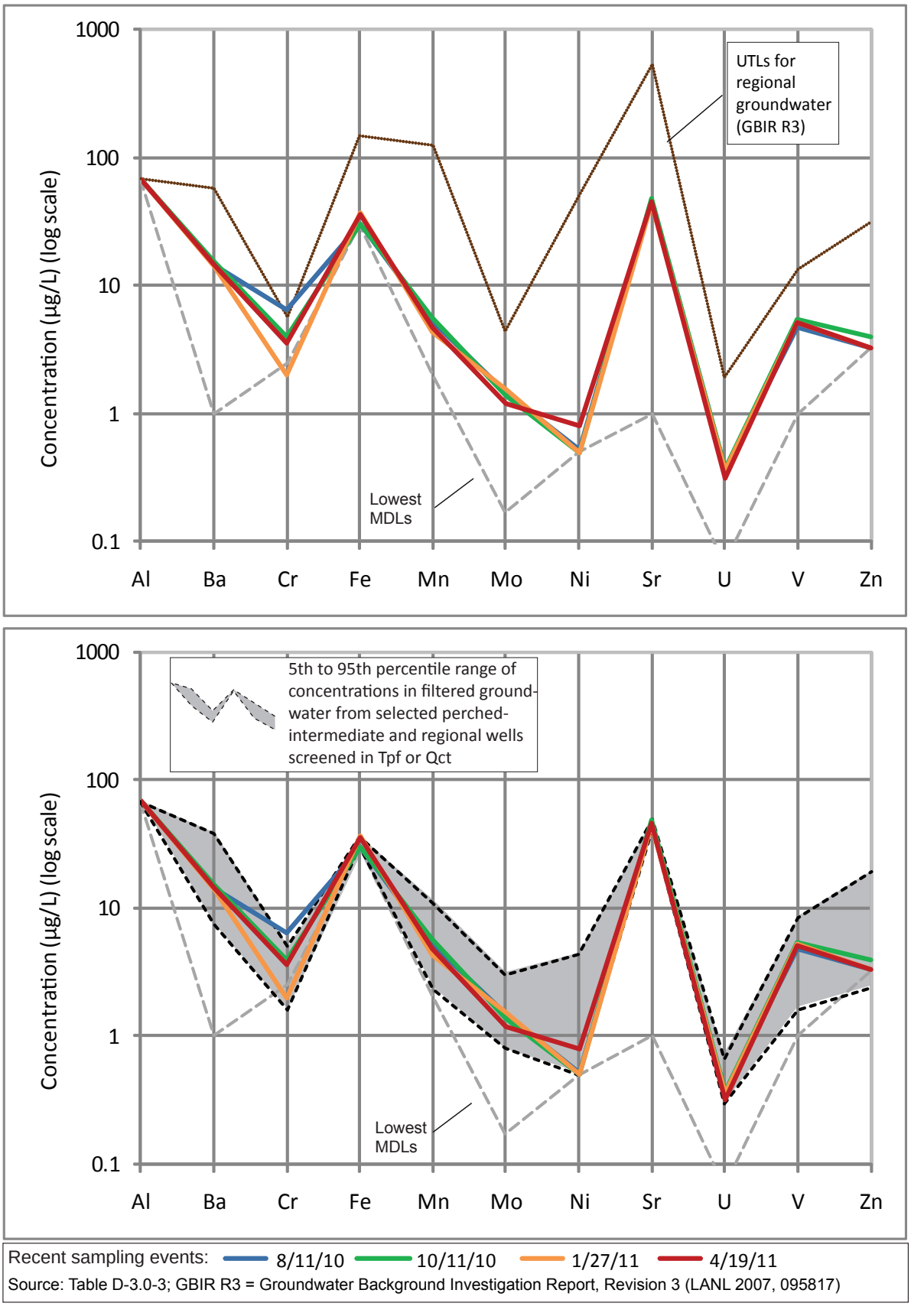


Figure D2-R21-3. Concentrations of trace metals in filtered groundwater from well R-21 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

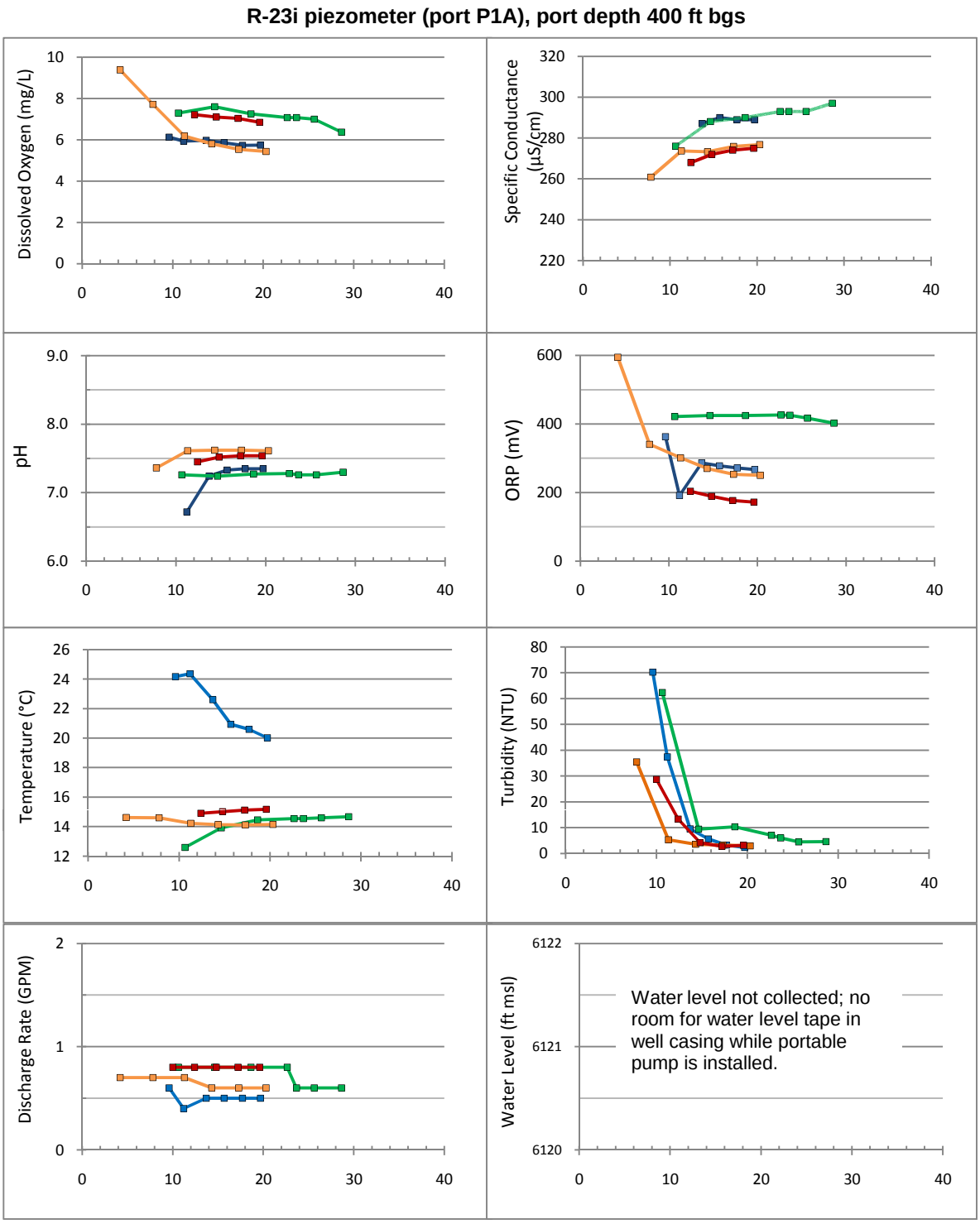


Figure D2-R23i-1. Time-series plots of field parameters monitored during purging of R-23i piezometer

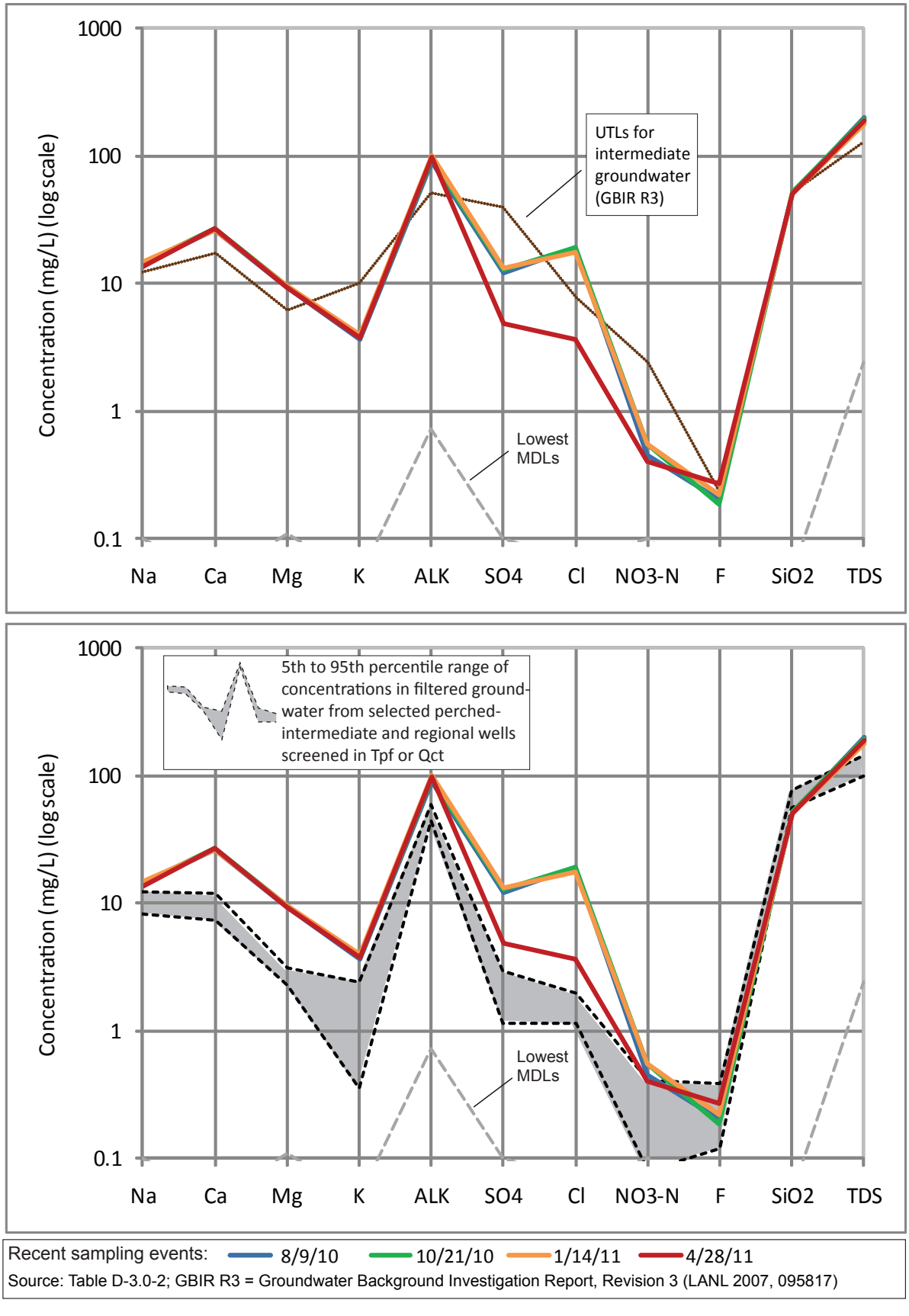


Figure D2-R23i-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

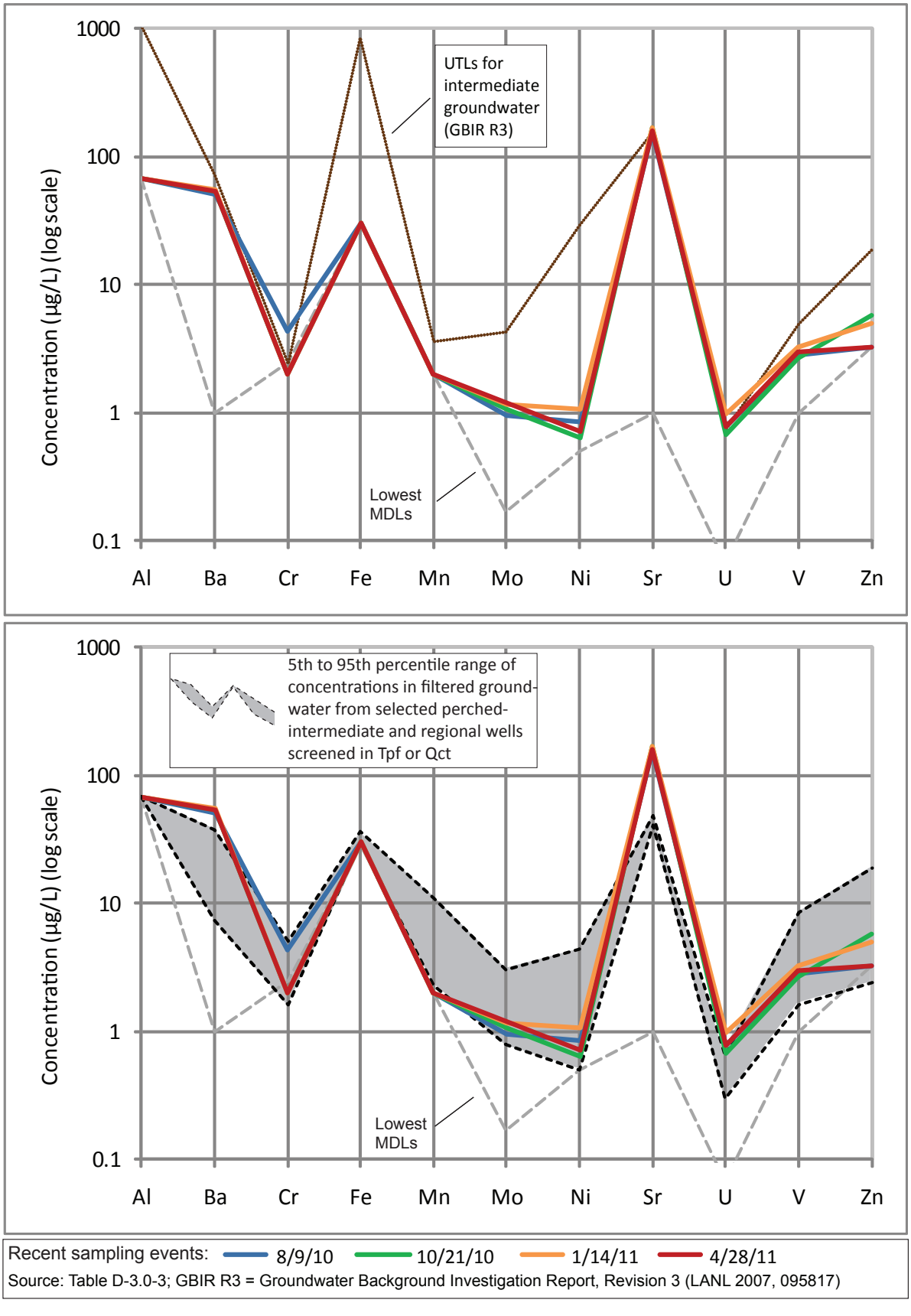


Figure D2-R23i-3. Concentrations of trace metals in filtered groundwater from well R-23i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23i screen 1 (port P2A), port depth 470 ft bgs

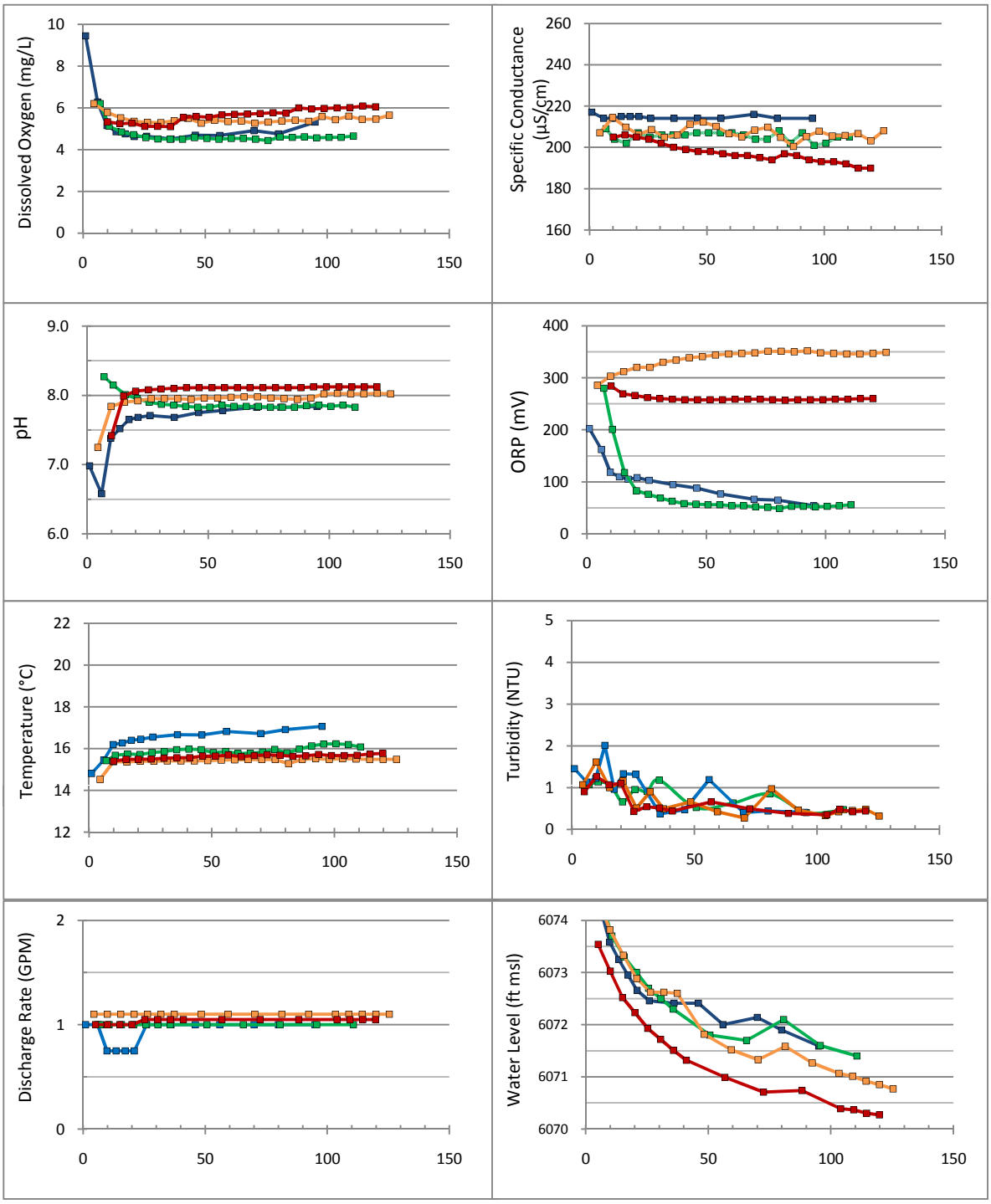


Figure D2-R23i-4. Time-series plots of field parameters monitored during purging of R-23i screen 1 (port P2A)

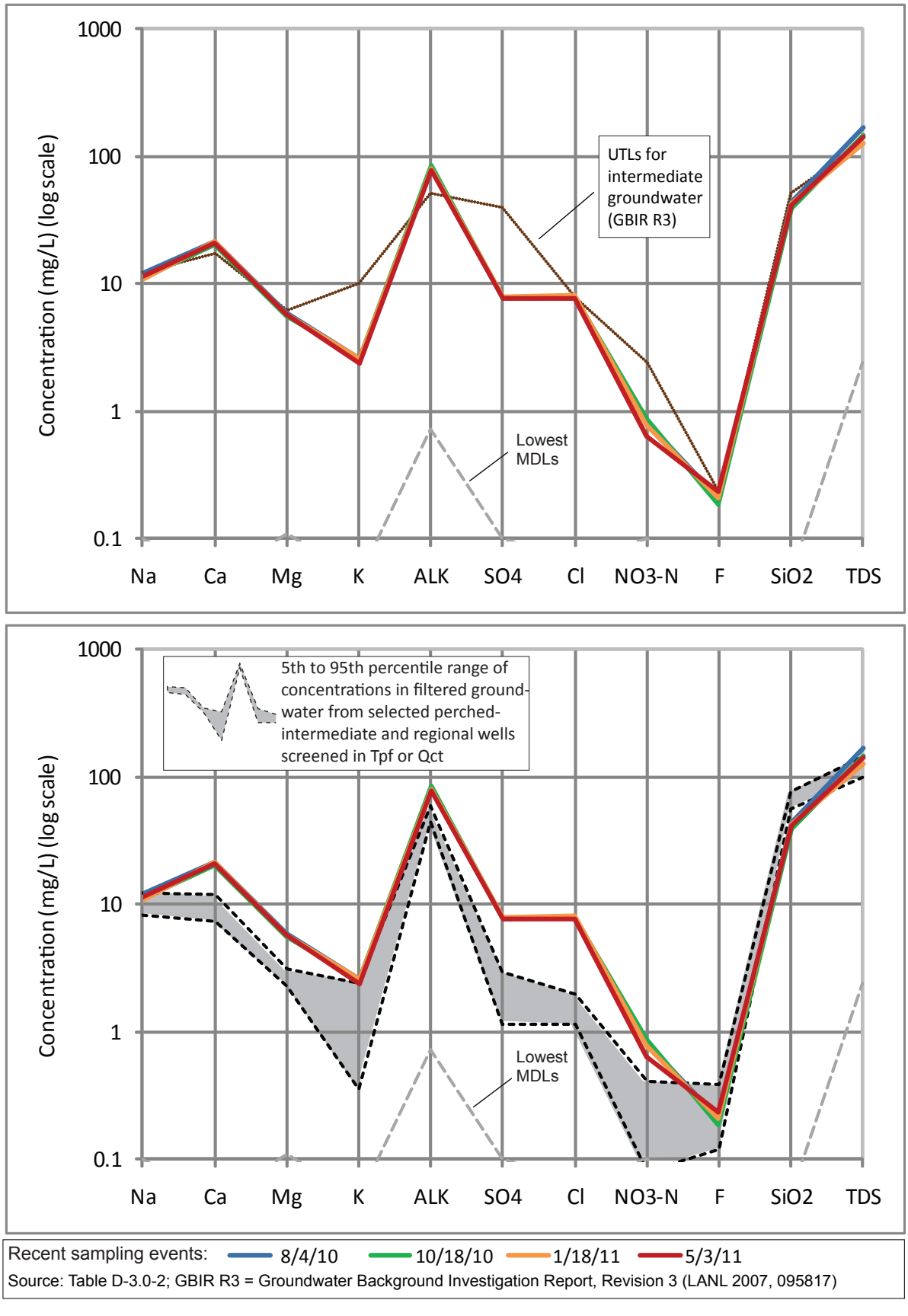


Figure D2-R23i-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23i screen 2 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

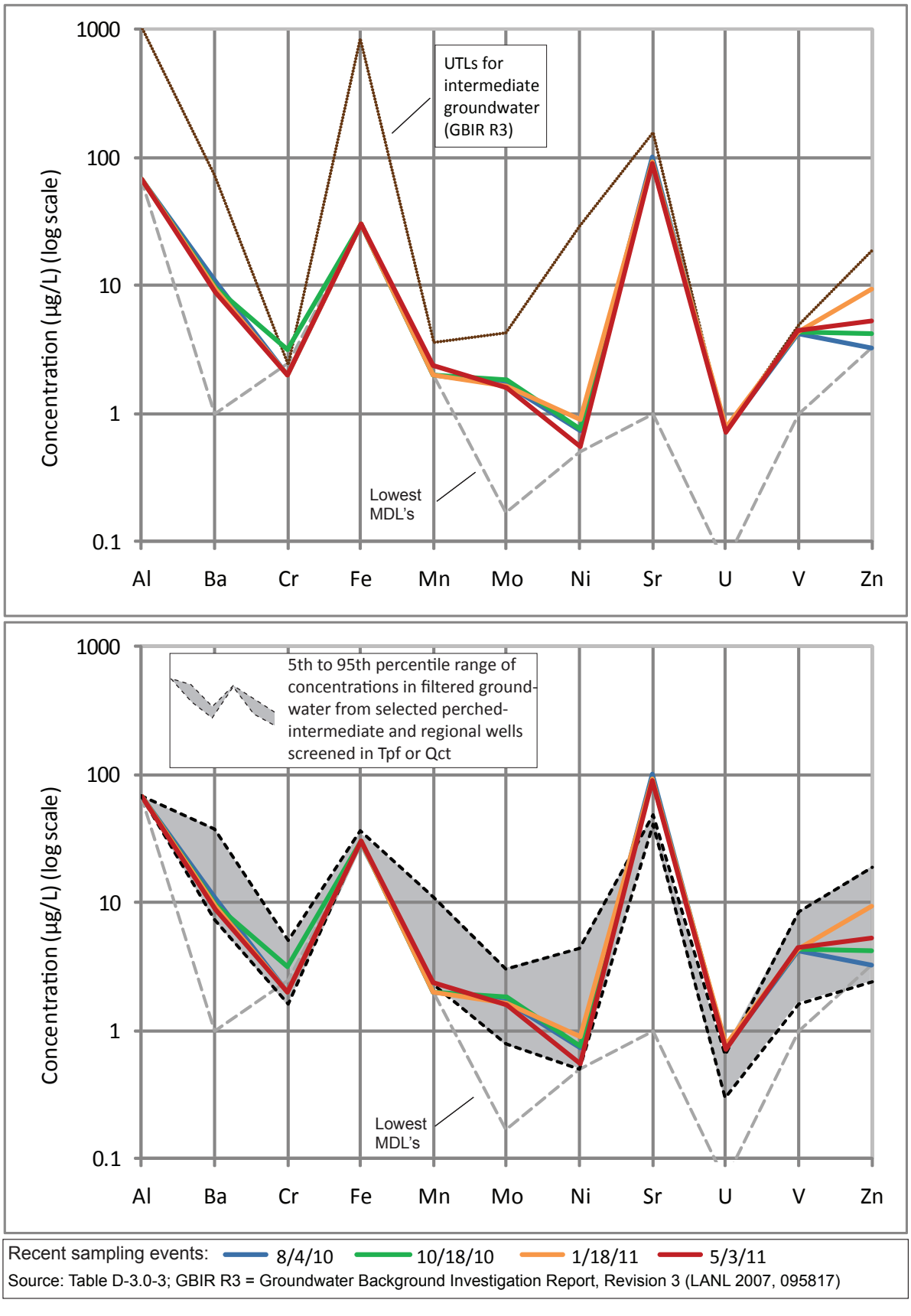
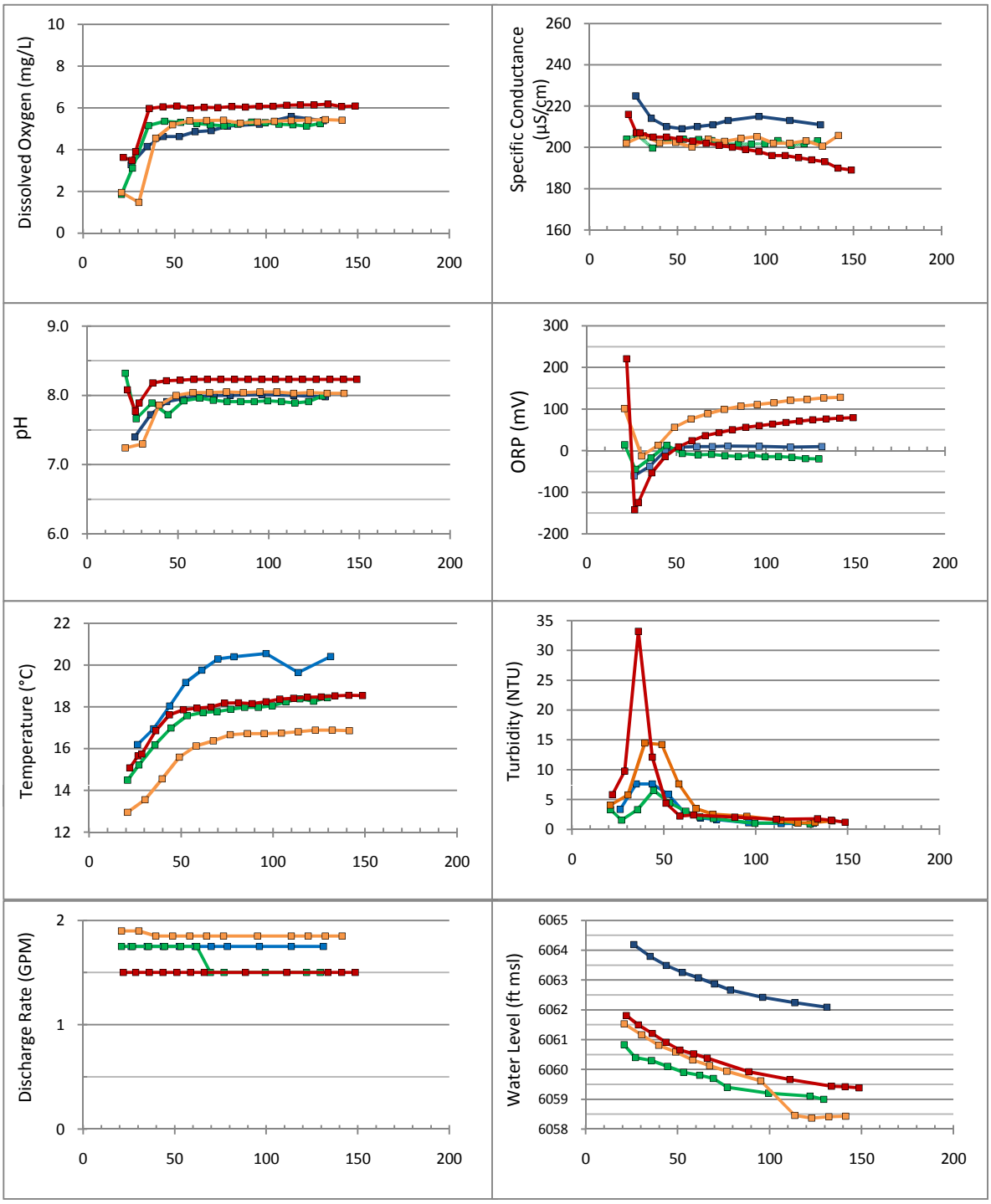


Figure D2-R23i-6. Concentrations of trace metals in filtered groundwater from well R-23i screen 2 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23i screen 2 (port P3A), port depth 524 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R23i-7. Time-series plots of field parameters monitored during purging of R-23i screen 2 (port P3A)

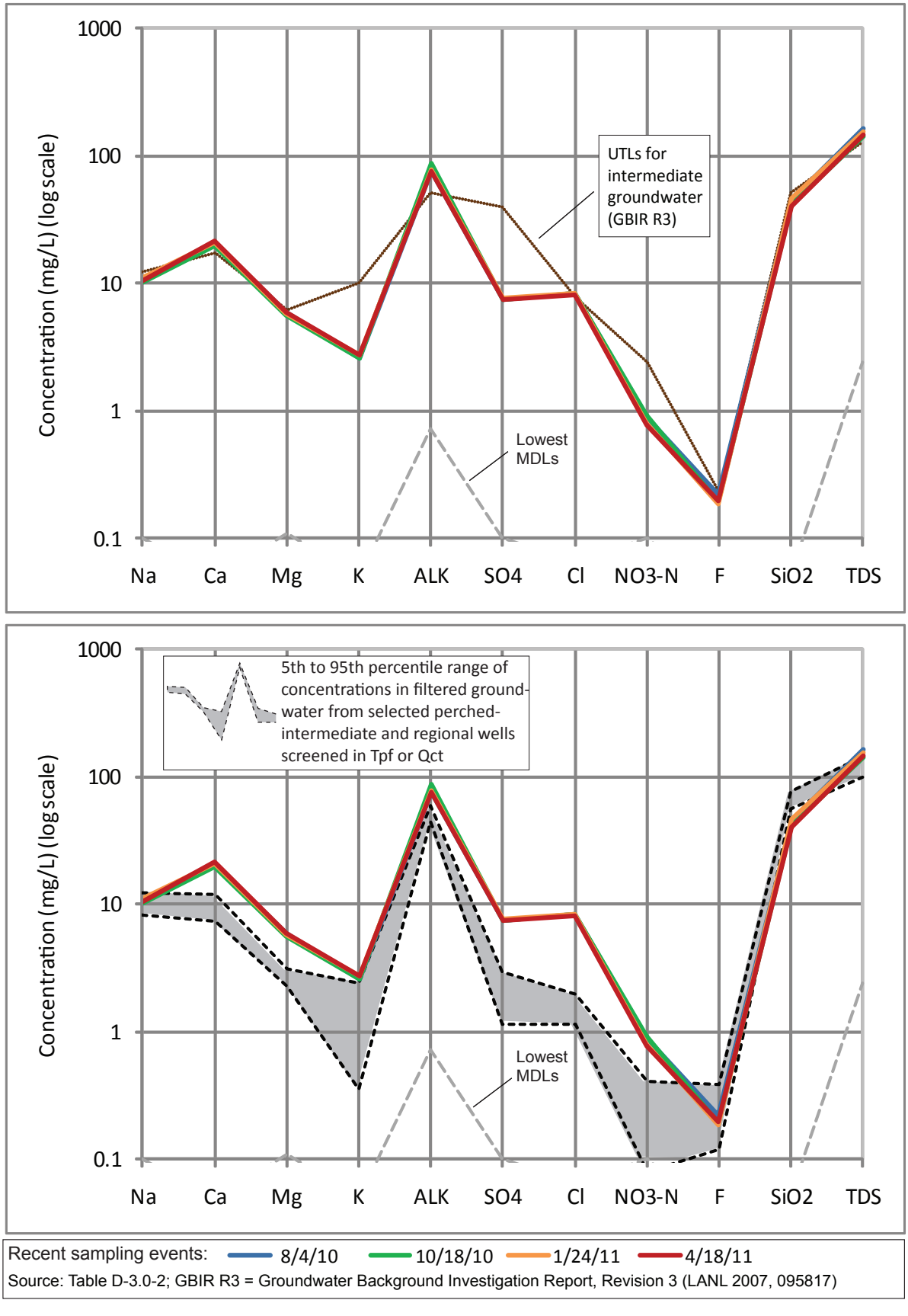


Figure D2-R-23i-8. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23i screen 3 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

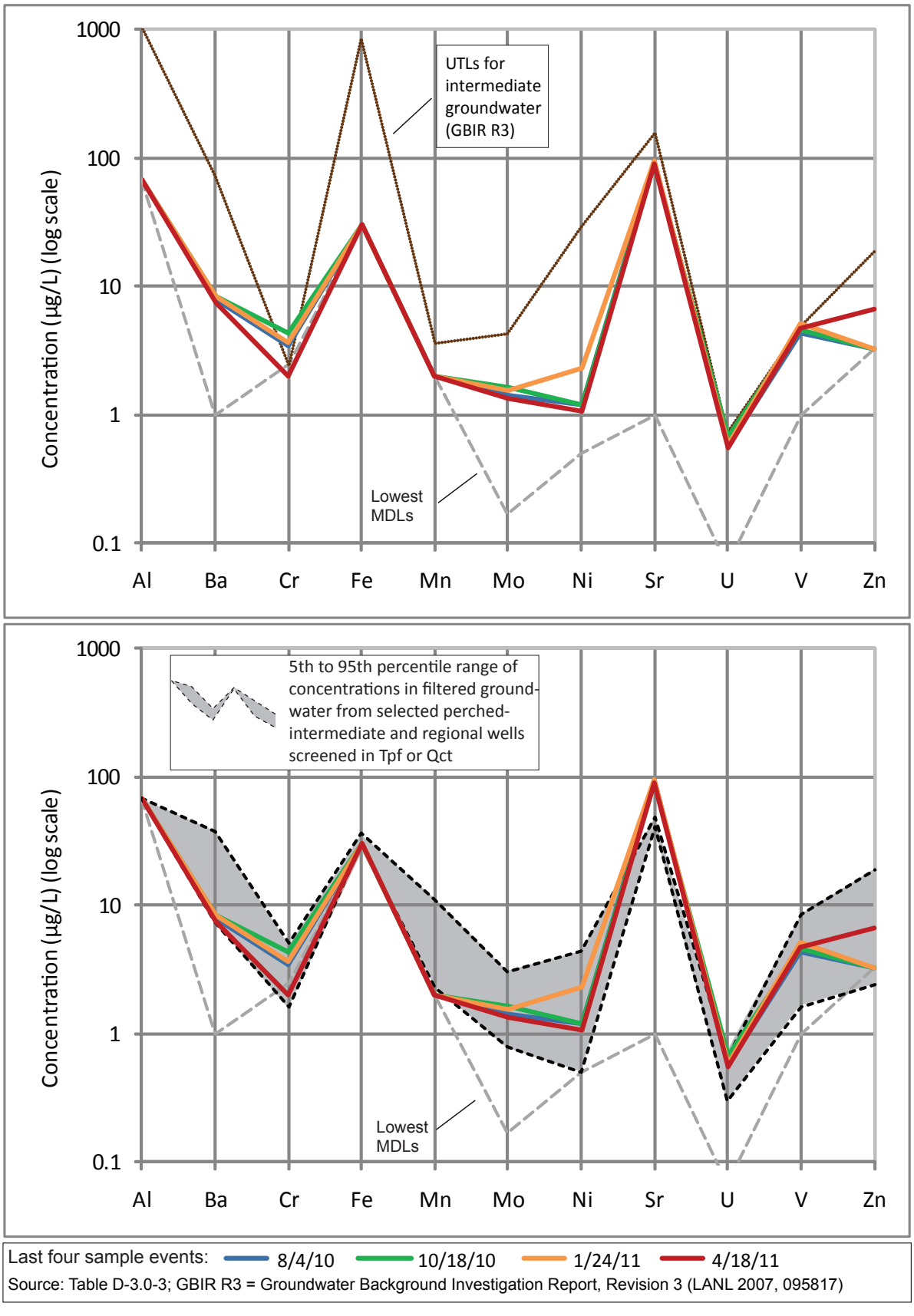
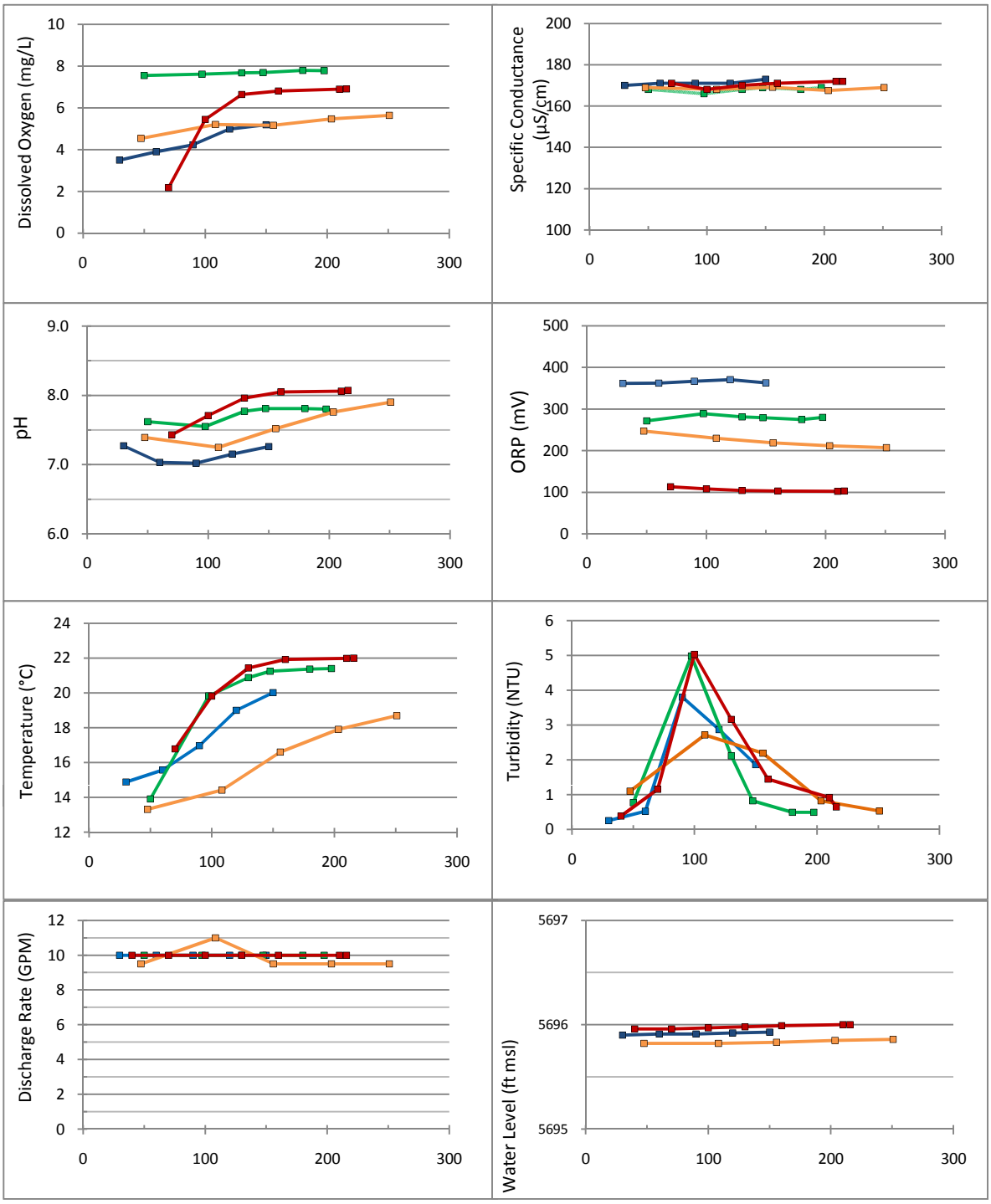


Figure D2-R23i-9. Concentrations of trace metals in filtered groundwater from well R-23i screen 3 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-23 (single screen), port depth 816 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R23-1. Time-series plots of field parameters monitored during purging of R-23 (single screen)

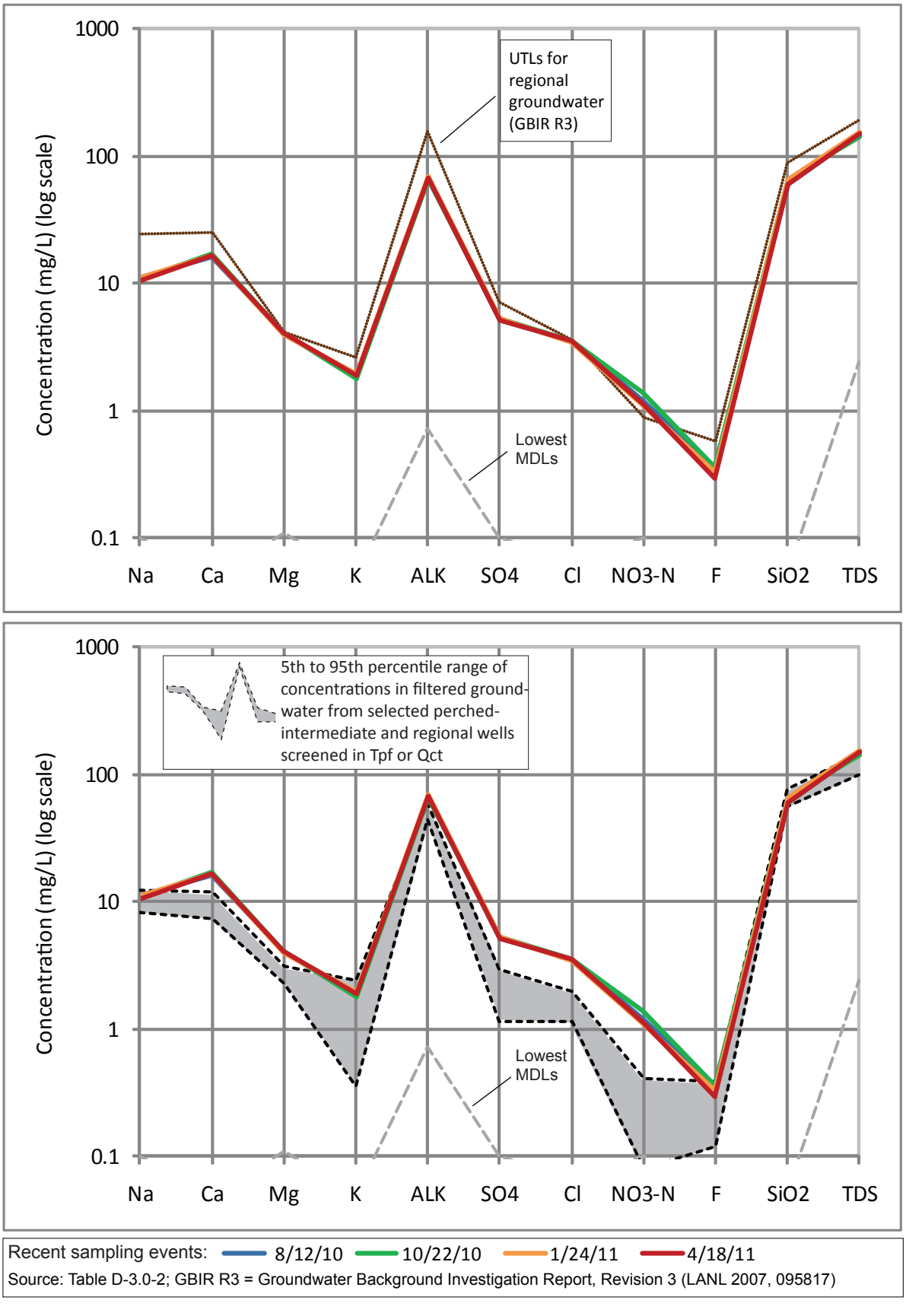


Figure D2-R23-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-23 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

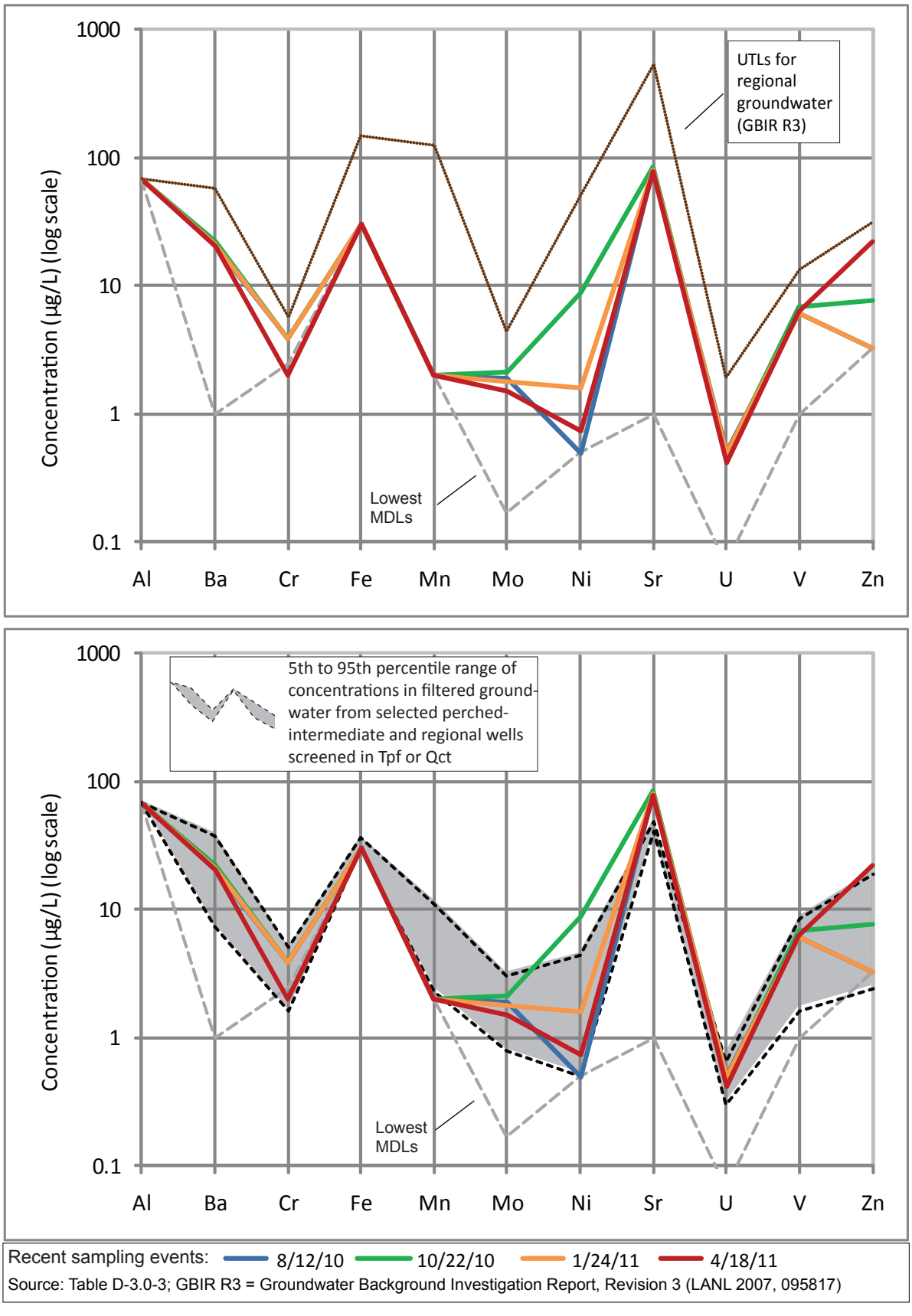
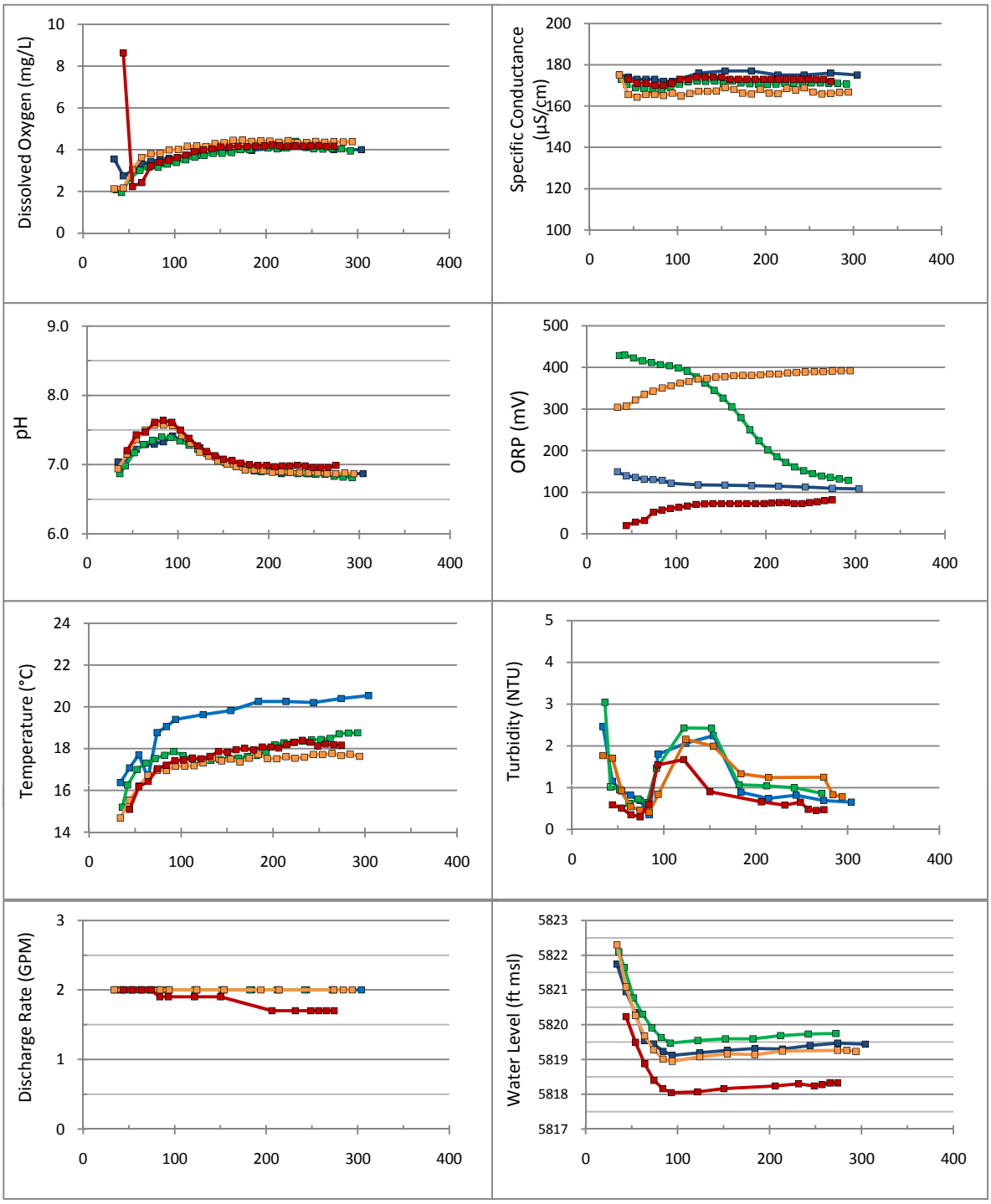


Figure D2-R23-3. Concentrations of trace metals in filtered groundwater from well R-23 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-32 (single screen), port depth 868 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R32-1. Time-series plots of field parameters monitored during purging of R-32 (single screen)

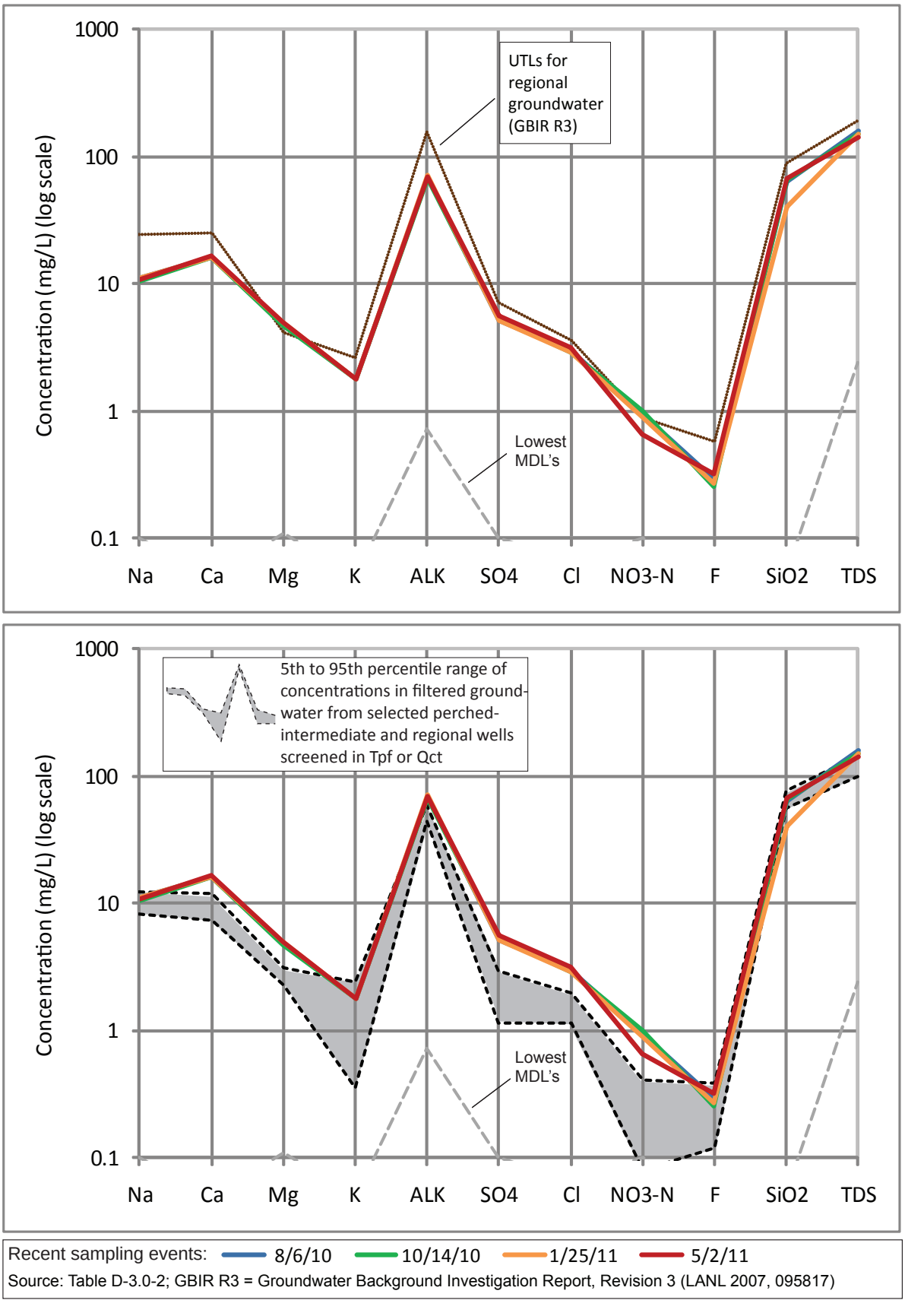


Figure D2-R32-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-32 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

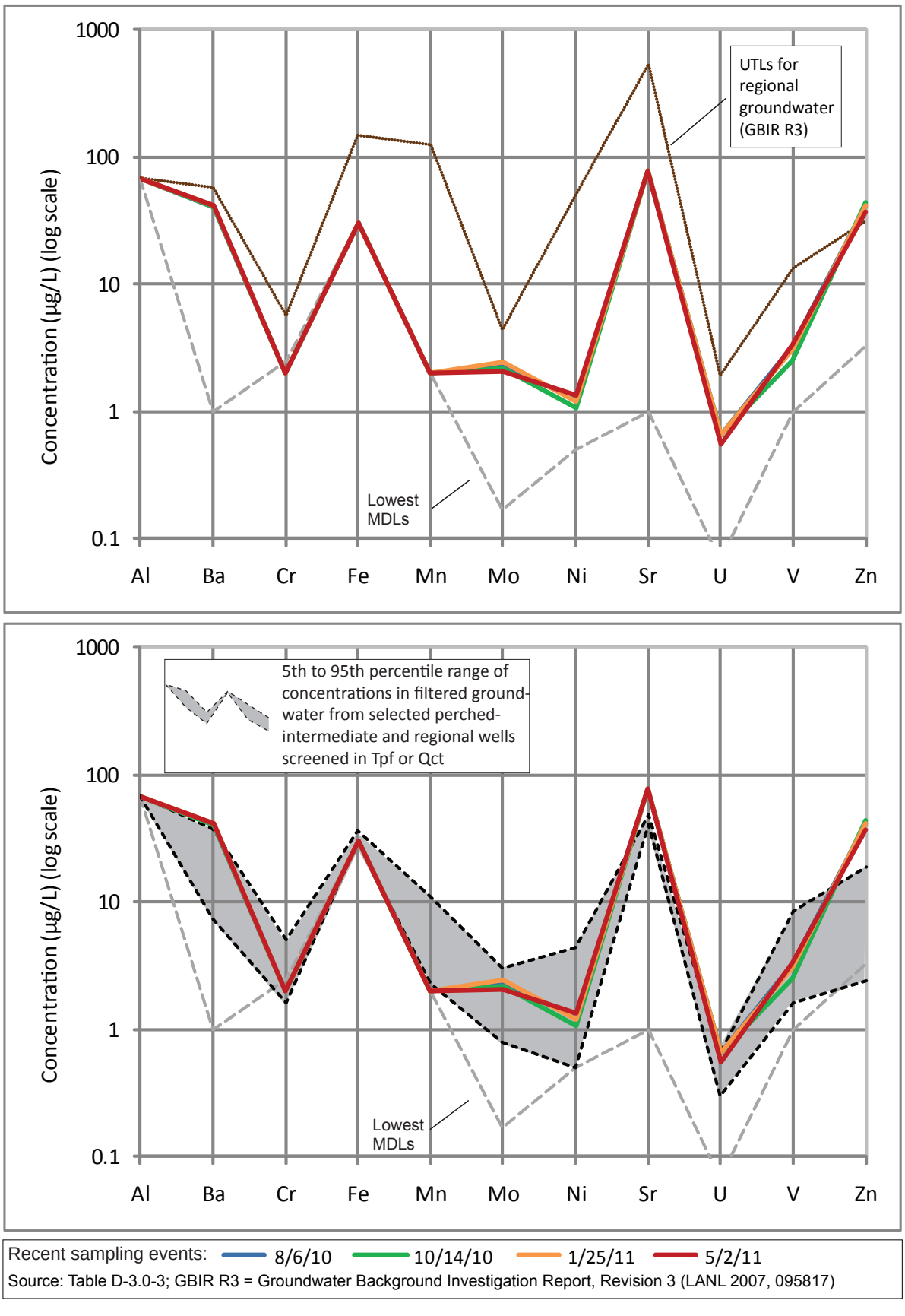
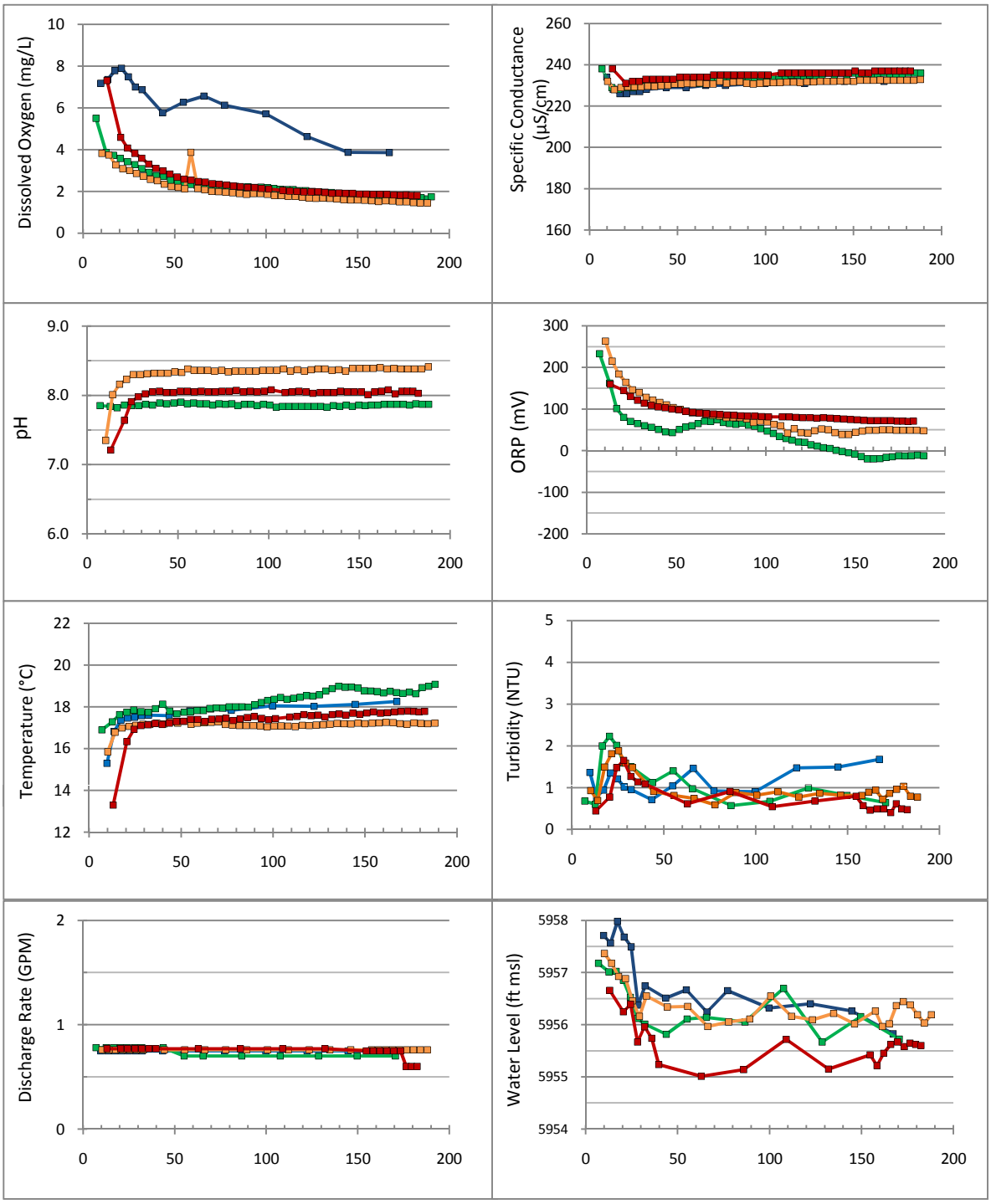


Figure D2-R32-3. Concentrations of trace metals in filtered groundwater from well R-32 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-37 screen 1 (port P1A), port depth 929 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R37-1. Time-series plots of field parameters monitored during purging of R-37 screen 1 (port P1A)

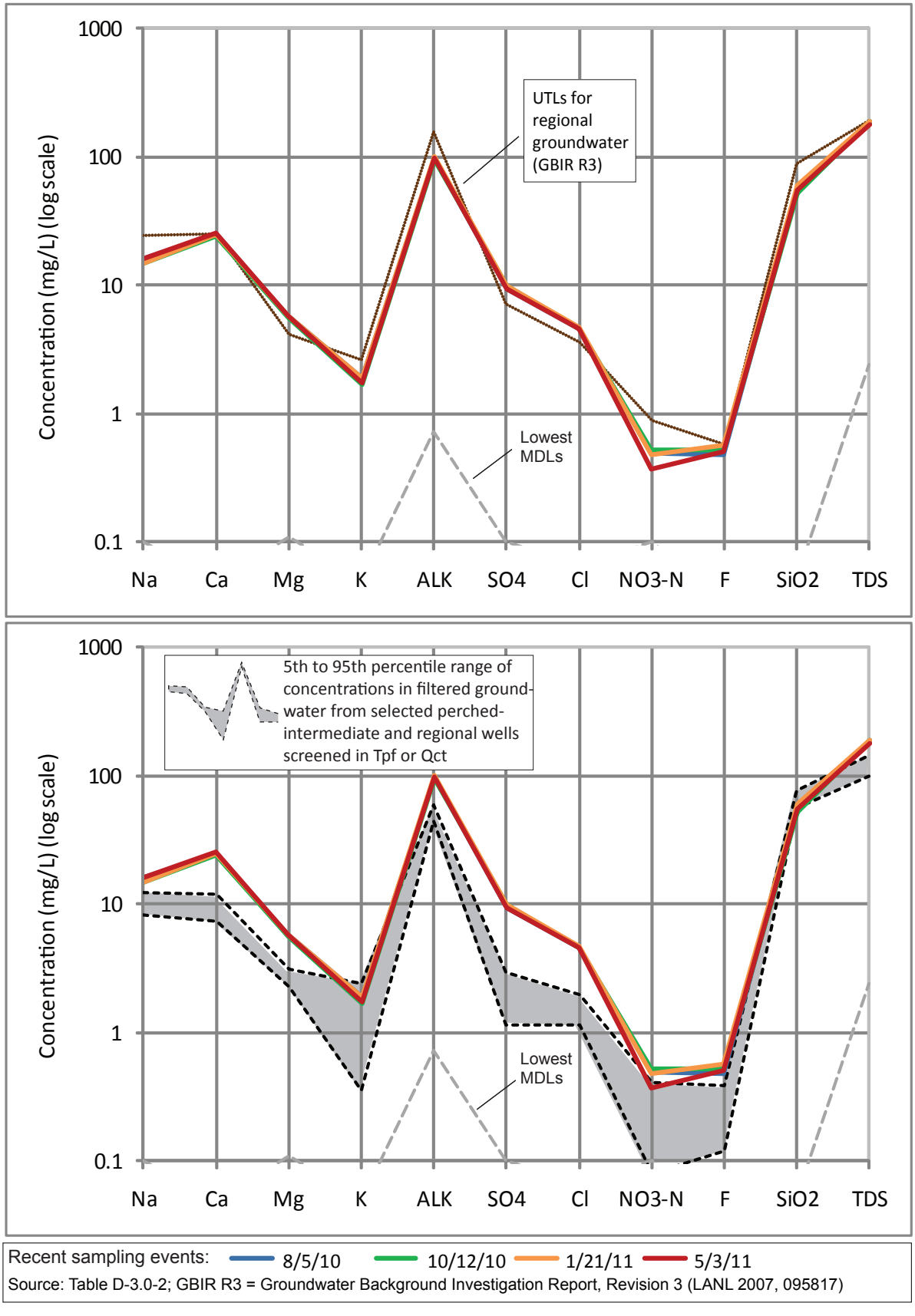


Figure D2-R37-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-37 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

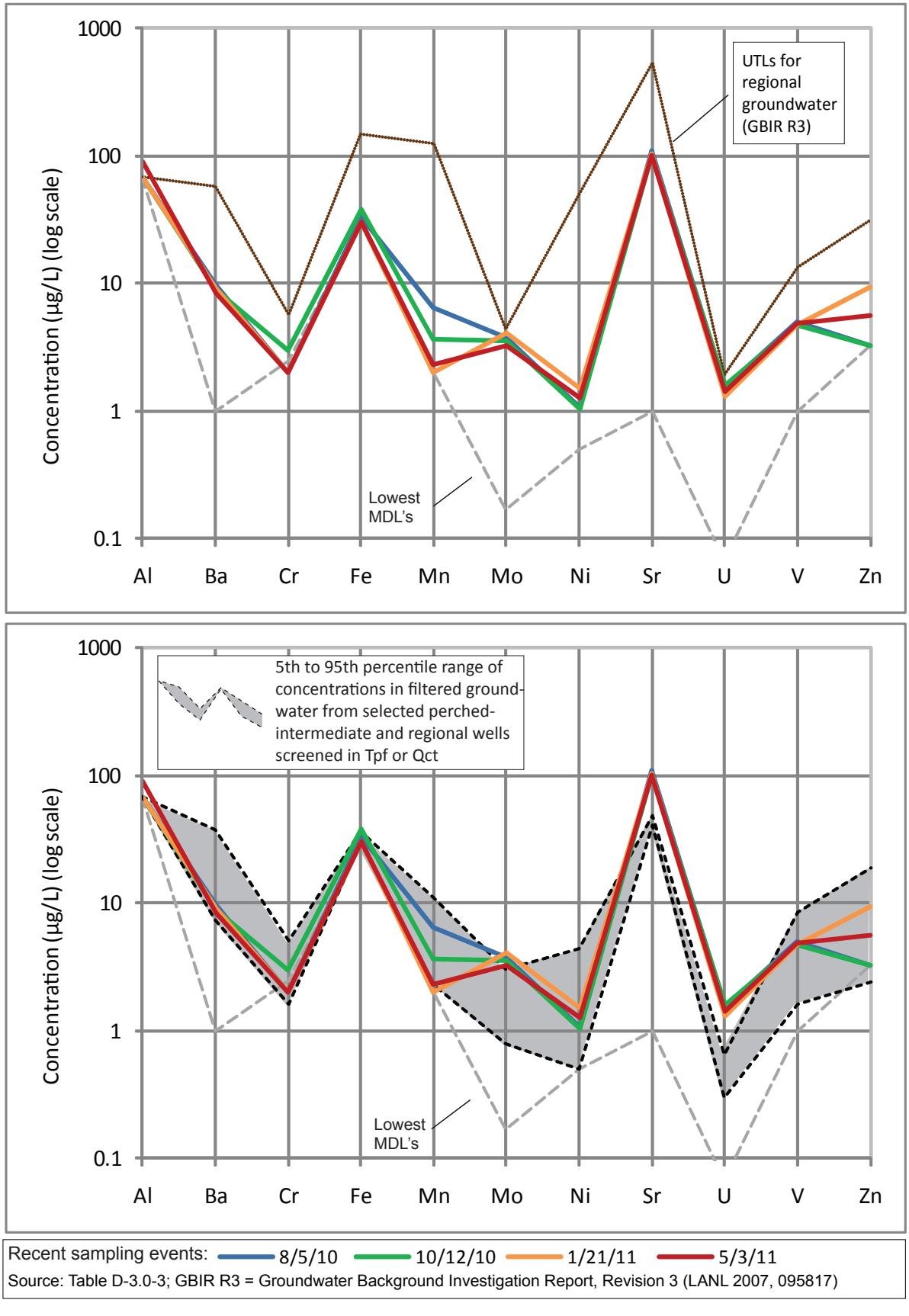
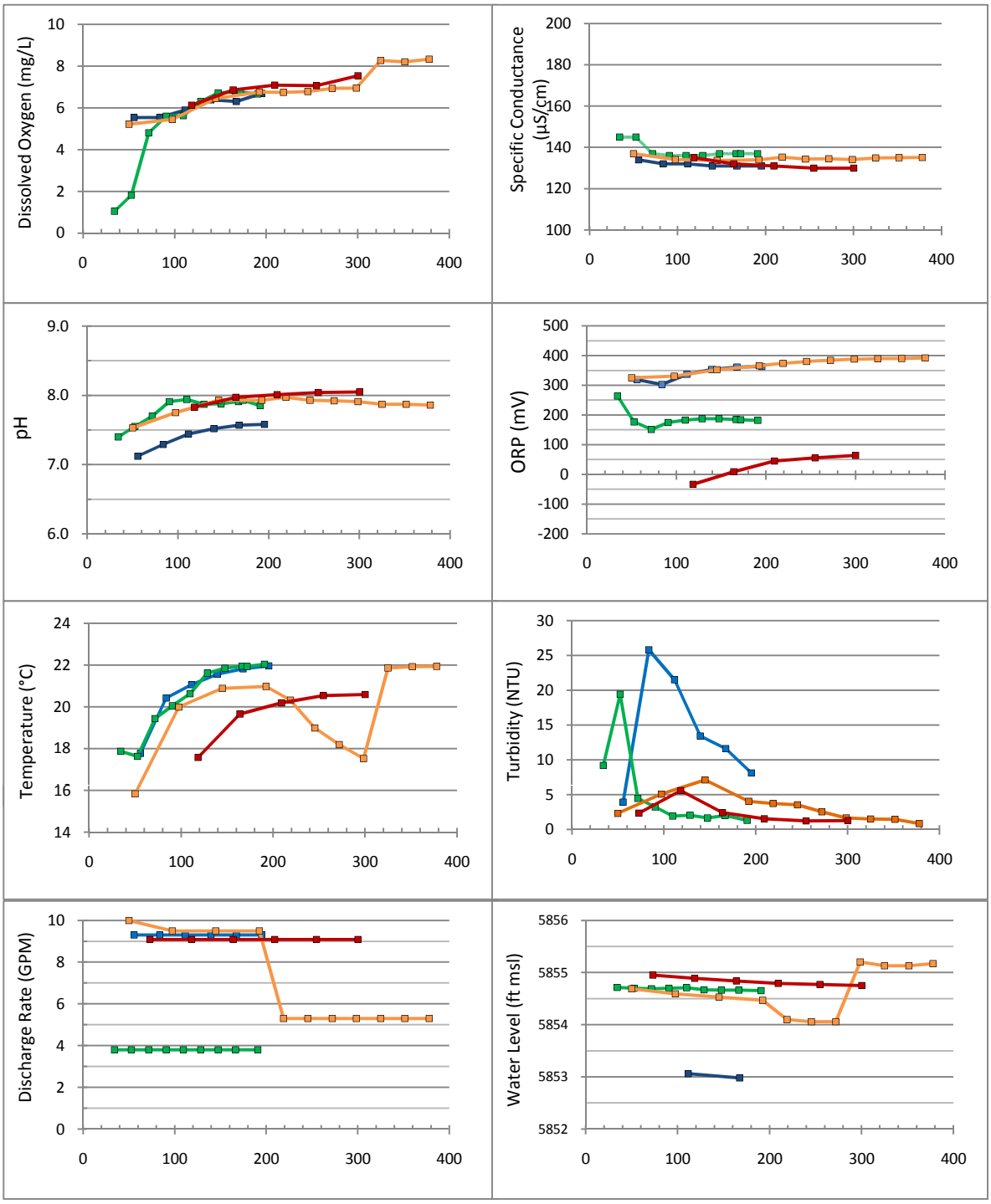


Figure D2-R37-3. Concentrations of trace metals in filtered groundwater from well R-37 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-37 screen 2 (port P2A), port depth 1026 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R37-4. **Time-series plots of field parameters monitored during purging of R-37 screen 2 (port P2A)**

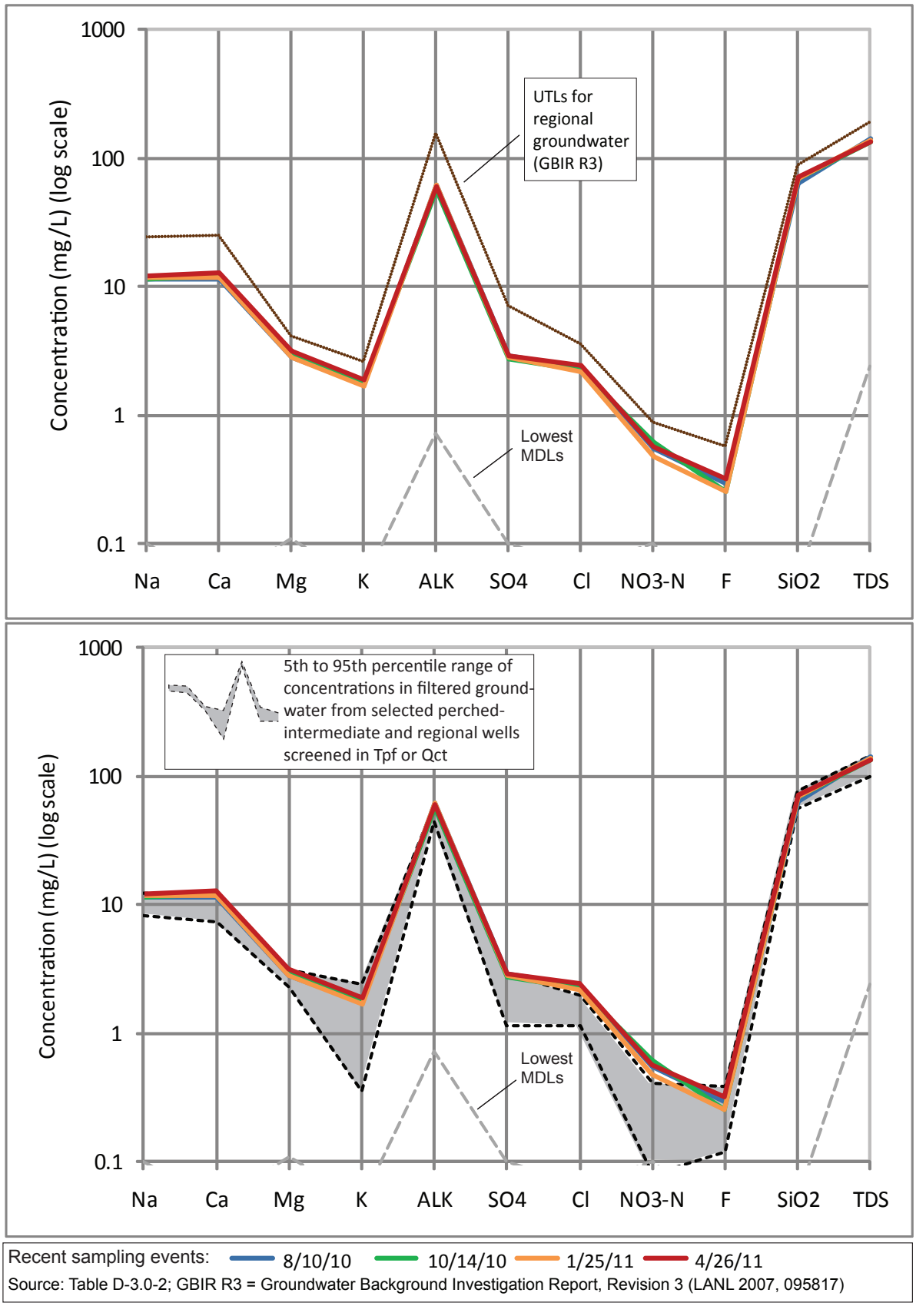


Figure D2-R37-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-37 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

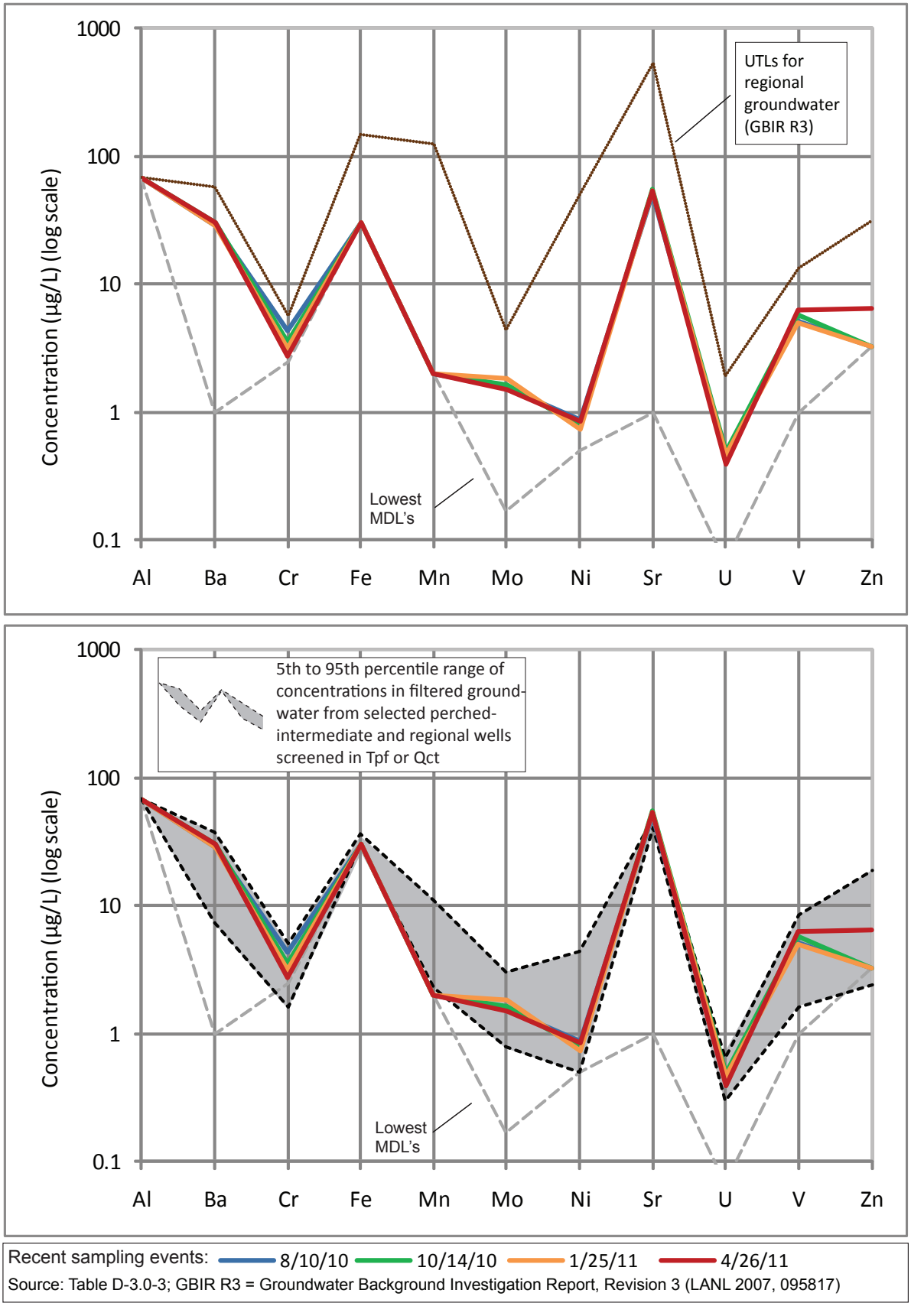
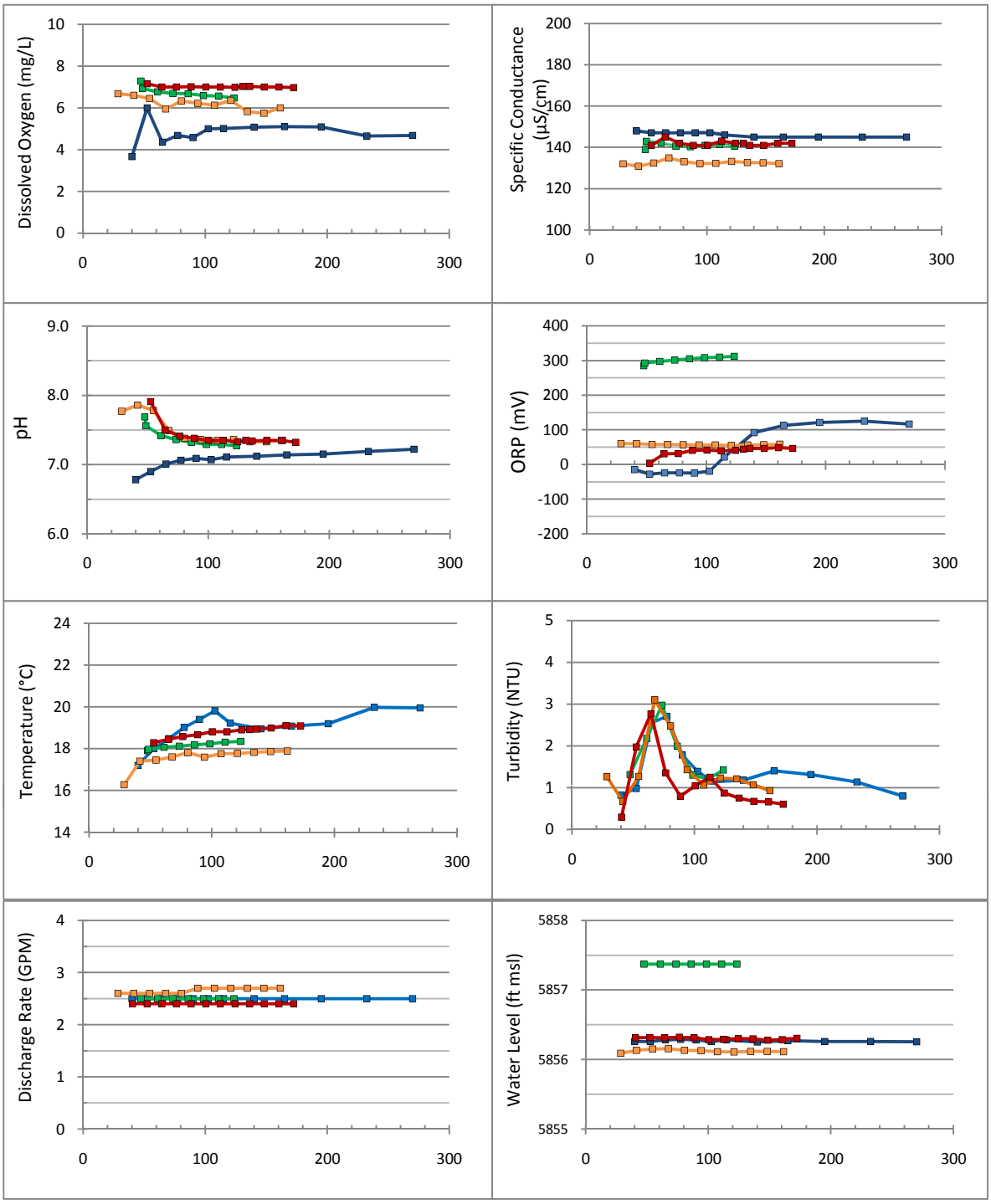


Figure D2-R37-6. Concentrations of trace metals in filtered groundwater from well R-37 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-38 (single screen), port depth 821 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R38-1. Time-series plots of field parameters monitored during purging of R-38 (single screen)

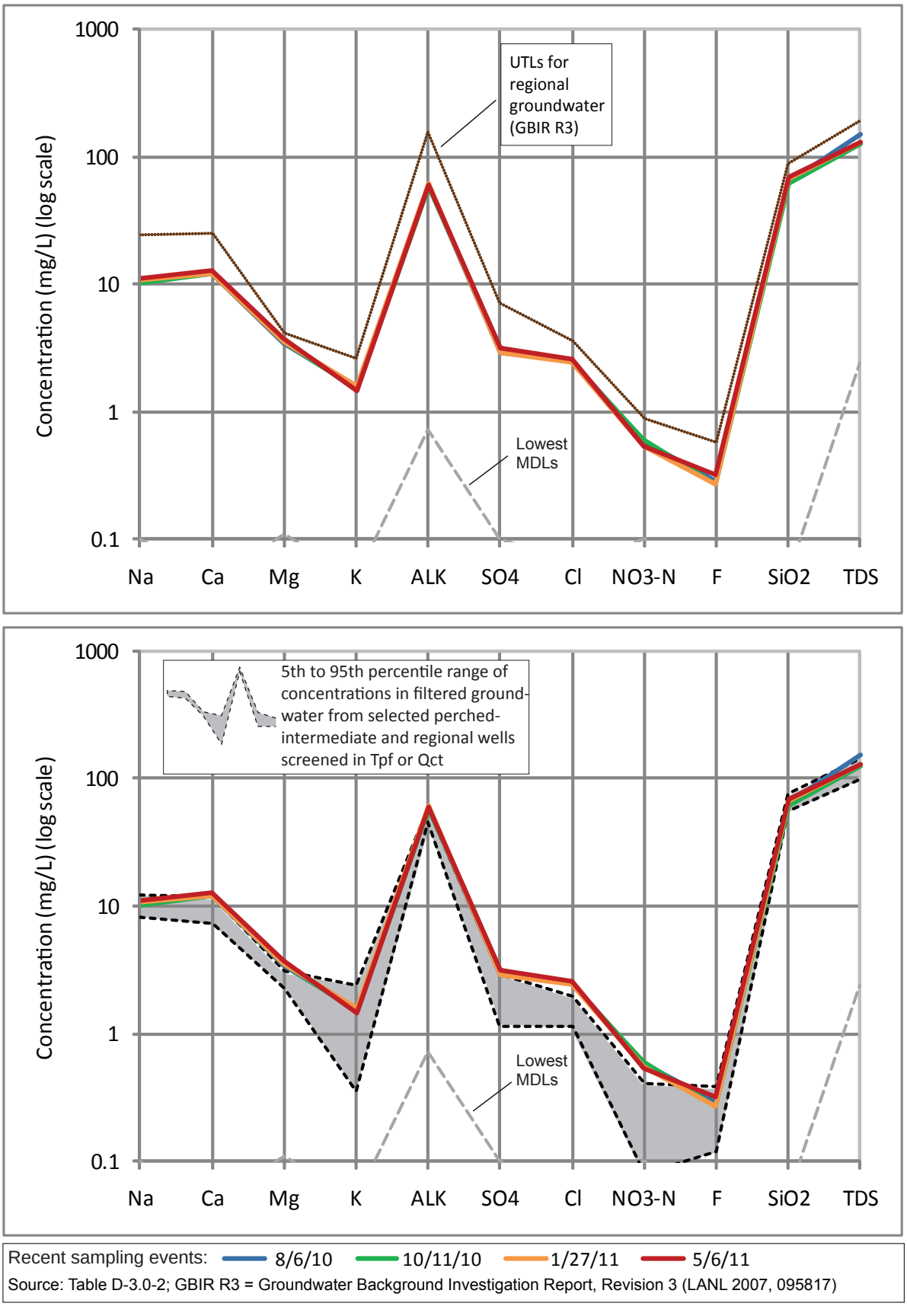


Figure D2-R38-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-38 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

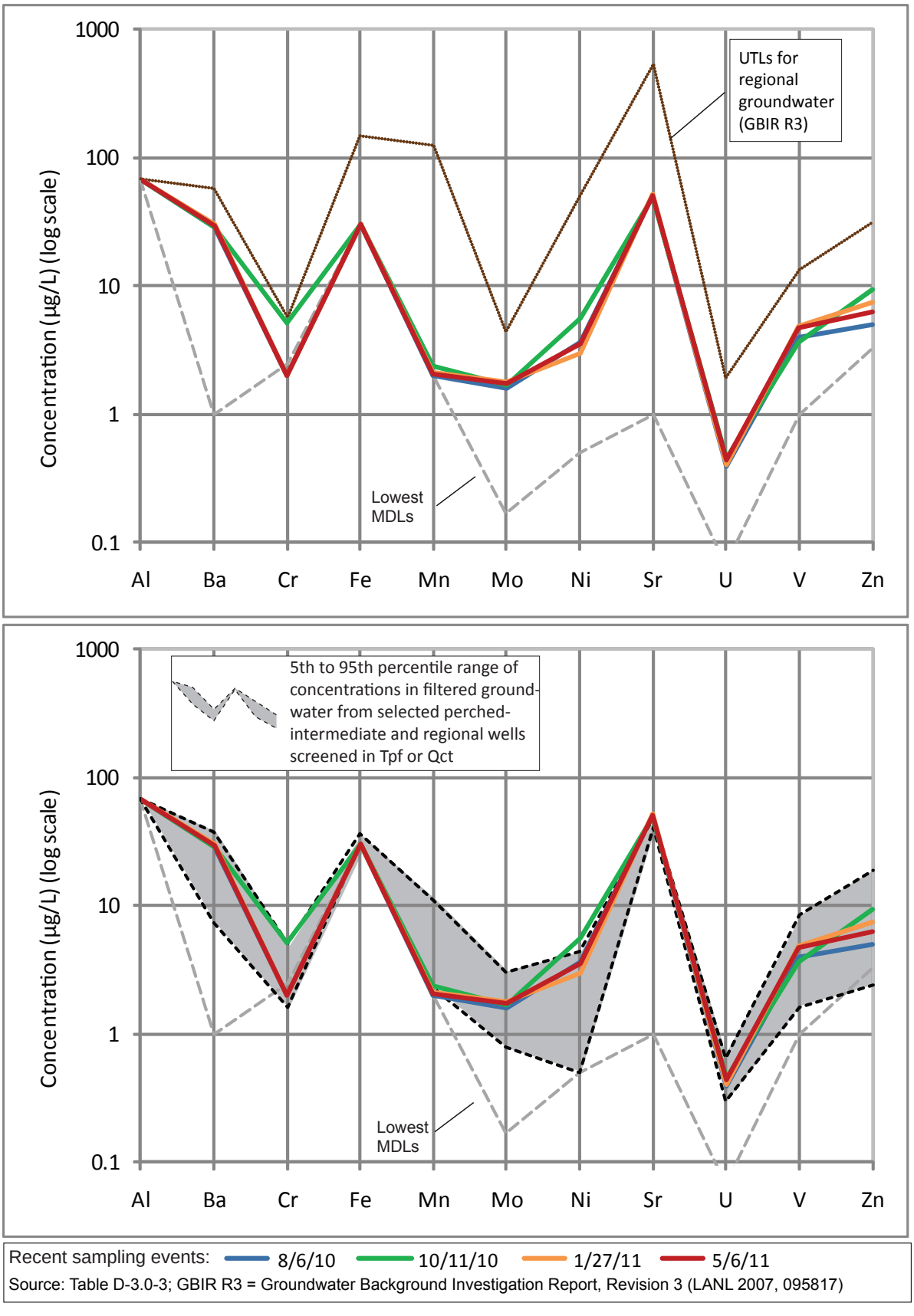
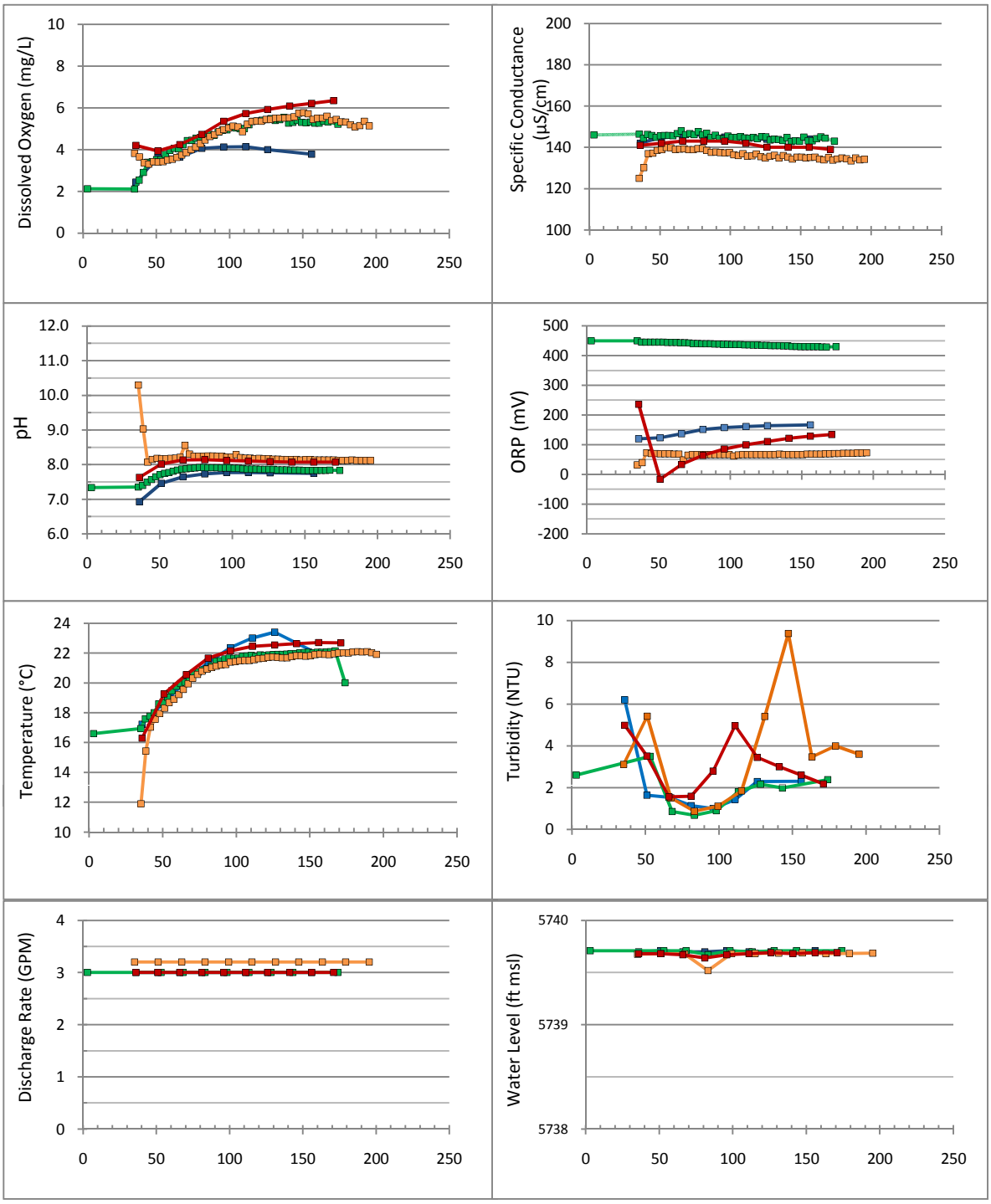


Figure D2-R38-3. Concentrations of trace metals in filtered groundwater from well R-38 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-39 (single screen), port depth 859 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R39-1. **Time-series plots of field parameters monitored during purging of R-39 (single screen)**

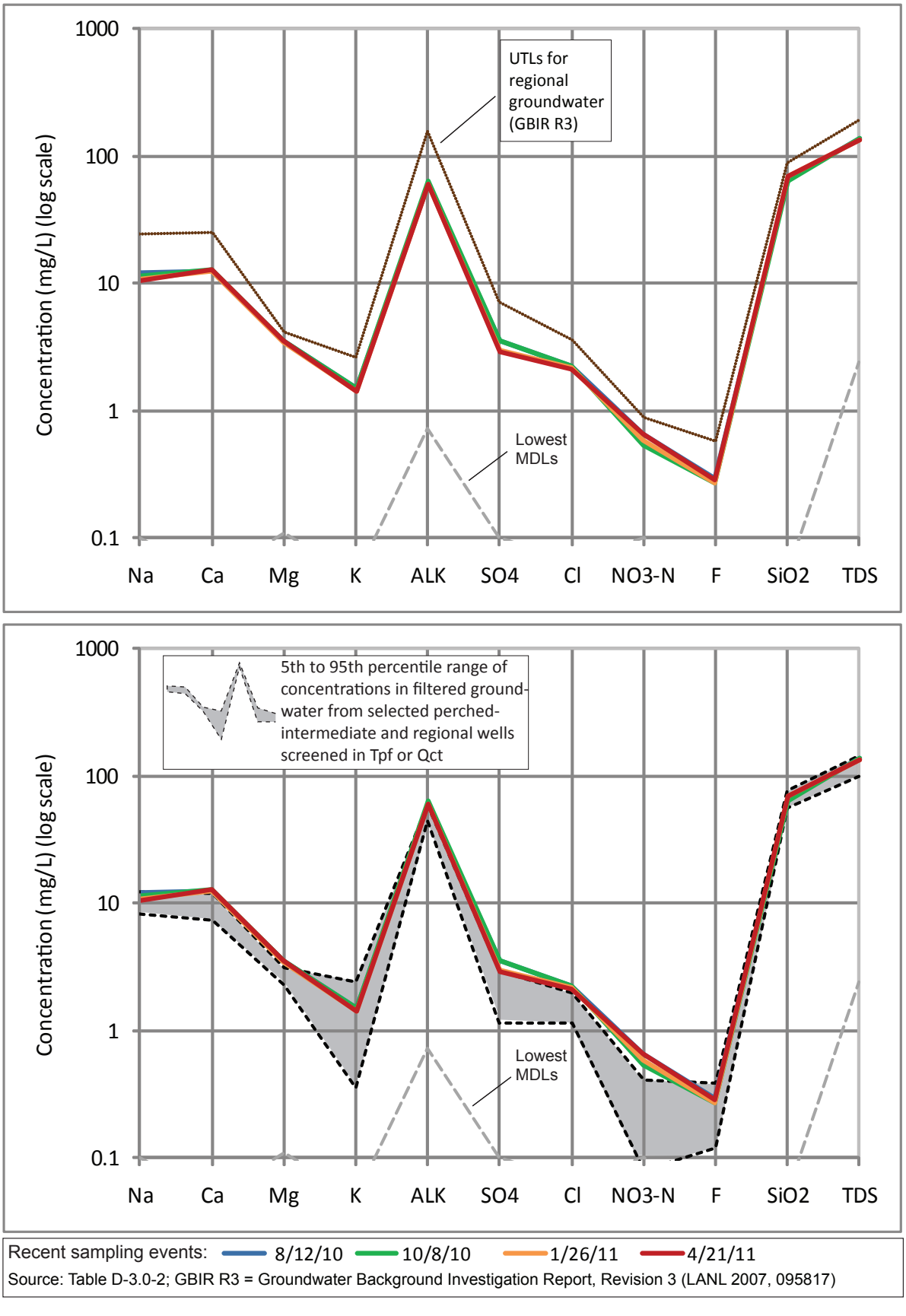


Figure D2-R39-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-39 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

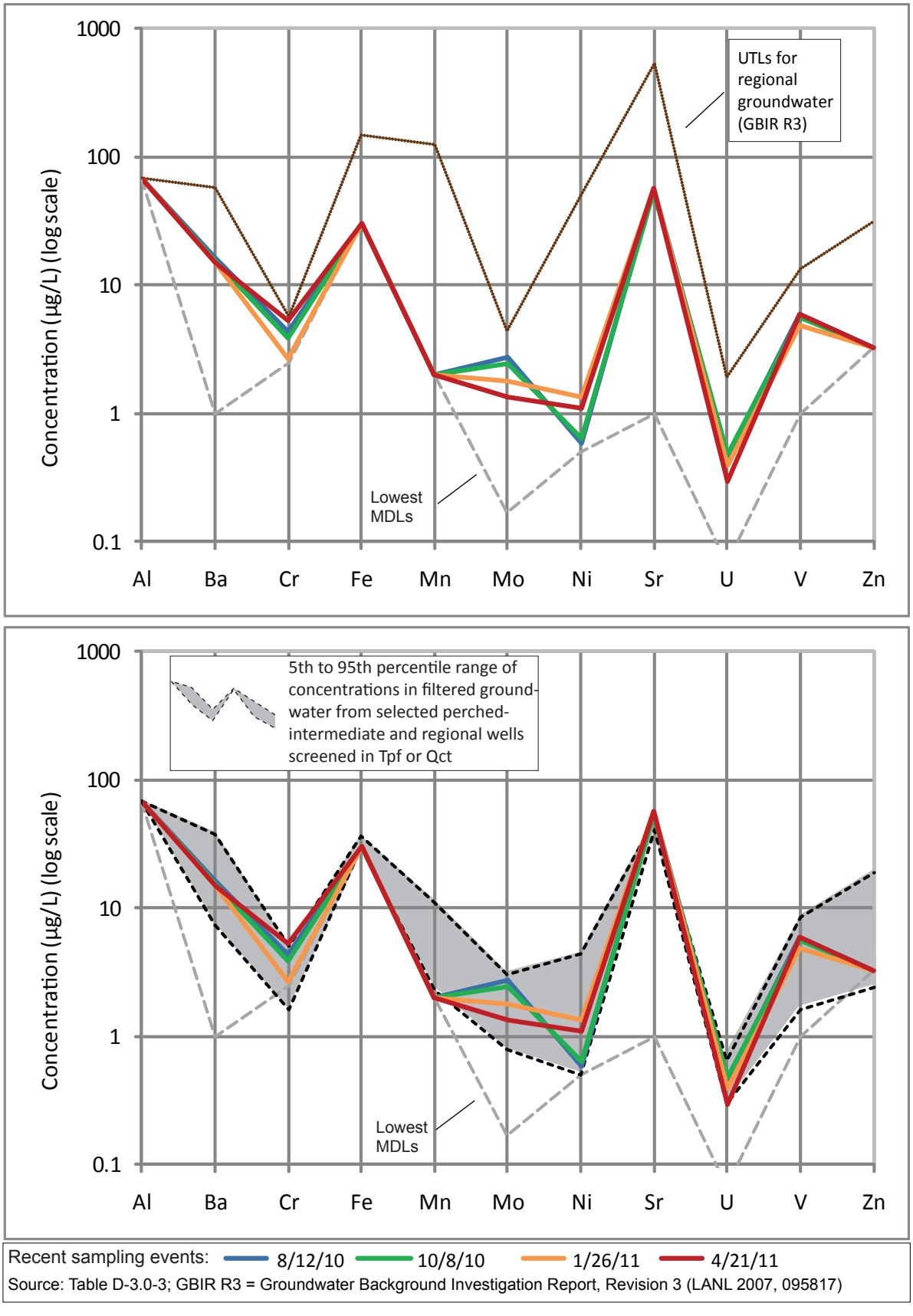


Figure D2-R39-3. Concentrations of trace metals in filtered groundwater from well R-39 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

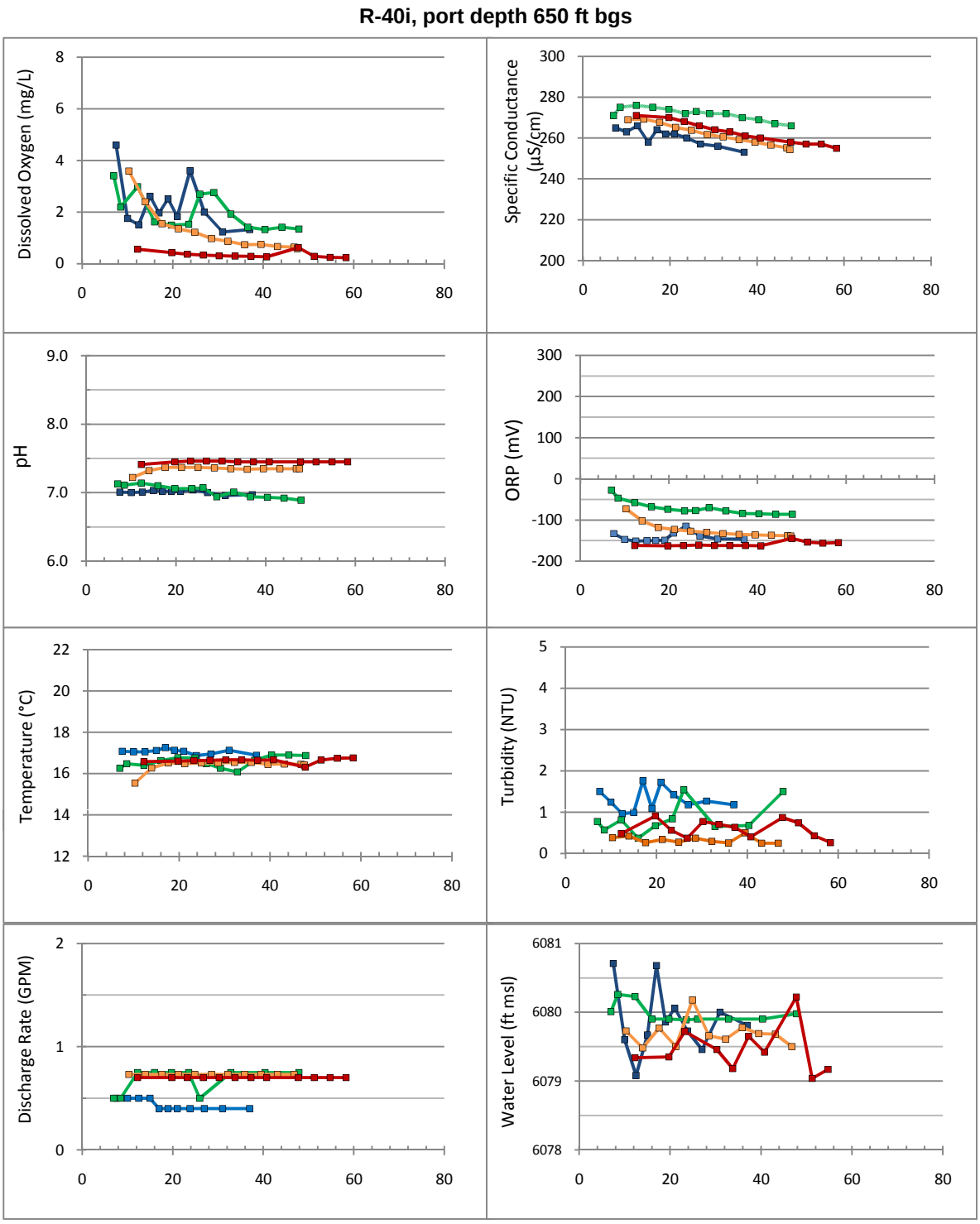


Figure D2-R40i-1. Time-series plots of field parameters monitored during purging of R-40i

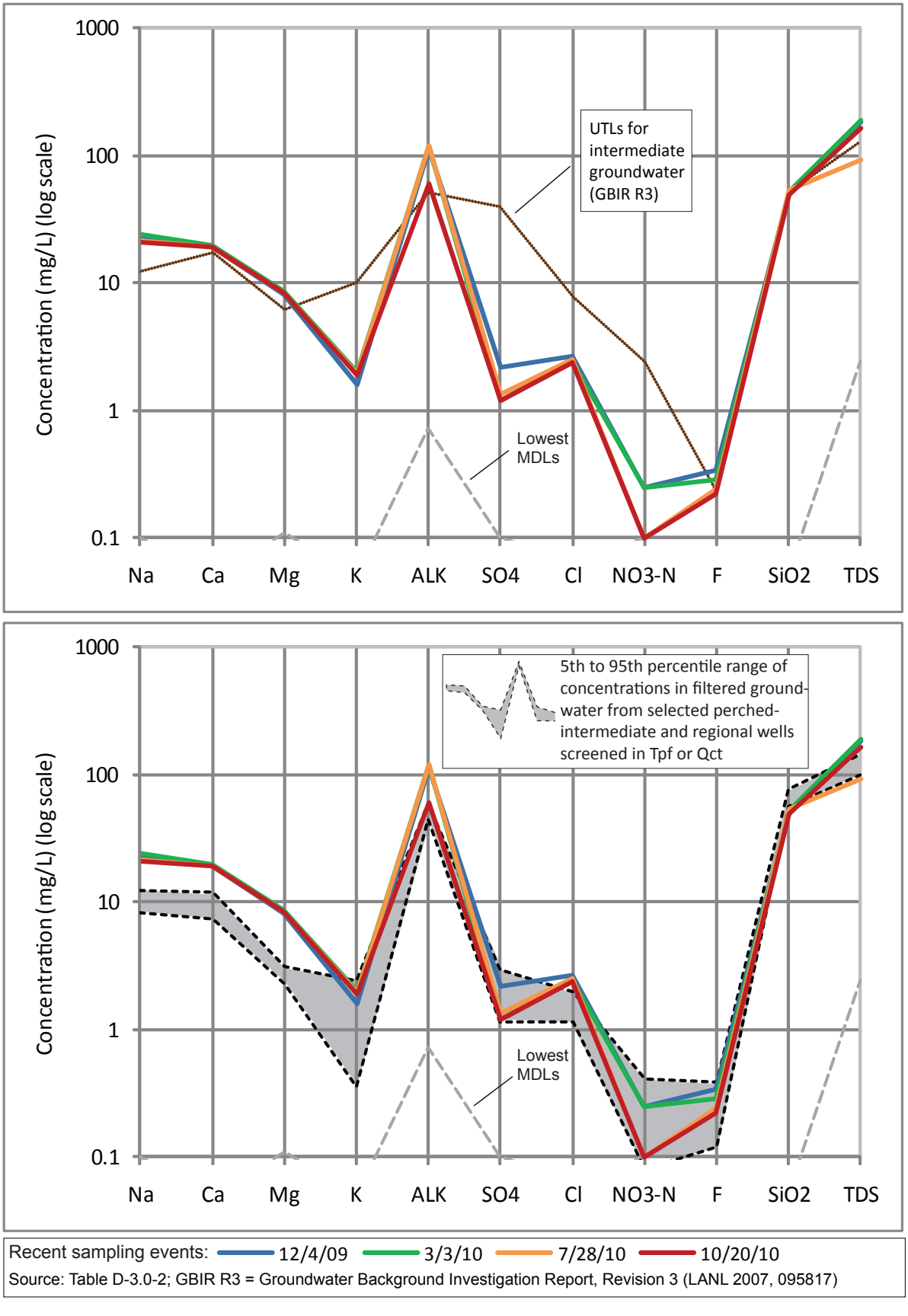


Figure D2-R40i-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-40i for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

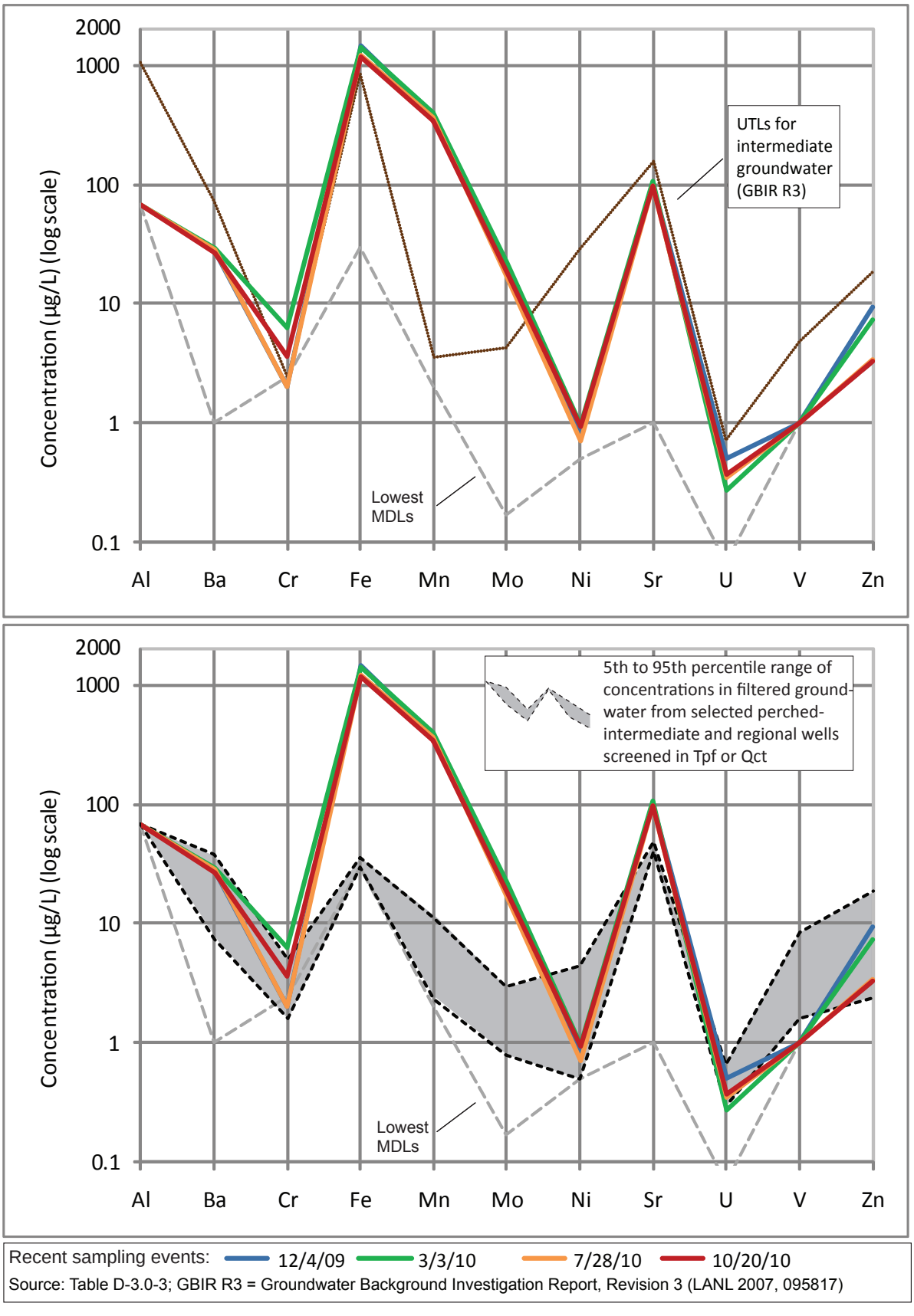
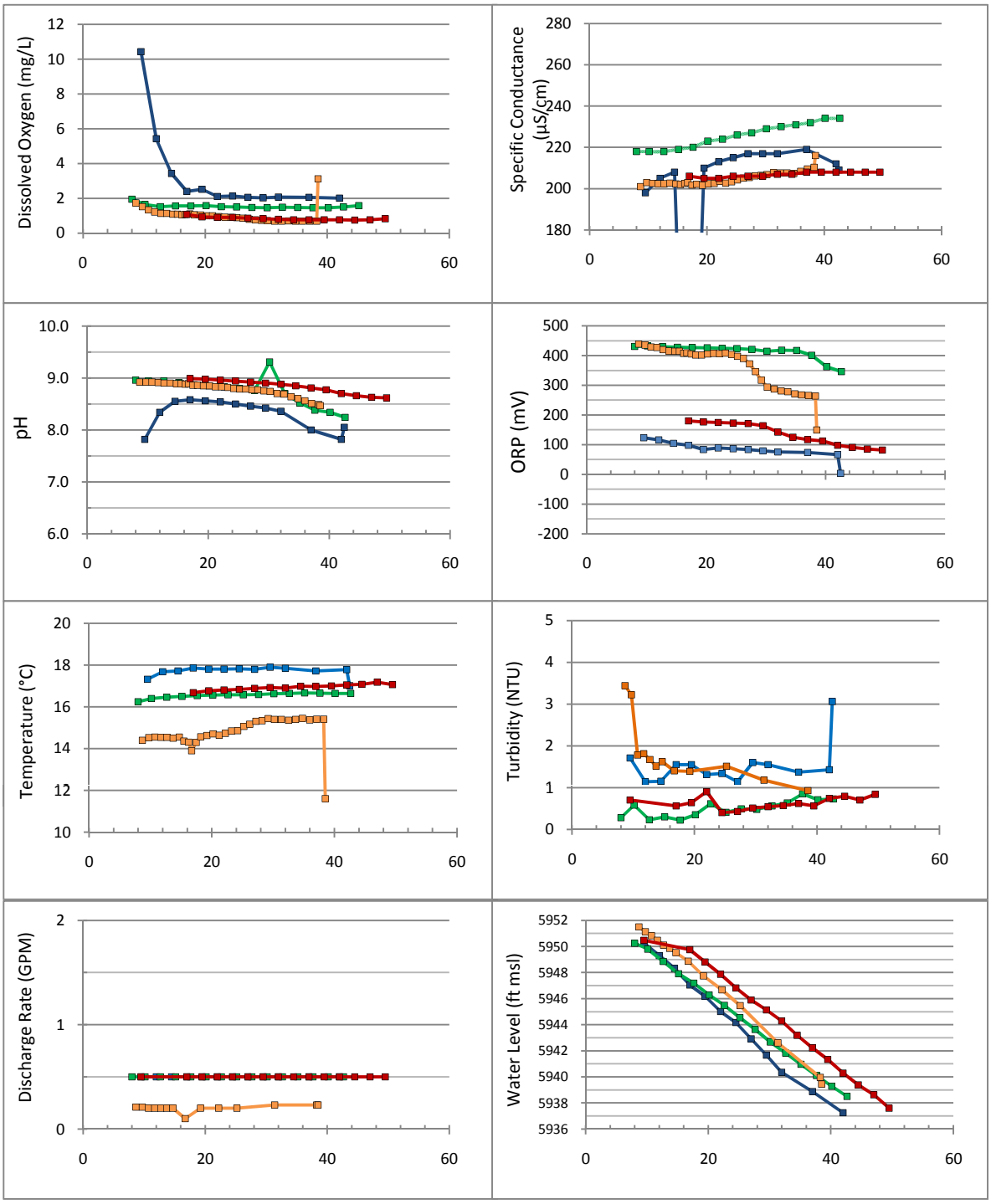


Figure D2-R40i-3. Concentrations of trace metals in filtered groundwater from well R-40i for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-40 screen 1 (port P1A), port depth 752 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R40-1. Time-series plots of field parameters monitored during purging of R-40 screen 1 (port P1A)

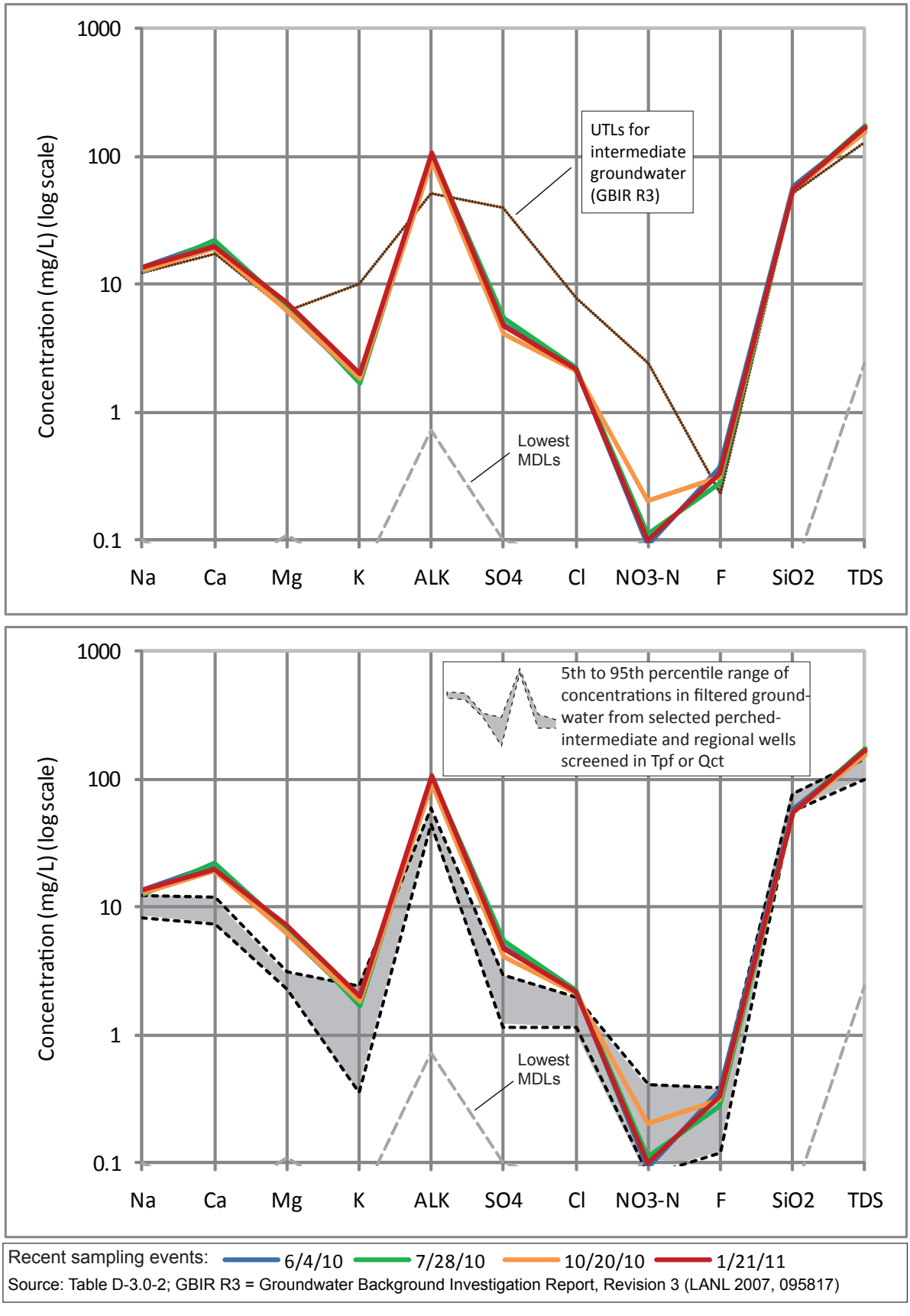


Figure D2-R40-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-40 screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

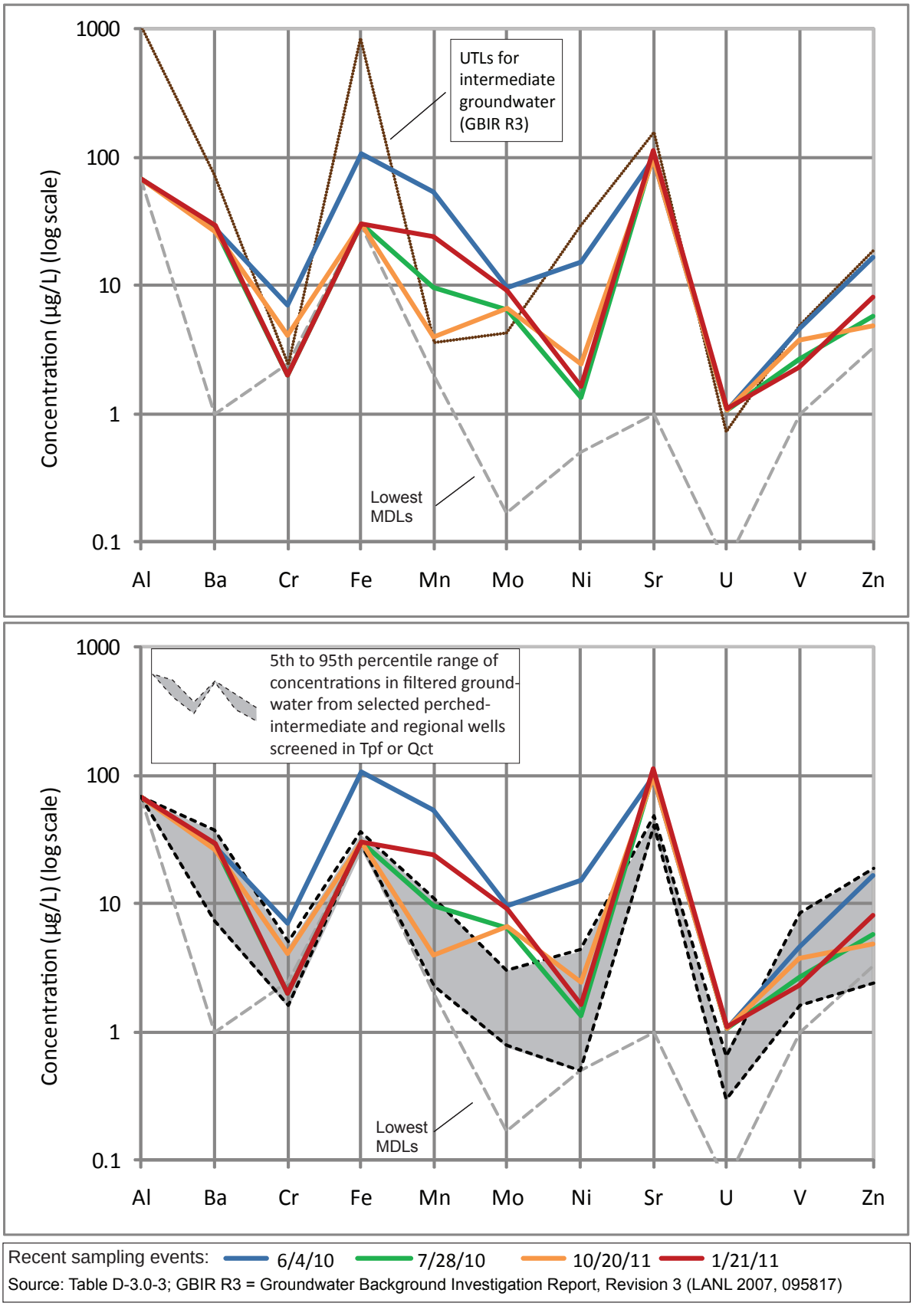


Figure D2-R40-3. Concentrations of trace metals in filtered groundwater from well R-40 screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-40 screen 2 (port P2A), port depth 849 ft bgs

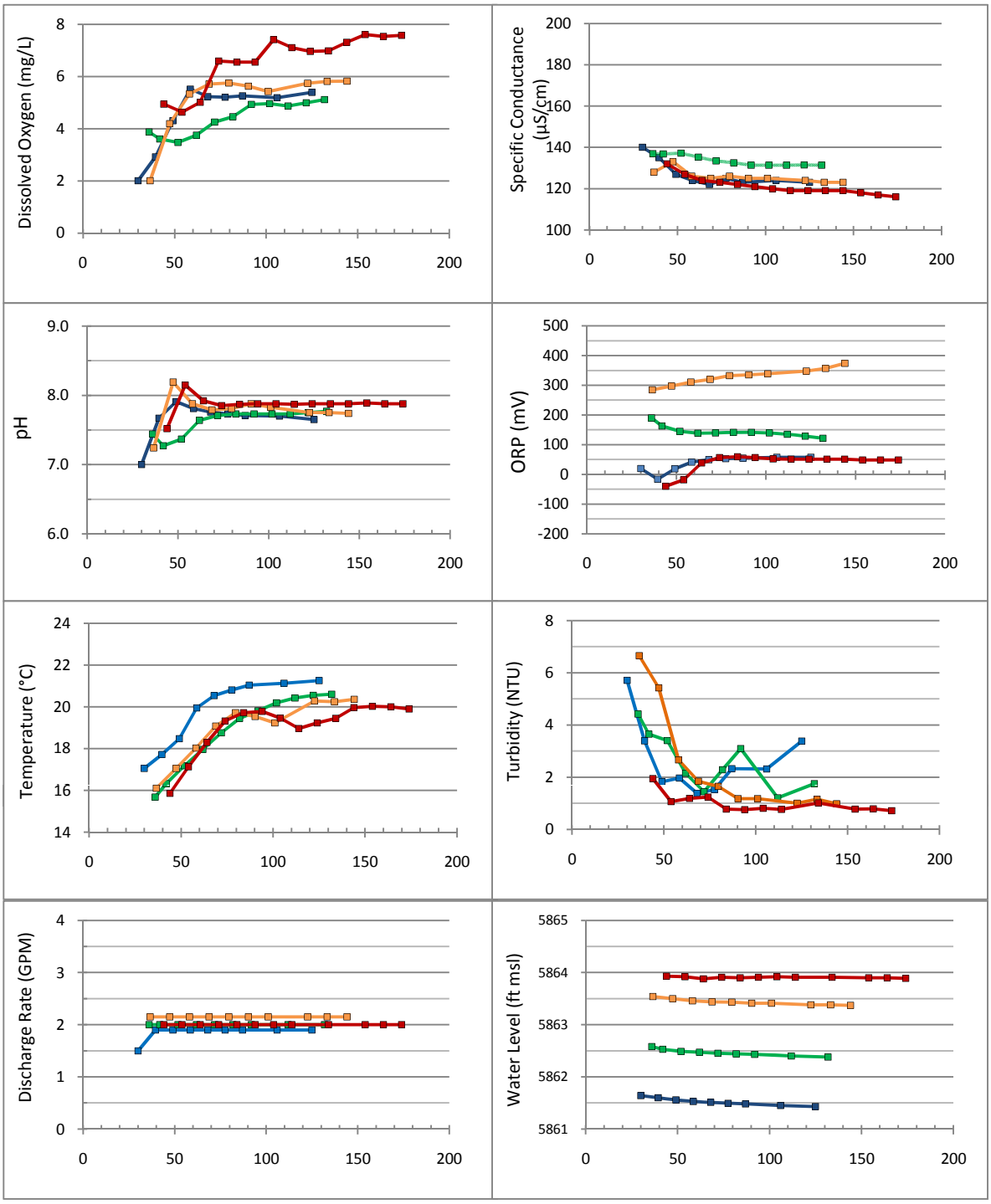


Figure D2-R40-4. **Time-series plots of field parameters monitored during purging of R-40 screen 2 (port P2A)**

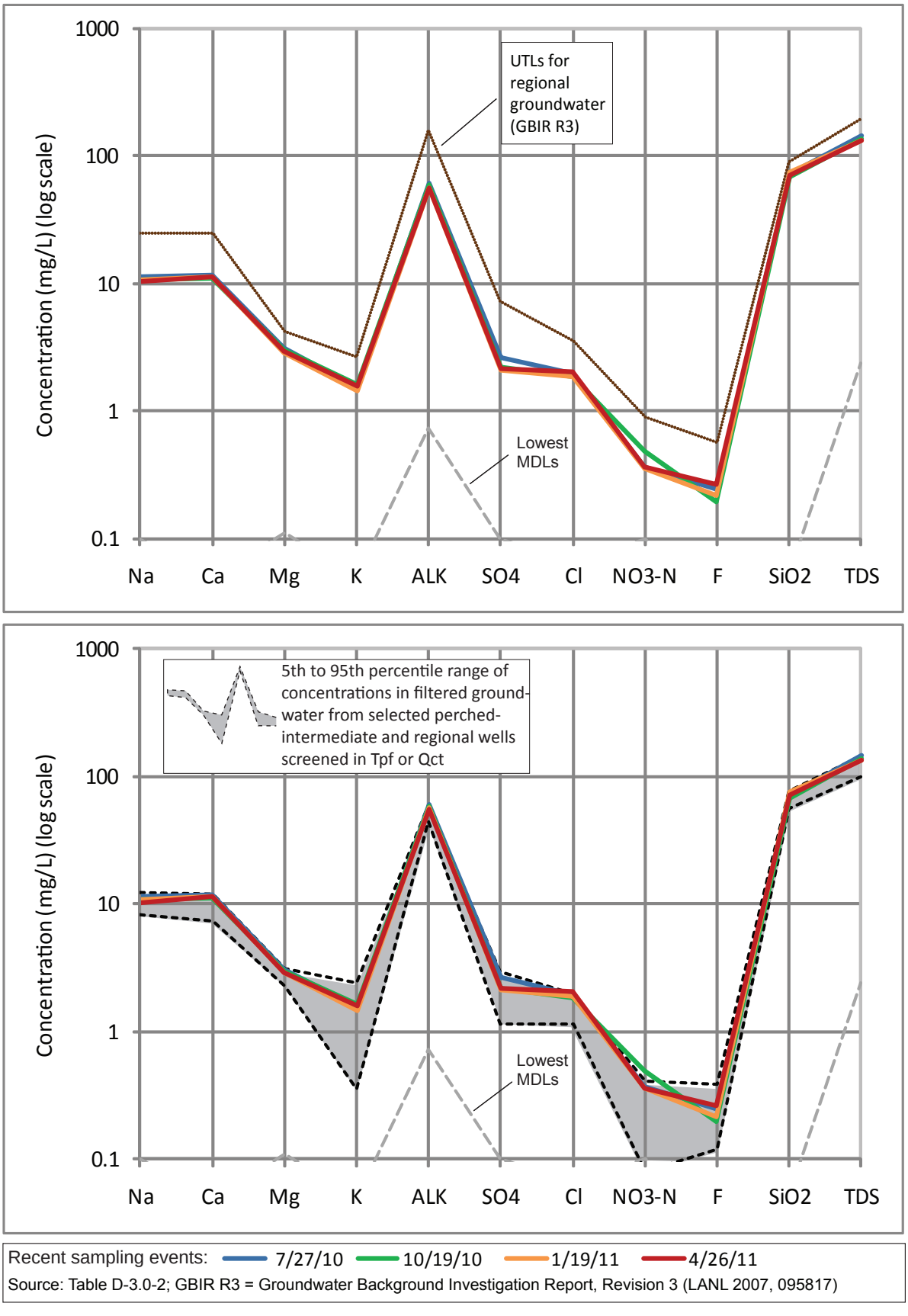


Figure D2-R40-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-40 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

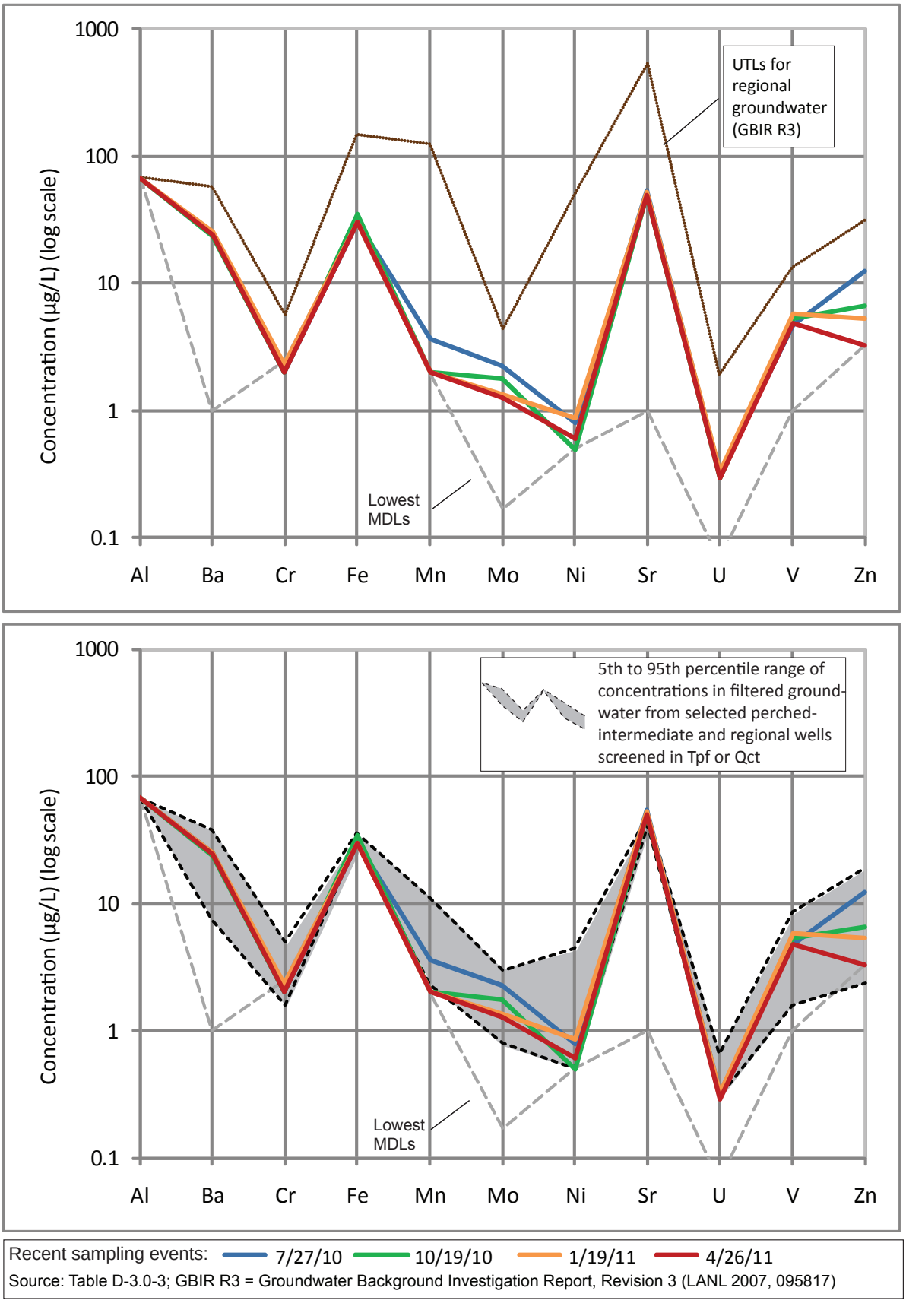


Figure D2-R40-6. Concentrations of trace metals in filtered groundwater from well R-40 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-41 screen 2 (port P2A), port depth 965 ft bgs

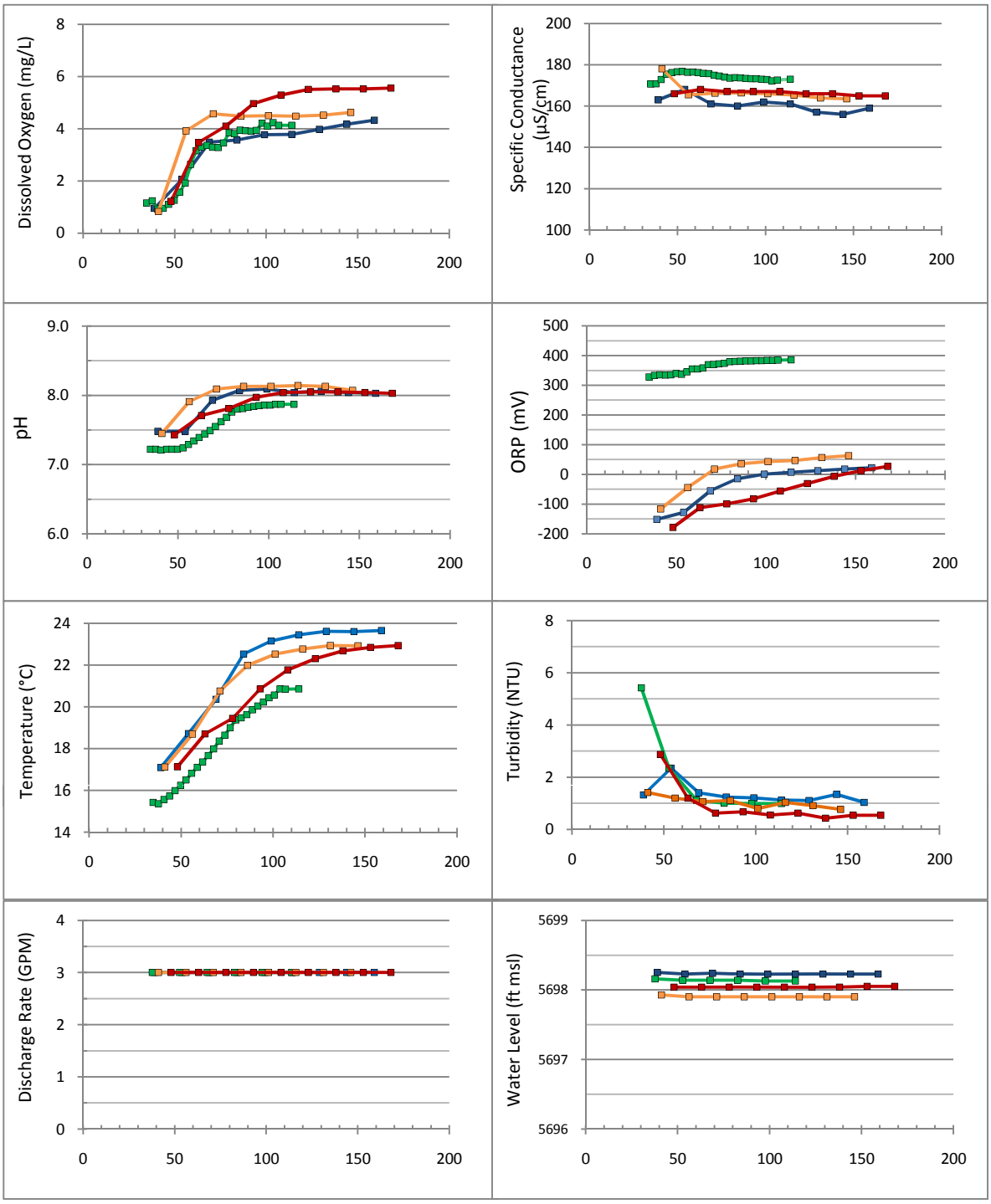


Figure D2-R41-1. **Time-series plots of field parameters monitored during purging of R-41 screen 2 (port P2A)**

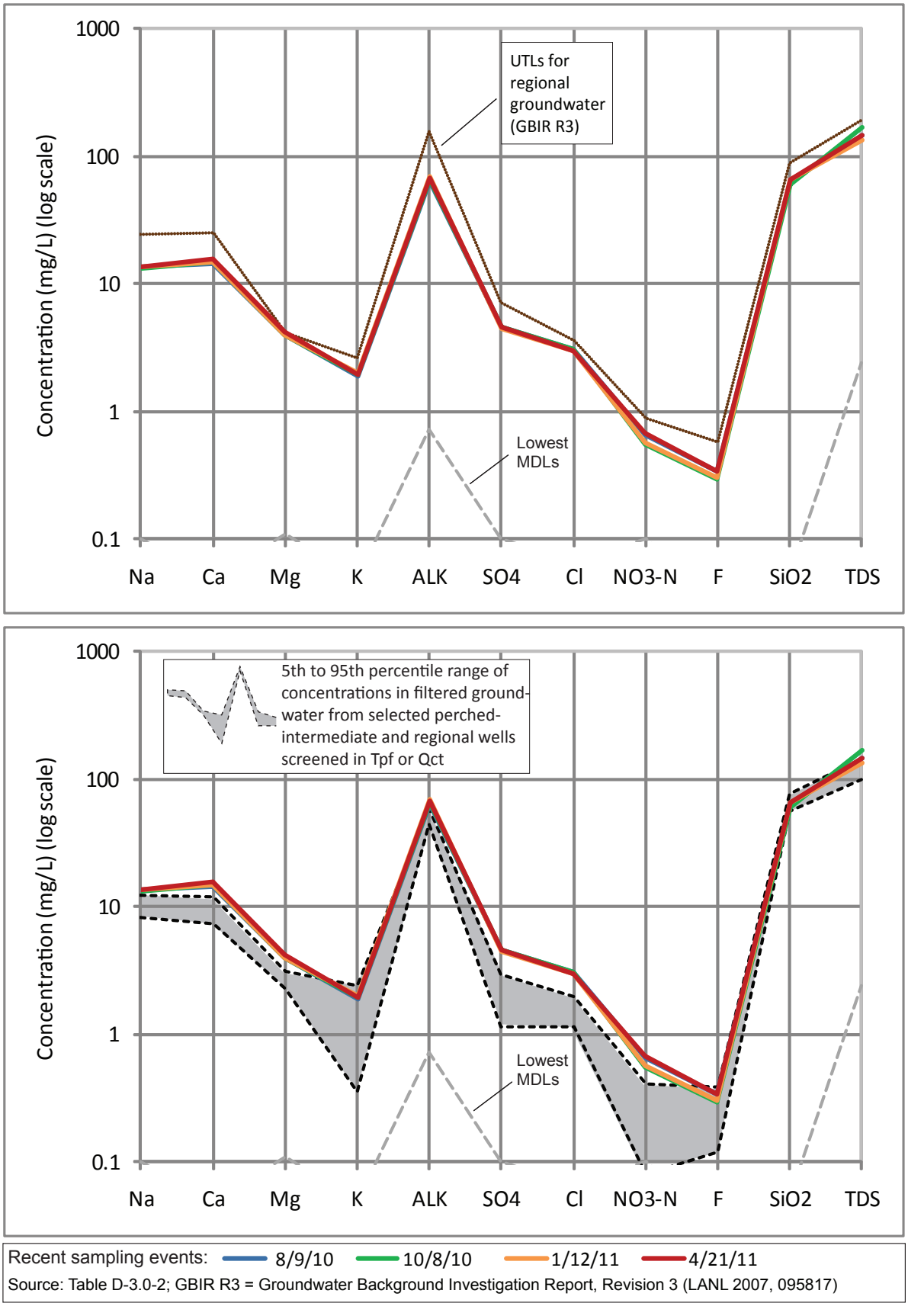


Figure D2-R41-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-41 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

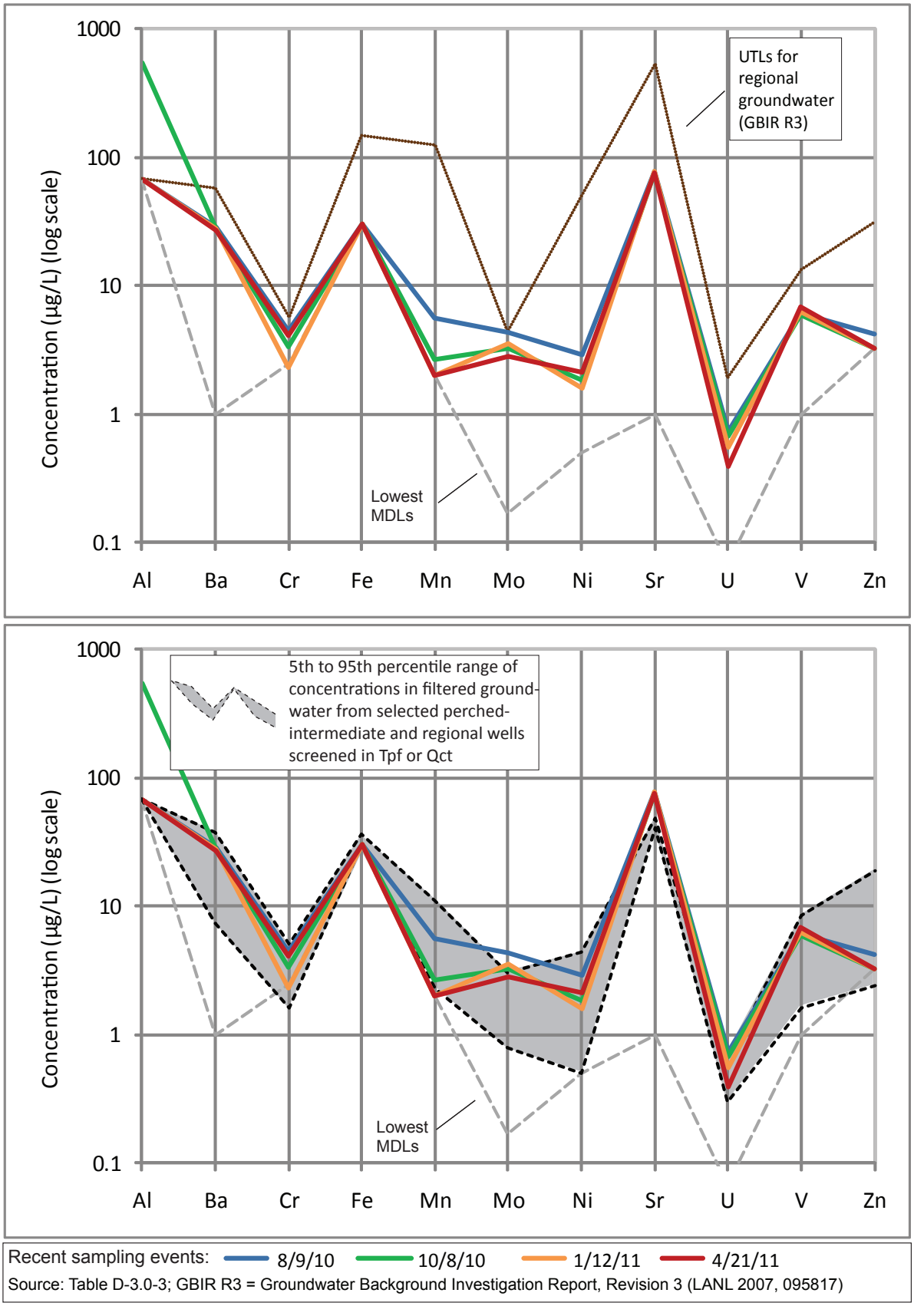


Figure D2-R41-3. Concentrations of trace metals in filtered groundwater from well R-41 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

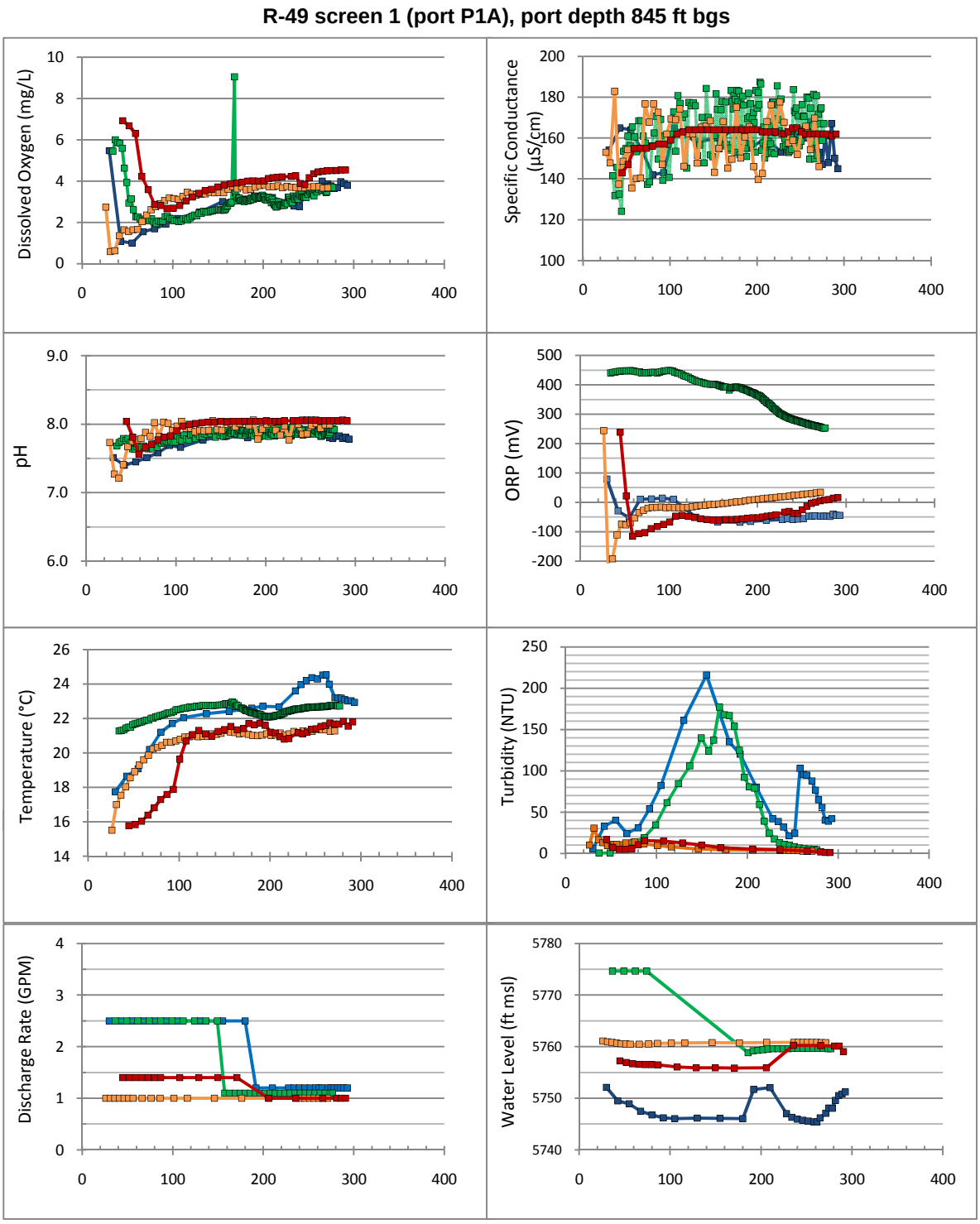


Figure D2-R49-1. Time-series plots of field parameters monitored during purging of R-49 screen 1 (port P1A)

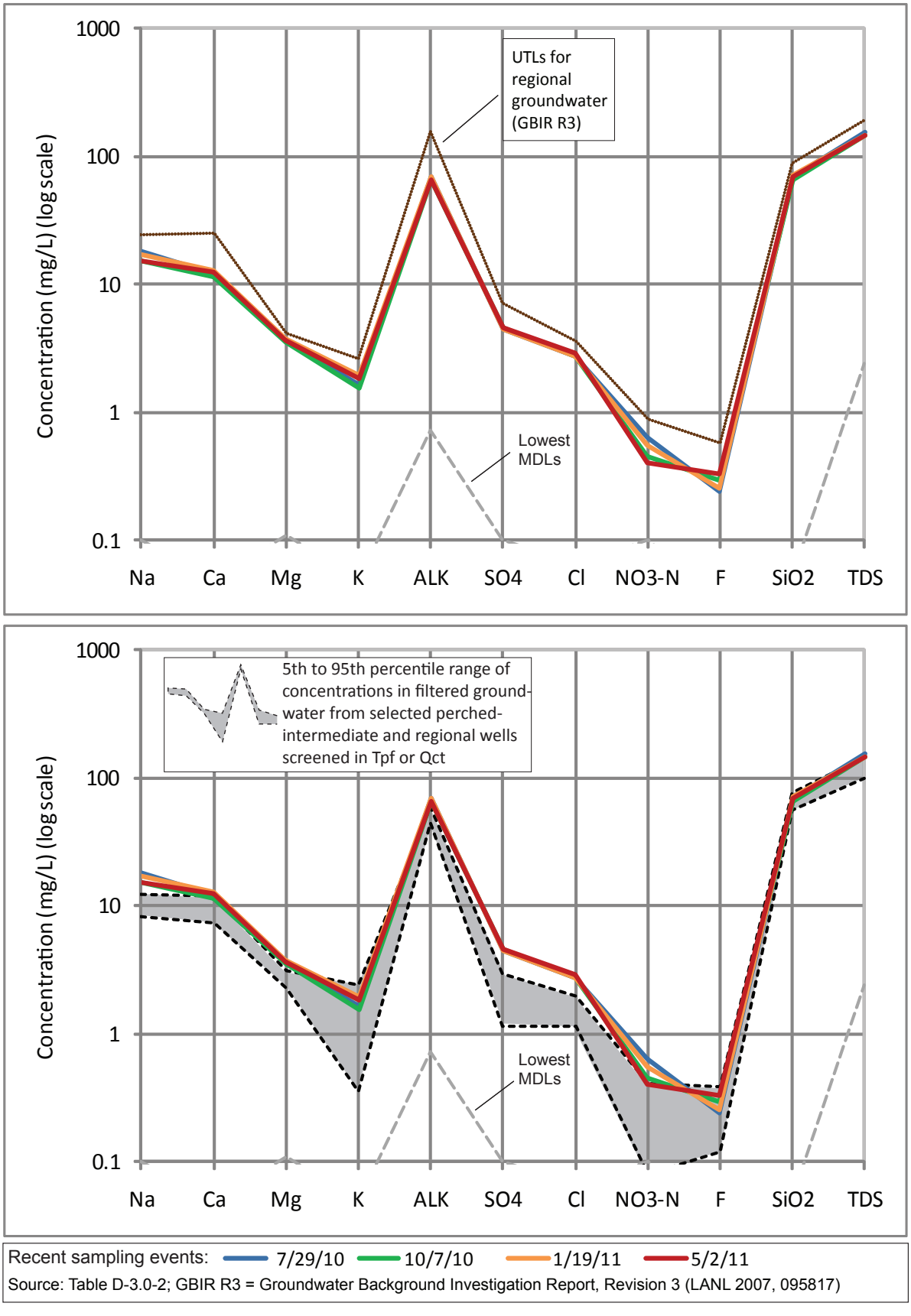


Figure D2-R49-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-49 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

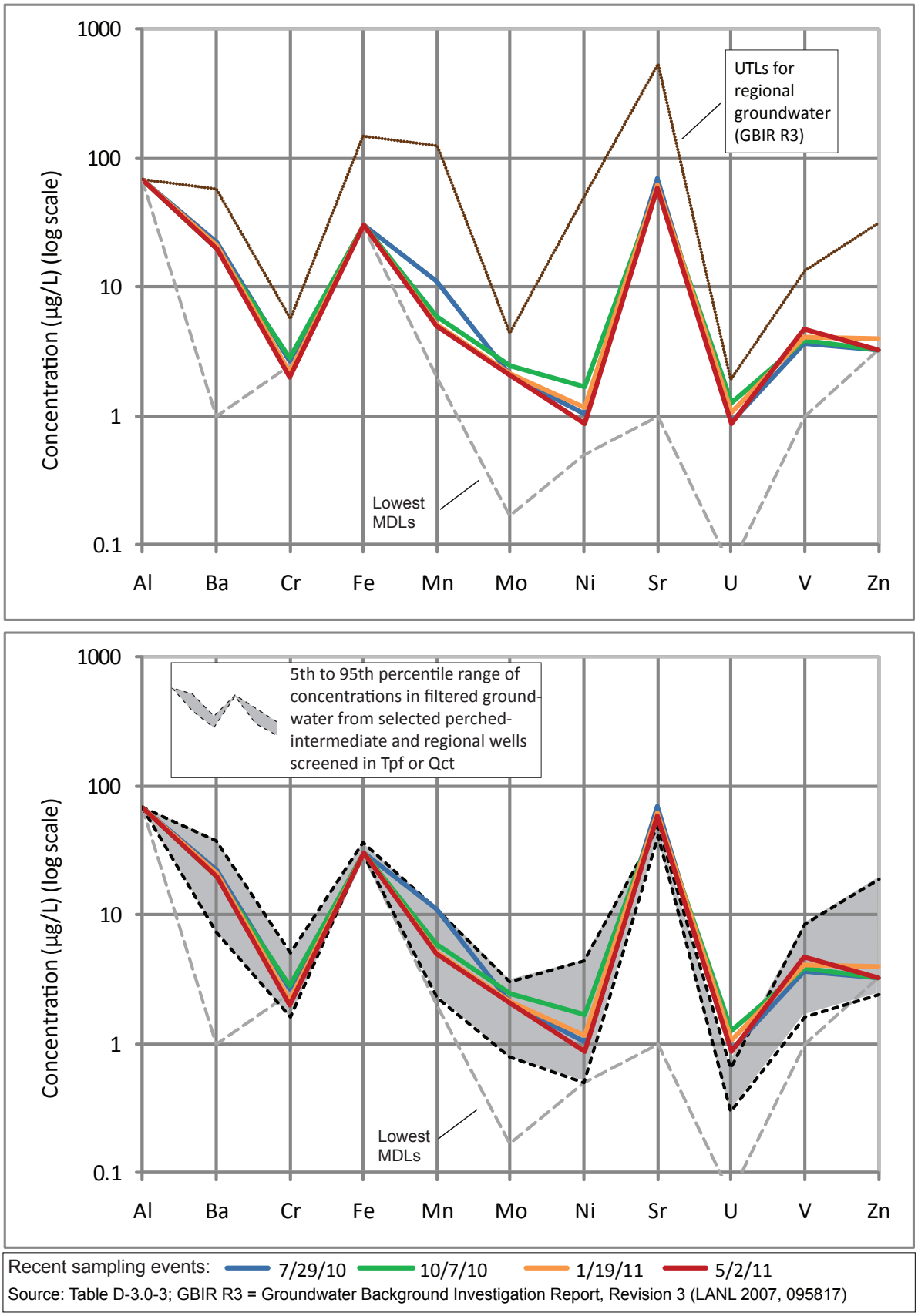
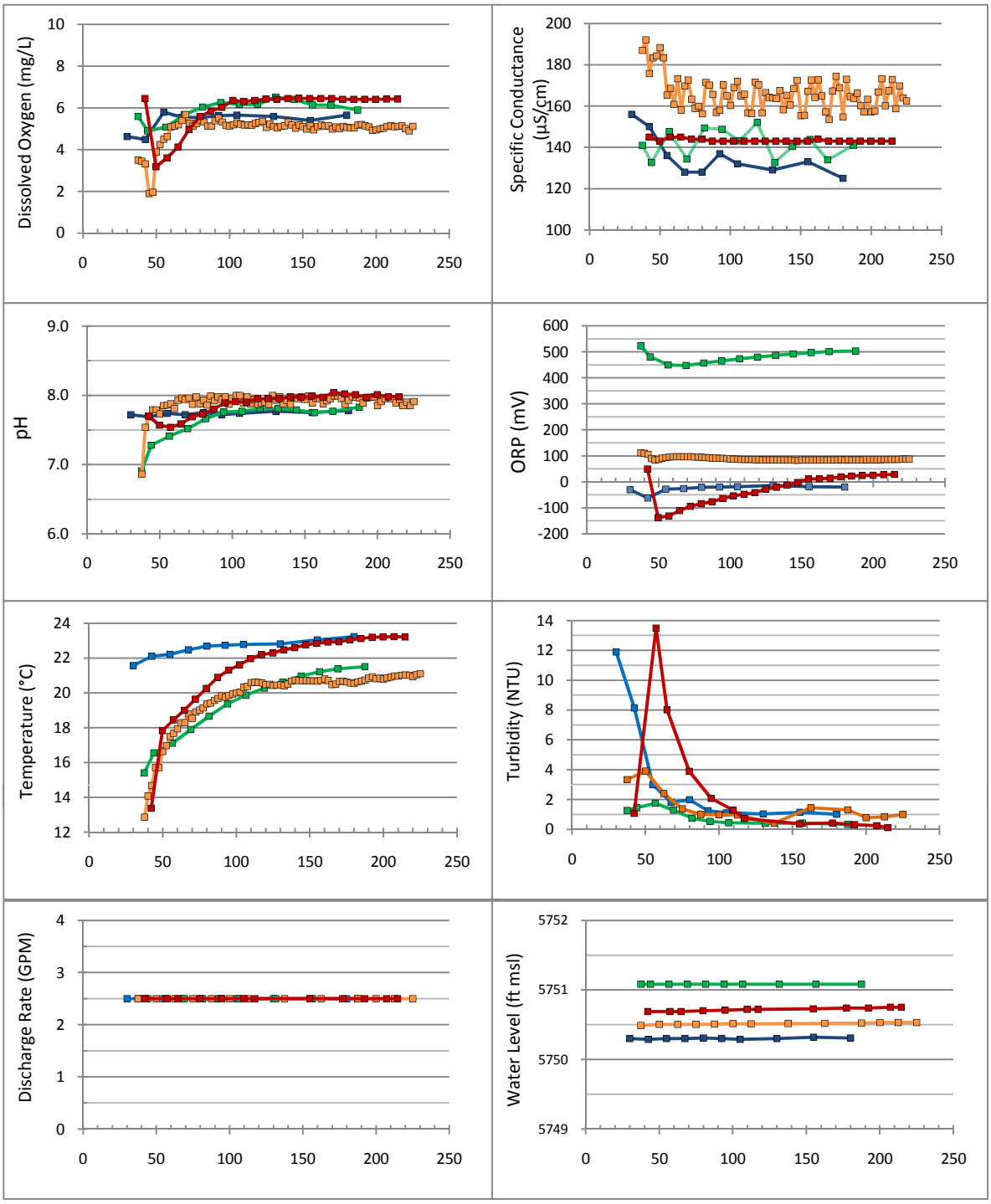


Figure D2-R49-3. Concentrations of trace metals in filtered groundwater from well R-49 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-49 screen 2 (port P2A), port depth 906 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R49-4. Time-series plots of field parameters monitored during purging of R-49 screen 2 (port P2A)

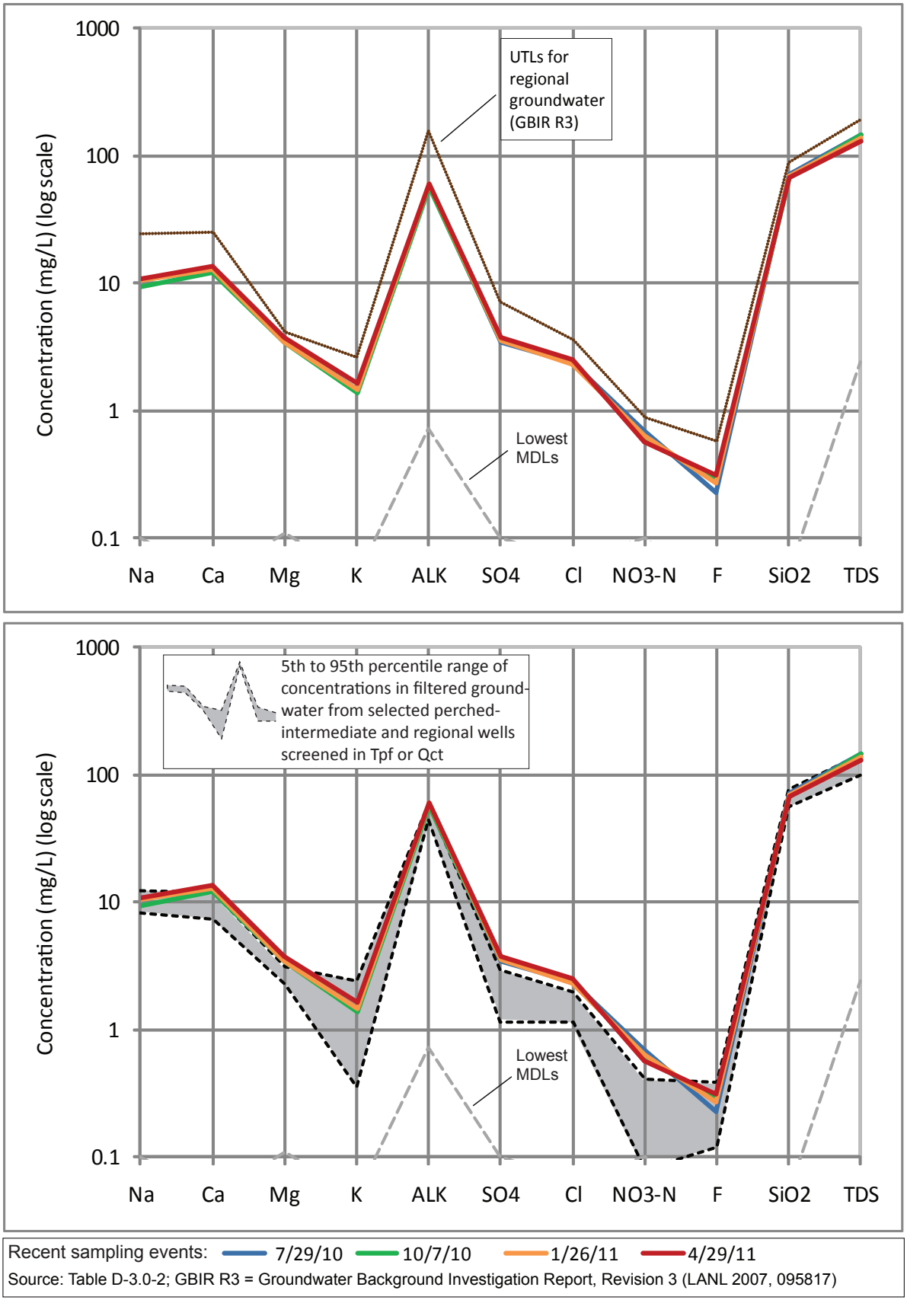


Figure D2-R49-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-49 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

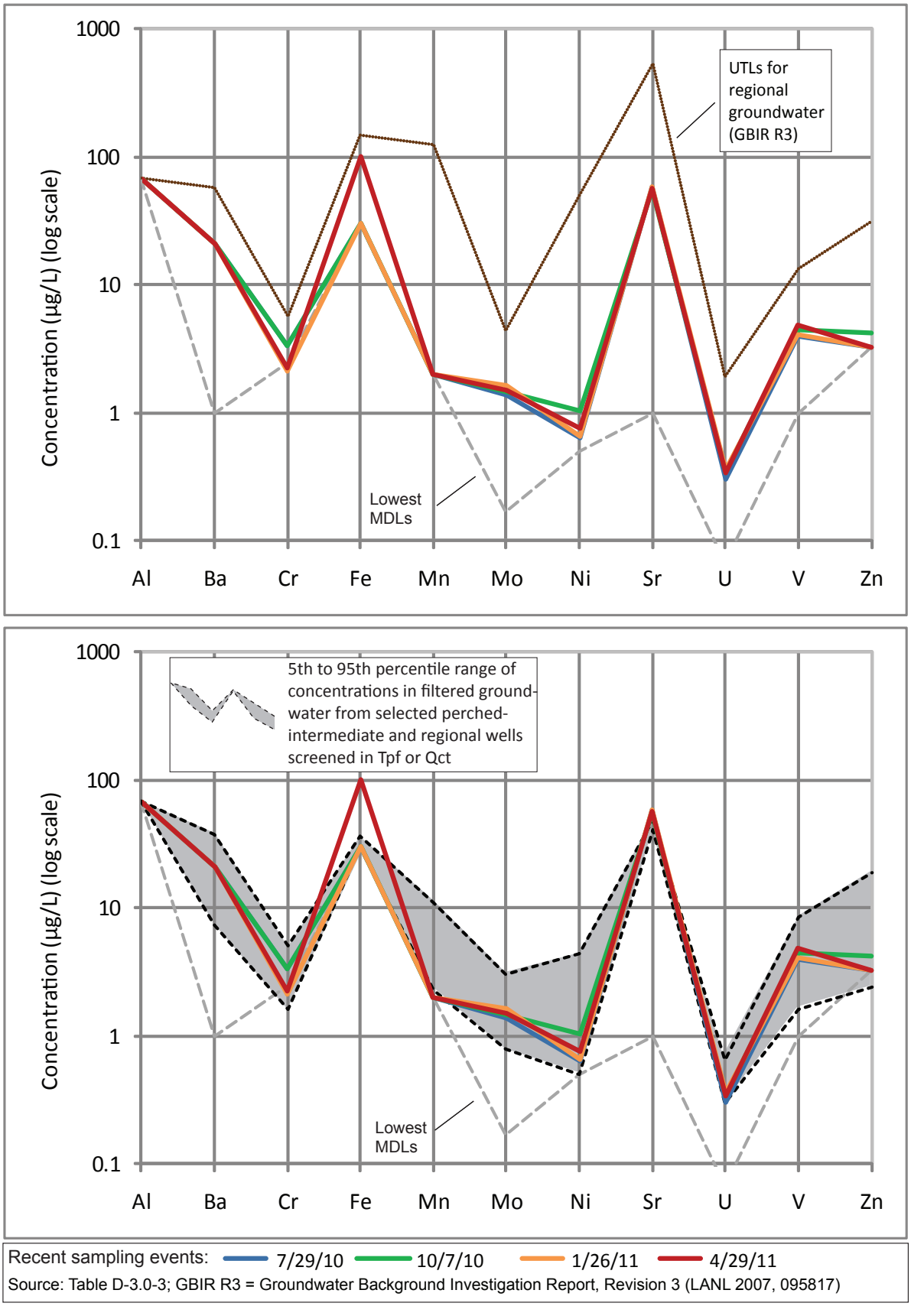


Figure D2-R49-6. Concentrations of trace metals in filtered groundwater from well R-49 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-51 screen 1 (port P1A), port depth 915 ft bgs

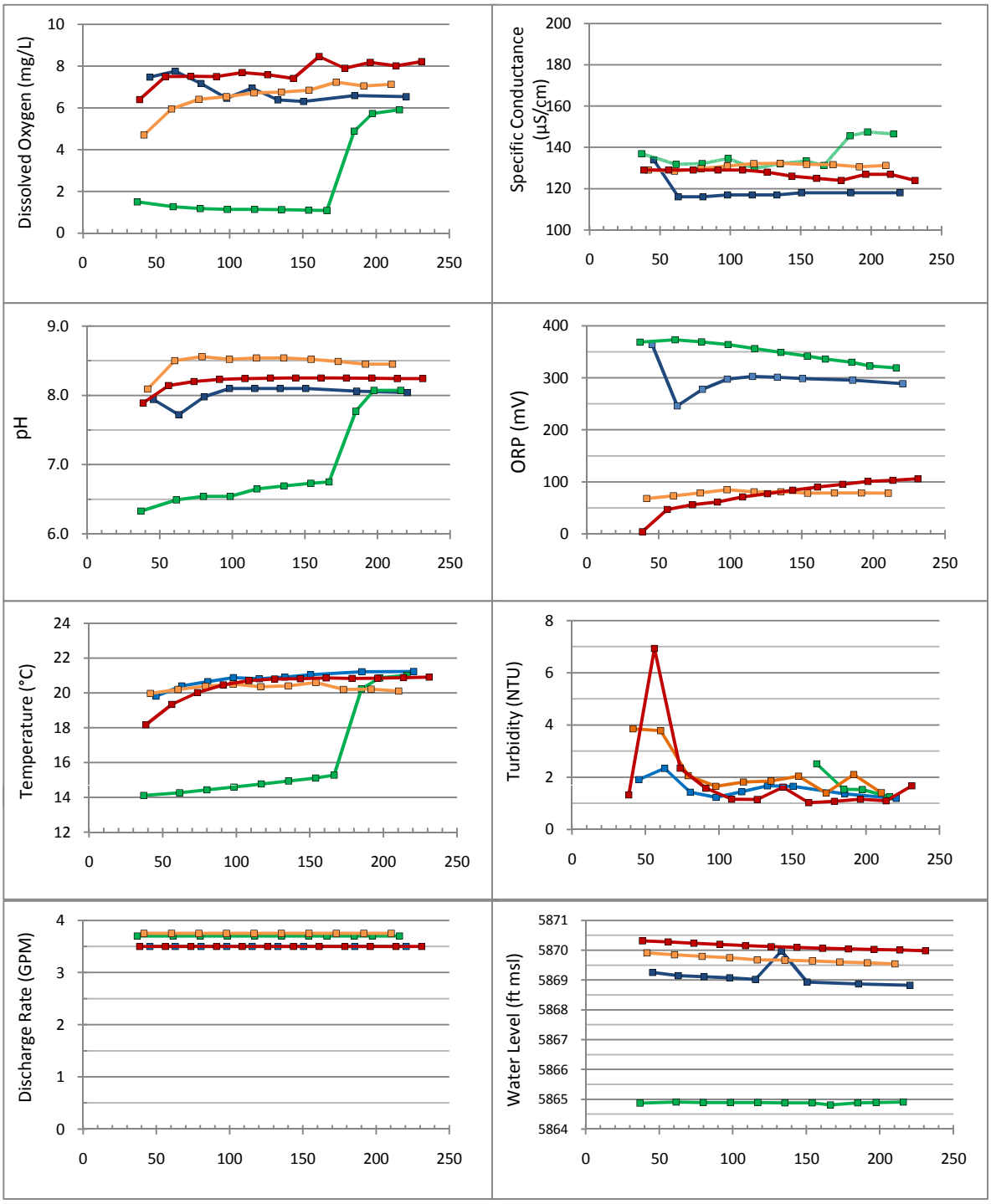


Figure D2-R51-1. Time-series plots of field parameters monitored during purging of R-51 screen 1 (port P1A)

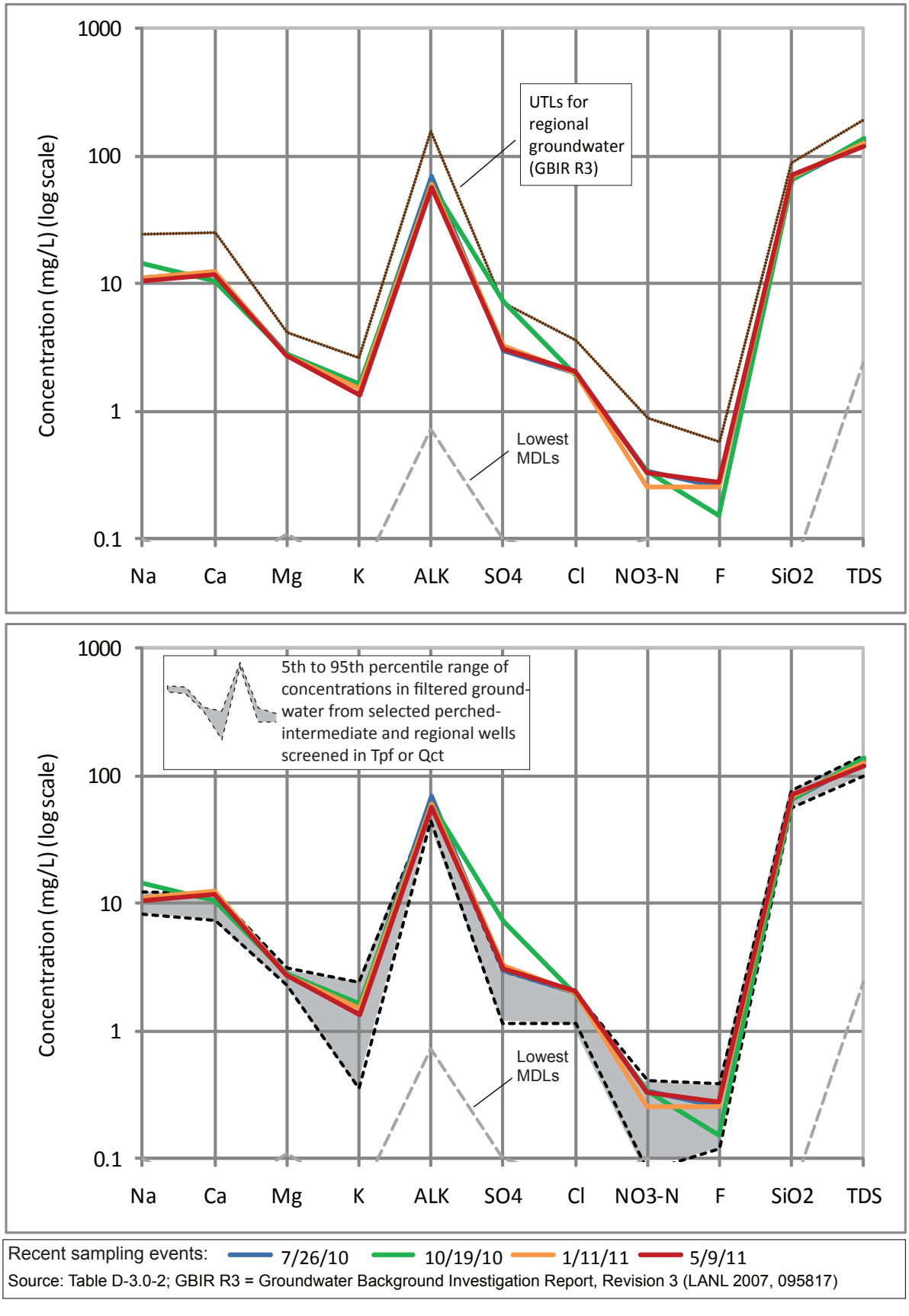


Figure D2-R51-3. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-51 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

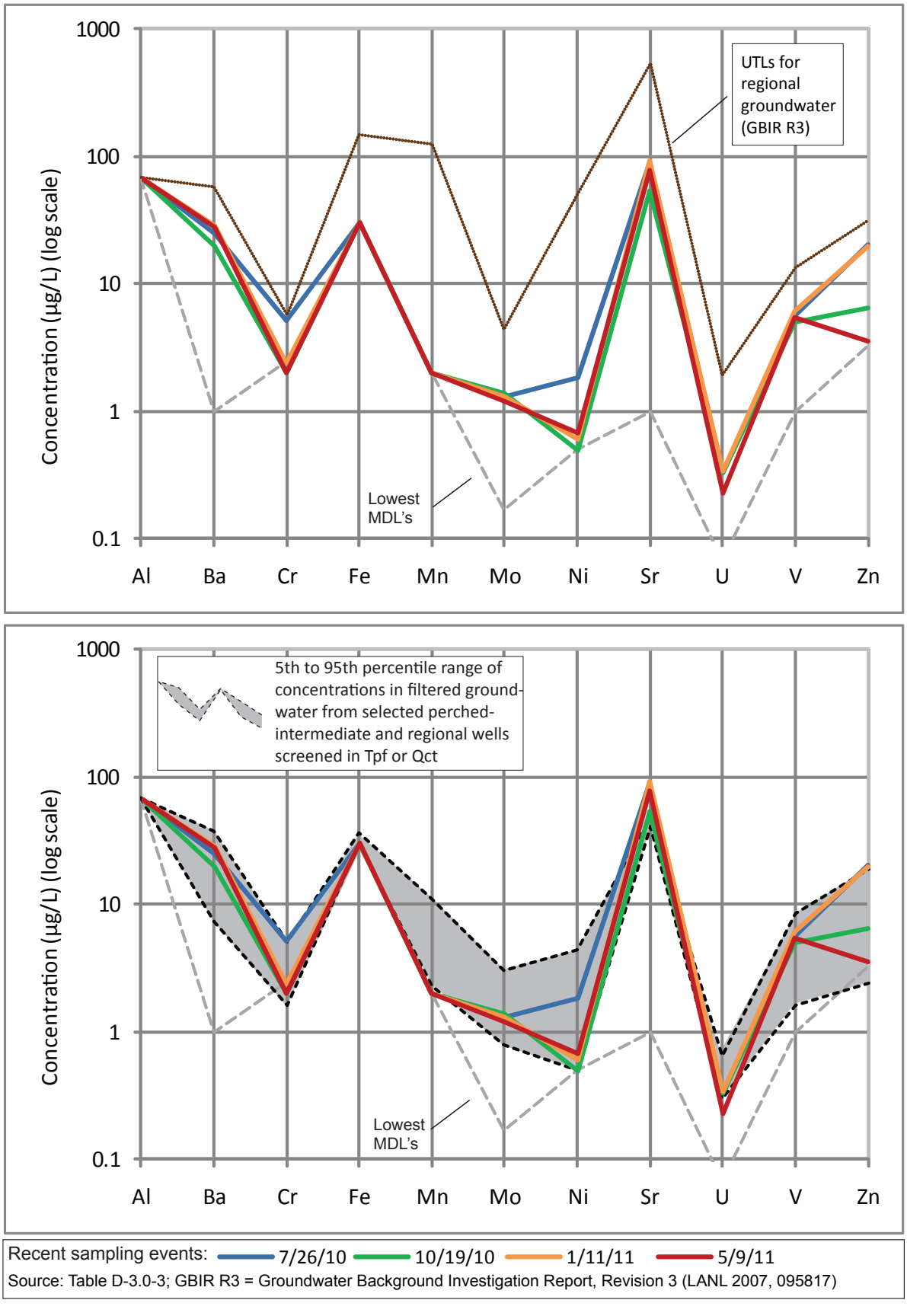


Figure D2-R51-3. Concentrations of trace metals in filtered groundwater from well R-51 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-51 screen 2 (port P2A), port depth 1031 ft bgs

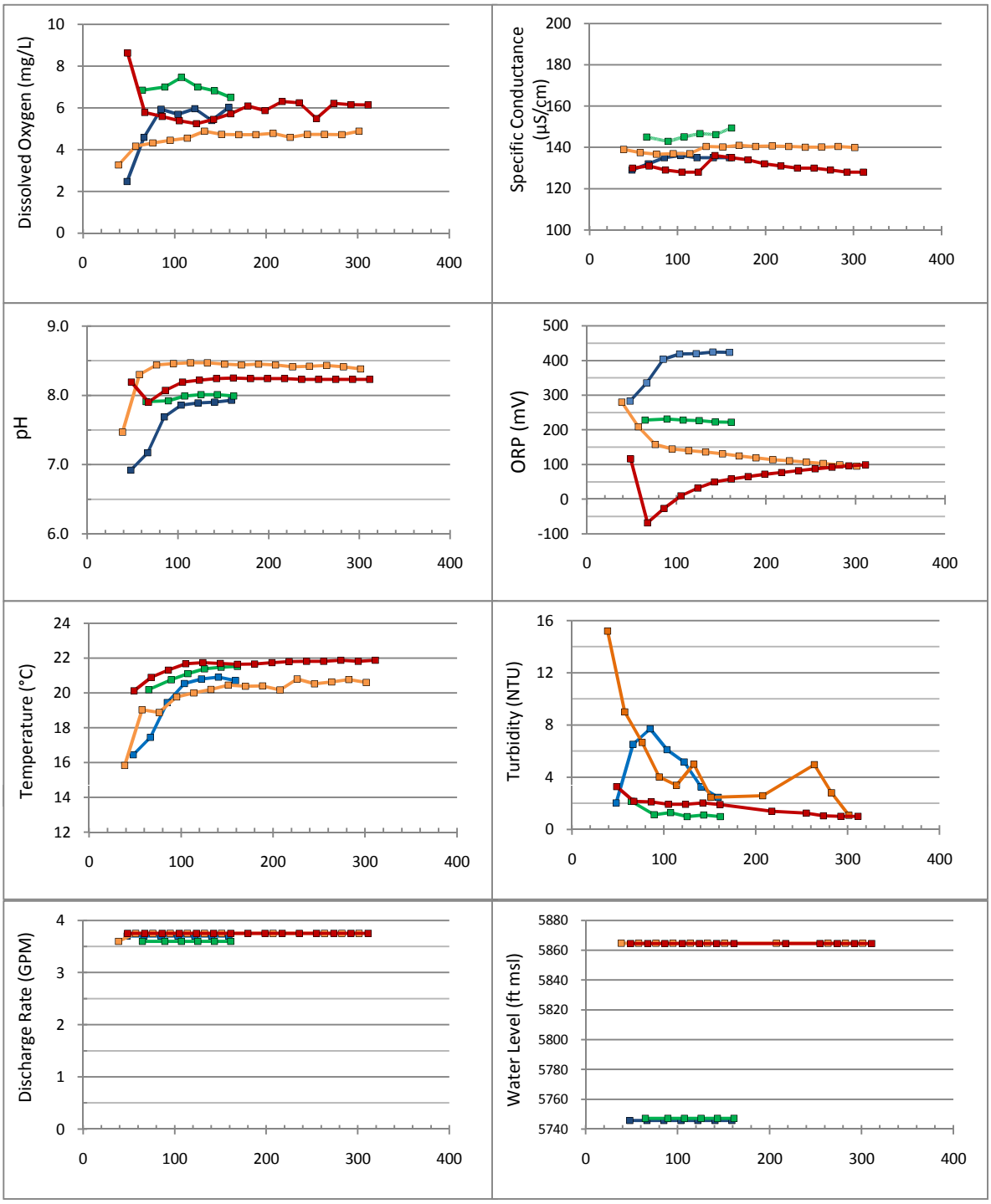


Figure D2-R51-4. **Time-series plots of field parameters monitored during purging of R-51 screen 2 (port P2A)**

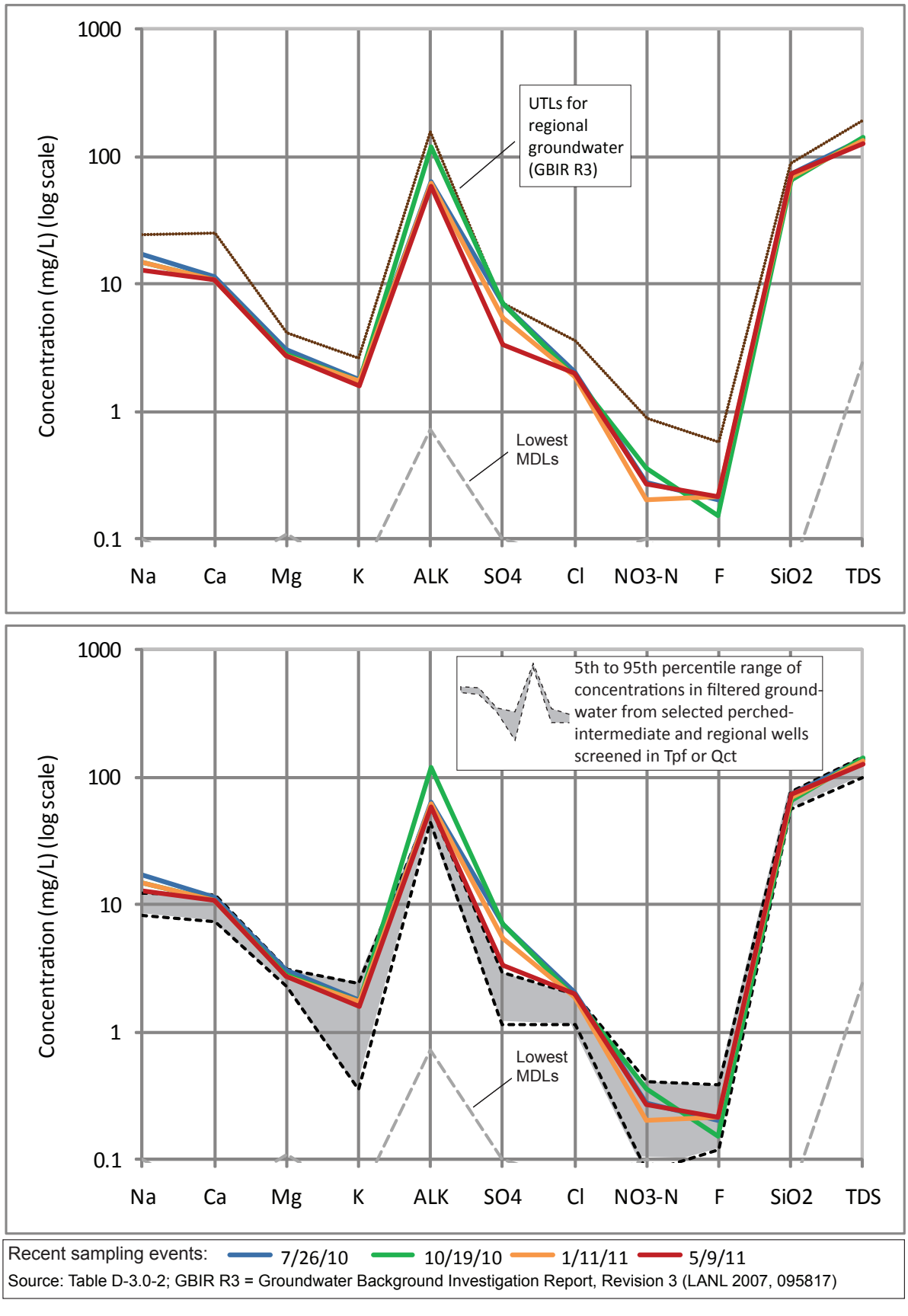


Figure D2-R51-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-51 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

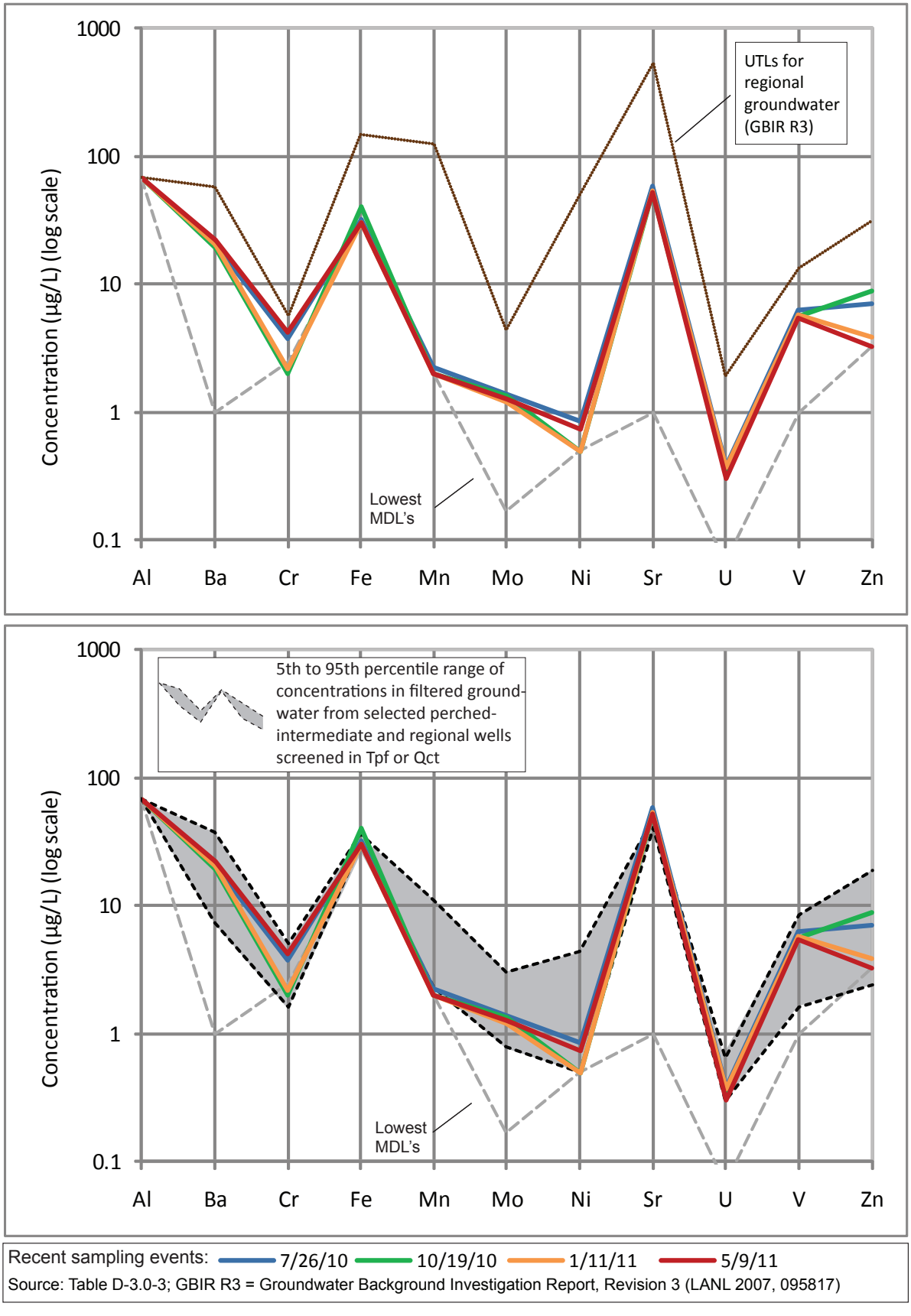


Figure D2-R51-6. Concentrations of trace metals in filtered groundwater from well R-51 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-52 screen 1 (port P1A), port depth 1035 ft bgs

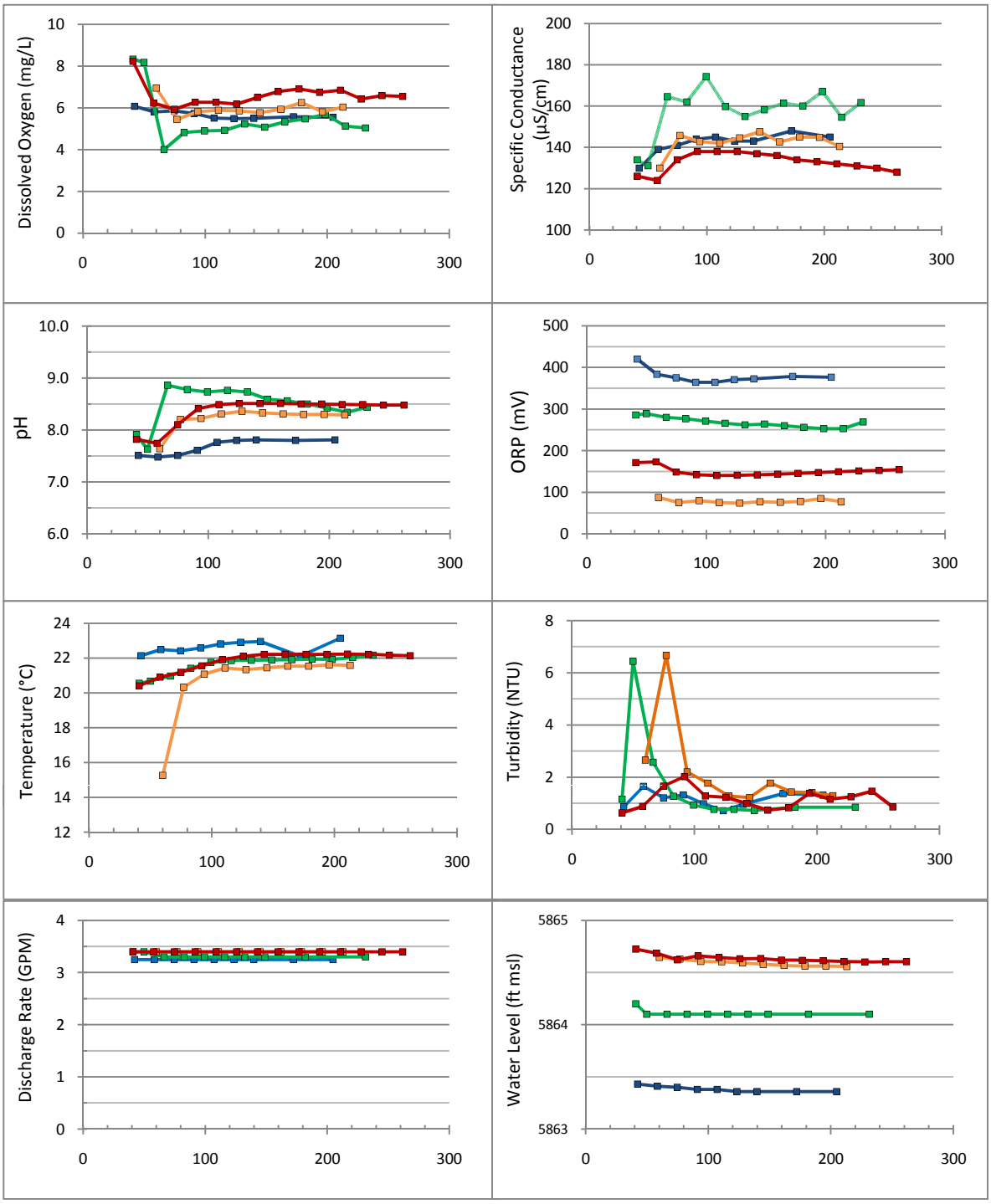


Figure D2-R52-1. Time-series plots of field parameters monitored during purging of R-52 screen 1 (port P1A)

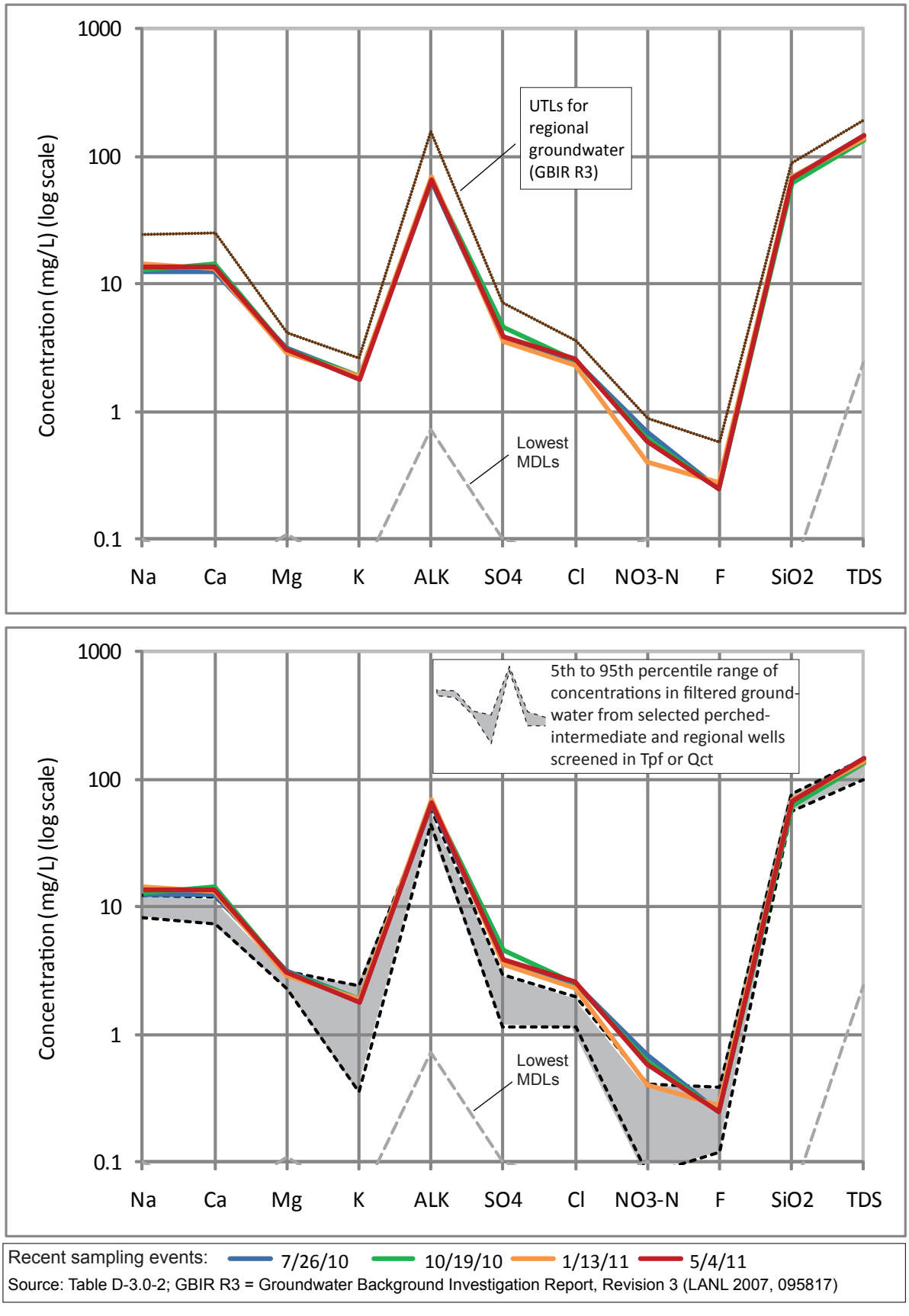


Figure D2-R52-3. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-52 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

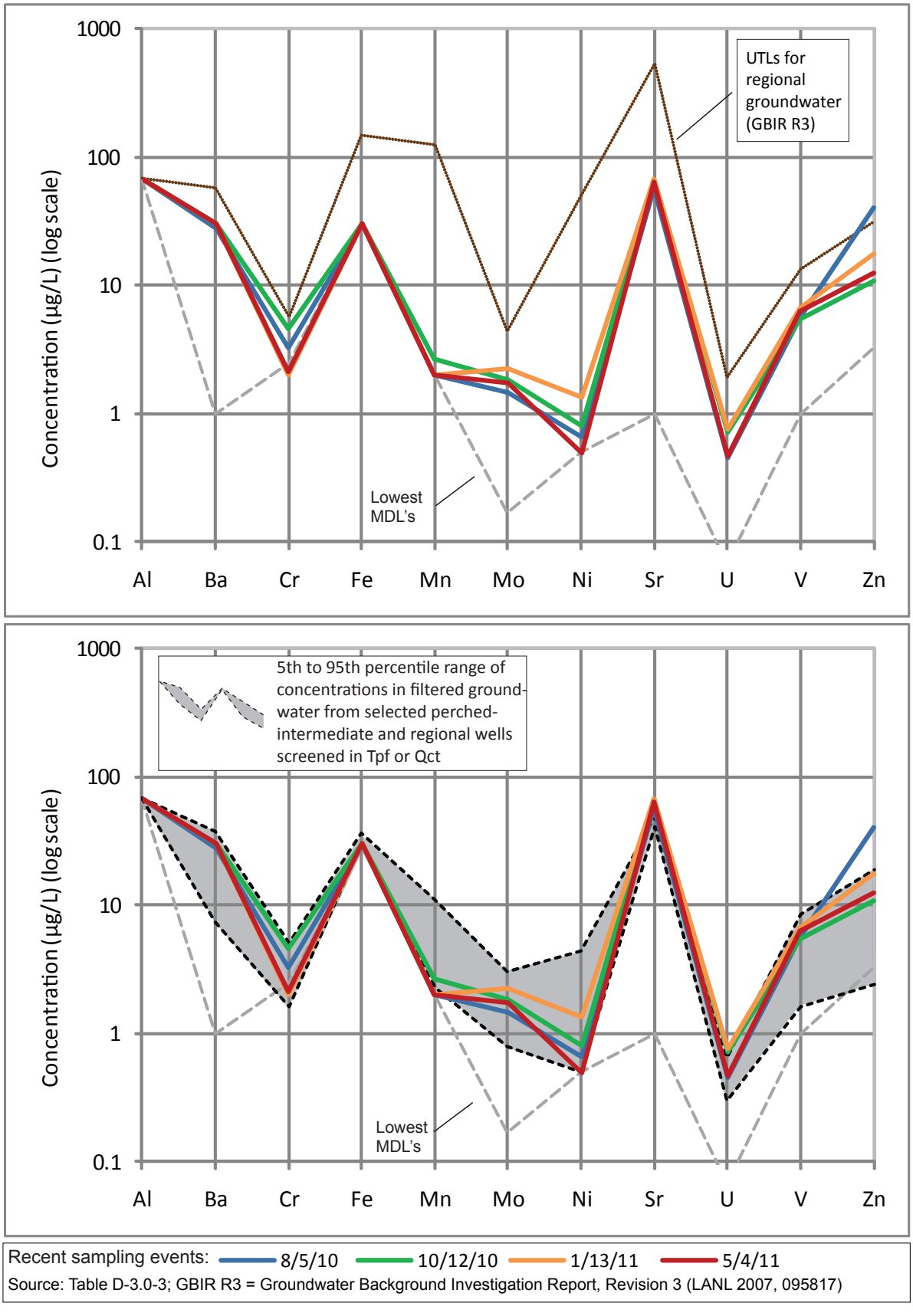


Figure D2-R52-3. Concentrations of trace metals in filtered groundwater from well R-52 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-52 screen 2 (port P2A), port depth 1107 ft bgs

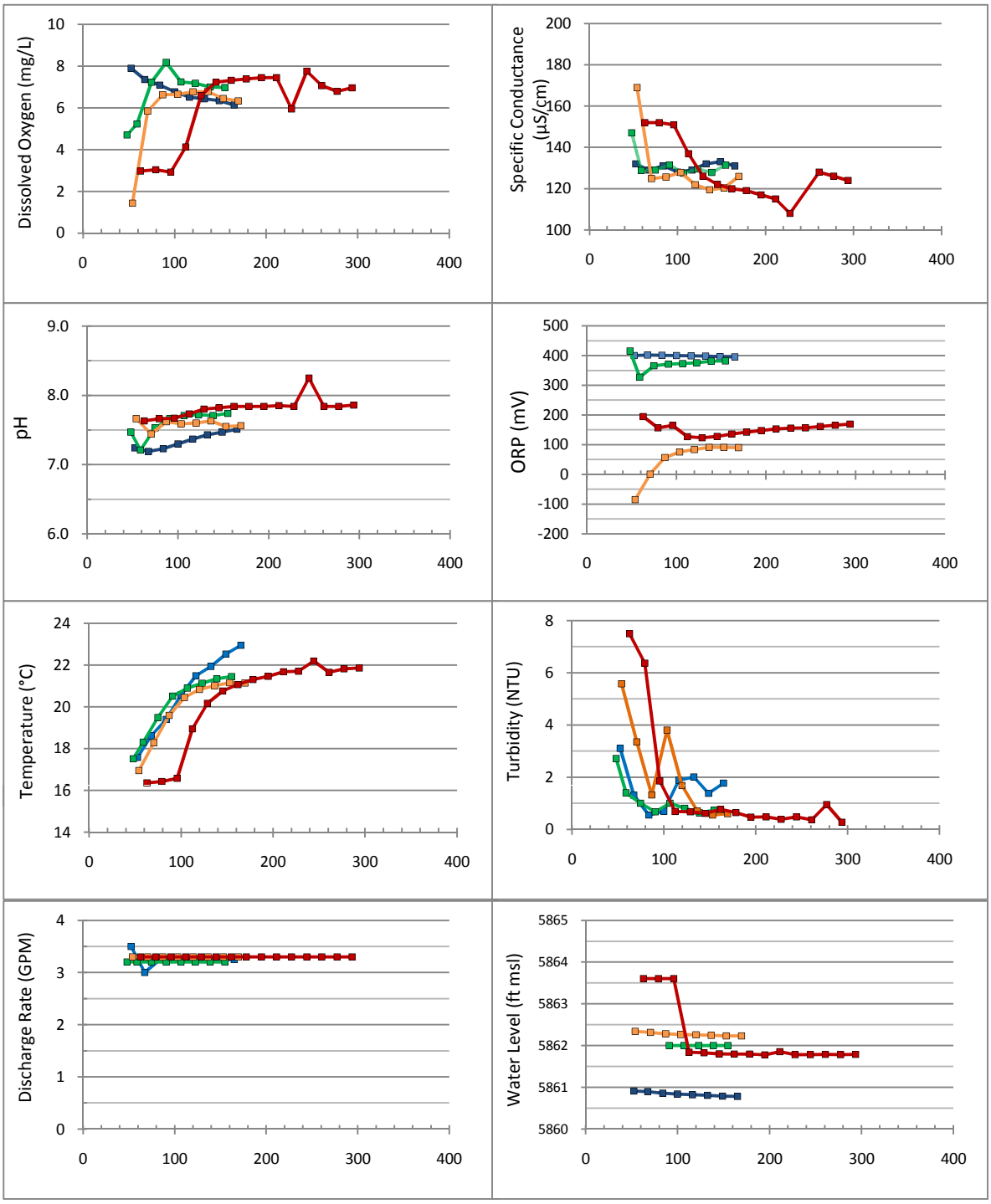


Figure D2-R52-4. **Time-series plots of field parameters monitored during purging of R-52 screen 2 (port P2A)**

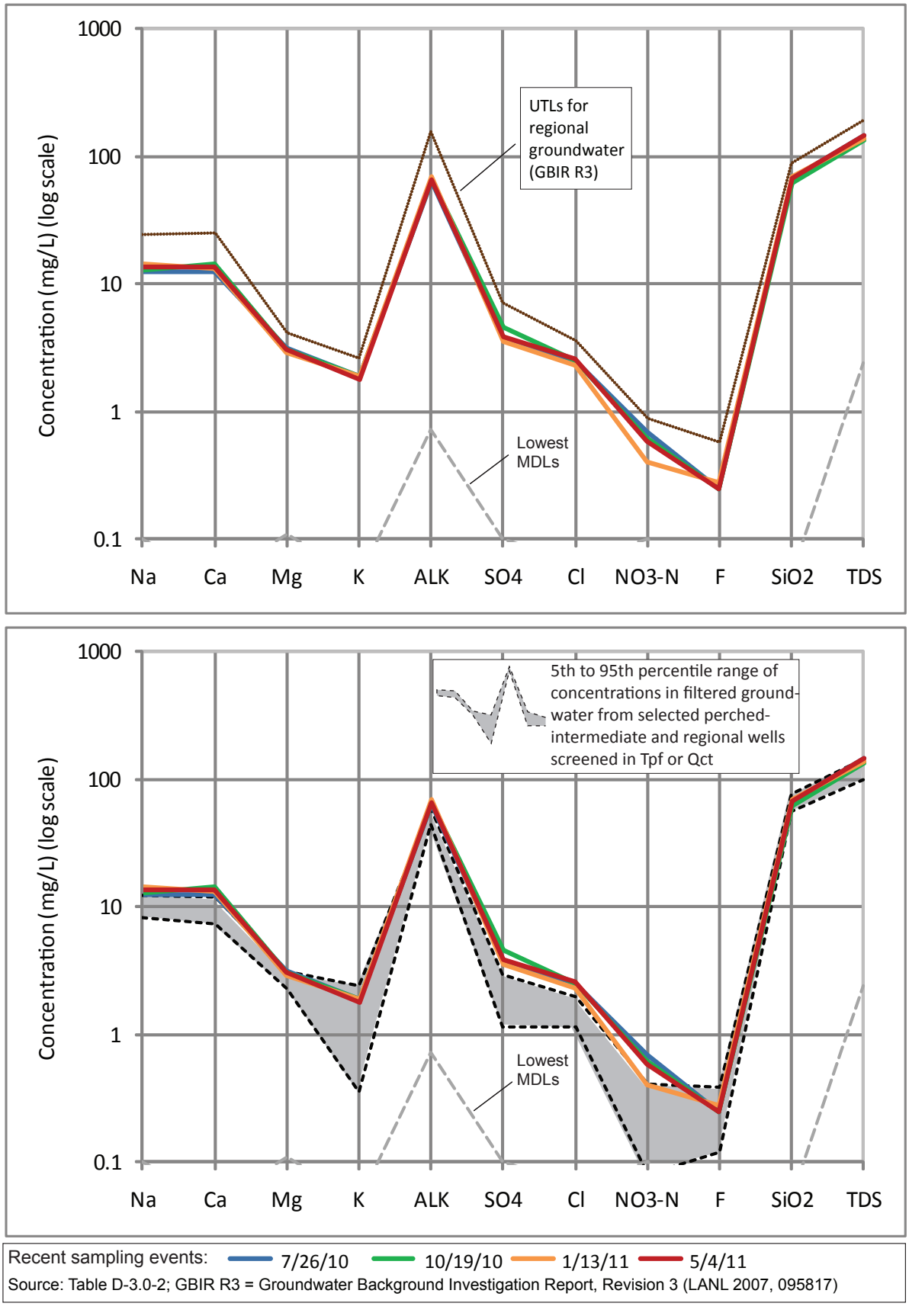


Figure D2-R52-3. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-52 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

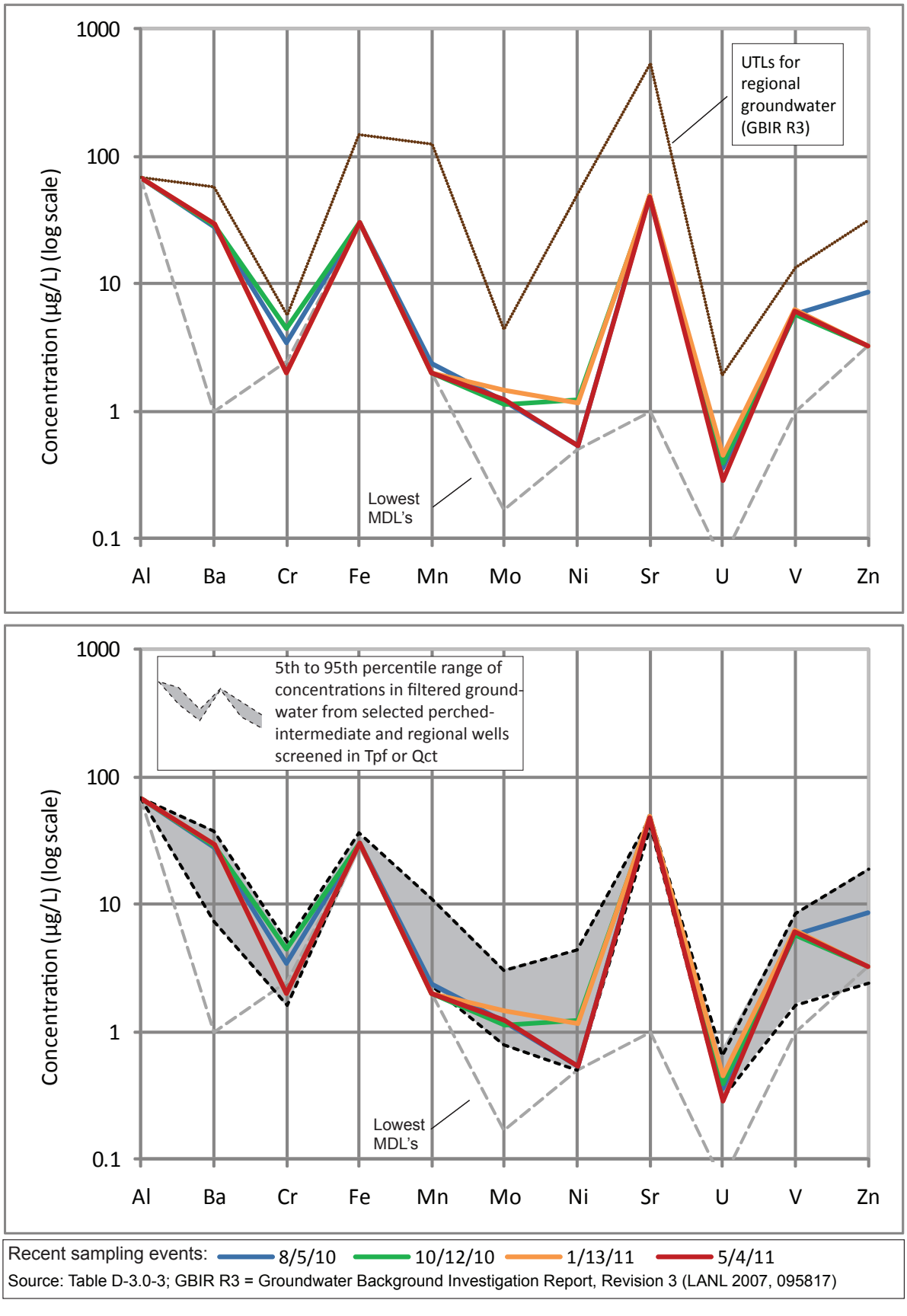


Figure D2-R52-6. Concentrations of trace metals in filtered groundwater from well R-52 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-53 screen 1 (port P1A), port depth 849 ft bgs

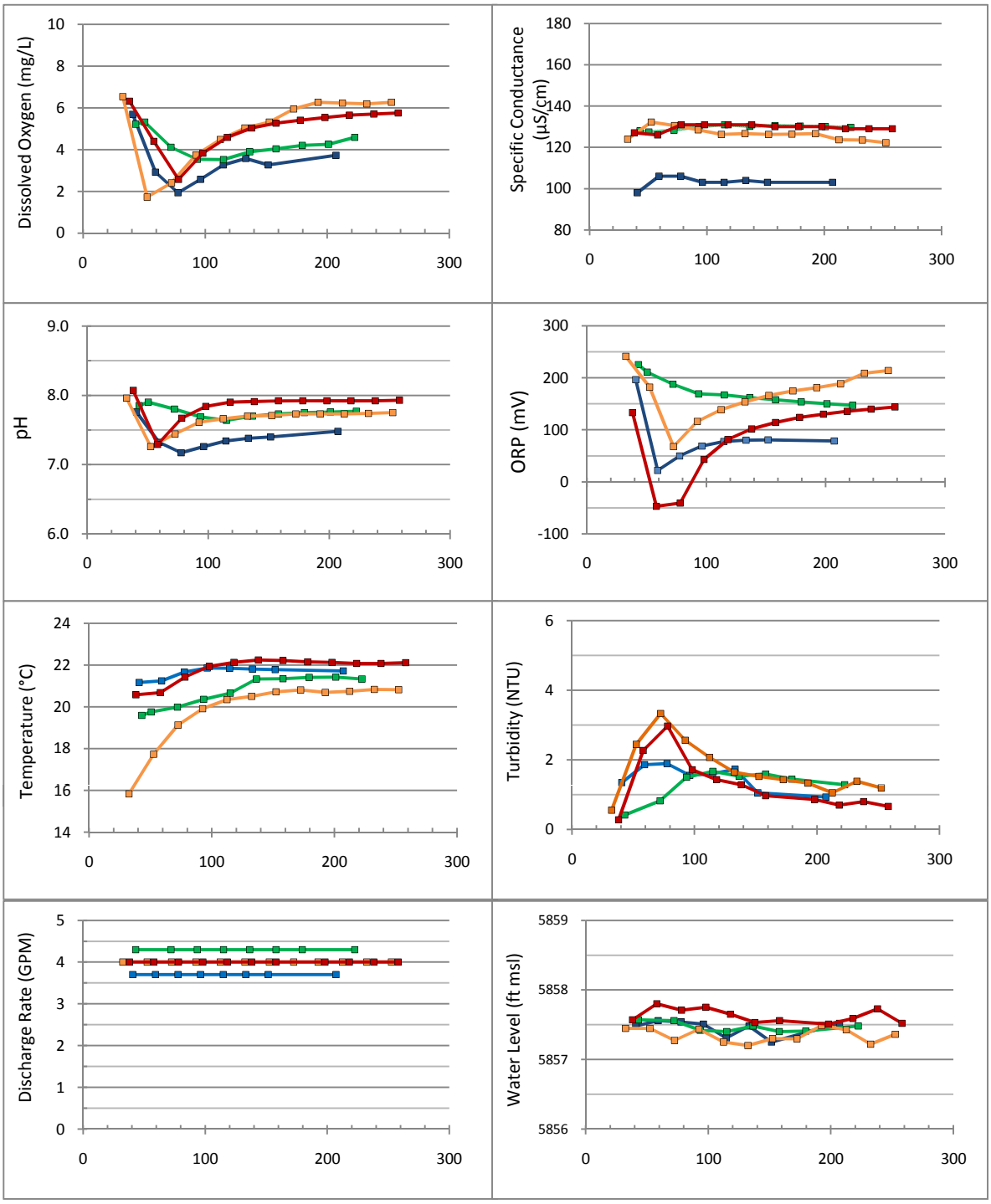


Figure D2-R53-1. **Time-series plots of field parameters monitored during purging of R-53 screen 1 (port P1A)**

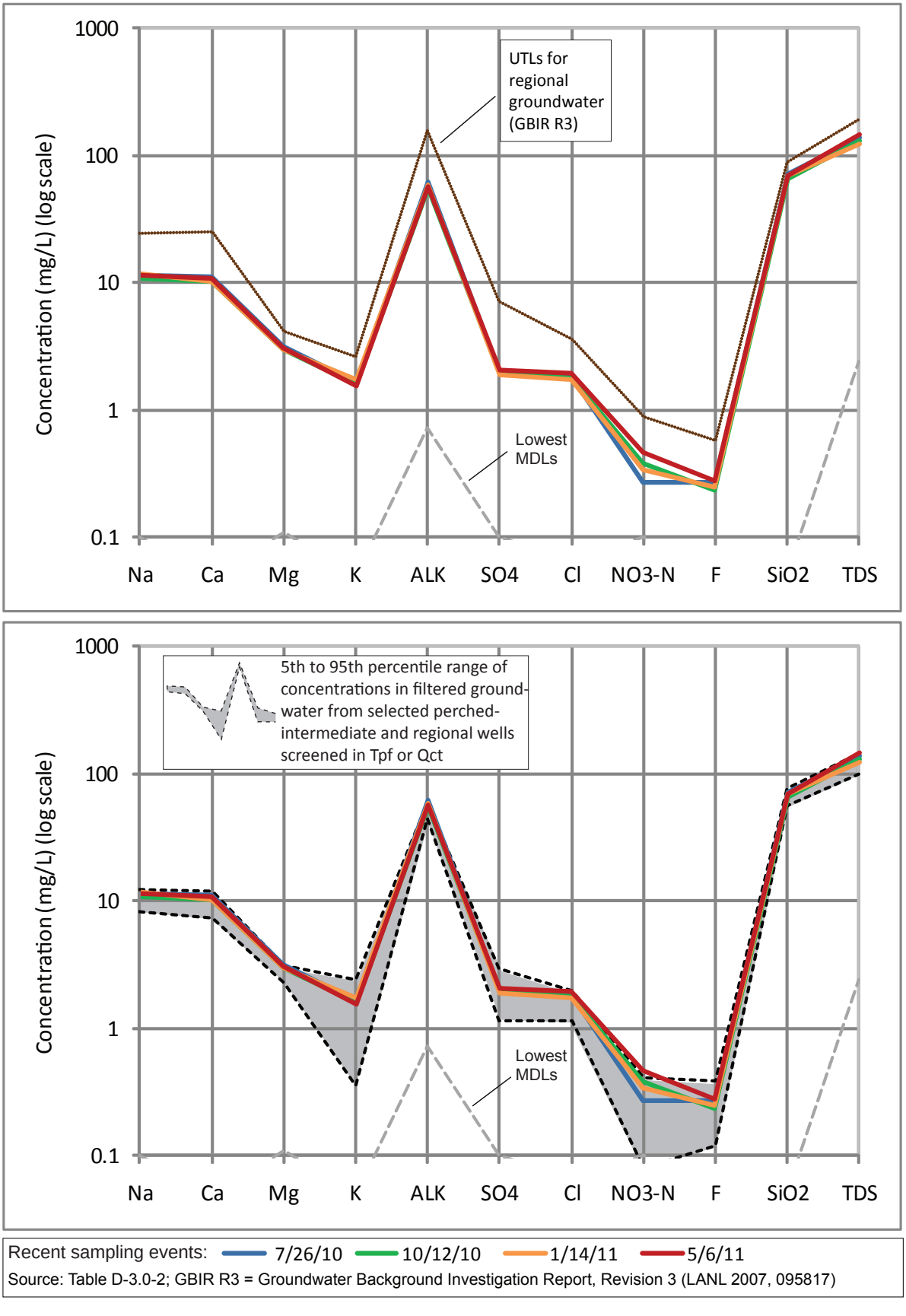


Figure D2-R53-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-53 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

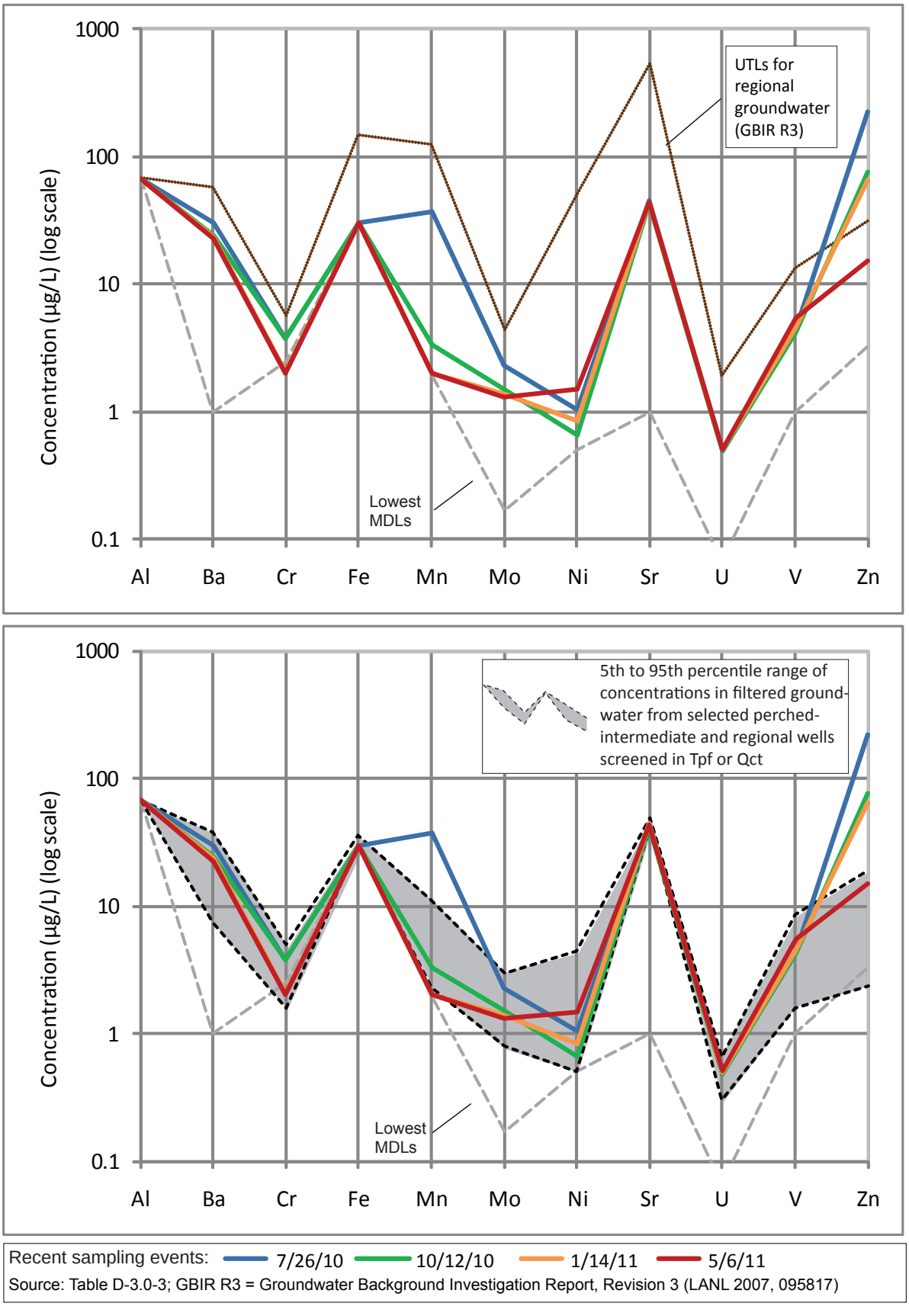


Figure D2-R53-3. Concentrations of trace metals in filtered groundwater from well R-53 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

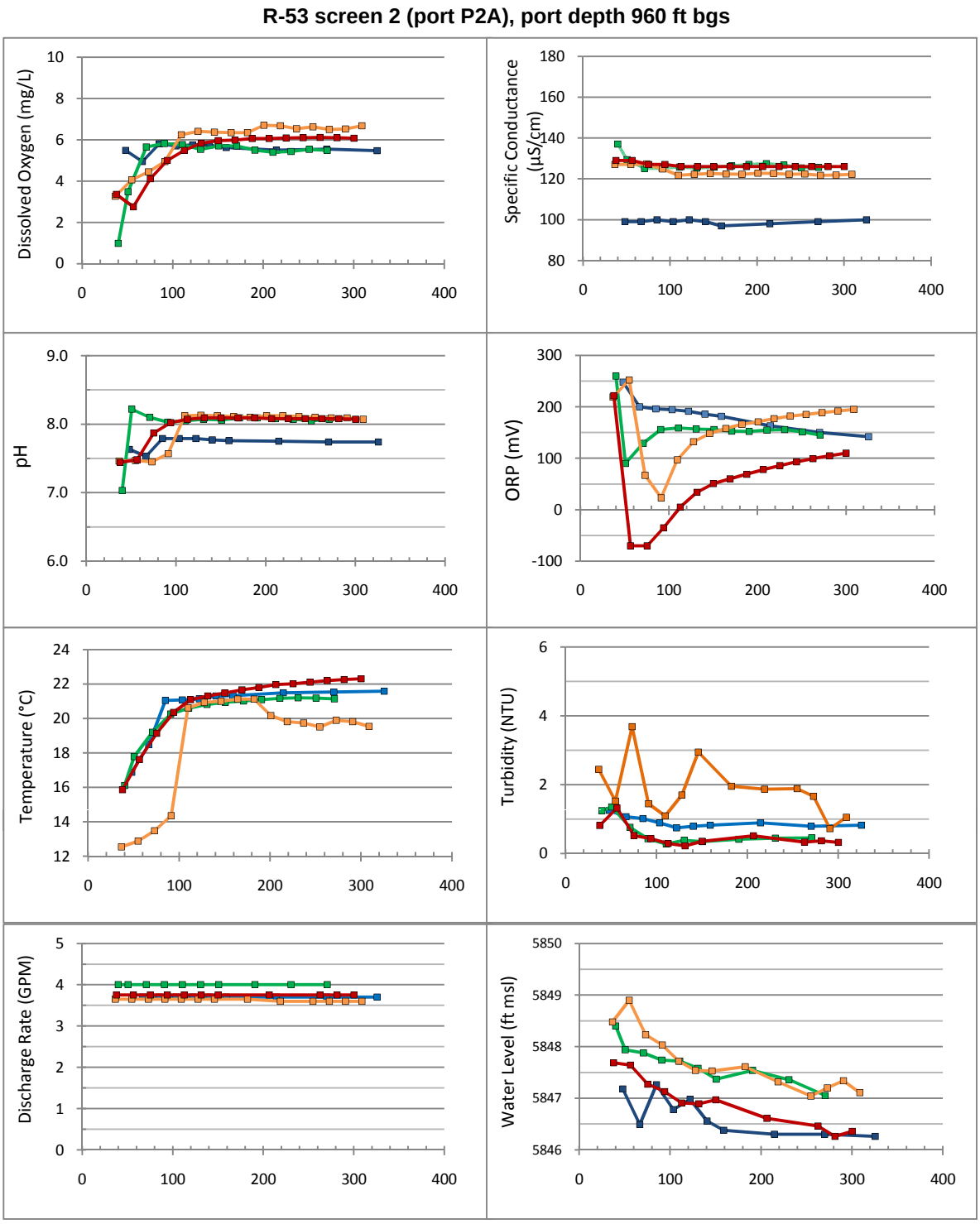


Figure D2-R53-4. **Time-series plots of field parameters monitored during purging of R-53 screen 2 (port P2A)**

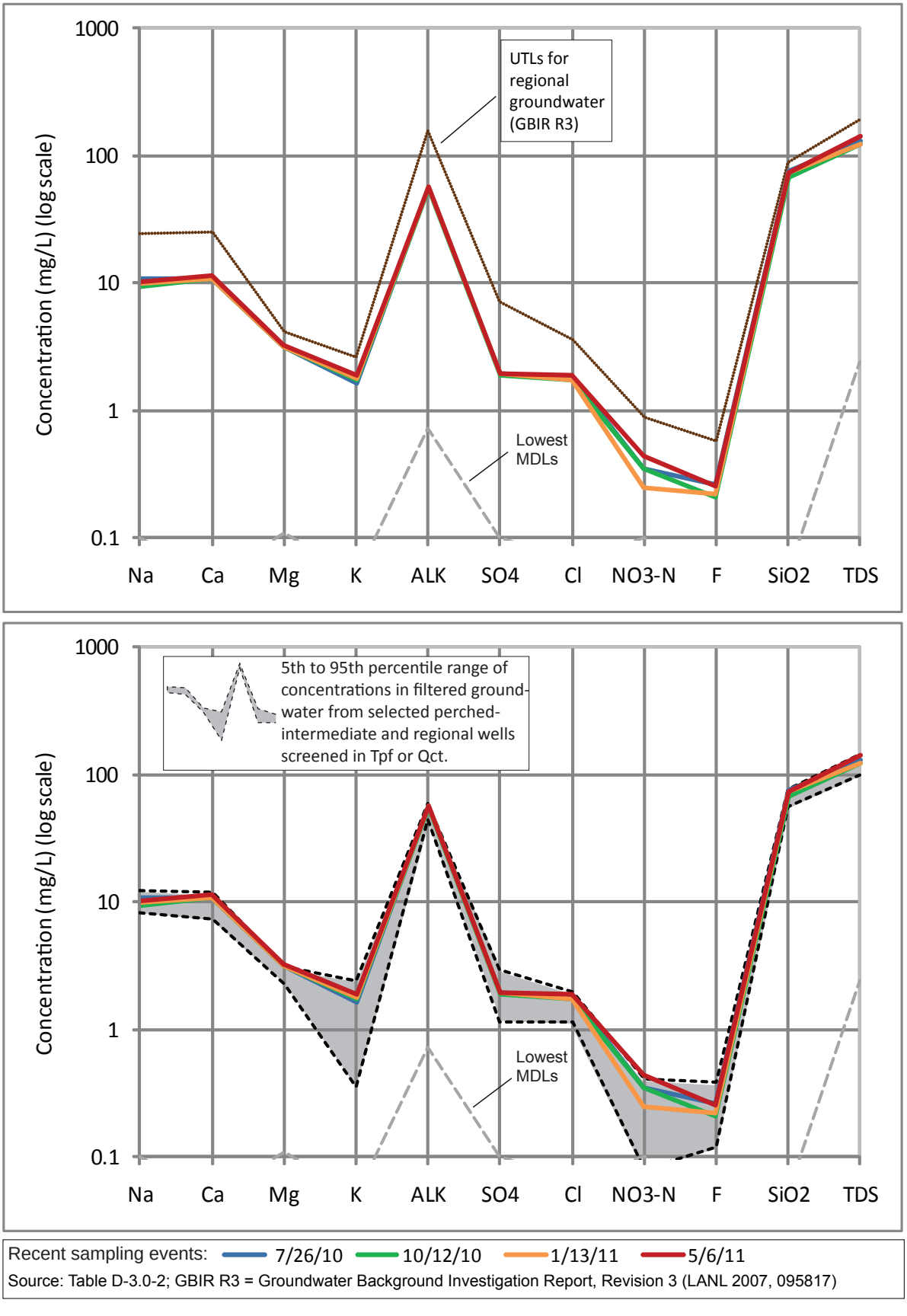


Figure D2-R53-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-53 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

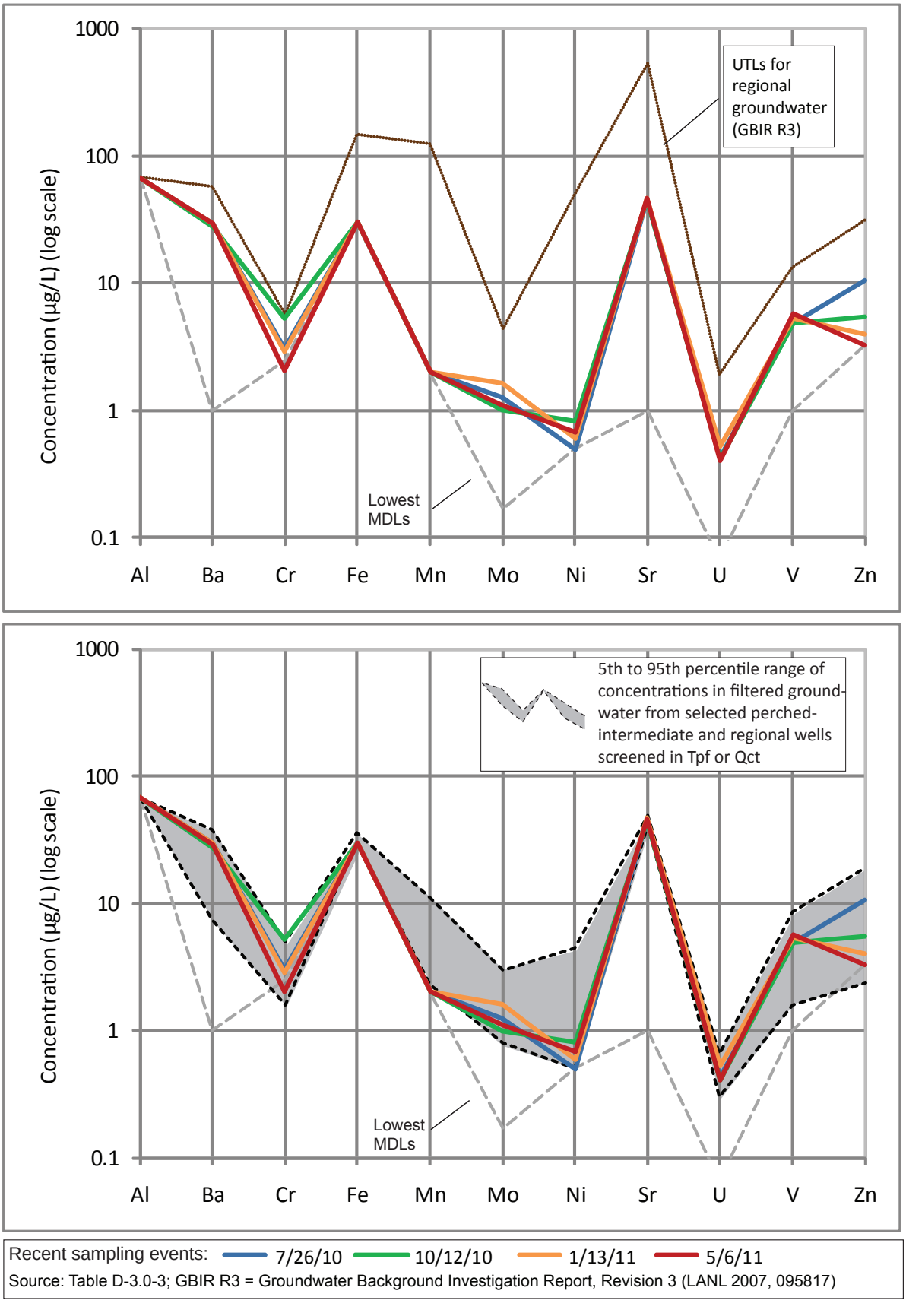
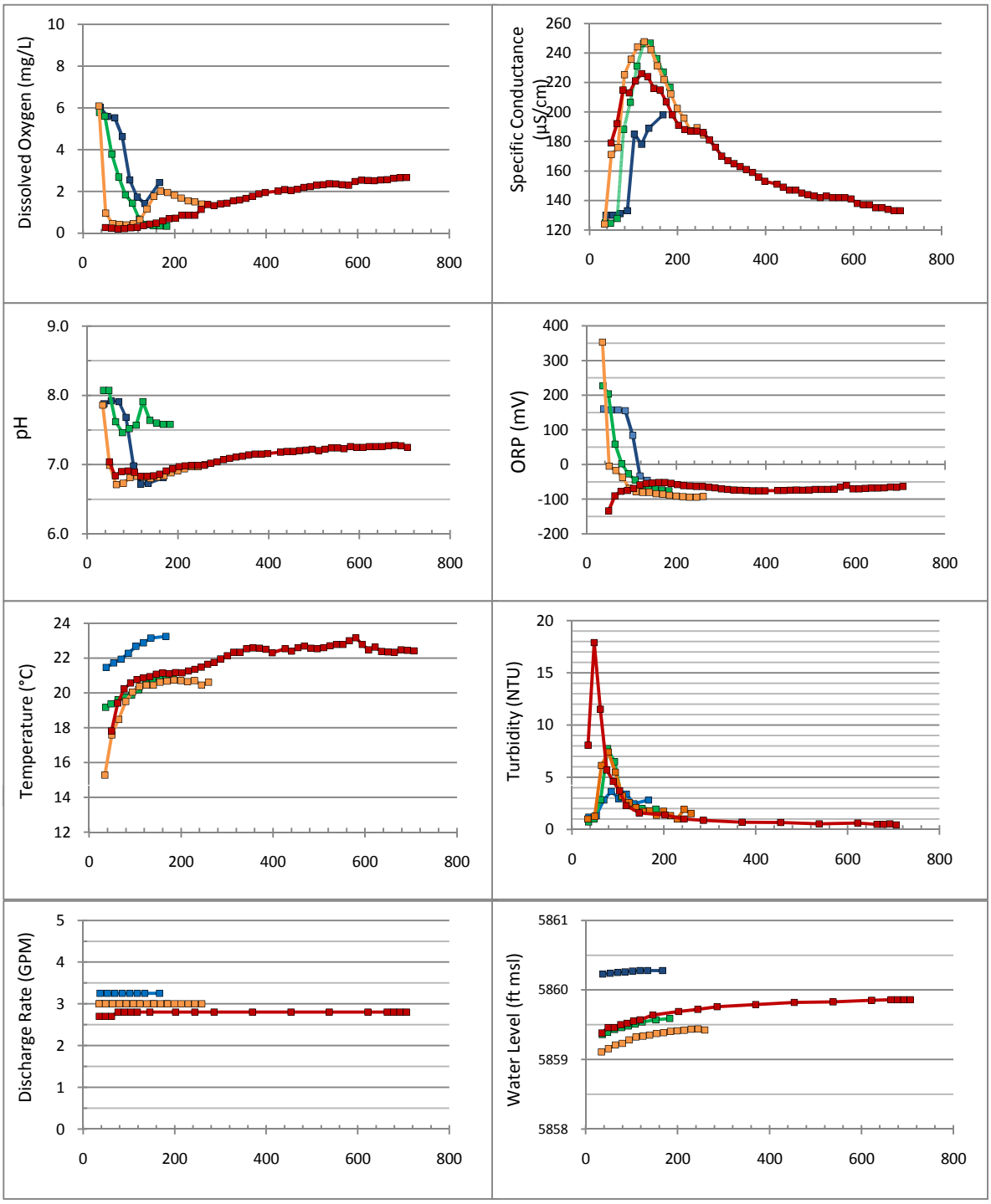


Figure D2-R53-6. Concentrations of trace metals in filtered groundwater from well R-53 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-54 screen 1 (port P1A), port depth 830 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R54-1. **Time-series plots of field parameters monitored during purging of R-54 screen 1 (port P1A)**

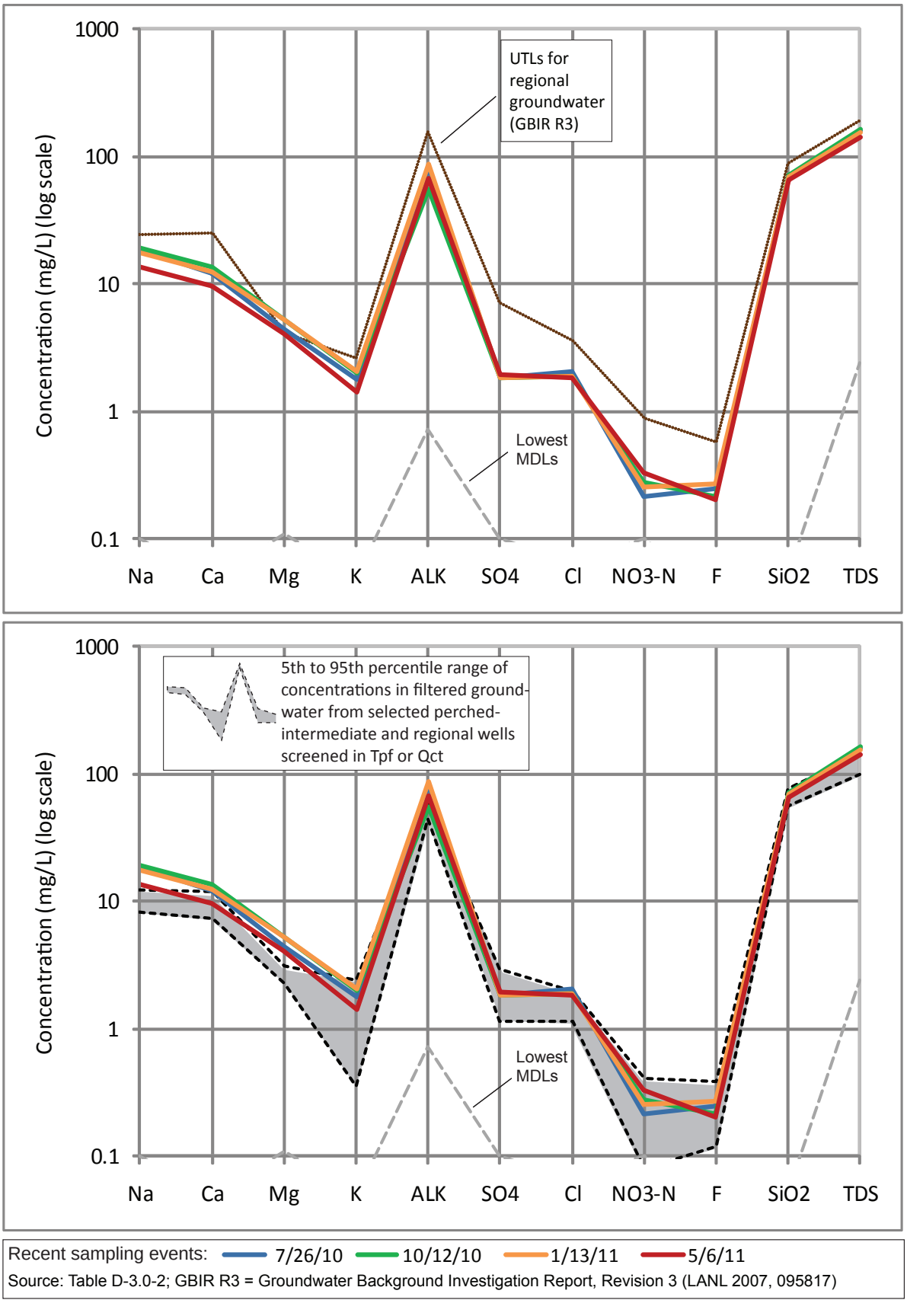


Figure D2-R54-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-54 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

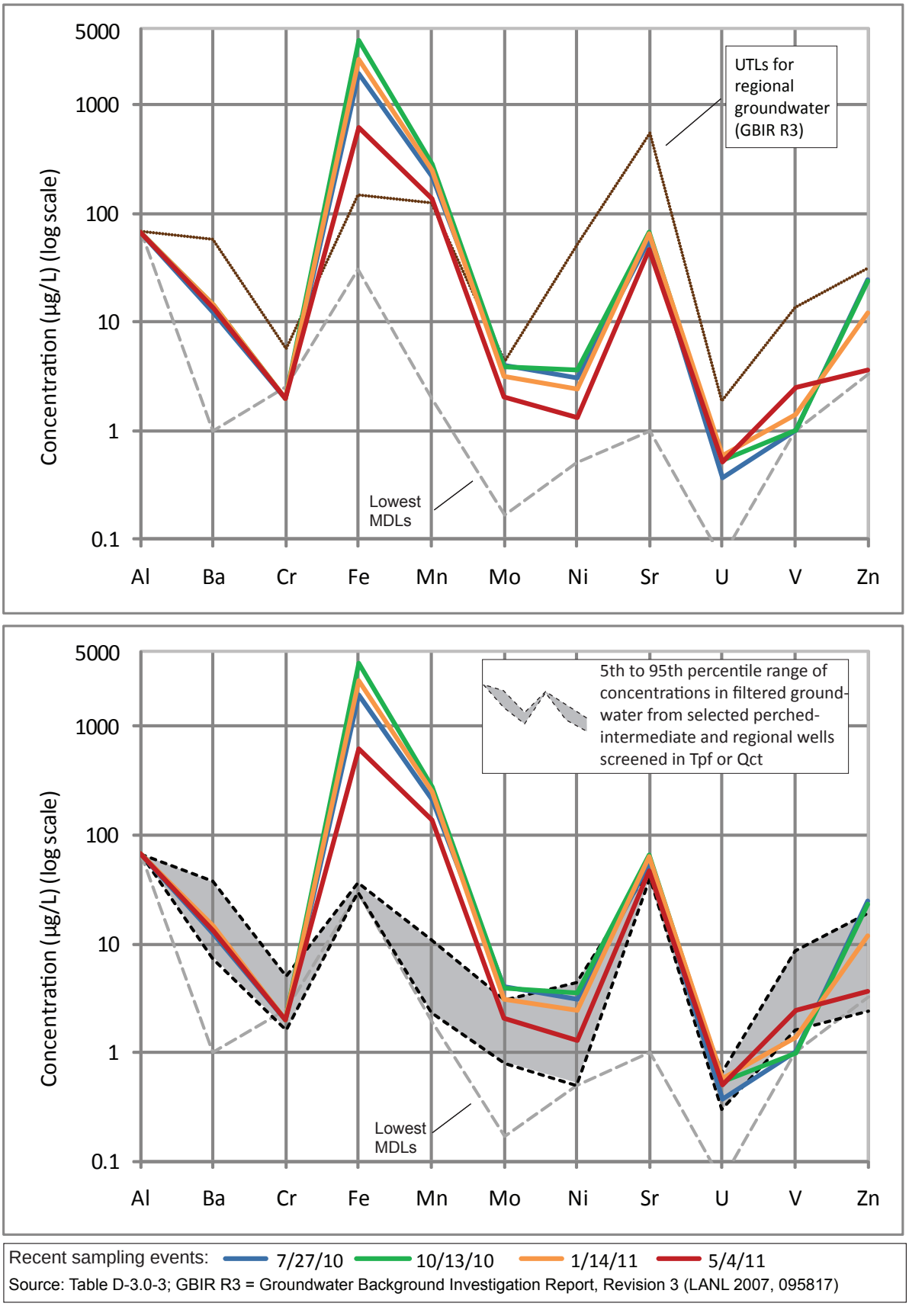


Figure D2-R54-3. Concentrations of trace metals in filtered groundwater from well R-54 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows"background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-54 screen 2 (port P2A), port depth 915 ft bgs

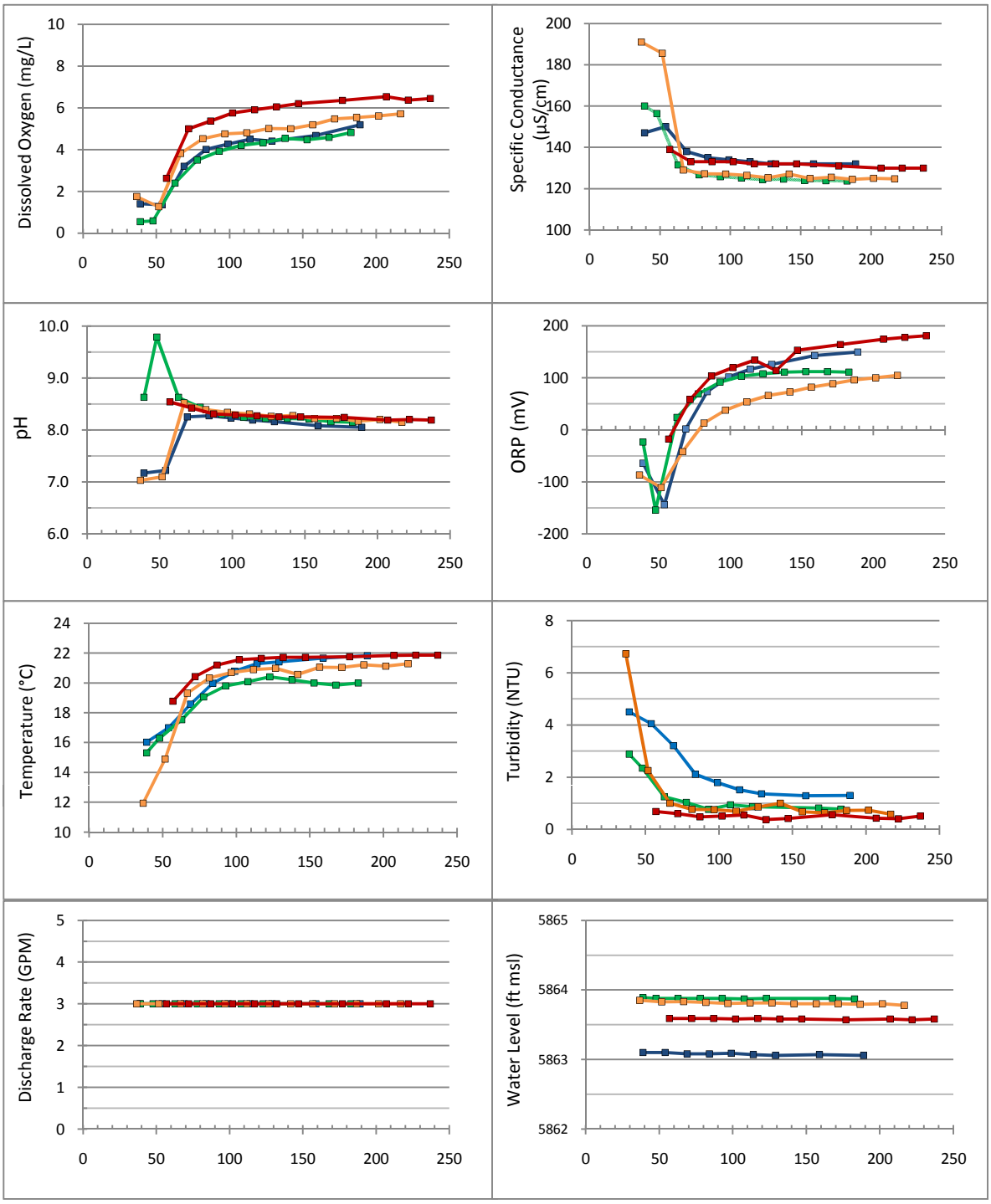


Figure D2-R54-4. **Time-series plots of field parameters monitored during purging of R-54 screen 2 (port P2A)**

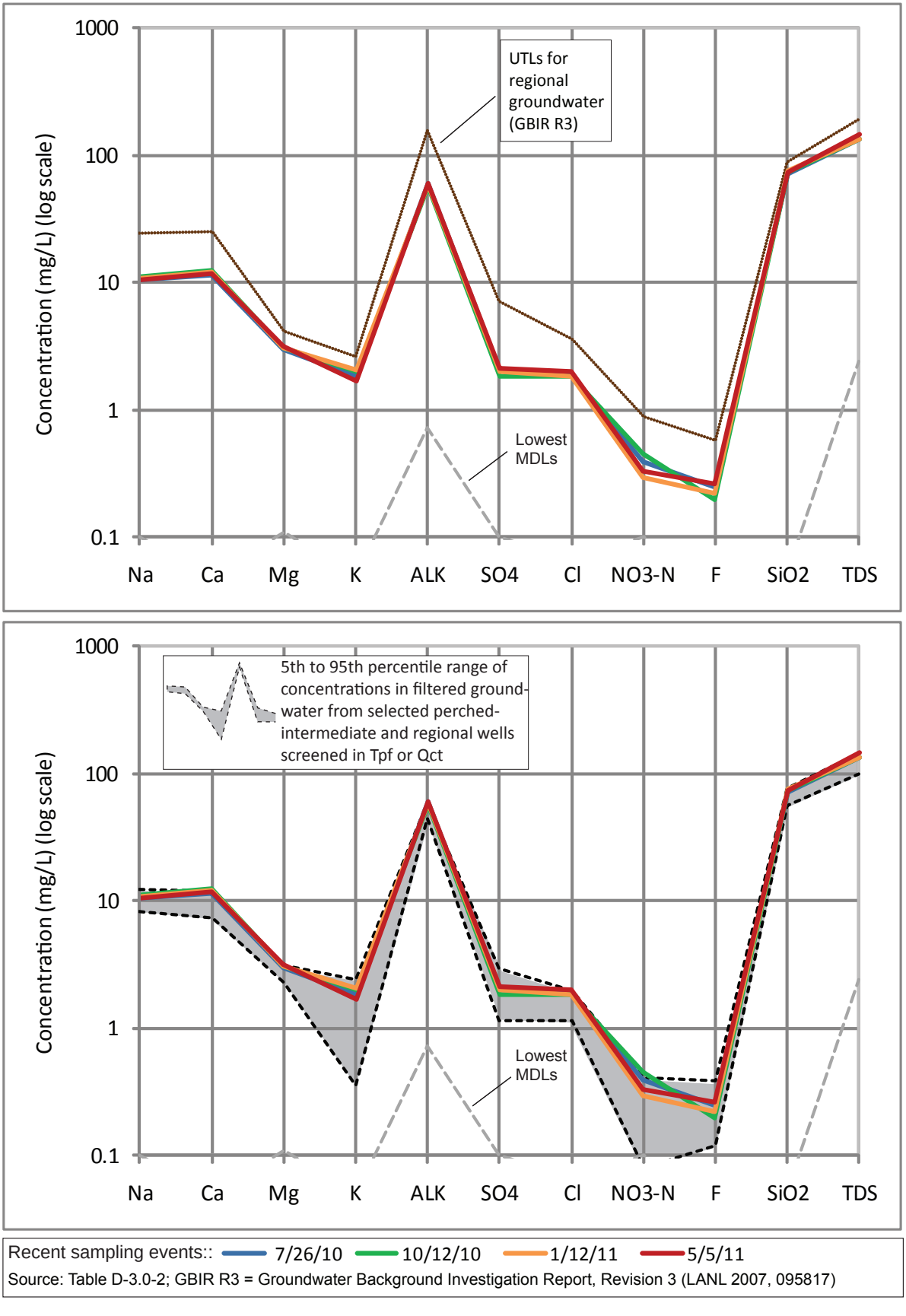


Figure D2-R54-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-54 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

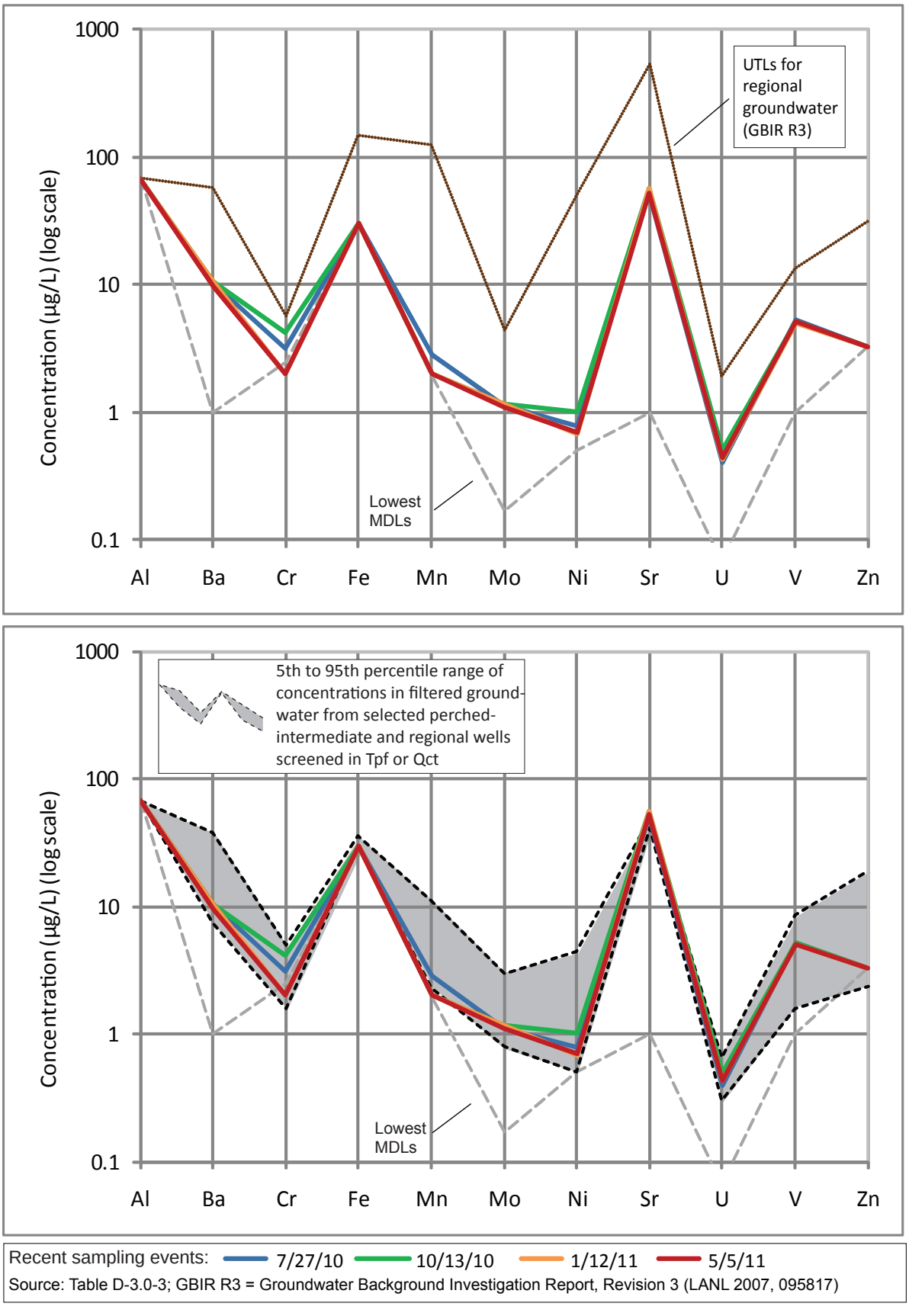
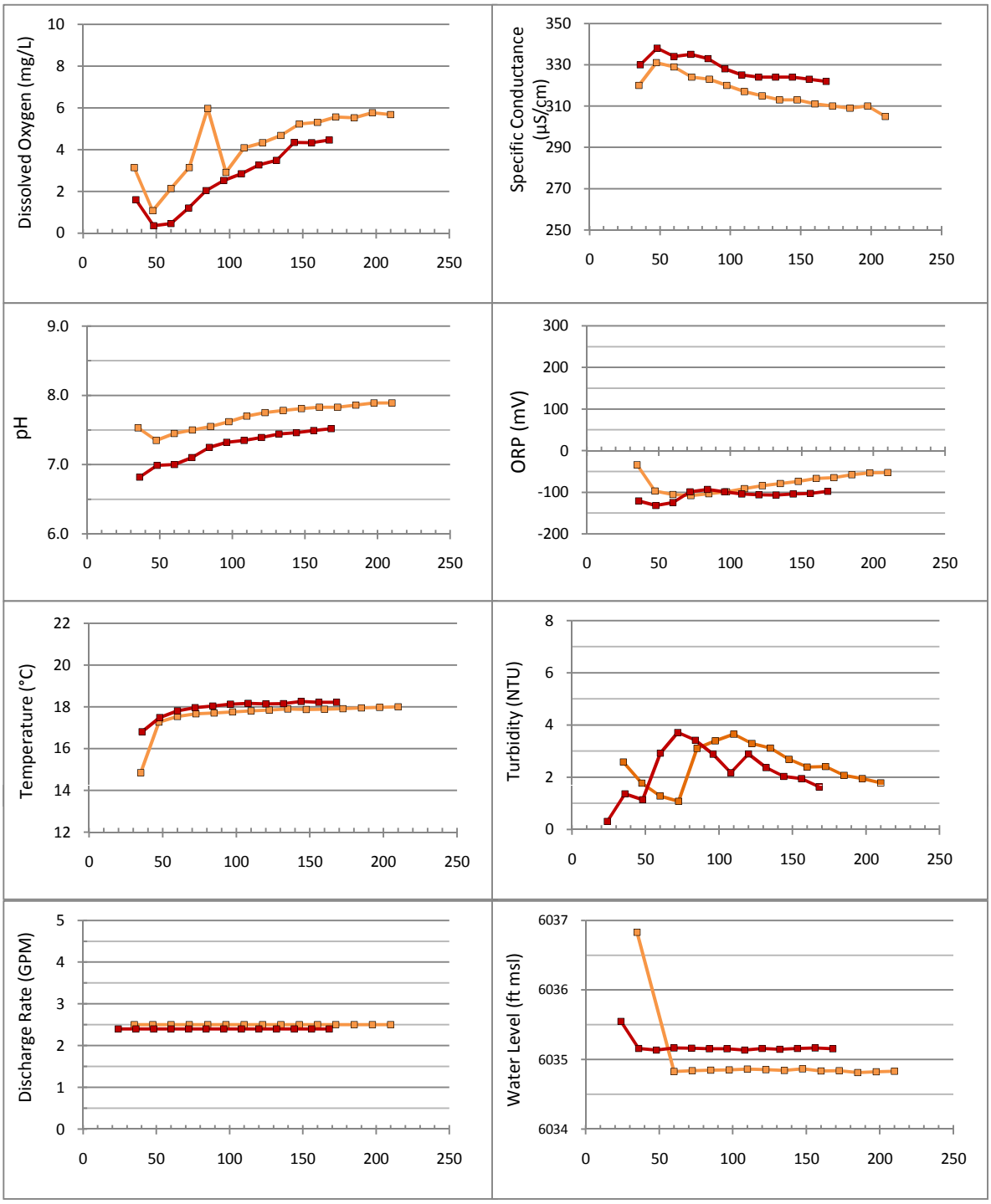


Figure D2-R54-6. Concentrations of trace metals in filtered groundwater from well R-54 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater. Lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-55i (single screen), port depth 510 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R55i-1. Time-series plots of field parameters monitored during purging of R-55i (single screen)

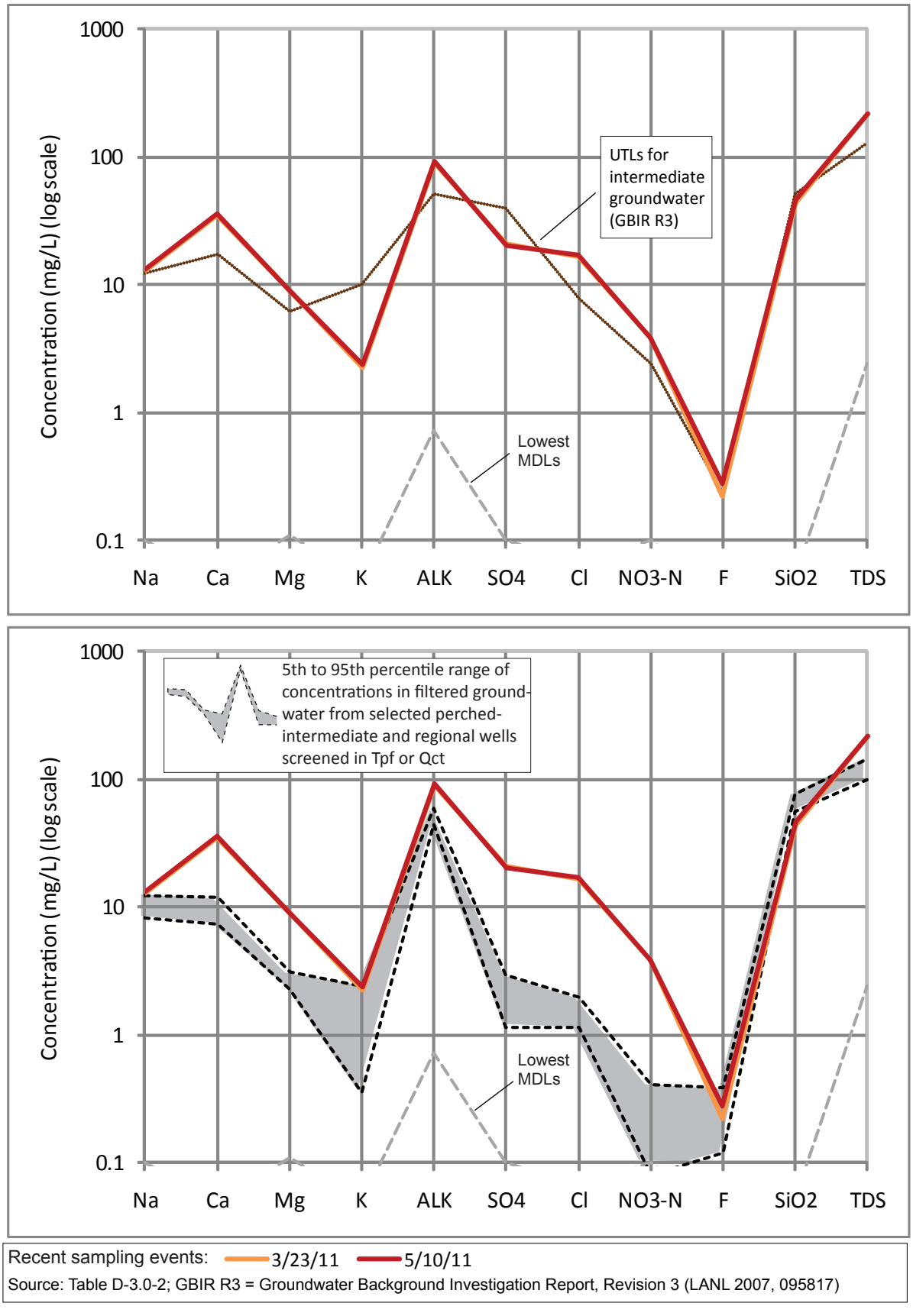


Figure D2-R-55i-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-55i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

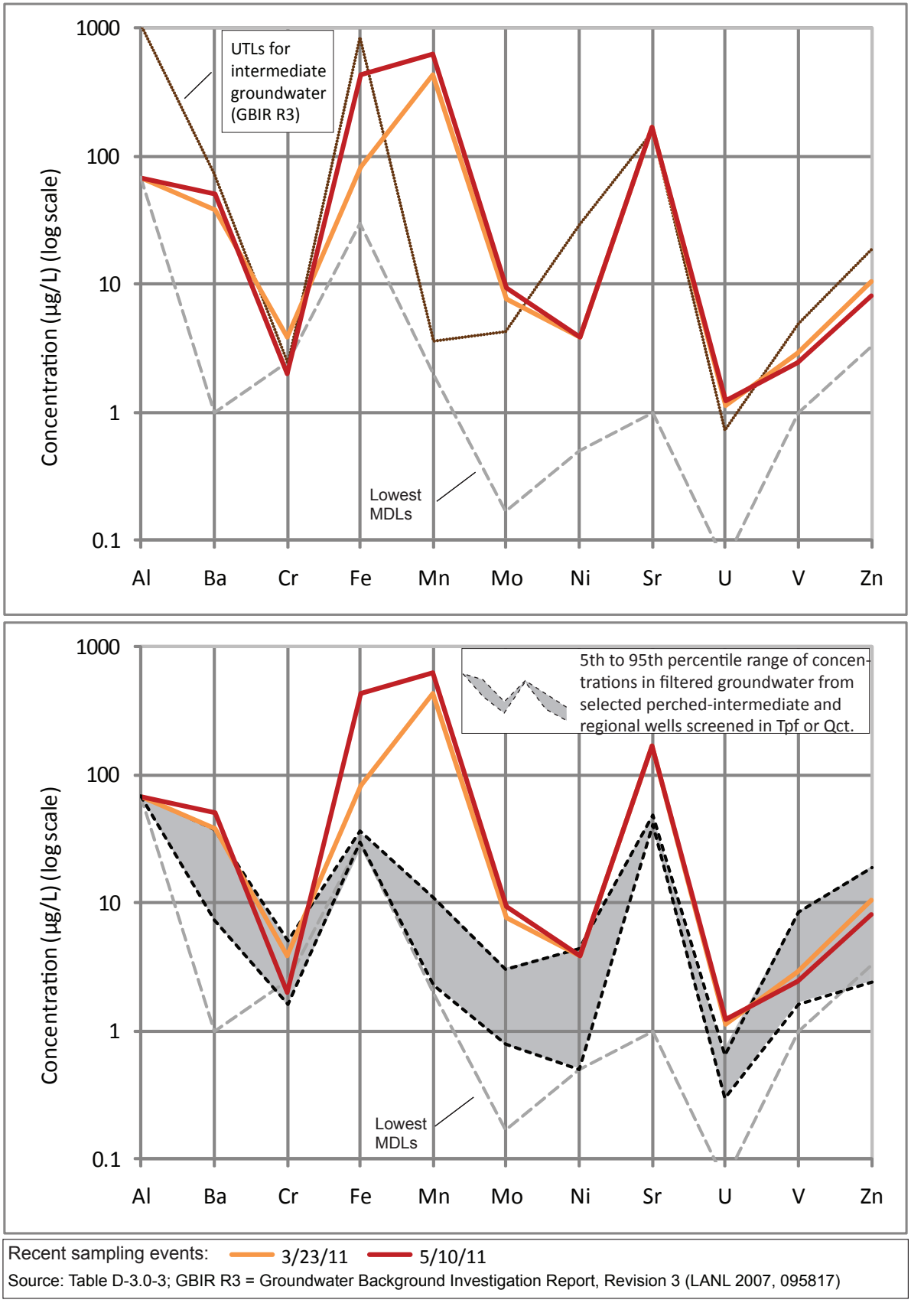


Figure D2-R55i-3. Concentrations of trace metals in filtered groundwater from well R-55i screen 1 for recent sampling events. Upper graph shows UTLs for intermediate groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-55 screen 1 (port P1A), port depth 860 ft bgs

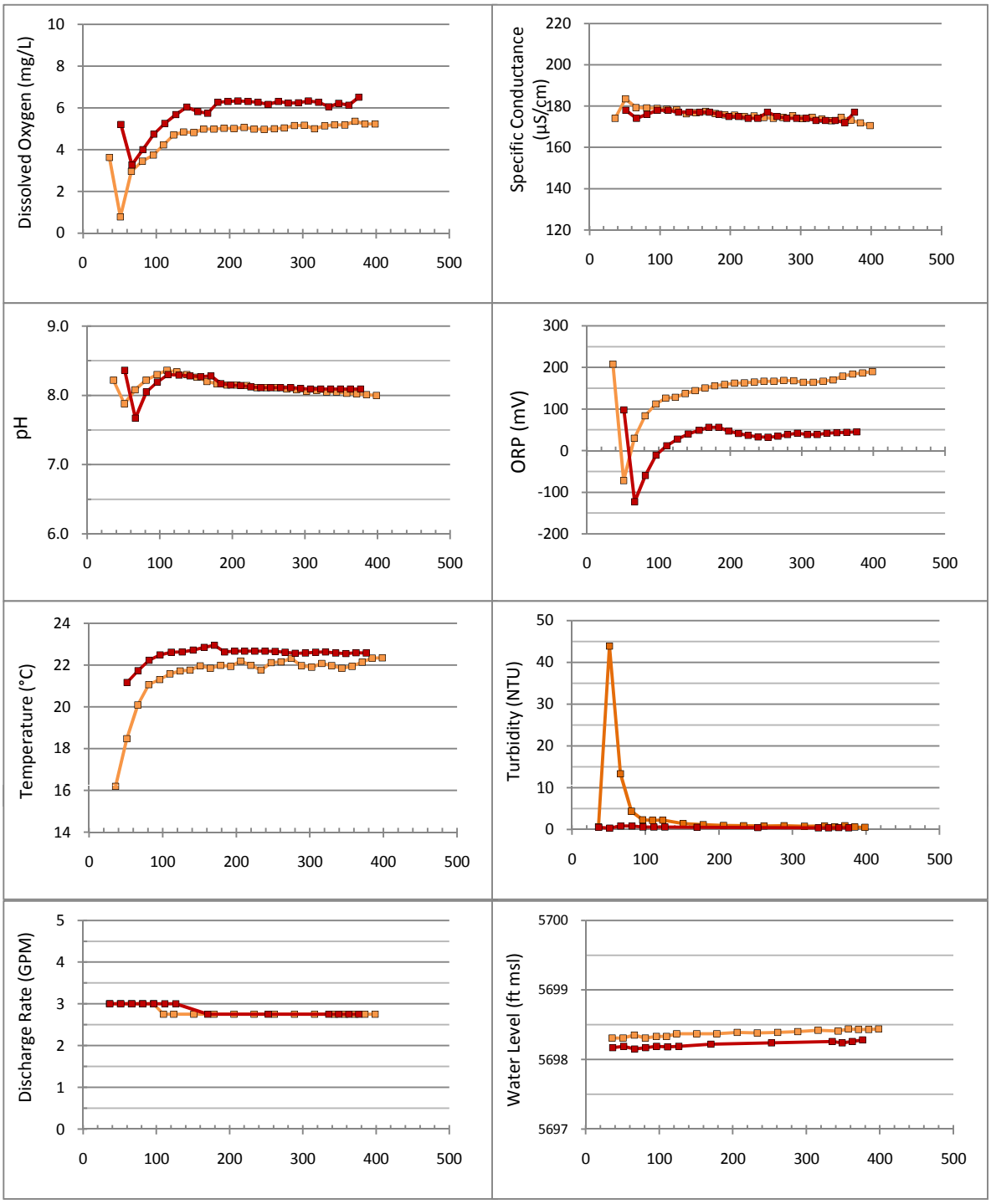


Figure D2-R55-1. **Time-series plots of field parameters monitored during purging of R-55 screen 1 (port P1A)**

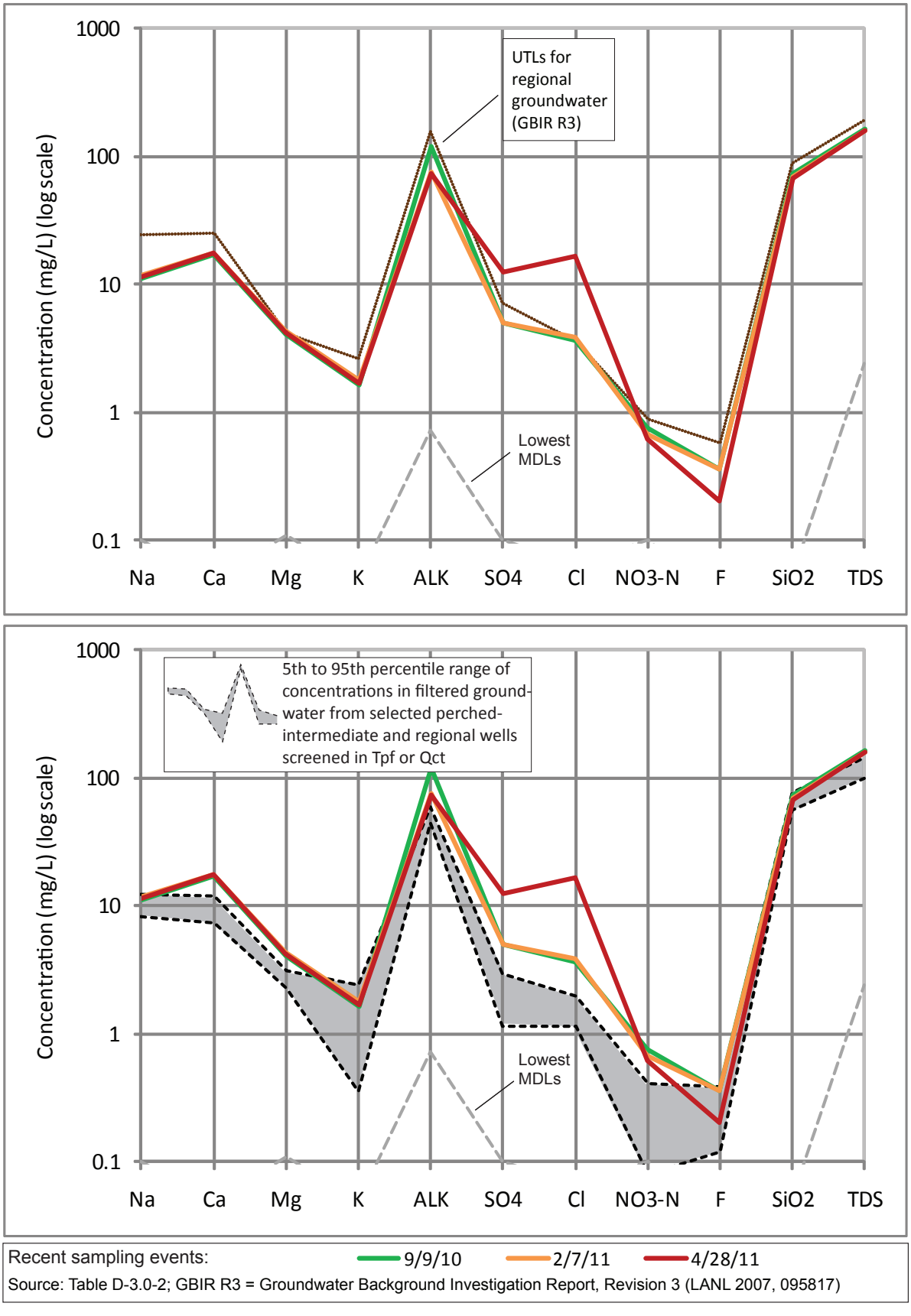


Figure D2-R55-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-55 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

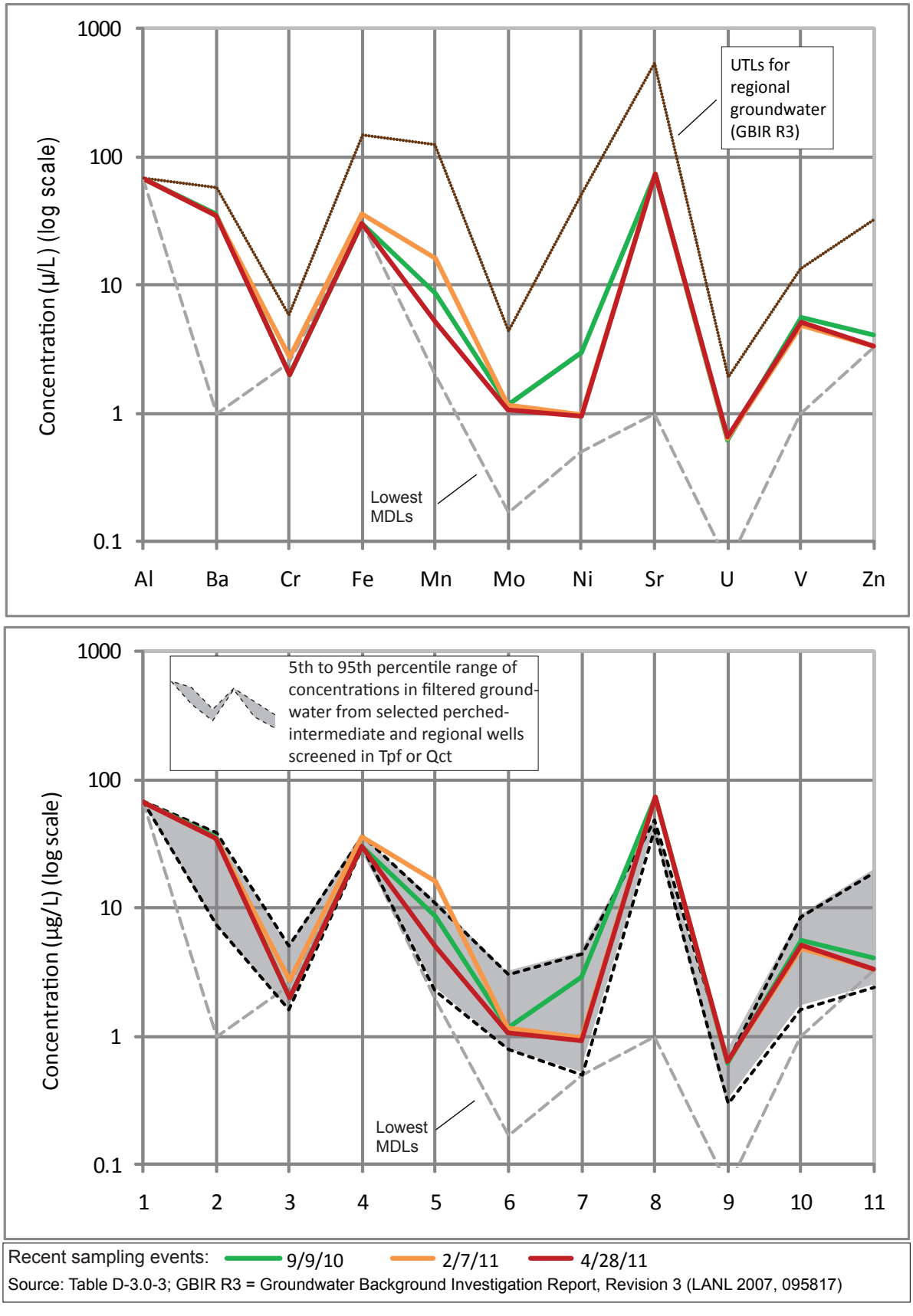
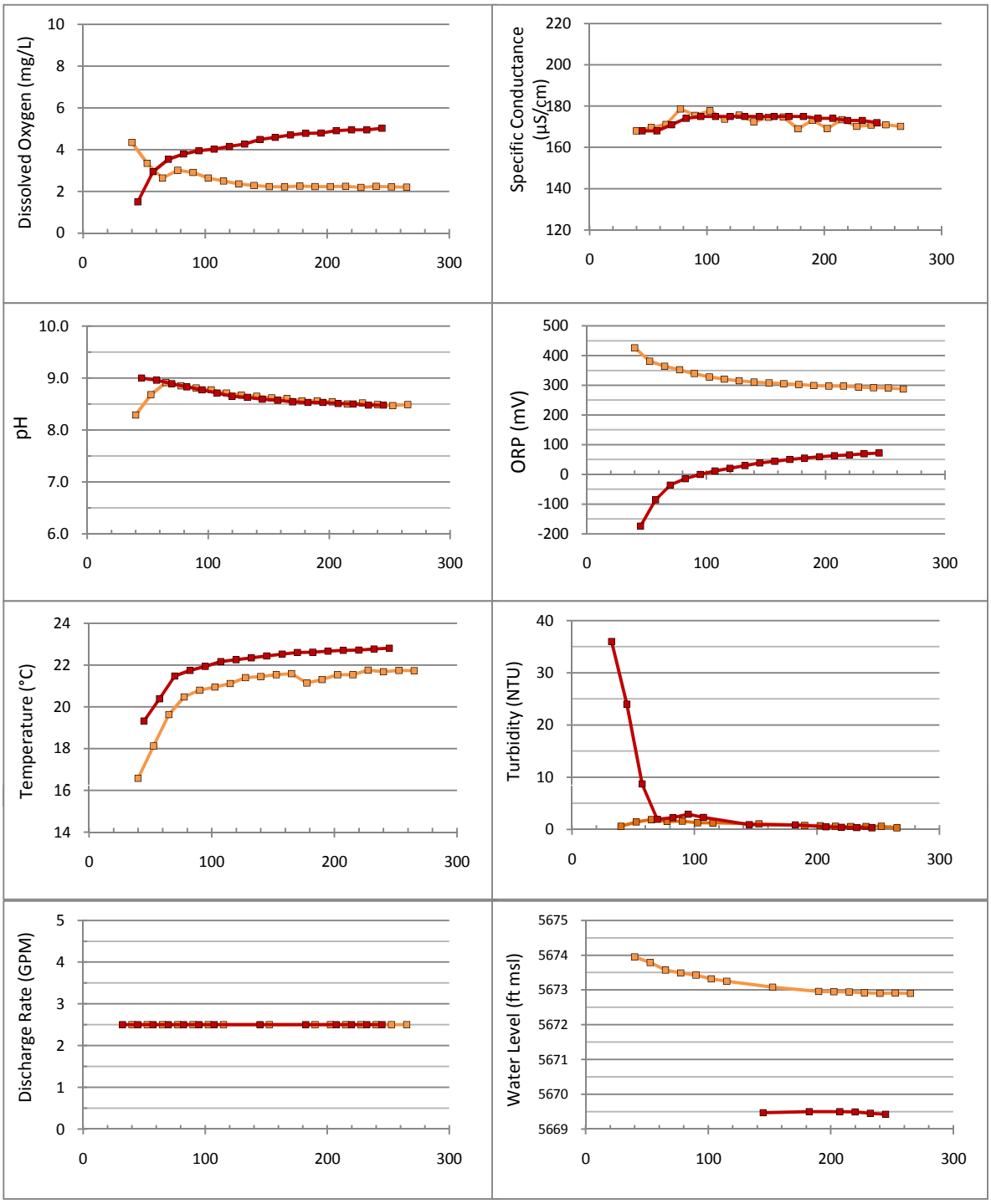


Figure D2-R55-3. Concentrations of trace metals in filtered groundwater from well R-55 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-55 screen 2 (port P2A), port depth 994 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R55-4. **Time-series plots of field parameters monitored during purging of R-55 screen 2 (port P2A)**

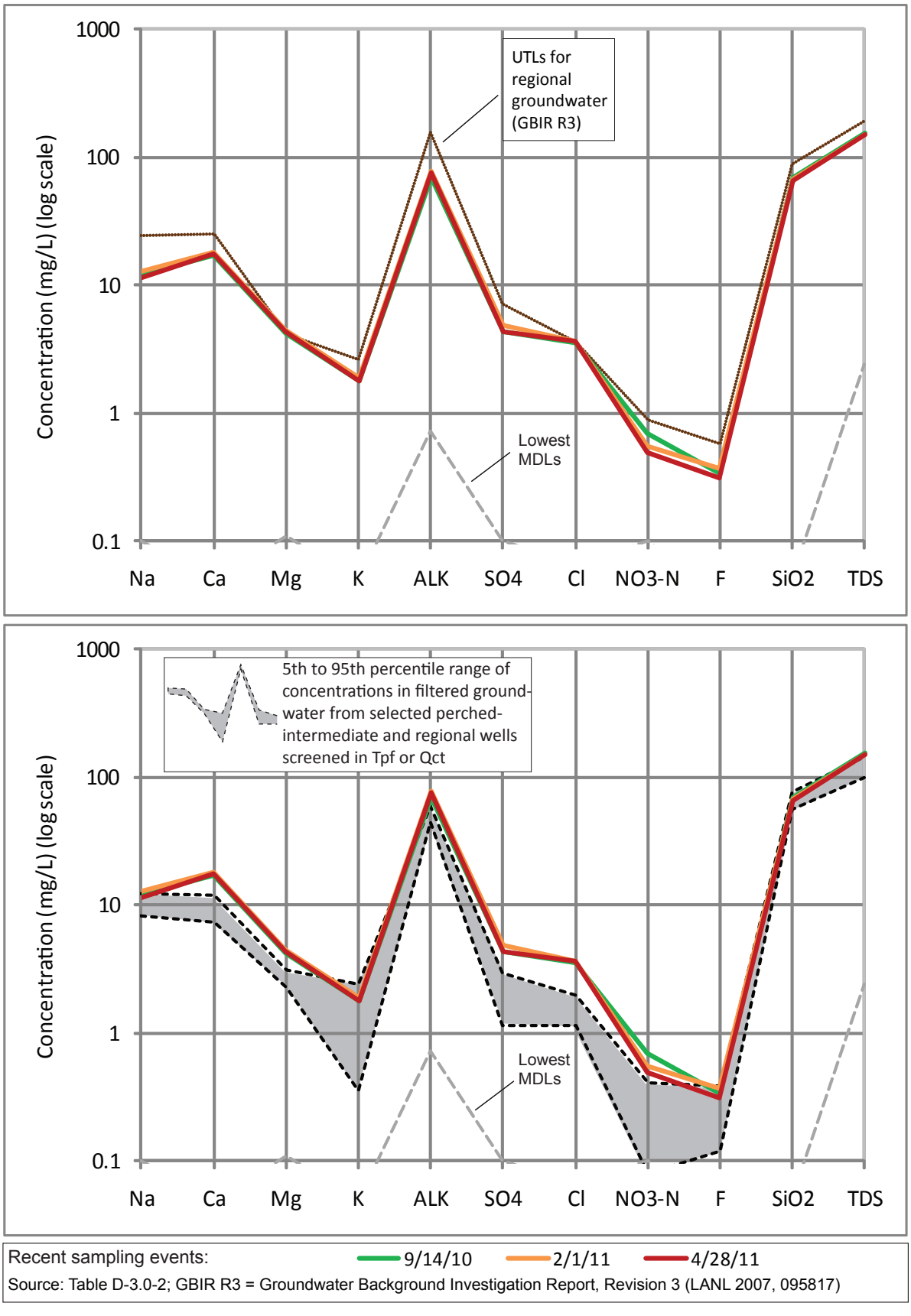


Figure D2-R55-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-55 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

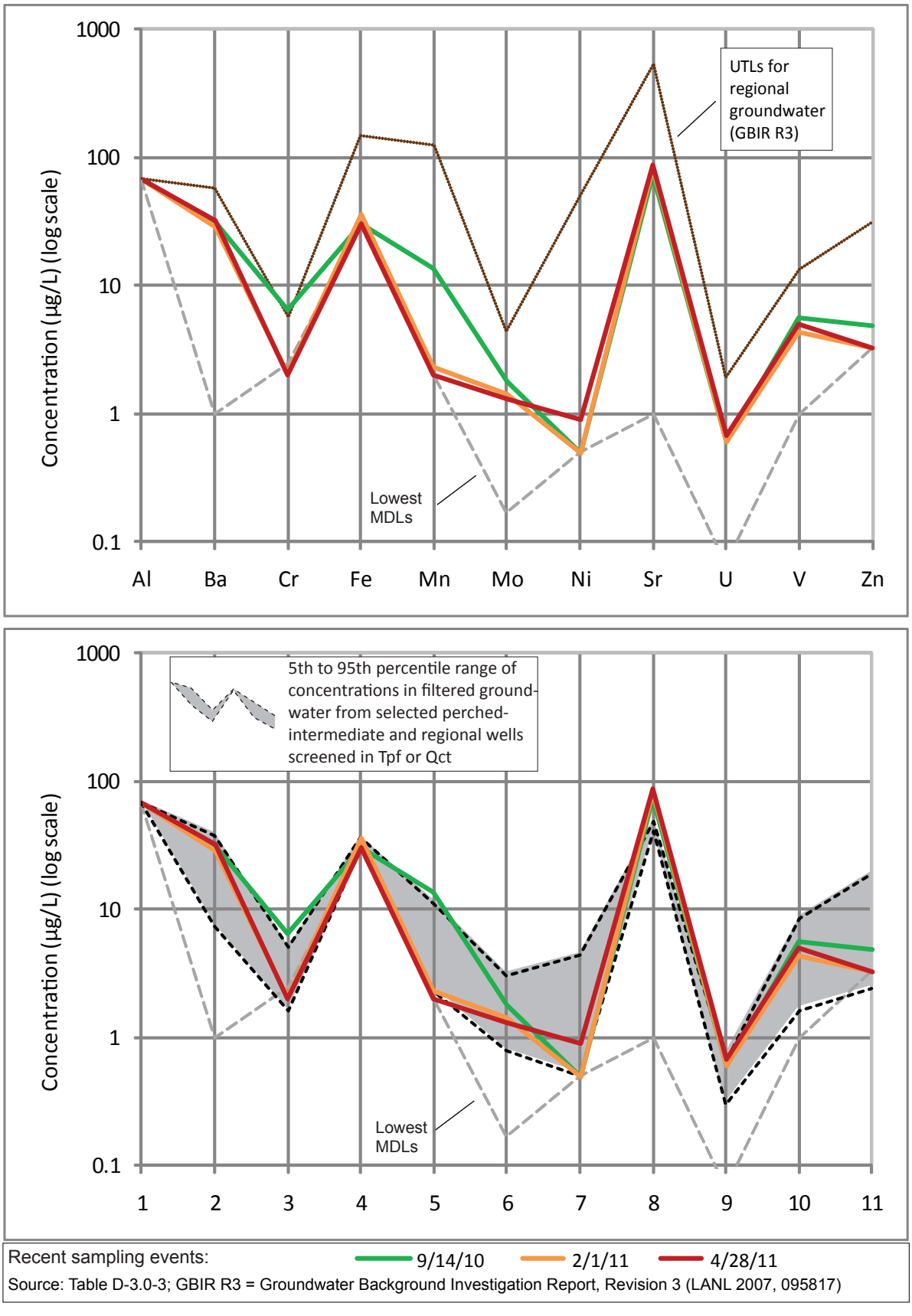
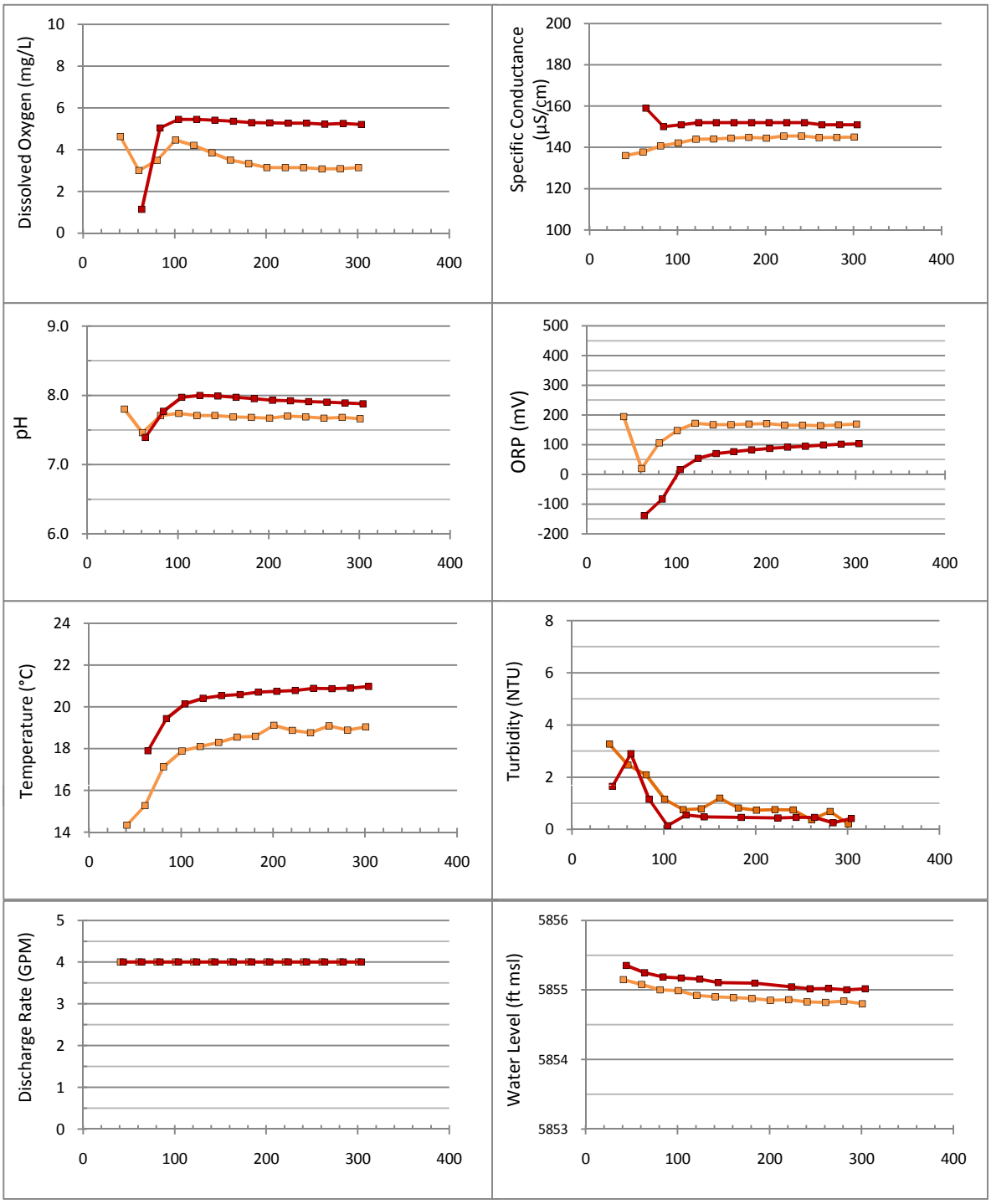


Figure D2-R55-6. Concentrations of trace metals in filtered groundwater from well R-55 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-56 screen 1 (port P1A), port depth 945 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R56-1. **Time-series plots of field parameters monitored during purging of R-56 screen 1 (port P1A)**

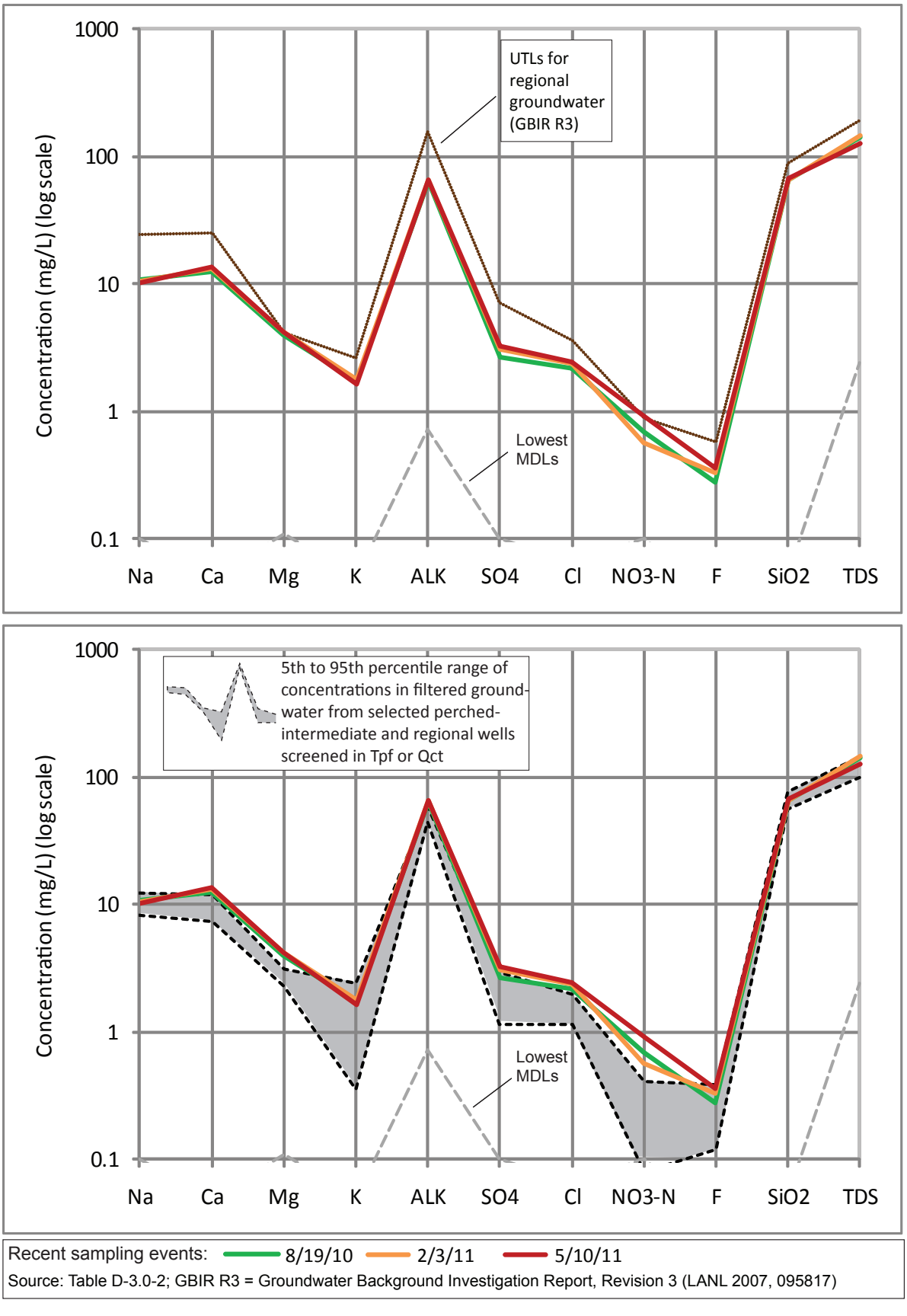


Figure D2-R56-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-56 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

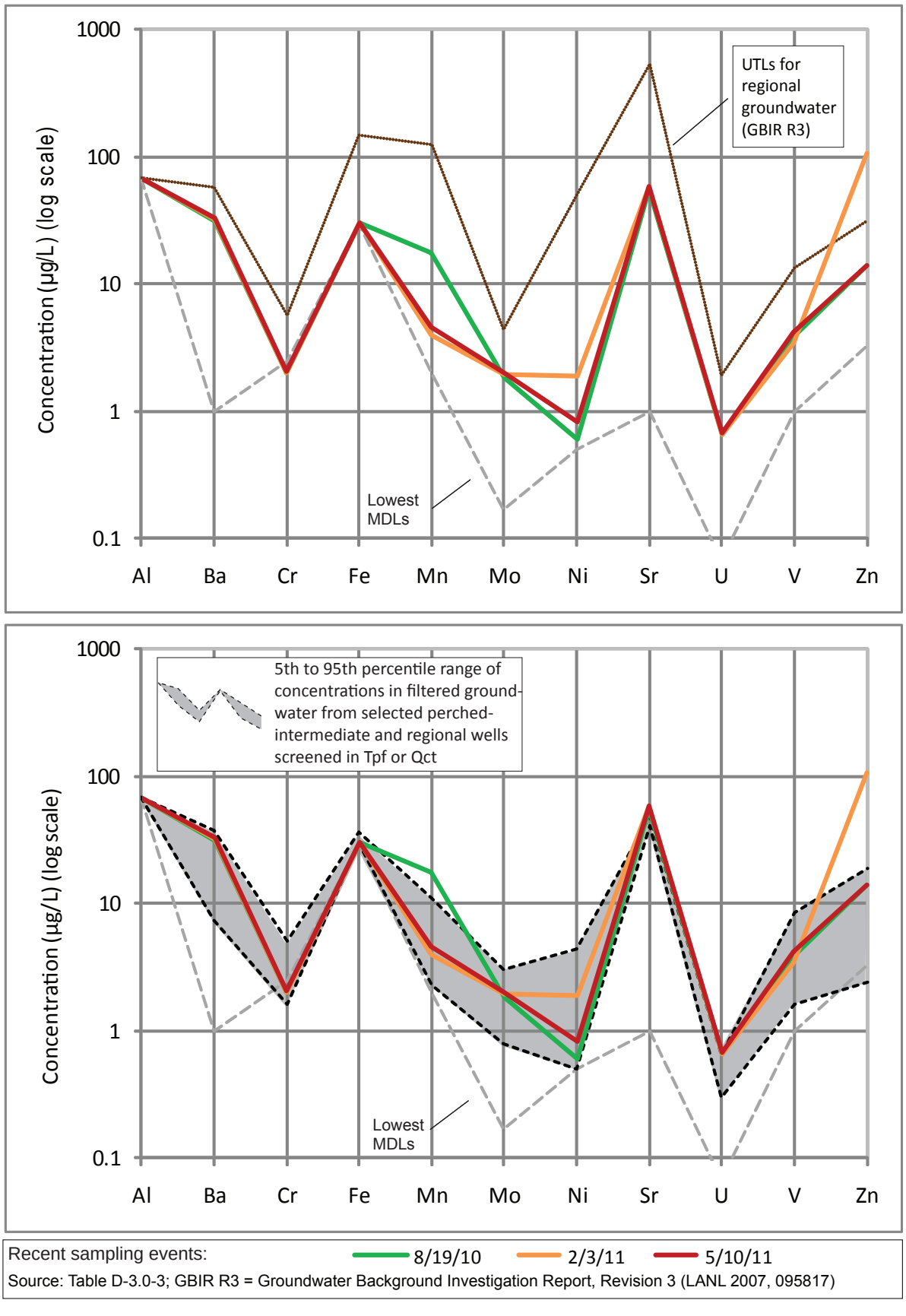


Figure D2-R56-3. Concentrations of trace metals in filtered groundwater from well R-56 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-56 screen 2 (port P2A), port depth 1047 ft bgs

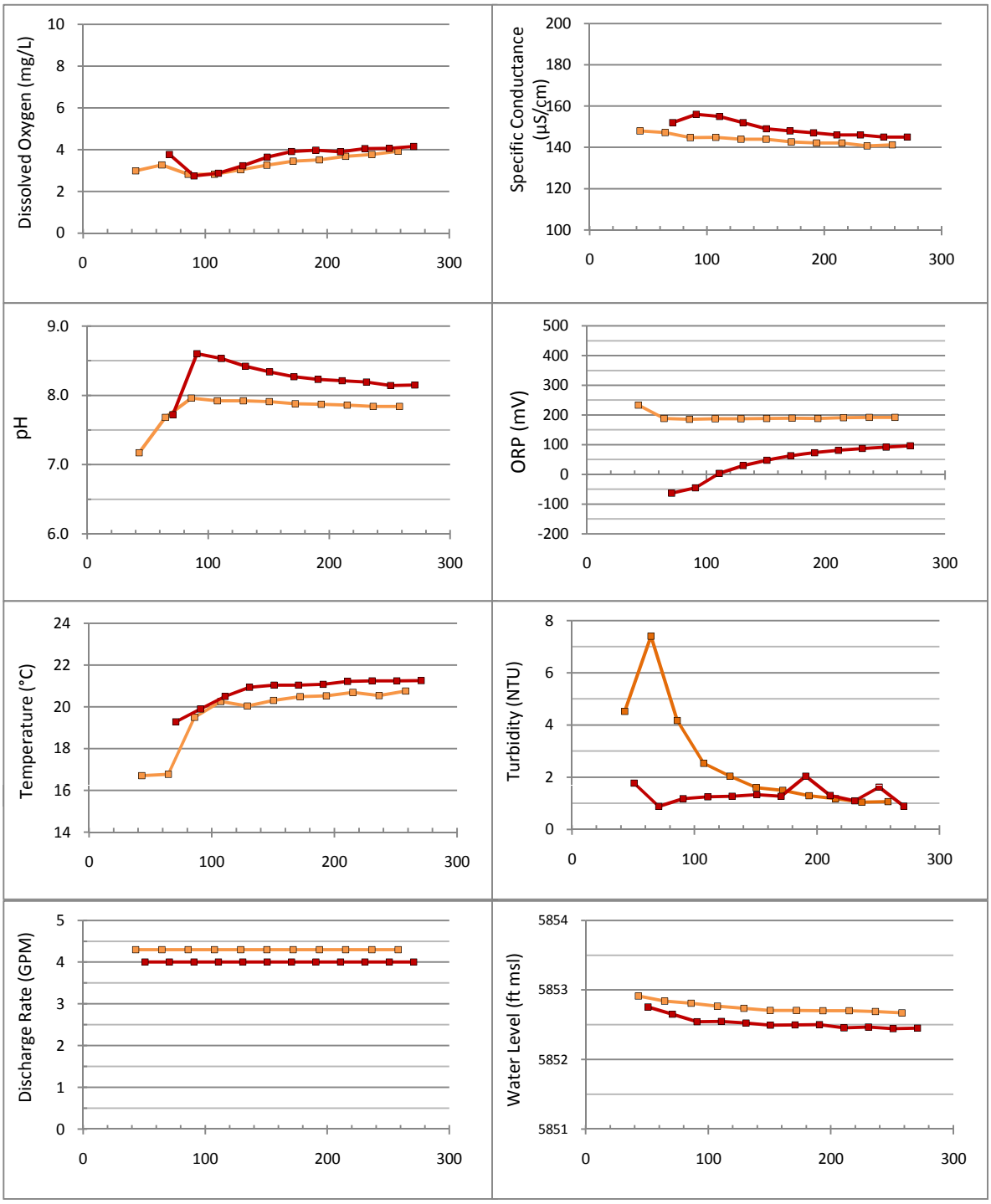


Figure D2-R56-4. **Time-series plots of field parameters monitored during purging of R-56 screen 2 (port P2A)**

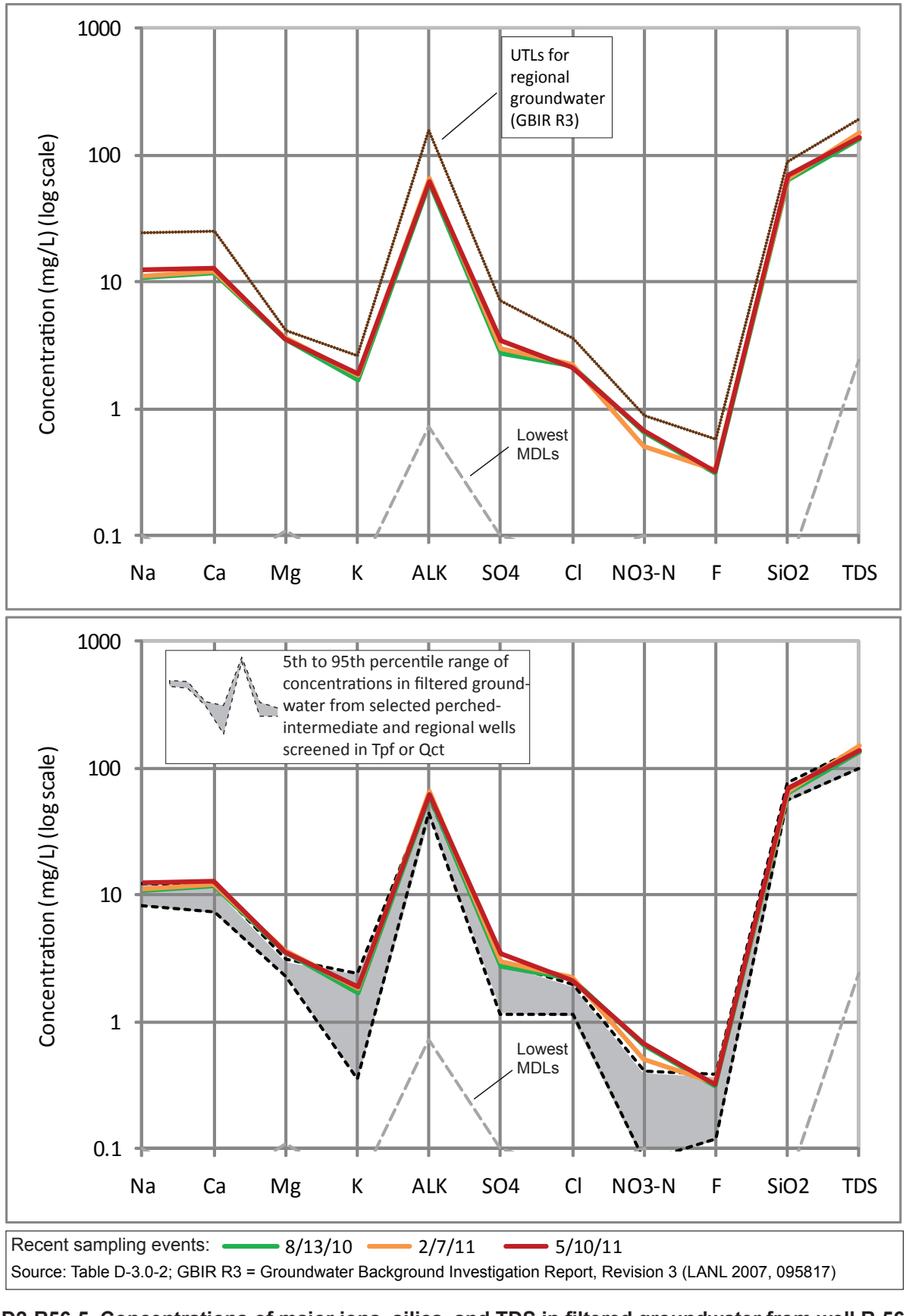


Figure D2-R56-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-56 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011,201564).

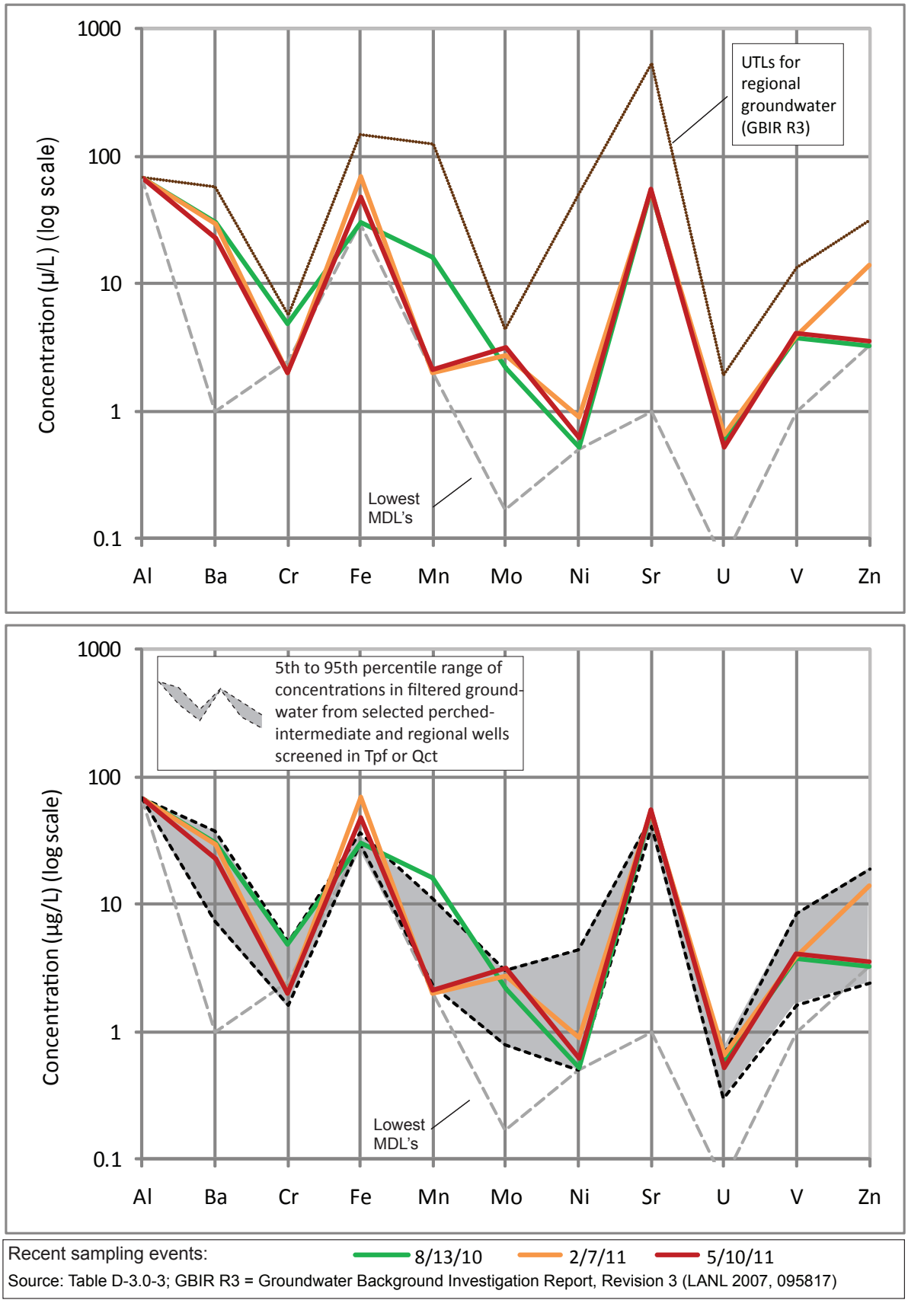
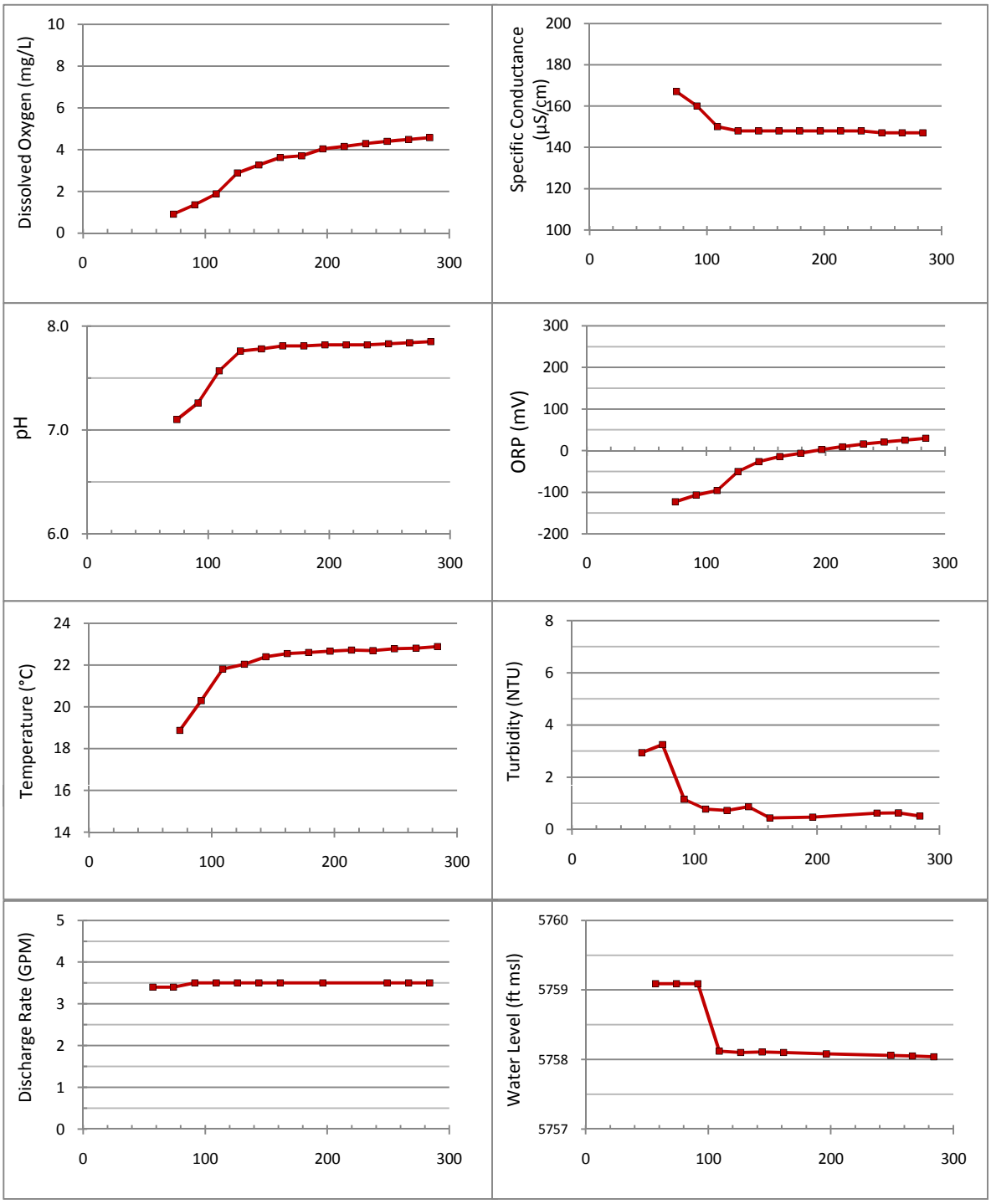


Figure D2-R56-6. Concentrations of trace metals in filtered groundwater from well R-56 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-57 screen 1 (port P1A), port depth 910 ft bgs



x-axis = cumulative volume purged (gals.), including drop pipe

Figure D2-R57-1. Time-series plots of field parameters monitored during purging of R-57 screen 1 (port P1A)

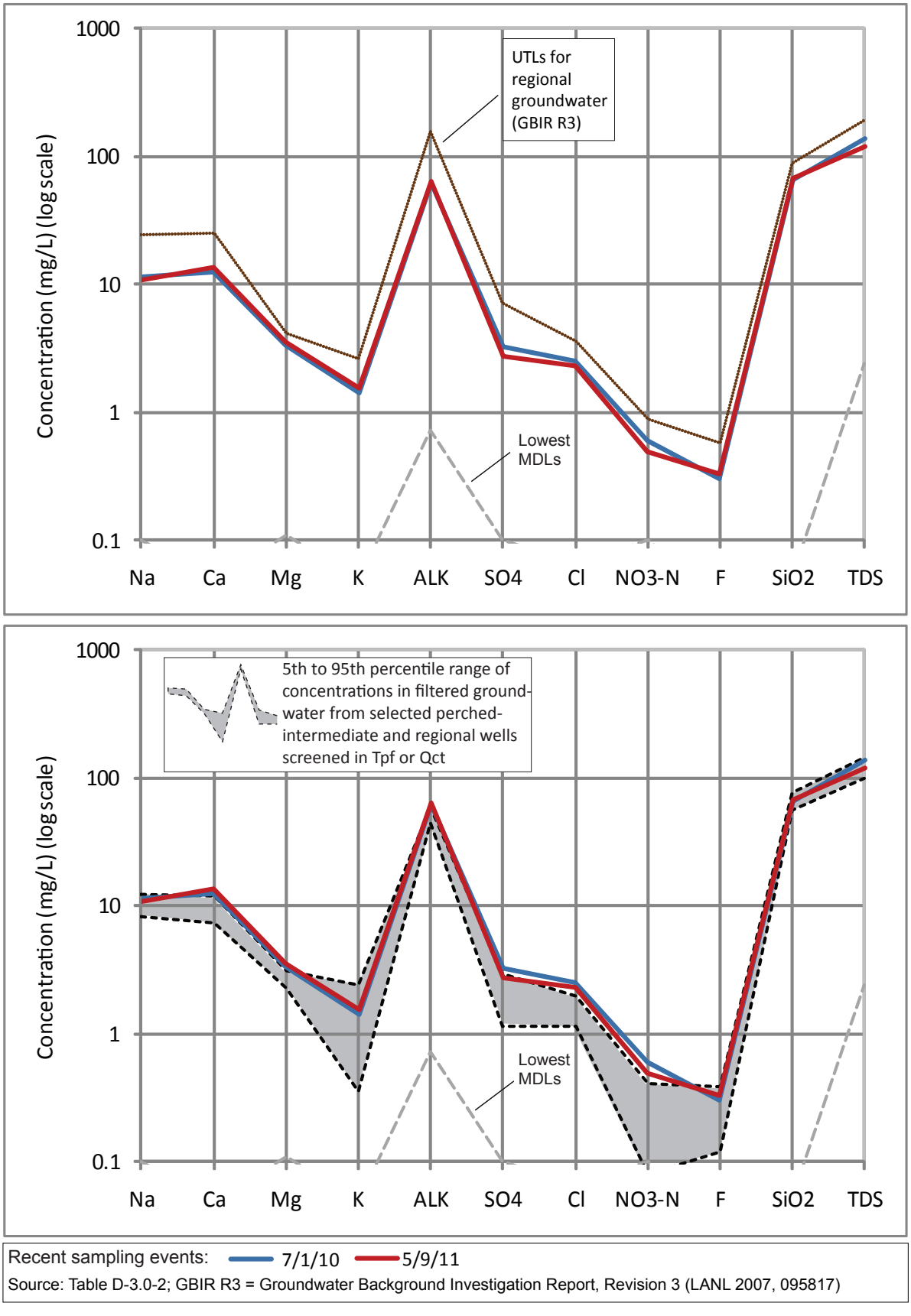


Figure D2-R57-2. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-57 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

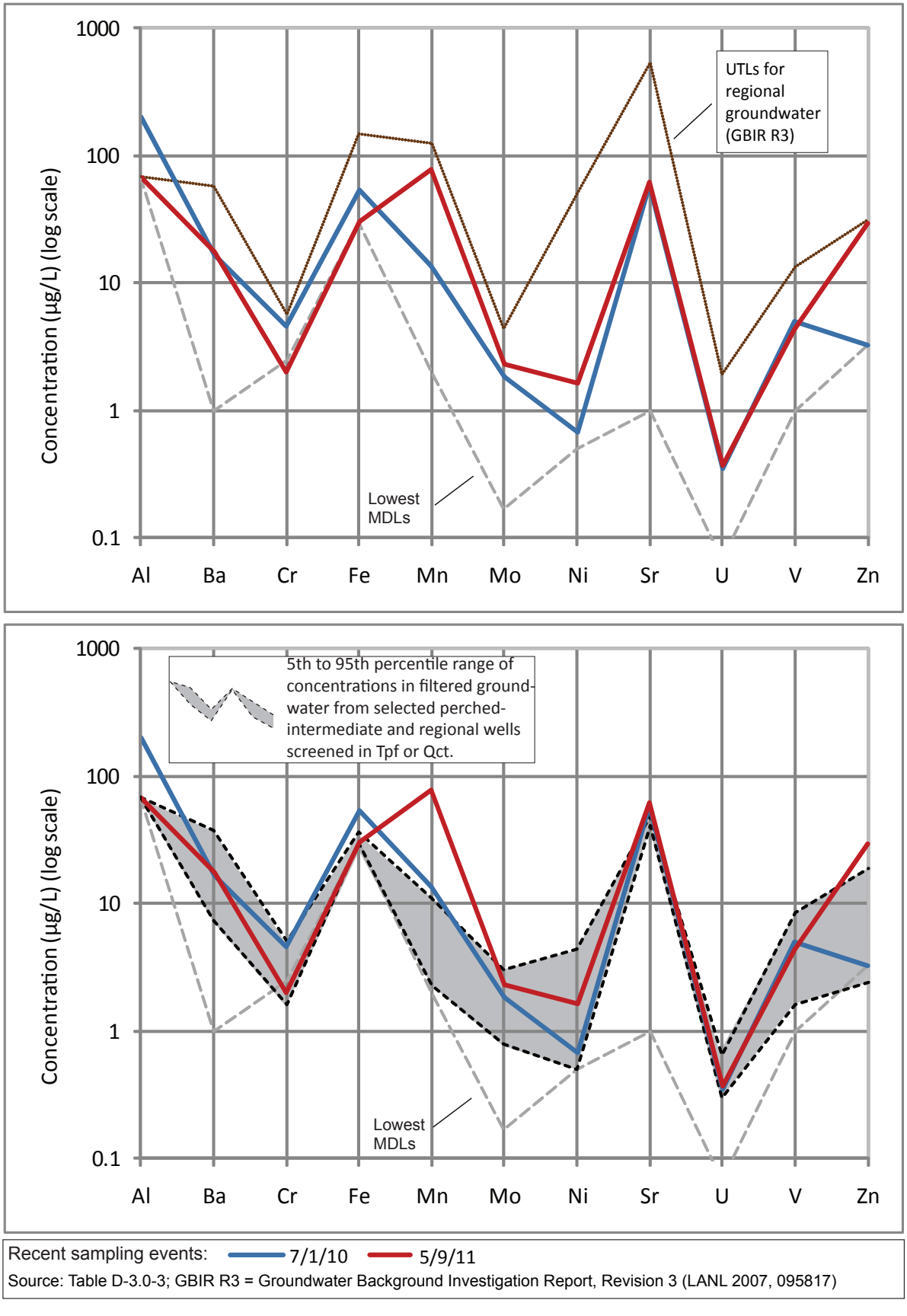


Figure D2-R57-3. Concentrations of trace metals in filtered groundwater from well R-57 screen 1 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

R-57 screen 2 (port P2A), port depth 972 ft bgs

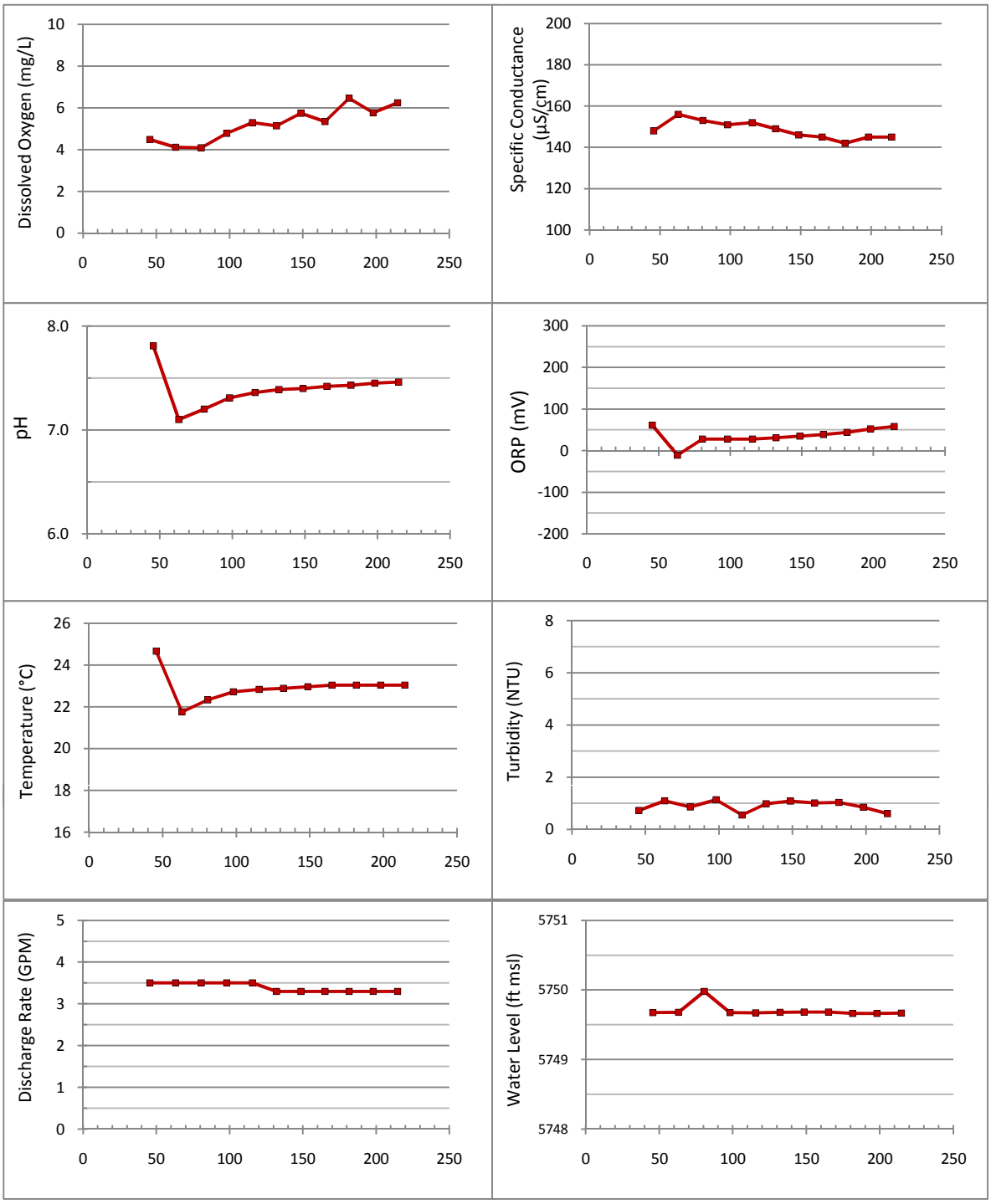


Figure D2-R57-4. Time-series plots of field parameters monitored during purging of R-57 screen 2 (port P2A)

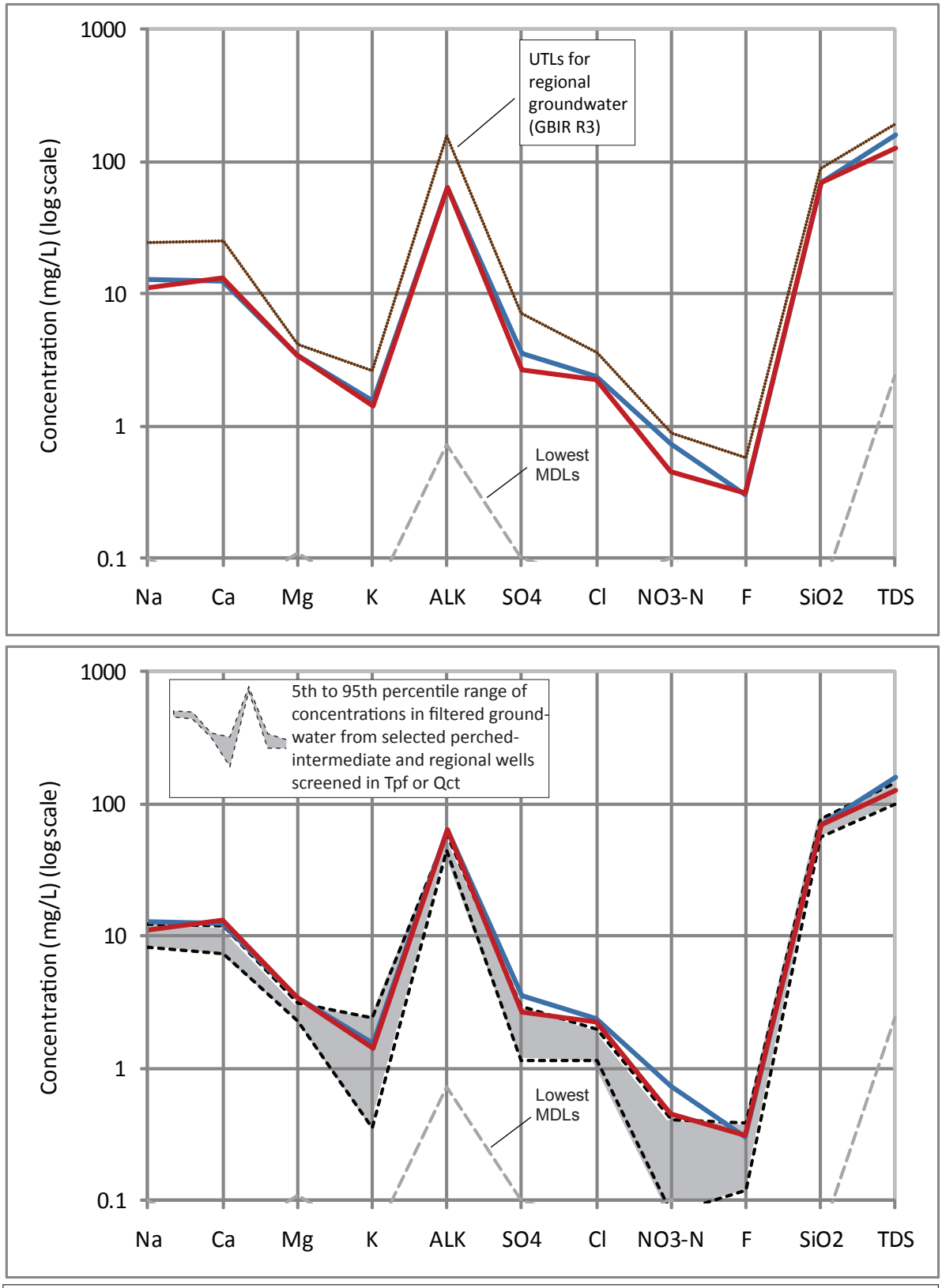


Figure D2-R57-5. Concentrations of major ions, silica, and TDS in filtered groundwater from well R-57 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background"values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

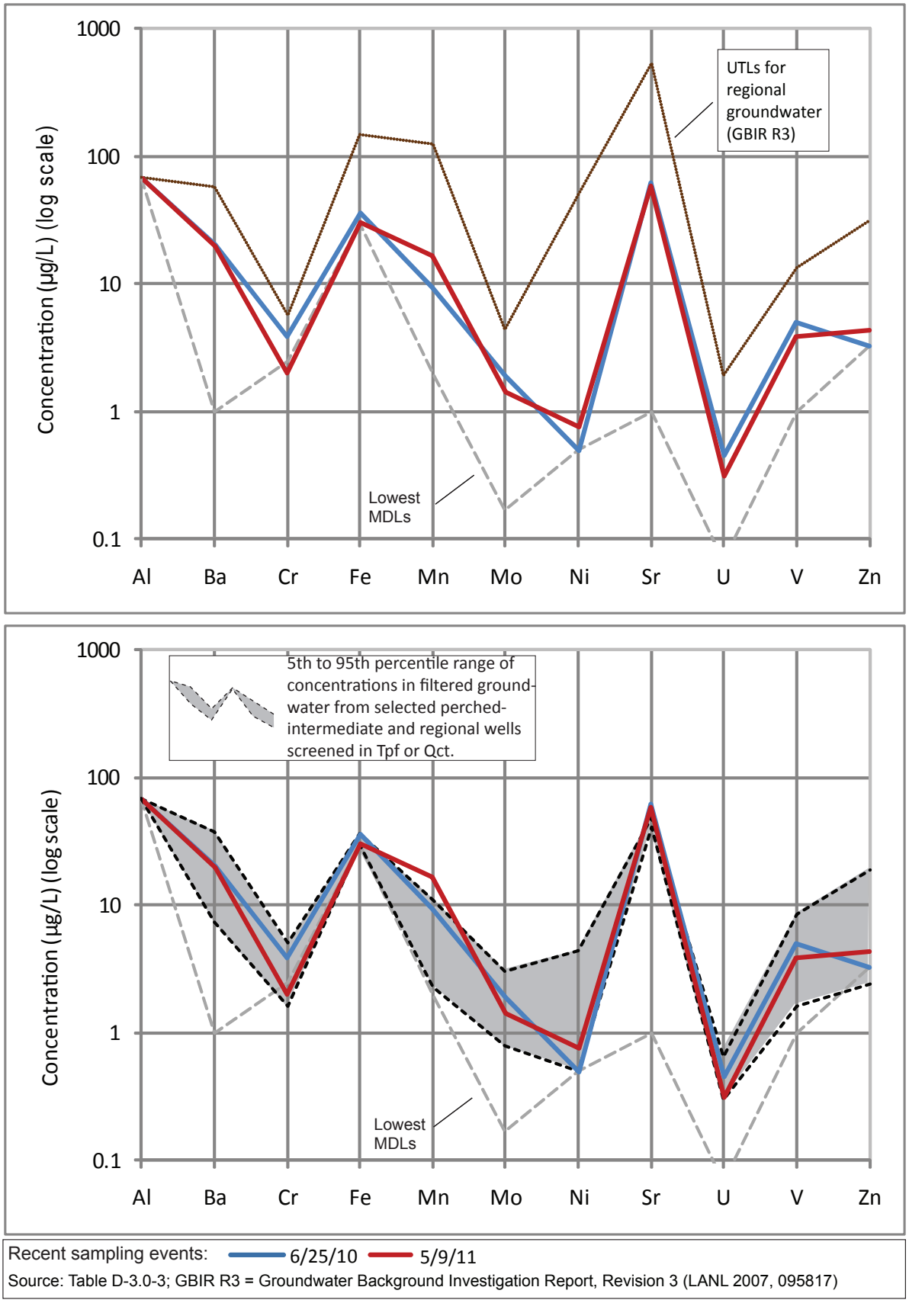


Figure D2-R57-6. Concentrations of trace metals in filtered groundwater from well R-57 screen 2 for recent sampling events. Upper graph shows UTLs for regional groundwater; lower graph shows "background" values for wells screened in Tpf (Puye Formation) or Qct (Cerro Toledo Formation) (LANL 2011, 201564).

Appendix E

Technical Area 54 Geology and
Material Disposal Area G Regional Aquifer Hydrology

E-1.0 INTRODUCTION

This appendix discusses the sitewide geology and hydrology of Technical Area 54 (TA-54). 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) G (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 (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 due to 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 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) thick 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-2.1-8, 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, E-2.1-7, 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 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 et al. 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 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 a foot [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 as exist next to MDA G (Broxton and Eller 1995, 058207; Reneau and Raymond 1995, 054709). Larger setbacks were recommended adjacent 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 G, the regional water-table elevation is approximately 5810 ft above mean sea level (amsl) or approximately 900 ft (300 m) below the ground surface.

As with the conditions observed elsewhere beneath the Pajarito Plateau, the regional aquifer beneath MDA G 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 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 Monitoring Wells near MDA G

Information about the hydrogeological properties of the regional aquifer can be obtained by analysis of the ambient water-level transients and pumping drawdowns observed at the monitoring wells near MDA G. 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 analysis evaluating monitoring well capabilities to characterize regional groundwater flow and to detect potential contaminants originating from MDA G. Drawdown data are collected during the pumping tests (up to 24-hours 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 the water-supply pumping effect is computationally intensive but allows for a cost-effective estimation of the effective large-scale properties of the aquifer(Harp and Vesselinov 2010, 111220).

Hydrogeologic information obtained from the intermediate and regional monitoring wells near MDA G (R-56, R-21, R-32, R-49, R-57, R-22, R-39, R-41, R-55, R-55i, R-23, and R-23i) is summarized below and in Tables E-3.1-1, E-3.1-2, E-3.1 3, and E-3.1-4.

Monitoring Wells

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 to 965.6 ft below ground surface (bgs). Screen 2 is 20.5 ft long and is positioned about 76 ft beneath screen 1, extending from 1046.6 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; 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 within the overlying Cerros del Rio lavas (Tb4). Therefore at this well location, the regional water table is located 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-3.1-1 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 NNW 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 suggests 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 (due to 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. Due to 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 that 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-21

R-21 is a single screen monitoring well; the screen length is 18 ft from 5750 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 due to 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 was on the order of 0.02 (about 2 ft head difference over 100 ft separation distance; Table E-3.1-3). Due to 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.

Screen 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 that 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, 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 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 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).

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).

R-49

Well R-49 is drilled through Cerros del Rio lavas and into underlying Totavi sediments; the contact between the lavas and riverine sediments is at 897 ft bgs. Screen 1 is 10 ft long and is set between the depths of 845 and 855 ft bgs in dacitic lava breccia. Screen 2 is 20.8 ft long and is set from 905.6 to 926.4 ft bgs in Totavi coarse-grained sedimentary deposits.

The composite water level in R-49 was 832.14 ft bgs during well installation. After the screens were isolated with packers, the screen 1 water level rose 22.64 ft to 809.50 ft bgs (5775.04 ft amsl), and the screen 2 water level dropped 0.83 ft to 832.97 ft bgs (5751.57 ft amsl). The head difference of 23.47 ft over an approximate 55-ft vertical distance implies an aquitard occurs between the two screens. The vertical component of the hydraulic gradient at R-49 is on the order of 0.4 (Table E-3.1-3).

R-49 screen 1 pressures respond to barometric fluctuations with approximately 30% barometric efficiency and an 18-hour lag time (Table E-3.1-4). This suggests delayed propagation of the barometric fluctuations through the vadose zone. It also suggests that the upper screen is under phreatic conditions. R-49 screen 2 showed near 100% barometric efficiency; this suggests that the saturated zone is not connected with the atmosphere (it may be either confined or unconfined).

R-49 screen 1 produced 1.5 gpm for 1440 min with about 20 ft of drawdown (specific capacity of 0.075 gpm/ft). Pumping-test analysis produced hydraulic conductivity estimates of 0.7 ft/d.

R-49 screen 2 produced 23.4 gpm for 1440 min with about 7 ft of drawdown (specific capacity of 3.34 gpm/ft). Pumping-test analysis produced hydraulic conductivity estimates between 18 and 133 ft/d.

Pumping R-49 screen 2 caused a drawdown of 0.06 ft in screen 1. Model simulations suggested that for a range of upper zone storage coefficient values (10^{-4} to 10^{-2}), the corresponding aquitard leakance ranged from 1.4×10^{-4} to 3.1×10^{-3} 1/d, respectively.

Pumping R-49 screen 2 caused a drawdown of 0.06 ft in R-39 (1100 ft east of R-49). This drawdown response implies a transmissivity ranging between 100,000 and 400,000 gpd/ft (hydraulic conductivity from 133 to 533 ft/d), depending on the assumed value of the storage coefficient (10^{-4} to 10^{-2}).

Transients in water-level data at R-49 screen 1 show no apparent response to water-supply pumping. However, screen 2 does respond to water-supply pumping at PM-4 (Table E-3.1-2). Response to PM-2 pumping is expected as well, but PM-2 has not been actively used for water supply since R-49 was completed. Pumping at R-57 screen 2 induced small drawdown (0.1 to 0.2 ft) at R-49 screen 2.

R-41

R-41 is completed in Totavi silts, sands and gravels located below the Cerros del Rio basalts; the contact between the basalt and riverine deposits is 920 ft bgs. Screen 1 is dry; it is 9.7 ft long, extending from 928.0 to 937.7 ft bgs. Screen 1 was included in the well design to assure that the top of the aquifer could be monitored in the event the water table at R-41 was similar to that at nearby well R-22; following well installation, the water level at R-41 screen 2 has remained lower than R-22 screen 1. Screen 2 is also 9.7 ft long from 965.3 to 975 ft bgs. The water level measured in screen 2 is 960.37 ft bgs. The regional water table is less than 5 ft above screen 2. The filter pack outside screen 2 extends above the water table. Hydraulic conductivity is estimated to be 3 ft/d.

None of the screens in R-22 showed any response to pumping of R-41 screen 2. Barometric pressure response showed that R-41 screen 2 has a barometric efficiency near 100% (Table E-3.1-4), suggesting that the screen is pneumatically isolated from the atmosphere. The screen is unconfined because it straddles the regional water table..

R-41 aquifer test data showed an increase in the time-drawdown slope rather than the flattening normally seen during the pumping tests in the regional aquifer near MDA G. This suggests that the screened interval is not well connected to the deeper aquifer sediments. Additional analyses of the pumping test data suggest significant groundwater flow during pumping from zones near the regional water table and above the pumped screen, behind the blank casing.

Transients in the R-41 screen 2 water-level data do not show an apparent response to water-supply pumping.

R-57

R-57 is a replacement well for R-22 (see below). R-57 screen 1 lies within dacitic lavas of the Cerros del Rio volcanic series. Screen 1 is 20.5 ft long, extending from 910 to 930.5 ft (bgs). Screen 2 is completed within riverine sands and gravels of the Totavi Lentil. Screen 2 is 20.6 ft long, placed from 971.5 to 992.1 ft bgs. The composite head was 896.67 ft bgs (5750.33 ft amsl) during well completion. When packers isolated the screen zones, the water level in screen 1 rose 7.16 ft (889.51 ft bgs; 5757.49 ft amsl), and the water level in screen 2 declined 1.11 ft (897.78 ft bgs; 5749.22 ft amsl). The head difference of 8.27 ft over an approximate 40-ft vertical distance implies a hydraulically resistive zone between the two screens. The vertical component of the hydraulic gradient is approximately 0.2 (Table E-3.1-3). Pumping either screen had no observable effect on the other, which confirms hydraulic disconnection between the two screens. No specific aquitards are identified in the saturated interval penetrated by R-57; possibly the hydraulic disconnection is caused by poor vertical connection of fractures in the dacite lava to the underlying sediments or silt-rich sediments (for example, soil horizons) at the contact between the dacite and the Totavi Lentil. It is assumed that the thickness of the upper zone is 60 ft from the water level of 889.51 ft bgs to the basal contact of the dacite at 950 ft. The thickness of the lower zone may be more than 100 ft thick.

R-57 screen 1 pressures respond to barometric fluctuations with approximately 40% barometric efficiency and a 19-hour lag time (Table E-3.1-4). This suggests delayed propagation of the barometric fluctuations through the vadose zone or through fractures in the basalt. It also suggests that the upper screen is under phreatic conditions. R-57 screen 2 showed near 100% barometric efficiency; this suggests that the saturated zone is not connected with the atmosphere (it may be either confined or unconfined).

Pumping R-57 screen 1 at 7.1 gpm for 1438 min with 3.27 ft of drawdown (specific capacity of 2.17 gpm/ft) had no discernable effect on water levels at R-39, R-41 screen 2, or R-49 screens 1 and 2. Pumping screen 2 at 16.5 gpm for 1440 min with 1.67 ft of drawdown (specific capacity of 9.9 gpm/ft) had no effect on water levels at the upper R-57 screen, R-41 screen 2, or R-49 screen 1, but it induced 0.1 to 0.2 ft of drawdown in R-39 and R-49 screen 2.

Analysis of the screen 1 pumping tests shows an average hydraulic conductivity value of 10.4 ft/d. The pumping-test data suggest dual-porosity characteristics suggesting prominent bedrock fracture effects – either classical dual-porosity effects or a major void that was dewatered during testing. Late drawdown and recovery data provided indirect evidence of the possibility of a nearby low-permeability boundary (this may be caused by pinching of the hydrostratigraphic unit, facies boundaries, or faults).

Analysis of the screen 2 pumping tests suggests a transmissivity of 19,200 gpd/ft for the screened interval or perhaps a somewhat greater thickness. This corresponds to an average hydraulic conductivity of about 125 ft/d or possibly less, depending on the sediment thickness represented by the computed transmissivity. Late drawdown and recovery water levels show significant flattening of the data curve, implying an overall transmissivity for the aquifer penetrated by screen 2 well in excess of 20,000 gpd/ft

Distance-drawdown analysis of the response to pumping R-57 screen 2 observed at R-39 and R-49 screen 2 suggests an area-wide aquifer transmissivity of 46,000 gpd/ft and an estimated storage coefficient of 3.3×10^{-4}.

Transients in the R-57 water-level data demonstrate that the 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 is expected as well, but PM-2 has not been actively used for water supply since R-57 was completed. The response to water-supply pumping is a very important observation. The water-level data collected at R-22, located 95 m east-southeast of R-57 (Figure E-2.1-1), did not demonstrate transients due to water-supply pumping at any of the R-22 regional aquifer screens for the 6.5-year period of continuous monitoring (see R-22 section below). The water levels at R-22 screens 1 and 2 in 2008 (5762 and 5754 ft, respectively) appear to be somewhat different from the current water level at R-57 screens 1 and 2 (5759 and 5750 ft, respectively).

R-22

R-22 has 5 screens. The upper 2 screens are located within Cerros del Rio basalts. Screens 3 and 5 are located within the Chamita Formation, and screen 4 is within Miocene basalt.

R-22 screens 1 and 2 show barometric efficiencies of 65% and 60%, respectively, with a lag time of about 24 hours (Table E-3.1-4). The barometric efficiency of these screens suggests that saturated zones are under unconfined or partially confined aquifer conditions. R-22 screens 3, 4 and 5 are nearly 100% barometrically efficient and are expected to be confined.

Transients in the water-level data demonstrate that water levels at R-22 are not impacted by water-supply pumping at PM-2 and PM-4. This observation is in sharp contrast to the pumping response observed at R-57 and R-49 (see above). Based on the existing hydrogeological information, a response to the water-supply pumping is expected in the deep screens of R-22 because PM-2 and PM-4 pumping produces

drawdowns in wells located at distances similar to R-22, but located to the north of the water supply wells. Therefore either (1) there are technical problems with the pressure data collected at R-22 (R-22 is located 95 m east-southeast of R-57), or (2) there is a pronounced hydrogeological barrier between R-57 and R-22 that prevents the propagation of the pumping drawdowns to R-22.

R-57 (see above) was drilled as a replacement well for R-22. It has two screens that are at elevations similar to the upper two screens at R-22. Currently, the R-22 water levels are not monitored because the transducers were removed during well rehabilitation and not reinstalled. A final decision for the disposition of R-22 is pending.

R-39

R-39 is completed in the regional aquifer in volcanic sediments just below the base of the Cerros del Rio lavas. The well screen is 10 ft long, between 859.0 and 869.0 ft bgs. The upper half of the well screen is within the base of dacite lavas of the Cerros del Rio volcanic series, and the bottom half extends into underlying unconsolidated volcanic sediments. The water level is 32.3 ft above the top of the screen. The overlying low-permeable lava might be expected to cause confined conditions. However, water-level data from R-39 showed a barometric efficiency of about 55% with a lag time of about 18 hours (Table E-3.1-4), suggesting the aquifer is under phreatic (unconfined) conditions.

Pumping R-39 at 1.7 gpm for 24 hours produced about 18 ft drawdown. Hydraulic conductivity is estimated to be approximately 1 ft/d. The water-level data collected during a single-screen pumping test demonstrated late-time reduction of the pumping drawdown. This drawdown behavior may be due to 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 lava), (3) three-dimensional flow (partial penetration well) effects, (4) or combinations of the above. Therefore, the pumping-test drawdown data suggest that the pumping of R-39 drains groundwater from the overlaying lavas.

Pumping at R-39 did not cause discernable drawdown in the upper screens at R-22 (about 700 ft to the north). Drawdown was expected at R-22 based on the existing hydrogeologic data. The lack of drawdown may be an indication of aquifer complexity (leaky aquifer, laterally changing volcanic geology, faulting, or other factors providing effectively hydraulic separation between the two wells). R-22 upper well screens are in basaltic lavas, and the R-39 well screen is partly in dacite lava; this indicates the aquifer is laterally heterogeneous. It is important to note during air drilling of R-39, there was a response observed in R-22 screen 2 (a 0.2-foot magnitude head rise and decline). The R-39 water level responds to the pumping from Totavi sediments at R-49 screen 2 and R-57 screen 2 (a replacement of R-22 screen 2); these responses indicate Puye and Totavi aquifer sediments underlying the Cerros del Rio lavas are hydraulically connected in this area.

Transients in the R-39 water-level data show no apparent response to water-supply pumping from PM-4. PM-2 has not been actively used for water supply line since R-39 was installed. Pumping at R-57 screen 2 induced small drawdown (0.1 to 0.2 ft) at R-39.

R-55 and R-55i

Both screens at regional well R-55 lie within riverine sands and gravels. Screen 1 is set within the Totavi Lentil, and screen 2 is set in the underlying Chamita Formation. Screen 1 is 20.6 ft long (from 860.0 to 880.6 ft bgs), and screen 2 is 21.0 ft long and is positioned about 114 ft beneath screen 1 (from 994.4 to 1015.4 ft bgs).

The composite water level was 834.67 ft bgs (5699.19 ft amsl) when the well was installed. When the screen zones were isolated, the water level in screen 1 rose 0.11 ft (834.56 ft bgs; 5699.30 ft amsl), and the water level in screen 2 declined 2.66 ft (837.33 ft bgs; 5696.53 ft amsl). The water levels show a head difference of 2.77 ft over vertical distance of about 114 ft; the vertical component of the hydraulic gradient is approximately 0.03 (Table E-3.1-3). The significant head difference implies resistive sediments separating the two screen zones.

A comparison of barometric pressure and R-55 water-level data shows a high barometric efficiency, close to 100%, for each zone (Table E-3.1-4).

Pumping screen 1 at 17.4 gpm with 0.97 ft of drawdown (specific capacity of 17.9 gpm/ft) for 1438 min had no discernable effect on water levels in screen 2. It also had no effect on water levels monitored at R-23, R-39, R-41 and R-49. Analysis of the screen 1 pumping tests showed an average hydraulic conductivity value of 128 ft/d for the screened interval. Late-time drawdown/recovery curves flattened almost completely, consistent with partial penetration effects (vertical growth of the cone of depression) or leakage from highly transmissive overlying and/or underlying sediments and likely delayed yield of the unconfined aquifer.

Pumping screen 2 at 4.3 gpm with 40.1 ft of drawdown for 1440 min caused no effect on water levels monitored at R-23, R-39, R-41 and R-49. Pumping-test data suggest very low specific capacity (0.11 gpm/ft) and low effective hydraulic conductivity (0.3 ft/d).

Transients in the R-55 water-level data show no apparent response to the water-supply pumping, although the period of record is not sufficient for full analyses. Water-supply pumping responses are not expected based on data for other wells in the area.

R-55i is an intermediate monitoring well in lower Cañada del Buey adjacent to R-55. The well screen is an intermediate perched zone within unconsolidated sediments associated with basaltic lava flows of the Cerros del Rio basalts. The well was completed in January 18, 2011, and there is a short record of water-level data for this well. The existing 3-mo data record (March–June 2011) suggest that the water levels are relatively steady at about 6035.4 ft. There are potentially seasonal fluctuations in the observed water levels.

A comparison of barometric pressure and R-55i water-level data showed the water-level response to be delayed and highly muted with a barometric efficiency on the order of 40%; these analyses are still preliminary. The saturated perched zone was estimated to include 52 ft of permeable sediments from the perched water level at 498 ft to about 550 ft bgs. Analysis of the R-55i pumping tests showed the perched zone has relatively high permeability with average hydraulic conductivity of 22 ft/d. The pumping test data did not show the presence of groundwater-flow boundaries, implying that the highly transmissive perched zone is also laterally extensive.

R-23 and R-23i

R-23 is a single-screen regional monitoring well; the screen length is 57 ft from 5655 to 5712 ft amsl. The screen is placed within Totavi Lentil sediments located just below Cerros del Rio lavas. The well screen straddles the regional water table, and the screened interval appears to be unconfined. The R-23 water levels do not respond to water-supply pumping, however, they show a general trend of decline (approximately 0.3 ft/yr) consistent with other wells on the Pajarito Plateau. No pumping test was conducted at R-23, and hydraulic conductivity of the aquifer at R-23 is unknown. A comparison of barometric pressure and R-23 water-level data demonstrate a high barometric efficiency, close to 100% (Table E-3.1-4).

The intermediate well R-23i is located adjacent to regional well R-23. The well has three screens; screen 1 is in a 2.1-in.-diameter piezometer, and screens 2 and 3 are in a 4-in.-diameter well. All screens are in Cerros del Rio basalt. The water levels appear to be relatively steady without pronounced general trends of increase or decrease. The water levels at screens 2 and 3 are typically about 9 ft apart (6079 and 6070 ft amsl); the water level at screen 1(6122 ft amsl) is about 40 ft higher than screen 2. The water levels at screens 2 and 3 show small seasonal fluctuations (less than 2 ft) potentially associated with seasonally fluctuating infiltration recharge. Pumping tests conducted at well screen 3 during well development demonstrated the intermediate saturated zones have relative low permeability.

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 G related to estimated hydraulic conductivity 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 is 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 not sufficient to analyze the transients. Hydraulic properties could not be estimated based on PM-2 pumping for water-level transients at R-56, R-21, R-32, R-49, R-41, R-57, R-39, R-22, R-55, or R-23 because PM-2 was not pumping actively 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 online in the fall of 2011 and potentially replace it 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, all located next to MDA G, do not appear to be substantially impacted by the water-supply pumping. 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.

Table E-3.1-4 presents information regarding barometric efficiency of the monitoring well screens near MDA G 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.

Beneath MDA G, the shallow portion of the regional aquifer is located within the Cerros del Rio lavas, and the deeper portion is located within the underlying sediments. 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 G represent unconfined, partially confined, or confined hydrogeologic conditions (Table E-3.1-1). The uppermost well screens at the wells upgradient from MDA G (R-21, R-56, R-32) are located in the sediments below the lavas (Pliocene clastic sedimentary deposits; interbedded Puye Formation and Totavi lentil), but the water levels are within the overlying Cerros del Rio lavas. The downgradient wells, R-49 and R-57, have upper screens placed in Cerros del Rio dacite breccia and dacite lava, respectively, and lower screens are within the underlying sediments (Totavi lentil). At R-39, the screen straddles the lavas and the underlying volcaniclastic sediments. At R-41, the two screens are within Totavi sediments, but the upper screen is dry.

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 2005, 090040). The general shape of the regional water table beneath the Laboratory is predominantly controlled by the areas of regional recharge to the west (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 plateau vary in time due to 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 for the same period of time 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 being 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 in contrast to 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.

In the analyses of the regional water levels and regional groundwater flow directions near MDA G, a major question is how to interpret the R-41 hydrogeological data. Based on the expected structure of the regional groundwater flow, it was anticipated that R-41 and R-57 would have similar water levels, and the lavas at R-41 would be saturated and a part of the regional aquifer (Figure E-2.1-8). However, the R-41 water level (in sediments) is approximately 60 ft lower than the water levels observed approximately 600 ft to the south at R-57 and R-22 (in lavas), and the lavas at R-41 appear to be unsaturated. R-41 screen 1 and R-57 screen 1 are screened at similar elevations, but R-41 screen 1 is within the Totavi sands and gravels, and R-57 screen 1 is within Cerros del Rio dacite lava. The R-41 screen 2 water level (5699.2 ft amsl) is similar to the water level measured at well R-55 (5698.5 ft amsl), approximately 2000 ft east of R-41. The R-41 screen 2 water level is also similar to the water level observed in R-22 screen 3 (5699 ft amsl), which is located within the Chamita Formation and at an elevation approximately 400 ft deeper.

Various hydrogeological conceptual models can be proposed to explain the hydrogeological observations related to R-41 and the other regional monitoring wells near MDA G.

The first conceptual model is that R-41 is in a relatively small, localized area that is hydraulically disconnected from the rest of the regional aquifer. This separation causes the lavas to be unsaturated and hydraulically disconnected with the groundwater flow occurring through the lavas south of R-41, near R-57 and R-49. This separation also affects the R-41 screen 2 water level (in the sediments) that appears to be lower than expected for the deep aquifer sediments. This conceptual model is somewhat consistent with the interpretation of the pumping-test data collected during the development of R-41; pumping-test data suggest that R-41 is screened in a spatially limited (bounded) zone of saturation. The shape and the size of this localized area around R-41 are unknown.

The second plausible explanation is that the aquifer zones screened at R-57 and R-41, respectively, are in two different flow domains of the regional aquifer that are hydraulically disconnected due to lateral changes in geology caused by volcanic vents, and/or faulting that impact the lateral structure of the groundwater flow in the basalts and underlying sediments. Geologic logs for wells near R-41 show that the rocks in this area are heterogeneous and there is considerable lateral variability over short distances (Figure E-2.1-8). The heterogeneity and lateral variability of the rock units may explain the differences in water levels between R-41 and R-57 if the aquifer is compartmentalized by juxtaposing lithologies of strongly contrasting hydraulic properties or by a vertical barrier to groundwater flow (for example, a near-vertical fault or a series of volcanic vents); if there is faulting in the area east of MDA G, it is expected that the faults will have north-south orientation. This conceptual model is also supported by the observed water-level transients due to water-supply pumping. Based on the existing water-level data, most of the monitoring wells located near MDA G (R-21, R-56, R-32, R-49, and R-57) respond to the water-supply pumping at PM-2 and PM-4 (Table E-3.1-1). In contrast, the monitoring wells R-22 and R-41 do not appear to respond to water-supply pumping at all. However, this is somewhat surprising considering the proximity of R-57 and R-22. The lack of pumping response in the deep screens at R-22 may indicate the presence of localized flow barriers (aquifer heterogeneities, low permeable zones, faulting, volcanic vents, etc.) in the regional aquifer between R-57 and R-22. These observations support a conceptual model where the groundwater flow is disconnected over a short distance.

The third conceptual model is that the observed water level of the R-41 saturated zone is due to the spatial extent of the lavas and/or Totavi lentil riverine deposits within the regional aquifer. The lavas extent within the regional aquifer terminates between R-57 and R-41 (Figure E-2.1-8). The lavas are saturated and a part of the regional aquifer beneath MDA G; the lavas are unsaturated and above the regional aquifer to the northeast and east of MDA G. Therefore, the groundwater accumulated in the lavas beneath MDA G may discharge into the sediments. As a result of lava heterogeneity, the flow, discharge and saturation of groundwater in the lavas is expected to be spatially nonuniform. This may result of predominant south to southeasterly discharge, for example, in the area of R-57 and R-39, and may cause the lavas near R-41 to be unsaturated. In addition, the riverine deposits appear to be highly permeable and their spatial extent within the regional aquifer is predominantly to the east of MDA G. As a result, the highly permeable Totavi lentil riverine deposits may be capable of sustaining high lateral groundwater flow rates that cause a sharp decline in the elevation of the regional water table to the east of MDA G, similar to the water-level decline observed at R-41. Under this conceptual model, it is also possible that the lavas and the riverine deposits create a complex three-dimensional groundwater flow structure. In this case, the relatively thick Totavi lentil riverine deposits may facilitate vertical groundwater flow from the shallow into the deep zone of the regional aquifer after the regional groundwater flow in the lavas is discharged into the more permeable aquifer sediments near R-41. This conceptualization is somewhat supported by the similarity in the water levels in R-41 screen 2, R-22 screen 3 and R-55 screen 1 (all close to 5699 ft amsl). It is also supported by relatively high values for the vertical component of the hydraulic gradient in the wells east of MDA G (Table E-3.1-3). However, this conceptual model is not supported by other observations: (1) despite their coarse-grained nature, the sediments at the top of the aquifer at R-41 contain considerable silt and do not appear to be very permeable; (2) highly-permeable Totavi lentil riverine deposits are observed at R-57, but their occurrence does not result in lower water levels at R-57 and R-22.

It is also plausible that the actual hydrogeologic conditions in the regional aquifer beneath and downgradient from MDA G are some combination of conceptual elements from all the models described above.

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 monthly-averaged water-level data from February 2011 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 G (e.g., R-57 and R-55). The R-41 screen 2 water level is not taken into account, assuming that it is an anomalous observation caused by a localized hydrogeologic feature that is hydraulically disconnected with the rest of the aquifer; this is consistent with the first conceptual model discussed above. As a result, the R-41 water level is not expected to affect the large-scale structure of the groundwater flow in the regional aquifer, as presented in Figure E-3.3-1.

The groundwater flow in the regional aquifer beneath MDA G is predominantly from northwest to southeast. The direction of the potential contaminant transport in the regional aquifer is expected to follow the hydraulic gradients along the regional water table, although fractures or interbedded sediments may cause permeability anisotropy that could lead to deviations from the predominant flow direction. In the area downgradient from MDA G, the direction of the regional aquifer flow is believed to be dominantly towards the southeast based on regional water-table levels and maps. 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. The regional water table is observed within the Cerros del Rio lavas beneath MDA G and in the underlying sediments to the west, north, and east of MDA G (Figures E-2.1-2, E-2.1-7, E-2.1-8, and E-2.1-12).

The structure of the regional aquifer flow near MDA G is represented in greater detail by a series of water-table (piezometric) maps presented in Figures E-3.3-2 through E-3.3-6.

The water-level contour maps in Figures E-3.3-2, E-3.3-3, and E-3.3-4 incorporate information from the shallowest screens in the regional aquifer at the monitoring wells; the three different maps represent alternative conceptual models related to uncertainties associated with (1) the lateral continuity of the shallow aquifer flow and (2) the R-41 water-level data.

The water-table map in Figure E-3.3-2 ignores the water level at R-41 assuming that the well is drilled through a hydrogeologic zone with limited lateral extent within the lavas that is hydraulically disconnected from the regional aquifer. As a result, the lavas near R-41 are locally unsaturated, and the R-41 observation is not representative of the general structure of the groundwater flow in the shallow portion of the regional aquifer. Therefore, the map in Figure E-3.3-2 is consistent with the first conceptual model discussed above; contour lines in Figures E-3.3-1 and E-3.3-2 are equivalent.

The map in Figure E-3.3-3 takes into account the water level at R-41 but assumes that there is a vertical barrier that impacts the shallow aquifer flow between R-57 and R-22 (R-41 as well) associated potentially with a fault structure and/or volcanic vents. The groundwater flow barrier is assumed to have a north-south orientation. This analysis is consistent with the second conceptual model discussed above.

Analysis presented in Figure E-3.3-4 also takes into account the water level at R-41 but assumes that there is a lateral disconnection in the shallow aquifer flow between R-57 and R-41 due to the lateral extent of the lavas along the top of the regional aquifer beneath MDA G (Figure E-2.1-8). The orientation of the lateral disconnections is consistent with the expected boundary of lavas terminating in the regional aquifer. This analysis is consistent with the third conceptual model discussed above.

The water-level contour maps in Figures E-3.3-5 and E-3.3-6 incorporate information from the deeper screens in the regional aquifer at the monitoring wells with more than one screen; both maps take into account the R-41 water-level data.

Figure E-3.2-5 does not make any assumptions related to discontinuities in the deep aquifer flow. This analysis is consistent with the third conceptual model discussed above. In this case, the mound in the regional piezometric levels near R-57 in the deep aquifer may be caused by groundwater discharge from the overlying lavas.

Figure E-3.2-6 assumes that there is a vertical barrier impacting the shallow aquifer flow between R-57 and R-22 (R-41 as well) associated potentially with a fault structure and/or volcanic vents This analysis is consistent with the second conceptual model discussed above and implemented for the shallow aquifer flow in Figure E-3.2-3.

Groundwater flow in the upper part of the regional aquifer beneath MDA G appears to be substantially impacted by the Cerros del Rio lavas (Figures E-2.1-2, E-2.1-7, E-2.1-8, E-2.1-10, and E-2.1-11). These lavas are more than 150 ft thick beneath the regional water table beneath MDA G (Figure E-2.1-12). 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 hydraulic interconnection of the fractures and interbedded sediments. The permeability of the intact lava matrix is expected to be quite low. Because of local fracture properties, there might be local zones within the lavas (laterally and vertically) with either relatively high or relatively low groundwater flows. For example, high-permeability fractures and interbedded sediments can lead to relatively high local groundwater flow velocities and preferential contaminant migration though the phreatic zone. Low-permeability zones or zones with fractures hydraulically disconnected from the phreatic zone may appear to be unsaturated; for example, a similar zone may have been observed near R-41, and this conceptual uncertainty is represented in the water-table map presented in Figure E-3.2-2. 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 in other parts of the Pajarito 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-2.1-12)

The northeastward direction of the groundwater flow northwest of MDA G (e.g., in the area between wells R-40 and R-38; Figure E-3.2-1) may indicate a complex three-dimensional structure of the groundwater flow that is potentially influenced by hydrostratigraphy, aquifer recharge, and/or water supply pumping in the deep sections of the regional aquifer. For example, it is plausible that the shape of regional water table near wells R-40, R-20, and R-54 is influenced by water-supply pumping of PM-2. The presence of the low permeability Cerros del Rio lavas below the regional water table in the area beneath MDA G may act as a hydrogeologic barrier that diverts flow northeastward in the R-40 area (Figures E-3.2-1 and E-3.1-8). 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 observed during the pumping tests conducted at these wells are impacted by boundary effects (Table E-3.1-1). The relatively lower water levels and flat hydraulic gradients in the area north of R-38 are potentially caused by flow through highly permeable Puye Formation sediments (as indicated by the pumping test results from wells at R-28, R-11, R-13, R-44, and R-45) (LANL 2009, 107453). 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 downgradient of MDA G is a redundant system that is designed to provide reliable detection of potential contaminants reaching the regional aquifer. The wells are located both near the facility boundary and at more distal locations along the dominant regional flow direction as well as along potential local flow directions to the northeast. Because of the difficulties associated with monitoring groundwater in lavas beneath MDA G, the network is made up of two-screen wells with an upper well screen placed as close to the water table as possible to monitor the first arrival of contaminants in the aquifer and a lower screen placed in permeable aquifer sediments to monitor the primary groundwater pathways downgradient of the facility. The monitoring wells located immediately downgradient of MDA G (R-41, R-57, R-49, and R-39) are screened in sections of the regional aquifer that appear to be the best locations for monitoring potential contaminants. The design of these wells includes at least one well screen that is placed in relatively high permeable sediments close to the regional water table (section E-2.1).

Hydrogeologic data also suggest that the screened regional-aquifer zones at the monitoring wells near MDA G have either unconfined, partially confined, or confined hydrogeologic conditions. This suggests that the upper well screens and the regional water table are potentially hydraulically connected. At R-41, the relatively low water level and the lack of cross-well pumping responses lead to uncertainties related to (1) the groundwater flow direction in the regional aquifer along the water table near R-41, and (2) the hydraulic connection of the deep saturated zone tapped by R-41 with the rest of aquifer. Various hydrogeological conceptual models to explain the R-41 water-level data are discussed above.

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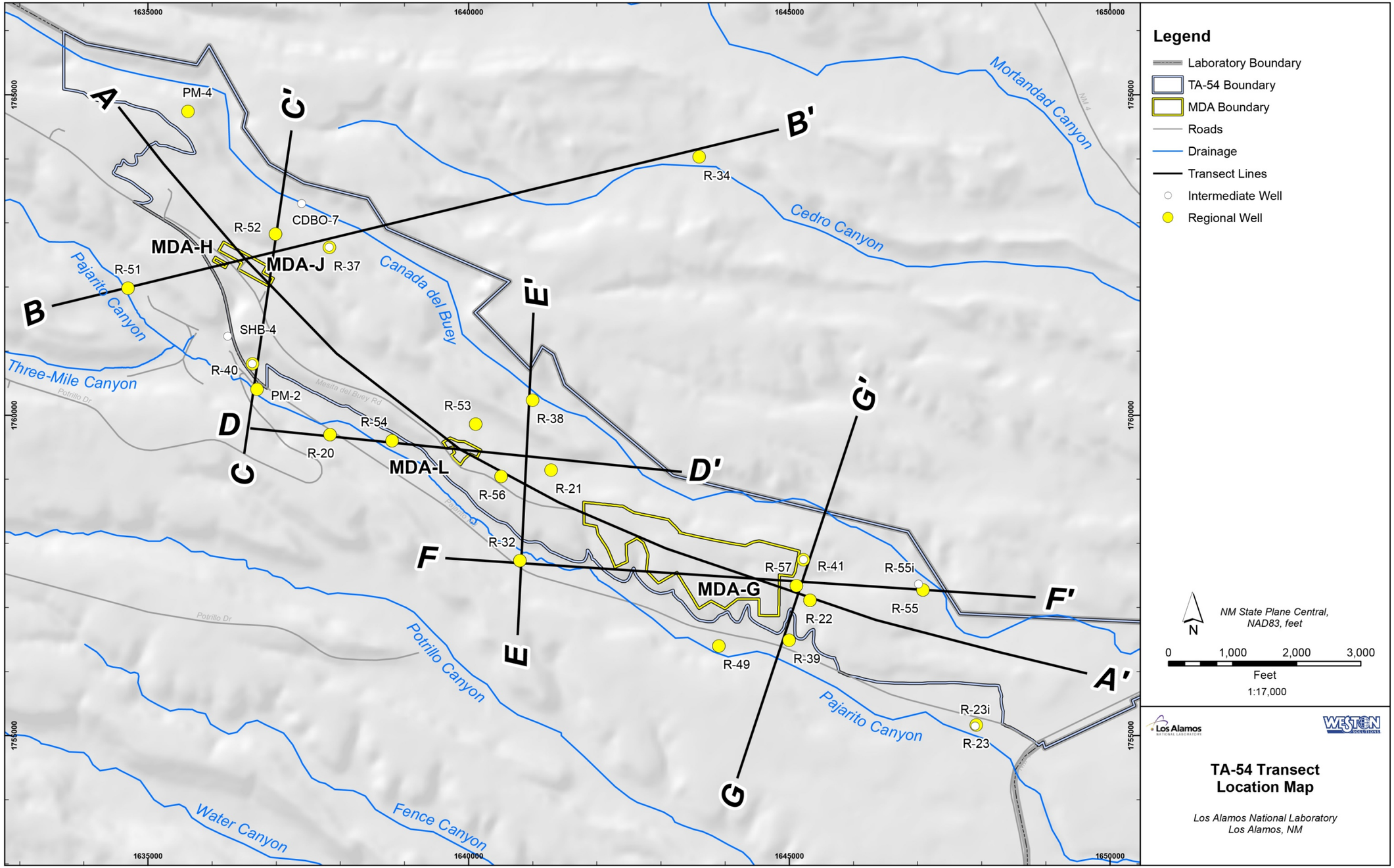
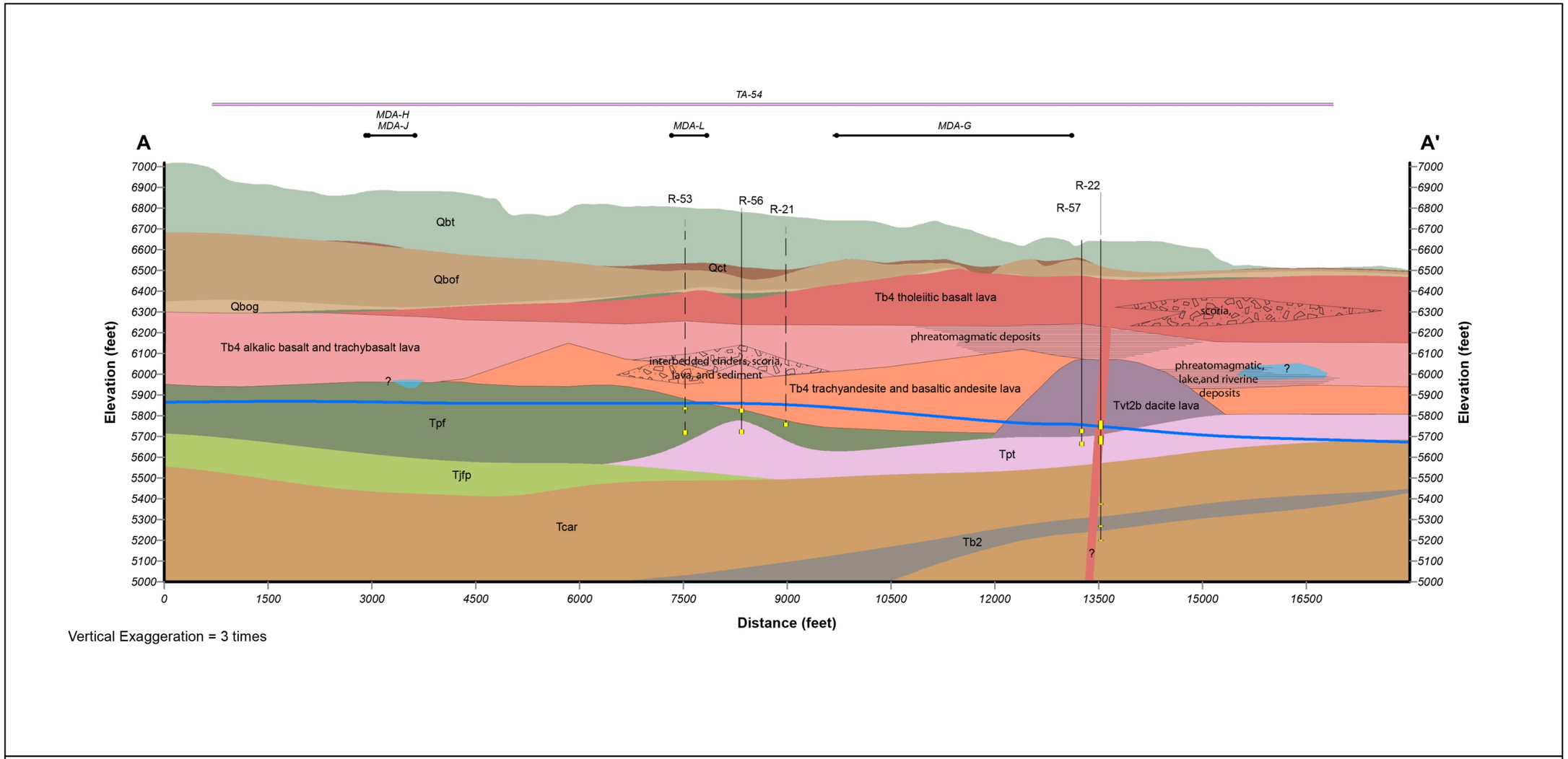


Figure E-2.1-1 Location of regional and intermediate wells in the vicinity of TA-54 and the lines of section for geologic cross-sections shown in Figures E-2.1-2 through E-2.1-8



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 - 2250

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, basalt
- 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

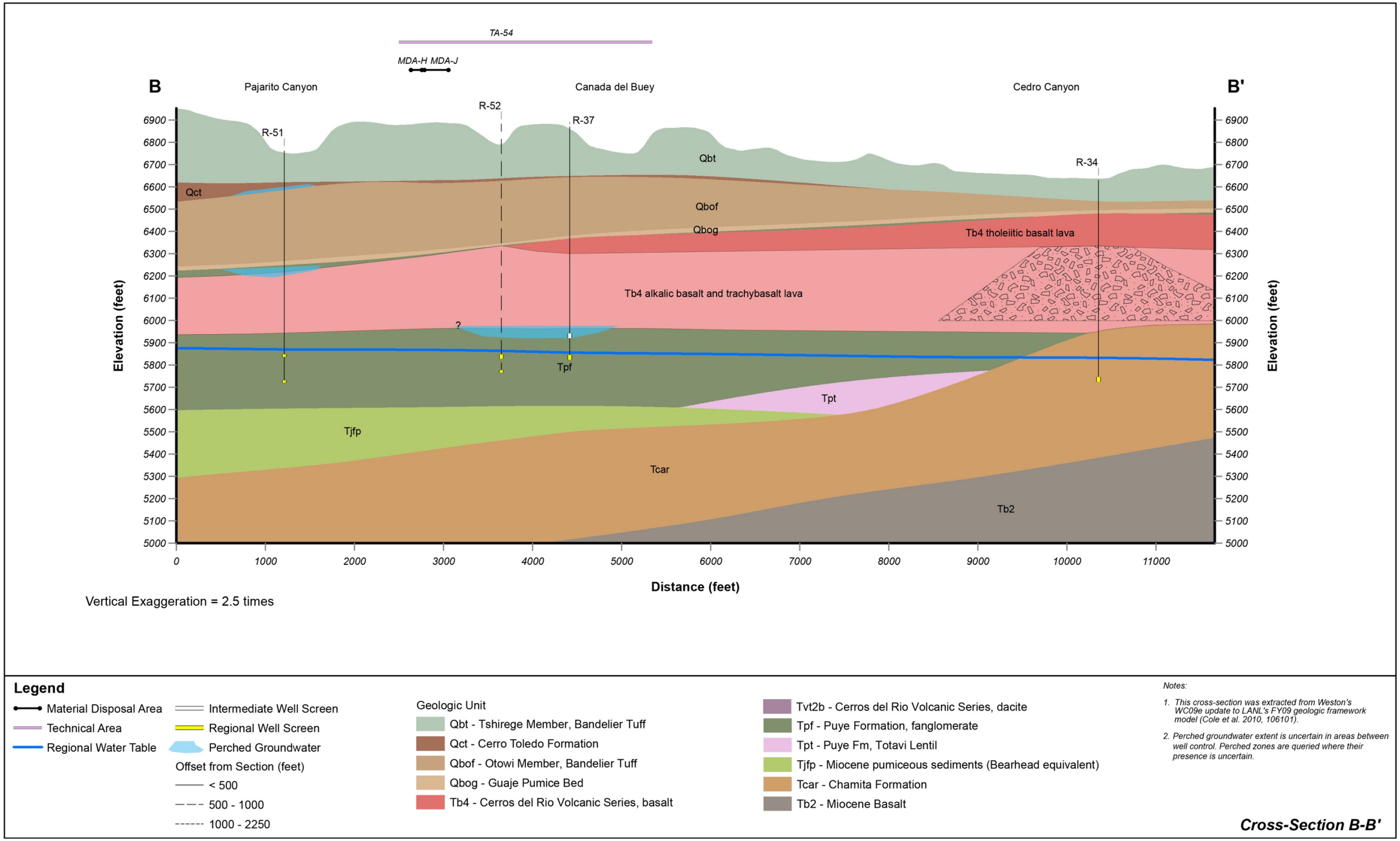
Notes:

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 A-A'

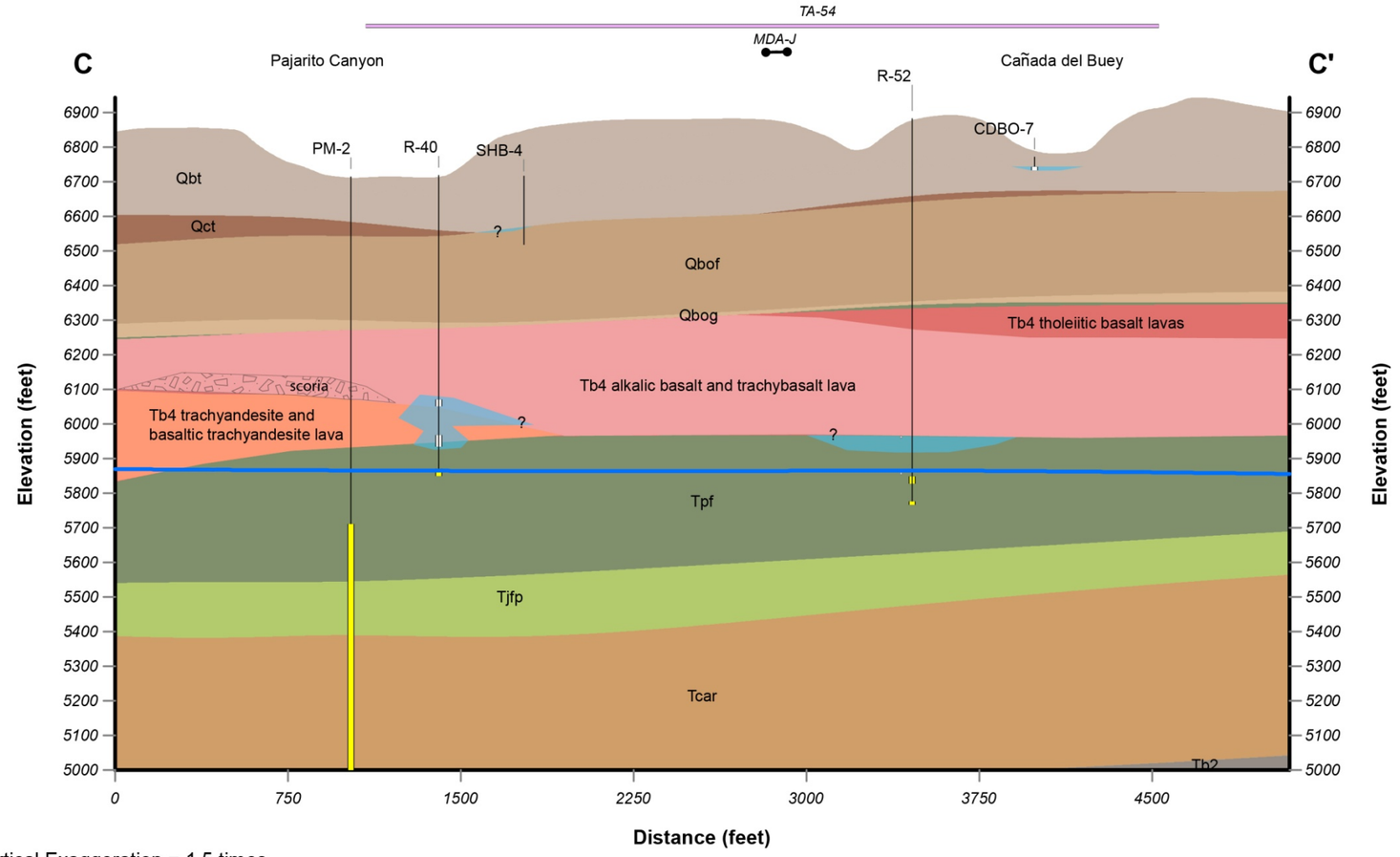
Note: See Figure E-2.1-1 for location of cross-section.

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

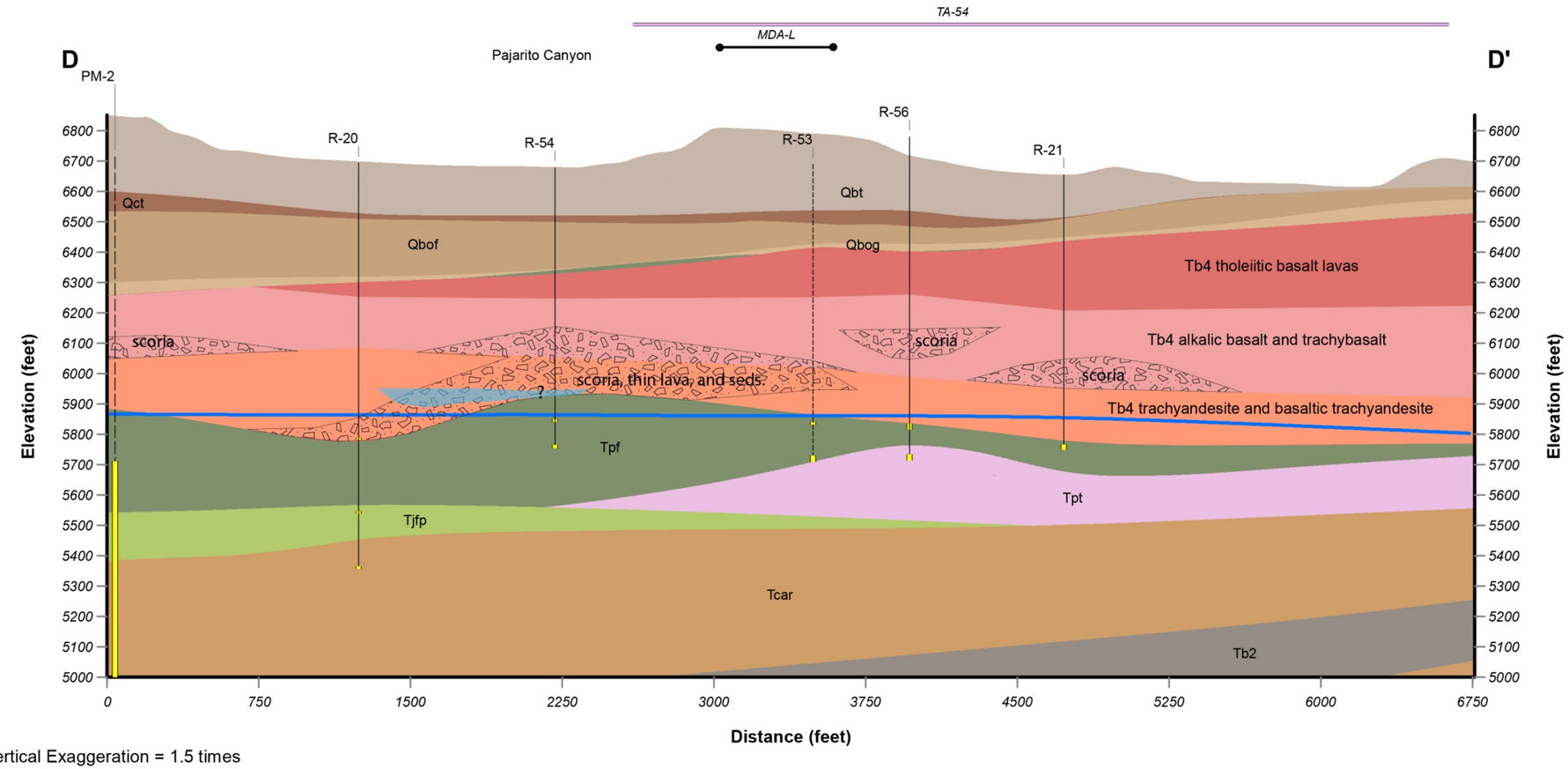
Notes:

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



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

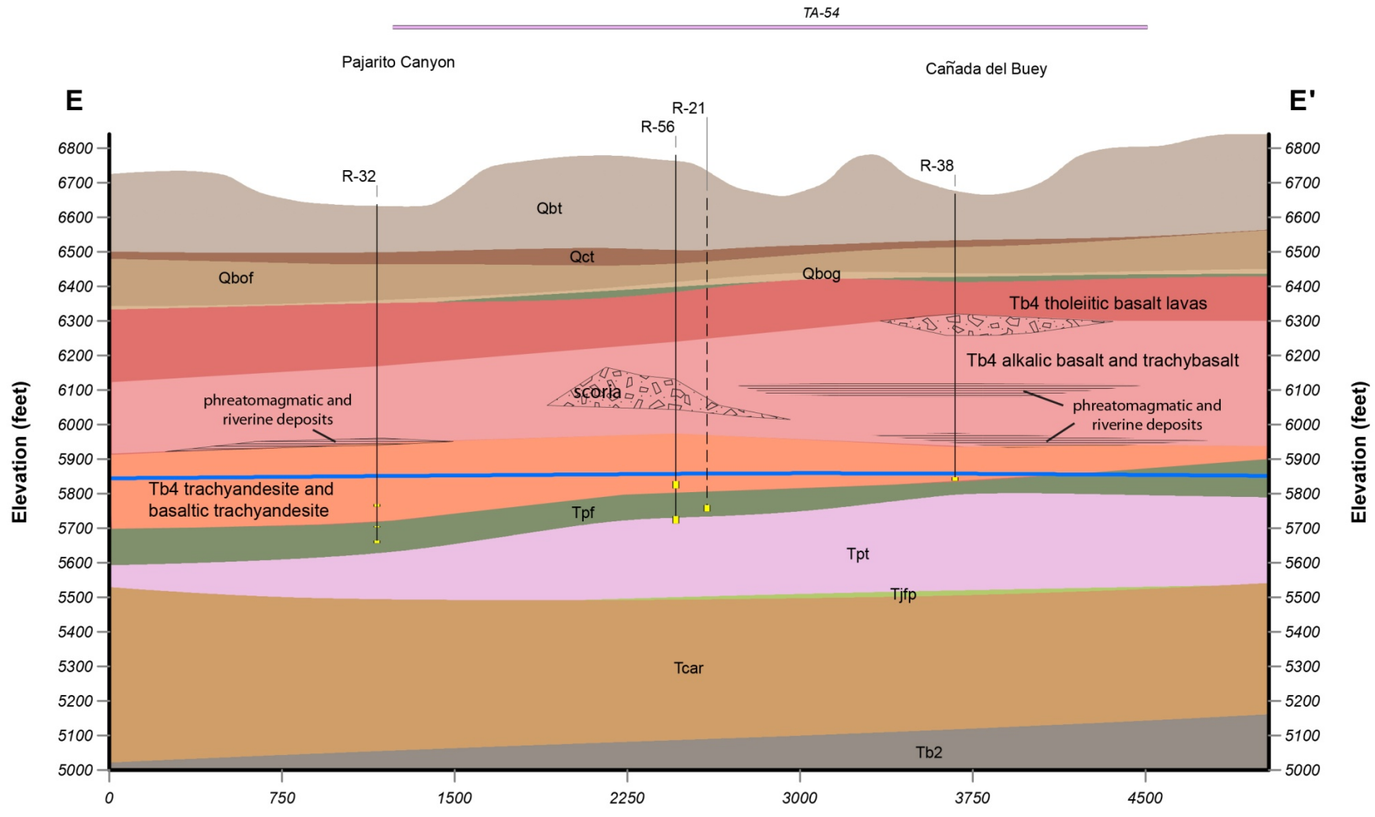
Notes:

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 D-D'

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

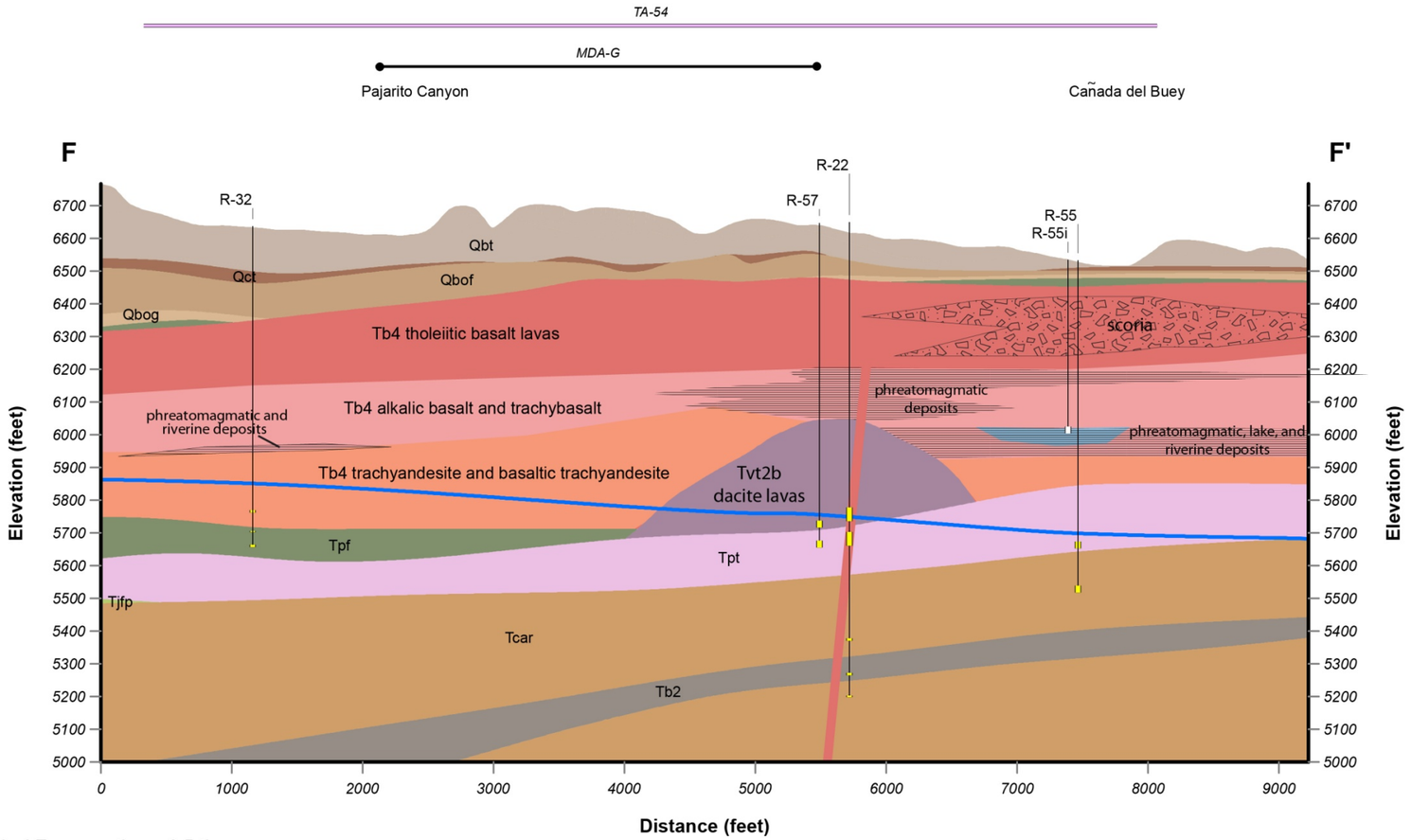
Notes:

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



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

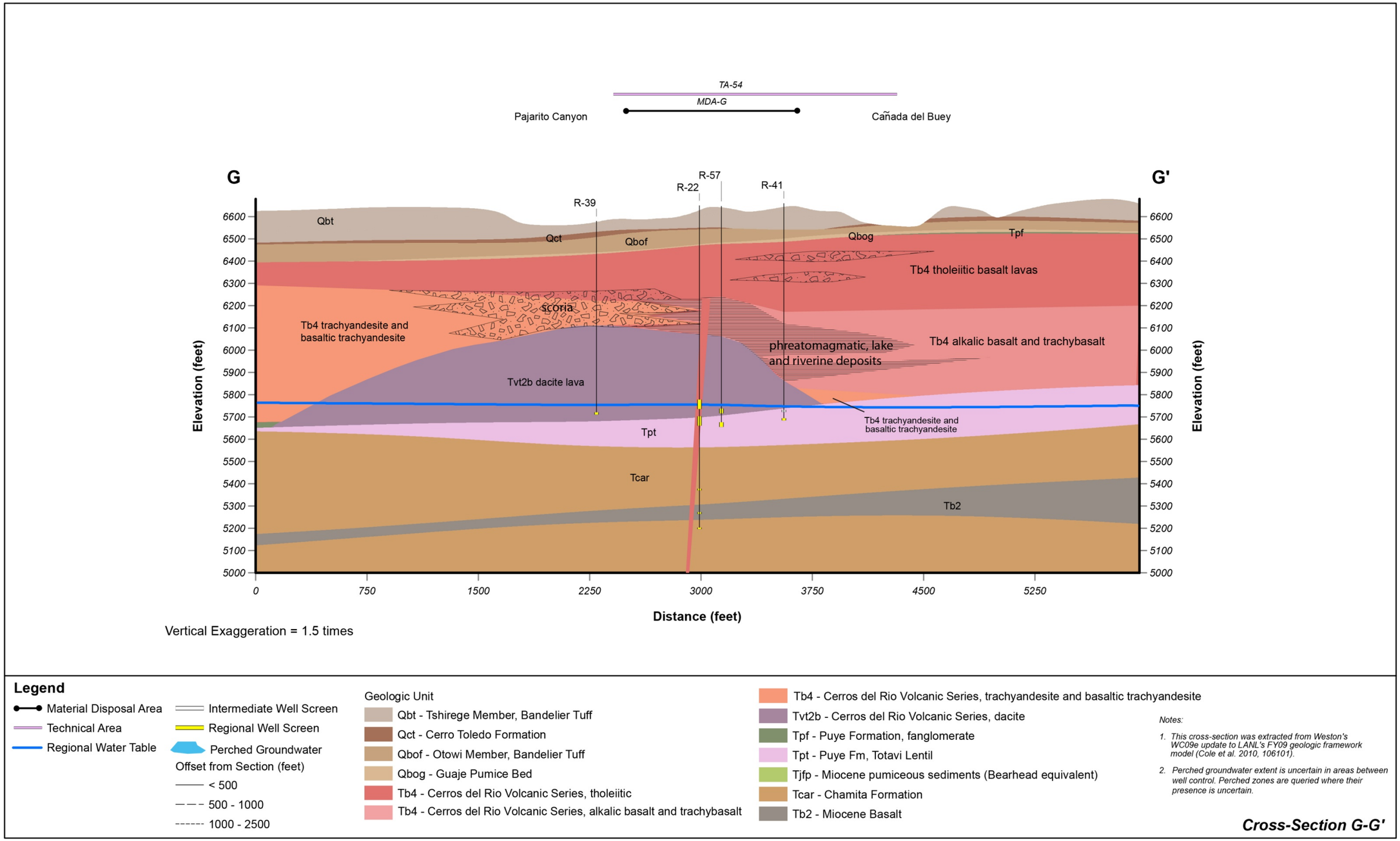
Notes:

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 F-F'

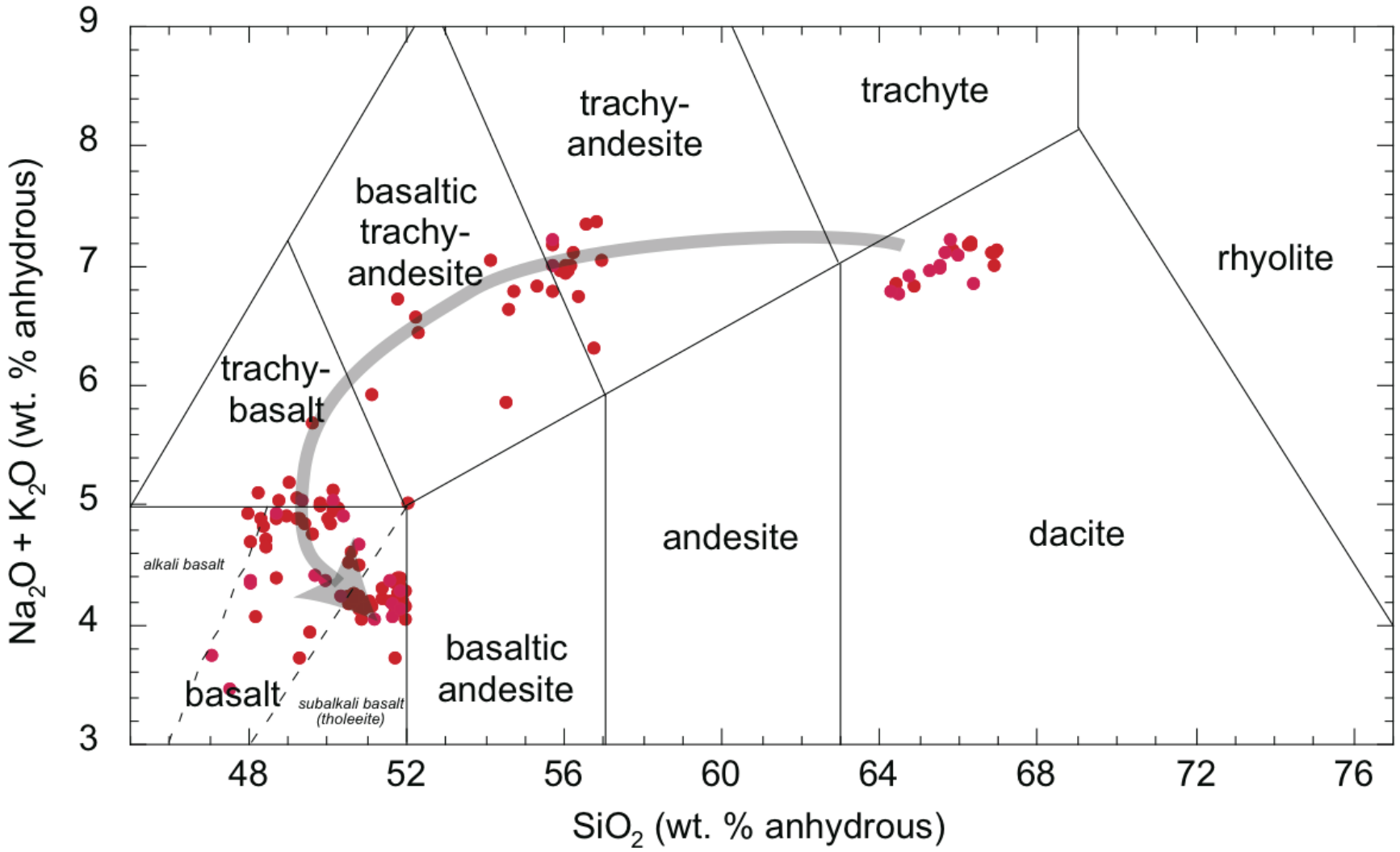
Note: See Figure E-2.1-1 for location of cross-section.

Figure E-2.1-7 West to east geologic cross-section F-F' through MDA G



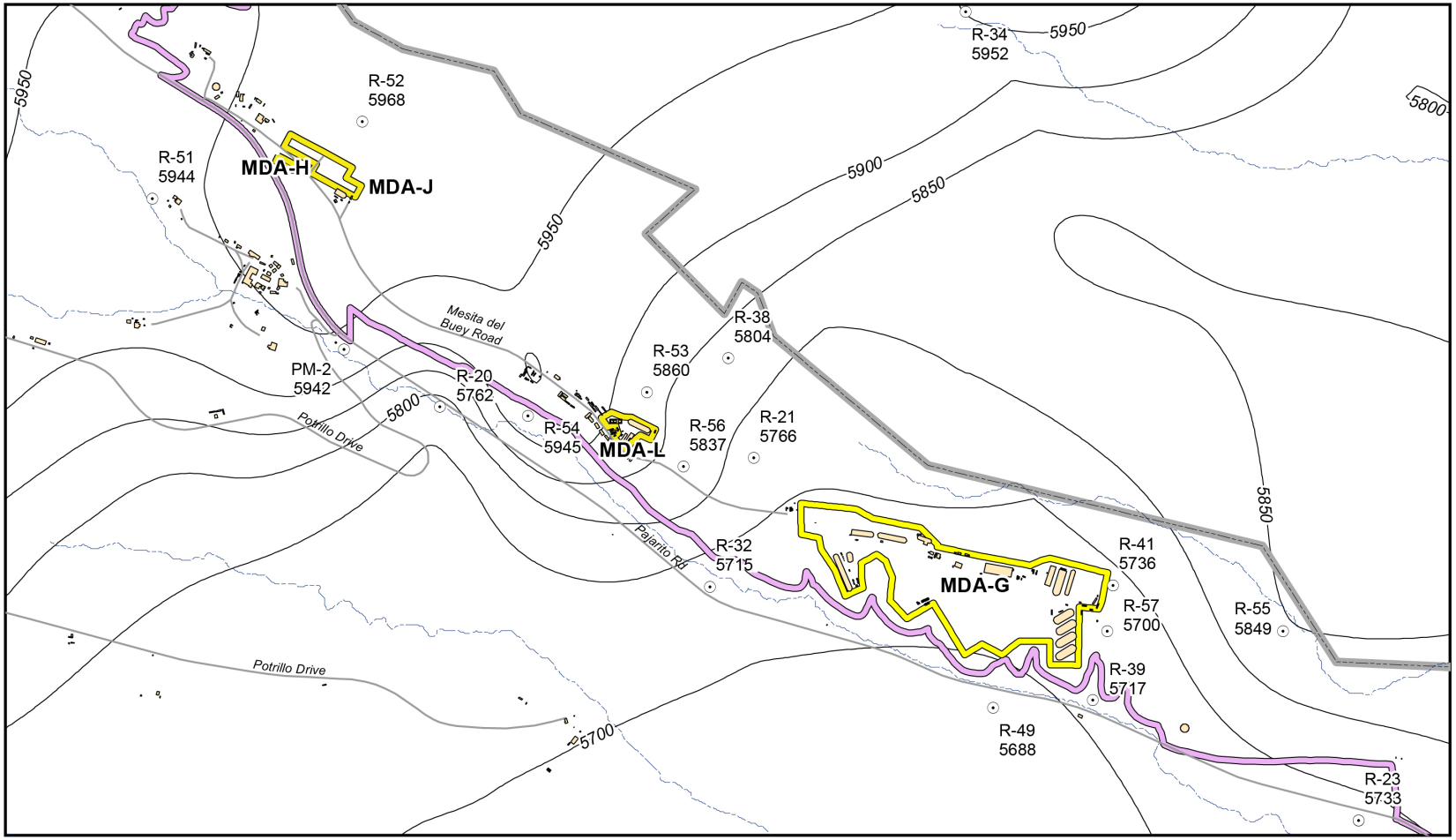
Note: See Figure E-2.1-1 for location of cross-section.

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

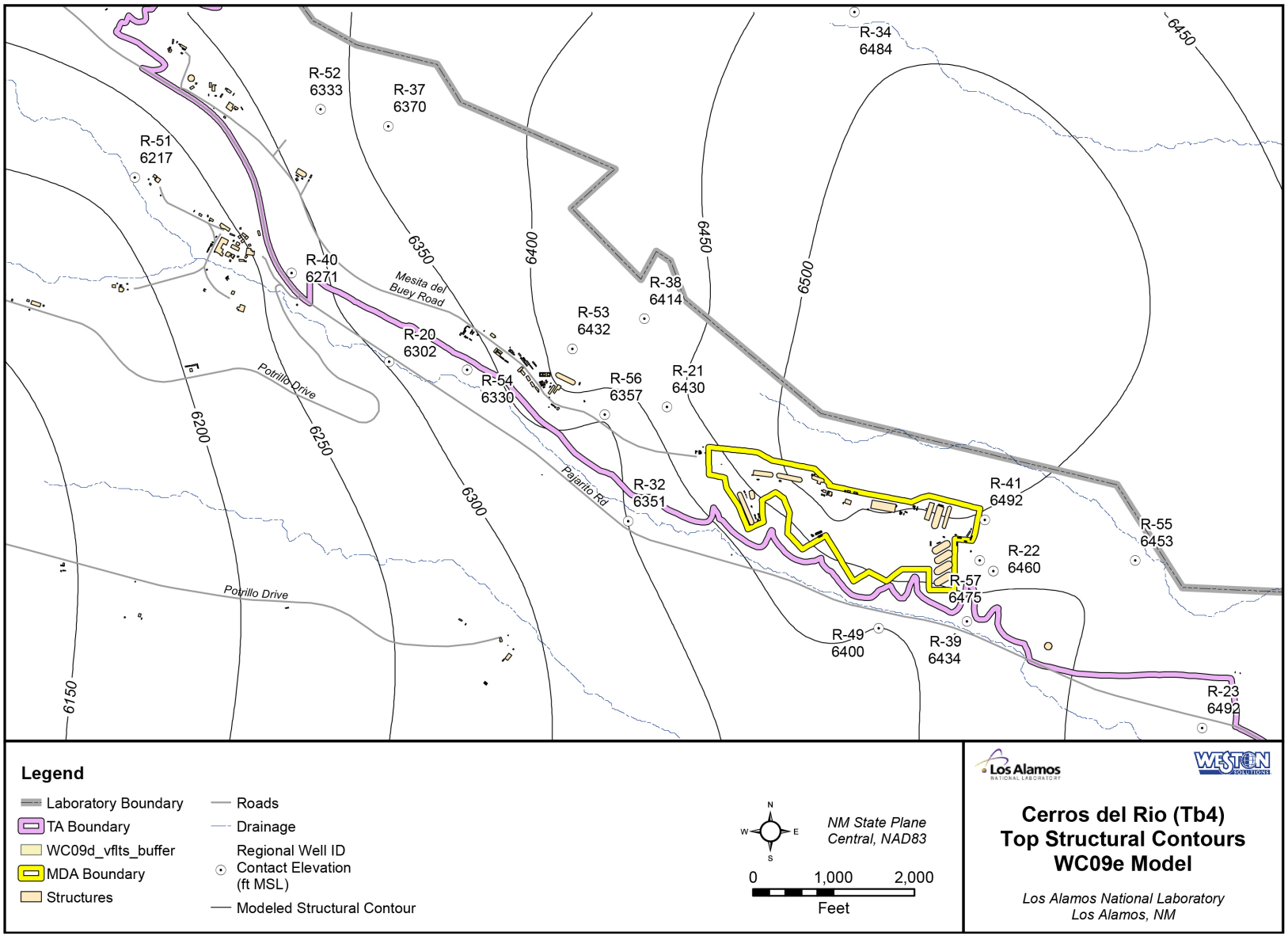
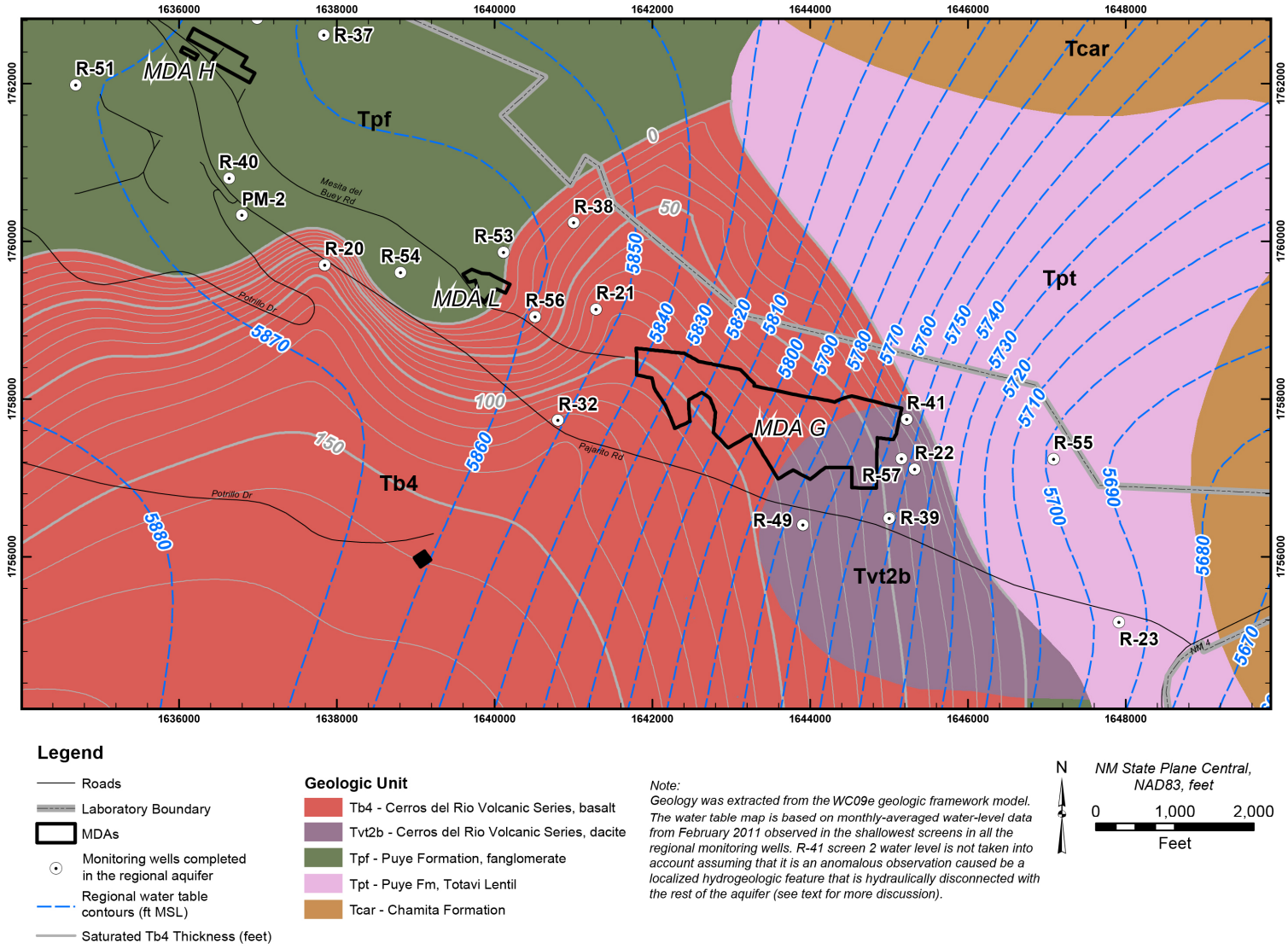


Figure E-2.1-11 Structure contour map for the top of Cerros del Rio volcanic rocks in the vicinity of TA-54



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)

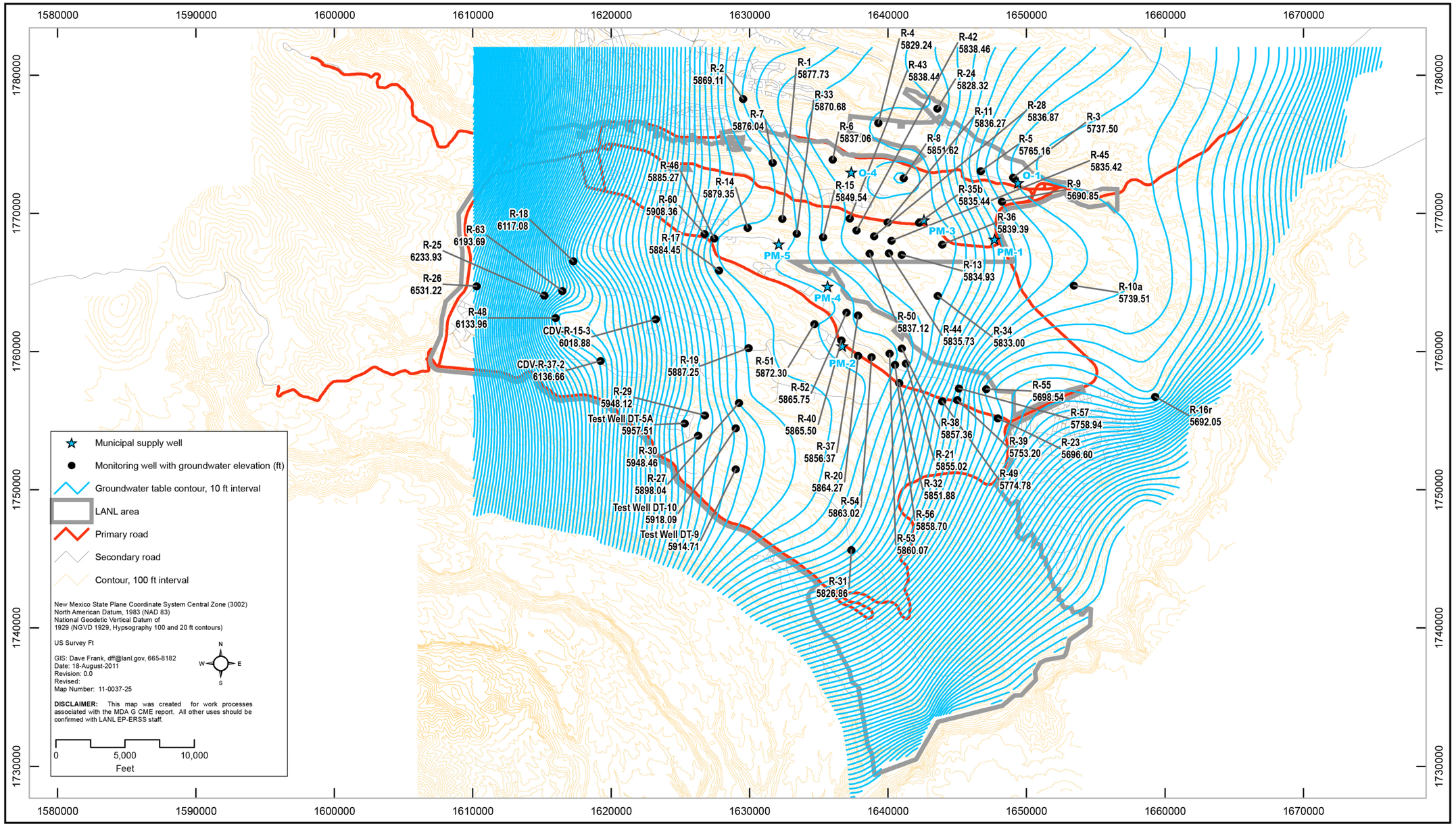
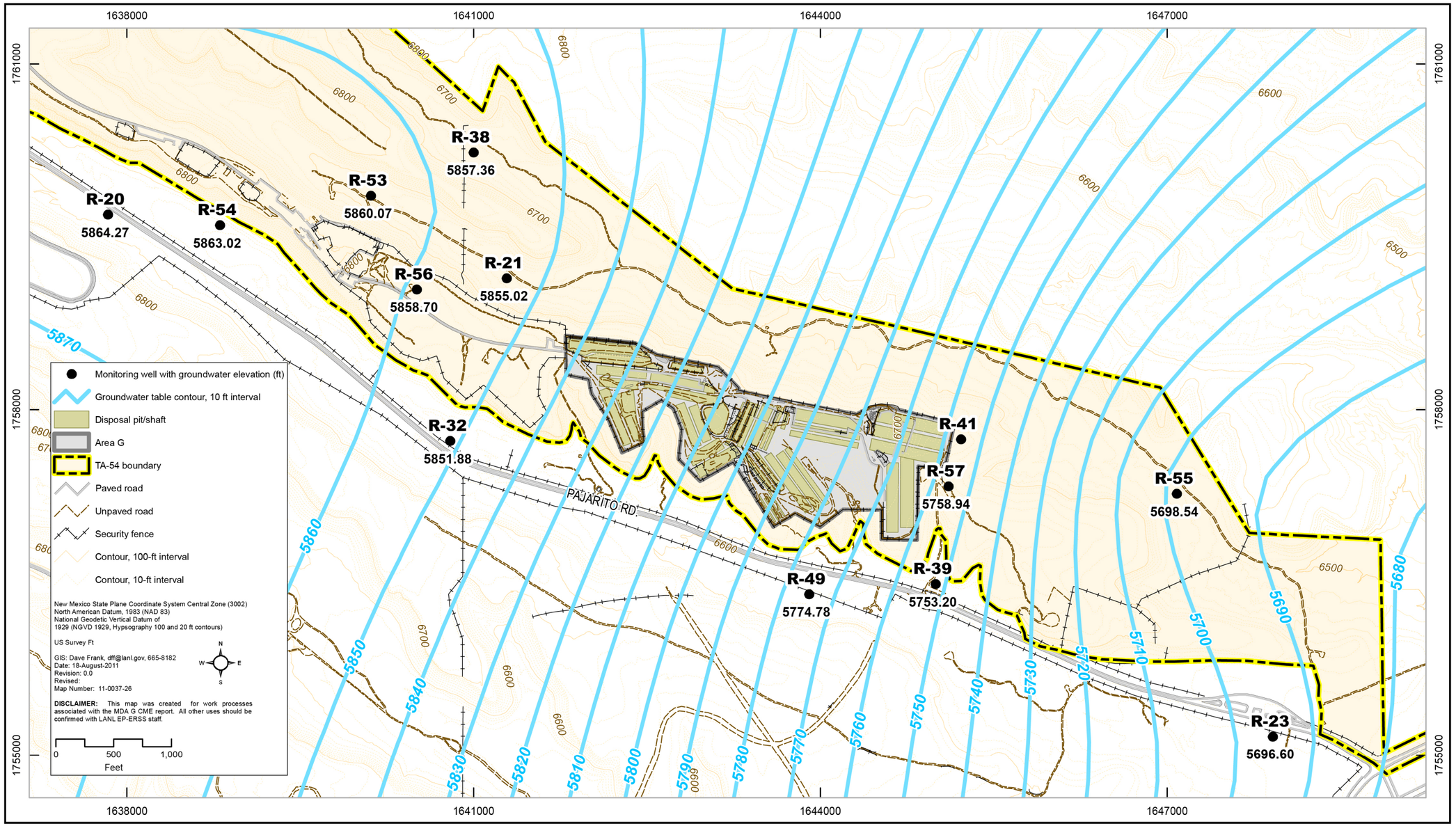
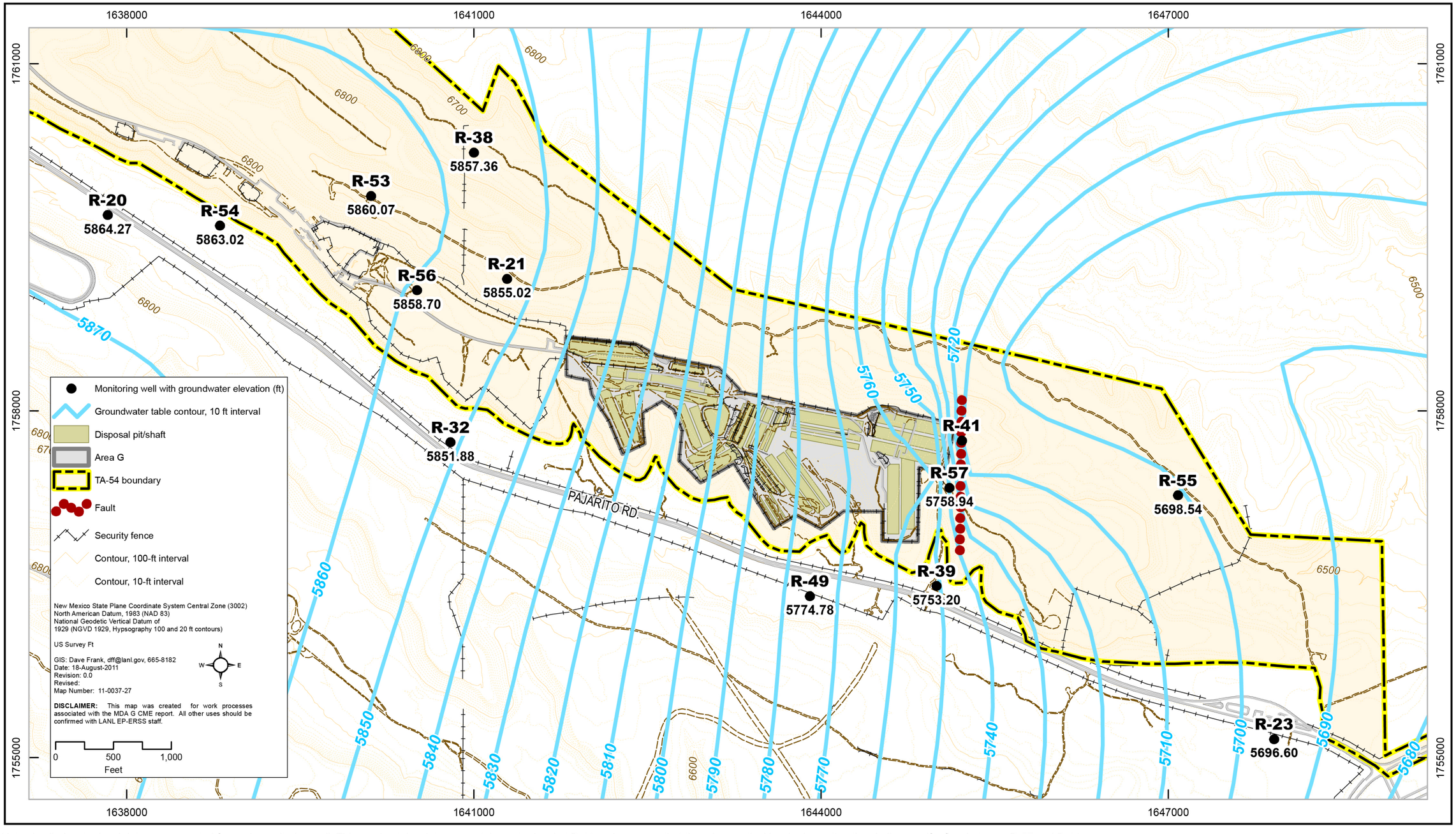


Figure E-3.3-1 **Laboratory scale regional water-table map based on February 2011 water levels; R-41 water level is not taken into account assuming that it is an anomalous observation caused by a localized hydrogeologic feature that is hydraulically disconnected with the rest of the aquifer; as a result, the R-41 water level is not expected to affect the large-scale structure of the groundwater flow in the regional aquifer.**



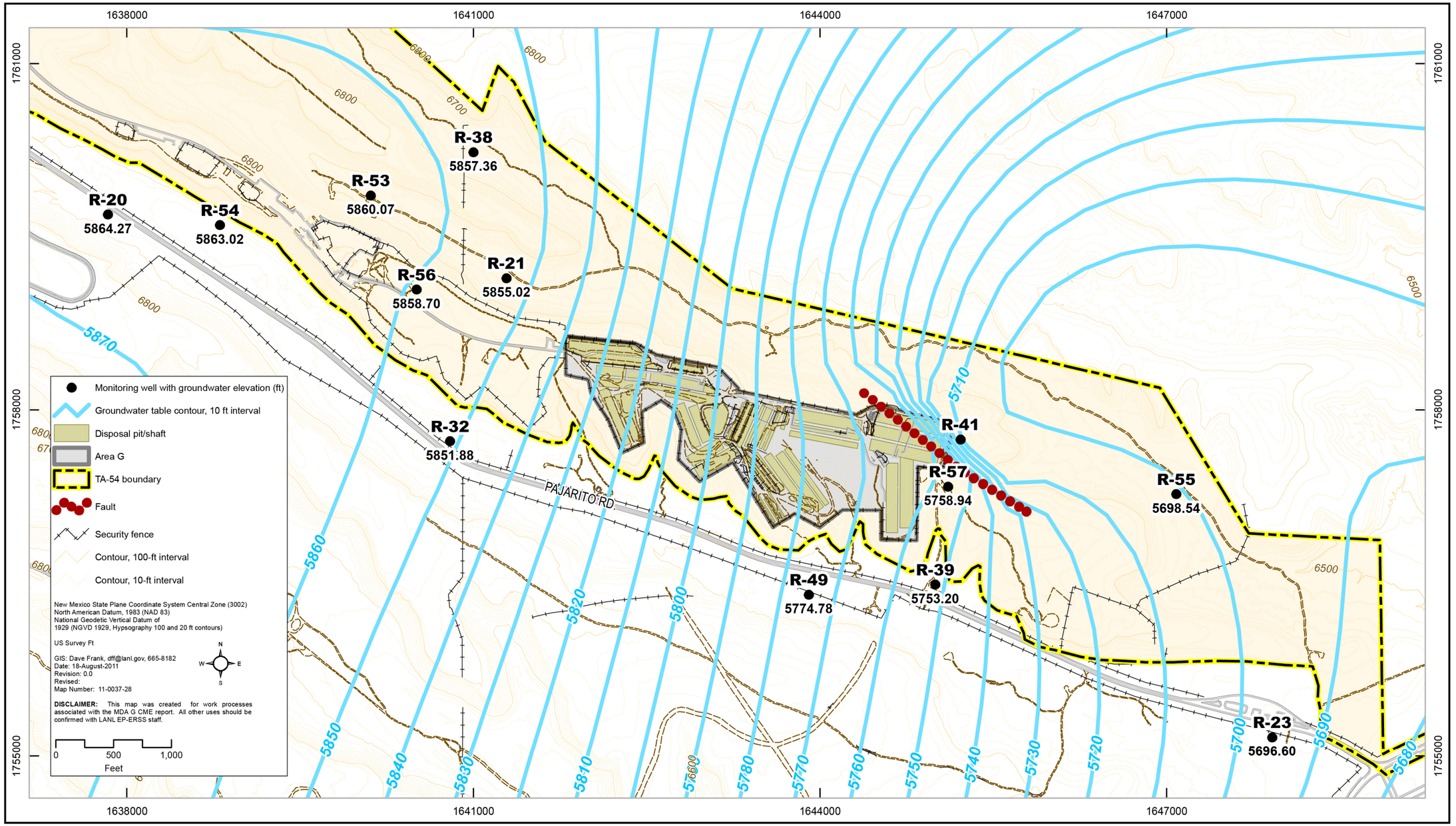
Note: Applied water-level data are presented for each monitoring well. Water-level contours in Figures E-3.3-1 and E-3.3-2 are equivalent. This version ignores the water level at R-41 assuming that R-41 is within a hydrogeologic zone with limited lateral extent that is disconnected from the aquifer.

Figure E-3.3-2 Version 1 of the water-level contour map representative of the regional water table near MDA G; the map is based on February 2011 water levels measured in the shallowest screens in the monitoring wells



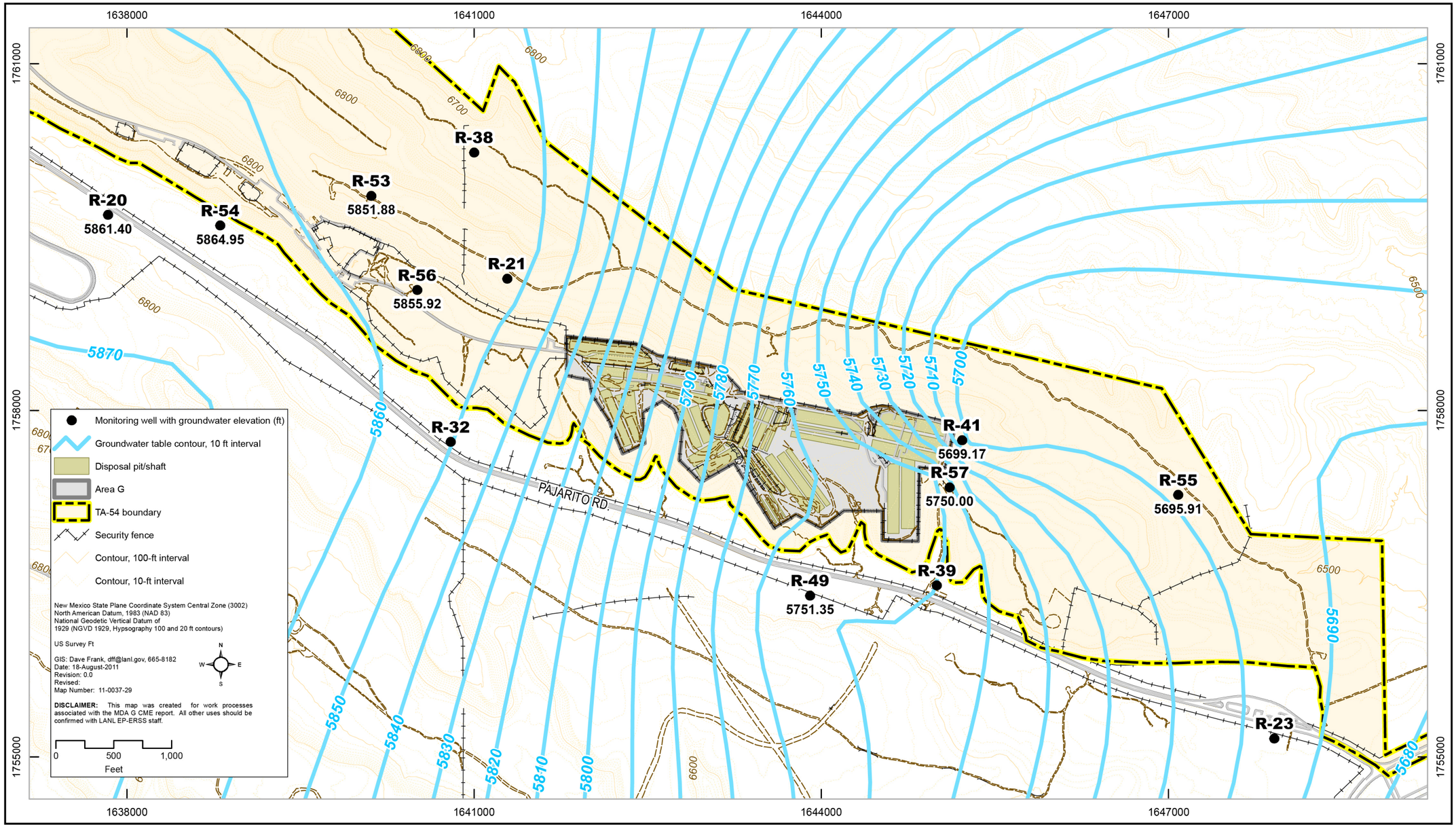
Note: Applied water-level data are presented for each monitoring well. This version takes into account the water level at R-41 and assumes that there is a vertical barrier impacting the shallow aquifer flow between R-57 and R-41.

Figure E-3.3-3 Version 2 of the water-level contour map representative of the regional water table near MDA G; the map is based on February 2011 water levels measured in the shallowest screens in the monitoring wells



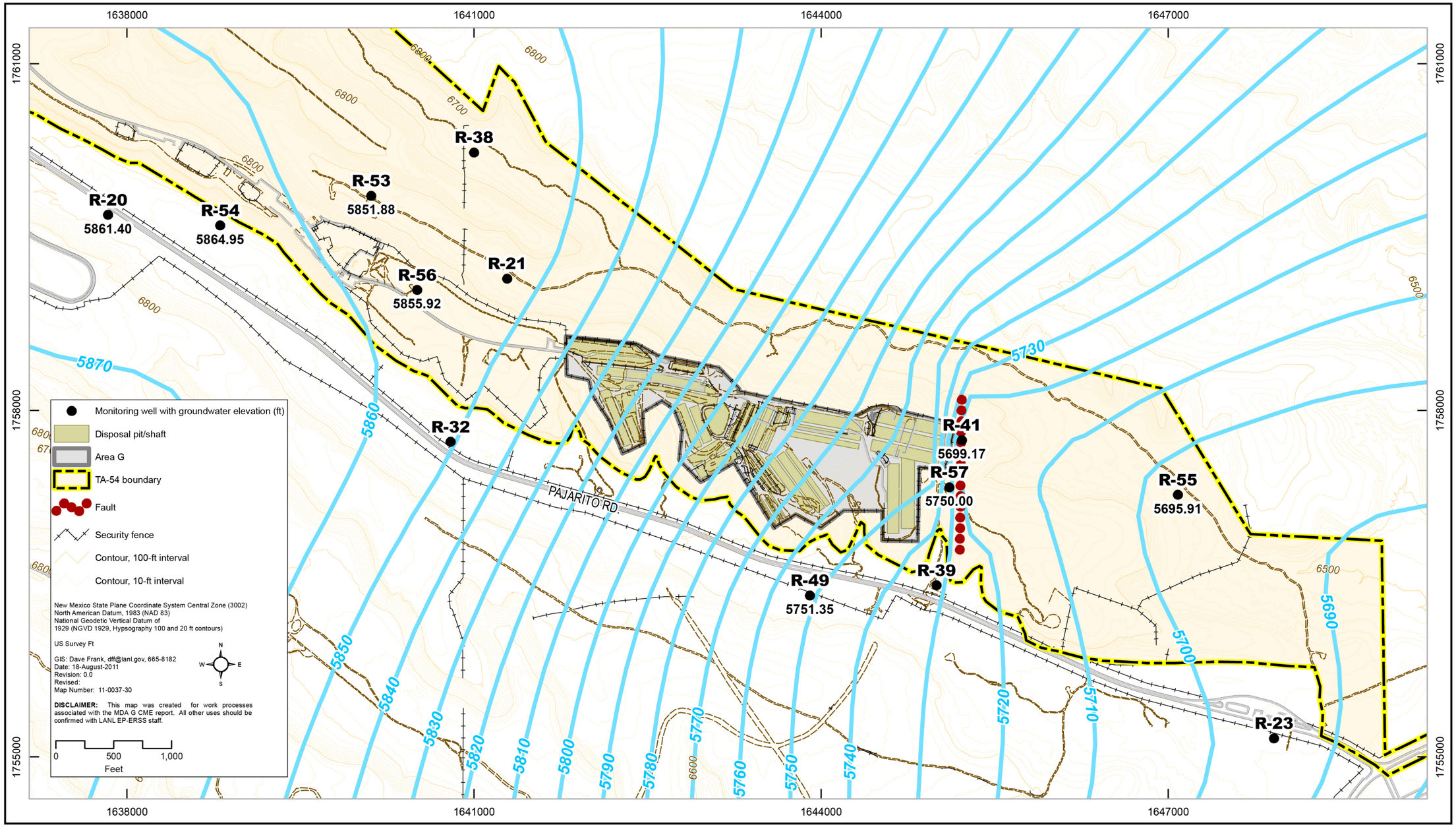
Note: Applied water-level data are presented for each monitoring well. This version takes into account the water level at R-41 and assumes that there is a lateral disconnection in the shallow aquifer flow due to basalts at the top of the regional aquifer beneath MDA G. Black and red labels represent shallow and deep water levels.

Figure E-3.3-4 Version 3 of the water-level contour map representative of the regional water table near MDA G; 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. This version does not make any assumptions related to discontinuities in the deep aquifer flow.

Figure E-3.3-5 Version 1 of the water-level contour map representative of the regional piezometric surfaces near MDA G; the map is based on February 2011 water levels measured in the deepest screens in the monitoring wells



Note: Applied water-level data are presented for each monitoring well. This version takes into account the deep water level at R-41 and assumes that there is a vertical barrier impacting the deep aquifer flow between R-57 and R-41.

Figure E-3.3-6 Version 2 of the water-level contour map representative of the regional piezometric surfaces near MDA G; the map is based on February 2011 water levels measured in the deepest screens in the monitoring wells

Table E-3.1-1
Hydrogeologic Characteristics of the Regional Monitoring Wells in the Area Near MDA G

Well Screen	k [ft/d]	Unit	Submergence below the Water Table	Hydrodynamic Conditions	Comments
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-21	1	Tpf	85	confined	observed water level is within the overlying lavas (Tb4); due to 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); due to 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
R-49#1	0.7	Tvt2b (dacite breccia)	35	unconfined or partly confined	drawdown equilibration at late pumping times
R-49#2	133	Tpt	96	confined	drawdown equilibration at late pumping times
R-41#2	3	Tpt	5	unconfined	sharp drawdown increase at late pumping times
R-57#1	10	Tvt2b (dacite)	20	unconfined or partly confined	low permeability boundary effects
R-57#2	125	Tpt	91	unconfined or partly confined	drawdown equilibration at late pumping times
R-39	1	Tvt2b/ Tpf	32	unconfined or partly confined	drawdown equilibration at late pumping times
R-22#1	ND	Tb4	-16	unconfined or partly confined	no pumping test conducted
R-22#2	ND	Tb4	60	unconfined or partly confined	no pumping test conducted
R-22#3	ND	Tcar	420	confined	no pumping test conducted
R-22#4	ND	Tb2	490	confined	no pumping test conducted
R-22#5	ND	Tcar	560	confined	no pumping test conducted
R-55#1	128	Tpt	25	unconfined or partly confined	drawdown equilibration at late pumping times

Table E-3.1-1 (continued)

R-55#2	0.3	Tcar	140	confined	none
R-23	ND	Tpt	-12	unconfined or partly confined	no pumping test conducted

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 G 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-56#1	—[a]	—	—	—	No apparent or very small water-supply pumping response (more data are needed)
R-56#2	ND[b]	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-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
R-49#1	—	—	—	—	No apparent water-supply pumping response
R-49#2	ND	ND	2.4E+03	2.6E-03	Responses to PM-4 (~0.4 ft based on the existing data); Responses to PM-2 also expected
R-41#2	—	—	—	—	No apparent water-supply pumping response
R-57#1	—	—	—	—	No apparent water-supply pumping response
R-57#2	ND	ND	9.3E+02	7.1E-03	Responses to PM-4 (~0.4 ft based on the existing data); Responses to PM-2 also expected
R-39	—	—	—	—	No apparent water-supply pumping response
R-22#1	—	—	—	—	No apparent water-supply pumping response
R-22#2	—	—	—	—	No apparent water-supply pumping response
R-22#3	—	—	—	—	No apparent water-supply pumping response
R-22#4	—	—	—	—	No apparent water-supply pumping response
R-22#5	—	—	—	—	No apparent water-supply pumping response
R-55#1	—	—	—	—	No apparent water-supply pumping response
R-55#2	—	—	—	—	No apparent water-supply pumping response
R-23	—	—	—	—	No apparent water-supply pumping response

Note: Wells are ordered from west to east, approximately following the general groundwater flow direction of the regional aquifer.

[a] — = Not determined because there is not apparent wate- level response to water-supply pumping during the period of observation.

[b] ND = Not determined because PM-2 was not actively used for water supply 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

Note: 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 and Earth-Tide Responses of the
Monitoring-Well Screens near MDA G Based on Hourly Water-level Data

Well	Screen	Barometric efficiency	Time Lag (hr)	Earth Tide Response
R-56	R-56 #1	100	1	Possible
R-56	R-56 #2	100	4	Y
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
R-49	R-49 #1	30	18	N
R-49	R-49 #2	100	2	N
R-41	R-41 Screen #2	100	1	N
R-57	R-57 #1	40	19	N
R-57	R-57 #2	100	3	Y
R-22	R-22 #1	65	24	N
R-22	R-22 #2	60	24	Possible
R-22	R-22 #3	100	16	Possible
R-22	R-22 #4	100	2	Possible
R-22	R-22 #5	100	3	Possible
R-39	R-39 #1	55	18	Y

Table E-3.1-4 (continued)

Well	Screen	Barometric efficiency	Time Lag (hr)	Earth Tide Response
R-55	R-55 #1	100	3	Possible
R-55	R-55 #2	100	3	Possible
R-23	R-23 #1	100	1	Y

Note: Wells are ordered from west to east, approximately following the general groundwater flow directions of the regional aquifer.

Appendix F

U.S. Department of Energy Requirements at Area G

F-1.0 DOE ORDER 435.1, RADIOACTIVE-WASTE MANAGEMENT

Portions of Area G at Technical Area 54 are used for radioactive waste disposal and are therefore regulated by the U.S. Department of Energy (DOE) through its authority under the Atomic Energy Act. DOE implements this authority via Order 435.1 and Order 458.1, and performance objectives are included in Order 435.1 to further limit the potential for exposure from disposed low-level waste (LLW). In an effort to present a comprehensive corrective measures evaluation for Material Disposal Area (MDA) G, Los Alamos National Laboratory (the Laboratory) has voluntarily provided information on DOE closure requirements and performance objectives applicable to LLW disposal facilities. The following sections outline the performance criteria, closure requirements and performance objectives for Area G under Orders 435.1 and 458.1.

DOE Order 435.1 requires that radioactive waste be managed in a manner that protects worker and public health and safety and the environment. In accordance with Order 435.1, the long-term performance of a LLW disposal facility is evaluated through a series of performance objectives. These criteria are designed to achieve the following:

- Ensure the health and safety of the public
- Protect groundwater resources
- Safeguard persons who may inadvertently intrude into the buried waste
- Maintain radiation doses from DOE facilities at levels that are as low as reasonably achievable (ALARA)

F-1.1 Performance Objectives

DOE Order 435.1 does not set specific closure design criteria for LLW disposal facilities but instead establishes specific objectives for the performance of the closed facility. Compliance with the performance objectives is demonstrated through the preparation and maintenance of site-specific radiological performance assessments and composite analyses. The performance assessment addresses waste disposed of after September 26, 1988; the composite analysis includes all radioactive waste disposed at a given facility as well as other sources of radioactive material that may interact with releases from that facility. The results of the performance assessment are evaluated with respect to the following objectives and limits to determine, with a reasonable degree of certainty, that the disposal facility will perform safely for a period of at least 1000 yr following closure.

- All-Pathway: Dose to representative members of the public shall not exceed 25 mrem in a year total effective dose equivalent (TEDE) from all exposure pathways, excluding the dose from radon and its progeny.
- Air-Pathway: Dose to representative members of the public via the air pathway shall not exceed 10 mrem in a year TEDE, excluding the dose from radon and its progeny.
- Release of Radon: Release of radon shall be less than an average flux of 20 $pCi/m^2/s$ at the surface of the disposal facility. Alternatively, a limit of 0.5 pCi/L of radon in air may be applied at the boundary of the facility.
- Groundwater Protection: The average annual concentration of beta-particle and photon radioactivity from anthropogenic radionuclides in drinking water must not exceed an annual dose equivalent to the total body or any internal organ of 4 mrem/yr.

The all-pathway performance objective addresses exposures that may be received from any and all modes of exposure, including exposures from airborne contaminants (except radon and its progeny). The air pathway performance objective addresses exposures from all sources of airborne radioactivity at DOE facilities, excluding the contributions of radon and its progeny. Compliance with these performance objectives must be demonstrated over a period of 1000 yr following closure of the disposal facility, at the point(s) of maximum exposure.

Releases of radon gas (i.e., radon-220 and radon-222) are subject to the requirements in 40 Code of Federal Regulations 61, Subpart Q (http://www.epa.gov/enviro/html/rad/rad_subpart_q.html), which limit releases to an average flux of 20 pCi/m^2/s at the surface of the disposal facility. An incremental increase of radon (0.5 pCi/L) at the point of assessment may also be used to demonstrate compliance with the "Release of Radon" performance objective. Compliance must be demonstrated for a period of 1000 yr following closure of the disposal facility.

The performance assessment must also include an assessment of impacts to groundwater resources. Potential impacts are to be assessed on a site-specific basis in accordance with a hierarchical set of criteria. In general, these criteria require that the LLW disposal site comply with applicable state or federal regulations for water resource protection. Potential impacts are to be evaluated at the point of highest groundwater concentration outside of a 100-m (330-ft) buffer zone for a period of 1000 yr following facility closure.

Finally, the performance assessment must consider impacts for a person who inadvertently intrudes into the disposed waste after a 100-yr active institutional control period. Projected intruder exposures are subject to chronic and acute dose limits of 100 and 500 mrem/yr, respectively, excluding contributions of radon in air. Compliance with these objectives must also be demonstrated for a period of 1000 yr following closure of the disposal facility.

The primary performance objective for the composite analysis is to ensure DOE's primary dose limit of 100 mrem/yr is met. This limit, established in Order 458.1, takes into account radioactivity coming from all sources and all exposure pathways. Order 435.1 imposes a dose constraint of 30 mrem/yr on the composite analysis to ensure any exposures received in conjunction with the disposal facility do not constitute an extraordinary portion of the primary dose limit. Potential exposures are to be evaluated at the point(s) of maximum exposure accessible to members of the public. Additionally, airborne releases from all activities, excluding the contributions of radon and its progeny, must not result in exposures that are greater than 10 mrem/yr. Compliance with these objectives must be demonstrated for a period of 1000 yr following closure of the disposal facility.

F-1.2 Closure

Order 435.1 requires DOE sites to prepare closure plans for LLW disposal facilities. The objective of final closure is to achieve long-term stability of the waste in a manner that protects human health and safety and the environment, and minimizes the need for active maintenance. Satisfactory long-term performance of the closed facility will depend largely on the final remedy for the disposal units. As discussed, the effectiveness of final closure is measured against performance objectives using the performance assessment and composite analysis. Although not regulated by the New Mexico Environment Department (NMED), the requirements under Order 435.1 will not be less stringent than those required by the Resource Conservation and Recovery Act.

A closure plan has been developed for the radioactive waste that is projected for disposal at Area G that describes the conceptual closure design for the site. This conceptual closure calls for installation of a cover over disposed radioactive waste. The proposed final cover design for Area G was developed using

an iterative approach in which successive cover designs underwent long-term analysis using the SIBERIA landscape evolution computer code. The result was an optimized design that is expected to be capable of meeting design criteria under a range of potential site conditions that could occur over the 1000-yr compliance period.

The cover design was evaluated in Revision 4 of the Performance Assessment and Composite Analysis for Los Alamos National Laboratory, Technical Area 54, Area G (French et al. 2008, 106890). The modeling results suggest the facility is capable of satisfying all Order 435.1 performance objectives. The proposed cover will effectively limit the degree to which plants and animals inhabiting the closed site can penetrate into the buried waste. The thickness and engineered aspects of the final cover (e.g., rock armor around the edge of the facility) will mitigate the effects of surface erosion and limit the degree to which inadvertent human intrusion disrupts the waste. The hydraulic properties of the cover are expected to limit the amount of water that percolates through the waste, thereby minimizing exposures received by persons living downgradient of the disposal facility. The cover design described in the Area G performance assessment and composite analysis may change depending on the remedial alternative selected by NMED for closure of MDA G. The corrective measures implementation process may provide an opportunity for improving the cover design to provide a more cost-effective solution while still meeting closure requirements under Order 435.1. The findings of any such evaluations will be used to update the Order 435.1 closure plan, performance assessment, and composite analysis as appropriate.

F-2.0 DOE ORDER 458.1, RADIATION PROTECTION OF THE PUBLIC AND THE ENVIRONMENT

The primary objective of Order 458.1 is to operate facilities and conduct activities so radiation exposures to members of the public are maintained within limits (established in the order) that control radioactive contamination and are ALARA. The order requires that DOE facilities have the capabilities, consistent with the types of operations conducted, to monitor routine and nonroutine releases and to assess radiological doses to members of the public and the environment.

Order 458.1 requires that exposure of members of the public to radiation sources as a consequence of routine DOE activities must not cause, in a year, an effective dose equivalent greater than 100 mrem. The limit of 100 mrem is the sum of the effective dose equivalent from exposures to radiation sources external to the body during the year plus the committed effective dose equivalent from radionuclides taken into the body during the year. The dose limits apply to both operational facilities and those that have been closed. If a facility is removed, but radioactive contamination remains, then the dose limits in Order 458.1 remain applicable to the property. The DOE cannot release the property from its control unless it can be demonstrated that the exposure to a member of the public will be below 100 mrem/yr. In accordance with DOE Policy 454.1, Use of Institutional Controls, DOE will implement institutional controls and maintain them into the future as long as necessary to protect human health and the environment.

Compliance with the dose limits is demonstrated by monitoring effluent discharges, conducting dose evaluations, and reporting the results of these evaluations.

Monitoring and Surveillance. General requirements for routine effluent monitoring are part of the environmental monitoring plan prescribed in DOE 5400.1. Specific requirements for radiological effluent monitoring and environmental surveillance are prescribed in DOE guidance. These monitoring requirements are applicable to all DOE and DOE-contractor operations that are subject to the standards and requirements of this Order.

Dose Evaluations. Doses to members of the public in the vicinity of DOE activities are evaluated and documented to demonstrate compliance with the dose limits of Order 458.1 and to assess exposures of the public from unplanned events. Collective doses to the public within 80 km of the site are also evaluated and documented at least annually.

F-3.0 REFERENCE

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.

French, S., R. Shuman, G.L. Cole, K.J. Crowell, M.S. Day, C.W. Gable, M.O. Gard, J.J. Whicker, D.G. Levitt, B.D. Newman, B.A. Robinson, E.P. Springer, and P.H. Stauffer, October 2008. "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal, Area G, Revision 4," Los Alamos National Laboratory document LA-UR-08-06764, Los Alamos, New Mexico. (French et al. 2008, 106890)

Appendix G

Supporting Information for
Cost Estimates for Material Disposal Area G

G-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 the Material Disposal Area (MDA) G 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).

Three corrective measures alternatives were retained and have been brought forward for cost estimating purposes. These are in addition to the no-action alternative.

G-1.1 Compliance Order on Consent Requirements

The Compliance Order on Consent (hereafter, the 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.

G-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 G-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. The cost is then burdened with applicable taxes, including New Mexico gross receipts tax (NMGRT), general and administrative (G&A) tax, infrastructure tax, and Associate Director (AD) tax.

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 of the CME report. The actual design and operations costs will vary from these estimates when the corrective measure implementation (CMI) is completed.

G-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; 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 includes a $7 per direct job hour cost to account for the non-labor costs associated with temporary utilities/services, small tools, consumables, construction equipment not specifically identified in direct work line items, and training costs. An example would be

> Site fencing labor hours (2692) + RCRA cover labor hours (131,988) + SVE labor hours (11,194) = 145,874 hours * 20% = 29,175 hr of field non-manual

> Site fencing labor hours (2692) + RCRA cover labor hours (131,988) + SVE labor hours (11,194) = 145,874 hours * 25% = 36,468 hr of craft distributable–labor

> Site fencing labor hours (2692) + RCRA cover labor hours (131,988) + SVE labor hours (11,194) = 141,874 hours * 25% = 36,468 hr * $7/hr = $255,276, which is then burdened with applicable taxes including NMGRT, G&A, infrastructure, and AD support taxes for a total craft distributable–material cost of $436,808.

The design costs were calculated as 16% of the total direct capital costs. An example would be

> Site fence total ($1,039,331) + RCRA cover total ($58,722,278) + SVE total ($2,356,831) + distributable total ($6,627,668) = $68,746,108 * 16% = $10,999,377, which is then burdened with applicable taxes including NMGRT, G&A, infrastructure, and AD support taxes for a total design cost of $16,013,993.

The professional management costs were calculated as 26 % of the total direct capital costs and design. An example would be:

> Site fence total ($1,039,331) + RCRA cover total ($58,722,278) + SVE total ($2,356,831) + distributable total ($6,627,668) + design total ($16,013,993) = $84,760,101 * 26% = $22,037,626, which is then burdened with applicable taxes including, NMGRT, G&A, infrastructure, and AD support taxes for a total professional management cost of $48,287,292.

The contingency costs were calculated as 50% of the total direct capital costs plus design and professional management costs. An example would be

Total direct capital costs ($68,746,108) + design costs ($16,013,993) + professional management costs ($48,287,292) = $133,047,393 * 50% = $66,523,696.

G-2.2 Operations and Maintenance Costs

The 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 before PV analysis. The costs are then discounted based on the PV analysis discussed below in section G-2.3.

The contingency costs were calculated as 50% of the total direct O&M costs plus professional management costs. An example would be

> Total direct O&M costs ($6,738,601) + professional management O&M costs ($2,299,651) = $9,038,252 * 50% = $4,519,127.

G-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.

G-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 (HAZWOPER) 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.

Three years of soil vapor extraction (SVE) and rebound vapor monitoring are assumed for cost estimation purposes for Alternatives 2A, 2B, and 3. However, SVE operations will continue until shut down parameters are achieved as described in Appendix J. Attachment G-1 is the detailed cost assembly report for the estimates described below.

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 and not Defense Program project, and escalation was not accounted for.

G-3.0 MDA G ALTERNATIVES

Three corrective measures alternatives, plus the no-action alternative, are described below.

G-3.1 Alternative 1: No Action

This alternative involves leaving the site as is. No costs are involved with this alternative.

G-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, and pits
- 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

Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Area to be covered by the multilayer (RCRA) cover is 51 acres.
- Fencing around the site will total 10,250 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, 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
    - cover armoring of slopes over 1:4 (25%) and not cut into bedrock. This assumption is 4840 yrd^3 of cobble material.
- Time to complete construction will be 24 mo; irrigation will continue for 1 yr.
- Armoring material parametric unit costs are higher than other cover materials because of the increase in hand labor needed to place these on steeper slopes.
- There is no shoulder material included in the MDA G cover estimates because of the assumption that the shoulders of the site would be built into the tuff on the sides of the mesa and some of the operational cover would be used during the cut-and-fill process for these purposes.
- 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.
- Four existing monitoring wells will be converted from Flexible Liner Underground Technologies (FLUTe) to stainless-steel systems.
- One existing open monitoring well will be completed with a stainless-steel system with two ports.
- Operation of SVE will continue for 3 yr.
- Eighteen 10-in.-diameter extraction boreholes will be installed to a depth of 150 ft.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Construction of each borehole will require 2 wk.
- SVE operations will involve 3 SVE units operating 30 d at each of the 24 boreholes once per yr for 3 yr.
- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples (one per week for a month) at 24 boreholes (120 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per yr, at 27 ports (243 samples/yr).
- Yearly vapor monitoring will consist of 58 ports each sampled once per yr (58 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), which calculates the design cost as a percentage of direct capital costs.
- Contingency is based on 50% total for both direct and indirect costs.
- Assuming 5 ft of clay, drainage soil, and topsoil from within a 25-mi radius (50-mi roundtrip. Over 51 acres, a total of 27,427 trucks (assuming 15 yd^3/truck) are required. Total mileage is approximately 1,371,000 mi.

G-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 and pits
- 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

Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Area to be covered by the ET cover is 51 acres.
- Fencing around the site will total 10,250 ft.
- Construction of the ET 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 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
    - ❖ cover armoring of slopes over 1:4 (25%) and not cut into bedrock. This assumption is 4840 yrd^3 of cobble material.
- Time to complete construction will be 6 mo; irrigation will continue for 1 yr.
- Armoring material parametric unit costs are higher than other cover materials because of the increase in hand labor needed to place these on steeper slopes.
- There is no shoulder material included in the MDA G cover estimates because of the assumption that the shoulders of the site would be built into the tuff on the sides of the mesa and some of the operational cover would be used during the cut-and-fill process for these purposes.

- 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.
- Four existing monitoring wells will be converted from FLUTe to stainless-steel systems.
- One existing open monitoring well will be completed with a stainless-steel system with two ports.
- Operation of SVE will continue for 3 yr.
- Eighteen 10-in.-diameter extraction boreholes will be installed to a depth of 150 ft.
- Six 10-in.-diameter extraction boreholes will be installed to a depth of 200 ft.
- Construction of each borehole will require 2 wk.
- SVE operations will involve 3 SVE units operating 30 d at each of the 24 boreholes once per yr for 3 yr.
- VOC monitoring of extraction boreholes for 3 yr during operations will include 5 samples (one per week for a month) at 24 boreholes (120 samples/yr).
- Rebound monitoring for 3 yr will include 3 samples, 3 times per yr, at 27 ports (243 samples/yr).
- Yearly vapor monitoring will consist of 58 ports each sampled once per yr (58 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.
- Assuming 3.5 ft of crushed tuff from TA-61 (23-mi roundtrip). Assuming 1.5 ft of gravel admixture and topsoil from within a 25-mi radius (50-mi roundtrip). Over 51 acres, a total of 27,427 trucks (assuming 15- yd^3/truck) are required. Total mileage is approximately 853,000 mi.

G-3.4 Alternative 3: Excavation, SVE, and Institutional Controls

This technology includes the following tasks:

- excavation, analysis, and segregation of the waste in the pits and shafts regulated by the Consent Order (Tables G-3.4-1 and G-3.4-2) using standard excavation methods (Figures G-3.4-1 and G-3.4-2)
- construction of three excavation enclosures with supplied air and high-efficiency particulate air filters to control releases and for weather protection
- construction of an on-site waste analysis, and segregation facility
- off-site treatment and disposal of wastes
- site surveillance, monitoring and maintenance of the site
- institutional controls for 100 yr

G-3.5.1 Assumptions

The following assumptions were used to develop the cost estimate for this technology:

- Excavation of both pits and shafts will use standard excavation equipment.
- Excavation is assumed to be performed under an enclosure (three total for estimating purposes) to maintain control of airborne particulates, avoid stormwater infiltration, and reduce downtime because of the weather. The scope to erect and move these structures is captured in the excavation site preparation portion of the detailed estimate in attachment G-1.
- Excavation, segregation, analysis, treatment and disposal activities will be complete within a 30-yr period based on the assumption of a productivity of 1,654,535 yd^3 (total volume) / 30 yr * 250 work days/yr = 220 yd^3/d being excavated and processed. Based on activities at MDA B and North Ancho, 220 yd is a reasonable estimate for a feasible productivity rate at this site.
- Backfilling the excavation will require clean fill to be imported from TA-61 to complete filling the excavation. At 23-mi round trip with a 15-yd^3 truck capacity, truck miles are 1,384,316.
- Three 600-ft-long access roads will be required to access the shaft excavations.
- Approximately 10,250 ft of fencing will be installed around the site.
- The following are estimated quantities for the purposes of cost estimating. Detailed estimates of waste and excavation quantity associated with each group are presented in Tables G-3.4-1 and and G-3.4-2.
- Transporting the transuranic (TRU) waste, RCRA, and mixed low-level waste (MLLW) to Clive, Utah (1450-mi round trip) and assuming 15-yd^3 truck capacity would result in 87,272,116 truck miles. Total truck miles for this technology are 88,656,433 mi.
- Assuming 1,654,535 $yd^3$of waste material to be disposed of in Clive, Utah (1450-mi roundtrip), a total of 110,302 trucks (assuming 15 yd^3/truck) are required. Total mileage is approximately 160 million miles. Additionally, the same volume of crushed tuff and the same number of trucks are required to backfill the excavation (assuming a 23-mi roundtrip from TA-61). The additional miles are approximately 2.5 million miles. Total mileage for this alternative is approximately 162.5 million miles.

Pits:

- Total excavated volume – 1,491,253 yd^3
- Total waste volume in pits – 898,924 yd^3
    - ❖ Total TRU – 54,536 yd^3
    - ❖ Total MLLW requiring off-site disposal – 844,388 yd^3
- Material suitable for backfill – 592,329 yd^3

Shafts:

- Total excavated volume – 163,282 yd^3
- Total waste volume in shafts – 3891 yd^3
  - ❖ Polychlorinated biphenyls (PCBs) requiring off-site disposal – 754 yd^3
  - ❖ Total RCRA requiring off-site disposal – 68 yd^3
  - ❖ Total MLLW requiring off-site disposal – 3069 yd^3
- Material suitable for backfill – 159,391 yd^3

Total:

- Total excavated volume – 1,654,535 yd^3
- Total waste volume in pits and shafts – 902,815 yd^3
  - ❖ Total TRU – 54,536 yd^3
  - ❖ PCBs requiring off-site disposal – 754 yd^3
  - ❖ Total RCRA requiring off-site disposal – 68 yd^3
  - ❖ Total MLLW requiring off-site disposal – 847,457 yd^3
- Material suitable for backfill – 751,720 yd^3
- All waste is assumed to be treated and disposed of off-site.
- The excavated area will be graded and seeded.
- A gravel access road is included in the estimate to facilitate O&M on the site.
- Indirect O&M cost for professional management is based on 26% of direct O&M costs.
- Design costs are calculated using the percentage method (16% of direct capital costs).

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.

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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)

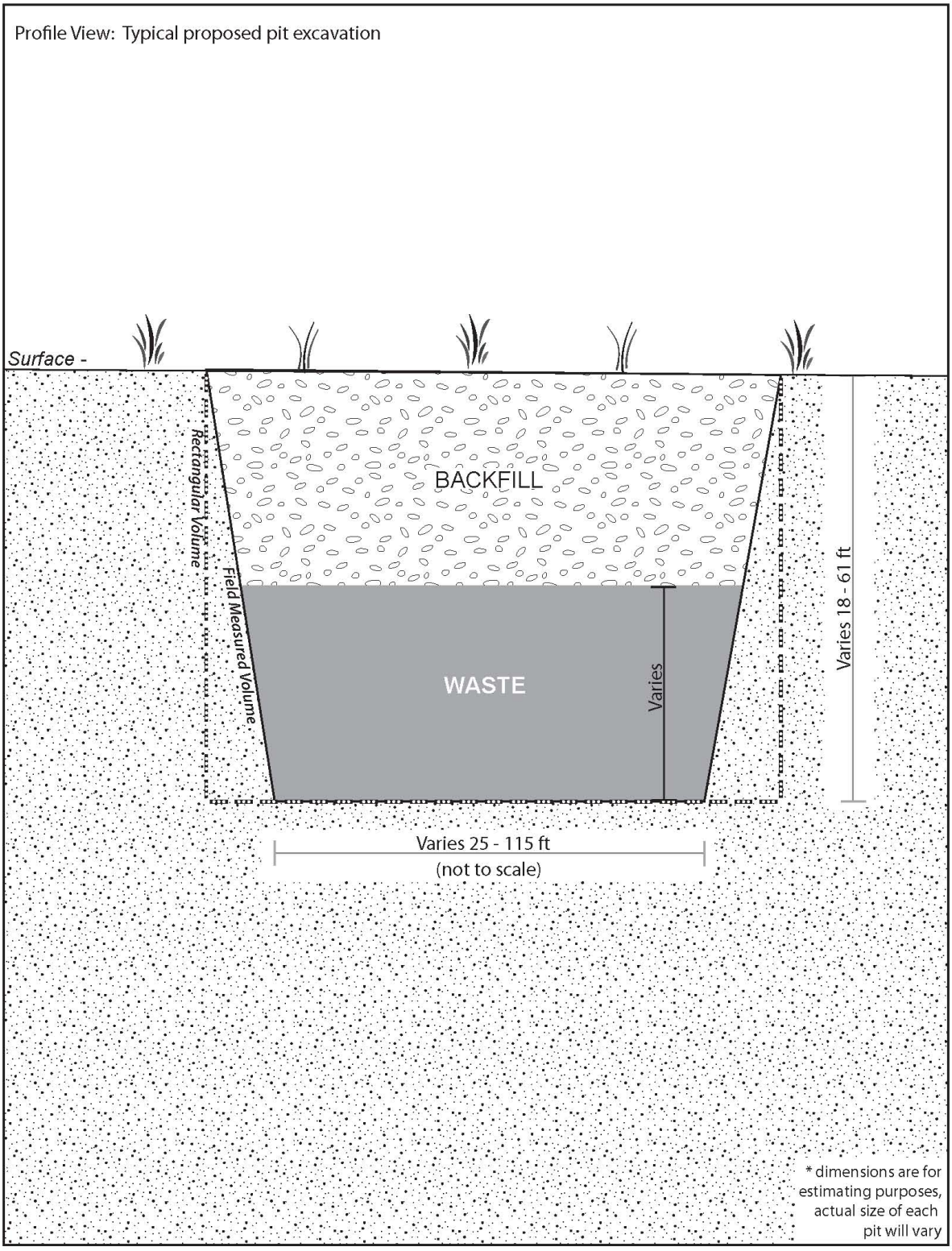

Figure G-3.4-1 Typical cross-section of pits excavation

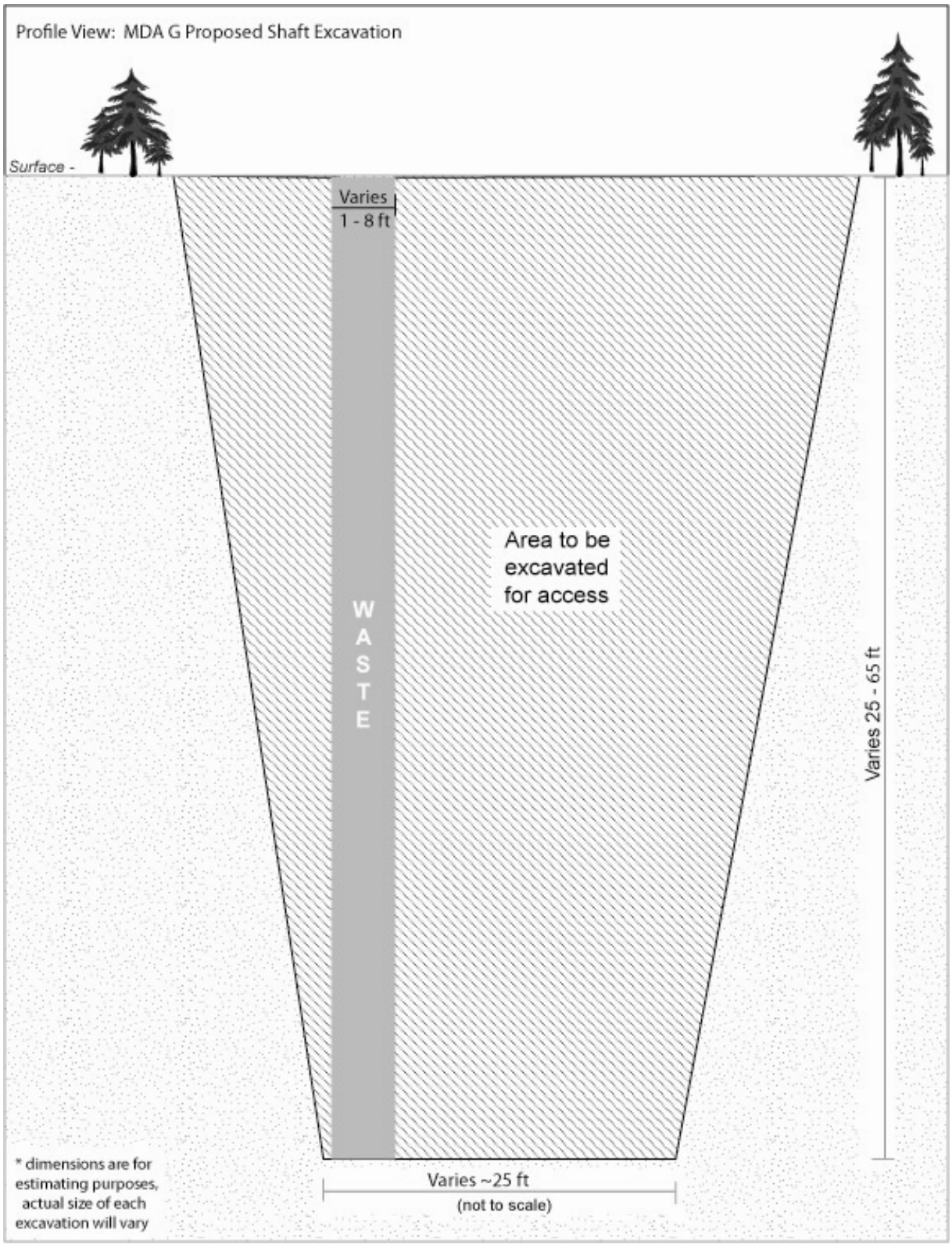

Figure G-3.4-2 Typical cross-section of shaft excavation

Table G-3.4-1
Excavation of Pits

Pit No.	Dimensions (length × width × depth)	Rectangular Volume of Pit (yd^3)	Field-Measured Pit Volume (yd^3)	Estimated Disposed Waste Volume in Pit (yd^3)	Estimated TRU Waste Volume (yd^3)[a]	Estimated MLLW Volume (yd^3)[b]	Estimated Total Waste Volume (yd^3)[c]	Estimated Materials Suitable for Backfill (yd^3)[d]
1	616 ft × 113 ft × 20 ft	51,561	37,080	5529	5529	31,551	37,080	14,481
2	618 ft × 104 ft × 26 ft	61,892	42,911	6407	6407	36,504	42,911	18,981
3	655 ft × 115 ft × 33 ft	92,064	56,759	9473	9473	47,286	56,759	35,305
4	600 ft × 110 ft × 34 ft	83,111	44,950	8212	8212	36,738	44,950	38,161
5	600 ft × 100 ft × 29 ft	64,444	41,258	6624	6624	34,634	41,258	23,186
6	600 ft × 113 ft × 26 ft	65,289	43,933	6696		43,933	43,933	21,356
7	600 ft × 50 ft × 30 ft	33,333	17,101	4343	4343	12,758	17,101	16,232
8	400 ft × 25 ft × 25 ft	9259	6528	2311	2311	4217	6528	2731
10	380 ft × 57 ft × 27 ft	21,660	15,549	4016		15,549	15,549	6111
12	400 ft × 25 ft × 25 ft	9259	7303	2363	2363	4940	7303	1956
13	400 ft × 42 ft × 28 ft	17,422	12,107	1931		12,107	12,107	5315
16	400 ft × 25 ft × 25 ft	9259	8081	2235		8081	8081	1178
17	600 ft × 46 ft × 24 ft	24,533	17,399	4962	4962	12,437	17,399	7134
18	600 ft × 75 ft × 40 ft	66,667	46,685	12,358		46,685	46,685	19,982
19	153 ft × 30 ft × 18 ft	3060	1371	0		1371	1371	1689
20	600 ft × 71 ft × 36 ft	56,800	37,454	14,899		37,454	37,454	19,346
21	402 ft × 56 ft × 26 ft	21,678	13,328	3607		13,328	13,328	8350
22	413 ft × 56 ft × 33 ft	28,268	17,690	3744		17,690	17,690	10,578
24	600 ft × 58 ft × 30 ft	38,667	23,388	7327		23,388	23,388	15,279
25	395 ft × 103 ft × 39 ft	58,767	47,000	6530		47,000	47,000	11,767
26	310 ft × 100 ft × 36 ft	41,333	22,209	4312	4312	17,897	22,209	19,124
27	400 ft × 80 ft × 46 ft	54,519	26,946	7441		26,946	26,946	27,573
28	330 ft × 83 ft × 40 ft	40,578	21,381	4422		21,381	21,381	19,197
29	658 ft × 80 ft × 50 ft	97,481	45,795	9784		45,795	45,795	51,686

Table G-3.4-1 (continued)

Pit No.	Dimensions (length × width × depth)	Rectangular Volume of Pit (yd^3)	Field-Measured Pit Volume (yd^3)	Estimated Disposed Waste Volume in Pit (yd^3)	Estimated TRU Waste Volume (yd^3)[a]	Estimated MLLW Volume (yd^3)[b]	Estimated Total Waste Volume (yd^3)[c]	Estimated Materials Suitable for Backfill (yd^3)
30	568 ft × 39 ft × 35 ft	42,843	28,716	13,464		28,716	28,716	14,127
31	280 ft × 52 ft × 25 ft	13,481	13,481	2702		13,481	13,481	0
32	518 ft × 74 ft × 51 ft	72,405	36,364	5367		36,364	36,364	36,041
33	425 ft × 115 ft × 40 ft	72,407	59,930	7776		59,930	59,930	12,477
35	363 ft × 83 ft × 40 ft	44,636	20,957	3361		20,957	20,957	23,679
36	435 ft × 83 ft × 43 ft	57,501	28,057	4491		28,057	28,057	29,444
37	731 ft × 83 ft × 61 ft	137,076	57,213	24,299		57,213	57,213	79,863
Totals		**1,491,253**	**898,924**	**200,986**	**54,536**	**844,388**	**898,924**	**592,329**

Note: Blank cell indicates this waste type/material is not known to be found in the pit.

[a] Newly generated TRU equals volume of waste in pit containing TRU in Table 2.1-1.

[b] Difference between the field-measured pit volume and estimated TRU waste volume.

[c] Sum of estimated TRU waste volume and estimated MLLW volume.

[d] Difference between the rectangular volume of pit and field-measured pit volume.

Table G-3.4-2
Shaft Excavation

	Shaft Excavation Area (yd^2)	Shaft Excavation Volume (yd^3)	Shaft Volume (yd^3)	PCB (yd^3)[a]	RCRA (yd^3)[b]	MLLW (yd^3)[c]	Total Estimated Waste (yd^3)	Estimated Materials Suitable for Backfill (yd^3)
GROUP 1: 1-20, 22, 24–96, 99–112, 114, 115, 118–123, 125–135								
Total	260 ft × 120 ft	75,111	2103	0	0	2103	2103	73,008
GROUP 2: 136, 138–140								
Total	100 ft × 50 ft	12,037	188	0	0	188	188	11,849
GROUP 3: 150,151								
Total	85 ft × 50 ft	10,231	79	0	0	79	79	10,153
GROUP 4: 152–160								
Total	175 ft × 45 ft	18,958	105	0	0	105	105	18,854
GROUP 5: 189-192, 196								
Total	175 ft × 60 ft	25,278	595	0	0	595	595	24,683
GROUP 6 – PCBs: C1-10, C12, C13								
Total	180 ft × 50 ft	21,667	754	754	0	0	754	20,913
RCRA: 124, 144, 145								
Total	**n/a**[d]	**—**	**68**	**0**	**68**	**0**	**68**	**0**
Grand Total	—	**163,282**	**3891**	**754**	**68**	**3069**	**3891**	**159,460**

Note: Blank cell indicates this waste type/material is not known to be found in the shafts.

[a] Estimated PCB waste volume is equal to shaft volume as shown in Table 2.1-3.

[b] Estimated RCRA waste volume is equal to shaft volume as shown in Table 2.1-3.

[c] Estimated MLLW waste volume is equal to shaft volume as shown in Table 2.1-3.

[d] n/a = Not applicable. Shafts within other excavation areas

Attachment G-1

Detailed Cost Estimate Report

MDA-G Feasability Study Update

Project WBS	Activity Description		Takeoff Quantity - Adjusted	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 "G" Feasability Study											
1.MDAG2A	2A Multilayer (RCRA) Cover, SVE, Institutional Controls											
1.MDAG2A.1	2A Multilayer (RCRA) Cover, SVE, Institutional Controls											
	MDA G - Direct Capital Costs											
1.MDAG2A.1.01	RCRA Cover MDA G -DC- Fence											
1.MDAG2A.1.01	RCRA Cover MDA G -DC- Fence											
1.MDAG2A.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire		10,250.0	LF	56.72	2,489.9	198,846.06	771,714.79	24,203.78			994,765
1.MDAG2A.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, 3" diameter, includes excavation, in concrete		34.0	EA	162.19	37.1	2,966.64	6,108.70	360.70			9,436
1.MDAG2A.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, includes excavation, posts & hardware in concrete		2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAG2A.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes posts		103.0	EA	120.98	85.7	6,843.88	12,601.54	1,877.01			21,322
1.MDAG2A.1.01		Total				2,692.8	215,055.04	796,071.72	28,203.95			1,039,331
1.MDAG2A.1.01		Total				2,692.8	215,055.04	796,071.72	28,203.95			1,039,331
1.MDAG2A.1.02	RCRA Cover MDA G -DC- RCRA Cover											
1.MDAG2A.1.02.01	RCRA Cover MDA G -DC- RCRA Cover - Site Prep											
1.MDAG2A.1.02.01	Excavation permit		2.0	ea	700.00					2,395.57		2,396
1.MDAG2A.1.02.01	Lister support		48.0	hour	100.10	87.4	8,221.59					8,222
1.MDAG2A.1.02.01	Track out device		4.0	EA	5,234.35	21.8	1,603.97	34,222.39				35,826
1.MDAG2A.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.MDAG2A.1.02.01	Rent toilet portable chemical		24.0	mnth	400.00				16,426.74			16,427
1.MDAG2A.1.02.01	Chemical toilet cleaning.		24.0	mnth	946.50	393.1	24,556.60		14,313.20			38,870
1.MDAG2A.1.02.01	Chemical toilet cleaning (labor)		24.0	mnth	573.07	393.1	23,534.02					23,534
1.MDAG2A.1.02.01	Selective clearing, brush, with brush saw, includes cutting and site cleanup, excludes removal offsite		51.0	acre	3,022.82	2,972.4	253,981.84		9,810.71			263,793
1.MDAG2A.1.02.01	Laydown - Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep		8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAG2A.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.MDAG2A.1.02.01	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller		1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAG2A.1.02.01		Total				4,125.7	332,535.96	135,520.65	66,958.22	2,395.57		537,410
1.MDAG2A.1.02.02	RCRA Cover MDA G -DC- RCRA Cover - Cover Prep											
1.MDAG2A.1.02.02	Borrow, fill material only.		122,774.0	ton	20.50			4,306,659.62				4,306,660
1.MDAG2A.1.02.02	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction		61,387.0	CY	4.46	2,225.1	190,127.24		278,357.27			468,485
1.MDAG2A.1.02.02	Backfill, structural, common earth, 80 H.P. dozer, 300' haul		61,387.0	CY	4.62	4,055.9	346,561.04		138,666.13			485,227
1.MDAG2A.1.02.02	Water wagon 1,000 gal compaction		61,387.0	CY	0.44	737.4	46,061.16					46,061
1.MDAG2A.1.02.02	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller		61,387.0	CY	0.94	563.3	44,513.87		54,622.81			99,137
1.MDAG2A.1.02.02	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 150 H.P., up to 50 miles		4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAG2A.1.02.02		Total				7,601.1	628,799.11	4,306,659.62	473,733.78			5,409,193
1.MDAG2A.1.02.03	RCRA Cover MDA G -DC- RCRA Cover - 2' of 10-7 Clay Compacted											
1.MDAG2A.1.02.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction		162,914.0	CY	4.46	5,905.2	504,575.70		738,728.00			1,243,304
1.MDAG2A.1.02.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul		162,914.0	CY	4.62	10,763.8	919,732.93		368,003.89			1,287,737
1.MDAG2A.1.02.03	Water wagon 1,000 gal compaction		162,914.0	CY	0.44	1,956.9	122,240.99					122,241
1.MDAG2A.1.02.03	Clay handling and rework		51.0	acre	100,000.00	41,448.1	3,541,600.45		5,185,107.83			8,726,708
1.MDAG2A.1.02.03	Clay backfill material delivered, medium cost, up to 20 miles haul distance (40 miles round trip for mobilization/demobilization crew), L.C.Y.		162,914.0	L.C.Y.	50.00			13,938,264.24				13,938,264
1.MDAG2A.1.02.03	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller		162,914.0	CY	0.94	1,495.0	118,134.68		144,962.61			263,097
1.MDAG2A.1.02.03		Total				61,569.0	5,206,284.75	13,938,264.24	6,436,802.33			25,581,351
1.MDAG2A.1.02.04	RCRA Cover MDA G -DC- RCRA Cover - 40 mm HDPE Geomembrane											
1.MDAG2A.1.02.04	40 mm HDPE Liner		259,182.0	SY	7.21	3,135.2	267,895.90	2,660,947.89	268,238.65			3,197,082
1.MDAG2A.1.02.04	Liner binding		111,078.0	SF	7.26	6,765.1	749,267.45	600,613.95	29,769.75			1,379,651
1.MDAG2A.1.02.04		Total				9,900.4	1,017,163.35	3,261,561.84	298,008.40			4,576,734
1.MDAG2A.1.02.05	RCRA Cover MDA G -DC- RCRA Cover - 1' of 10-2 Drainage Layer											
1.MDAG2A.1.02.05	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only		82,197.0	CY	24.50			3,445,897.33				3,445,897
1.MDAG2A.1.02.05	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction		82,197.0	CY	4.46	2,979.4	254,579.77		372,719.51			627,299

MDA-G Feasability Study Update

Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG2A.1.02.05	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	82,197.0	CY	4.62	5,430.8	464,044.14		185,673.52			649,718
1.MDAG2A.1.02.05	Water wagon 1,000 gal compaction	82,197.0	CY	0.44	987.4	61,675.75					61,676
1.MDAG2A.1.02.05	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	82,197.0	CY	0.94	754.3	59,603.94		73,139.77			132,744
1.MDAG2A.1.02.05	**Total**				**10,151.8**	**839,903.60**	**3,445,897.33**	**631,532.79**			**4,917,334**
1.MDAG2A.1.02.06	**RCRA Cover MDA G -DC- RCRA Cover - 2' of Cover Soil/Surface Treatment**										
1.MDAG2A.1.02.06	TUFF - Borrow, fill material only.	164,394.0	ton	20.50			5,766,603.70				5,766,604
1.MDAG2A.1.02.06	Tuff - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	82,197.0	CY	4.46	2,979.4	254,579.77		372,719.51			627,299
1.MDAG2A.1.02.06	TUFF - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	82,197.0	CY	4.62	5,430.8	464,044.14		185,673.52			649,718
1.MDAG2A.1.02.06	TUFF - Water wagon 1,000 gal compaction	82,197.0	CY	0.44	987.4	61,675.75					61,676
1.MDAG2A.1.02.06	Soil - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	82,197.0	CY	4.46	2,979.4	254,579.77		372,719.51			627,299
1.MDAG2A.1.02.06	Soil - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	82,197.0	CY	4.62	5,430.8	464,044.14		185,673.52			649,718
1.MDAG2A.1.02.06	Soil - Water wagon 1,000 gal compaction	82,197.0	CY	0.44	987.4	61,675.75					61,676
1.MDAG2A.1.02.06	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	82,197.0	CY	0.94	754.3	59,603.94		73,139.77			132,744
1.MDAG2A.1.02.06	Soil - Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	82,197.0	CY	15.54	6,992.4	552,544.62	1,040,801.64	592,113.00			2,185,459
1.MDAG2A.1.02.06	Soil - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	82,197.0	CY	0.94	754.3	59,603.94		73,139.77			132,744
1.MDAG2A.1.02.06	**Total**				**27,296.0**	**2,232,351.82**	**6,807,405.34**	**1,855,178.59**			**10,894,936**
1.MDAG2A.1.02.08	**RCRA Cover MDA G -DC- RCRA Cover - Cover Armoring**										
1.MDAG2A.1.02.08	Manual Backfill, by hand, slope building	4,840.0	CY	90.61	8,782.2	750,408.68					750,409
1.MDAG2A.1.02.08	Cobble - Cobble Material and Delivery	6,534.0	TN	20.50			229,199.29				229,199
1.MDAG2A.1.02.08	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	4,840.0	CY	3.30	133.2	10,528.96		16,811.68			27,341
1.MDAG2A.1.02.08	**Total**				**8,915.4**	**760,937.65**	**229,199.29**	**16,811.68**			**1,006,949**
1.MDAG2A.1.02.09	**RCRA Cover MDA G -DC- RCRA Cover - Re Vegetation**										
1.MDAG2A.1.02.09	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	2,222.0	Msf	34.33	1,214.4	89,185.54		41,347.91			130,533
1.MDAG2A.1.02.09	Hydroseeding materials.	1.0	lsum	2,233,902.00			3,822,472.76				3,822,473
1.MDAG2A.1.02.09	Broadcasting Mulch and Humate	2,222.0	Msf	34.33	1,214.4	89,185.54		41,347.91			130,533
1.MDAG2A.1.02.09	Mulch and Humate materials.	1.0	LS	1,002,170.00			1,714,832.40				1,714,832
1.MDAG2A.1.02.09	**Total**				**2,428.7**	**178,371.08**	**5,537,305.16**	**82,695.83**			**5,798,372**
1.MDAG2A.1.02	**Total**				**131,988.2**	**11,196,347.33**	**37,661,813.47**	**9,861,721.61**	**2,395.57**		**58,722,278**
1.MDAG2A.1.03	**SVE MDA G -DC- SVE**										
1.MDAG2A.1.03.01	**SVE MDA G -DC- SVE - SVE Unit**										
1.MDAG2A.1.03.01	SVE Unit - Contractors Price	8.0	ea	35,000.00	8.0				479,113.40		479,113
1.MDAG2A.1.03.01	SVE Piping Equipment (1 per extraction borehole)	24.0	ea	2,000.00	43.7				82,133.72		82,134
1.MDAG2A.1.03.01	**Total**				**51.7**				**561,247.12**		**561,247**
1.MDAG2A.1.03.02	**SVE MDA G -DC- SVE - Extraction Boreholes**										
1.MDAG2A.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	75.0	bag	9.80			1,257.67				1,258
1.MDAG2A.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' deep, excludes excavation, backfill and cast in place concrete	24.0	EA	1,018.17	363.1	25,871.78	15,810.74	130.45			41,813
1.MDAG2A.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	12.0	CY	210.12	54.6	4,314.50					4,314
1.MDAG2A.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 CY truck, cycle 4 miles, 15 MPH, no loading equipment	83.0	CY	103.13	181.3	14,324.13		322.39			14,647
1.MDAG2A.1.03.02	Pore Gas Monitoring - LLW Disposition	83.0	CY	1,200.00					170,427.48		170,427
1.MDAG2A.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit mobilization to site, excluding cost of conduit	24.0	EA	1,158.34	349.9	27,651.87		19,917.43			47,569
1.MDAG2A.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	1,200.0	LF	138.80	1,800.0	186,602.01	94,453.78	3,942.42			284,998
1.MDAG2A.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 4" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	3,900.0	LF	33.52	1,860.3	206,035.90	17,684.42				223,720
1.MDAG2A.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	1.9	Csf	334.06	8.6	951.77	25.52	108.77			1,086
1.MDAG2A.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only	55.5	CY	24.50			2,326.69				2,327
1.MDAG2A.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	72.0	CF	3.74			460.77				461
1.MDAG2A.1.03.02	Structural concrete, placing, excludes material	72.0	CF	1.90	2.8	201.00		33.26			234

MDA-G Feasability Study Update

Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG2A.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	1,240.0	CF	3.74			7,935.49				7,935
1.MDAG2A.1.03.02	Grout - concrete, placing, excludes material	1,240.0	CF	1.90	48.6	3,461.74		572.88			4,035
1.MDAG2A.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	11.0	CY	275.66	50.0	5,188.57					5,189
1.MDAG2A.1.03.02	Project Geologist	480.0	hour	77.00	480.0	80,984.15					80,984
1.MDAG2A.1.03.02	Field Technician	480.0	hour	65.00	480.0	68,363.24					68,363
1.MDAG2A.1.03.02	Radiological Control Technician	480.0	hour	65.00	480.0	68,363.24					68,363
1.MDAG2A.1.03.02	Health and Safety Officer - Site	48.0	hour	77.00	48.0	8,098.41					8,098
1.MDAG2A.1.03.02	Project Engineer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2A.1.03.02	Project Manager	120.0	hour	77.00	120.0	20,246.04					20,246
1.MDAG2A.1.03.02	Health and Safety Officer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2A.1.03.02	Project Scientist - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2A.1.03.02	Health and Safety Officer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2A.1.03.02	Health and Safety Officer - Site	150.0	hour	77.00	150.0	25,307.55					25,308
1.MDAG2A.1.03.02	Project Geologist	1,920.0	hour	77.00	1,920.0	323,936.59					323,937
1.MDAG2A.1.03.02	**Total**				**8,557.3**	**1,096,897.20**	**139,955.09**	**25,027.60**	**170,427.48**		**1,432,307**
1.MDAG2A.1.03.03	**SVE MDA G -DC- SVE - Monitoring Boreholes**										
1.MDAG2A.1.03.03	Bentonite clay, 50# bag, 1 per 10' of rod	184.0	EA	38.00			11,964.15				11,964
1.MDAG2A.1.03.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only	1.4	CY	24.50			57.01				57
1.MDAG2A.1.03.03	Backfill, heavy soil, by hand, no compaction	12.8	CY	123.87	209.7	2,713.12					2,713
1.MDAG2A.1.03.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes weld joint and clevis type hangers 10' OC	3,200.0	LF	16.95	730.1	75,685.16	14,718.36	2,409.26			92,813
1.MDAG2A.1.03.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, includes the weld machine	16.0	EA	121.05	26.5	2,752.19	474.73	87.06			3,314
1.MDAG2A.1.03.03	Mud Dauber (monitoring port)	16.0	EA	122.45	26.5	2,752.19	513.17	87.06			3,352
1.MDAG2A.1.03.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit mobilization to site, excluding cost of conduit	4.0	EA	1,158.34	58.3	4,608.64		3,319.57			7,928
1.MDAG2A.1.03.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	200.0	LF	138.80	300.0	31,100.33	15,742.30	657.07			47,500
1.MDAG2A.1.03.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	840.0	LF	37.76	400.7	41,540.83	11,426.85	1,307.98			54,276
1.MDAG2A.1.03.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	12.0	CF	3.74			76.80				77
1.MDAG2A.1.03.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includes vibrating, excludes material	12.0	CF	1.90	0.5	33.50		5.54			39
1.MDAG2A.1.03.03	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	2.0	CY	210.12	9.1	719.08					719
1.MDAG2A.1.03.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	4.0	EA	80.25	2.4	251.57	297.73				549
1.MDAG2A.1.03.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 CY truck, cycle 6 miles, 15 MPH, excludes loading equipment	18.0	CY	12.87	2.4	192.98		203.51			396
1.MDAG2A.1.03.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 150 H.P., up to 50 miles	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAG2A.1.03.03	Monitoring Well Waste	18.0	CY	1,200.00					36,960.18		36,960
1.MDAG2A.1.03.03	**Total**				**1,785.7**	**163,885.40**	**55,271.11**	**10,164.62**	**36,960.18**		**266,281**
1.MDAG2A.1.03.04	**SVE MDA G -DC- SVE - Monitoring Borehole Conversion 600'**										
1.MDAG2A.1.03.04	Bentonite clay, 50# bag, 1 per 10' of rod	130.0	EA	38.00			8,452.93				8,453
1.MDAG2A.1.03.04	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only	1.2	CY	24.50			50.31				50
1.MDAG2A.1.03.04	Backfill, heavy soil, by hand, no compaction	9.6	CY	123.87	157.2	2,034.84					2,035
1.MDAG2A.1.03.04	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes weld joint and clevis type hangers 10' OC	1,200.0	LF	16.95	273.8	28,381.93	5,519.39	903.47			34,805
1.MDAG2A.1.03.04	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, includes the weld machine	2.0	EA	121.05	3.3	344.02	59.34	10.88			414
1.MDAG2A.1.03.04	Mud Dauber (monitoring port)	2.0	EA	122.45	3.3	344.02	64.15	10.88			419
1.MDAG2A.1.03.04	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	50.0	LF	138.80	75.0	7,775.08	3,935.57	164.27			11,875
1.MDAG2A.1.03.04	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	600.0	LF	37.76	286.2	29,672.02	8,162.04	934.27			38,768
1.MDAG2A.1.03.04	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	4.0	CF	3.74			25.60				26
1.MDAG2A.1.03.04	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includes vibrating, excludes material	4.0	CF	1.90	0.2	11.17		1.85			13
1.MDAG2A.1.03.04	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"	1.0	EA	80.25	0.6	62.89	74.43				137
1.MDAG2A.1.03.04	**Total**				**799.6**	**68,625.99**	**26,343.76**	**2,025.62**			**96,995**
1.MDAG2A.1.03	**Total**				**11,194.4**	**1,329,408.59**	**221,569.95**	**37,217.84**	**768,634.78**		**2,356,831**

MDA-G Feasability Study Update

Project WBS	Activity Description		Takeoff Quantity - Adjusted	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.MDAG2A.1.04	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -DC- Distribs											
1.MDAG2A.1.04	Field Non-Manual - JHRS		29,175.0	hour	66.10	29,175.0	3,299,837.90					3,299,838
1.MDAG2A.1.04	Craft Distributable - Labor		36,468.0	hour	46.33	36,468.0	2,891,022.72					2,891,023
1.MDAG2A.1.04	Craft Distributable - Materials		36,468.0	hour	7.00	36,468.0		436,807.68				436,808
1.MDAG2A.1.04		Total				102,111.0	6,190,860.62	436,807.68				6,627,668
1.MDAG2A.1		Total				247,986.4	18,931,671.57	39,116,262.82	9,927,143.41	771,030.34		68,746,108
1.MDAG2A.2	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G - Indirect Capital Costs											
1.MDAG2A.2.01	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -IC- Design											
1.MDAG2A.2.01	RCRA MDA G Pad Design		1.0	lsum	10,999,377.00					16,013,992.97		16,013,993
1.MDAG2A.2.01		Total								16,013,992.97		16,013,993
1.MDAG2A.2.02	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -IC- Professional Management											
1.MDAG2A.2.02	Professional Management		1.0	lsum	22,037,626.00	221,261.3	48,287,292.44					48,287,292
1.MDAG2A.2.02		Total				221,261.3	48,287,292.44					48,287,292
1.MDAG2A.2.03	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -IC- Contingency											
1.MDAG2A.2.03	Contingency - Cost 30%		1.0	lsum	39,914,217.00	1.0					39,914,217.00	39,914,217
1.MDAG2A.2.03	Contingency - Schedule 10%		1.0	lsum	13,304,739.00	1.0					13,304,739.00	13,304,739
1.MDAG2A.2.03	Contingency - TPRA 10%		1.0	lsum	13,304,739.00	1.0					13,304,739.00	13,304,739
1.MDAG2A.2.03		Total				3.0					66,523,695.00	66,523,695
1.MDAG2A.2		Total				221,264.3	48,287,292.44			16,013,992.97	66,523,695.00	130,824,980
1.MDAG2A.3	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G - Direct O&M Costs											
1.MDAG2A.3.01	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -DOM- Cover Maintenance & Inspections											
1.MDAG2A.3.01	Active SVE Operation (3 years)		1.0	lsum	2,301,191.00	49,669.9	3,350,303.98					3,350,304
1.MDAG2A.3.01	Active SVE Monitoring (3 years)		1.0	lsum	329,216.00	4,204.5	479,305.57					479,306
1.MDAG2A.3.01	Rebound SVE Monitoring (3 years)		1.0	lsum	666,663.00	14,389.5	970,594.66					970,595
1.MDAG2A.3.01	Subsurface VOC Vapor Monitoring (30 years)		1.0	lsum	1,025,807.00	13,101.0	1,493,472.41					1,493,472
1.MDAG2A.3.01	Cover Inspections and Maintenance (100 years)		1.0	lsum	148,476.00	3,204.8	216,166.21					216,166
1.MDAG2A.3.01	Annual Long Term Monitoring Report (100 years)		1.0	lsum	157,125.00	2,006.7	228,758.29					228,758
1.MDAG2A.3.01		Total				86,576.5	6,738,601.12					6,738,601
1.MDAG2A.3		Total				86,576.5	6,738,601.12					6,738,601
1.MDAG2A.4	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G - Indirect O&M Costs											
1.MDAG2A.4.02	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -IOM- Professional Management											
1.MDAG2A.4.02	Professional Management (years 0-3)		1.0	lsum	732,073.00	7,350.1	1,604,066.75					1,604,067
1.MDAG2A.4.02	Professional Management (years 4-30)		1.0	lsum	285,000.00	2,861.4	624,471.91					624,472
1.MDAG2A.4.02	Professional Management (years 31-100)		1.0	lsum	32,455.00	325.9	71,113.11					71,113
1.MDAG2A.4.02		Total				10,537.4	2,299,651.76					2,299,652
1.MDAG2A.4.03	2A Multilayer (RCRA) Cover, SVE, Institutional Controls MDA G -IOM- Contingency											
1.MDAG2A.4.03	Contingency - Cost 30%		1.0	lsum	2,711,475.90	1.0					2,711,475.90	2,711,476
1.MDAG2A.4.03	Contingency - Schedule 10%		1.0	lsum	903,825.30	1.0					903,825.30	903,825
1.MDAG2A.4.03	Contingency - TPRA 10%		1.0	lsum	903,825.30	1.0					903,825.30	903,825
1.MDAG2A.4.03		Total				3.0					4,519,126.50	4,519,127
1.MDAG2A.4		Total				10,540.4	2,299,651.76				4,519,126.50	6,818,778
1.MDAG2A		Total				566,367.6	76,257,216.89	39,116,262.82	9,927,143.41	16,785,023.32	71,042,821.50	213,128,468
1.MDAG2B	2B ET Cover, SVE, Institutional Controls											
1.MDAG2B.1	2B ET Cover, SVE, Institutional Controls MDA G - Direct Capital Costs											
1.MDAG2B.1.01	ET Cover MDA G -DC- Fence											

MDA-G Feasability Study Update

Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG2B.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire	10,250.0	LF	56.72	2,489.9	198,846.06	771,714.79	24,203.78			994,765
1.MDAG2B.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, 3" diameter, includes excavation, in concrete	34.0	EA	162.19	37.1	2,966.64	6,108.70	360.70			9,436
1.MDAG2B.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, includes excavation, posts & hardware in concrete	2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAG2B.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes posts	103.0	EA	120.98	85.7	6,843.88	12,601.54	1,877.01			21,322
1.MDAG2B.1.01	**Total**				**2,692.8**	**215,055.04**	**796,071.72**	**28,203.95**			**1,039,331**
1.MDAG2B.1.02	**ET Cover MDA G -DC- ET Cover**										
1.MDAG2B.1.02.01	**ET Cover MDA G -DC- ET Cover - Site Prep**										
1.MDAG2B.1.02.01	Excavation permit	2.0	ea	700.00					2,395.57		2,396
1.MDAG2B.1.02.01	Lister support	48.0	hour	100.10	87.4	8,221.59					8,222
1.MDAG2B.1.02.01	Track out device	4.0	EA	5,234.35	21.8	1,603.97	34,222.39				35,826
1.MDAG2B.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.MDAG2B.1.02.01	Rent toilet portable chemical	24.0	mnth	400.00				16,426.74			16,427
1.MDAG2B.1.02.01	Chemical toilet cleaning.	24.0	mnth	946.50	393.1	24,556.60		14,313.20			38,870
1.MDAG2B.1.02.01	Chemical toilet cleaning (labor)	24.0	mnth	573.07	393.1	23,534.02					23,534
1.MDAG2B.1.02.01	Selective clearing, brush, with brush saw, includes cutting and site cleanup, excludes removal offsite	51.0	acre	3,022.82	2,972.4	253,981.84		9,810.71			263,793
1.MDAG2B.1.02.01	Laydown - Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAG2B.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.MDAG2B.1.02.01	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAG2B.1.02.01	**Total**				**4,125.7**	**332,535.96**	**135,520.65**	**66,958.22**	**2,395.57**		**537,410**
1.MDAG2B.1.02.02	**ET Cover MDA G -DC- ET Cover - Cover Prep**										
1.MDAG2B.1.02.02	Borrow, fill material only.	122,774.0	ton	20.50			4,306,659.62				4,306,660
1.MDAG2B.1.02.02	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	61,387.0	CY	4.46	2,225.1	190,127.24		278,357.27			468,485
1.MDAG2B.1.02.02	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	61,387.0	CY	4.62	4,055.9	346,561.04		138,666.13			485,227
1.MDAG2B.1.02.02	Water wagon 1,000 gal compaction	61,387.0	CY	0.44	737.4	46,061.16					46,061
1.MDAG2B.1.02.02	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	61,387.0	CY	0.94	563.3	44,513.87		54,622.81			99,137
1.MDAG2B.1.02.02	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 150 H.P., up to 50 miles	4.0	EA	529.39	19.4	1,535.80		2,087.57			3,623
1.MDAG2B.1.02.02	**Total**				**7,601.1**	**628,799.11**	**4,306,659.62**	**473,733.78**			**5,409,193**
1.MDAG2B.1.02.03	**ET Cover MDA G -DC- ET Cover - Installation of 1' Biobarrier**										
1.MDAG2B.1.02.03	Cobble - Cobble Material and Delivery	110,965.0	TN	20.50			3,892,424.17				3,892,424
1.MDAG2B.1.02.03	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	82,197.0	CY	3.30	2,262.8	178,811.81		285,510.18			464,322
1.MDAG2B.1.02.03	**Total**				**2,262.8**	**178,811.81**	**3,892,424.17**	**285,510.18**			**4,356,746**
1.MDAG2B.1.02.04	**ET Cover MDA G -DC- ET Cover - Installation of .5' Filter Layer**										
1.MDAG2B.1.02.04	Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	246,840.0	SY	8.87	3,584.4	306,277.78	3,125,557.84	312,647.32			3,744,483
1.MDAG2B.1.02.04	**Total**				**3,584.4**	**306,277.78**	**3,125,557.84**	**312,647.32**			**3,744,483**
1.MDAG2B.1.02.05	**ET Cover MDA G -DC- ET Cover - Installation of 3.5' Fine Grained Cover Soil (ET Layer)**										
1.MDAG2B.1.02.05	TUFF - TUFF Material and Delivery	575,960.0	TN	20.50			20,203,493.22				20,203,493
1.MDAG2B.1.02.05	TUFF - Backfill, bulk, 6" to 12" lifts, dozer backfilling	287,980.0	CY	3.30	7,927.9	626,473.31		1,000,294.69			1,626,768
1.MDAG2B.1.02.05	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	287,980.0	CY	0.94	2,642.6	208,824.44		256,247.67			465,072
1.MDAG2B.1.02.05	TUFF & SOIL - Rent water truck, off highway, 6000 gallon capacity - Rent per day	522.0	days	1,309.30	5,700.2	450,439.48		719,029.43			1,169,469
1.MDAG2B.1.02.05	**Total**				**16,270.8**	**1,285,737.23**	**20,203,493.22**	**1,975,571.79**			**23,464,802**
1.MDAG2B.1.02.06	**ET Cover MDA G -DC- ET Cover - Installation of 1.5' Cover Soil/ Surface Treatment**										
1.MDAG2B.1.02.06	TUFF - Borrow, fill material only.	123,295.0	ton	20.50			4,324,935.23				4,324,935
1.MDAG2B.1.02.06	Tuff - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	61,647.0	CY	4.46	2,234.5	190,932.51		279,536.23			470,469
1.MDAG2B.1.02.06	TUFF - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	61,647.0	CY	4.62	4,073.1	348,028.87		139,253.44			487,282
1.MDAG2B.1.02.06	TUFF - Water wagon 1,000 gal compaction	61,647.0	CY	0.44	740.5	46,256.25					46,256
1.MDAG2B.1.02.06	Soil - Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	61,647.0	CY	4.46	2,234.5	190,932.51		279,536.23			470,469
1.MDAG2B.1.02.06	Soil - Backfill, structural, common earth, 80 H.P. dozer, 300' haul	61,647.0	CY	4.62	4,073.1	348,028.87		139,253.44			487,282

MDA-G Feasability Study Update

Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG2B.1.02.06	Soil - Water wagon 1,000 gal compaction	61,647.0	CY	0.44	740.5	46,256.25					46,256
1.MDAG2B.1.02.06	TUFF - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	61,647.0	CY	0.94	565.7	44,702.41		54,854.16			99,557
1.MDAG2B.1.02.06	Soil - Soils for earthwork, common borrow, spread with 200 H.P. dozer, includes load at pit and haul, 2 miles round trip, excludes compaction	61,647.0	CY	15.54	5,244.2	414,403.42	780,591.74	444,079.35			1,639,075
1.MDAG2B.1.02.06	Soil - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	61,647.0	CY	0.94	565.7	44,702.41		54,854.16			99,557
1.MDAG2B.1.02.06	**Total**				**20,471.8**	**1,674,243.50**	**5,105,526.97**	**1,391,367.01**			**8,171,137**
1.MDAG2B.1.02.08	**ET Cover MDA G -DC- ET Cover - Cover Armoring**										
1.MDAG2B.1.02.08	Manual Backfill, by hand, slope building	4,840.0	CY	90.61	8,782.2	750,408.68					750,409
1.MDAG2B.1.02.08	Cobble - Cobble Material and Delivery	6,534.0	TN	20.50			229,199.29				229,199
1.MDAG2B.1.02.08	Cobble - Backfill, bulk, 6" to 12" lifts, dozer backfilling	4,840.0	CY	3.30	133.2	10,528.96		16,811.68			27,341
1.MDAG2B.1.02.08	**Total**				**8,915.4**	**760,937.65**	**229,199.29**	**16,811.68**			**1,006,949**
1.MDAG2B.1.02.09	**ET Cover MDA G -DC- ET Cover - Revegetation**										
1.MDAG2B.1.02.09	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	2,222.0	Msf	34.33	1,214.4	89,185.54		41,347.91			130,533
1.MDAG2B.1.02.09	Hydroseeding materials.	1.0	lsum	2,233,902.00			3,822,472.76				3,822,473
1.MDAG2B.1.02.09	Broadcasting Mulch and Humate	2,222.0	Msf	34.33	1,214.4	89,185.54		41,347.91			130,533
1.MDAG2B.1.02.09	Mulch and Humate materials.	1.0	LS	1,002,170.00			1,714,832.40				1,714,832
1.MDAG2B.1.02.09	**Total**				**2,428.7**	**178,371.08**	**5,537,305.16**	**82,695.83**			**5,798,372**
1.MDAG2B.1.02.10	**ET Cover MDA G -DC- ET Cover - TDR Moisture Monitor**										
1.MDAG2B.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.MDAG2B.1.02.10	**Total**				**72.8**	**7,566.18**	**64,166.97**				**71,733**
1.MDAG2B.1.02	**Total**				**65,733.6**	**5,353,280.30**	**42,599,853.89**	**4,605,295.81**	**2,395.57**		**52,560,826**
1.MDAG2B.1.03	**SVE MDA G -DC- SVE**										
1.MDAG2B.1.03.01	**SVE MDA G -DC- SVE - SVE Unit**										
1.MDAG2B.1.03.01	SVE Unit - Contractors Price	8.0	ea	35,000.00	8.0				479,113.40		479,113
1.MDAG2B.1.03.01	SVE Piping Equipment (1 per extraction borehole)	24.0	ea	2,000.00	43.7				82,133.72		82,134
1.MDAG2B.1.03.01	**Total**				**51.7**				**561,247.12**		**561,247**
1.MDAG2B.1.03.02	**SVE MDA G -DC- SVE - Extraction Boreholes**										
1.MDAG2B.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	75.0	bag	9.80			1,257.67				1,258
1.MDAG2B.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' deep, excludes excavation, backfill and cast in place concrete	24.0	EA	1,018.17	363.1	25,871.78	15,810.74	130.45			41,813
1.MDAG2B.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	12.0	CY	210.12	54.6	4,314.50					4,314
1.MDAG2B.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 CY truck, cycle 4 miles, 15 MPH, no loading equipment	83.0	CY	103.13	181.3	14,324.13		322.39			14,647
1.MDAG2B.1.03.02	Pore Gas Monitoring - LLW Disposition	83.0	CY	1,200.00					170,427.48		170,427
1.MDAG2B.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit mobilization to site, excluding cost of conduit	24.0	EA	1,158.34	349.9	27,651.87		19,917.43			47,569
1.MDAG2B.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	1,200.0	LF	138.80	1,800.0	186,602.01	94,453.78	3,942.42			284,998
1.MDAG2B.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 4" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	3,900.0	LF	33.52	1,860.3	206,035.90	17,684.42				223,720
1.MDAG2B.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	1.9	Csf	334.06	8.6	951.77	25.52	108.77			1,086
1.MDAG2B.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only	55.5	CY	24.50			2,326.69				2,327
1.MDAG2B.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	72.0	CF	3.74			460.77				461
1.MDAG2B.1.03.02	Structural concrete, placing, excludes material	72.0	CF	1.90	2.8	201.00		33.26			234
1.MDAG2B.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	1,240.0	CF	3.74			7,935.49				7,935
1.MDAG2B.1.03.02	Grout - concrete, placing, excludes material	1,240.0	CF	1.90	48.6	3,461.74		572.88			4,035
1.MDAG2B.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	11.0	CY	275.66	50.0	5,188.57					5,189
1.MDAG2B.1.03.02	Project Geologist	480.0	hour	77.00	480.0	80,984.15					80,984
1.MDAG2B.1.03.02	Field Technician	480.0	hour	65.00	480.0	68,363.24					68,363
1.MDAG2B.1.03.02	Radiological Control Technician	480.0	hour	65.00	480.0	68,363.24					68,363
1.MDAG2B.1.03.02	Health and Safety Officer - Site	48.0	hour	77.00	48.0	8,098.41					8,098
1.MDAG2B.1.03.02	Project Engineer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2B.1.03.02	Project Manager	120.0	hour	77.00	120.0	20,246.04					20,246
1.MDAG2B.1.03.02	Health and Safety Officer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2B.1.03.02	Project Scientist - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749

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Project WBS	Activity Description		Takeoff Quantity - Adjusted	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.MDAG2B.1.03.02	Health and Safety Officer - Readiness		40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG2B.1.03.02	Health and Safety Officer - Site		150.0	hour	77.00	150.0	25,307.55					25,308
1.MDAG2B.1.03.02	Project Geologist		1,920.0	hour	77.00	1,920.0	323,936.59					323,937
1.MDAG2B.1.03.02		**Total**				**8,557.3**	**1,096,897.20**	**139,955.09**	**25,027.60**	**170,427.48**		**1,432,307**
1.MDAG2B.1.03.03	**SVE MDA G -DC- SVE - Monitoring Boreholes**											
1.MDAG2B.1.03.03	Bentonite clay, 50# bag, 1 per 10' of rod		184.0	EA	38.00			11,964.15				11,964
1.MDAG2B.1.03.03	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only		1.4	CY	24.50			57.01				57
1.MDAG2B.1.03.03	Backfill, heavy soil, by hand, no compaction		12.8	CY	123.87	209.7	2,713.12					2,713
1.MDAG2B.1.03.03	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes weld joint and clevis type hangers 10' OC		3,200.0	LF	16.95	730.1	75,685.16	14,718.36	2,409.26			92,813
1.MDAG2B.1.03.03	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, includes the weld machine		16.0	EA	121.05	26.5	2,752.19	474.73	87.06			3,314
1.MDAG2B.1.03.03	Mud Dauber (monitoring port)		16.0	EA	122.45	26.5	2,752.19	513.17	87.06			3,352
1.MDAG2B.1.03.03	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit mobilization to site, excluding cost of conduit		4.0	EA	1,158.34	58.3	4,608.64		3,319.57			7,928
1.MDAG2B.1.03.03	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC		200.0	LF	138.80	300.0	31,100.33	15,742.30	657.07			47,500
1.MDAG2B.1.03.03	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC		840.0	LF	37.76	400.7	41,540.83	11,426.85	1,307.98			54,276
1.MDAG2B.1.03.03	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments		12.0	CF	3.74			76.80				77
1.MDAG2B.1.03.03	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includes vibrating, excludes material		12.0	CF	1.90	0.5	33.50		5.54			39
1.MDAG2B.1.03.03	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits		2.0	CY	210.12	9.1	719.08					719
1.MDAG2B.1.03.03	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"		4.0	EA	80.25	2.4	251.57	297.73				549
1.MDAG2B.1.03.03	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 CY truck, cycle 6 miles, 15 MPH, excludes loading equipment		18.0	CY	12.87	2.4	192.98		203.51			396
1.MDAG2B.1.03.03	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 150 H.P., up to 50 miles		4.0	EA	529.39	19.4	1,535.81		2,087.58			3,623
1.MDAG2B.1.03.03	Monitoring Well Waste		18.0	CY	1,200.00					36,960.18		36,960
1.MDAG2B.1.03.03		**Total**				**1,785.7**	**163,885.41**	**55,271.11**	**10,164.64**	**36,960.18**		**266,281**
1.MDAG2B.1.03.04	**SVE MDA G -DC- SVE - Monitoring Borehole Conversion 600'**											
1.MDAG2B.1.03.04	Bentonite clay, 50# bag, 1 per 10' of rod		130.0	EA	38.00			8,452.93				8,453
1.MDAG2B.1.03.04	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only		1.2	CY	24.50			50.31				50
1.MDAG2B.1.03.04	Backfill, heavy soil, by hand, no compaction		9.6	CY	123.87	157.2	2,034.84					2,035
1.MDAG2B.1.03.04	Pipe, stainless steel, butt weld, 1/4" diameter, schedule 5, type 304, includes weld joint and clevis type hangers 10' OC		1,200.0	LF	16.95	273.8	28,381.93	5,519.39	903.47			34,805
1.MDAG2B.1.03.04	Elbow, 90 Deg., stainless steel, long, butt weld, 1/2", schedule 5, type 304, includes the weld machine		2.0	EA	121.05	3.3	344.02	59.34	10.88			414
1.MDAG2B.1.03.04	Mud Dauber (monitoring port)		2.0	EA	122.45	3.3	344.02	64.15	10.88			419
1.MDAG2B.1.03.04	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC		50.0	LF	138.80	75.0	7,775.08	3,935.57	164.27			11,875
1.MDAG2B.1.03.04	Pipe, steel, black, welded, 2" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC		600.0	LF	37.76	286.2	29,672.02	8,162.04	934.27			38,768
1.MDAG2B.1.03.04	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments		4.0	CF	3.74			25.60				26
1.MDAG2B.1.03.04	Structural concrete, placing, elevated slab, pumped, less than 6" thick, includes vibrating, excludes material		4.0	CF	1.90	0.2	11.17		1.85			13
1.MDAG2B.1.03.04	Valves, bronze, check, swing, regrinding disc, threaded, class 150, 1/4"		1.0	EA	80.25	0.6	62.89	74.43				137
1.MDAG2B.1.03.04		**Total**				**799.6**	**68,625.99**	**26,343.76**	**2,025.62**			**96,995**
1.MDAG2B.1.03		**Total**				**11,194.4**	**1,329,408.60**	**221,569.95**	**37,217.86**	**768,634.78**		**2,356,831**
1.MDAG2B.1.04	**2B ET Cover, SVE, Institutional Controls MDA G -DC- Distribs**											
1.MDAG2B.1.04	Field Non-Manual - JHRS		15,924.0	hour	66.10	15,924.0	1,801,083.76					1,801,084
1.MDAG2B.1.04	Craft Distributable - Labor		19,905.0	hour	46.33	19,905.0	1,577,980.89					1,577,981
1.MDAG2B.1.04	Craft Distributable - Materials		19,905.0	hour	7.00	19,905.0		238,418.80				238,419
1.MDAG2B.1.04		**Total**				**55,734.0**	**3,379,064.65**	**238,418.80**				**3,617,483**
1.MDAG2B.1		**Total**				**135,354.8**	**10,276,808.59**	**43,855,914.37**	**4,670,717.62**	**771,030.34**		**59,574,471**
1.MDAG2B.2	**2B ET Cover, SVE, Institutional Controls MDA G - Indirect Capital Costs**											

MDA-G Feasability Study Update

Project WBS	Activity Description		Takeoff Quantity - Adjusted	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.MDAG2B.2.01	2B ET Cover, SVE, Institutional Controls MDA G -IC-Design											
1.MDAG2B.2.01	ET MDA L Mat Design		1.0	lsum	9,531,915.00					13,877,515.05		13,877,515
1.MDAG2B.2.01		Total								13,877,515.05		13,877,515
1.MDAG2B.2.02	2B ET Cover, SVE, Institutional Controls MDA G-IC-Professional Management											
1.MDAG2B.2.02	Professional Management		1.0	lsum	19,097,516.00	191,742.1	41,845,130.68					41,845,131
1.MDAG2B.2.02		Total				191,742.1	41,845,130.68					41,845,131
1.MDAG2B.2.03	2B ET Cover, SVE, Institutional Controls MDA G -IC-Contingency											
1.MDAG2B.2.03	Contingency - Cost 30%		1.0	lsum	34,589,135.00	1.0					34,589,135.00	34,589,135
1.MDAG2B.2.03	Contingency - Schedule 10%		1.0	lsum	11,529,711.00	1.0					11,529,711.00	11,529,711
1.MDAG2B.2.03	Contingency - TPRA 10%		1.0	lsum	11,529,711.00	1.0					11,529,711.00	11,529,711
1.MDAG2B.2.03		Total				3.0					57,648,557.00	57,648,557
1.MDAG2B.2		Total				191,745.1	41,845,130.68			13,877,515.05	57,648,557.00	113,371,203
1.MDAG2B.3	2B ET Cover, SVE, Institutional Controls MDA G - Direct O&M Costs											
1.MDAG2B.3.01	2B ET Cover, SVE, Institutional Controls MDA G -DOM-Cover Maintenance & Inspections											
1.MDAG2B.3.01	Active SVE Operation (3 years)		1.0	lsum	2,301,191.00	49,669.9	3,350,303.98					3,350,304
1.MDAG2B.3.01	Active SVE Monitoring (3 years)		1.0	lsum	329,216.00	4,204.5	479,305.57					479,306
1.MDAG2B.3.01	Rebound SVE Monitoring (3 years)		1.0	lsum	666,663.00	14,389.5	970,594.66					970,595
1.MDAG2B.3.01	Subsurface VOC Vapor Monitoring (30 years)		1.0	lsum	1,025,807.00	13,101.0	1,493,472.41					1,493,472
1.MDAG2B.3.01	Cover Inspections and Maintenance (100 years)		1.0	lsum	148,476.00	3,204.8	216,166.21					216,166
1.MDAG2B.3.01	Annual Long Term Monitoring Report (100 years)		1.0	lsum	157,125.00	2,006.7	228,758.29					228,758
1.MDAG2B.3.01		Total				86,576.5	6,738,601.12					6,738,601
1.MDAG2B.3		Total				86,576.5	6,738,601.12					6,738,601
1.MDAG2B.4	2B ET Cover, SVE, Institutional Controls MDA G - Indirect O&M Costs											
1.MDAG2B.4.02	2B ET Cover, SVE, Institutional Controls MDA G -IOM-Professional Management											
1.MDAG2B.4.02	Professional Management (years 0-3)		1.0	lsum	732,073.00	7,350.1	1,604,066.75					1,604,067
1.MDAG2B.4.02	Professional Management (years 4-30)		1.0	lsum	285,000.00	2,861.4	624,471.91					624,472
1.MDAG2B.4.02	Professional Management (years 31-100)		1.0	lsum	32,455.00	325.9	71,113.11					71,113
1.MDAG2B.4.02		Total				10,537.4	2,299,651.76					2,299,652
1.MDAG2B.4.03	2B ET Cover, SVE, Institutional Controls MDA G -IOM-Contingency											
1.MDAG2B.4.03	Contingency - Cost 30%		1.0	lsum	2,711,475.90	1.0					2,711,475.90	2,711,476
1.MDAG2B.4.03	Contingency - Schedule 10%		1.0	lsum	903,825.30	1.0					903,825.30	903,825
1.MDAG2B.4.03	Contingency - TPRA 10%		1.0	lsum	903,825.30	1.0					903,825.30	903,825
1.MDAG2B.4.03		Total				3.0					4,519,126.50	4,519,127
1.MDAG2B.4		Total				10,540.4	2,299,651.76				4,519,126.50	6,818,778
1.MDAG2B		Total				424,216.9	61,160,192.16	43,855,914.37	4,670,717.62	14,648,545.39	62,167,683.50	186,503,053
1.MDAG3X	Excavation, SVE, and Institutional Contols MDA G											
1.MDAG3X.1	Excavation, SVE, and Institutional Contols MDA G - Direct Capital Costs											
1.MDAG3X.1.01	Excavation -DC- Fence											
1.MDAG3X.1.01	Fence, chain link industrial, aluminized steel, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, includes excavation, in concrete, excludes barbed wire		10,250.0	LF	56.72	2,489.9	198,846.06	771,714.79	24,203.78			994,765
1.MDAG3X.1.01	Fence, chain link industrial, galvanized steel, add for corner post, 6 ga. wire, 2-1/2" posts @ 10' OC, 8' high, 3" diameter, includes excavation, in concrete		34.0	EA	162.19	37.1	2,966.64	6,108.70	360.70			9,436
1.MDAG3X.1.01	Fence, chain link industrial, double swing gates, 8' high, 20' opening, includes excavation, posts & hardware in concrete		2.0	Opng	4,034.67	80.1	6,398.45	5,646.69	1,762.45			13,808
1.MDAG3X.1.01	Signs, stock, aluminum, reflectorized, .080" aluminum, 24" x 24", excludes posts		103.0	EA	120.98	85.7	6,843.88	12,601.54	1,877.01			21,322
1.MDAG3X.1.01		Total				2,692.8	215,055.04	796,071.72	28,203.95			1,039,331

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Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.02	Excavation -DC- Site Prep										
1.MDAG3X.1.02	Excavation permit	30.0	ea	700.00					35,933.50		35,934
1.MDAG3X.1.02	Lister support	720.0	hour	100.10	1,310.4	123,323.79					123,324
1.MDAG3X.1.02	Track out device	4.0	EA	5,234.35	21.8	1,603.97	34,222.39				35,826
1.MDAG3X.1.02	Clean out track out device.	120.0	EA	1,185.53	1,310.4	96,238.27		147,190.95			243,429
1.MDAG3X.1.02	Rent toilet portable chemical	360.0	mnth	400.00				246,401.17			246,401
1.MDAG3X.1.02	Chemical toilet cleaning.	360.0	mnth	946.50	5,896.8	368,349.03		214,697.97			583,047
1.MDAG3X.1.02	Chemical toilet cleaning (labor)	360.0	mnth	573.07	5,896.8	353,010.34					353,010
1.MDAG3X.1.02	Selective clearing, brush, with brush saw, includes cutting and site cleanup, excludes removal offsite	51.0	acre	3,022.82	2,972.4	253,981.84		9,810.71			263,793
1.MDAG3X.1.02	Laydown - Base course drainage layers, aggregate base course for roadways and large paved areas, stone base, compacted, 3/4" stone base, to 6" deep	8,000.0	SY	8.87	116.2	9,926.36	101,298.26	10,132.79			121,357
1.MDAG3X.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.MDAG3X.1.02	laydown - Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	1,481.0	CY	0.94	13.6	1,073.93		1,317.81			2,392
1.MDAG3X.1.02	Moveable Covers	3.0	ea	39,584,000.00	1,440,000.0	192,932,119.93			10,266,715.62		203,198,836
1.MDAG3X.1.02	Moveable Covers Mob/Demob	618.0	ea	500,000.00					528,735,854.43		528,735,854
1.MDAG3X.1.02	Total				1,457,579.2	194,142,849.23	135,520.65	634,695.64	539,038,503.55		733,951,569
1.MDAG3X.1.03	SVE MDA G -DC- SVE										
1.MDAG3X.1.03.01	SVE MDA G -DC- SVE - SVE Unit										
1.MDAG3X.1.03.01	SVE Unit - Contractors Price	8.0	ea	35,000.00	8.0				479,113.40		479,113
1.MDAG3X.1.03.01	SVE Piping Equipment (1 per extraction borehole)	24.0	ea	2,000.00	43.7				82,133.72		82,134
1.MDAG3X.1.03.01	Total				51.7				561,247.12		561,247
1.MDAG3X.1.03.02	SVE MDA G -DC- SVE - Extraction Boreholes										
1.MDAG3X.1.03.02	Bentonite, granular, 50 lb. bags (.625 C.F.)	75.0	bag	9.80			1,257.67				1,258
1.MDAG3X.1.03.02	Well Heads, hand holes, precast concrete, with concrete cover, 2' x 2' x 3' deep, excludes excavation, backfill and cast in place concrete	24.0	EA	1,018.17	363.1	25,871.78	15,810.74	130.45			41,813
1.MDAG3X.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	12.0	CY	210.12	54.6	4,314.50					4,314
1.MDAG3X.1.03.02	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 10 min wait/load/unload, 8 CY truck, cycle 4 miles, 15 MPH, no loading equipment	83.0	CY	103.13	181.3	14,324.13		322.39			14,647
1.MDAG3X.1.03.02	Pore Gas Monitoring - LLW Disposition	83.0	CY	1,200.00					170,427.48		170,427
1.MDAG3X.1.03.02	Directional drilling, small equipment to 300', not to exceed 12" dia, small unit mobilization to site, excluding cost of conduit	24.0	EA	1,158.34	349.9	27,651.87		19,917.43			47,569
1.MDAG3X.1.03.02	Pipe, steel, black, welded, 10" diameter, schedule 40, Spec. A-53, includes yoke & roll hanger assembly, sized for covering, 10' OC	1,200.0	LF	138.80	1,800.0	186,602.01	94,453.78	3,942.42			284,998
1.MDAG3X.1.03.02	Pipe, plastic, high density polyethylene (HDPE), single wall, straight, welded, based on 40' length, 4" diam., DR 11, add 1 weld per joint, excludes hangers, trenching, backfill, hoisting or digging equipment.	3,900.0	LF	33.52	1,860.3	206,035.90	17,684.42				223,720
1.MDAG3X.1.03.02	Drainage Filter Fabric, plastic filter fabric, in underground drain lines	1.9	Csf	334.06	8.6	951.77	25.52	108.77			1,086
1.MDAG3X.1.03.02	Aggregate, sand, washed, for concrete, loaded at the pit, includes material only	55.5	CY	24.50			2,326.69				2,327
1.MDAG3X.1.03.02	Structural concrete, ready mix, normal weight, 3000 psi, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	72.0	CF	3.74			460.77				461
1.MDAG3X.1.03.02	Structural concrete, placing, excludes material	72.0	CF	1.90	2.8	201.00		33.26			234
1.MDAG3X.1.03.02	Grout - ready mix, normal weight, , includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	1,240.0	CF	3.74			7,935.49				7,935
1.MDAG3X.1.03.02	Grout - concrete, placing, excludes material	1,240.0	CF	1.90	48.6	3,461.74		572.88			4,035
1.MDAG3X.1.03.02	Structural excavation for minor structures, bank measure, normal soil, pits to 6' deep, hand pits	11.0	CY	275.66	50.0	5,188.57					5,189
1.MDAG3X.1.03.02	Project Geologist	480.0	hour	77.00	480.0	80,984.15					80,984
1.MDAG3X.1.03.02	Field Technician	480.0	hour	65.00	480.0	68,363.24					68,363
1.MDAG3X.1.03.02	Radiological Control Technician	480.0	hour	65.00	480.0	68,363.24					68,363
1.MDAG3X.1.03.02	Health and Safety Officer - Site	48.0	hour	77.00	48.0	8,098.41					8,098
1.MDAG3X.1.03.02	Project Engineer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG3X.1.03.02	Project Manager	120.0	hour	77.00	120.0	20,246.04					20,246
1.MDAG3X.1.03.02	Health and Safety Officer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG3X.1.03.02	Project Scientist - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG3X.1.03.02	Health and Safety Officer - Readiness	40.0	hour	77.00	40.0	6,748.68					6,749
1.MDAG3X.1.03.02	Health and Safety Officer - Site	150.0	hour	77.00	150.0	25,307.55					25,308
1.MDAG3X.1.03.02	Project Geologist	1,920.0	hour	77.00	1,920.0	323,936.59					323,937
1.MDAG3X.1.03.02	Total				8,557.3	1,096,897.20	139,955.09	25,027.60	170,427.48		1,432,307
1.MDAG3X.1.03	Total				8,609.0	1,096,897.20	139,955.09	25,027.60	731,674.60		1,993,554
1.MDAG3X.1.04	Excavation -DC- Excavation Shafts										
1.MDAG3X.1.04.01	Excavation -DC- Excavation Shaft 1 - Excavation										

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Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.04.01	Dozer D9 rental	16.0	MNTH	29,404.00				805,020.02			805,020
1.MDAG3X.1.04.01	Dozer D9 Scheduled Maintenance	1.2	YR	7,253.69						14,894.31	14,894
1.MDAG3X.1.04.01	Dozer D9 Ripper replacement	3.0	SET	647.69	22.6	1,771.48				1,553.35	3,325
1.MDAG3X.1.04.01	Dozer cutting edge replacement	8.0	EA	1,290.19	120.3	9,447.92	8,213.37				17,661
1.MDAG3X.1.04.01	980, 7 cy frontend loader rental	16.0	MNTH	16,734.00				458,141.92			458,142
1.MDAG3X.1.04.01	980 Loader: Scheduled Maintenance	1.2	YR	5,865.19						12,043.25	12,043
1.MDAG3X.1.04.01	980-7cy loader bucket teeth replacement.	8.0	EA	1,177.09	60.2	4,723.96	11,389.21				16,113
1.MDAG3X.1.04.01	825H High speed compactor (sheepsfoot) rental	16.0	MNTH	10,585.00				289,795.16			289,795
1.MDAG3X.1.04.01	825H: Scheduled Maintenance	1.2	YR	5,944.56						12,206.22	12,206
1.MDAG3X.1.04.01	963 Hydraulic Excavator rental	16.0	MNTH	18,640.00				510,324.21			510,324
1.MDAG3X.1.04.01	963 Hydraulic Excavator : Scheduled Maintenance	1.2	YR	7,349.52						15,091.09	15,091
1.MDAG3X.1.04.01	963 Hydraulic Excavator tip long replacement.	11.0	EA	773.08	82.7	6,495.44	8,055.76				14,551
1.MDAG3X.1.04.01	Water wagon 1,000 gal tuff processing	7,308.0	CY	0.91	181.4	11,328.53					11,329
1.MDAG3X.1.04.01	Equipment only. Water wagon 1,000 gal tuff processing	7,308.0	CY	0.26				3,301.28			3,301
1.MDAG3X.1.04.01	Rock crusher plant rental	16.0	MNTH	28,000.00				766,581.43			766,581
1.MDAG3X.1.04.01	Rock crusher plant : Scheduled Maintenance	11.0	EA	4,000.00						75,289.25	75,289
1.MDAG3X.1.04.01	Screening plant rental	16.0	MNTH	15,500.00				424,357.58			424,358
1.MDAG3X.1.04.01	Screening plant : Scheduled Maintenance	11.0	EA	2,400.00						45,173.55	45,174
1.MDAG3X.1.04.01	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	75,110.0	CY	48.09	65,034.5	5,556,982.99		623,754.20			6,180,737
1.MDAG3X.1.04.01	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	2,103.0	CY	173.65	7,313.1	624,883.34					624,883
1.MDAG3X.1.04.01	Dozer D9 rip tuff material for processing	73,008.0	CY	2.33	3,714.0	291,639.02					291,639
1.MDAG3X.1.04.01	980 Frontend loader soil processing	73,008.0	CY	2.33	3,714.0	291,639.02					291,639
1.MDAG3X.1.04.01	825H High speed compactor (sheepsfoot) soil processing	73,008.0	CY	1.24	1,972.1	154,852.58					154,853
1.MDAG3X.1.04.01	963 Hydraulic Excavator soil processing	73,008.0	CY	1.24	1,972.1	154,852.58					154,853
1.MDAG3X.1.04.01	**Total**				**84,187.0**	**7,108,616.87**	**27,658.34**	**3,881,275.79**		**176,251.02**	**11,193,802**
1.MDAG3X.1.04.03	**Excavation -DC- Excavation Shaft 1 - Backfill**										
1.MDAG3X.1.04.03	Borrow, fill material only.	1,788.0	ton	16.50			50,481.44				50,481
1.MDAG3X.1.04.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	75,110.0	CY	6.39	5,624.5	480,598.21		340,583.75			821,182
1.MDAG3X.1.04.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	75,110.0	CY	8.14	10,252.3	876,027.11		169,664.81			1,045,692
1.MDAG3X.1.04.03	Water wagon 1,000 gal tuff processing	75,110.0	CY	0.91	1,863.9	116,432.08					116,432
1.MDAG3X.1.04.03	Equipment only. Water wagon 1,000 gal tuff processing	75,110.0	CY	0.26				33,929.85			33,930
1.MDAG3X.1.04.03	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	75,110.0	CY	1.40	1,423.9	112,520.90		66,833.68			179,355
1.MDAG3X.1.04.03	**Total**				**19,164.7**	**1,585,578.31**	**50,481.44**	**611,012.08**			**2,247,072**
1.MDAG3X.1.04.04	**Excavation -DC- Excavation Shaft 1 - Disposal of Waste**										
1.MDAG3X.1.04.04	MLLW - Waste container delivery.	32.0	ea	1,453.61	962.6	63,802.03		15,791.57			79,594
1.MDAG3X.1.04.04	MLLW - Waste container unload on site and handling during project.	631.0	ea	4,607.32	56,941.5	4,499,522.70		475,075.62			4,974,598
1.MDAG3X.1.04.04	MLLW - Waste containers.	631.0	ea	2,018.34			2,179,234.51				2,179,235
1.MDAG3X.1.04.04	MLLW - Fill waste containers.	631.0	ea	549.81	7,117.6	562,435.25		31,203.55			593,639
1.MDAG3X.1.04.04	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	2,103.0	cy	1,114.00					4,008,710.98		4,008,711
1.MDAG3X.1.04.04	MLLW - Trucking cost per 43,000 pound load	127.0	Trip	4,471.00						971,602.61	971,603
1.MDAG3X.1.04.04	Confirmatory Sampling	17.0	EA	3,798.14	63.9	7,857.48		10.54	102,616.20		110,484
1.MDAG3X.1.04.04	**Total**				**65,085.6**	**5,133,617.46**	**2,179,234.51**	**522,081.28**	**4,111,327.18**	**971,602.61**	**12,917,863**
1.MDAG3X.1.04.05	**Excavation -DC- Excavation Shaft 2 - Excavation**										
1.MDAG3X.1.04.05	Dozer D9 rental	3.0	MNTH	29,404.00				150,941.25			150,941
1.MDAG3X.1.04.05	Dozer D9 Scheduled Maintenance	0.3	YR	7,253.69						3,102.98	3,103
1.MDAG3X.1.04.05	Dozer D9 Ripper replacement	1.0	SET	647.69	7.5	590.49				517.78	1,108
1.MDAG3X.1.04.05	Dozer cutting edge replacement	1.0	EA	1,290.19	15.0	1,180.99	1,026.67				2,208
1.MDAG3X.1.04.05	980, 7 cy frontend loader rental	3.0	MNTH	16,734.00				85,901.61			85,902
1.MDAG3X.1.04.05	980 Loader: Scheduled Maintenance	0.3	YR	5,865.19						2,509.01	2,509
1.MDAG3X.1.04.05	980-7cy loader bucket teeth replacement.	2.0	EA	1,177.09	15.0	1,180.99	2,847.30				4,028
1.MDAG3X.1.04.05	825H High speed compactor (sheepsfoot) rental	3.0	MNTH	10,585.00				54,336.59			54,337
1.MDAG3X.1.04.05	825H: Scheduled Maintenance	0.3	YR	5,944.56						2,542.96	2,543
1.MDAG3X.1.04.05	963 Hydraulic Excavator rental	3.0	MNTH	18,640.00				95,685.79			95,686
1.MDAG3X.1.04.05	963 Hydraulic Excavator : Scheduled Maintenance	0.3	YR	7,349.52						3,143.98	3,144
1.MDAG3X.1.04.05	963 Hydraulic Excavator tip long replacement.	2.0	EA	773.08	15.0	1,180.99	1,464.68				2,646
1.MDAG3X.1.04.05	Water wagon 1,000 gal tuff processing	11,849.0	CY	0.91	294.0	18,367.78					18,368
1.MDAG3X.1.04.05	Equipment only. Water wagon 1,000 gal tuff processing	11,849.0	CY	0.26				5,352.61			5,353
1.MDAG3X.1.04.05	Rock crusher plant rental	3.0	MNTH	28,000.00				143,734.02			143,734
1.MDAG3X.1.04.05	Rock crusher plant : Scheduled Maintenance	2.0	EA	4,000.00						13,688.95	13,689
1.MDAG3X.1.04.05	Screening plant rental	3.0	MNTH	15,500.00				79,567.05			79,567
1.MDAG3X.1.04.05	Screening plant : Scheduled Maintenance	2.0	EA	2,400.00						8,213.37	8,213
1.MDAG3X.1.04.05	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	12,037.0	CY	48.09	10,422.3	890,552.58		99,961.78			990,514
1.MDAG3X.1.04.05	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	188.0	CY	173.65	653.8	55,862.13					55,862
1.MDAG3X.1.04.05	Dozer D9 rip tuff material for processing	11,849.0	CY	2.33	602.8	47,332.22					47,332
1.MDAG3X.1.04.05	980 Frontend loader soil processing	11,849.0	CY	2.33	602.8	47,332.22					47,332
1.MDAG3X.1.04.05	825H High speed compactor (sheepsfoot) soil processing	11,849.0	CY	1.24	320.1	25,132.15					25,132
1.MDAG3X.1.04.05	963 Hydraulic Excavator soil processing	11,849.0	CY	1.24	320.1	25,132.15					25,132

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Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.04.05	Total				13,268.5	1,113,844.70	5,338.66	715,480.70		33,719.04	1,868,383
1.MDAG3X.1.04.07	Excavation -DC- Excavation Shaft 2 - Backfill										
1.MDAG3X.1.04.07	Borrow, fill material only.	167.8	ton	16.50			4,737.58				4,738
1.MDAG3X.1.04.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	12,037.0	CY	6.39	901.4	77,019.85		54,581.37			131,601
1.MDAG3X.1.04.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	12,037.0	CY	8.14	1,643.0	140,390.61		27,190.19			167,581
1.MDAG3X.1.04.07	Water wagon 1,000 gal tuff processing	12,037.0	CY	0.91	298.7	18,659.21					18,659
1.MDAG3X.1.04.07	Equipment only. Water wagon 1,000 gal tuff processing	12,037.0	CY	0.26				5,437.54			5,438
1.MDAG3X.1.04.07	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	12,037.0	CY	1.40	228.2	18,032.41		10,710.65			28,743
1.MDAG3X.1.04.07	Total				3,071.3	254,102.07	4,737.58	97,919.75			356,759
1.MDAG3X.1.04.08	Excavation -DC- Excavation Shaft 2 - Disposal of Waste										
1.MDAG3X.1.04.08	MLLW - Waste container delivery.	3.0	ea	1,453.61	90.2	5,981.44		1,480.46			7,462
1.MDAG3X.1.04.08	MLLW - Waste container unload on site and handling during project.	57.0	ea	4,607.32	5,143.7	406,454.11		42,914.87			449,369
1.MDAG3X.1.04.08	MLLW - Waste containers.	57.0	ea	2,018.34			196,856.37				196,856
1.MDAG3X.1.04.08	MLLW - Fill waste containers.	57.0	ea	549.81	643.0	50,806.76		2,818.73			53,625
1.MDAG3X.1.04.08	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	188.0	cy	1,114.00					358,363.13		358,363
1.MDAG3X.1.04.08	MLLW - Trucking cost per 43,000 pound load	12.0	Trip	4,471.00						91,804.97	91,805
1.MDAG3X.1.04.08	Confirmatory Sampling	2.0	EA	3,798.14	7.5	924.41		1.24	12,072.49		12,998
1.MDAG3X.1.04.08	Total				5,884.4	464,166.73	196,856.37	47,215.30	370,435.62	91,804.97	1,170,479
1.MDAG3X.1.04.09	Excavation -DC- Excavation Shaft 3 - Excavation										
1.MDAG3X.1.04.09	Dozer D9 rental	2.0	MNTH	29,404.00				100,627.50			100,628
1.MDAG3X.1.04.09	Dozer D9 Scheduled Maintenance	0.2	YR	7,253.69						2,482.39	2,482
1.MDAG3X.1.04.09	Dozer D9 Ripper replacement	1.0	SET	647.69	7.5	590.49				517.78	1,108
1.MDAG3X.1.04.09	Dozer cutting edge replacement	1.0	EA	1,290.19	15.0	1,180.99	1,026.67				2,208
1.MDAG3X.1.04.09	980, 7 cy frontend loader rental	2.0	MNTH	16,734.00				57,267.74			57,268
1.MDAG3X.1.04.09	980 Loader: Scheduled Maintenance	0.2	YR	5,865.19						2,007.21	2,007
1.MDAG3X.1.04.09	980-7cy loader bucket teeth replacement.	1.0	EA	1,177.09	7.5	590.49	1,423.65				2,014
1.MDAG3X.1.04.09	825H High speed compactor (sheepsfoot) rental	2.0	MNTH	10,585.00				36,224.39			36,224
1.MDAG3X.1.04.09	825H: Scheduled Maintenance	0.2	YR	5,944.56						2,034.37	2,034
1.MDAG3X.1.04.09	963 Hydraulic Excavator rental	2.0	MNTH	18,640.00				63,790.53			63,791
1.MDAG3X.1.04.09	963 Hydraulic Excavator : Scheduled Maintenance	0.2	YR	7,349.52						2,515.18	2,515
1.MDAG3X.1.04.09	963 Hydraulic Excavator tip long replacement.	1.0	EA	773.08	7.5	590.49	732.34				1,323
1.MDAG3X.1.04.09	Water wagon 1,000 gal tuff processing	10,153.0	CY	0.91	252.0	15,738.72					15,739
1.MDAG3X.1.04.09	Equipment only. Water wagon 1,000 gal tuff processing	10,153.0	CY	0.26				4,586.47			4,586
1.MDAG3X.1.04.09	Rock crusher plant rental	2.0	MNTH	28,000.00				95,822.68			95,823
1.MDAG3X.1.04.09	Rock crusher plant : Scheduled Maintenance	1.0	EA	4,000.00						6,844.48	6,844
1.MDAG3X.1.04.09	Screening plant rental	2.0	MNTH	15,500.00				53,044.70			53,045
1.MDAG3X.1.04.09	Screening plant : Scheduled Maintenance	1.0	EA	2,400.00						4,106.69	4,107
1.MDAG3X.1.04.09	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	10,231.0	CY	48.09	8,858.6	756,936.40		84,963.78			841,900
1.MDAG3X.1.04.09	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	79.0	CY	173.65	274.7	23,473.98					23,474
1.MDAG3X.1.04.09	Dozer D9 rip tuff material for processing	10,153.0	CY	2.33	516.5	40,557.35					40,557
1.MDAG3X.1.04.09	980 Frontend loader soil processing	10,153.0	CY	2.33	516.5	40,557.35					40,557
1.MDAG3X.1.04.09	825H High speed compactor (sheepsfoot) soil processing	10,153.0	CY	1.24	274.2	21,534.88					21,535
1.MDAG3X.1.04.09	963 Hydraulic Excavator soil processing	10,153.0	CY	1.24	274.2	21,534.88					21,535
1.MDAG3X.1.04.09	Total				11,004.4	923,286.02	3,182.66	496,327.79		20,508.09	1,443,305
1.MDAG3X.1.04.11	Excavation -DC- Excavation Shaft 3 - Backfill										
1.MDAG3X.1.04.11	Borrow, fill material only.	71.0	ton	16.50			2,004.58				2,005
1.MDAG3X.1.04.11	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	10,231.0	CY	6.39	766.1	65,463.99		46,392.12			111,856
1.MDAG3X.1.04.11	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	10,231.0	CY	8.14	1,396.5	119,326.77		23,110.65			142,437
1.MDAG3X.1.04.11	Water wagon 1,000 gal tuff processing	10,231.0	CY	0.91	253.9	15,859.63					15,860
1.MDAG3X.1.04.11	Equipment only. Water wagon 1,000 gal tuff processing	10,231.0	CY	0.26				4,621.71			4,622
1.MDAG3X.1.04.11	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	10,231.0	CY	1.40	194.0	15,326.87		9,103.65			24,431
1.MDAG3X.1.04.11	Total				2,610.5	215,977.26	2,004.58	83,228.13			301,210
1.MDAG3X.1.04.12	Excavation -DC- Excavation Shaft 3 - Disposal of Waste										
1.MDAG3X.1.04.12	MLLW - Waste container delivery.	2.0	ea	1,453.61	60.2	3,987.63		986.97			4,975
1.MDAG3X.1.04.12	MLLW - Waste container unload on site and handling during project.	24.0	ea	4,607.32	2,165.8	171,138.57		18,069.42			189,208
1.MDAG3X.1.04.12	MLLW - Waste containers.	24.0	ea	2,018.34			82,886.89				82,887
1.MDAG3X.1.04.12	MLLW - Fill waste containers.	24.0	ea	549.81	270.7	21,392.32		1,186.83			22,579
1.MDAG3X.1.04.12	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	79.0	cy	1,114.00					150,588.76		150,589
1.MDAG3X.1.04.12	MLLW - Trucking cost per 43,000 pound load	5.0	Trip	4,471.00						38,252.07	38,252
1.MDAG3X.1.04.12	Confirmatory Sampling	1.0	EA	3,798.14	3.8	462.20		0.62	6,036.25		6,499
1.MDAG3X.1.04.12	Total				2,500.4	196,980.73	82,886.89	20,243.85	156,625.01	38,252.07	494,989
1.MDAG3X.1.04.13	Excavation -DC- Excavation Shaft 4 - Excavation										

MDA-G Feasability Study Update

Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.04.13	Dozer D9 rental	4.0	MNTH	29,404.00				201,255.00			201,255
1.MDAG3X.1.04.13	Dozer D9 Scheduled Maintenance	0.3	YR	7,253.69						4,095.94	4,096
1.MDAG3X.1.04.13	Dozer D9 Ripper replacement	1.0	SET	647.69	7.5	590.49				517.78	1,108
1.MDAG3X.1.04.13	Dozer cutting edge replacement	2.0	EA	1,290.19	30.1	2,361.98	2,053.34				4,415
1.MDAG3X.1.04.13	980, 7 cy frontend loader rental	4.0	MNTH	16,734.00				114,535.48			114,535
1.MDAG3X.1.04.13	980 Loader: Scheduled Maintenance	0.3	YR	5,865.19						3,311.89	3,312
1.MDAG3X.1.04.13	980-7cy loader bucket teeth replacement.	2.0	EA	1,177.09	15.0	1,180.99	2,847.30				4,028
1.MDAG3X.1.04.13	825H High speed compactor (sheepsfoot) rental	4.0	MNTH	10,585.00				72,448.79			72,449
1.MDAG3X.1.04.13	825H: Scheduled Maintenance	0.3	YR	5,944.56						3,356.71	3,357
1.MDAG3X.1.04.13	963 Hydraulic Excavator rental	4.0	MNTH	18,640.00				127,581.05			127,581
1.MDAG3X.1.04.13	963 Hydraulic Excavator : Scheduled Maintenance	0.3	YR	7,349.52						4,150.05	4,150
1.MDAG3X.1.04.13	963 Hydraulic Excavator tip long replacement.	4.0	EA	773.08	30.1	2,361.98	2,929.37				5,291
1.MDAG3X.1.04.13	Water wagon 1,000 gal tuff processing	18,854.0	CY	0.91	467.9	29,226.61					29,227
1.MDAG3X.1.04.13	Equipment only. Water wagon 1,000 gal tuff processing	18,854.0	CY	0.26				8,517.02			8,517
1.MDAG3X.1.04.13	Rock crusher plant rental	4.0	MNTH	28,000.00				191,645.36			191,645
1.MDAG3X.1.04.13	Rock crusher plant : Scheduled Maintenance	4.0	EA	4,000.00						27,377.91	27,378
1.MDAG3X.1.04.13	Screening plant rental	4.0	MNTH	15,500.00				106,089.39			106,089
1.MDAG3X.1.04.13	Screening plant : Scheduled Maintenance	4.0	EA	2,400.00						16,426.74	16,427
1.MDAG3X.1.04.13	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	18,958.0	CY	48.09	16,414.9	1,402,599.97		157,437.52			1,560,037
1.MDAG3X.1.04.13	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	105.0	CY	173.65	365.1	31,199.60					31,200
1.MDAG3X.1.04.13	Dozer D9 rip tuff material for processing	18,854.0	CY	2.33	959.1	75,314.52					75,315
1.MDAG3X.1.04.13	980 Frontend loader soil processing	18,854.0	CY	2.33	959.1	75,314.52					75,315
1.MDAG3X.1.04.13	825H High speed compactor (sheepsfoot) soil processing	18,854.0	CY	1.24	509.3	39,990.01					39,990
1.MDAG3X.1.04.13	963 Hydraulic Excavator soil processing	18,854.0	CY	1.24	509.3	39,990.01					39,990
1.MDAG3X.1.04.13	**Total**				**20,267.5**	**1,700,130.66**	**7,830.01**	**979,509.62**		**59,237.03**	**2,746,707**
1.MDAG3X.1.04.15	**Excavation -DC- Excavation Shaft 4 - Backfill**										
1.MDAG3X.1.04.15	Borrow, fill material only.	93.7	ton	16.50			2,645.48				2,645
1.MDAG3X.1.04.15	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	18,958.0	CY	6.39	1,419.7	121,304.50		85,964.41			207,269
1.MDAG3X.1.04.15	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	18,958.0	CY	8.14	2,587.7	221,112.00		42,823.93			263,936
1.MDAG3X.1.04.15	Water wagon 1,000 gal tuff processing	18,958.0	CY	0.91	470.5	29,387.82					29,388
1.MDAG3X.1.04.15	Equipment only. Water wagon 1,000 gal tuff processing	18,958.0	CY	0.26				8,564.00			8,564
1.MDAG3X.1.04.15	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	18,958.0	CY	1.40	359.4	28,400.63		16,869.03			45,270
1.MDAG3X.1.04.15	**Total**				**4,837.2**	**400,204.95**	**2,645.48**	**154,221.37**			**557,072**
1.MDAG3X.1.04.16	**Excavation -DC- Excavation Shaft 4 - Disposal of Waste**										
1.MDAG3X.1.04.16	MLLW - Waste container delivery.	2.0	ea	1,453.61	60.2	3,987.63		986.97			4,975
1.MDAG3X.1.04.16	MLLW - Waste container unload on site and handling during project.	32.0	ea	4,607.32	2,887.7	228,184.76		24,092.56			252,277
1.MDAG3X.1.04.16	MLLW - Waste containers.	32.0	ea	2,018.34			110,515.85				110,516
1.MDAG3X.1.04.16	MLLW - Fill waste containers.	32.0	ea	549.81	361.0	28,523.10		1,582.44			30,106
1.MDAG3X.1.04.16	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	105.0	cy	1,114.00					200,149.62		200,150
1.MDAG3X.1.04.16	MLLW - Trucking cost per 43,000 pound load	21.0	Trip	4,471.00						160,658.70	160,659
1.MDAG3X.1.04.16	Confirmatory Sampling	1.0	EA	3,798.14	3.8	462.20		0.62	6,036.25		6,499
1.MDAG3X.1.04.16	**Total**				**3,312.6**	**261,157.69**	**110,515.85**	**26,662.60**	**206,185.87**	**160,658.70**	**765,181**
1.MDAG3X.1.04.17	**Excavation -DC- Excavation Shaft 5 - Excavation**										
1.MDAG3X.1.04.17	Dozer D9 rental	6.0	MNTH	29,404.00				301,882.51			301,883
1.MDAG3X.1.04.17	Dozer D9 Scheduled Maintenance	0.5	YR	7,253.69						6,205.96	6,206
1.MDAG3X.1.04.17	Dozer D9 Ripper replacement	2.0	SET	647.69	15.0	1,180.99				1,035.57	2,217
1.MDAG3X.1.04.17	Dozer cutting edge replacement	3.0	EA	1,290.19	45.1	3,542.97	3,080.01				6,623
1.MDAG3X.1.04.17	980, 7 cy frontend loader rental	6.0	MNTH	16,734.00				171,803.22			171,803
1.MDAG3X.1.04.17	980 Loader: Scheduled Maintenance	0.5	YR	5,865.19						5,018.02	5,018
1.MDAG3X.1.04.17	980-7cy loader bucket teeth replacement.	4.0	EA	1,177.09	30.1	2,361.98	5,694.60				8,057
1.MDAG3X.1.04.17	825H High speed compactor (sheepsfoot) rental	6.0	MNTH	10,585.00				108,673.18			108,673
1.MDAG3X.1.04.17	825H: Scheduled Maintenance	0.5	YR	5,944.56						5,085.93	5,086
1.MDAG3X.1.04.17	963 Hydraulic Excavator rental	6.0	MNTH	18,640.00				191,371.58			191,372
1.MDAG3X.1.04.17	963 Hydraulic Excavator : Scheduled Maintenance	0.5	YR	7,349.52						6,287.95	6,288
1.MDAG3X.1.04.17	963 Hydraulic Excavator tip long replacement.	5.0	EA	773.08	37.6	2,952.47	3,661.71				6,614
1.MDAG3X.1.04.17	Water wagon 1,000 gal tuff processing	24,683.0	CY	0.91	612.5	38,262.46					38,262
1.MDAG3X.1.04.17	Equipment only. Water wagon 1,000 gal tuff processing	24,683.0	CY	0.26				11,150.19			11,150
1.MDAG3X.1.04.17	Rock crusher plant rental	6.0	MNTH	28,000.00				287,468.04			287,468
1.MDAG3X.1.04.17	Rock crusher plant : Scheduled Maintenance	5.0	EA	4,000.00						34,222.39	34,222
1.MDAG3X.1.04.17	Screening plant rental	6.0	MNTH	15,500.00				159,134.09			159,134
1.MDAG3X.1.04.17	Screening plant : Scheduled Maintenance	5.0	EA	2,400.00						20,533.43	20,533
1.MDAG3X.1.04.17	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	25,278.0	CY	48.09	21,887.1	1,870,182.61		209,922.23			2,080,105
1.MDAG3X.1.04.17	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	595.0	CY	173.65	2,069.1	176,797.71					176,798
1.MDAG3X.1.04.17	Dozer D9 rip tuff material for processing	24,683.0	CY	2.33	1,255.7	98,599.14					98,599
1.MDAG3X.1.04.17	980 Frontend loader soil processing	24,683.0	CY	2.33	1,255.7	98,599.14					98,599
1.MDAG3X.1.04.17	825H High speed compactor (sheepsfoot) soil processing	24,683.0	CY	1.24	666.7	52,353.53					52,354
1.MDAG3X.1.04.17	963 Hydraulic Excavator soil processing	24,683.0	CY	1.24	666.7	52,353.53					52,354

MDA-G Feasability Study Update

Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.04.17	**Total**				**28,541.4**	**2,397,186.53**	**12,436.33**	**1,441,405.03**		**78,389.25**	**3,929,417**
1.MDAG3X.1.04.19	**Excavation -DC- Excavation Shaft 5 - Backfill**										
1.MDAG3X.1.04.19	Borrow, fill material only.	531.0	ton	16.50			14,991.97				14,992
1.MDAG3X.1.04.19	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	25,278.0	CY	6.39	1,892.9	161,743.60		114,622.23			276,366
1.MDAG3X.1.04.19	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	25,278.0	CY	8.14	3,450.4	294,823.77		57,100.08			351,924
1.MDAG3X.1.04.19	Water wagon 1,000 gal tuff processing	25,278.0	CY	0.91	627.3	39,184.80					39,185
1.MDAG3X.1.04.19	Equipment only. Water wagon 1,000 gal tuff processing	25,278.0	CY	0.26				11,418.97			11,419
1.MDAG3X.1.04.19	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	25,278.0	CY	1.40	479.2	37,868.50		22,492.63			60,361
1.MDAG3X.1.04.19	**Total**				**6,449.8**	**533,620.67**	**14,991.97**	**205,633.92**			**754,247**
1.MDAG3X.1.04.20	**Excavation -DC- Excavation Shaft 5 - Disposal of Waste**										
1.MDAG3X.1.04.20	MLLW - Waste container delivery.	9.0	ea	1,453.61	270.7	17,944.33		4,441.38			22,386
1.MDAG3X.1.04.20	MLLW - Waste container unload on site and handling during project.	179.0	ea	4,607.32	16,153.0	1,276,408.52		134,767.75			1,411,176
1.MDAG3X.1.04.20	MLLW - Waste containers.	179.0	ea	2,018.34			618,198.06				618,198
1.MDAG3X.1.04.20	MLLW - Fill waste containers.	179.0	ea	549.81	2,019.1	159,551.06		8,851.79			168,403
1.MDAG3X.1.04.20	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	595.0	cy	1,114.00					1,134,181.19		1,134,181
1.MDAG3X.1.04.20	MLLW - Trucking cost per 43,000 pound load	36.0	Trip	4,471.00						275,414.91	275,415
1.MDAG3X.1.04.20	Confirmatory Sampling	6.0	EA	3,798.14	22.6	2,773.23		3.72	36,217.48		38,994
1.MDAG3X.1.04.20	**Total**				**18,465.4**	**1,456,677.14**	**618,198.06**	**148,064.65**	**1,170,398.67**	**275,414.91**	**3,668,753**
1.MDAG3X.1.04.21	**Excavation -DC- Excavation Shaft 6 - Excavation**										
1.MDAG3X.1.04.21	Dozer D9 rental	5.0	MNTH	29,404.00				251,568.76			251,569
1.MDAG3X.1.04.21	Dozer D9 Scheduled Maintenance	0.5	YR	7,253.69						6,205.96	6,206
1.MDAG3X.1.04.21	Dozer D9 Ripper replacement	2.0	SET	647.69	15.0	1,180.99				1,035.57	2,217
1.MDAG3X.1.04.21	Dozer cutting edge replacement	3.0	EA	1,290.19	45.1	3,542.97	3,080.01				6,623
1.MDAG3X.1.04.21	980, 7 cy frontend loader rental	5.0	MNTH	16,734.00				143,169.35			143,169
1.MDAG3X.1.04.21	980 Loader: Scheduled Maintenance	0.5	YR	5,865.19						5,018.02	5,018
1.MDAG3X.1.04.21	980-7cy loader bucket teeth replacement.	4.0	EA	1,177.09	30.1	2,361.98	5,694.60				8,057
1.MDAG3X.1.04.21	825H High speed compactor (sheepsfoot) rental	5.0	MNTH	10,585.00				90,560.99			90,561
1.MDAG3X.1.04.21	825H: Scheduled Maintenance	0.5	YR	5,944.56						5,085.93	5,086
1.MDAG3X.1.04.21	963 Hydraulic Excavator rental	5.0	MNTH	18,640.00				159,476.32			159,476
1.MDAG3X.1.04.21	963 Hydraulic Excavator : Scheduled Maintenance	0.5	YR	7,349.52						6,287.95	6,288
1.MDAG3X.1.04.21	963 Hydraulic Excavator tip long replacement.	4.0	EA	773.08	30.1	2,361.98	2,929.37				5,291
1.MDAG3X.1.04.21	Water wagon 1,000 gal tuff processing	20,913.0	CY	0.91	519.0	32,418.38					32,418
1.MDAG3X.1.04.21	Equipment only. Water wagon 1,000 gal tuff processing	20,913.0	CY	0.26				9,447.14			9,447
1.MDAG3X.1.04.21	Rock crusher plant rental	5.0	MNTH	28,000.00				239,556.70			239,557
1.MDAG3X.1.04.21	Rock crusher plant : Scheduled Maintenance	4.0	EA	4,000.00						27,377.91	27,378
1.MDAG3X.1.04.21	Screening plant rental	5.0	MNTH	15,500.00				132,611.74			132,612
1.MDAG3X.1.04.21	Screening plant : Scheduled Maintenance	4.0	EA	2,400.00						16,426.74	16,427
1.MDAG3X.1.04.21	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	21,667.0	CY	48.09	18,760.5	1,603,024.24		179,934.52			1,782,959
1.MDAG3X.1.04.21	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	754.0	CY	173.65	2,622.0	224,042.81					224,043
1.MDAG3X.1.04.21	Dozer D9 rip tuff material for processing	20,913.0	CY	2.33	1,063.9	83,539.43					83,539
1.MDAG3X.1.04.21	980 Frontend loader soil processing	20,913.0	CY	2.33	1,063.9	83,539.43					83,539
1.MDAG3X.1.04.21	825H High speed compactor (sheepsfoot) soil processing	20,913.0	CY	1.24	564.9	44,357.22					44,357
1.MDAG3X.1.04.21	963 Hydraulic Excavator soil processing	20,913.0	CY	1.24	564.9	44,357.22					44,357
1.MDAG3X.1.04.21	**Total**				**25,279.4**	**2,124,726.65**	**11,703.99**	**1,206,325.52**		**67,438.09**	**3,410,194**
1.MDAG3X.1.04.23	**Excavation -DC- Excavation Shaft 6 - Backfill**										
1.MDAG3X.1.04.23	Borrow, fill material only.	791.7	ton	16.50			22,352.44				22,352
1.MDAG3X.1.04.23	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	21,667.0	CY	6.39	1,622.5	138,638.28		98,248.28			236,887
1.MDAG3X.1.04.23	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	21,667.0	CY	8.14	2,957.5	252,707.75		48,943.25			301,651
1.MDAG3X.1.04.23	Water wagon 1,000 gal tuff processing	21,667.0	CY	0.91	537.7	33,587.19					33,587
1.MDAG3X.1.04.23	Equipment only. Water wagon 1,000 gal tuff processing	21,667.0	CY	0.26				9,787.75			9,788
1.MDAG3X.1.04.23	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	21,667.0	CY	1.40	410.8	32,458.93		19,279.53			51,738
1.MDAG3X.1.04.23	**Total**				**5,528.5**	**457,392.16**	**22,352.44**	**176,258.80**			**656,003**
1.MDAG3X.1.04.24	**Excavation -DC- Excavation Shaft 6 - Disposal of Waste**										
1.MDAG3X.1.04.24	PCB Waste - Fill Waste Containers	227.0	L.C.Y.	933.98	6,059.4	343,711.69		19,069.47			362,781
1.MDAG3X.1.04.24	PCB Waste - Selective demolition, dump charges, typical urban city, reclamation station, usual charge, includes tipping fees only	754.0	ton	1,002.00					1,292,764.30		1,292,764
1.MDAG3X.1.04.24	**Total**				**6,059.4**	**343,711.69**		**19,069.47**	**1,292,764.30**		**1,655,545**
1.MDAG3X.1.04.25	**Excavation -DC- Excavation Shaft 6 - Disposal of RCRA Waste**										
1.MDAG3X.1.04.25	RCRA - Waste container delivery.	2.0	ea	1,453.61	60.2	3,987.63		986.97			4,975
1.MDAG3X.1.04.25	RCRA - Waste container unload on site and handling during project.	21.0	ea	4,607.32	1,895.0	149,746.25		15,810.74			165,557
1.MDAG3X.1.04.25	RCRA - Waste containers.	21.0	ea	2,018.34			72,526.03				72,526
1.MDAG3X.1.04.25	RCRA - Fill waste containers.	21.0	ea	549.81	236.9	18,718.28		1,038.48			19,757

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Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.04.25	RCRA - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	68.0	cy	1,114.00					129,620.71		129,621
1.MDAG3X.1.04.25	RCRA - Trucking cost per 43,000 pound load	5.0	Trip	4,471.00						38,252.07	38,252
1.MDAG3X.1.04.25	Confirmatory Sampling	1.0	EA	3,798.14	3.8	462.20		0.62	6,036.25		6,499
1.MDAG3X.1.04.25	**Total**	**1.0**		**255,497.23**	**2,195.8**	**172,914.37**	**72,526.03**	**17,836.81**	**135,656.95**	**38,252.07**	**437,186**
1.MDAG3X.1.04	**Total**				**327,713.7**	**26,843,892.64**	**3,425,581.19**	**10,849,772.45**	**7,443,393.60**	**2,011,527.85**	**50,574,168**
1.MDAG3X.1.05	**Excavation -DC- Excavation Pits**										
1.MDAG3X.1.05.01	**Excavation -DC- Excavation Pits - Excavation Pit MLLW**										
1.MDAG3X.1.05.01	Dozer D9 Mobilization	4.0	ea	1,750.00						11,977.83	11,978
1.MDAG3X.1.05.01	980 Loader Mobilization	4.0	ea	697.00						4,770.60	4,771
1.MDAG3X.1.05.01	Screening plant, Mobilization	2.0	ea	3,000.00						10,266.72	10,267
1.MDAG3X.1.05.01	963 Hydraulic Excavator Mobilization	4.0	ea	2,050.00						14,031.18	14,031
1.MDAG3X.1.05.01	Rock crusher plant, Mobilization	2.0	ea	5,000.00						17,111.19	17,111
1.MDAG3X.1.05.01	Rock crusher plant, Set up costs.	2.0	ea	2,000.00						6,844.48	6,844
1.MDAG3X.1.05.01	825H Mobilization	4.0	ea	812.00						5,557.72	5,558
1.MDAG3X.1.05.01	Treatment - Mob/Demob VOC treatment plant.	2.0	ea	130,000.00					444,891.01		444,891
1.MDAG3X.1.05.01	Dozer D9 rental	222.0	MNTH	29,404.00				11,169,652.73			11,169,653
1.MDAG3X.1.05.01	Dozer D9 Scheduled Maintenance	18.5	YR	7,253.69						229,620.68	229,621
1.MDAG3X.1.05.01	Dozer D9 Ripper replacement	37.0	SET	647.69	278.2	21,848.31				19,158.03	41,006
1.MDAG3X.1.05.01	Dozer cutting edge replacement	111.0	EA	1,290.19	1,669.4	131,089.88	113,960.54				245,050
1.MDAG3X.1.05.01	980, 7 cy frontend loader rental	222.0	MNTH	16,734.00				6,356,719.11			6,356,719
1.MDAG3X.1.05.01	980 Loader: Scheduled Maintenance	18.5	YR	5,865.19						185,666.73	185,667
1.MDAG3X.1.05.01	980-7cy loader bucket teeth replacement.	130.0	EA	1,177.09	977.6	76,764.34	185,074.66				261,839
1.MDAG3X.1.05.01	825H High speed compactor (sheepsfoot) rental	222.0	MNTH	10,585.00				4,020,907.84			4,020,908
1.MDAG3X.1.05.01	825H: Scheduled Maintenance	18.5	YR	5,944.56						188,179.25	188,179
1.MDAG3X.1.05.01	963 Hydraulic Excavator rental	222.0	MNTH	18,640.00				7,080,748.43			7,080,748
1.MDAG3X.1.05.01	963 Hydraulic Excavator : Scheduled Maintenance	18.5	YR	7,349.52						232,654.25	232,654
1.MDAG3X.1.05.01	963 Hydraulic Excavator tip long replacement.	167.0	EA	773.08	1,255.8	98,612.65	122,301.10				220,914
1.MDAG3X.1.05.01	Water wagon 1,000 gal tuff processing	415,038.0	CY	0.91	10,299.6	643,372.92					643,373
1.MDAG3X.1.05.01	Equipment only. Water wagon 1,000 gal tuff processing	415,038.0	CY	0.26				187,487.39			187,487
1.MDAG3X.1.05.01	Rock crusher plant rental	222.0	MNTH	28,000.00				10,636,317.38			10,636,317
1.MDAG3X.1.05.01	Rock crusher plant : Scheduled Maintenance	167.0	EA	4,000.00						1,143,027.67	1,143,028
1.MDAG3X.1.05.01	Screening plant rental	222.0	MNTH	15,500.00				5,887,961.41			5,887,961
1.MDAG3X.1.05.01	Screening plant : Scheduled Maintenance	167.0	EA	2,400.00						685,816.60	685,817
1.MDAG3X.1.05.01	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	1,020,464.0	CY	48.09	883,575.9	75,498,616.59		8,474,486.77			83,973,103
1.MDAG3X.1.05.01	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	605,426.0	CY	173.65	2,105,356.2	179,895,682.08					179,895,682
1.MDAG3X.1.05.01	Dozer D9 rip tuff material for processing	415,038.0	CY	2.33	21,113.7	1,657,917.99					1,657,918
1.MDAG3X.1.05.01	980 Frontend loader soil processing	415,038.0	CY	2.33	21,113.7	1,657,917.99					1,657,918
1.MDAG3X.1.05.01	825H High speed compactor (sheepsfoot) soil processing	415,038.0	CY	1.24	11,210.8	880,310.44					880,310
1.MDAG3X.1.05.01	963 Hydraulic Excavator soil processing	415,038.0	CY	1.24	11,210.8	880,310.44					880,310
1.MDAG3X.1.05.01	Mobilization or demobilization, dozer, loader, backhoe or excavator, above 150 H.P., up to 50 miles	4.0	EA	768.56	40.2	3,172.86		2,087.57			5,260
1.MDAG3X.1.05.01	**Total**				**3,068,102.0**	**261,445,616.49**	**421,336.31**	**53,816,368.62**	**444,891.01**	**2,754,682.93**	**318,882,895**
1.MDAG3X.1.05.03	**Excavation -DC- Excavation Pits - Backfill Pit MLLW**										
1.MDAG3X.1.05.03	Borrow, fill material only.	540,342.7	ton	16.50			15,255,748.31				15,255,748
1.MDAG3X.1.05.03	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	1,020,464.0	CY	6.39	76,416.5	6,529,532.28		4,627,259.38			11,156,792
1.MDAG3X.1.05.03	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	1,020,464.0	CY	8.14	139,290.8	11,901,932.26		2,305,110.18			14,207,042
1.MDAG3X.1.05.03	Water wagon 1,000 gal tuff processing	1,020,464.0	CY	0.91	25,323.8	1,581,876.60					1,581,877
1.MDAG3X.1.05.03	Equipment only. Water wagon 1,000 gal tuff processing	1,020,464.0	CY	0.26				460,979.80			460,980
1.MDAG3X.1.05.03	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	1,020,464.0	CY	1.40	19,345.9	1,528,738.26		908,019.74			2,436,758
1.MDAG3X.1.05.03	**Total**				**260,377.0**	**21,542,079.40**	**15,255,748.31**	**8,301,369.10**			**45,099,197**
1.MDAG3X.1.05.04	**Excavation -DC- Excavation Pits - Disposal of Waste Pit MLLW**										
1.MDAG3X.1.05.04	MLLW - Waste container delivery.	9,082.0	ea	1,453.61	273,186.6	18,107,823.58		4,481,847.09			22,589,671
1.MDAG3X.1.05.04	MLLW - Waste container unload on site and handling during project.	181,628.0	ea	4,607.32	16,390,110.7	1,295,148,190.76		136,746,355.14			1,431,894,546
1.MDAG3X.1.05.04	MLLW - Waste containers.	181,628.0	ea	2,018.34			627,274,178.26				627,274,178
1.MDAG3X.1.05.04	MLLW - Fill waste containers.	181,628.0	ea	549.81	2,048,763.8	161,893,523.84		8,981,749.24			170,875,273
1.MDAG3X.1.05.04	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	605,426.0	cy	1,114.00					1,154,055,090.01		1,154,055,090
1.MDAG3X.1.05.04	MLLW - Trucking cost per 43,000 pound load	36,326.0	Trip	4,471.00						277,908,948.27	277,908,948
1.MDAG3X.1.05.04	Confirmatory Sampling	6,054.0	EA	3,798.14	22,763.0	2,798,187.86		3,755.18	36,543,439.36		39,345,382
1.MDAG3X.1.05.04	**Total**				**18,734,824.2**	**1,477,947,726.04**	**627,274,178.26**	**150,213,706.65**	**1,190,598,529.37**	**277,908,948.27**	**3,723,943,089**
1.MDAG3X.1.05.05	**Excavation -DC- Excavation Pits - Excavation Pit MLLW /TRU**										
1.MDAG3X.1.05.05	Dozer D9 rental	102.0	MNTH	29,404.00				5,132,002.60			5,132,003
1.MDAG3X.1.05.05	Dozer D9 Scheduled Maintenance	8.5	YR	7,253.69						105,501.39	105,501
1.MDAG3X.1.05.05	Dozer D9 Ripper replacement	17.0	SET	647.69	127.8	10,038.41				8,802.34	18,841
1.MDAG3X.1.05.05	Dozer cutting edge replacement	51.0	EA	1,290.19	767.0	60,230.48	52,360.25				112,591

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Project WBS	Activity Description	Takeoff Quantity - Adjusted	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.MDAG3X.1.05.05	980, 7 cy frontend loader rental	102.0	MNTH	16,734.00				2,920,654.73			2,920,655
1.MDAG3X.1.05.05	980 Loader: Scheduled Maintenance	8.5	YR	5,865.19						85,306.34	85,306
1.MDAG3X.1.05.05	980-7cy loader bucket teeth replacement.	60.0	EA	1,177.09	451.2	35,429.70	85,419.07				120,849
1.MDAG3X.1.05.05	825H High speed compactor (sheepsfoot) rental	102.0	MNTH	10,585.00				1,847,444.14			1,847,444
1.MDAG3X.1.05.05	825H: Scheduled Maintenance	8.5	YR	5,944.56						86,460.73	86,461
1.MDAG3X.1.05.05	963 Hydraulic Excavator rental	102.0	MNTH	18,640.00				3,253,316.85			3,253,317
1.MDAG3X.1.05.05	963 Hydraulic Excavator : Scheduled Maintenance	8.5	YR	7,349.52						106,895.20	106,895
1.MDAG3X.1.05.05	963 Hydraulic Excavator tip long replacement.	77.0	EA	773.08	579.0	45,468.11	56,390.33				101,858
1.MDAG3X.1.05.05	Water wagon 1,000 gal soil processing	177,291.0	CY	0.91	4,399.7	274,828.40					274,828
1.MDAG3X.1.05.05	Equipment only. Water wagon 1,000 gal soil processing	177,291.0	CY	0.26				80,088.64			80,089
1.MDAG3X.1.05.05	Rock crusher plant rental	102.0	MNTH	28,000.00				4,886,956.64			4,886,957
1.MDAG3X.1.05.05	Rock crusher plant : Scheduled Maintenance	77.0	EA	4,000.00						527,024.74	527,025
1.MDAG3X.1.05.05	Screening plant rental	102.0	MNTH	15,500.00				2,705,279.57			2,705,280
1.MDAG3X.1.05.05	Screening plant : Scheduled Maintenance	77.0	EA	2,400.00						316,214.84	316,215
1.MDAG3X.1.05.05	Excavating, 3/8 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	470,789.0	CY	48.09	407,635.9	34,831,133.88		3,909,687.31			38,740,821
1.MDAG3X.1.05.05	Excavating, by hand with pick and shovel, 2' to 6' deep, light soil, excludes sheeting or dewatering	293,498.0	CY	173.65	1,020,633.1	87,209,705.07					87,209,705
1.MDAG3X.1.05.05	Dozer D9 rip tuff material for processing	177,291.0	CY	2.33	9,019.1	708,209.70					708,210
1.MDAG3X.1.05.05	980 Frontend loader soil processing	177,291.0	CY	2.33	9,019.1	708,209.70					708,210
1.MDAG3X.1.05.05	825H High speed compactor (sheepsfoot) soil processing	177,291.0	CY	1.24	4,788.9	376,040.55					376,041
1.MDAG3X.1.05.05	963 Hydraulic Excavator soil processing	177,291.0	CY	1.24	4,788.9	376,040.55					376,041
1.MDAG3X.1.05.05	**Total**				**1,462,209.9**	**124,635,334.56**	**194,169.65**	**24,735,430.46**		**1,236,205.58**	**150,801,140**
1.MDAG3X.1.05.07	**Excavation -DC- Excavation Pits - Backfill Pit MLLW/TRU**										
1.MDAG3X.1.05.07	Equipment only. Water wagon 1,000 gal tuff processing	470,789.0	CY	0.26				212,672.10			212,672
1.MDAG3X.1.05.07	Borrow, fill material only.	261,647.0	ton	16.50			7,387,202.19				7,387,202
1.MDAG3X.1.05.07	Fill, from stockpile, 300 H.P. dozer, 2-1/2 C.Y., 300' haul, spread fill, with front-end loader, excludes compaction	470,789.0	CY	6.39	35,254.6	3,012,386.50		2,134,776.74			5,147,163
1.MDAG3X.1.05.07	Backfill, structural, common earth, 80 H.P. dozer, 300' haul	470,789.0	CY	8.14	64,261.5	5,490,932.35		1,063,457.91			6,554,390
1.MDAG3X.1.05.07	Water wagon 1,000 gal tuff processing	470,789.0	CY	0.91	11,683.1	729,795.56					729,796
1.MDAG3X.1.05.07	Compaction, 2 passes, 6" lifts, riding, sheepsfoot or wobbly wheel roller	470,789.0	CY	1.40	8,925.2	705,280.30		418,913.07			1,124,193
1.MDAG3X.1.05.07	**Total**				**120,124.4**	**9,938,394.71**	**7,387,202.19**	**3,829,819.82**			**21,155,417**
1.MDAG3X.1.05.08	**Excavation -DC- Excavation Pits - Disposal of Waste Pit MLLW/TRU**										
1.MDAG3X.1.05.08	TRU - Waste Containers	5,454.0	ea	2,776.12			25,906,865.93	1,110.23			25,907,976
1.MDAG3X.1.05.08	TRU - Waste container unload on site and handling during project.	109,072.0	ea	7,960.00	17,761,262.1	1,403,496,711.65		82,119,488.45			1,485,616,200
1.MDAG3X.1.05.08	TRU - Fill waste containers.	109,072.0	ea	549.81	1,230,332.2	97,220,970.52		5,393,757.31			102,614,728
1.MDAG3X.1.05.08	TRU - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	54,536.0	cy	1,114.00					103,955,806.97		103,955,807
1.MDAG3X.1.05.08	TRU - Site Delivery	16,361.0	EA	50.00	11,444.7	977,909.05		421,872.06			1,399,781
1.MDAG3X.1.05.08	MLLW - Waste container delivery.	3,585.0	ea	1,453.61	107,836.8	7,147,825.10		1,769,150.17			8,916,975
1.MDAG3X.1.05.08	MLLW - Waste container unload on site and handling during project.	71,689.0	ea	4,607.32	6,469,215.4	511,198,045.72		53,974,108.91			565,172,155
1.MDAG3X.1.05.08	MLLW - Waste containers.	71,689.0	ea	2,018.34			247,586,597.69				247,586,598
1.MDAG3X.1.05.08	MLLW - Fill waste containers.	71,689.0	ea	549.81	808,651.9	63,899,755.71		3,545,117.61			67,444,873
1.MDAG3X.1.05.08	MLLW - Waste, ship off site. Packaging, Handling, Shipping and Disposal fees.	328,962.0	cy	1,114.00					627,063,044.07		627,063,044
1.MDAG3X.1.05.08	MLLW - Trucking cost per 43,000 pound load	14,338.0	Trip	4,471.00						109,691,639.60	109,691,640
1.MDAG3X.1.05.08	Confirmatory Sampling	2,390.0	EA	3,798.14	8,986.4	1,104,669.47		1,482.47	14,426,630.34		15,532,782
1.MDAG3X.1.05.08	**Total**				**26,397,729.4**	**2,085,045,887.22**	**273,493,463.62**	**147,226,087.22**	**745,445,481.38**	**109,691,639.60**	**3,360,902,559**
1.MDAG3X.1.05.09	**Excavation -DC- Excavation Pits - Confirmatory Sampling After Excavation**										
1.MDAG3X.1.05.09	51 Acre Site Confirmatory Sampling for cleanness before backfill.	88,862.4	EA	3,798.14	334,122.6	41,072,627.77		55,119.63	536,395,395.77		577,523,143
1.MDAG3X.1.05.09	**Total**				**334,122.6**	**41,072,627.77**		**55,119.63**	**536,395,395.77**		**577,523,143**
1.MDAG3X.1.05.10	**Excavation -DC- Excavation Pits - Equipment Decontamination**										
1.MDAG3X.1.05.10	Decontamination of equipment.	600.0	hour	287.76	2,256.0	192,767.69	102,667.16				295,435
1.MDAG3X.1.05.10	Swipes	3,000.0	hour	787.76	11,280.0	963,838.47	3,080,014.69				4,043,853
1.MDAG3X.1.05.10	RCT involvment in swipes and decontamination process	300.0	hour	193.88	564.0	48,191.92	51,333.58				99,526
1.MDAG3X.1.05.10	**Total**				**14,100.0**	**1,204,798.08**	**3,234,015.42**				**4,438,814**
1.MDAG3X.1.05	**Total**				**50,391,589.5**	**4,022,832,464.28**	**927,260,113.75**	**388,177,901.51**	**2,472,884,297.52**	**391,591,476.38**	**8,202,746,253**
1.MDAG3X.1.06	**Excavation -DC- Revegetation**										
1.MDAG3X.1.06	Seeding, seeding utility mix with Bio-Sol, 0.09 lb. per M.S.F., hydro-seeding	2,222.0	Msf	34.33	1,214.4	89,185.54		41,347.91			130,533
1.MDAG3X.1.06	Hydroseeding materials.	1.0	lsum	2,233,902.00			3,822,472.76				3,822,473
1.MDAG3X.1.06	Broadcasting Mulch and Humate	2,222.0	Msf	34.33	1,214.4	89,185.54		41,347.91			130,533
1.MDAG3X.1.06	Mulch and Humate materials.	1.0	LS	1,002,170.00			1,714,832.40				1,714,832
1.MDAG3X.1.06	**Total**				**2,428.7**	**178,371.08**	**5,537,305.16**	**82,695.83**			**5,798,372**

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Project WBS	Activity Description		Takeoff Quantity - Adjusted	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.MDAG3X.1.07	Excavation, SVE, and Institutional Contols MDA G -DC-Distribs											
1.MDAG3X.1.07	Field Non-Manual - JHRS		10,438,122.0	hour	66.10	10,438,122.0	1,180,603,619.16					1,180,603,619
1.MDAG3X.1.07	Craft Distributable - Labor		13,047,653.0	hour	46.33	13,047,653.0	1,034,360,569.81					1,034,360,570
1.MDAG3X.1.07	Craft Distributable - Materials		13,047,653.0	hour	7.00			156,282,633.34				156,282,633
1.MDAG3X.1.07		Total				23,485,775.0	2,214,964,188.97	156,282,633.34				2,371,246,822
1.MDAG3X.1		Total				75,676,387.8	6,460,273,718.45	1,093,577,180.89	399,798,296.98	3,020,097,869.28	393,603,004.24	11,367,350,070
1.MDAG3X.2	Excavation, SVE, and Institutional Contols MDA G - Indirect Capital Costs											
1.MDAG3X.2.01	Excavation, SVE, and Institutional Contols MDA G -IC-Design											
1.MDAG3X.2.01	Full Excavation Design		1.0	lsum	681,823,108.00					992,666,262.94		992,666,263
1.MDAG3X.2.01		Total										
1.MDAG3X.2.02	Excavation, SVE, and Institutional Contols MDA G -IC-Professional Management											
1.MDAG3X.2.02	Professional Management		1.0	lsum	3,213,604,246.00	32,265,102.9	7,041,423,064.74					7,041,423,065
1.MDAG3X.2.02		Total										
1.MDAG3X.2.03	Excavation, SVE, and Institutional Contols MDA G -IC-Contingency											
1.MDAG3X.2.03	Contingency - Cost 30%		1.0	lsum	5,820,431,819.00	1.0					5,820,431,819.00	5,820,431,819
1.MDAG3X.2.03	Contingency - Schedule 10%		1.0	lsum	1,940,143,939.00	1.0					1,940,143,939.00	1,940,143,939
1.MDAG3X.2.03	Contingency - TPRA 10%		1.0	lsum	1,940,143,939.00	1.0					1,940,143,939.00	1,940,143,939
1.MDAG3X.2.03		Total										
1.MDAG3X.2		Total				32,265,105.9	7,041,423,064.74			992,666,262.94	9,700,719,697.00	17,734,809,025
1.MDAG3X.3	Excavation, SVE, and Institutional Contols MDA G - Direct O&M Costs											
1.MDAG3X.3.01	Excavation, SVE, and Institutional Contols MDA G -DOM-Cover Maintenance & Inspections											
1.MDAG3X.3.01	Active SVE Operation (3 years)		1.0	lsum	2,301,191.00	49,669.9	3,350,303.98					3,350,304
1.MDAG3X.3.01	Active SVE Monitoring (3 years)		1.0	lsum	329,216.00	4,204.5	479,305.57					479,306
1.MDAG3X.3.01	Rebound SVE Monitoring (3 years)		1.0	lsum	666,663.00	14,389.5	970,594.66					970,595
1.MDAG3X.3.01		Total				68,264.0	4,800,204.21					4,800,204
1.MDAG3X.3		Total				68,264.0	4,800,204.21					4,800,204
1.MDAG3X.4	Excavation, SVE, and Institutional Contols MDA G - Indirect O&M Costs											
1.MDAG3X.4.02	Excavation, SVE, and Institutional Contols MDA G-IOM-Professional Management											
1.MDAG3X.4.02	Professional Management (years 0-3)		1.0	lsum	857,238.00	8,606.8	1,878,319.47					1,878,319
1.MDAG3X.4.02		Total				8,606.8	1,878,319.47					1,878,319
1.MDAG3X.4.03	Excavation, SVE, and Institutional Contols MDA G -IOM-Contingency											
1.MDAG3X.4.03	Contingency - Cost 30%		1.0	lsum	2,003,556.90	1.0					2,003,556.90	2,003,557
1.MDAG3X.4.03	Contingency - Schedule 10%		1.0	lsum	667,852.00	1.0					667,852.00	667,852
1.MDAG3X.4.03	Contingency - TPRA 10%		1.0	lsum	667,852.00	1.0					667,852.00	667,852
1.MDAG3X.4.03		Total				3.0					3,339,260.90	3,339,261
1.MDAG3X.4		Total				8,609.8	1,878,319.47				3,339,260.90	5,217,580
1.MDAG3X		Total				108,018,367.5	13,508,375,306.87	1,093,577,180.89	399,798,296.98	4,012,764,132.22	10,097,661,962.14	29,112,176,879
1		Total				109,008,952.0	13,645,792,715.92	1,176,549,358.08	414,396,158.01	4,044,197,700.93	10,230,872,467.14	29,511,808,400
		Grand Total				109,008,952.0	13,645,792,715.92	1,176,549,358.08	414,396,158.01	4,044,197,700.93	10,230,872,467.14	29,511,808,400

Acronyms and Abbreviations for Attachment G-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 costs
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 H

Conceptual Multilayer
Resource Conservation and Recovery Act Cover Design

H-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) G within Technical Area 54 (TA-54). The specifications for the MDA G RCRA cover are based on standard prescribed specifications for a RCRA cover. A standard RCRA cover for MDA G was used in the modeling scenarios provided in Attachment H-1.

This appendix provides a summary of the basis for the conceptual multilayer cover design for MDA G 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:

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% percent.

The multilayer cover will cover the waste disposal units at MDA G, approximately 51 acres of the 63 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 the comparison of 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.

H-2.0 CONCEPTUAL DESIGN

The RCRA cover conceptual design is shown in Figure H–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 H-2.0-1, with expanded descriptions presented in sections H-2.1 to H-2.5.

H-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 H-2.1-1 lists the seed mix to be used for the cover system at MDA G.

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 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-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% to 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.

H-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 through 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.

H-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 G.

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 that 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 enforced during the construction activity.

H-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-percent 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.

H-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 modeling other cover types that do not contain geomembrane liners. This is 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.

H-3.1 HELP Input Parameters

A set of input parameters were 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 H-1 HELP Model Run Output, and are discussed as they relate to the different conditions listed below.

H-3.2 Model Geometry

The model geometry was based on the depth of the cover profile shown in Figure H-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 H-1.

H-3.3 Boundary Conditions

Los Alamos, New Mexico, is located in a dry environment where the climate's demand for water, referred to a 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 in Los Alamos is not expected.

H-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 the 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 was the regulatory driver for determining the storage capacity requirements of the cover profile, the wettest decade on record was deemed to provide a conservative measure for evaluation.

H-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.

H-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 were obtained using flexible wall permeameters in accordance with the American Society for Testing and Materials (ASTM) 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 H-1.

H-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 totals rate, is provided in Attachment H-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-year timeframe, or an average of 0.09 cm/yr (0.9 mm/yr).

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.

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)

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)

van Genuchten, M.T., F.J. Leij, and S.R. Yates, December 1991. "The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils," EPA/600/2-91/065, Office of Research and Development, Washington, D.C. (van Genuchten et al. 1991, 205358)

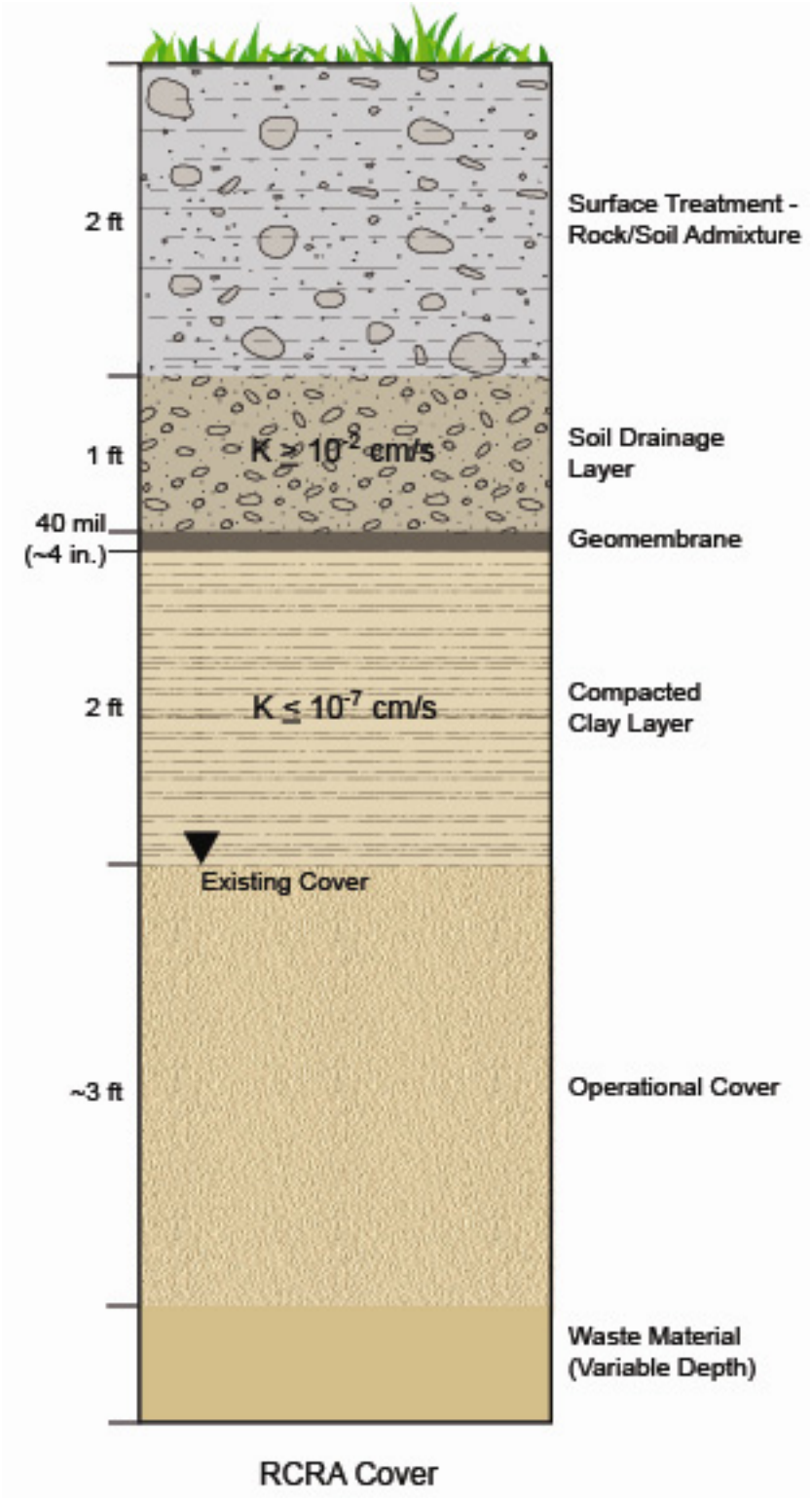

Figure H-2.0-1 RCRA cover conceptual design

Table H-2.0-1
RCRA 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). Refer to Table H-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 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.	The gravel/soil admixture is designed to minimize erosion due to both wind and surface run off.
Soil Drainage Layer	The granular material will be 12-in. thick and have a hydraulic conductivity of at least 1×10^{-2}. 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 H-2.1-1
Seed Mix

Common Name	Scientific Name	Percent of Mix	PLS (lb/acre)
Sideoats grama	Boutela 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%	.75
Western yarrow	Achillea millefoium	2%	.5
Prairie coneflower	Ratibida columnifera	4%	1
Blue flax	Linum perenne lewisii	6%	1.5
Total			**25**

Source: Dwyer et al. 2007, 096232.

Attachment H-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 I

Conceptual Evapotranspiration Cover Design

I-1.0 INTRODUCTION

This appendix describes modeling used to develop specifications for an evapotranspiration (ET) cover at Material Disposal Area (MDA) G within Technical Area 54 (TA-54) at Los Alamos National Laboratory (LANL or the Laboratory). The effectiveness of an ET cover depends on precipitation, potential ET, and unsaturated soil hydraulic properties.

Borrow soil with amendments will be used to construct the ET covers at MDA G. TA-61 is a likely source of the borrow soil. Attachment I-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 consisting 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 I-1).

I-2.0 BACKGROUND

MDA G 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 G is a 63-acre site containing 333 active and inactive waste disposal units, that lies within the boundaries of TA-54. The majority of stormwater runoff from MDA G enters the Pajarito Canyon watershed with a much smaller portion draining into the Mortandad Canyon watershed.

This appendix provides a summary of the basis for the conceptual ET cover design for MDA G as part of the corrective measures evaluation (CME) for remediation of the site. At MDA G, 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 I-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 the combination of water removal 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 G 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 I-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.

I-3.0 CONCEPTUAL DESIGN

The ET cover system proposed for MDA G is shown in Figure I-3.0-1. A brief description of each layer in the cover profile is presented in Table I-3.0-1, with more complete descriptions presented in sections I-3.1 through I-3.5.

I-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 I-3.1-1 lists the seed mix to be used for the cover system at MDA G.

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 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 I-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.

I-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 was 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 I-3.3. Salts in this soil will also be limited in the cover soil as described in section I-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 I-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.

Because the gravel is used to control erosion and is subject to weathering, it must meet the durability requirements described in U.S. Nuclear Regulatory Commission Regulation (NRC 2002, 097900, Appendix D) (see Table I-3.2-1).

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.

I-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, CA. 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 I-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 I-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 I-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 I-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 I-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 no greater 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 I-3.3-2) is unknown as of the date of this 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.

I-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 G 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:

$$D_{15}/ d_{85} \leq 5 \qquad \textbf{Equation I-3.4-1}$$

where

D_{15} = particle size of the coarse soil for which 15% of the particles are finer,

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.

I-3.5 Biobarrier

As stated in section I-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 offsite 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.

I-3.6 Subgrade/Interim (Operational) Cover Preparation

MDA G 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.

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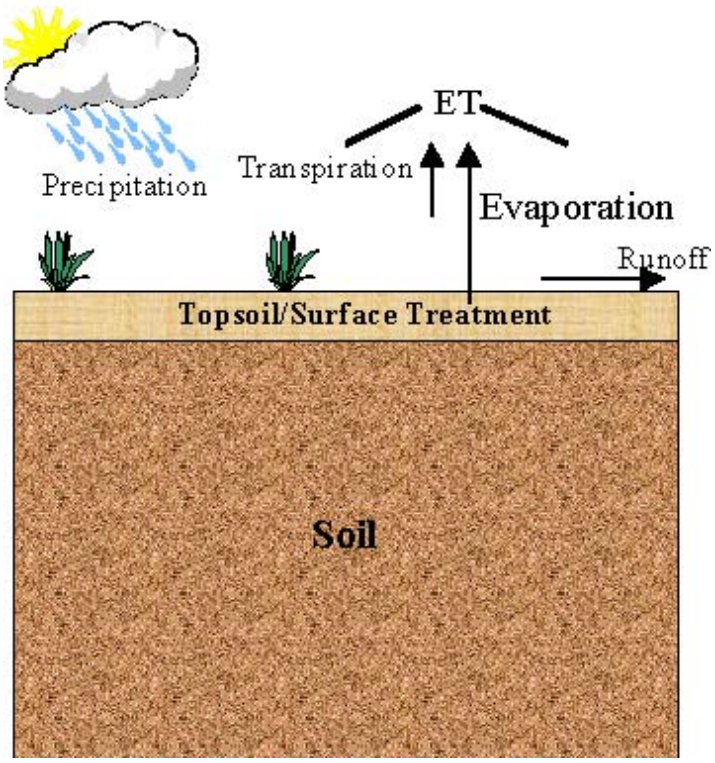


Figure I-2.0-1 Typical ET cover profile

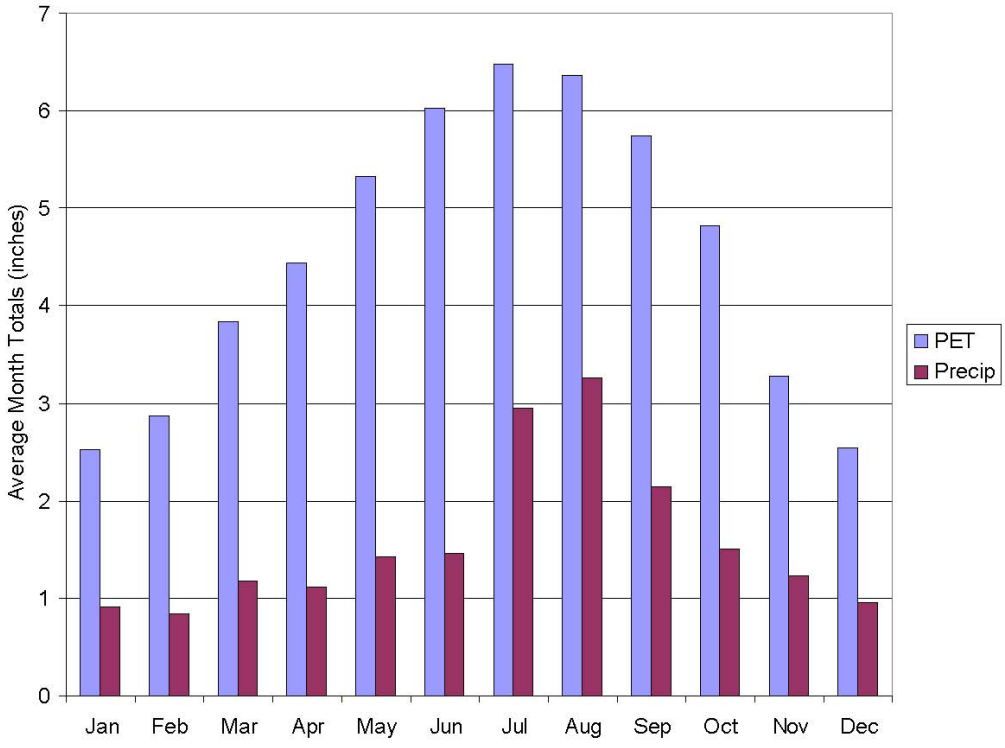


Figure I-2.0-2 Climate's demand for water (PET) versus supply of water (precipitation) for Los Alamos, New Mexico

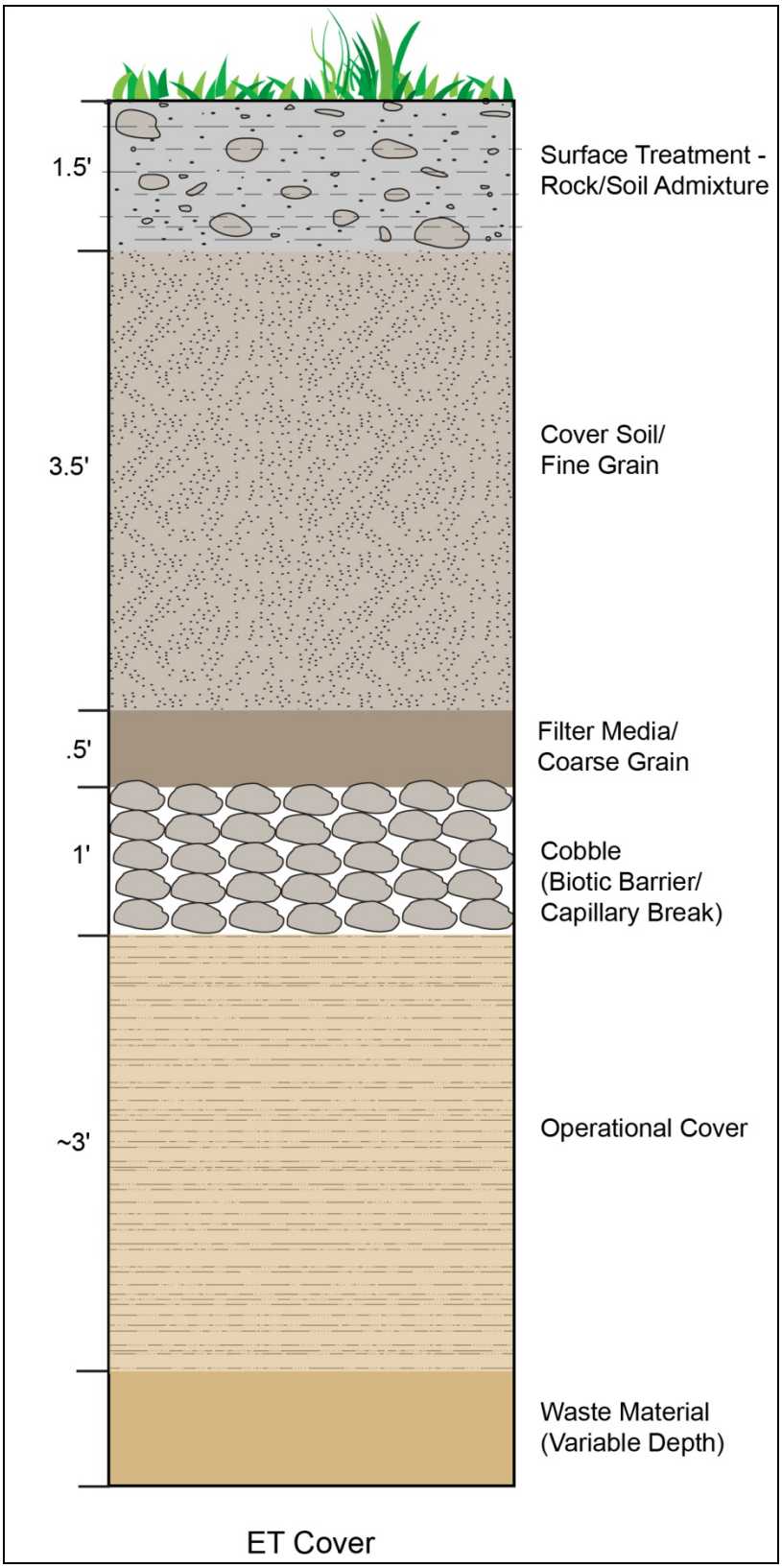


Figure I-3.0-1 MDA G CME conceptual ET cover profile

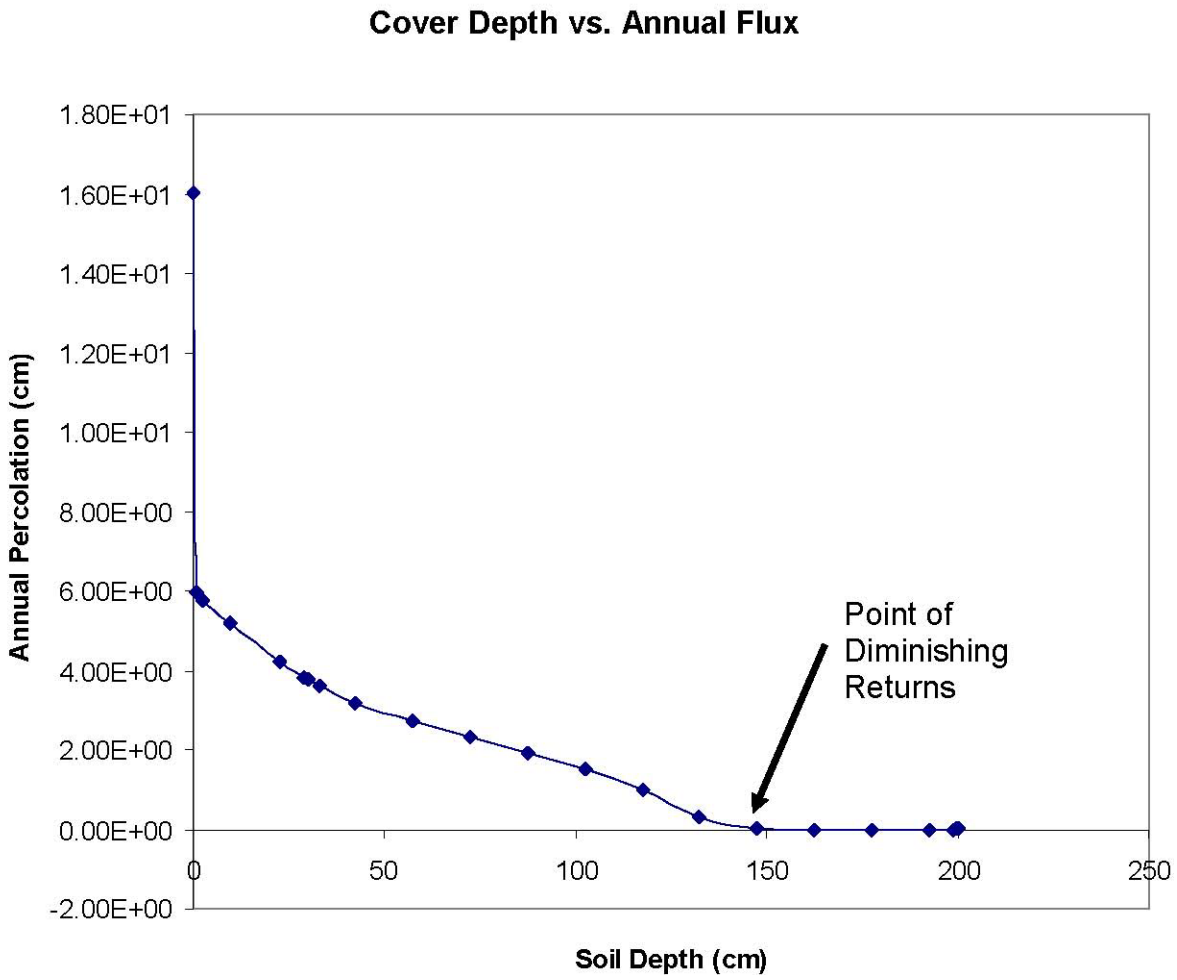


Figure I-3.3-1 Typical sandy loam soil: point of diminishing returns (1.5 m)

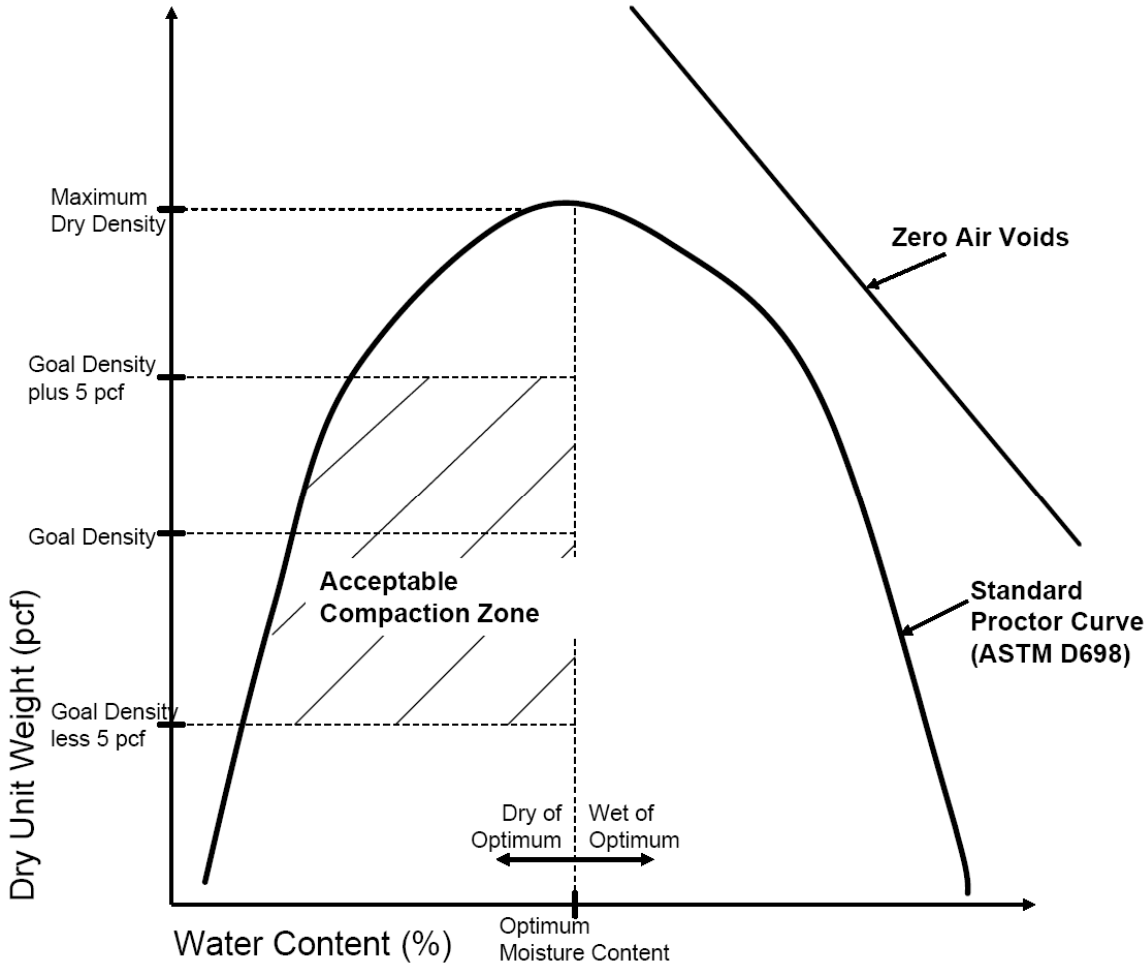


Figure I-3.3-2 Acceptable compaction zone for soil placement

Table I-3.0-1
MDA G CME 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 I-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 1.75 in. (4.4 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 I-3.1-1
Seed Mix

Common Name	Scientific Name	% of Mix	Pure Live Seed (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%	.75
Western yarrow	Achillea millefoium	2%	.5
Prairie coneflower	Ratibida columnifera	4%	1
Blue flax	Linum perenne lewisii	6%	1.5
Total			**25**

Source: Dwyer et al. 2007, 096232.

Table I-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 NUREG (NRC 2002, 097900).

[a] SSD = Saturated Surface Dry

[b] psi = pounds per square inch.

Table I-3.3-1
Recommended Available Plant Nutrients for Cover Soil

Test	Limits
CEC	Greater than 15
Percent organic matter	Greater than 2% (g/g)
N	Greater than 6 parts per million (ppm)
P	4 to 7 ppm
K	61 to 120 ppm

Table I-3.3-2
Recommended Limitations of Salt in Cover Soil

Test	Limits
EC	Less than 8 µS/cm
SAR	Less than 6
ESP	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 I-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.

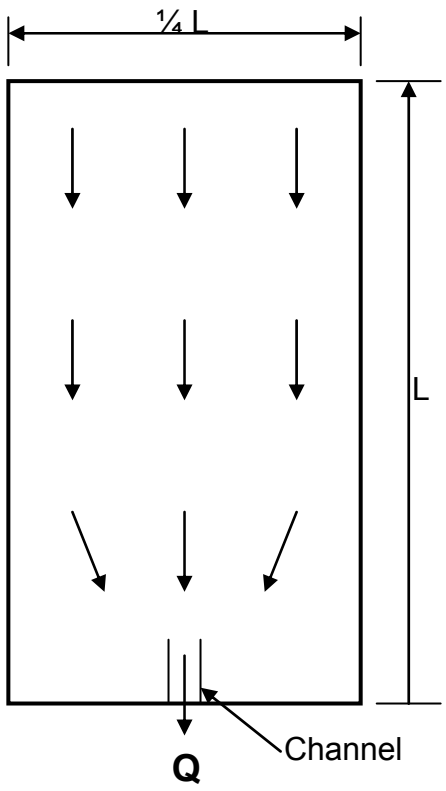


Figure A.1
Contributory area for gully formation

Channel Geometry

The channel geometry shown in Figure A.2 is that assumed for the gully formation.

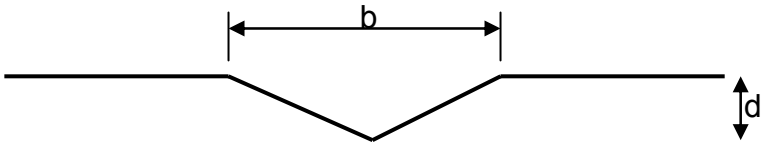


Figure A.2
Channel geometry

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:

$$b = 0.5\, F^{0.6}\, F_r^{-0.4} Q^{0.4} \qquad \textbf{Equation A.3}$$

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:

$$D_c = \tau / F_s(\gamma_s - \gamma) \qquad \textbf{Equation A.4}$$

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:

$$\tau = \gamma\, d_h\, S \qquad \textbf{Equation A.5}$$

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):

$$Y_s = Y_a [(1/P_{c)}-1] \qquad \textbf{Equation A.6}$$

where:

Y_s = scour depth;

Y_a = armor layer thickness;

P_c = decimal fraction of material coarser than the incipient particle size.

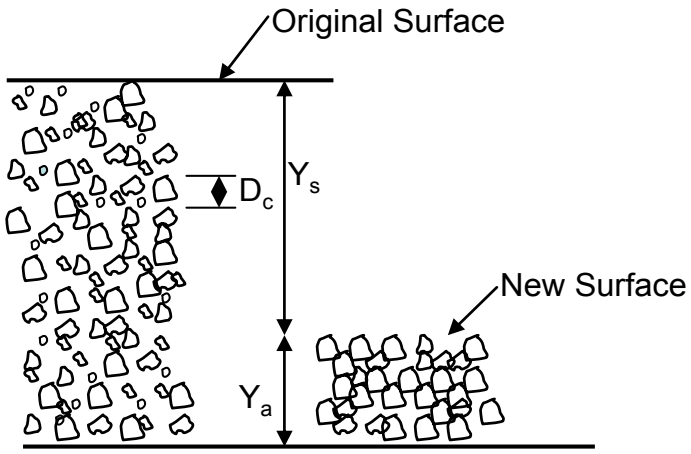


Figure A.3
"Desert Pavement" development

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).

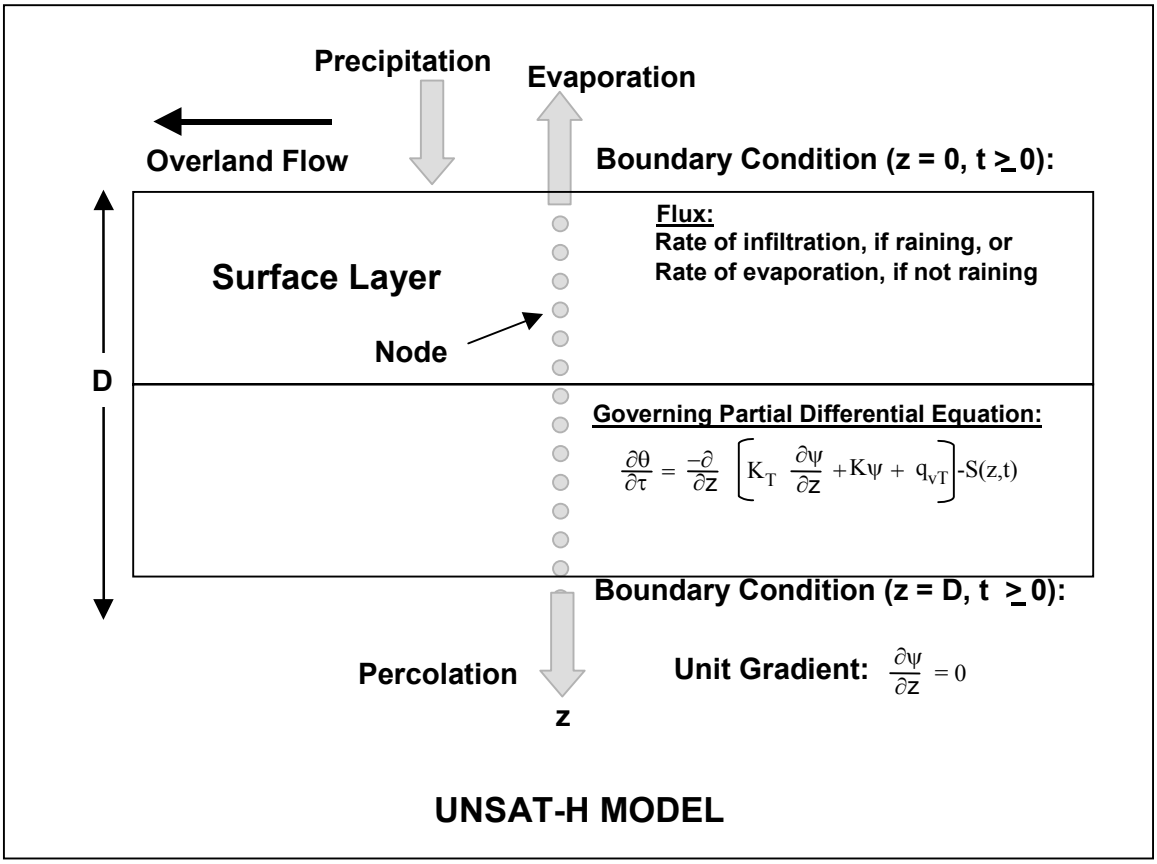
Attachment C
MODELING

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

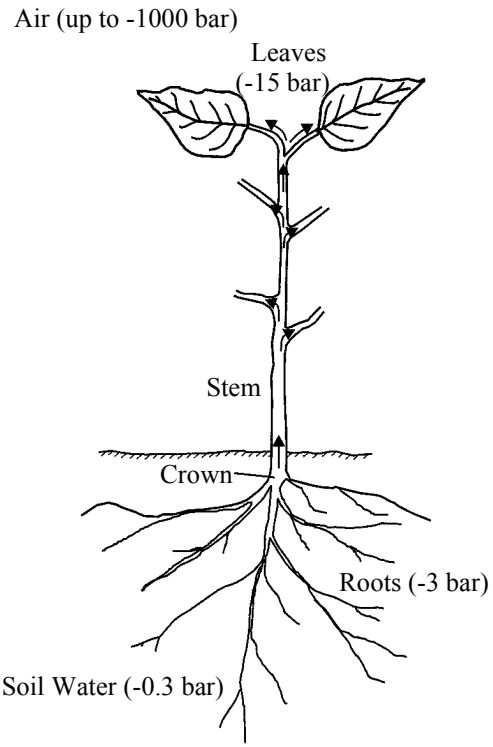
The parameters used for the RLD functions in Equation C.2 were: a = 0.315, b=0.0073, and c = 0.076 (Fayer 2000). The time required for maximum rooting depth establishment was set at full depth beginning on day 1. The rooting depth was set at 6.6-feet (200 cm) (Foxx et al 1984). An average LAI of 0.65 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 Admixture	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 J

Soil-Vapor Extraction and Long-Term Vapor-Monitoring Plan for Material Disposal Area G

J-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) G in Technical Area 54 at Los Alamos National Laboratory (LANL or the Laboratory).

J-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 G. The final design of the system will be provided as part of the corrective measures implementation (CMI) plan.

J-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 C 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, which define the target plume for remediation.

As discussed in Appendix C of this report, nine VOCs exceeded their Tier I screening limits in 2010. The nine VOCs of concern at MDA G and their corresponding Tier I and Tier II limits are provided in Table J-2.1-1. Of these nine, four exceed the Tier II screening limits in either 2009 or 2010: 1,1-dichloroethene (DCE), perchloroethene (PCE), 1,1,1-trichloroethane (TCA), and trichloroethene (TCE). TCA and TCE are wider spread than are DCE and PCE. The target vapor plumes for SVE, where the combined TCA and TCE concentrations exceed the Tier II screening limits, are shown in Figures J-2.1-1 (plan view) and J-2.1-2 (cross-sectional view). These figures also show the locations where DCE and PCE exceeded their Tier II screening limits, which are within the target vapor plumes with the exception of DCE at borehole 54-01121.

J-2.2 Extraction Well Specifications

Based on the evaluation presented in Appendix C 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 Tshirege units of the Bandelier tuff Qbt 2, Qbt 1v, and Qbt 1g (approximately the upper 150 ft on the western end of MDA G but less on the eastern end). SVE boreholes are proposed to remediate the upper Tshirege units 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 no greater than 150 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 150-ft deep extraction well, it is assumed the Qct unit begins approximately 180 ft below ground surface (bgs), although the depth of Qct varies across MDA G (Figure J-2.1-2).

Figure J-2.2-1 illustrates an example of the two extraction borehole designs. The extraction intervals vary slightly from the generalized design discussed below because the unit thicknesses included in the figure are from the eastern end of MDA G, where the tuff is thinner.

The Qbt unit extraction borehole design (similar to that shown in Figure J-2.2-1) is as follows:

- total depth (TD) of 150 ft bgs,
- drilled with 10-in.outside-diameter hollow-stem auger,
- 4-in. polyvinyl chloride (PVC) slotted well screen from 60 to 150 ft bgs,
- 4-in. PVC solid casing from the surface to 60 ft bgs,
- sand filter pack outside the well screen in the borehole annulus from 58 to 150 ft bgs,
- bentonite seal from 55 to 58 ft bgs, and
- grout from the surface to 55 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 (Appendix C, section C-4.0), extraction in the Qct interval will provide additional protection against vapor-phase transport toward groundwater. The initial design of the Qct unit extraction boreholes is as follows (similar to that shown in Figure J-2.2-1):

- TD of 200 ft bgs,
- drilled with 10-in. outside-diameter hollow-stem auger,
- 4-in. PVC slotted well screen from 180 to 200 ft bgs,
- 4-in. PVC solid casing from the surface to 180 ft bgs,
- sand filter pack outside the well screen in the borehole annulus from 175 to 200 ft bgs,
- bentonite seal from 165 to 175 ft bgs, and
- grout from the surface to 165 ft.

J-2.3 Number of Extraction Wells

For the previous SVE pilot test at MDA L conducted in 2008, a ROI of 150 ft was estimated for the shallow extraction borehole, which was screened over units Qbt 1v and Qbt 1g (LANL 2009, 105112). Based on the permeability testing at MDA G done during the 2010 SVE pilot study (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. To be conservative, an ROI of 125 ft is used in the layout design for the 150-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 J-2.4). However, for the purposes of the initial design, a 150-ft ROI is assumed for the deeper extraction wells that will extract from the Qct unit. The 125-ft and 150-ft design ROIs are used to space the proposed SVE wells; however, extraction wells will not be drilled through pits or shafts.

Eighteen SVE wells for primary VOC mass removal in the Qbt units are included in the initial design for the MDA G alternatives. The proposed location of these extraction wells is shown in Figure J-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 150 ft in the vadose zone. Additional wells are recommended for Pits 1 and 3 because VOC surface fluxes measured at MDA G indicated vapors near these two pits may be more widespread than indicated by the target vapor plumes (Trujillo et al. 1998, 058242). Depending on the performance of the system after operations begin, additional wells may be added as necessary.

Six 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 J-2.3-2; the configuration is designed mostly to inhibit downward migration of the plume, but it will also remediate the combined extent of the vapor plume that exceeds Tier II concentration limits within the Qct unit. Depending on the performance of the system after operations begin, additional wells may be added as necessary.

Figure J-2.3-3 shows the screened intervals for all of the proposed SVE wells laid atop the A-A' cross-section geology and target vapor plume (Figure J-2.1-1). Some of the wells are located off of the cross-section, but the figure illustrates that the wells cover the plume extent.

J-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 eight SVE units is proposed for extraction at the 24 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 G, eight SVE units are proposed for use.

J-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 in-line 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 TCA, 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 and 2B will be performed at the seven pore-gas monitoring wells shown in Figure J-2.5-1. The selected rebound monitoring wells and sampling ports are provided in Table J-2.5-1. These wells and ports were chosen for rebound sampling because one or more of the four VOCs of concern exceeded its Tier II screening level at one or more ports within these wells during 2009 or 2010. Sampling will include field screening and VOC sample collection with SUMMA canisters. The same wells will be used for rebound monitoring under Alternative 3 unless the excavation impacts a selected well, in which case an alternate well will be proposed.

J-2.6 Operational Schedule—Alternatives 2A and 2B

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,
- 90-d SVE operations at the first group of eight SVE wells,
- 30-d rebound monitoring and relocation of SVE units to next group of eight SVE wells,
- 90-d SVE operations at next group of eight SVE wells,
- 30-d rebound monitoring and relocation of SVE units to next group of eight SVE wells,
- 90-d SVE operations at final group of eight SVE wells, and
- 30-d rebound monitoring and relocation of SVE units to first group of eight SVE wells.

After approximately a year, SVE will have been conducted on all 24 extraction wells. The 90-d extraction period is thought to be sufficient to maximize the operational ROI. 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.

J-2.7 Operational Schedule—Alternative 3

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 eight SVE wells,
- 30-d rebound monitoring and relocation of SVE units to next group of eight SVE wells,
- 90-d SVE operations,
- 30-d rebound monitoring and relocation of SVE units to next group of eight SVE wells,
- 90-d SVE operations, and
- 30-d rebound monitoring.

After approximately a year, SVE will have been conducted on all 24 extraction wells. The 90-d extraction period is thought to be sufficient to maximize the operational ROI. 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.

J-2.8 Shutdown Parameters

The following shutdown parameters are proposed for the operation of the SVE system.

- The first parameter is the Tier II screening limits for each of the four VOCs that have recently exceeded their respective Tier II limits (Table J-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 and 2B. Long-term vapor monitoring will not be required for Alternative 3 because no additional releases will occur following excavation.
- The SVE extraction boreholes will be maintained for Alternatives 2A and 2B in the event that long-term vapor monitoring identifies a postremedy release from the disposal units. Additional operation of SVE will be performed as necessary.

J-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.

J-3.0 LONG-TERM VAPOR MONITORING

Pore-gas monitoring activities have been conducted at MDA G 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 G. 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 and 2B in the event an additional release of VOCs from the source areas occurs.

Long-term monitoring is not a component of Alternative 3. Extraction wells and vapor monitoring wells will be abandoned after the shutdown parameters have been met.

J-3.1 Monitoring Distribution and Frequency—Alternatives 2A and 2B

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 and 2B. Pore-gas monitoring will be conducted once per year at the monitoring borehole locations identified in Table J-3.1-1.

The following boreholes are currently constructed with the Flexible Liner Underground Technologies (FLUTe) sampling system and are proposed to be retrofitted with dedicated stainless-steel sampling systems: 54-01107, 54-01110, 54-01111, and 54-01121. Additionally, borehole 54-25105, currently a borehole that is open in the Cerros del Rio basalt (Tb 4) from 485 to 701 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 J-3.1-1.

J-3.2 Monitoring Methods—Alternatives 2A and 2B

Monitoring activities will be conducted in accordance with the Laboratory's current revision of SOP-5074, Sampling Subsurface Vapor, or equivalent.

J-3.3 Reporting—Alternatives 2A and 2B

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.

J-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.

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), January 2009. "Pilot Test Report for Evaluating Soil-Vapor Extraction at Material Disposal Area G at Technical Area 54, Revision 1," Los Alamos National Laboratory document LA-UR-09-0565, Los Alamos, New Mexico. (LANL 2009, 105112)

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Trujillo, V., R. Gilkeson, M. Morgenstern, and D. Krier, June 1998. "Measurement of Surface Emission Flux Rates for Volatile Organic Compounds at Technical Area 54," Los Alamos National Laboratory report LA-13329, Los Alamos, New Mexico. (Trujillo et al. 1998, 058242)

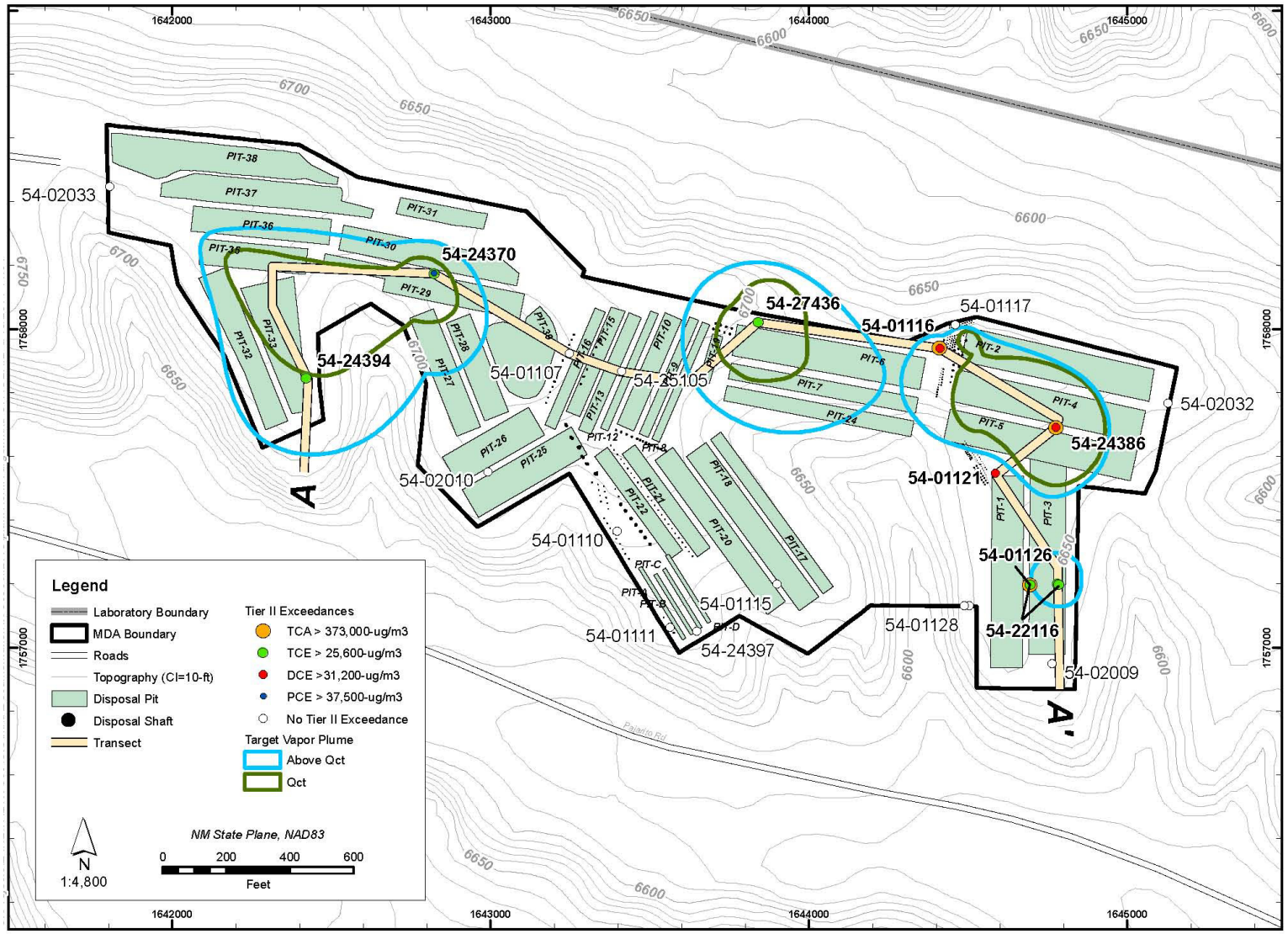

Figure J-2.1-1 Plan view map of extent of target vapor plumes for four VOCs that exceed Tier II screening limits, based on 2009 and 2010 data

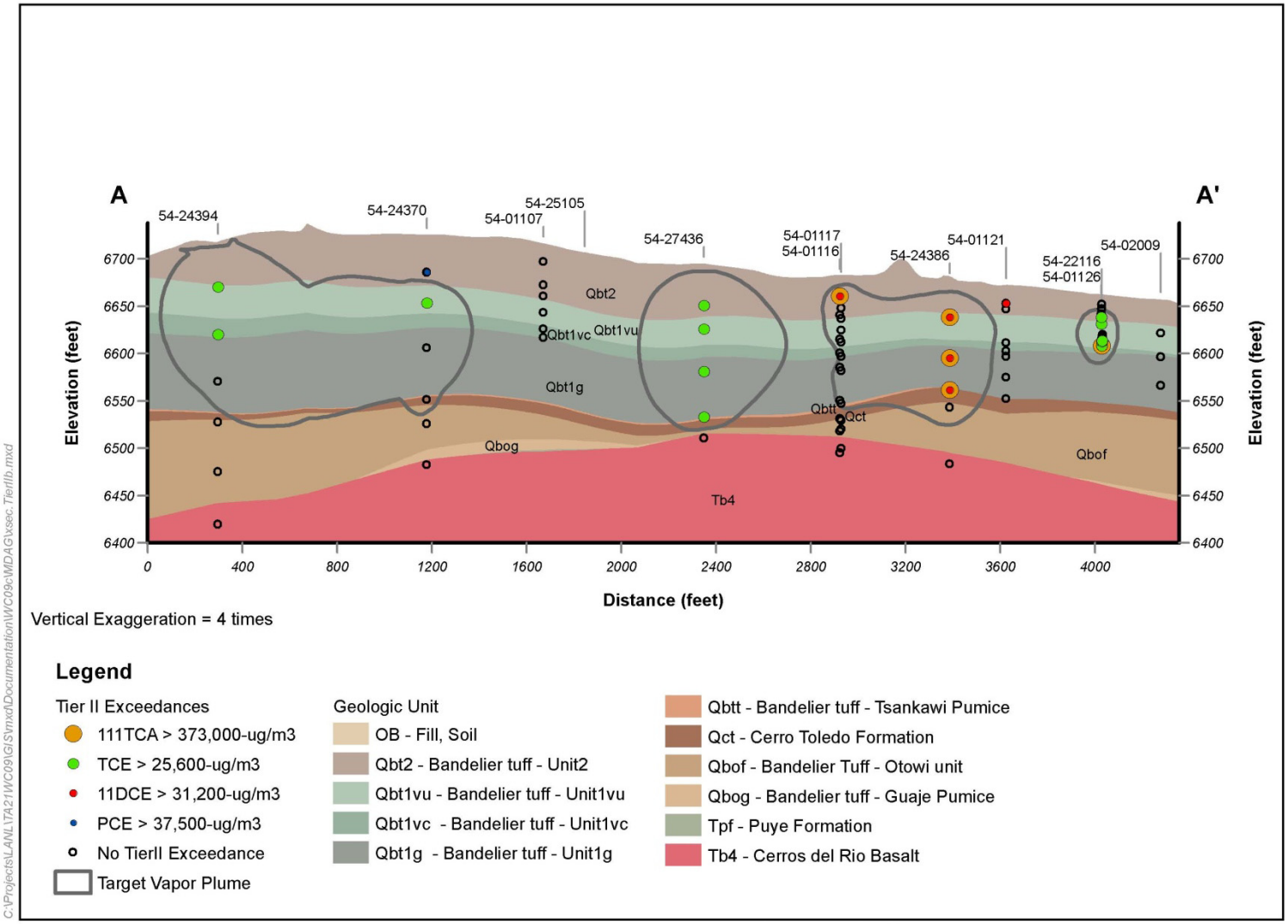

Figure J-2.1-2 Cross-sectional view of extent of target vapor plumes for four VOCs that exceed Tier II screening limits, based on 2009 and 2010 data

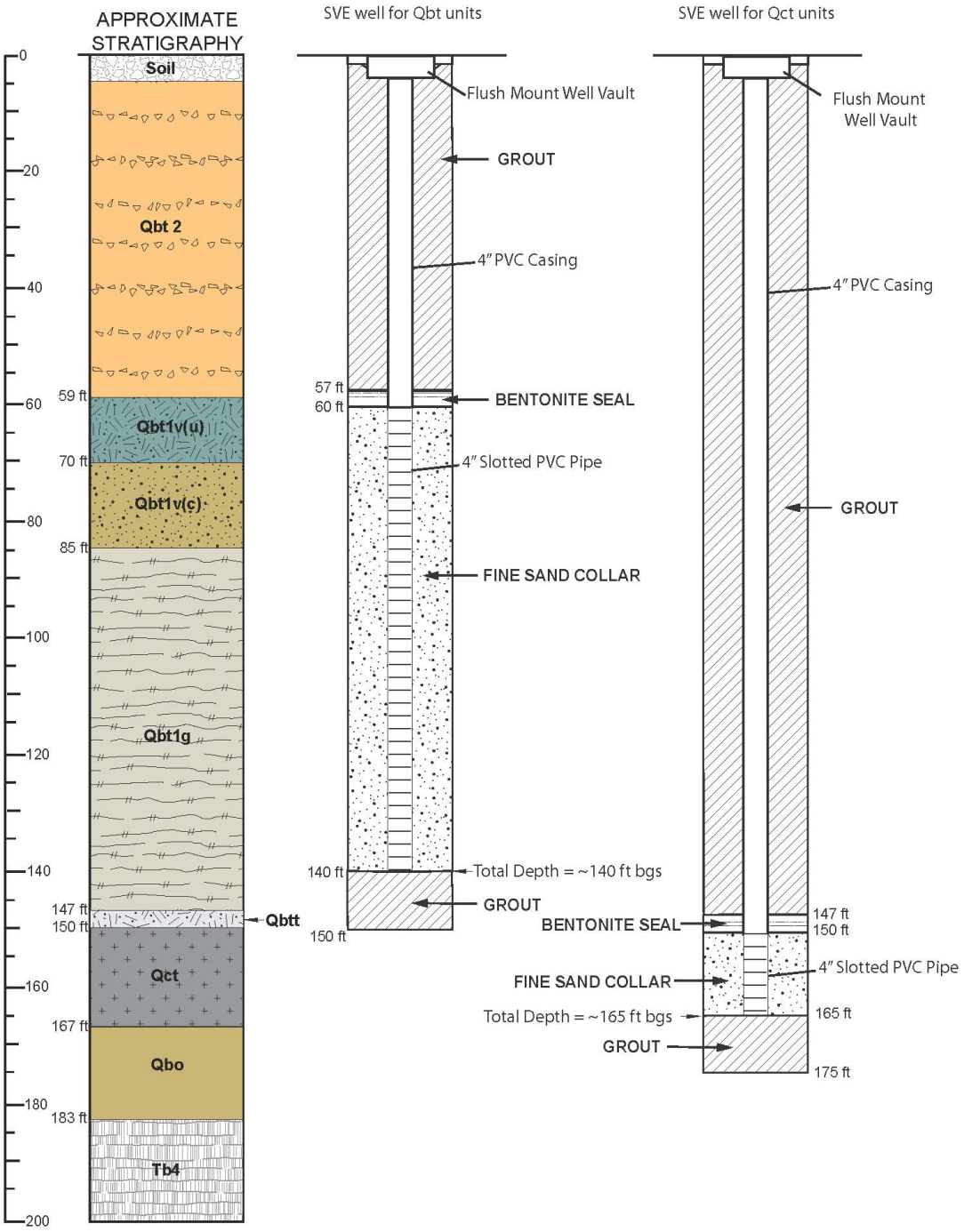

Figure J-2.2-1 Proposed extraction well designs for SVE at MDA G

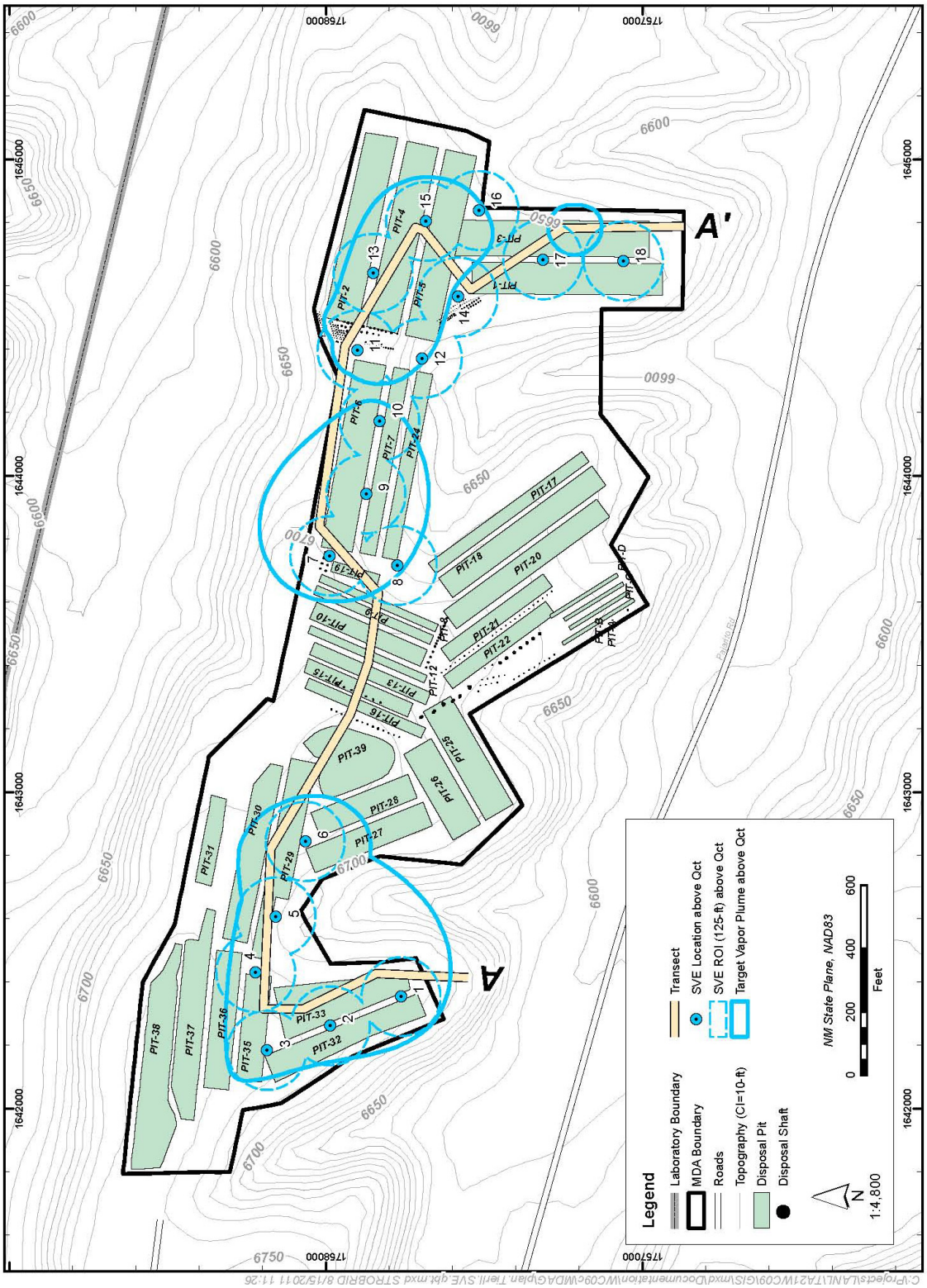

Figure J-2.3-1 Plan view map of proposed placement for 18 SVE wells that remediate the Qbt units

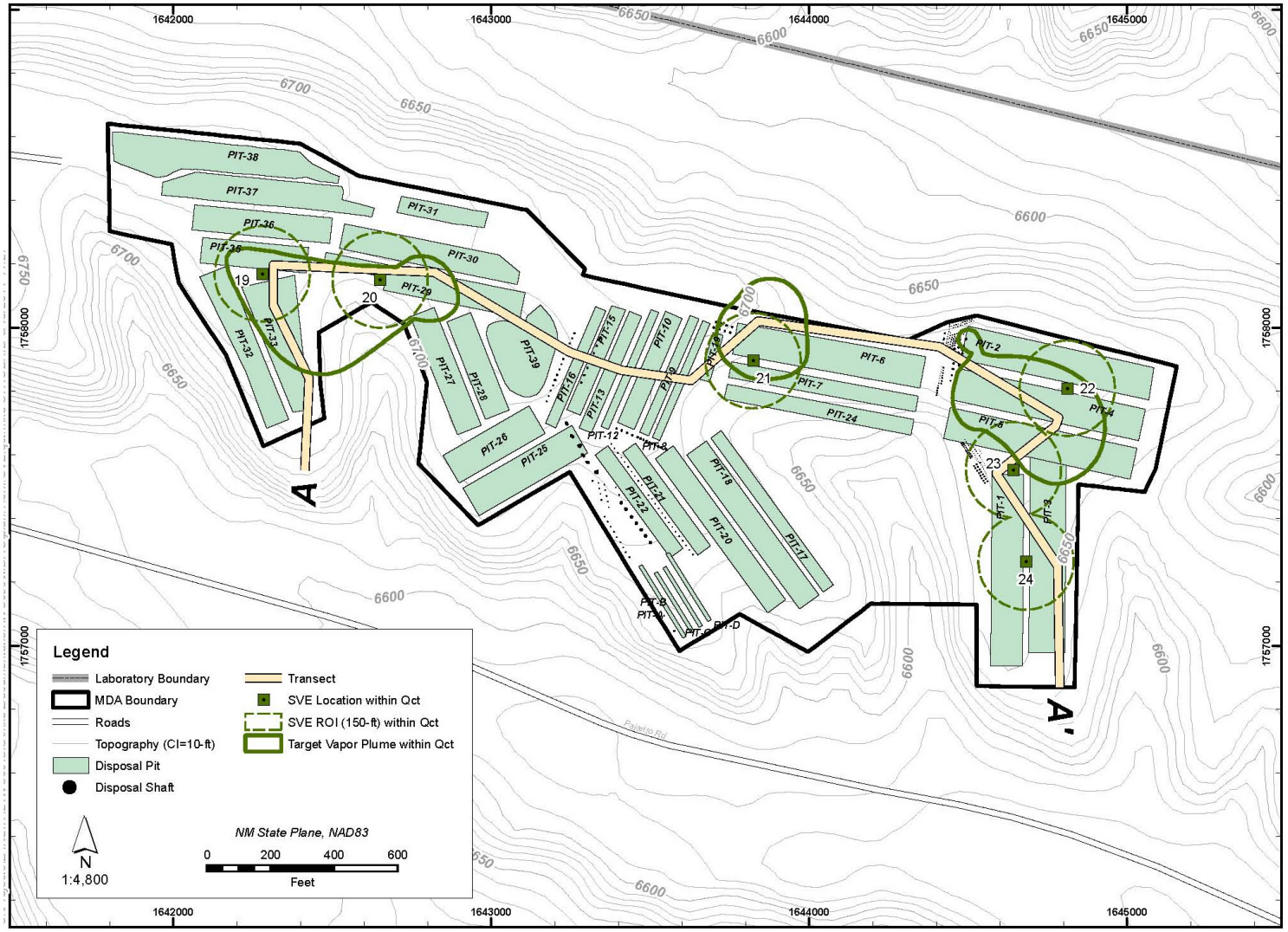

Figure J-2.3-2 Plan view map of proposed placement for six SVE wells that remediate the Qct unit

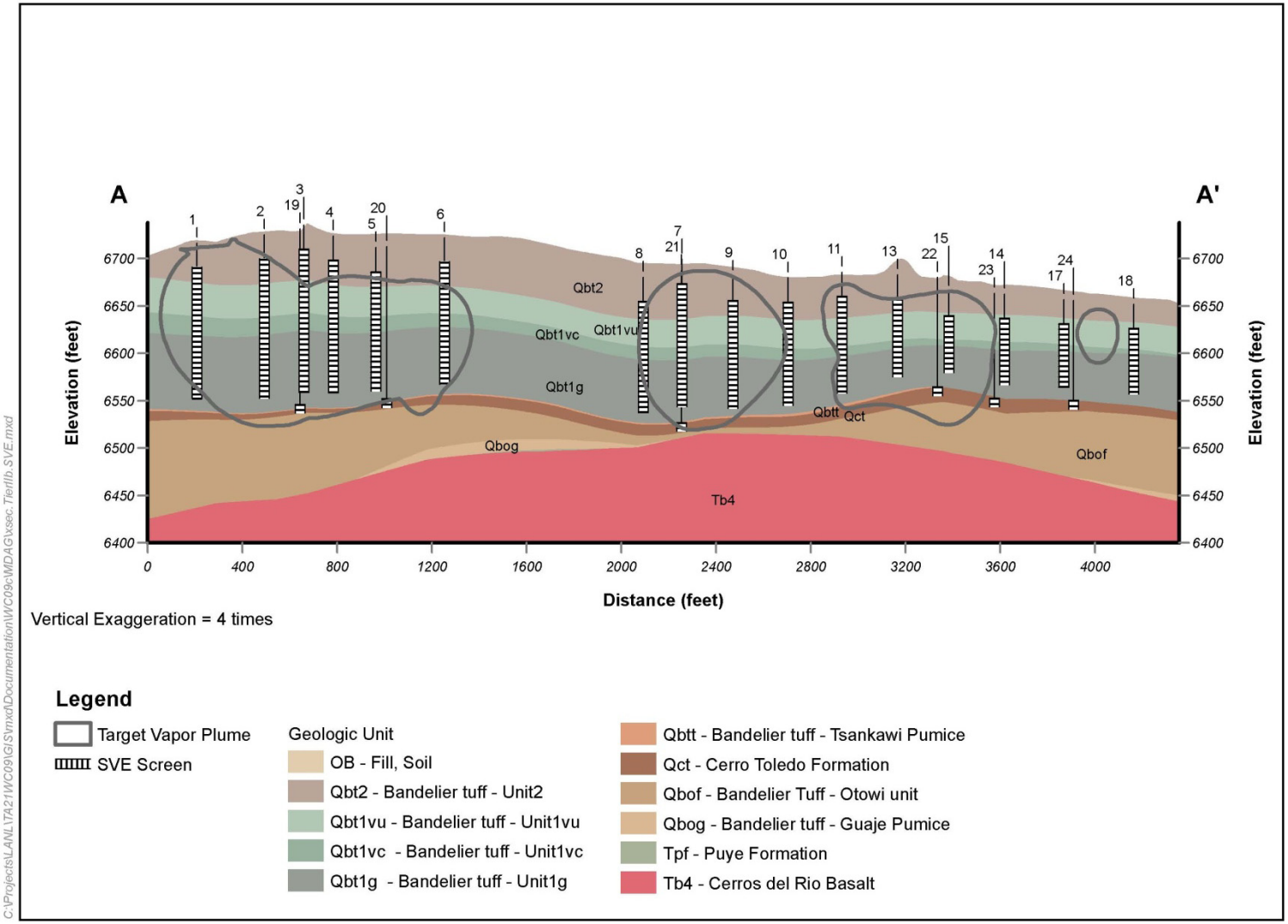

Figure J-2.3-3 Cross-sectional view of proposed placement and screened intervals for SVE wells

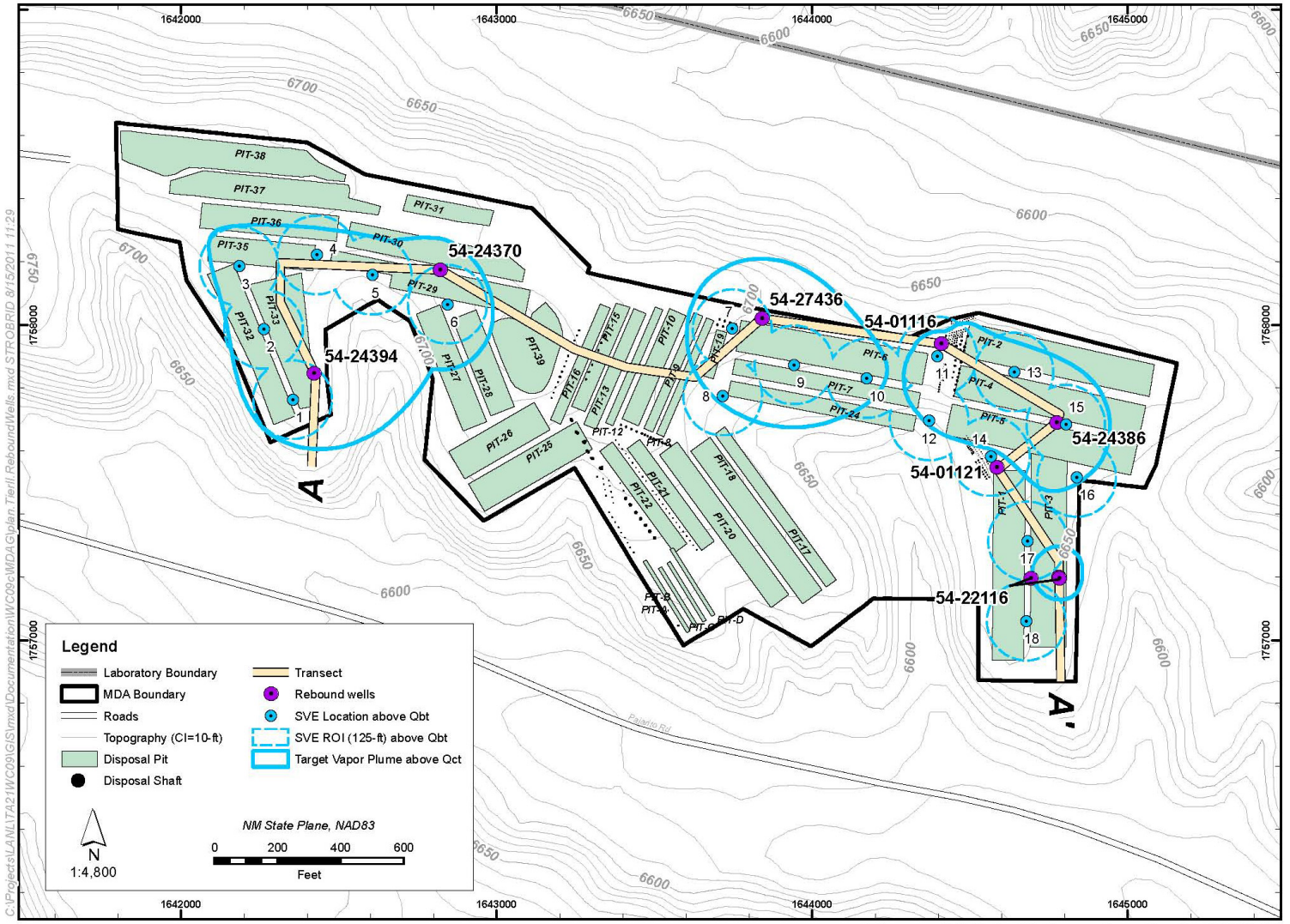

Figure J-2.5-1 Plan view map of rebound monitoring wells in comparison to the locations of the target vapor plumes and SVE wells in the Qbt units

Table J-2.1-1
Tier I and Tier II Pore-Gas Concentration Limits for VOCs of Concern at MDA G

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)
Dichloroethane[1,1-]	25	NMWQCC	5750	9.855×10^4
Dichloroethene[1,1-]	5	NMWQCC	5500	3.121×10^4
Dichloroethene[1,2-]	5	EPA MCL	240	9000
Dichloroethene[cis-1,2-]	70	EPA MCL	11,900	2.539×10^5
Methylene Chloride	5	EPA MCL	650	1.569×10^4
Tetrachloroethene	5	EPA MCL	3600	3.750×10^4
Trichloroethane[1,1,1-]	60	NMWQCC	42,300	7.450×10^5
Trichloroethane[1,1,2-]	5	EPA MCL	170	1.510×10^4
Trichloroethene	5	EPA MCL	2000	5.127×10^4

Notes: VOCs in bold exceed both the Tier I and Tier II limits. This table is derived from Tables C-2.1-1, C-2.1-2, and C-2.1-3 of this report. EPA MCL = U.S. Environmental Protection Agency maximum contaminant level; NMWQCC = New Mexico Water Quality Control Commission.

Table J-2.5-1
Proposed Rebound Monitoring Boreholes and Ports

Borehole ID	VOC Rebound Monitoring Port Depths (ft bgs)
54-01116	22.5, 42.5, 67.5, 132.5
54-01121[a, b]	20, 61.5, 98
54-22116[a,c]	172, 190, 226, 262, 280
54-24370	72.5, 120, 174.7, 200
54-24386	40, 83, 117, 135
54-24394	50, 100, 150
54-27436	45, 70, 115, 163

[a] Borehole constructed with FLUTe sample train.

[b] Borehole 54-01121 will be converted to stainless-steel monitoring ports at the depths indicated.

[c] Borehole 54-22116 is a horizontal borehole. Port depths and intervals are length from borehole head. FLUTe sample train will not be converted to stainless-steel monitoring system.

Table J-3.1-1
Proposed MDA G 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)
54-01107	Annual Vapor-Monitoring Program	56.5 (55.5–57.5), 100 (99–101)
54-01110	Annual Vapor-Monitoring Program	60 (59–61), 90 (89–91)
54-01111	Annual Vapor-Monitoring Program	20 (19–21), 50 (49–51), 139 (138–140)
54-01115	Annual Vapor-Monitoring Program	40 (39–41), 68 (67–69)
54-01116	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	22.5 (20–25), 42.5 (40–45), 67.5 (65–70), 132.5 (130–135), 187.8 (185.3–190.3)
54-01117	Annual Vapor-Monitoring Program	20 (18.5–22.5), 67.5 (65–70), 179.8 (177.3–182.3)
54-01121	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	20 (19–21), 61.5 (60.5–62.5), 98 (97–99), 121 (120–122)
54-01126	Annual Vapor-Monitoring Program	35 (34–36), 49 (48–50)
54-01128	Annual Vapor-Monitoring Program	20 (19–21), 39 (38–40)
54-02009	Annual Vapor-Monitoring Program	37 (34.5–39.5), 92 (89.5–94.5)
54-02010	Annual Vapor-Monitoring Program	30 (27.5–32.5), 95 (92.5–97.5)
54-02032	Annual Vapor-Monitoring Program	20 (20), 60 (60), 156 (156)
54-02033	Annual Vapor-Monitoring Program	60 (60), 277 (277)
54-22116	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	172 (171–173), 190 (189–191), 280 (279–281)
54-24370	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	72.5 (67.5–77.5), 120 (115–125), 174.7 (169.7–179.7), 243.7 (238.7–248.7)
54-24386	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	40 (37.5–42.5), 117 (114.5–119.5), 135 (132.5–137.5), 195 (192.5–197.5)
54-24394	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	50 (45–55), 100 (95–105), 150 (145–155), 300.5 (295.5–305.5)
54-24397	Annual Vapor-Monitoring Program	50 (45–55), 90 (85–95), 239.75 (234.75–244.3)
54-25105	Annual Vapor-Monitoring Program	500 ft, 650 ft
54-27436	Annual Vapor-Monitoring Program; SVE Rebound Monitoring	45 (40–50), 70 (65–75), 115 (110–120), 185 (180–190)

Notes: Boreholes 54-01107, 54-01110, 54-01111, and 54-01121 are vertical boreholes constructed with FLUTe membranes and will be converted to stainless-steel monitoring ports at the depths indicated.

Boreholes 54-01115, 54-01126, and 54-01128 are angled boreholes constructed with FLUTe membranes. These boreholes will not be converted to stainless-steel monitoring ports.

Borehole 54-25105 is cased to 485 ft bgs and open from 485 to 701 ft bgs. It will be converted to stainless-steel monitoring ports in unit Tb4 at the approximate depths indicated.

Borehole 54-22116 is a horizontal borehole. Port depths and intervals are length from borehole head. FLUTe membrane train will not be converted to stainless-steel monitoring system.