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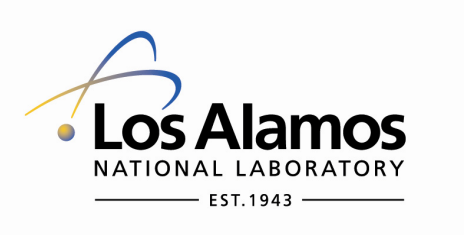
Phase III Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50



Prepared by the Environmental Programs Directorate

EP2011-0223

Phase III Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50

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EXECUTIVE SUMMARY

This investigation report presents the results of Phase III investigation activities at Solid Waste Management Unit 50-009, also known as Material Disposal Area (MDA) C, at Los Alamos National Laboratory (the Laboratory). MDA C is located in Technical Area 50. The objective of the 2010 to 2011 investigation was to finalize chemical and radionuclide characterization of MDA C in accordance with the approved MDA C Phase III investigation work plan. Characterization data from the Phase III investigation were used to define the extent of subsurface contamination associated with waste disposal activities at MDA C.

Field activities conducted from 2010 to 2011 included installing one new regional aquifer monitoring well and four new vapor-monitoring wells, as directed by the Phase III work plan, collecting quarterly vapor samples, and collecting dacite samples from the Tschicoma Formation. Vapor samples were analyzed for volatile organic compounds (VOCs) and tritium. Dacite samples from the Tschicoma Formation were analyzed for inorganic chemicals. A new regional groundwater monitoring well (R-60) was also installed next to the downgradient boundary of MDA C. Groundwater samples were collected from well R-60 as well as from existing monitoring well R-46, also located downgradient of MDA C. Installation of a second regional groundwater monitoring well (R-59) proposed in the Phase III investigation work plan has been delayed pending New Mexico Environment Department review of the Phase III investigation results presented in this report.

Based on the characterization data from the 2010 to 2011 investigation as well as previous investigations conducted at the site, the nature and extent of contamination in vapor are defined. Sampling results from the four deepest sampling ports, ranging from 632.5 ft to 688 ft below ground surface (bgs), indicate very low VOC concentrations in the deepest stratigraphic units sampled. The maximum concentrations of most organic chemicals in vapor were detected at a depth of approximately 250 ft, with concentrations decreasing sharply below that depth. The highest detected concentrations of tritium were generally at depths of less than 125 ft bgs. Tritium concentrations decreased with depth in most of, but especially in the deeper, boreholes. The vertical extent of both VOCs and tritium in vapor is defined. Vapor sampling results for VOCs and tritium were screened to evaluate the potential for the detected concentrations to result in groundwater contamination above cleanup levels. Results of this screening evaluation show no current risk of groundwater contamination.

The results of dacite sampling indicate concentrations of inorganic chemicals previously detected at the top of the dacite lava during the Phase II investigation appear to be naturally occurring and are associated with soil present at the top of the dacite.

The results of sampling performed at wells R-46 and R-60 indicate no release of contaminants from MDA C to the regional aquifer. Water-level data collected from R-60 during the Phase III investigation were used to update an evaluation of the groundwater monitoring network for MDA C. This evaluation showed that wells R-46 and R-60 have a high efficiency for detecting potential releases from MDA C.

Based on the results of this and previous investigations, it is recommended that a corrective measures evaluation be conducted to assess alternatives for preventing future exposure, especially through infiltration, biointrusion, direct contact, and vapor diffusion.

Although further investigation is not necessary, additional focused subsurface vapor monitoring is recommended to ensure detected concentrations of VOCs and tritium remain protective of groundwater. Based on the results from monitoring wells R-46 and R-60, the evaluation of subsurface vapor data, and the proposed vapor monitoring in the deep stratigraphic units, installation of well R-59 is not recommended at this time.

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1.0 INTRODUCTION

Los Alamos National Laboratory (LANL or the Laboratory) is a multidisciplinary research facility 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 finger-like mesas separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft above sea level.

The Laboratory is participating in a national effort by the U.S. Department of Energy (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).

This Phase III investigation report addresses SWMU 50-009, also known as Material Disposal Area (MDA) C, which is contaminated with both hazardous and radioactive components. The New Mexico Environment Department (NMED), pursuant to the New Mexico Hazardous Waste Act, regulates cleanup of hazardous wastes and hazardous constituents. DOE regulates cleanup of radioactive contamination, pursuant to DOE Order 5400.5, Radiation Protection of the Public and the Environment; DOE Order 435.1, Radioactive Waste Management; and DOE Order 458.1, Administrative Change 1, Radiation Protection of the Public and the Environment. 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.

Corrective actions at the Laboratory are subject to a Compliance Order on Consent (the Consent Order). This investigation report describes activities executed and completed in accordance with the Consent Order.

1.1 General Site Information

MDA C is located within Technical Area 50 (TA-50) at the head of Ten Site Canyon. TA-50 is bounded on the north by Effluent and Mortandad Canyons, on the east by the upper reaches of Ten Site Canyon, on the south by Twomile Canyon, and on the west by TA-55. Facilities at TA-50 include a radioactive liquid waste treatment facility, a waste reduction characterization facility, offices, several storage areas, SWMUs, and MDA C. Figure 1.1-1 shows the location of MDA C and the surrounding TAs.

MDA C is an inactive 11.8-acre landfill consisting of 7 disposal pits and 108 shafts (Figure 1.1-2). Solid waste containing hazardous constituents as well as radioactive waste was disposed of in the landfill between 1948 and 1974. The depths of the 7 pits at MDA C range from 12 to 25 ft below the original ground surface, and the depths of the 108 shafts range from 10 to 25 ft below the original ground surface. The original ground surface is defined as the surface beneath the cover that was placed over the site in 1984. The pits and shafts are constructed in the Tshirege Member of the Bandelier Tuff. The regional aquifer is approximately 1320 ft below ground surface (bgs) (LANL 2011, 111798). The topography of MDA C is relatively flat, although the slope descends to the north where the northeast corner of MDA C abuts the south wall of Ten Site Canyon.

1.2 Purpose of Phase III Investigation

The purpose of the Phase III investigation was to determine the extent of vapor contaminants at MDA C and evaluate the potential for releases of contaminants to groundwater. The specific objective for the Phase III investigation was to characterize subsurface vapor concentrations of volatile organic compounds (VOCs) and tritium (LANL 2010, 109260). This report presents the results of the investigation activities conducted at MDA C in 2010 and 2011 and discusses the extent of contamination in vapor based on the latest available data and visualization of the trichloroethene (TCE) distribution beneath MDA C. It also describes background sampling results for inorganic chemicals in the Tschicoma Formation dacite and groundwater chemistry results obtained from regional wells R-46 and R-60, located downgradient of MDA C.

1.3 Phase III Site Investigation Activities

The MDA C Phase III investigation work plan was submitted to NMED in April 2010 (LANL 2010, 109260) and was approved with modification in May 2010 (NMED 2010, 109695). The work plan proposed the following activities:

- collecting quarterly vapor samples from 14 existing vapor-monitoring wells;
- drilling four new vapor-monitoring wells to the base of the Guaje Pumice Bed (approximately 650 ft bgs) and, if possible, at least 10 ft into the underlying Tschicoma Formation dacite;
- determining representative background concentrations for inorganic chemicals in Tschicoma Formation dacite;
- collecting vapor samples from the new vapor-monitoring wells; and
- drilling and constructing two regional groundwater-monitoring wells.

Phase III investigations began in October 2010 and were completed in May 2011. Vapor samples were collected quarterly from the 14 existing vapor-monitoring wells. Results from the most recent sampling conducted during the first, second, and third quarters of fiscal year (FY) 2011 (October 2010 to January 2011, January 2011 to March 2011, and March 2011 to May 2011, respectively) are presented in this report. Results from earlier sampling conducted during the second, third, and fourth quarters of FY2010 (January 2010 to April 2010, April 2010 to July 2010, and July 2010 to September 2010, respectively) are included in Appendix D but are not presented in the report. Vapor samples were collected quarterly from the four new vapor-monitoring wells beginning in the second quarter of FY2011. Sampling results from the second and third quarters of FY2011 for the four new wells are presented in this report. Vapor samples were analyzed only for VOCs and tritium.

During the Phase III investigation, sampling was also performed to evaluate background concentrations of inorganic chemicals in the dacite lava flow beneath MDA C. The dacite background investigation was undertaken because a sample collected during the Phase II investigation from the top of a dacite lava flow at monitoring well location 50-603470 showed elevated concentrations for 12 inorganic chemicals (arsenic, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, and vanadium) compared with samples from the overlying Bandelier Tuff (LANL 2009, 107389, Table F-2.2-1 and Plate 5). It was hypothesized the elevated concentrations detected in this sample likely represented the natural chemistry of the Tschicoma Formation. However, because no defined background values (BVs) for the Tschicoma Formation dacite are available, it was not possible to determine whether these results were above background.

The Phase III investigation work plan (LANL 2010, 109260) proposed evaluating background concentrations by analyzing samples of archived dacite core collected elsewhere at the Laboratory. This approach was proposed because it was not known whether the drill rigs used for vapor-well installation could penetrate the dacite. The sample collected during the Phase II investigation at location 50-603470 was collected from the top of the dacite because the drill rig met refusal at that depth. During installation of the first Phase III vapor well at MDA C, field staff determined it was possible to drill into the dacite and collect samples using the drill rig. Therefore, rather than analyze archived samples, the Laboratory collected site-specific background samples from the two Phase III boreholes drilled to the south of MDA C. Based on the results of the Phase II investigation, these locations are outside of areas potentially impacted by releases of inorganic chemicals from MDA C and are representative of background for inorganic chemicals.

A new regional groundwater monitoring well (R-60) was installed at the downgradient boundary east of MDA C during the Phase III investigation, and groundwater samples were collected from this well and from existing regional well R-46, also located downgradient of MDA C (LANL 2011, 111798; NMED 2011, 202660). The Phase III investigation work plan (LANL 2010, 109260) called for installing an additional regional well (R-59) at MDA C. Based on water levels and chemistry data from wells R-46 and R-60 and on low observed vapor concentrations in the deepest vapor-monitoring ports, it appears the regional groundwater has not been impacted by wastes disposed of at MDA C. Therefore, the Laboratory proposed deferring a decision on the need for and location of R-59 until NMED could review the results of the Phase III investigation (LANL 2011, 203595). NMED concurred with this approach (NMED 2011, 203627).

Table 1.3-1 summarizes the vapor-monitoring wells sampled in the Phase III investigation. The total depths (TDs) of the 18 monitoring wells range from 452.5 ft to 697.5 ft bgs. Figure 1.3-1 shows the locations of the 18 monitoring wells.

Vapor samples were analyzed for VOCs and tritium. Samples of dacite collected from the Tschicoma Formation were analyzed for target analyte list (TAL) metals.

Deviations of Phase III activities from the work plan are discussed in Appendix B of this report.

1.4 Overview of Phase III Investigation Report

This investigation report presents details and results of the Phase III investigation activities conducted in 2010 and 2011 according to the approved investigation work plan (LANL 2010, 109260; NMED 2010, 109695).

Section 1 presents general site information, the purpose of the investigation, and an overview of the Phase III investigation. Section 2 presents the historical site use, waste inventory, historical releases, summary of previous investigations, and the conceptual site model. Section 3 describes the field activities performed during the 2010 to 2011 investigation. Section 4 presents the results of the field investigations. Section 5 describes the screening levels (SLs) used to evaluate vapor data. The results of vapor, rock, and groundwater sampling are summarized in section 6. Section 7 presents conclusions with respect to the nature and extent of surface and subsurface contamination at MDA C and current site risk, based on the results of the Phase III and previous investigations. Section 8 presents recommendations for further activities at the site, including a vapor-monitoring plan. Section 9 includes a list of references cited and the map data sources for all figures.

Appendixes include a list of acronyms and abbreviations, a metric conversion table, and definitions of the data qualifiers used in this report (Appendix A); field methods (Appendix B); analytical program descriptions and summaries of data quality (Appendix C); analytical suites and results, and analytical reports (Appendix D on DVD); investigation-derived waste (IDW) storage and disposal documentation (Appendix E); VOC and tritium contaminant screening method and soil-vapor plume characteristics (Appendix F); and an evaluation of the locations of existing monitoring wells for detecting potential contaminants in the regional aquifer (Appendix G).

2.0 BACKGROUND

2.1 Historical Site Use and Waste Inventory

MDA C was established to replace MDA B at TA-21 as a disposal area for Laboratory-derived waste. MDA C operated from May 1948 to April 1974 but received waste only intermittently from 1968 until it was decommissioned in 1974. Wastes disposed of at MDA C consisted of liquids, solids, and containerized gases generated from a broad range of nuclear research and development activities conducted at the Laboratory. These wastes included uncontaminated classified materials, metals, hazardous materials, and radioactively contaminated materials.

MDA C contains 7 pits and 108 shafts (Figure 1.1-2). Ten shafts in Shaft Group 3 (Shafts 98–107) are lined with 12-in.-thick concrete, while the rest of the pits and shafts are unlined. Fill dirt was used to cover the material disposed of in the pits as they were filled. The dirt acted as a temporary cover. The pits were filled with crushed tuff when they were decommissioned. The shafts were sealed by filling them with crushed tuff, followed by concrete. The dimensions and operation dates of the pits and shafts are listed in the historical investigation report for MDA C (LANL 2005, 091493, Table B-1, p. B-33).

The waste disposal records for MDA C are contained in a series of disposal logbooks (LASL 1948–1969, 076035). Waste inventory information gleaned from the logbooks is summarized in the Resource Conservation and Recovery Act facility investigation (RFI) work plan for Operable Unit 1147 (LANL 1992, 007672, pp. 2-52–2-56).

Present-day radionuclide inventories in the MDA C pits were estimated to be 5600 Ci, 320 Ci, and 0.75 Ci for surface-contaminated waste, concrete and sludge, and soil, respectively. For surface-contaminated waste, which contains most of the estimated radioactivity for the MDA C pits, plutonium isotopes are responsible for approximately 90% of the activity. Most of the activity in concrete and sludge can also be attributed to plutonium isotopes, and most of the activity for soil can be attributed to uranium isotopes. A summary of the radionuclide inventory is presented in Appendix J of the MDA C investigation report (LANL 2006, 094688). Hazardous constituents and uncontaminated classified materials were buried with radioactively contaminated materials. However, little data exist on the volume of nonradioactive waste (i.e., hazardous constituents) disposed of at MDA C.

Detailed inventories for the wastes disposed of at MDA C are provided in sections 2.2.1 and 2.2.2 of the MDA C investigation report (LANL 2006, 094688).

2.2 Historical Releases

The results of historical investigations indicated contaminants have been released to environmental media as a direct consequence of disposal activities. When MDA C was decommissioned in 1974, most of the surface was covered with crushed tuff and fill, and the surface was recontoured and seeded with a native grama-grass mixture. Over time, wastes in some pits (especially in Pit 5 on the north side of MDA C) were exposed at the ground surface as a result of natural degradation or erosion of the shallow

soil covers. Fires involving chemical wastes disposed of at MDA C had also occurred, and it is possible the fires served as a vehicle of contaminant transport from open pits to the surrounding surface soil. In 1984, approximately 1.5 ft of crushed tuff, followed by 0.5 to 3 ft of topsoil, was placed over the surface of MDA C, except at the northeast corner of the site where no pits or shafts are located. Windborne deposition of contamination released during waste disposal activities and stack emissions from operations at TA-50 may have resulted in radionuclide contamination of the surface soil at MDA C.

2.3 Summary of Previous Investigations

Previous investigations at MDA C included water-infiltration tests as early as 1956, followed by radiological surveys at various times starting from 1976, surface sampling at various times starting from 1985, geophysical surveys at various times starting from 1994, and borehole drilling/sampling from 1995 to 1996 and 2005 to 2009.

The initial phase of investigation for MDA C under the Consent Order was implemented from 2004 to 2006. As directed by the notice of disapproval for the 2006 investigation report (NMED 2007, 095437), the Laboratory submitted a Phase II investigation work plan for MDA C (LANL 2007, 098425). The Phase II investigation was implemented during 2008/2009. Details of these previous investigations are presented in the 2006 investigation report (LANL 2006, 094688) and the Phase II investigation report (LANL 2009, 107389). The Phase II investigation report recommended conducting quarterly vapor monitoring at selected boreholes at MDA C. In addition, the notice of disapproval for the Phase II investigation report (NMED 2009, 107361) required installation of additional groundwater- and vapor-monitoring wells. These activities were incorporated into the Phase III investigation work plan for MDA C (LANL 2010, 109260).

2.4 Conceptual Site Model

This section describes the conceptual site model of contaminant sources, transport, pathways, and receptors at MDA C. This conceptual model is used to guide development of recommendations related to future actions at MDA C. As the Phase III investigation focused on subsurface vapor and groundwater sampling, this conceptual model focuses on VOCs and tritium rather than on other contaminants addressed in previous investigations (e.g., metals, nonvolatile organic chemicals, and radionuclides other than tritium). The conceptual model discussion focuses on TCE because it is the most widely detected VOC and is present at the highest concentrations.

2.4.1 Potential Contaminant Sources

MDA C was the primary disposal site at the Laboratory before waste disposal operations began at TA-54. Although information on the waste inventory at MDA C is limited, it is likely wastes received at the site included waste solvents as well as solid wastes with incidental solvent contamination. The use of TCE as a degreasing solvent peaked in the 1960s when it began to be replaced by 1,1,1-trichloroethane. The last waste disposal at MDA C occurred in 1974; thus, TCE in the vapor plume is consistent with the age of the site.

TCE and other VOCs are present in vapors beneath MDA C because solvent-contaminated wastes were disposed of in the MDA C trenches and shafts. The spatial distribution of TCE indicates a plume with a center of mass near the eastern end of MDA C with the highest concentrations occurring approximately 200 ft bgs in unit Qbt 1g (Appendix F). This distribution suggests the trenches and shafts near the eastern end of MDA C are likely the primary source of TCE. However, the characteristics of the TCE vapor plume, particularly the depth where the maximum concentrations occur, indicate the plume is predominantly

related to releases that occurred in the past rather than from ongoing releases. TCE vapors are present near the trenches and shafts, but their concentrations are not as high as in the deeper units. These elevated concentrations near the source areas are caused, at least in part, by diffusion of TCE from the deeper concentration zone, but they may indicate that small TCE releases occur. The reasons for these assumptions related to the nature of the source are described in section 2.4.2.

2.4.2 Potential Contaminant Transport Mechanisms

Vapor-phase transport accounts for the observed migration of TCE within the subsurface at MDA C. Vapor migration of VOCs within the tuff units can be described by diffusive behavior that spreads vapor-phase contaminants in all directions along concentration gradients. However, with low vapor concentrations present in the air phase along the mesa, the steepest concentration gradients are upward toward the surface, which leads to preferential VOC transport toward the mesa top and yields releases to the atmosphere. The surface of MDA C is not paved, allowing free exchange of vapors at the surface with the atmosphere. Shallow vapor-phase contaminants will tend to diffuse out at the surface, while deeper vapor-phase contaminants may diffuse deeper. Any new releases from the trenches and shafts would preferentially diffuse toward the surface. However, if the trenches and shafts have stopped releasing vapors, transport to the atmosphere at the ground surface may reduce contaminant concentrations in the shallow portion of the subsurface while leaving behind residual vapors at greater depths.

As shown in the cross-sections provided in Appendix F, the center of mass is located at a depth approximately 200–300 ft bgs. This vertical distribution, particularly the absence of high concentrations near the trenches and shafts, suggests the bulk of the TCE is from past releases with little or no contribution from ongoing releases. Vapor concentrations approaching the vapor pressure for TCE (approximately 5×10^8 µg/m^3) would be expected near ongoing releases and, as discussed in section 7.3.1, maximum detected vapor concentrations of TCE (7×10^4 µg/m^3) are orders of magnitude below its vapor pressure. The TCE plume maps and cross-sections presented in Appendix F are consistent with this conceptual model of a source that is either no longer releasing or is releasing very slowly.

Stratigraphic controls, such as dipping interfaces between units, have less impact on vapor-phase transport than for liquid-phase transport because of the tendency for the plume to spread diffusively in all directions rather than being gravity-driven. The pore structure and moisture content of each stratigraphic unit do, however, affect diffusion through the different geologic media. If a rock layer has a higher moisture content, this inhibits vapor diffusion because there are fewer dry pore spaces through which the vapors can diffuse. Besides decreasing diffusion rates, pore water also acts as a reservoir for VOC vapors, which can transfer into the pore water according to Henry's law partitioning. This partitioning further slows vapor plume growth and, again, higher moisture content decreases plume growth. The distribution of TCE detected beneath MDA C is consistent with this conceptual model. The highest concentrations are found in units Qbt 1v and Qbt 1g of the Tshirege Member of the Bandelier Tuff. The decrease in concentrations below units Qbt 1v and Qbt 1g is likely related to the relatively higher moisture content of the underlying Cerro Toledo interval and Otowi Member (Appendix F). Concentrations decrease sharply in the Cerro Toledo interval and the Otowi Member, and TCE is nearly absent in the underlying Tschicoma dacite.

2.4.3 Potential Receptors and Pathways

The receptors of primary concern with respect to subsurface TCE contamination are consumers of contaminated groundwater. These receptors could be exposed to TCE that migrates through the vadose zone to the regional aquifer. Municipal water-supply well PM-5 is located approximately 1 mi east and

downgradient of MDA C (Figure 4.1-1). The groundwater-monitoring results presented in section 6.3 indicate this pathway is presently incomplete.

3.0 SCOPE OF ACTIVITIES

This section describes the investigation activities conducted at MDA C in accordance with the approved Phase III work plan (LANL 2010, 109260; NMED 2010, 109695). Activities included drilling and constructing 4 new vapor-monitoring wells and collecting quarterly subsurface vapor samples from the 4 new and 14 existing vapor-monitoring wells. Four cuttings samples were collected from the Tschicoma Formation dacite. In addition, a new regional aquifer monitoring well was installed, and groundwater samples were collected.

The standard operating procedures (SOPs) used during the 2010 to 2011 investigation activities are listed in Table B-1.0-2 in Appendix B. The most current versions of all SOPs were used to implement the approved Phase III work plan (LANL 2010, 109260; NMED 2010, 109695). Details of the methods used for drilling and sampling activities are presented in Appendix B, along with any deviations from the approved work plan.

3.1 Field Screening

Screening for radioactivity was performed during sampling of Tschicoma Formation dacite to ensure worker safety and to determine whether samples could be transported off-site. For boreholes located within the MDA C facility boundary, all drilling tools, equipment, and casing were screened for radioactivity immediately upon extraction from the borehole using an Eberline E-600 radiation meter with SHP 380 alpha/beta/gamma probe. In addition, drill cuttings were screened as they were extracted from the borehole. Screening measurements were compared with local (MDA C) background levels that were measured at least once each day during field activities. Field-screening results were recorded for each dacite sample in a sample collection log (SCL) and chain-of-custody (COC) forms (Appendix D) and are presented in Table 3.1-1. The field-screening process is described in Appendix B.

Each dacite sample collected was screened for VOCs using a MiniRAE 2000 photoionization detector (PID) with an 11.7-electronvolt lamp. Calibration of the PID was performed at least once each day during field activities, and a yearly calibration was performed by the vendor. Daily calibration was performed using a standard source of 100 ppm isobutylene. The rated detection limit for the PID used was 0.2 ppm. The PID screening results were recorded for each sample in SCL/COC forms (Appendix D) and are presented in Table 3.1-1.

Ambient-air conditions at the site were monitored using a Data Ram portable dust monitor during fieldwork. Action levels for dust monitoring were 15.7 mg/m^3 for inorganic chemicals and 22.2 mg/m^3 for radionuclides. Surface air conditions did not exceed dust action levels for either inorganic chemicals or radionuclides at any time.

Health and safety measures and monitoring activities did not adversely affect or limit the completion of any investigation activities or result in changes to the scope of activities.

3.2 Geodetic Survey

All sampling locations were surveyed using a Trimble model TSC-1 global positioning system. The survey method is described in Appendix B. The surveyed coordinates for all Phase III sampling locations were uploaded into the Sample Management Database and are presented in Table 3.2-1.

3.3 Subsurface Investigation

3.3.1 Drilling

Four new boreholes (locations 50-613182 through 50-613185) were drilled during the Phase III investigation using the air-rotary drilling method to depths ranging from 646 to 697 ft bgs. The boreholes were drilled into the upper portion of the Tschicoma Formation dacite. Casing was advanced as the drill bit advanced to prevent sloughing of material from soft, unconsolidated intervals into the borehole during drilling and after drilling was completed. When the boreholes reached the target depth, stainless-steel vapor-monitoring wells were installed.

At the surface, the cuttings were screened for radioactivity and VOCs and inspected for lithologic identification by the geologist. Details of the methods used for drilling are presented in Appendix B. Information on the 18 vapor-monitoring wells sampled during Phase III is summarized in Table 1.3-1.

Regional well R-60 was drilled in September 2010. The R-60 borehole was advanced to a TD of 1418 ft bgs in the Puye Formation. Additional details on the drilling of well R-60 and the stratigraphic units encountered are provided in the well completion report (LANL 2010, 111798).

3.3.2 Monitoring-Well Installation

Vapor-monitoring wells were installed at four new locations in and around MDA C (50-613182 through 50-613185) as directed by the approved Phase III work plan (LANL 2010, 109260). Each monitoring well was equipped with 5 to 10 sampling ports at the required depths. Table 3.3-1 presents the depths and lithology for all sampling ports installed at each of the 18 vapor-monitoring wells. The following general guidelines were used to construct each well:

- Install a 20-ft-long surface casing and cement in place.
- Place a layer of bentonite at the bottom of the borehole and hydrate for a minimum of 1 h.
- Set a 0.25-in. × 12-in.-long cylindrical stainless-steel screen in filter-pack sand and connect the screen to 0.25-in. stainless-steel tubing.
- Place a layer of bentonite above the sand pack and hydrate for a minimum of 1 h.
- Repeat above steps for installing additional vapor-monitoring ports at required depths.

All Phase III boreholes at MDA C were overreamed for the upper 10 ft of each borehole and installed with a 10-in.-inside diameter steel-surface casing fitted with a lockable steel cover. The surface casing was lowered into each borehole to provide structure for the steel cap and was cemented in place.

Borehole logs recorded during drilling of the four Phase III vapor-monitoring wells are presented in Appendix B, Attachment B-1. As-built drawings for the four Phase III vapor-monitoring wells are presented in Appendix B, Attachment B-2.

Regional well R-60 was drilled in September 2010, and the borehole was advanced to a TD of 1418 ft bgs. The regional aquifer was encountered at a depth of 1319.5 ft bgs in the Puye Formation. Well R-60 has a single well screen set at a depth of 1330 ft to 1350 ft bgs. Additional details of the drilling and construction of well R-60 are provided in the well completion report (LANL 2011, 111798).

3.3.3 Vapor Sampling

3.3.3.1 Collection of Vapor Samples

Quarterly vapor sampling was conducted during the Phase III investigation. Tables 3.3-2 through 3.3-4 provide information on the wells and ports sampled and the analyses requested for the three most recent events that occurred from October 2010 to May 2011. Data from three previous events that occurred from January 2010 to September 2010 are included in Appendix D but are not presented in this report. For the first four sampling events, only the 14 Phase II monitoring wells were in place and sampled. The four new Phase III wells were available for the final two sampling events, and all available vapor-monitoring ports were sampled.

Vapor sampling was performed in accordance with SOP-5074, Sampling of Subatmospheric Air. Once the vapor-sampling system was in place, ambient air was purged from the sampling tubing and/or inert space inside the system. After a 30-min purge, a vapor sample was collected in a SUMMA canister for analysis of VOCs. A tritium sample was collected in a silica gel tube after the vapor sample was collected. Depending on the temperature and moisture content of the formation air, the tritium sample took 1 to 2 h to collect the required 5 g of water for analysis.

Field quality control samples, including field duplicates and field trip blanks, were collected in accordance with SOP-5059, Field Quality Control Samples, at a frequency of approximately 10% of the number of investigation samples collected. Field trip blank samples were collected by pulling calibration gas (99.9% ultrahigh-purity nitrogen) through the packer sampling apparatus.

Two sampling ports at the 14 original vapor-monitoring wells had become partially or completely plugged by the second quarter of FY2011. The plugged sampling ports were the 30-ft depth ports at locations 50-603468 and 50-603471. Because sampling at these ports was not expected to provide valid results, additional ports were installed at the new monitoring wells placed next to these locations. Sampling ports were added at the 30-ft depth in the new monitoring wells at locations 50-613183 and 50-613184. The partially plugged original sampling port at location 50-603471 was inadvertently sampled for VOCs and tritium during the second quarter of FY2011. Because that port was effectively replaced by the 30-ft depth sampling port at adjacent location 50-613183, the results of the second quarter FY2011 samples from location 50-603471 are not included in this report.

3.3.3.2 Analysis of Vapor Samples

The vapor samples were submitted through the Laboratory's Sample Management Office (SMO) to off-site contract laboratories for analysis of VOCs by U.S. Environmental Protection Agency (EPA) Method TO-15. Tritium samples were submitted through the SMO to an off-site contract laboratory for analysis of tritium by EPA Method 906.0. Analytical methods and data-quality results are summarized in Appendix C.

3.3.4 Sampling the Tschicoma Formation

3.3.4.1 Collection of Tschicoma Formation Dacite Samples

A background study was performed during the Phase III investigation to evaluate background concentrations for inorganic chemicals in the dacite lava flow at MDA C. The dacite background investigation was undertaken because a sample collected during the Phase II investigation from the top of a dacite lava flow at monitoring-well location 50-603470 showed elevated concentrations of 12 inorganic chemicals (arsenic, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, and vanadium) compared with samples from the overlying Bandelier Tuff (LANL 2009, 107389,

Table F-2.2-1 and Plate 5). It was hypothesized the elevated concentrations detected in this sample likely represented the natural chemistry of the Tschicoma Formation. However, because no defined BVs are available for the Tschicoma Formation dacite, it was not possible to determine whether these results were above background.

The Phase III investigation work plan (LANL 2010, 109260) proposed evaluating background concentrations by analyzing samples of archived dacite core collected elsewhere at the Laboratory. This approach was proposed because it was not known whether the drill rigs used to install the vapor-monitoring wells could penetrate the dacite. The sample collected during the Phase II investigation at location 50-603470 was collected from the top of the dacite because the drill rig met refusal at that depth. During installation of the first Phase III vapor-monitoring well at MDA C, the Laboratory determined it was possible to drill into the dacite and collect samples. Therefore, rather than analyze archived samples, the Laboratory collected site-specific background samples from two Phase III boreholes drilled to the south of MDA C, locations 50-613184 and 50-613185 (Table 3.3-5).

3.3.4.2 Analysis of Tschicoma Formation Dacite Samples

Tschicoma Formation dacite samples were submitted to an off-site contract analytical laboratory for analysis of TAL metals only (Table 3.3-5). Details of the methods used for sampling are presented in Appendix B. Analytical methods and data-quality results are summarized in Appendix C.

3.4 Borehole Abandonment

No boreholes were abandoned as part of the Phase III investigation.

3.5 Equipment Decontamination

The sampling equipment that came in contact (or could have come in contact) with sample material was decontaminated after each sample was collected. Decontamination included wiping the equipment with a household-strength cleaning spray and paper towels.

Decontamination of the drilling equipment was conducted before the drill rig was mobilized to another borehole to avoid cross-contamination between samples and boreholes. Residual material adhering to equipment was removed using dry decontamination methods such as the use of wire brushes and scrapers. Decontamination activities were performed in accordance with SOP-5061, Field Decontamination of Equipment.

Decontaminated equipment was surveyed by a radiation control technician before it was released from the site.

3.6 Storage and Disposal of IDW

All IDW generated during the MDA C Phase III field investigation was managed in accordance with SOP-5238, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable EPA and NMED regulations, DOE orders, and Laboratory implementation requirements.

Before field investigation activities began, a waste characterization strategy form (WCSF) was prepared, reviewed, and approved. The WCSF provided information on IDW characterization, management, containerization, and estimated volumes. The IDW characterization was completed through a combination of review of existing documentation, review of analytical data from samples collected from

the media being investigated, and direct sampling of containerized waste. The WCSF and related waste management documentation, such as the waste profile form and chemical waste disposal requests, are included in Appendix E of this investigation report. Appendix E also includes details of types and volumes of waste generated, and the disposition of all wastes as of the date of publication of this investigation report.

Waste minimization was achieved by evaluating drill cuttings to determine if they were suitable for land application. All cuttings met the requirements for land application and were land-applied to drill site access roads and drill pads.

4.0 FIELD INVESTIGATION RESULTS

4.1 Surface Conditions

MDA C is located on Mesita del Buey, a finger-shaped mesa that trends southeast (Figure 4.1-1). The elevation of Mesita del Buey ranges from 7210 to 7280 ft above sea level. The topography at MDA C slopes gently from west to northeast, gradually getting steeper across the northeastern quadrant of the site toward Ten Site Canyon. At MDA C, Mesita del Buey is approximately 2000 ft wide and is bounded by Ten Site and Effluent Canyons to the north and Twomile Canyon 750 ft to the south, across Pajarito Road (Figure 4.1-1).

No surface structures other than the surrounding chainlink fence exist at the site. The outlines of the pits and shafts are not visible at the surface because of the fill material emplaced on top of the site.

Vegetation at MDA C consists of a mixture of grasses, small shrubs, and a few piñon pine and juniper trees, which are limited to the extreme north-central edge of the site. The site has been disturbed by excavation and emplacement of backfill and has historically been maintained by mowing and removing trees. At the time of this investigation, no trees were growing in the areas of the waste pits or shafts. Pine trees were found growing on the site as recently as 2003 when biota sampling was conducted. All trees have since been removed by cutting at ground level.

No streams exist on Mesita del Buey; water flows only as stormwater and snowmelt runoff on the mesa and in small drainages off the mesa to nearby canyons. Runoff may occur as minor sheet flow from MDA C into Ten Site Canyon.

4.1.1 Relationship to Other SWMUs and AOCs

SWMU 50-006(a) is located directly north of Pit 5 at the head of Ten Site Canyon. SWMU 50-006(a) includes the area affected by two accidental operational releases in 1974 of untreated radioactive wastes and unknown chemicals. The outfall area was partially remediated in 1981 when 70 m^3 of contaminated soil was removed (LANL 1992, 007672). Although SWMU 50-006(a) has impacted Ten Site Canyon, the release did not affect MDA C because it is located downslope of MDA C.

Emissions from exhaust stacks at a number of the buildings at TA-50 were designated as SWMU 50-006(c). Radioactive emissions from these stacks may potentially have been deposited on surface soil within TA-50, including MDA C. Any surface contamination that may have deposited on MDA C related to stack emissions would be accounted for in the surface soil samples collected during previous RFI activities and the 2004 to 2006 investigation.

The other SWMUs within TA-50 include an active underground drainage system [SWMU 50-001(b)]; two areas of active underground tanks [SWMU 50-002(a) and Consolidated Unit 50-002(b)-00]; a decommissioned aboveground tank [SWMU 50-002(d)]; a container storage area [SWMU 50-003(a)]; decommissioned waste lines and tanks [Consolidated Unit 50-004(a)-00]; and a decommissioned septic system [SWMU 50-011(a)]. Based on the locations and operational histories of these sites, no viable transport pathways are available for releases related to these SWMUs to have affected MDA C (LANL 2007, 098954).

Based on the previous RFI data for MDA C and adjacent SWMUs at TA-50 and TA-35, the only area within close proximity that may have been affected by MDA C is Ten Site Canyon (Figure 4.1-1), which is considered an AOC. Eroded surface soil from MDA C, in addition to soil and contaminant releases from other SWMUs and/or AOCs at TA-50 and other TAs, may have been deposited in the canyon bottom and stream banks, which are included in investigations of Mortandad Canyon (LANL 2007, 100119).

4.2 Drilling Investigations

No exploratory drilling or excavation was performed at MDA C during the Phase III investigation. All drilling was conducted for the purpose of collecting samples, installing vapor-monitoring wells, or installing a regional monitoring well as required by the Phase III work plan (LANL 2010, 109260). Investigation borehole drilling and sampling are discussed in sections 1.3 and 3.3.

4.3 Subsurface Conditions

The general stratigraphy of the bedrock beneath MDA C can be inferred from descriptions of the regional geology (Broxton and Eller 1995, 058207; Broxton et al. 1995, 050119) and has been further defined using geologic logs from the boreholes drilled at the site as part of this and previous investigations.

- The predominant tuff unit at the surface is unit 3 of the Tshirege Member of the Bandelier Tuff (Qbt 3), a series of volcanic ashfall and ash flow deposits. Unit Qbt 3 is approximately 100 ft thick.
- Below unit 3 is unit 2 of the Tshirege Member (Qbt 2), which is approximately 65 ft thick.
- Below unit 2 is unit 1v of the Tshirege Member (Qbt 1v), which is approximately 75 ft thick.
- Below unit 1v is unit 1g of the Tshirege Member (Qbt 1g), which is approximately 75 ft thick.
- Below unit 1g is approximately 2 ft of Tsankawi pumice (Qbtt).
- Below Qbtt is the Cerro Toledo interval (Qct), a zone of reworked tuff that is approximately 65 ft thick.
- Below the Cerro Toledo interval is the Otowi Member of the Bandelier Tuff (Qbo), which is approximately 230 ft thick.
- Below the Otowi Member lies the Guaje Pumice Bed, which is approximately 35 ft thick.
- Below the Guaje Pumice Bed is the Tschicoma Formation, which is approximately 300 ft thick at MDA C and was the target formation for the four new boreholes drilled at MDA C.
- Below the Tschicoma Formation is the Puye Formation, which contains the regional groundwater aquifer.

A generalized stratigraphic cross-section is shown in Figure 4.3-1. Detailed cross-sections through MDA C, as defined by the stratigraphy encountered during drilling of the vapor-monitoring wells and regional wells R-46 and R-60, are shown in Figure 4.3-2. This figure also illustrates the vapor-monitoring ports and regional aquifer wells available for sampling during the Phase III investigation.

Known subsurface features at MDA C include disposal pits and shafts as shown in Figure 1.1-2. These features were specifically avoided during this investigation to prevent waste in the pits and shafts from being disturbed.

A buried utility corridor extends roughly east to west along the southern boundary of MDA C, between the boundary fence and Pajarito Road (Figure 4.3-3). This utility corridor contains electrical, water, industrial waste, and communications lines. The utilities were not disturbed during this investigation.

4.4 Groundwater Conditions

Groundwater occurs in three distinct modes on the Pajarito Plateau:

- shallow alluvial groundwater found in canyon-bottom alluvium (LANL 1998, 059730);
- intermediate-depth saturated horizons; and
- the regional aquifer.

Regional monitoring well R-46 was installed 880 ft downgradient (east-southeast) of MDA C (Figure 4.1-1) to serve as a monitoring well for the site (LANL 2009, 105076). The upper surface of the regional aquifer is located in the Puye Formation, and the depth to water following well development at R-46 was 1327.9 ft bgs. In characterization well R-14 (Figure 4.1-1), located in Ten Site Canyon approximately 3000 ft (900 m) east of MDA C, groundwater was encountered at a depth of 1182 ft bgs (LANL 2003, 076062, p. 5).

Regional monitoring well R-60 was installed 100 ft downgradient (east) of MDA C (Figure 4.1-1) to serve as a monitoring well for the site (LANL 2009, 105076). The upper surface of the regional aquifer is located in the Puye Formation, and the depth to water following well completion at R-60 was 1319.5 ft bgs. The regional aquifer should be present at approximately this depth beneath MDA C. Figure G-1.0-1 shows the elevations of the top of the regional aquifer for an extended area of the Laboratory surrounding MDA C.

The regional aquifer is the only known aquifer in the Los Alamos area capable of producing a municipal and industrial water supply. The velocity of groundwater flow ranges from about 20 ft/yr to 250 ft/yr across the plateau (LANL 1998, 059599). Near MDA C, the groundwater velocity is approximately 40 ft/yr and the direction of groundwater flow in the regional aquifer is to the east-southeast, toward the Rio Grande (see Appendix G). More detailed information about groundwater flow directions beneath MDA C is presented in Appendix G.

No perched groundwater or intermediate-depth saturated horizons were encountered during previous investigations at MDA C (LANL 1998, 059599; LANL 2005, 091493, p. 6); in any of the boreholes drilled during this investigation; or during the drilling of regional wells R-46 or R-60. Perched groundwater was encountered in the Puye Formation and dacite lavas at wells R-17 and PCI-2, located in Pajarito Canyon, 3000 ft southeast of MDA C; however, these perched zones do not appear to extend under Mesita del Buey at MDA C, based on the results of drilling beneath the mesa. MDA C is located on a mesa top, so no shallow alluvial groundwater is present in the immediate vicinity. Alluvial groundwater is not known to be present in Ten Site Canyon to the north and northeast of MDA C.

4.5 Surface Water Conditions

No permanent surface water exists at MDA C. Occasional surface runoff occurs as a result of snowmelt or seasonal thunderstorms that can produce significant rainfall in short time periods. Surface runoff may occur as minor sheet flow that drains toward the east-northeast into the upper portion of Ten Site Canyon, which borders the northeast corner of the site. No significant drainage channels exist on the site.

4.6 Surface Air and Subsurface Vapor Conditions

Surface air conditions were monitored for health and safety purposes during the Phase III investigation using a Data Ram portable dust monitor. Surface air conditions did not exceed dust action levels for either inorganic chemicals or radionuclides and did not result in any impacts to the investigation activities. Subsurface vapor-screening results are presented in Table 3.1-1.

5.0 REGULATORY CRITERIA

Regulatory criteria are used for the purpose of screening investigation results. The Phase III investigation involved collecting subsurface dacite, groundwater, and vapor samples. The dacite samples were collected at depths of over 600 ft bgs for the purpose of evaluating ranges of inorganic chemical concentrations in dacite. These samples were not collected to screen against regulatory criteria. All groundwater samples collected by the Laboratory, including those collected from the well installed as part of the Phase III investigation, were screened in accordance with the specific criteria in Section IV.A.3.g of the Consent Order. Screening results are reported monthly to NMED (e.g., LANL 2011, 203596), and no additional groundwater screening was performed as part of the Phase III investigation. Screening of the Phase III vapor data is described below.

The Consent Order does not specifically address cleanup standards, SLs, or other regulatory criteria for vapor. Appendix F describes the methodology used to screen vapor-phase VOCs detected in the vadose zone beneath MDA C. 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 in Appendix F as a Tier I screening evaluation.

The Tier I screening evaluation uses Henry's law to identify the vapor-phase VOC concentration thresholds that 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. The Tier II screen 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.

6.0 SITE CONTAMINATION

6.1 Subsurface Sampling of Tschicoma Formation Dacite

In 2010, four dacite samples, plus one field duplicate, were collected and analyzed for TAL metals. Two dacite samples were collected new boreholes 50-613184 and 50-613185, drilled during the Phase III investigation. Samples were collected from two depths, approximately 20 vertical ft apart, in the two boreholes. Table 3.3-5 lists the dacite samples collected and the analyses requested for each sample.

6.1.1 Dacite Sample Screening Results

No organic vapors were detected above ambient air during PID screening of the dacite samples. All radiological screening results were at or below the daily site background levels. Field-screening results are presented in Table 3.1-1.

6.1.2 Dacite Sample Analytical Results

6.1.2.1 Inorganic Chemicals

Table 6.1-1 lists the inorganic chemicals detected in dacite samples collected from two Phase III boreholes (locations 50-613184 and 50-613185). The borehole locations are shown in Figure 1.3-1.

This Phase III investigation evaluated the inorganic chemistry of the dacite beneath MDA C by analyzing TAL metals in drill cuttings from two new boreholes (50-613184 and 50-613185) that penetrated the dacite lava at locations south of MDA C; these locations were considered representative of natural background conditions, while the other two Phase III boreholes are located within MDA C near disposal Pits 4 and 5 (Figure 1.3-1). Two samples were collected from each of the two Phase III boreholes for a total of four samples (Table 3.3-5). One sample was collected at the top of the dacite, and a second sample was collected from approximately 20 ft below the top of the dacite. These background samples were collected from the same dacite lava flow that underlies MDA C. The samples were submitted to an external laboratory for analysis of TAL metals, including extraction using EPA Method 3050. Analytical results for the background samples are presented in Table 6.1-1.

BVs (i.e., 95% upper tolerance limits [UTLs]) for metals in the dacite lava flow were not computed because of the small number of samples (a total of four). Instead, the anomalous metal concentrations in the dacite sample collected at location 50-603470 were compared with the range of metal concentrations found in the background samples collected at locations 50-613184 and 50-613185 (Table 6.1-1). Figure 6.1-1 graphically compares the anomalous metal concentrations from location 50-603470 with metal analyses collected from the four background dacite samples. In cases where metal concentrations are at or below the detection limit, the detection limit is plotted in Figure 6.1-1. Figure 6.1-1 also shows BVs for Bandelier Tuff and Pajarito Plateau soils to provide comparisons with existing background data sets (LANL 1998, 059730). Three BVs are shown for the Bandelier Tuff: Qbt 2, 3, and 4; Qbt 1v; and Qbt 1g, Qct, and Qbo.

6.2 Subsurface Vapor Sampling

Vapor samples were collected during six sampling events (January 2010 to April 2010, April 2010 to July 2010, July 2010 to September 2010, October 2010 to January 2011, January 2011 to March 2011, and March 2011 to May 2011) and analyzed for VOCs and tritium. Tables 3.3-2 through 3.3-4 list the vapor samples collected and the analyses requested for each of the three most recent sampling events. A more detailed discussion of the vapor-sampling results is presented in Appendix F.

6.2.1 Subsurface Vapor Sampling Results

6.2.1.1 VOCs

First Quarter FY2011

A total of 152 vapor samples, including 13 field duplicates and 13 field trip blanks, were collected from 126 sampling ports at 14 monitoring wells during the first quarter of FY2011 (October 18, 2010, to January 13, 2011) (Table 3.3-2). The samples were submitted to off-site contract analytical laboratories for analysis of VOCs.

Table 6.2-1 lists the VOCs detected in vapor samples collected from 14 monitoring wells in the first quarter of FY2011. The sampling locations and detected concentrations are shown on Plates 1 and 2.

The VOCs detected in vapor samples collected during the first quarter of FY2011 are

> acetone; benzene; bromomethane; 2-butanone; carbon disulfide; carbon tetrachloride; chlorobenzene; chloroform; chloromethane; dichlorodifluoromethane; 1,1-dichloroethane; 1,1-dichloroethene; cis-1,2-dichloroethene; 1,2-dichloropropane; ethylbenzene; 4-ethyltoluene; 2-hexanone; methylene chloride; tetrachloroethene (PCE); toluene; 1,1,2-trichloro-1,2,2-trifluoroethane; 1,1,1-trichloroethane; TCE; trichlorofluoromethane; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; vinyl chloride; total xylene; 1,2-xylene; and 1,3-xylene+1,4-xylene.

Second Quarter FY2011

A total of 179 vapor samples, including 16 field duplicates and 15 field trip blanks, were collected from 148 sampling ports at 18 monitoring wells during the second quarter of FY2011 (January 18, 2011, to March 16, 2011) (Table 3.3-3). The samples were submitted to off-site contract analytical laboratories for analysis of VOCs.

Table 6.2-2 lists the VOCs detected in vapor samples collected from 18 monitoring wells during the second quarter of FY2011. The sampling locations and detected concentrations are shown on Plates 3 and 4.

The VOCs detected in vapor samples collected during the second quarter of FY2011 are

> acetone; benzene; 2-butanone; carbon disulfide; carbon tetrachloride; chlorobenzene; chloroform; 1,2-dichloro-1,1,2,2-tetrafluoroethane; dichlorodifluoromethane; 1,1-dichloroethane; 1,1-dichloroethene; cis-1,2-dichloroethene; 1,2-dichloropropane; ethylbenzene; 4-ethyltoluene; 2-hexanone; methylene chloride; styrene; PCE; toluene; 1,1,2-trichloro-1,2,2-trifluoroethane; 1,1,1-trichloroethane; TCE; trichlorofluoromethane; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; total xylene; 1,2-xylene; and 1,3-xylene+1,4-xylene.

Third Quarter FY2011

A total of 189 vapor samples, including 18 field duplicates and 18 field trip blanks, were collected from 153 sampling ports at 18 monitoring wells during the third quarter of FY2011 (March 18, 2011, to May 2, 2011) (Table 3.3-4). The samples were submitted to off-site contract analytical laboratories for analysis of VOCs.

Table 6.2-3 lists the VOCs detected in vapor samples collected from 18 monitoring wells in the third quarter of FY2011. The sampling locations and detected concentrations are shown on Plates 5 and 6.

The VOCs detected in vapor samples collected during the third quarter of FY2011 at the four new monitoring wells are

> acetone; benzene; bromomethane; 2-butanone; carbon disulfide; carbon tetrachloride; chloroform; chloromethane; 1,2-dichloro-1,1,2,2-tetrafluoroethane; dichlorodifluoromethane; 1,1-dichloroethene; cis-1,2-dichloroethene; 1,2-dichloropropane; ethylbenzene; 4-ethyltoluene; 2-hexanone; methylene chloride; styrene; PCE; toluene; 1,1,2-trichloro-1,2,2-trifluoroethane; 1,1,1-trichloroethane; TCE; trichlorofluoromethane; 1,2,4-trimethylbenzene; 1,3,5-trimethylbenzene; total xylene; 1,2-xylene; and 1,3-xylene+1,4-xylene.

Figure 6.2-1 summarizes the horizontal and vertical distribution of the TCE vapor plume at MDA C. TCE results are presented because TCE is the most frequently detected VOC and is present at the highest concentrations. As shown in Figure 6.2-1, the highest TCE concentrations are located approximately 250 ft below the eastern end of MDA C and concentrations decrease in all directions. The shape of the plume is not affected by stratigraphic controls, such as dipping interfaces. A detailed evaluation of vapor data, including the results of Tier I and Tier II screening evaluations and calculation of subsurface contaminant mass, is presented in Appendix F.

6.2.1.2 Tritium

First Quarter FY2011

A total of 140 vapor samples, including 13 field duplicates, were collected from 127 sampling ports at the 14 monitoring wells during the first quarter of FY2011. The samples were submitted to an off-site contract analytical laboratory for analysis of tritium. Table 6.2-4 presents the activities of detected tritium in vapor samples collected from the 14 monitoring wells sampled during the first quarter of FY2011. Tritium was detected in each of the 14 monitoring wells sampled for tritium during the first quarter of FY2011. The sampling locations and detected activities are shown on Plate 7.

Second Quarter FY2011

A total of 170 vapor samples, including 16 field duplicates, were collected from 154 sampling ports at 18 monitoring wells during the second quarter of FY2011. The samples were submitted to an off-site contract analytical laboratory for analysis of tritium. Tritium was detected in vapor samples in 17 of the 18 monitoring wells sampled for tritium during the second quarter of FY2011. Table 6.2-5 presents the activities of detected tritium in vapor samples collected from the 18 boreholes sampled during second quarter of FY2011. The sampling locations and detected activities are shown on Plate 8.

Third Quarter FY2011

A total of 172 vapor samples, including 18 field duplicates, were collected from 154 sampling ports at 18 monitoring wells in the third quarter of FY2011. The samples were submitted to an off-site contract analytical laboratory for analysis of tritium. Tritium was detected in 17 of the 18 boreholes sampled for tritium during the third quarter of FY2011. Table 6.2-6 presents the activities of detected tritium in vapor samples collected from the 18 boreholes sampled during the third quarter of FY2011. The sampling locations and detected activities are shown on Plate 9.

6.3 Regional Groundwater Sampling Results

The current regional aquifer monitoring network for MDA C consists of regional wells R-46 and R-60, both of which are to the east (downgradient) of MDA C. Well R-46 was installed in 2009 to detect contaminants potentially migrating from MDA C toward water-supply well PM-5. R-60 was installed in 2010 as part of the Phase III investigation for MDA C. Well R-60 is designed for early detection of contaminant releases and is screened at the top of the regional aquifer at the eastern boundary of MDA C. As discussed in Appendix G, wells R-46 and R-60 provide a high probability of detecting releases of VOCs (99.7%) and tritium (95.9%).

Two VOCs (acetone and toluene) have been detected in R-46. Acetone was detected in five samples collected over the period May 2009 to February 2010. Concentrations decreased over time from 60.3 µg/L in the May 2009 sample to 6.24 µg/L in the February 2010 sample. Acetone was not detected in samples collected since February 2010. Toluene was detected in eight samples collected over the period

May 2009 to November 2010. Concentrations decreased over time from 10.9 µg/L in the May 2009 sample to 0.38 µg/L in the November 2010 sample. Toluene was not detected in one sample collected at R-46 since November 2010. Tritium was not detected in six samples collected at R-46 from March 2009 to February 2010. Tritium was detected at 36.7 pCi/L in the sample collected in May 2010 and 24.4 pCi/L in the sample collected in November 2010. All results from R-46 are reported in the periodic monitoring reports for Mortandad and Sandia watersheds (e.g., LANL 2011, 203407).

Groundwater samples were collected from R-60 in December 2010, after well development, and in January 2010 as part of quarterly watershed monitoring. The results from the December 2010 sampling showed six organic chemicals detected. Four polycylic aromatic hydrocarbons ([PAHs] benzo[a]pyrene; benzo[b]fluoranthene; benzo[g,h,i]perylene; and benzo[k]fluoranthene) and one VOC (acetone) were detected. Two of these PAHs were detected above SLs: benzo[a]pyrene was detected at 0.851 µg/L, which exceeds the maximum contaminant level of 0.2 µg/L, and benzo[b]fluoranthene was detected at 0.714 µg/L, which exceeds the EPA tap water SL of 0.29 µg/L. One additional PAH (dibenz[a,h]anthracene) was detected only in a field duplicate sample at 1.35 µg/L, which exceeds the EPA tap water SL of 0.029 µg/L. Acetone was detected at 68.5 µg/L, which is less than the EPA tap water SL of 22,000 µg/L. Five inorganic chemicals (aluminum, iron, manganese, molybdenum, and zinc) were detected above background levels, but none exceeded an SL. These results were reported to NMED in the February 2011 groundwater data review (LANL 2011, 201565). Only one organic chemical, 4-nitrotoluene, was detected the sample collected in January 2011. Nitrotoluene(4-) was detected at 0.327 µg/L, which is less than the EPA tap water SL of 42 µg/L. This result was reported to NMED in the March 2011 groundwater data review (LANL 2011, 202271). No VOCs were detected in the January 2011 sample.

VOCs and semivolatile organic compounds are commonly detected in initial samples collected at newly installed monitoring wells and are associated with drilling products or installation activities. In these cases, the highest concentrations are typically observed in the first or second sampling rounds, and concentrations steadily decline thereafter from the gradual removal via groundwater flow, purging, and biodegradation. This behavior was observed for acetone and toluene at R-46 and is expected to occur at R-60.

7.0 CONCLUSIONS

The conclusions presented in the following sections are based on the results of all investigations to date, including the 2010 to 2011 Phase III investigation.

7.1 Nature and Extent of Inorganic Chemical Contamination in Surface and Near-Surface Soil

The nature and extent of inorganic chemical contamination in surface and near-surface soil were evaluated during the Phase II and earlier investigations. Based on the results of these two phases of investigation, the Phase II investigation report concluded the lateral and vertical extent of contamination are defined for all inorganic chemicals in the surface and near-surface at MDA C (LANL 2009, 107389, p. 22).

7.2 Nature and Extent of Contamination in Tuff

7.2.1 Inorganic Chemicals in Tuff

The nature and extent of inorganic chemical contamination in tuff core were evaluated during the 2004 to 2006 and Phase II investigations. Based on the results of these two phases of investigation, the Phase II investigation report concluded the lateral and vertical extent of contamination are defined for all inorganic chemicals in tuff at MDA C (LANL 2009, 107389, p. 23). This conclusion was based on decreasing

concentration trends laterally and vertically. One exception noted during the Phase II investigation was concentration increases with depth at one borehole where the deepest sample was collected from the Tschicoma Formation dacite, for which no BV is available. The report concluded the elevated concentrations in the Tschicoma Formation likely reflect the natural chemical composition of the dacite in that formation, which is substantially different from the overlying rock units, or the presence of pedogenic carbonate at the top of the dacite. As a result of this uncertainty, the Phase III investigation work plan (LANL 2010, 109260) proposed sampling to evaluate background concentrations of inorganic chemicals in dacite. The results of this sampling are presented in section 6.1.2.

The hypothesis that the anomalous metal concentrations detected in the sample at location 50-603470 likely represented the natural chemistry of the Tschicoma Formation is not supported by the new dacite background data. With the possible exception of vanadium, metal concentrations for the dacite sample at location 50-603470 are significantly greater than those for the four dacite background samples (Figure 6.1-1). For many metals, concentrations in the dacite background samples overlap the range of BVs for Bandelier Tuff but are below the soil BVs. The anomalous metal concentrations detected at location 50-603470 are most similar to the elevated concentrations that characterize the soil BVs.

The dacite sample at location 50-603470 was collected at a depth of 650 to 653 ft, immediately below the contact between the Guaje Pumice Bed and the dacite lava flow (650 ft). The borehole log for location 50-603470 does not indicate the presence of a soil horizon or highly weathered zone at the top of the lava flow (LANL 2009, 107389, Appendix C). However, a borehole video log for well R-60 shows that a 1-ft-thick soil of brown clay and silt is present on top of the dacite lava flow at a distance of only 150 ft from location 50-603470. Similarly, the lithologic log for borehole SHB-1, located west of MDA C, shows several feet of silt- and clay-rich sediments immediately below the contact between the Guaje Pumice Bed and the dacite lava flow.

The observations of soils in nearby wells and boreholes, coupled with a soil-like geochemical signature, suggest the anomalous sample at location 50-603470 contained a component of soil material. Therefore, it is recommended that no further action be taken to investigate metals associated with the dacite at location 50-603470. The conclusion that these anomalous metals are not contaminants is supported by the lack of elevated metal concentrations in the overlying tuffs of the Otowi Member. During the Phase II investigation, samples were collected at location 50-603470 over the depth range of 198 to 650 ft bgs and included units Qbt 1v (one sample), Qbt 1g (two samples), Qct (one sample), and Qbo (five samples), in addition to the dacite sample. In all cases, the highest detected concentration of the 12 anomalous metals is in the dacite sample. This vertical distribution of concentrations is not indicative of a release from the shallow disposal units at MDA C. This conclusion is also consistent with the results of the Phase II investigation (LANL 2009, 107389), which showed vertical extent of potential releases of inorganic chemicals was defined by samples collected from units above the dacite.

7.2.2 Organic Chemicals in Tuff

The nature and extent of organic chemical contamination in tuff was evaluated during the 2004 to 2006 and Phase II investigations. Based on the results of these two phases of investigation, the Phase II investigation report concluded the lateral and vertical extent of contamination are defined for all organic chemicals in tuff at MDA C (LANL 2009, 107389, p. 23). Organic chemicals either were not detected in tuff or their concentrations decreased with depth and were generally at low levels near or less than estimated quantitation levels.

7.2.3 Radionuclides in Tuff

The nature and extent of radionuclide contamination in tuff were evaluated during the 2004 to 2006 and Phase II investigations. Based on the results of these two phases of investigation, the Phase II investigation report concluded the lateral and vertical extent of contamination are defined for all radionuclides in tuff at MDA C (LANL 2009, 107389, p. 23). Radionuclides were either not detected in tuff or their activities decreased with depth.

7.3 Nature and Extent of Contamination in Subsurface Vapor

7.3.1 VOCs in Subsurface Vapor

The nature and extent of VOCs in subsurface vapor were evaluated during the 2004 to 2006 and Phase II investigations. Based on the results of these two phases of investigation, which showed decreases in concentration with depth and distance from disposal units, the Phase II investigation report concluded the lateral and vertical extent of contamination are defined for all VOCs in vapor at MDA C (LANL 2009, 107389, p. 23). However, in several of the deep Phase II boreholes, concentrations of TCE did not decrease to the SLs specified in the Phase II investigation work plan. Based on the results of the Phase III investigation, the vertical extent of VOC contamination in vapor to SLs is defined (Appendix F). Concentrations decreased with depth in the Phase III wells, and all results from the deepest sampling ports in the Guaje Pumice Bed and dacite were below Tier I SLs (Appendix F).

7.3.2 Tritium in Subsurface Vapor

The nature and extent of tritium in subsurface vapor were evaluated during the 2004 to 2006 and Phase II investigations. Based on the results of these two phases of investigation, the Phase II investigation report concluded the lateral and vertical extent of contamination are defined for tritium in vapor at MDA C (LANL 2009, 107389, p. 24). Tritium activities decreased with depth, and activities in boreholes outside MDA C were substantially lower than the concentrations detected in boreholes located in the central area of MDA C. Results from the Phase III wells showed tritium activities decreased with depth in the deeper screens, and tritium was below detection limits in samples from the deepest ports in the dacite.

7.4 VOCs and Tritium in Groundwater

Regional well R-60 was installed during the Phase III investigation to supplement existing well R-46 and provide data to determine whether VOCs or tritium had migrated through the vadose zone to the regional aquifer. One VOC (acetone) was detected at low concentrations in the first sample (December 2010) collected from R-60, and no VOCs have been detected during subsequent sampling. No tritium has been detected in samples from R-60. Based on these results, no releases of VOCs or tritium to groundwater have occurred from MDA C.

The results of vapor sampling show concentrations of VOCs (primarily TCE) and tritium above SLs; thus, some potential exists for migration of contaminants to groundwater. As described in the conceptual site model (section 2.4), to reach groundwater VOCs or tritium would have to migrate through the lower Otowi Member, the Guaje Pumice Bed, and the Tschicoma dacite. As long as concentrations of VOCs and tritium in these units remain below SLs, contamination of groundwater above cleanup levels cannot occur.

7.5 Risk-Screening Assessments

Because the nature and extent of contamination at depths and media appropriate for risk-screening assessments had been determined, risk screenings were performed as part of the Phase II investigation (LANL 2009, 107389). The total excess cancer risk and hazard index (HI) for the industrial scenario, which is the current and reasonably foreseeable land use for MDA C, were approximately 3×10^{-6} and 0.09, respectively. These are less than the NMED targets of 1×10^{-5} and 1.0, respectively. The total dose for the industrial scenario is approximately 10 mrem/yr, which is less than the DOE target dose of 15 mrem/yr (DOE 2000, 067489). The total excess cancer risk, HI, and dose for the residential scenario were approximately 1×10^{-5}, 0.3, and 11 mrem/yr, respectively.

Several chemicals of potential ecological concern (COPECs) were identified as part of the Phase II investigation. All the COPECs were eliminated following evaluations based on one or more lines of evidence, including minimum ecological SLs, HI analysis, comparisons to background, potential effects to populations, and comparison to previous field and Laboratory canyon investigations. The Phase II investigation report concluded the results of the ecological risk-screening assessment do not indicate a potential risk to ecological receptors at MDA C (LANL 2009, 107389, p. 24).

No data were collected during the Phase III investigations that would change the results of the risk-screening assessments.

8.0 RECOMMENDATIONS

The nature and extent of contamination have been defined for all potential contaminants and media at MDA C, and no further investigation of the site is recommended.

Although releases from wastes disposed of at MDA C currently do not pose an unacceptable risk, future exposure of receptors to these wastes could result in unacceptable risk. Similarly, VOCs and tritium released to subsurface vapor have not migrated to the regional aquifer, but the potential for future migration exists. Therefore, a corrective measures evaluation (CME) is recommended to evaluate alternatives for preventing future exposure. Based on the results of the initial and the Phase II and III investigations, it is recommended that the CME address the following pathways.

- *Infiltration*. The results of subsurface tuff sampling do not indicate infiltration has resulted in migration of contaminants beyond the immediate vicinity of disposal units. The CME should evaluate the potential long-term migration by this pathway and whether infiltration controls are required.
- *Biointrusion*. Potential human and biotic intrusion into buried wastes and subsurface contamination is currently controlled by site access restrictions and maintenance of the site cover. The CME should evaluate the potential for biointrusion to result in unacceptable risks if current institutional controls are not maintained.
- *Direct Contact*. Exposure to subsurface contaminants is currently prevented by the existing vegetative cover at MDA C. The CME should evaluate the long-term stability of this cover and whether controls are needed to prevent erosion that could result in exposure to buried wastes and subsurface contamination.
- *Vapor Diffusion*. Contaminants present in subsurface vapor have not migrated to the regional aquifer. The CME should evaluate the need to prevent future migration by removal of the subsurface contaminant inventory by soil-vapor extraction.

Although further investigation is not necessary, additional focused subsurface vapor monitoring is recommended. The objectives of this monitoring are to

- ensure concentrations in the lower Otowi Member, Guaje Pumice Bed, and upper Tschicoma Formation dacite remain below Tier I SLs;
- evaluate changes in concentrations near waste disposal units that would indicate additional releases; and
- evaluate changes in concentrations near the lateral plume boundary that would indicate spreading or contraction of the plume.

To accomplish these objectives, monitoring at the locations, depths, and frequencies specified in Table 8.0-1 is recommended. This monitoring would be performed until a long-term monitoring plan was developed as part of corrective measures implementation.

The results from the vapor monitoring performed during the first and second quarters of FY2011 indicate sampling may have been impacted by drilling operations conducted at that time (Appendix F). Therefore, in addition to meeting the above objectives, additional vapor monitoring is also recommended to evaluate whether subsurface plume conditions have reequilibrated since drilling was completed.

The groundwater data from regional wells R-46 and R-60 do not indicate a contaminant release to groundwater from MDA C. The monitoring-network evaluation presented in Appendix G indicates wells R-46 and R-60 are appropriately placed to detect potential releases from MDA C. In addition, the existing vapor-monitoring network includes sampling ports located in deeper stratigraphic units (i.e., the Otowi Member, the Guaje Pumice Bed, and the Tschicoma Formation dacite) that are well-suited to provide early detection of contaminants at concentrations of concern for groundwater contamination. Contaminants above conservative Tier I SLs (Appendix F) have not been detected in these ports, and continued monitoring of these ports is recommended. Based on these factors, the Laboratory does not recommend installing regional well R-59 for detection monitoring purposes at this time. The need for an additional regional well or wells at MDA C may be identified during the CME based on other monitoring objectives.

9.0 REFERENCES AND MAP DATA SOURCES

9.1 References

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

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

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9.2 Map Data Sources

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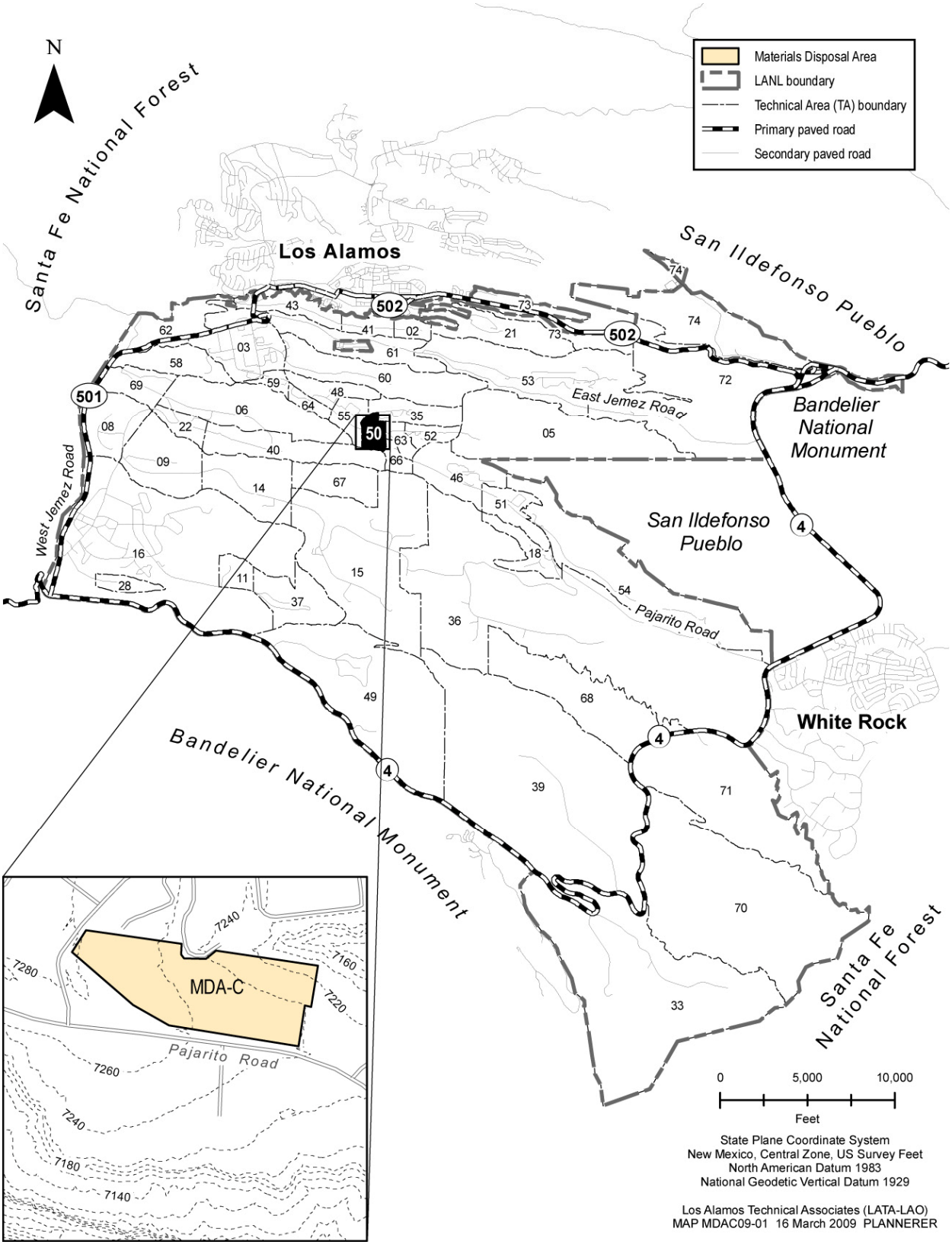

Figure 1.1-1 Location of MDA C and surrounding technical areas

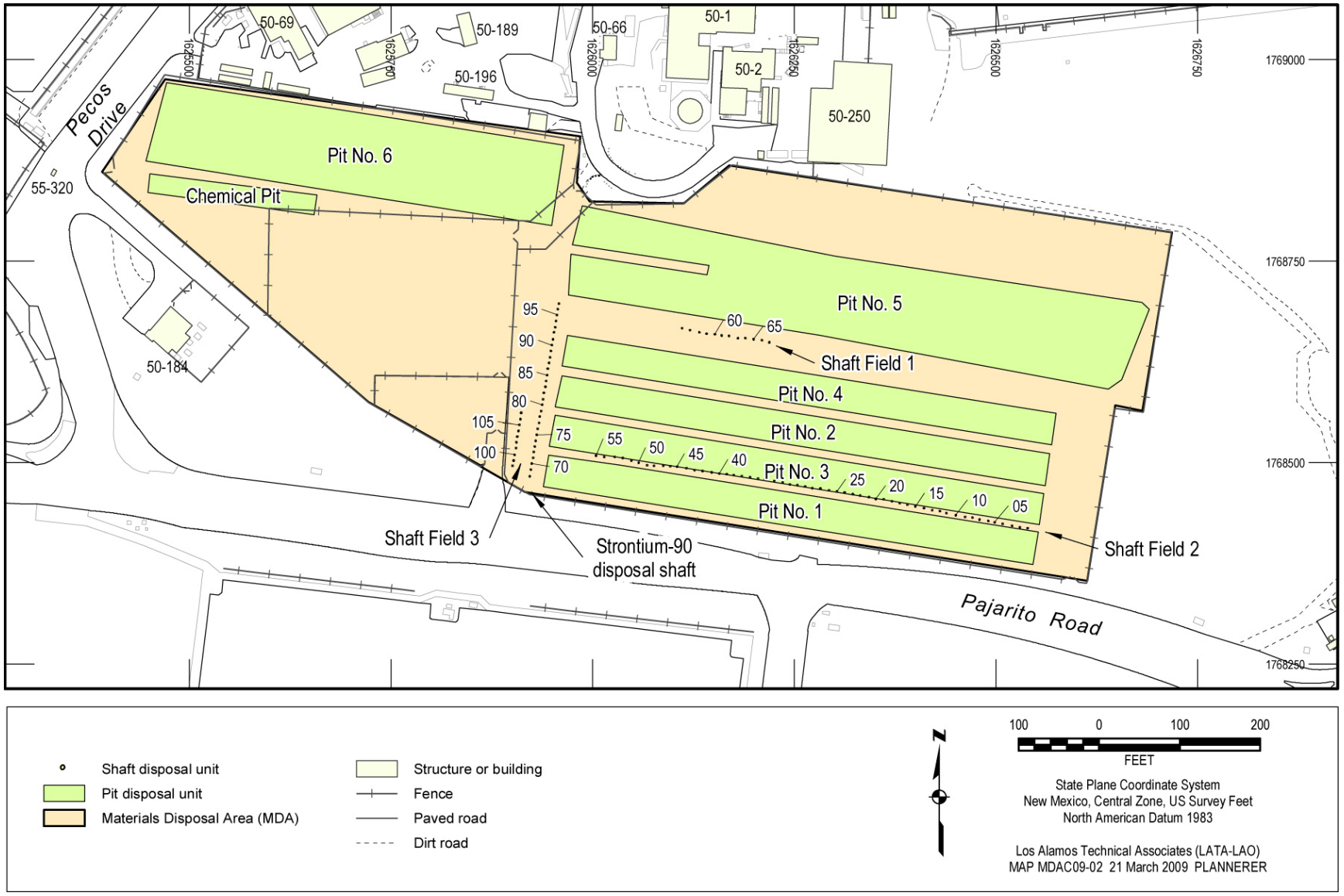

Figure 1.1-2 Location of pits and shafts at MDA C

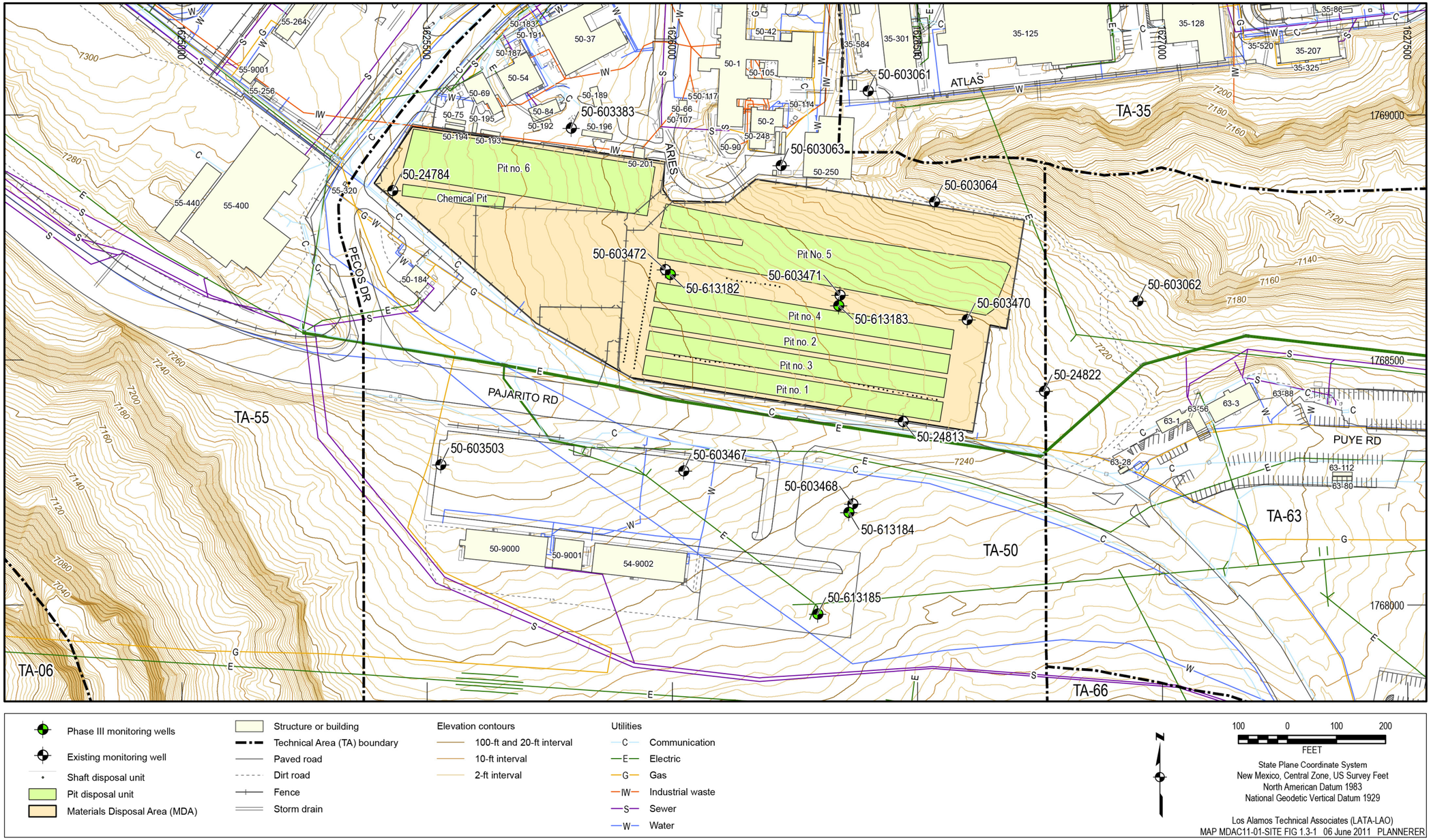

Figure 1.3-1 Locations of vapor-monitoring boreholes sampled during Phase III investigation at MDA C

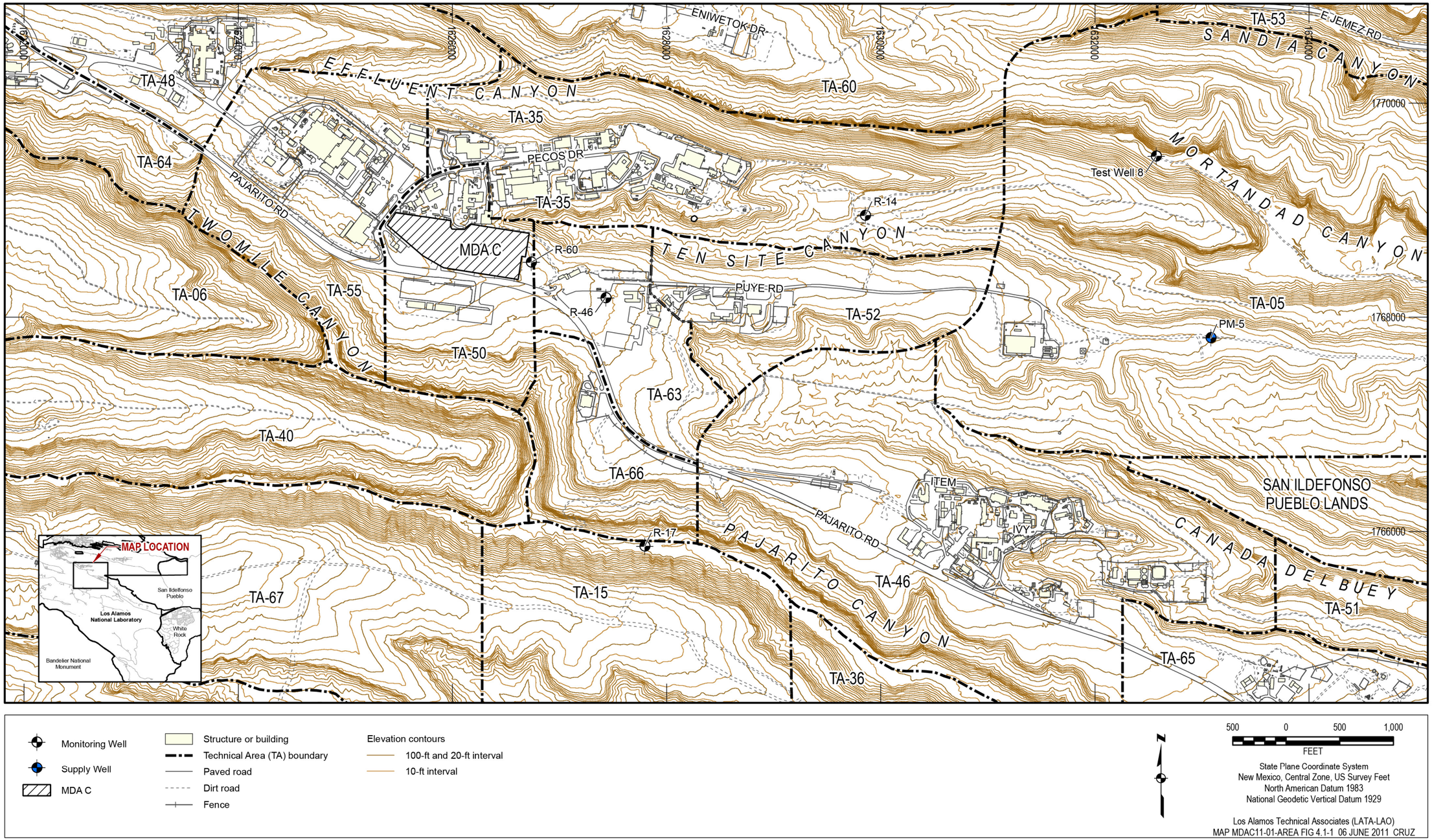

Figure 4.1-1 Area map of MDA C showing mesa-top setting, nearby TAs, and related canyons

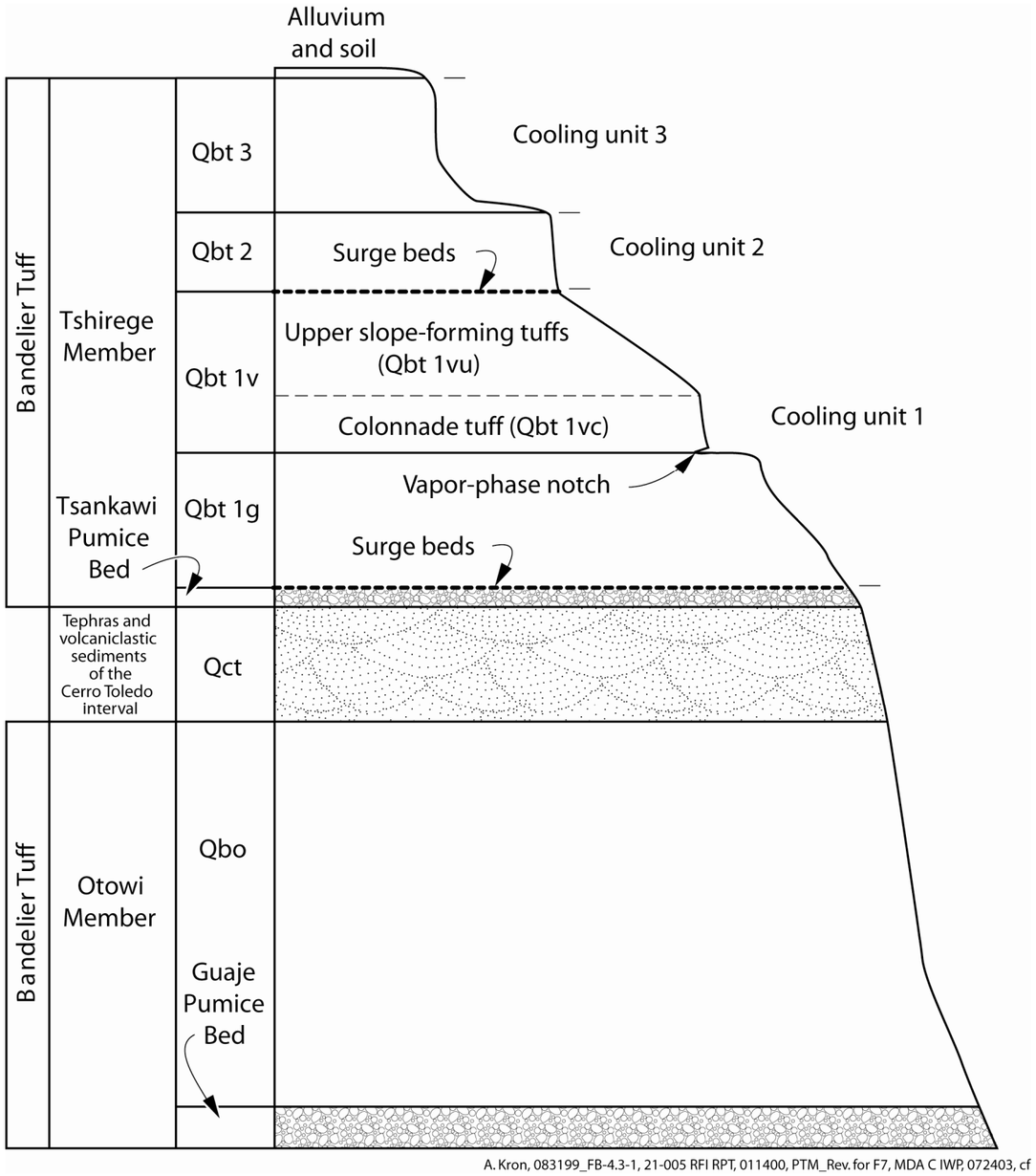

Figure 4.3-1 Generalized stratigraphy in the vicinity of MDA C

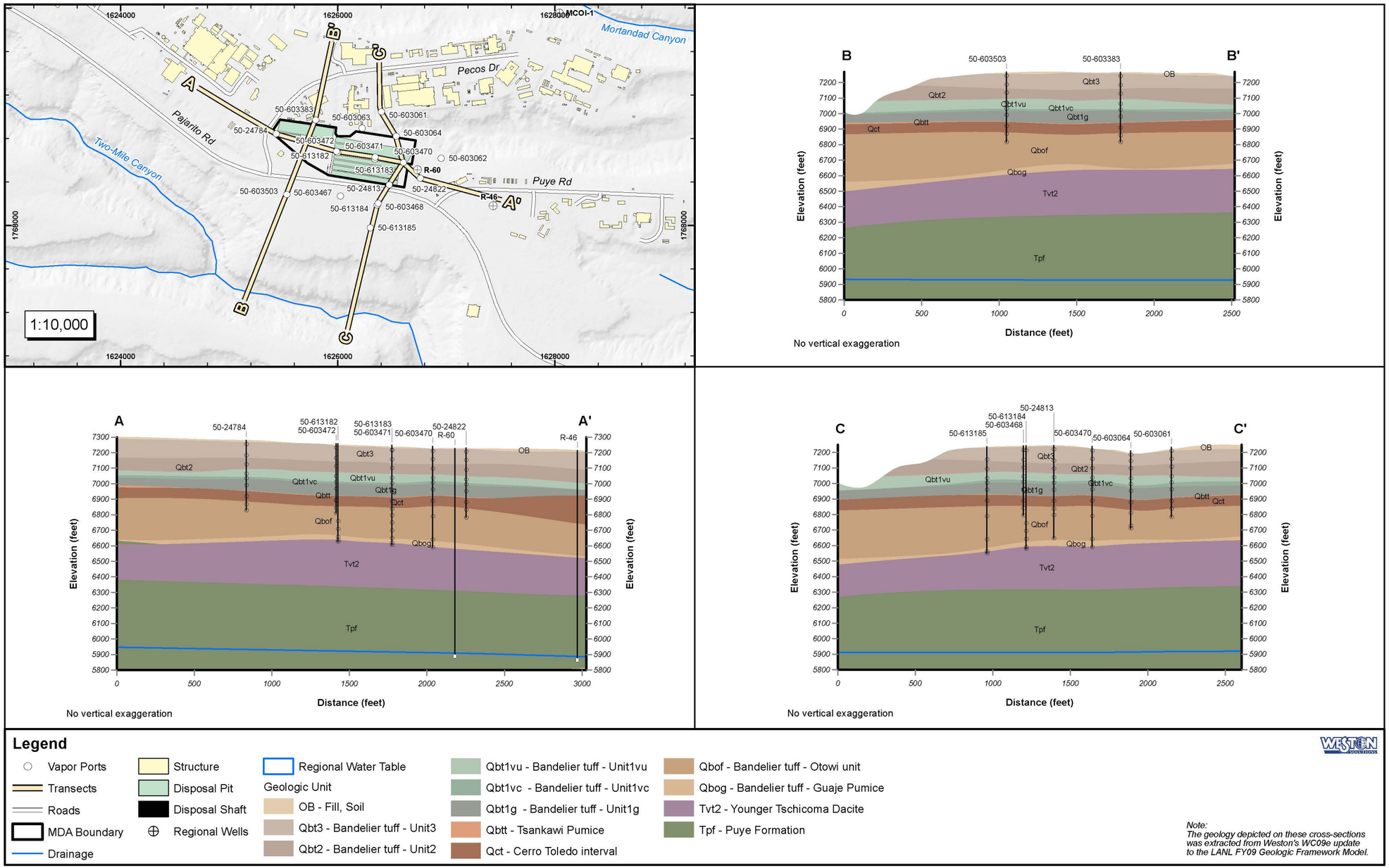

Figure 4.3-2 Plan and map views of stratigraphic units beneath MDA C. Also included are the locations of vapor-monitoring wells and ports as well as regional wells R-60 and R-46 and their well screen locations

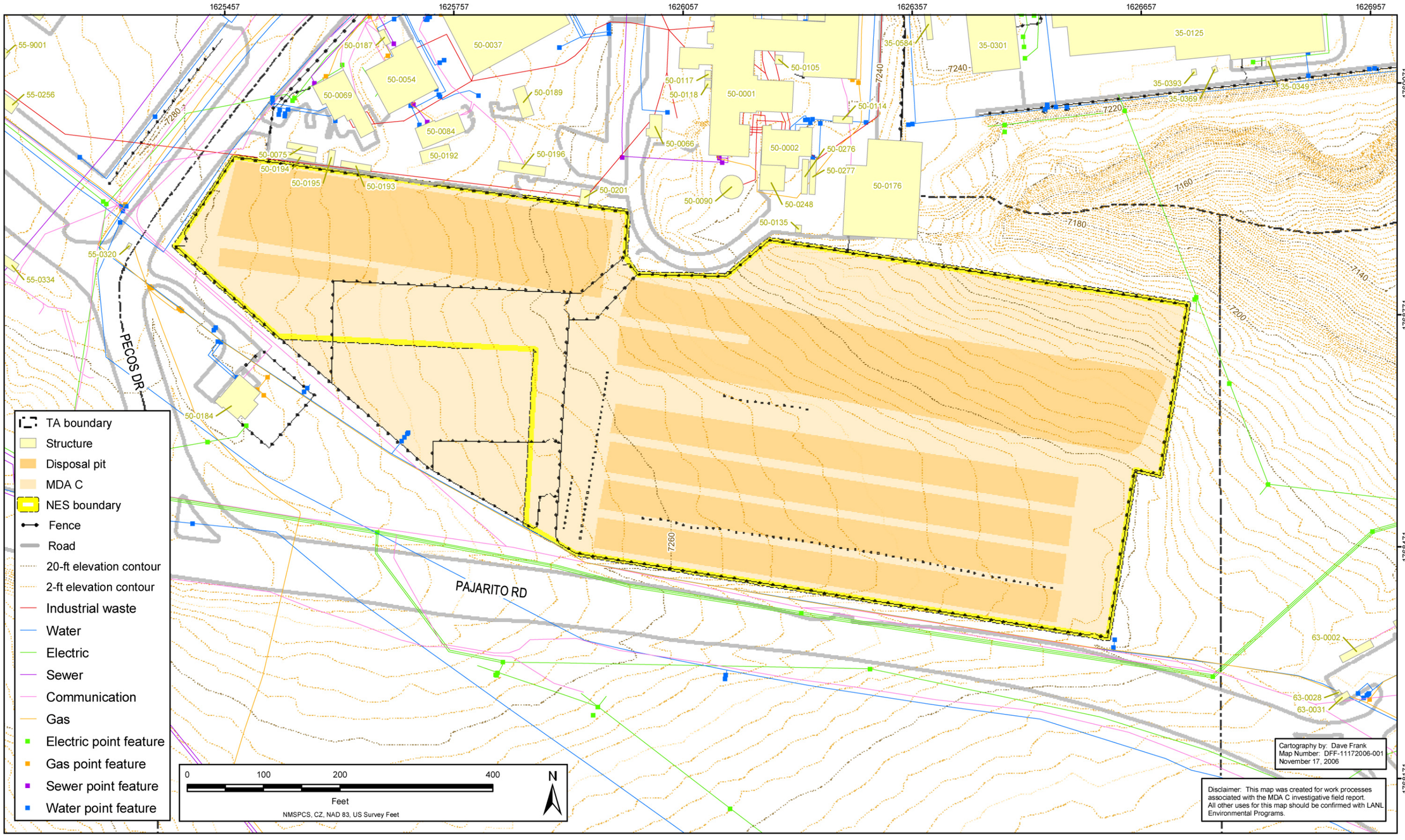

Figure 4.3-3 Utilities and other subsurface and surface structures at MDA C

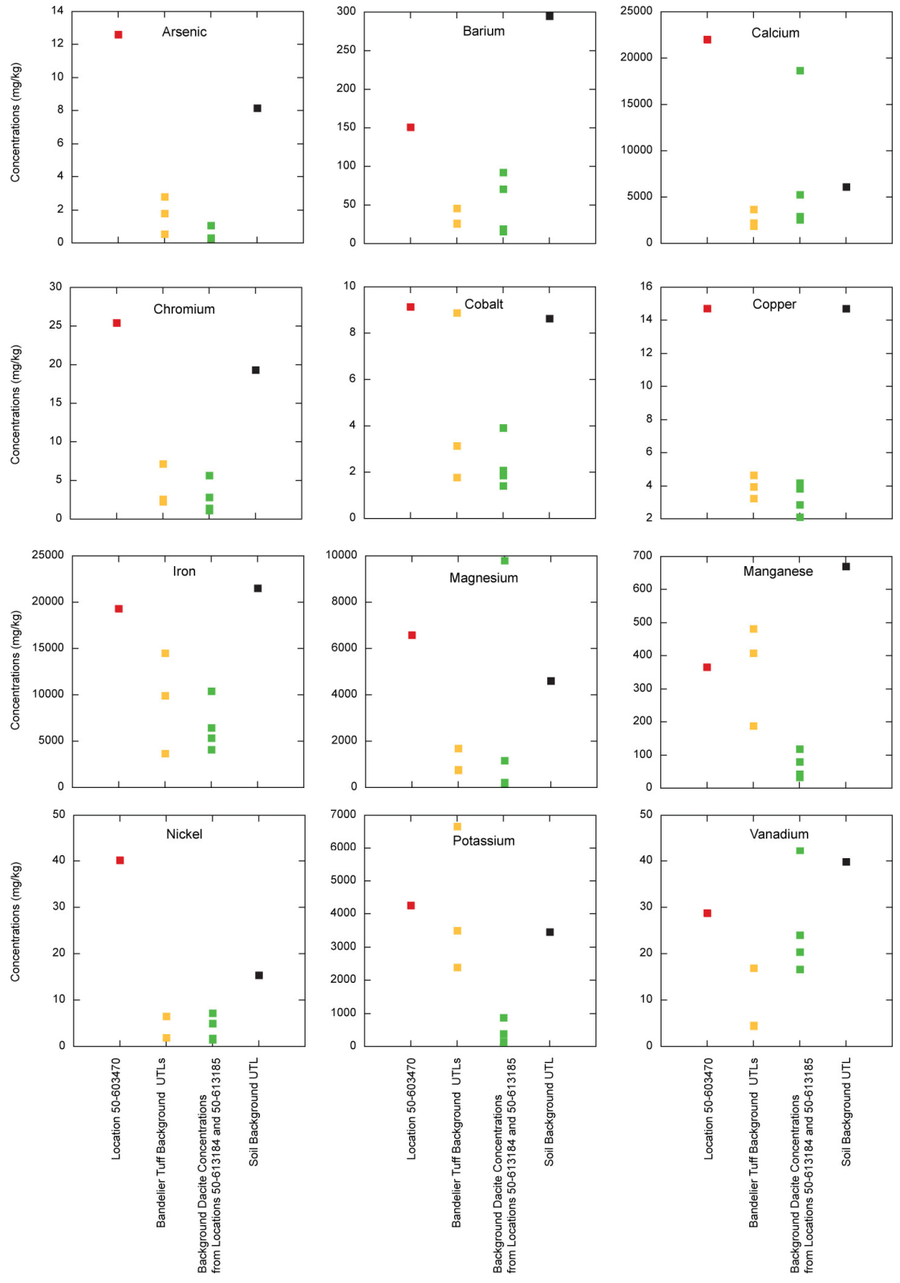

Figure 6.1-1 Concentrations of inorganic chemicals in Tschicoma formation dacite and Bandelier Tuff background samples

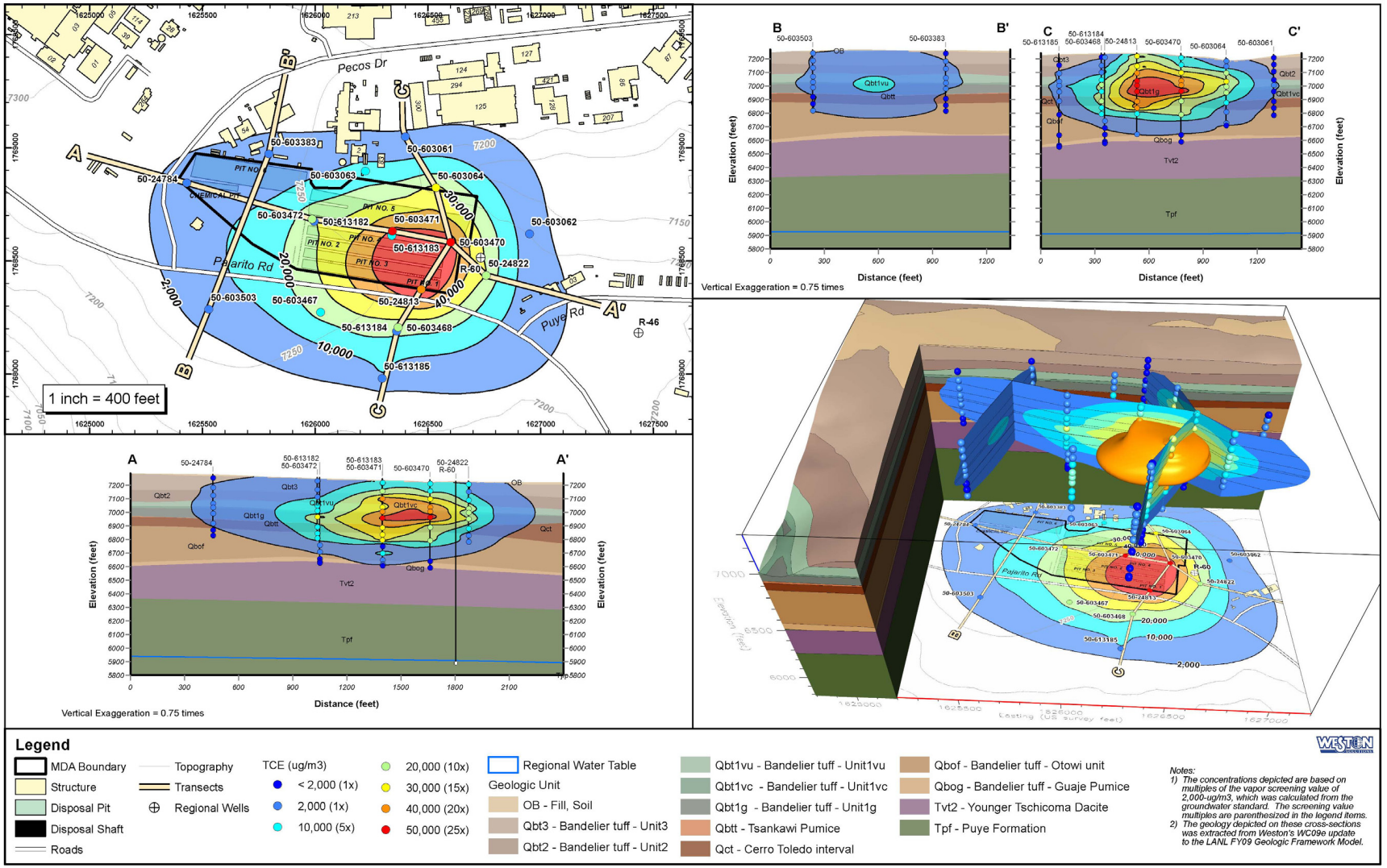

Figure 6.2-1 Plan and map views of the average TCE vapor concentrations measured at MDA C, based on second quarter FY2010 through third quarter FY2011 data

Table 1.3-1
Summary of Boreholes Sampled during Phase III Investigation at MDA C

Location ID	Year Drilled	TD (ft)	Purpose
50-24784	2006; extended in 2009	460	Vapor sampling
50-24813	2006; extended in 2008 and 2009	635	Vapor sampling
50-24822	2005; extended in 2008	452.5	Vapor sampling
50-603061	2008	460	Vapor sampling
50-603062	2008	460	Vapor sampling
50-603063	2008	460	Vapor sampling
50-603064	2008	510	Vapor sampling
50-603383	2008	460	Vapor sampling
50-603467	2008	600	Vapor sampling
50-603468	2008	460	Vapor sampling
50-603470	2008	653	Vapor sampling
50-603471	2008	460	Vapor sampling
50-603472	2008	460	Vapor sampling
50-603503	2008	450	Vapor sampling
50-613182	2010	646	Vapor sampling
50-613183	2010	652	Vapor sampling
50-613184	2011	676	Vapor sampling, Tschicoma dacite sampling
50-613185	2011	697.5	Vapor sampling, Tschicoma dacite sampling

Table 3.1-1
Field-Screening Results for Samples Collected during Phase III Investigation at MDA C

Location ID	Depth (ft)	Sample Type	Sample ID	PID (ppm)	Alpha (dpm*)	Beta/Gamma (dpm)
50-613184	654–654.2	Cuttings	RE50-11-4142	0	≤34	≤1656
50-613184	675.8–676	Cuttings	RE50-11-4143	0	≤34	≤1656
50-613185	677.5–677.7	Cuttings	RE50-11-4144	0	≤34	≤1656
50-613185	697.3–697.5	Cuttings	RE50-11-4145	0	≤34	≤1656

* dpm = Disintegrations per minute.

Table 3.2-1
Surveyed Coordinates for All Locations Sampled during Phase III Investigation at MDA C

Location ID	Easting (ft)	Northing (ft)
50-24784	1625429.58	1768845.82
50-24813	1626470.19	1768374.83
50-24822	1626758.15	1768436.53
50-603061	1626385.96	1769012.10
50-603062	1626950.74	1768620.04
50-603063	1626221.306	1768897.687
50-603064	1626534.608	1768823.496
50-603383	1625793.321	1768973.355
50-603467	1626022.621	1768273.749
50-603468	1626367.515	1768206.41
50-603470	1626601.072	1768582.757
50-603471	1626341.807	1768632.509
50-603472	1625985.806	1768684.962
50-603503	1625527.565	1768286.877
50-613182	1625995.701	1768674.538
50-613183	1626338.792	1768611.645
50-613184	1626359.883	1768189.454
50-613185	1626296.318	1767981.842

Table 3.3-1
Phase II and Phase III Vapor-Monitoring Wells and Sampling Ports

Sampling Port	Depth (ft bgs)	Unit Screened
Well 50-603470 (stainless steel)		
1	30	Qbt 3
2	83	Qbt 3
3	143	Qbt 2
4	203	Qbt 1v
5	233	Qct
6	278	Qbt 1g
7	351	Qct
8	450	Qbo
9	600	Qbo
10	650	Qbog
Well 50-603471 (FLUTe)		
1	30	Qbt 3
2	90	Qbt 3
3	146	Qbt 2
4	209	Qbt 1v
5	242	Qct
6	288	Qbt 1g
7	360	Qct
8	410	Qbo
9	450	Qbo
Well 50-603472 (stainless steel)		
1	27	Qbt 3
2	93	Qbt 3
3	146	Qbt 2
4	210	Qbt 1v
5	247	Qbt 1vc
6	292	Qbt 1g
7	364	Qct
8	414	Qbo
9	450	Qbo
Well 50-24784 (stainless steel)		
1	25	Qbt 3
2	96	Qbt 3
3	155	Qbt 2
4	215	Qbt 1v
5	244	Qbt 1vc
6	289	Qbt 1g
7	362	Qct
8	411	Qbo
9	450	Qbo

Table 3.3-1 (continued)

Sampling Port	Depth (ft bgs)	Unit Screened
Well 50-24813 (stainless steel)		
1	25	Qbt 3
2	99	Qbt 3
3	150	Qbt 2
4	207	Qbt 1v
5	241	Qbt 1vc
6	286	Qbt 1g
7	358	Qct
8	408	Qbo
9	450	Qbo
10	600	Qbo
Well 50-603383 (FLUTe)		
1	26	Qbt 3
2	85	Qbt 3
3	139	Qbt 2
4	206	Qbt 1v
5	244	Qbt 1vc
6	286	Qbt 1g
7	359	Qct
8	408	Qbo
9	450	Qbo
Well 50-603467 (FLUTe)		
1	26	Qbt 3
2	91	Qbt 3
3	143	Qbt 2
4	206	Qbt 1v
5	244	Qbt 1vc
6	287	Qbt 1g
7	360	Qct
8	409	Qbo
9	500	Qbo
10	600	Qbo
Well 50-603468 (FLUTe)		
1	30	Qbt 3
2	92	Qbt 3
3	142	Qbt 2
4	198	Qbt 1v
5	233	Qbt 1vc
6	282	Qbt 1g
7	354	Qct
8	403	Qbo
9	450	Qbo

Table 3.3-1 (continued)

Sampling Port	Depth (ft bgs)	Unit Screened
Well 50-24822 (stainless steel)		
1	25	Qbt 3
2	81	Qbt 3
3	142	Qbt 2
4	204	Qbt 1v
5	235	Qbt 1vc
6	280	Qbt 1g
7	351	Qct
8	402	Qbo
9	450	Qbo
Well 50-603503 (stainless steel)		
1	25	Qbt 3
2	80	Qbt 3
3	133	Qbt 2
4	198	Qbt 1v
5	237	Qbt 1vc
6	278	Qbt 1g
7	347	Qct
8	397	Qbo
9	450	Qbo
Well 50-603061 (stainless steel)		
1	25	Qbt 3
2	76	Qbt 3
3	128	Qbt 2
4	190	Qbt 1v
5	228	Qbt 1vc
6	274	Qbt 1g
7	347	Qct
8	397	Qbo
9	450	Qbo
Well 50-603062 (stainless steel)		
1	25	Qbt 3
2	64	Qbt 3
3	122	Qbt 2
4	184	Qbt 1v
5	217	Qbt 1vc
6	263	Qbt 1g
7	337	Qct
8	387	Qbo
9	450	Qbo
Well 50-603063 (stainless steel)		
1	25	Qbt 3
2	76	Qbt 3
3	128	Qbt 2
4	190	Qbt 1v
5	228	Qbt 1vc
6	274	Qbt 1g

Table 3.3-1 (continued)

Sampling Port	Depth (ft bgs)	Unit Screened
7	347	Qct
8	397	Qbo
9	450	Qbo
Well 50-603064 (stainless steel)		
1	25	Qbt 3
2	66	Qbt 3
3	113	Qbt 2
4	176	Qbt 1v
5	214	Qbt 1vc
6	259	Qbt 1g
7	332	Qct
8	482	Qbo
9	500	Qbo
Well 50-613182 (stainless steel)		
1	500	Qbo
2	550	Qbo
3	600	Qbog
4	620	Qbog
5	632.5	Tt
Well 50-613183 (stainless steel)		
1	30	Qbt 3
2	500	Qbo
3	550	Qbo
4	600	Qbog
5	630	Qbog
6	642.5	Tt
Well 50-613184 (stainless steel)		
1	30	Qbt 3
2	500	Qbo
3	550	Qbo
4	600	Qbo
5	652	Qbog
6	664.5	Tt
Well 50-613185 (stainless steel)		
1	85	Qbt 3
2	145	Qbt 2
3	205	Qbt 1v
4	235	Qbt 1vc
5	280	Qbt 1g
6	350	Qct
7	450	Qbo
8	600	Qbo
9	675	Qbog
10	688	Tt

Table 3.3-2
Samples Collected in and Analyses Requested for Vapor-Monitoring Wells, First Quarter FY2011

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-10-27179	50-24784	25–25	11-533	11-534
MD50-10-27176	50-24784	96–96	11-533	11-534
MD50-10-27175	50-24784	155–155	11-533	11-534
MD50-10-27181	50-24784	215–215	11-533	11-534
MD50-10-27180	50-24784	244–244	11-533	11-534
MD50-10-27178	50-24784	289–289	11-543	11-544
MD50-10-27182	50-24784	362–362	11-533	11-534
MD50-10-27177	50-24784	411–411	11-607	11-606
MD50-10-27183	50-24784	450–450	11-587	11-586
MD50-10-27186	50-24813	25–25	11-993	11-992
MD50-10-27189	50-24813	99–99	11-1043	11-1042
MD50-10-27185	50-24813	150–150	11-993	11-992
MD50-10-27190	50-24813	207–207	11-1031	11-1030
MD50-10-27193	50-24813	241–241	11-1043	11-1042
MD50-10-27194	50-24813	241–241	11-1043	11-1042
MD50-10-27191	50-24813	286–286	11-1031	11-1030
MD50-10-27343	50-24813	358–358	11-1110	11-1111
MD50-10-27192	50-24813	408–408	11-1043	11-1042
MD50-10-27188	50-24813	450–450	11-1110	11-1111
MD50-10-27195	50-24813	600–600	11-1065	11-1064
MD50-10-27227	50-24822	25–25	11-319	11-318
MD50-10-27232	50-24822	81–81	11-319	11-318
MD50-10-27235	50-24822	142–142	11-501	11-500
MD50-10-27229	50-24822	204–204	11-319	11-318
MD50-10-27233	50-24822	235–235	11-501	11-500
MD50-10-27231	50-24822	280–280	11-319	11-318
MD50-10-27230	50-24822	351–351	11-364	11-352
MD50-10-27228	50-24822	450–450	11-319	11-318
MD50-10-27249	50-603061	25–25	11-635	11-634
MD50-10-27251	50-603061	76–76	11-661	11-662
MD50-10-27247	50-603061	128–128	11-635	11-634
MD50-10-27255	50-603061	190–190	11-661	11-662
MD50-10-27248	50-603061	228–228	11-635	11-634
MD50-10-27253	50-603061	274–274	11-635	11-634
MD50-10-27252	50-603061	347–347	11-661	11-662
MD50-10-27254	50-603061	397–397	11-635	11-634

Table 3.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-10-27250	50-603061	450–450	11-635	11-634
MD50-10-27262	50-603062	25–25	11-212	11-211
MD50-10-27265	50-603062	64–64	11-212	11-211
MD50-10-27257	50-603062	122–122	11-192	11-191
MD50-10-27263	50-603062	184–184	11-212	11-211
MD50-10-27260	50-603062	217–217	11-192	11-191
MD50-10-27264	50-603062	263–263	11-212	11-211
MD50-10-27259	50-603062	337–337	11-245	11-244
MD50-10-27261	50-603062	387–387	11-212	11-211
MD50-10-27258	50-603062	450–450	11-192	11-191
MD50-10-27267	50-603063	25–25	11-607	11-606
MD50-10-27272	50-603063	76–76	11-607	11-606
MD50-10-27275	50-603063	128–128	11-612	11-611
MD50-10-27268	50-603063	190–190	11-607	11-606
MD50-10-27273	50-603063	228–228	11-607	11-606
MD50-10-27269	50-603063	274–274	11-607	11-606
MD50-10-27274	50-603063	347–347	11-607	11-606
MD50-10-27271	50-603063	450–450	11-612	11-611
MD50-10-27280	50-603064	25–25	11-302	11-301
MD50-10-27285	50-603064	66–66	11-302	11-301
MD50-10-27279	50-603064	113–113	11-275	11-274
MD50-10-27283	50-603064	176–176	11-302	11-301
MD50-10-27277	50-603064	214–214	11-275	11-274
MD50-10-27281	50-603064	259–259	11-302	11-301
MD50-10-27278	50-603064	332–332	11-302	11-301
MD50-10-27282	50-603064	400–400	11-302	11-301
MD50-10-27284	50-603064	500–500	11-302	11-301
MD50-10-27199	50-603383	26–26	11-516	11-515
MD50-10-27197	50-603383	85–85	11-516	11-515
MD50-10-27205	50-603383	139–139	11-566	11-565
MD50-10-27204	50-603383	206–206	11-566	11-565
MD50-10-27203	50-603383	244–244	11-566	11-565
MD50-10-27201	50-603383	286–286	11-516	11-515
MD50-10-27202	50-603383	359–359	11-566	11-565
MD50-10-27200	50-603383	408–408	11-516	11-515
MD50-10-27196	50-603383	450–450	11-566	—*
MD50-10-27214	50-603467	26–26	11-261	11-260
MD50-10-27210	50-603467	91–91	11-261	11-260
MD50-10-27211	50-603467	143–143	11-261	11-260

Table 3.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-10-27215	50-603467	206–206	11-261	11-260
MD50-10-27207	50-603467	244–244	11-261	11-260
MD50-10-27213	50-603467	287–287	11-261	11-260
MD50-10-27212	50-603467	360–360	11-275	11-274
MD50-10-27208	50-603467	409–409	11-275	11-274
MD50-10-27206	50-603467	500–500	11-261	11-260
MD50-10-27209	50-603467	600–600	11-275	11-274
MD50-10-27220	50-603468	92–92	11-946	11-945
MD50-10-27217	50-603468	142–142	11-935	11-934
MD50-10-27218	50-603468	198–198	11-935	11-934
MD50-10-27219	50-603468	233–233	11-946	11-945
MD50-10-27226	50-603468	282–282	11-935	11-934
MD50-10-27223	50-603468	354–354	11-946	11-945
MD50-10-27221	50-603468	403–403	11-935	11-934
MD50-10-27222	50-603468	450–450	11-935	11-934
MD50-10-27145	50-603470	30–30	11-790	11-791
MD50-10-27149	50-603470	83–83	11-862	11-861
MD50-10-27144	50-603470	143–143	11-790	11-791
MD50-10-27151	50-603470	203–203	11-862	11-861
MD50-10-27147	50-603470	233–233	11-790	11-791
MD50-10-27153	50-603470	278–278	11-862	11-861
MD50-10-27146	50-603470	351–351	11-790	11-791
MD50-10-27152	50-603470	450–450	11-862	11-861
MD50-10-27148	50-603470	600–600	11-862	11-861
MD50-10-27115	50-603470	650–650	11-1065	11-1064
MD50-10-27158	50-603471	30–30	11-792	11-793
MD50-10-27155	50-603471	90–90	11-678	11-679
MD50-10-27157	50-603471	146–146	11-711	11-710
MD50-10-27162	50-603471	209–209	11-711	11-710
MD50-10-27161	50-603471	242–242	11-792	11-793
MD50-10-27160	50-603471	288–288	11-792	11-793
MD50-10-27156	50-603471	360–360	11-792	11-793
MD50-10-27163	50-603471	410–410	11-792	11-793
MD50-10-27159	50-603471	450–450	11-792	11-793
MD50-10-27165	50-603472	27–27	11-1008	11-1007
MD50-10-27168	50-603472	93–93	11-1008	11-1007
MD50-10-27170	50-603472	146–146	11-1011	11-1012
MD50-10-27172	50-603472	210–210	11-1019	11-1018
MD50-10-27166	50-603472	247–247	11-1008	11-1007

Table 3.3-2 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-10-27174	50-603472	292–292	11-1019	11-1018
MD50-10-27169	50-603472	364–364	11-1008	11-1007
MD50-10-27167	50-603472	414–414	11-1011	11-1012
MD50-10-27173	50-603472	450–450	11-1019	11-1018
MD50-10-27243	50-603503	25–25	11-245	11-244
MD50-10-27237	50-603503	80–80	11-245	11-244
MD50-10-27244	50-603503	133–133	11-245	11-244
MD50-10-27238	50-603503	198–198	11-245	11-244
MD50-10-27245	50-603503	237–237	11-245	11-244
MD50-10-27239	50-603503	278–278	11-245	11-244
MD50-10-27241	50-603503	347–347	11-245	11-244
MD50-10-27240	50-603503	397–397	11-245	11-244
MD50-10-27242	50-603503	450–450	11-245	11-244

* — = Analysis not requested.

Table 3.3-3
Samples Collected in and Analyses Requested
for Vapor-Monitoring Wells, Second Quarter FY2011

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-4012	50-24784	25–25	11-1357	11-1356
MD50-11-4010	50-24784	96–96	11-1357	11-1356
MD50-11-4009	50-24784	155–155	11-1357	11-1356
MD50-11-4006	50-24784	215–215	11-1357	11-1356
MD50-11-4004	50-24784	244–244	11-1341	11-1340
MD50-11-4008	50-24784	289–289	11-1341	11-1340
MD50-11-4007	50-24784	362–362	11-1357	11-1356
MD50-11-4005	50-24784	411–411	11-1341	11-1340
MD50-11-4003	50-24784	450–450	11-1341	11-1340
MD50-11-4023	50-24813	25–25	11-1411	11-1410
MD50-11-4021	50-24813	99–99	11-1408	11-1407
MD50-11-4020	50-24813	150–150	11-1408	—*
MD50-11-4095	50-24813	150–150	—	11-1623
MD50-11-4019	50-24813	207–207	11-1372	11-1371
MD50-11-4018	50-24813	241–241	11-1372	11-1371
MD50-11-4017	50-24813	286–286	11-1408	11-1407
MD50-11-4014	50-24813	358–358	11-1372	11-1371
MD50-11-4013	50-24813	408–408	11-1408	11-1407
MD50-11-4015	50-24813	450–450	11-1408	11-1407

Table 3.3-3 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-4016	50-24813	600–600	11-1408	11-1407
MD50-11-4058	50-24822	25–25	11-1223	11-1224
MD50-11-4059	50-24822	81–81	11-1250	—
MD50-11-4057	50-24822	142–142	11-1223	11-1224
MD50-11-4055	50-24822	204–204	11-1209	11-1208
MD50-11-4060	50-24822	235–235	11-1250	11-1249
MD50-11-4061	50-24822	280–280	11-1223	11-1224
MD50-11-4056	50-24822	351–351	11-1209	11-1208
MD50-11-4062	50-24822	402–402	11-1250	—
MD50-11-4064	50-24822	450–450	11-1250	—
MD50-11-4080	50-603061	25–25	11-1535	11-1536
MD50-11-4081	50-603061	76–76	11-1535	11-1536
MD50-11-4083	50-603061	128–128	11-1535	11-1536
MD50-11-4082	50-603061	190–190	11-1535	11-1536
MD50-11-4084	50-603061	228–228	11-1535	11-1536
MD50-11-4076	50-603061	274–274	11-1530	11-1529
MD50-11-4077	50-603061	347–347	11-1530	11-1529
MD50-11-4078	50-603061	397–397	11-1530	11-1529
MD50-11-4079	50-603061	450–450	11-1535	11-1536
MD50-11-4092	50-603062	25–25	11-1265	11-1264
MD50-11-4091	50-603062	64–64	11-1265	11-1264
MD50-11-4093	50-603062	122–122	11-1265	11-1264
MD50-11-4090	50-603062	184–184	11-1265	11-1264
MD50-11-4089	50-603062	217–217	11-1259	11-1258
MD50-11-4087	50-603062	263–263	11-1259	11-1258
MD50-11-4086	50-603062	337–337	11-1259	11-1258
MD50-11-4088	50-603062	387–387	11-1265	11-1264
MD50-11-4085	50-603062	450–450	11-1265	11-1264
MD50-11-4103	50-603063	25–25	11-1665	11-1664
MD50-11-4102	50-603063	76–76	11-1665	11-1664
MD50-11-4101	50-603063	128–128	11-1665	11-1664
MD50-11-4100	50-603063	190–190	11-1665	11-1664
MD50-11-4099	50-603063	228–228	11-1665	11-1664
MD50-11-4098	50-603063	274–274	11-1648	11-1647
MD50-11-4096	50-603063	347–347	11-1648	11-1647
MD50-11-4104	50-603063	397–397	11-1665	11-1664
MD50-11-4097	50-603063	450–450	11-1648	11-1647

Table 3.3-3 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-4113	50-603064	25–25	11-1600	11-1599
MD50-11-4112	50-603064	66–66	11-1600	11-1599
MD50-11-4111	50-603064	113–113	11-1600	11-1599
MD50-11-4109	50-603064	176–176	11-1600	11-1599
MD50-11-4110	50-603064	214–214	11-1600	11-1599
MD50-11-4105	50-603064	259–259	11-1559	11-1558
MD50-11-4106	50-603064	332–332	11-1559	11-1558
MD50-11-4107	50-603064	400–400	11-1559	11-1558
MD50-11-4108	50-603064	500–500	11-1559	11-1558
MD50-11-4024	50-603383	26–26	11-1408	11-1407
MD50-11-4029	50-603383	85–85	11-1427	11-1426
MD50-11-4025	50-603383	139–139	11-1411	11-1410
MD50-11-4030	50-603383	206–206	11-1411	11-1410
MD50-11-4026	50-603383	244–244	11-1408	11-1407
MD50-11-4031	50-603383	286–286	11-1427	11-1426
MD50-11-4027	50-603383	359–359	11-1411	11-1410
MD50-11-4032	50-603383	408–408	11-1411	11-1410
MD50-11-4028	50-603383	450–450	11-1427	11-1426
MD50-11-4038	50-603467	91–91	11-1452	11-1451
MD50-11-4034	50-603467	26–26	11-1427	11-1426
MD50-11-4035	50-603467	143–143	11-1427	11-1426
MD50-11-4039	50-603467	206–206	11-1452	11-1451
MD50-11-4036	50-603467	244–244	11-1427	11-1426
MD50-11-4042	50-603467	287–287	11-1452	11-1451
MD50-11-4037	50-603467	360–360	11-1452	11-1451
MD50-11-4040	50-603467	409–409	11-1452	11-1451
MD50-11-4043	50-603467	500–500	11-1452	11-1451
MD50-11-4041	50-603467	600–600	11-1452	11-1451
MD50-11-4047	50-603468	92–92	11-1468	11-1467
MD50-11-4046	50-603468	142–142	11-1468	11-1467
MD50-11-4045	50-603468	198–198	11-1490	11-1489
MD50-11-4054	50-603468	233–233	11-1468	11-1467
MD50-11-4050	50-603468	282–282	11-1490	11-1489
MD50-11-4051	50-603468	354–354	11-1490	11-1489
MD50-11-4052	50-603468	403–403	11-1490	11-1489
MD50-11-4053	50-603468	450–450	11-1490	11-1489
MD50-11-3980	50-603470	83–83	11-1322	11-1321
MD50-11-3975	50-603470	143–143	11-1302	11-1301

Table 3.3-3 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-3973	50-603470	203–203	11-1302	11-1301
MD50-11-3972	50-603470	233–233	11-1322	11-1321
MD50-11-3974	50-603470	278–278	11-1302	11-1301
MD50-11-3979	50-603470	351–351	11-1306	11-1305
MD50-11-3978	50-603470	450–450	11-1306	11-1305
MD50-11-3977	50-603470	600–600	11-1306	11-1305
MD50-11-3976	50-603470	650–650	11-1322	11-1321
MD50-11-3992	50-603471	90–90	11-1341	11-1340
MD50-11-3990	50-603471	146–146	11-1336	11-1335
MD50-11-3988	50-603471	209–209	11-1341	11-1340
MD50-11-3989	50-603471	242–242	11-1336	11-1335
MD50-11-3987	50-603471	288–288	11-1336	11-1335
MD50-11-3986	50-603471	360–360	11-1336	11-1335
MD50-11-3984	50-603471	410–410	11-1322	11-1321
MD50-11-3985	50-603471	450–450	11-1336	11-1335
MD50-11-4002	50-603472	27–27	11-1341	11-1340
MD50-11-4000	50-603472	93–93	11-1341	11-1340
MD50-11-4001	50-603472	146–146	11-1341	11-1340
MD50-11-3998	50-603472	210–210	11-1341	11-1340
MD50-11-3999	50-603472	247–247	11-1341	11-1340
MD50-11-3996	50-603472	292–292	11-1341	—
MD50-11-3993	50-603472	364–364	11-1341	11-1340
MD50-11-3994	50-603472	414–414	11-1341	11-1340
MD50-11-3995	50-603472	450–450	11-1341	11-1340
MD50-11-4071	50-603503	25–25	11-1510	11-1509
MD50-11-4072	50-603503	80–80	11-1510	11-1509
MD50-11-4069	50-603503	133–133	11-1510	11-1509
MD50-11-4073	50-603503	198–198	11-1510	11-1509
MD50-11-4070	50-603503	237–237	11-1510	11-1509
MD50-11-4067	50-603503	278–278	11-1494	11-1493
MD50-11-4066	50-603503	347–347	11-1494	11-1493
MD50-11-4068	50-603503	397–397	11-1494	11-1493
MD50-11-4065	50-603503	450–450	11-1494	11-1493
MD50-11-3944	50-613182	500–500	11-1163	—
MD50-11-3943	50-613182	550–550	11-1132	11-1131
MD50-11-3942	50-613182	600–600	11-1132	11-1131
MD50-11-3945	50-613182	620–620	11-1145	—
MD50-11-3953	50-613182	620–620	—	11-1451

Table 3.3-3 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-3941	50-613182	632.5–632.5	11-1132	11-1131
MD50-11-3947	50-613183	30–30	11-1452	11-1451
MD50-11-3948	50-613183	500–500	11-1490	11-1489
MD50-11-3949	50-613183	550–550	11-1468	11-1467
MD50-11-3950	50-613183	600–600	11-1452	11-1451
MD50-11-3951	50-613183	630–630	11-1490	11-1489
MD50-11-3952	50-613183	642.5–642.5	11-1452	11-1451
MD50-11-3959	50-613184	30–30	11-1613	11-1612
MD50-11-3956	50-613184	500–500	11-1613	11-1612
MD50-11-3958	50-613184	550–550	11-1613	11-1612
MD50-11-3954	50-613184	600–600	11-1613	11-1612
MD50-11-3957	50-613184	652–652	11-1613	11-1612
MD50-11-3955	50-613184	664.5–664.5	11-1613	11-1612
MD50-11-3961	50-613185	85–85	11-1163	—
MD50-11-3962	50-613185	145–145	11-1250	11-1249
MD50-11-3963	50-613185	205–205	11-1145	11-1144
MD50-11-3964	50-613185	235–235	11-1145	11-1144
MD50-11-3965	50-613185	280–280	11-1169	11-1168
MD50-11-3966	50-613185	350–350	11-1169	11-1168
MD50-11-3967	50-613185	450–450	11-1196	11-1195
MD50-11-3969	50-613185	600–600	11-1196	11-1195
MD50-11-3968	50-613185	675–675	11-1171	11-1170
MD50-11-3970	50-613185	688–688	11-1196	11-1195

* — = Analysis not requested.

Table 3.3-4
Samples Collected in and Analyses Requested for
Vapor-Monitoring Wells, Third Quarter FY2011

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-6010	50-24784	25–25	11-2105	11-2106
MD50-11-6007	50-24784	96–96	11-2105	11-2106
MD50-11-6011	50-24784	155–155	11-2105	11-2106
MD50-11-6005	50-24784	215–215	11-2081	11-2080
MD50-11-6009	50-24784	244–244	11-2105	11-2106
MD50-11-6006	50-24784	289–289	11-2081	11-2080
MD50-11-6008	50-24784	362–362	11-2105	11-2106
MD50-11-6004	50-24784	411–411	11-2081	11-2080
MD50-11-6003	50-24784	450–450	11-2081	11-2080
MD50-11-6022	50-24813	25–25	11-2174	11-2173
MD50-11-6021	50-24813	99–99	11-2174	11-2173
MD50-11-6019	50-24813	150–150	11-2174	11-2173
MD50-11-6020	50-24813	207–207	11-2174	11-2173
MD50-11-6018	50-24813	241–241	11-2174	11-2173
MD50-11-6017	50-24813	286–286	11-2164	11-2163
MD50-11-6013	50-24813	358–358	11-2164	11-2163
MD50-11-6015	50-24813	408–408	11-2164	11-2163
MD50-11-6016	50-24813	450–450	11-2164	11-2163
MD50-11-6014	50-24813	600–600	11-2164	11-2163
MD50-11-6062	50-24822	25–25	11-1855	11-1854
MD50-11-6059	50-24822	81–81	11-1855	11-1854
MD50-11-6061	50-24822	142–142	11-1855	11-1854
MD50-11-6058	50-24822	204–204	11-1834	11-1833
MD50-11-6060	50-24822	235–235	11-1855	11-1854
MD50-11-6055	50-24822	280–280	11-1834	11-1833
MD50-11-6056	50-24822	351–351	11-1834	11-1833
MD50-11-6063	50-24822	402–402	11-1855	11-1854
MD50-11-6057	50-24822	450–450	11-1834	11-1833
MD50-11-6083	50-603061	25–25	11-2060	11-2059
MD50-11-6080	50-603061	76–76	11-2060	11-2059
MD50-11-6079	50-603061	128–128	11-2060	11-2059
MD50-11-6078	50-603061	190–190	11-2036	11-2035
MD50-11-6081	50-603061	228–228	11-2060	11-2059
MD50-11-6077	50-603061	274–274	11-2036	11-2035
MD50-11-6082	50-603061	347–347	11-2060	11-2059
MD50-11-6076	50-603061	397–397	11-2036	11-2035

Table 3.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-6075	50-603061	450–450	11-2036	11-2035
MD50-11-6088	50-603062	25–25	11-1896	11-1895
MD50-11-6085	50-603062	64–64	11-1942	11-1941
MD50-11-6087	50-603062	122–122	11-1896	11-1895
MD50-11-6092	50-603062	184–184	11-1942	11-1941
MD50-11-6086	50-603062	217–217	11-1896	11-1895
MD50-11-6090	50-603062	263–263	11-1942	11-1941
MD50-11-6094	50-603062	337–337	11-1921	11-1920
MD50-11-6091	50-603062	387–387	11-1942	11-1941
MD50-11-6089	50-603062	450–450	11-1942	11-1941
MD50-11-6102	50-603063	25–25	11-2014	11-2013
MD50-11-6100	50-603063	76–76	11-2014	11-2013
MD50-11-6099	50-603063	128–128	11-2014	11-2013
MD50-11-6097	50-603063	190–190	11-1989	11-1988
MD50-11-6098	50-603063	228–228	11-1989	11-1988
MD50-11-6103	50-603063	274–274	11-2014	11-2013
MD50-11-6095	50-603063	347–347	11-1989	11-1988
MD50-11-6101	50-603063	397–397	11-2014	11-2013
MD50-11-6096	50-603063	450–450	11-1989	11-1988
MD50-11-6108	50-603064	25–25	11-2239	11-2238
MD50-11-6107	50-603064	66–66	11-2239	11-2238
MD50-11-6105	50-603064	113–113	11-2239	11-2238
MD50-11-6110	50-603064	176–176	11-2255	11-2254
MD50-11-6111	50-603064	214–214	11-2255	11-2254
MD50-11-6112	50-603064	259–259	11-2255	11-2254
MD50-11-6113	50-603064	332–332	11-2255	11-2254
MD50-11-6109	50-603064	482–482	11-2255	11-2254
MD50-11-6106	50-603064	500–500	11-2252	11-2251
MD50-11-6027	50-603383	26–26	11-1989	11-1988
MD50-11-6025	50-603383	85–85	11-1989	11-1988
MD50-11-6024	50-603383	139–139	11-1989	11-1988
MD50-11-6032	50-603383	206–206	11-1989	11-1988
MD50-11-6026	50-603383	244–244	11-1989	11-1988
MD50-11-6029	50-603383	286–286	11-1989	11-1988
MD50-11-6028	50-603383	359–359	11-1989	11-1988
MD50-11-6030	50-603383	408–408	11-1989	11-1988
MD50-11-6031	50-603383	450–450	11-1989	11-1988
MD50-11-6041	50-603467	26–26	11-1981	11-1980

Table 3.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-6043	50-603467	91–91	11-1981	11-1980
MD50-11-6038	50-603467	143–143	11-1981	11-1980
MD50-11-6042	50-603467	206–206	11-1981	11-1980
MD50-11-6037	50-603467	244–244	11-1981	11-1980
MD50-11-6039	50-603467	287–287	11-1981	11-1980
MD50-11-6040	50-603467	360–360	11-1981	11-1980
MD50-11-6036	50-603467	409–409	11-1958	11-1957
MD50-11-6035	50-603467	500–500	11-1958	11-1957
MD50-11-6034	50-603467	600–600	11-1958	11-1957
MD50-11-6051	50-603468	92–92	11-1921	11-1920
MD50-11-6050	50-603468	142–142	11-1921	11-1920
MD50-11-6052	50-603468	198–198	11-1921	11-1920
MD50-11-6049	50-603468	233–233	11-1921	11-1920
MD50-11-6047	50-603468	282–282	11-1896	11-1895
MD50-11-6046	50-603468	354–354	11-1896	11-1895
MD50-11-6045	50-603468	403–403	11-1896	11-1895
MD50-11-6048	50-603468	450–450	11-1896	11-1895
MD50-11-5978	50-603470	30–30	11-2239	11-2238
MD50-11-5980	50-603470	83–83	11-2239	11-2238
MD50-11-5982	50-603470	143–143	11-2239	11-2238
MD50-11-5977	50-603470	203–203	11-2239	11-2238
MD50-11-5976	50-603470	233–233	11-2221	11-2220
MD50-11-5979	50-603470	278–278	11-2239	11-2238
MD50-11-5973	50-603470	351–351	11-2221	11-2220
MD50-11-5972	50-603470	450–450	11-2221	11-2220
MD50-11-5975	50-603470	600–600	11-2221	11-2220
MD50-11-5974	50-603470	650–650	11-2221	11-2220
MD50-11-5990	50-603471	90–90	11-2164	11-2163
MD50-11-5989	50-603471	146–146	11-2164	11-2163
MD50-11-5988	50-603471	209–209	11-2164	11-2163
MD50-11-5987	50-603471	242–242	11-2164	11-2163
MD50-11-6156	50-603471	288–288	11-2164	11-2163
MD50-11-5986	50-603471	360–360	11-2164	11-2163
MD50-11-5983	50-603471	410–410	11-2164	11-2163
MD50-11-5985	50-603471	450–450	11-2164	11-2163
MD50-11-6000	50-603472	27–27	11-2127	11-2126
MD50-11-5998	50-603472	93–93	11-2124	11-2125
MD50-11-6001	50-603472	146–146	11-2127	11-2126

Table 3.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-5997	50-603472	210–210	11-2124	11-2125
MD50-11-5999	50-603472	247–247	11-2124	11-2125
MD50-11-5995	50-603472	292–292	11-2124	11-2125
MD50-11-5994	50-603472	364–364	11-2124	11-2125
MD50-11-5993	50-603472	414–414	11-2124	11-2125
MD50-11-5996	50-603472	450–450	11-2124	11-2125
MD50-11-6072	50-603503	25–25	11-1885	11-1884
MD50-11-5992	50-603503	80–80	—*	11-2163
MD50-11-6071	50-603503	80–80	11-1885	—
MD50-11-6073	50-603503	133–133	11-1885	11-1884
MD50-11-6069	50-603503	198–198	11-1885	11-1884
MD50-11-6068	50-603503	237–237	11-1885	11-1884
MD50-11-6070	50-603503	278–278	11-1885	11-1884
MD50-11-6065	50-603503	347–347	11-1885	11-1884
MD50-11-6066	50-603503	397–397	11-1885	11-1884
MD50-11-6067	50-603503	450–450	11-1885	11-1884
MD50-11-5933	50-613182	500-500	11-1756	11-1757
MD50-11-5934	50-613182	550-550	11-1756	11-1757
MD50-11-5936	50-613182	600-600	11-1756	11-1757
MD50-11-5937	50-613182	620-620	11-1756	11-1757
MD50-11-5935	50-613182	632.5-632.5	11-1756	11-1757
MD50-11-5942	50-613183	30-30	11-1788	11-1787
MD50-11-5939	50-613183	500-500	11-1788	11-1787
MD50-11-5943	50-613183	550-550	11-1788	11-1787
MD50-11-5941	50-613183	600-600	11-1802	11-1801
MD50-11-5944	50-613183	630-630	11-1788	11-1787
MD50-11-5940	50-613183	642.5-642.5	11-1788	11-1787
MD50-11-5948	50-613184	30-30	11-1682	11-1683
MD50-11-5951	50-613184	500-500	11-1682	11-1683
MD50-11-5946	50-613184	550-550	11-1682	11-1683
MD50-11-5947	50-613184	600-600	11-1682	11-1683
MD50-11-5950	50-613184	652-652	11-1682	11-1683
MD50-11-5949	50-613184	664.5-664.5	11-1682	11-1683
MD50-11-5960	50-613185	85-85	11-1732	11-1733
MD50-11-5961	50-613185	145-145	11-1732	11-1733
MD50-11-5957	50-613185	205-205	11-1732	11-1733
MD50-11-5962	50-613185	235-235	11-1732	11-1733
MD50-11-5959	50-613185	280-280	11-1732	11-1733

Table 3.3-4 (continued)

Sample ID	Location ID	Depth (ft)	Tritium	VOC
MD50-11-5955	50-613185	350-350	11-1709	11-1708
MD50-11-5954	50-613185	450-450	11-1709	11-1708
MD50-11-5953	50-613185	600-600	11-1709	11-1708
MD50-11-5958	50-613185	675-675	11-1732	11-1733
MD50-11-5956	50-613185	688-688	11-1709	11-1708

* — = Analysis not requested.

Table 3.3-5
Samples Collected in and Analyses Requested for Tschicoma Formation Dacite

Sample ID	Location ID	Depth (ft)	Media	Metals
RE50-11-4142	50-613184	654–654.2	TT	11-1114
RE50-11-4143	50-613184	675.8–676	TT	11-1114
RE50-11-4144	50-613185	677.5–677.7	TT	11-1114
RE50-11-4145	50-613185	697.3–697.5	TT	11-1114

Table 6.1-1
Inorganic Chemicals Detected in Tschicoma Formation Dacite at Borehole Locations 50-613184 and 50-613185

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Nickel	Potassium	Sodium	Thallium	Vanadium	Zinc
RE50-11-4142	50-613184	654–654.2	TT	956	—*	—	15.6 (J)	0.0327 (J)	0.121 (J)	2550	—	1.85	4.19	5340	—	217 (J+)	42.9	1.88 (J)	160 (J)	687 (J-)	—	24	7.35
RE50-11-4143	50-613184	675.8–676	TT	935	—	—	18.9 (J+)	0.0255 (J)	—	2890	—	1.43	2.11	4100	—	194 (J+)	33.4	1.51 (J)	129 (J)	865 (J-)	—	16.7	3.74
RE50-11-4144	50-613185	677.5–677.7	TT	2710	0.35 (J)	0.278 (J)	92.6 (J+)	0.516	0.417 (J)	5260	5.71 (J)	3.93	3.83	10400	9.26	1160 (J+)	118	7.2 (J)	872 (J-)	954 (J-)	0.0605 (J)	42.4	16.4
RE50-11-4145	50-613185	697.3–697.5	TT	2940	0.312 (J)	0.313 (J)	71.1 (J+)	0.255	0.248 (J)	18700	2.86 (J)	2.08	2.85	6430	6.91	9820 (J+)	79.5	5.01 (J)	393 (J)	602 (J-)	—	20.4	11.3

Notes: Results are in mg/kg. Data qualifiers are defined in Appendix A.
*— = Not detected.

Table 6.2-1
VOCs Detected in Vapor Samples in First Quarter FY2011

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene
MD50-10-27179	50-24784	25–25	—*	—	—	—	—	—	—	250	—	—	—	—	—	—	—
MD50-10-27176	50-24784	96–96	—	—	—	—	—	110 (J-)	—	470	—	74	—	—	—	45	—
MD50-10-27175	50-24784	155–155	—	—	—	—	—	190 (J-)	—	180	—	94	—	—	—	46	—
MD50-10-27181	50-24784	215–215	—	—	—	—	—	290 (J-)	—	85	—	120	—	—	—	—	—
MD50-10-27180	50-24784	244–244	—	—	—	—	—	290 (J-)	—	73	—	110	—	—	—	—	—
MD50-10-27178	50-24784	289–289	—	—	—	—	—	420	—	51	—	160	—	—	—	—	—
MD50-10-27182	50-24784	362–362	—	—	—	—	—	440 (J-)	—	—	—	170	—	—	—	—	—
MD50-10-27177	50-24784	411–411	—	—	—	—	—	460	—	—	—	180	—	—	—	—	—
MD50-10-27183	50-24784	450–450	—	—	—	—	—	330	—	—	—	130	—	—	—	—	—
MD50-10-27186	50-24813	25–25	—	—	—	—	—	2400 (J)	—	1300	—	400 (J)	—	—	—	—	—
MD50-10-27189	50-24813	99–99	—	—	—	—	—	1700	—	2300	—	—	—	—	360	—	—
MD50-10-27185	50-24813	150–150	—	—	—	—	—	1300 (J)	—	2200	—	650 (J)	—	—	460	—	—
MD50-10-27190	50-24813	207–207	—	—	—	—	—	23 (J)	—	20	—	21	—	—	—	—	—
MD50-10-27193	50-24813	241–241	—	—	—	—	—	280	—	350	—	—	—	—	—	—	—
MD50-10-27194	50-24813	241–241	—	—	—	—	—	190	—	260	—	170	—	—	—	—	—
MD50-10-27191	50-24813	286–286	—	—	—	—	—	49 (J)	—	54	—	27	—	—	9.8	—	—
MD50-10-27343	50-24813	358–358	8.1	—	—	—	11	—	—	—	—	1200	—	—	—	—	—
MD50-10-27192	50-24813	408–408	—	—	—	—	—	410	—	—	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene
MD50-10-27188	50-24813	450–450	—	77	—	—	—	—	—	—	—	130 (J-)	—	—	—	—	—
MD50-10-27195	50-24813	600–600	6.9	—	—	3.2	—	2.4	—	—	—	3.2	—	0.82	0.8	—	—
MD50-10-27227	50-24822	25–25	—	—	—	—	—	—	—	200	—	120	—	—	—	—	—
MD50-10-27232	50-24822	81–81	—	—	—	—	—	—	—	320	—	180	—	—	—	—	—
MD50-10-27235	50-24822	142–142	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-10-27229	50-24822	204–204	—	—	—	—	—	—	—	400	—	470	—	—	—	—	—
MD50-10-27233	50-24822	235–235	—	—	—	—	—	—	—	390	—	—	—	—	—	—	—
MD50-10-27231	50-24822	280–280	—	—	—	—	—	—	—	290	—	540	—	—	—	—	—
MD50-10-27230	50-24822	351–351	—	—	—	—	—	—	—	—	—	280	—	—	—	—	—
MD50-10-27228	50-24822	450–450	—	—	—	—	—	—	—	—	—	300	—	—	—	—	—
MD50-10-27249	50-603061	25–25	—	—	—	—	—	—	—	—	—	580	—	180	—	—	—
MD50-10-27251	50-603061	76–76	—	—	—	—	—	—	—	—	—	380	—	700	—	—	—
MD50-10-27247	50-603061	128–128	—	—	—	—	—	—	—	—	—	—	—	1400	—	—	—
MD50-10-27255	50-603061	190–190	—	—	—	—	—	—	—	—	—	—	—	1600	—	—	—
MD50-10-27248	50-603061	228–228	—	—	—	—	—	—	—	—	—	—	—	950	—	—	—
MD50-10-27253	50-603061	274–274	—	—	—	—	—	—	—	—	—	—	—	470	—	—	—
MD50-10-27252	50-603061	347–347	—	—	—	—	—	110	—	—	—	150	—	170	—	—	—
MD50-10-27254	50-603061	397–397	—	—	—	—	—	85	—	—	—	150	—	96	—	—	—
MD50-10-27250	50-603061	450–450	15 (J)	1.6	—	2.9	15	50	—	2	—	100	1.5	34	—	—	—
MD50-10-27262	50-603062	25–25	—	—	—	—	—	—	—	26	—	45	—	—	—	—	—
MD50-10-27265	50-603062	64–64	—	—	—	—	—	—	—	49	—	50	—	—	—	—	—
MD50-10-27257	50-603062	122–122	—	—	—	—	—	51 (J)	—	72 (J)	—	140 (J)	—	—	—	—	—
MD50-10-27263	50-603062	184–184	—	—	—	—	—	59 (J)	—	50	—	160	—	—	—	—	—
MD50-10-27260	50-603062	217–217	—	18 (J)	—	—	—	65 (J)	—	44 (J)	—	160 (J)	—	7 (J)	11 (J)	—	—
MD50-10-27264	50-603062	263–263	—	—	—	—	—	140 (J)	—	52	—	360	—	—	—	—	—
MD50-10-27259	50-603062	337–337	—	—	—	—	—	—	—	—	—	120 (J-)	—	—	—	—	—
MD50-10-27261	50-603062	387–387	21	—	—	—	—	49 (J)	—	—	—	120	—	—	—	—	—
MD50-10-27258	50-603062	450–450	—	—	—	—	—	23	—	—	—	69 (J)	—	—	—	—	—
MD50-10-27267	50-603063	25–25	—	—	—	—	—	—	—	34	—	180	—	—	—	—	—
MD50-10-27272	50-603063	76–76	—	—	—	—	—	—	—	150	—	170	—	95	—	—	—
MD50-10-27275	50-603063	128–128	—	—	—	—	—	190 (J)	—	210	—	320	—	210	—	—	—
MD50-10-27268	50-603063	190–190	—	—	—	—	—	—	—	350	—	360	—	230	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene
MD50-10-27273	50-603063	228–228	—	—	—	—	—	—	—	340	—	370	—	210	—	—	790
MD50-10-27269	50-603063	274–274	—	—	—	—	—	—	—	320	—	—	—	—	—	—	—
MD50-10-27274	50-603063	347–347	—	—	—	—	—	—	—	120	—	170	—	—	—	—	—
MD50-10-27271	50-603063	450–450	—	—	—	—	—	230 (J)	—	110	—	—	—	—	—	—	—
MD50-10-27280	50-603064	25–25	—	—	—	—	—	—	—	200	—	—	—	74	—	—	—
MD50-10-27285	50-603064	66–66	—	—	—	—	—	—	—	400	—	130	—	210	58	—	—
MD50-10-27279	50-603064	113–113	—	—	—	—	—	—	—	740	—	—	—	490	—	—	—
MD50-10-27283	50-603064	176–176	—	—	—	—	—	—	—	570	—	530	—	520	—	—	—
MD50-10-27277	50-603064	214–214	—	—	—	—	—	—	—	470	—	520	—	450	—	—	—
MD50-10-27281	50-603064	259–259	—	—	—	—	—	—	—	—	—	460	—	280	—	—	—
MD50-10-27278	50-603064	332–332	—	—	—	—	—	140	—	—	—	—	—	97	—	—	—
MD50-10-27282	50-603064	400–400	—	—	—	—	—	120	—	—	—	310	—	—	—	—	—
MD50-10-27284	50-603064	500–500	—	—	—	—	—	87	—	—	—	240	—	—	—	—	—
MD50-10-27199	50-603383	26–26	—	—	—	—	—	27	—	24	—	65	—	—	—	16	—
MD50-10-27197	50-603383	85–85	—	—	—	—	—	65 (J-)	—	98	—	170	—	31	—	110	—
MD50-10-27205	50-603383	139–139	—	—	—	—	—	99	—	130	—	140	—	—	—	290	—
MD50-10-27204	50-603383	206–206	—	—	—	—	—	210	—	120	—	190	—	—	62	370	—
MD50-10-27203	50-603383	244–244	—	—	—	—	—	31	7.3	—	—	23	—	—	—	—	—
MD50-10-27201	50-603383	286–286	—	—	—	—	—	150 (J-)	—	39	—	100	—	—	—	140	—
MD50-10-27202	50-603383	359–359	—	—	—	—	—	130	—	60	—	100	—	—	—	220	—
MD50-10-27200	50-603383	408–408	—	—	—	—	—	190	—	—	—	100	—	—	—	—	—
MD50-10-27214	50-603467	26–26	—	—	—	—	—	—	—	550	—	220 (J)	—	—	91	—	—
MD50-10-27210	50-603467	91–91	—	—	—	—	—	—	—	410	—	170 (J)	—	—	72	—	—
MD50-10-27211	50-603467	143–143	—	—	—	—	—	180 (J-)	—	750	—	370 (J)	—	—	180	—	—
MD50-10-27215	50-603467	206–206	—	—	—	—	—	—	—	570	—	430 (J)	—	—	170	—	—
MD50-10-27207	50-603467	244–244	—	—	—	—	—	—	—	680	—	420 (J)	—	—	—	—	—
MD50-10-27213	50-603467	287–287	—	—	—	—	—	—	—	430	—	340 (J)	—	—	—	—	—
MD50-10-27212	50-603467	360–360	—	—	—	—	—	430	—	260	—	—	—	—	—	—	—
MD50-10-27208	50-603467	409–409	—	—	—	—	—	290	—	—	—	—	—	—	—	—	—
MD50-10-27206	50-603467	500–500	—	—	—	—	—	—	—	—	—	210 (J)	—	—	—	—	—
MD50-10-27209	50-603467	600–600	83	—	—	120	—	150	—	—	—	—	—	—	—	—	—
MD50-10-27220	50-603468	92–92	—	—	—	—	—	—	—	300	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene
MD50-10-27217	50-603468	142–142	—	—	—	—	—	—	—	180	—	—	—	—	58	—	—
MD50-10-27218	50-603468	198–198	—	—	—	—	—	—	—	510	—	350 (J)	—	—	—	—	—
MD50-10-27219	50-603468	233–233	—	—	—	—	—	—	—	510	—	430 (J)	—	—	190	—	—
MD50-10-27226	50-603468	282–282	—	—	—	—	—	—	—	430	—	410 (J)	—	—	180	—	—
MD50-10-27223	50-603468	354–354	—	—	—	—	—	—	—	270	—	400 (J)	—	—	—	—	—
MD50-10-27221	50-603468	403–403	—	—	—	—	—	—	—	210	—	520 (J)	—	—	—	—	—
MD50-10-27222	50-603468	450–450	—	—	—	—	—	—	—	—	—	280 (J)	—	—	—	—	—
MD50-10-27145	50-603470	30–30	—	—	—	—	—	180 (J)	—	800	—	300	—	—	—	—	—
MD50-10-27149	50-603470	83–83	—	—	—	—	—	—	—	990	—	330	—	—	190	—	—
MD50-10-27144	50-603470	143–143	—	—	—	—	—	—	—	1400	—	—	—	—	270	—	—
MD50-10-27151	50-603470	203–203	—	—	—	—	—	—	—	200	—	130	—	—	54	—	—
MD50-10-27147	50-603470	233–233	—	—	—	—	—	—	—	1000	—	—	—	—	—	—	—
MD50-10-27153	50-603470	278–278	—	—	—	—	—	—	—	750	—	860	—	—	—	—	—
MD50-10-27146	50-603470	351–351	—	—	—	—	—	—	—	—	—	670	—	—	—	—	—
MD50-10-27152	50-603470	450–450	—	—	—	—	—	—	—	—	—	380	—	—	—	—	—
MD50-10-27148	50-603470	600–600	—	—	—	—	—	86 (J)	—	—	—	200	—	—	—	—	—
MD50-10-27115	50-603470	650–650	7.1	6.2	—	—	—	—	—	—	—	3.7	—	—	—	—	3.7
MD50-10-27158	50-603471	30–30	—	—	—	—	—	2600 (J)	—	1400	—	270 (J-)	—	—	140	—	—
MD50-10-27155	50-603471	90–90	—	—	—	—	—	2300 (J)	—	1900	—	—	—	—	270	—	—
MD50-10-27157	50-603471	146–146	—	—	—	—	—	110	—	160	—	58	—	—	30	—	—
MD50-10-27162	50-603471	209–209	—	—	—	—	—	—	—	630	—	—	—	—	—	—	—
MD50-10-27161	50-603471	242–242	—	—	—	—	—	1700 (J)	—	1600	—	760 (J-)	—	—	360	—	—
MD50-10-27160	50-603471	288–288	—	—	—	—	—	1100 (J)	—	1300	—	—	—	—	420	—	—
MD50-10-27156	50-603471	360–360	—	—	—	—	—	700 (J)	—	370	—	460 (J-)	—	—	—	—	—
MD50-10-27163	50-603471	410–410	—	—	—	—	—	420 (J)	—	300	—	400 (J-)	—	—	—	—	—
MD50-10-27159	50-603471	450–450	—	—	—	—	—	320 (J)	—	200	—	—	—	—	—	—	—
MD50-10-27165	50-603472	27–27	—	—	—	—	—	—	—	390	—	—	—	—	27	39	—
MD50-10-27168	50-603472	93–93	8.5	23	—	—	—	—	—	—	—	2	—	—	—	—	20
MD50-10-27170	50-603472	146–146	22	11	—	—	33	—	—	1.5	3 (J+)	2.4	—	—	—	—	11
MD50-10-27172	50-603472	210–210	—	9.2	24	—	—	—	—	—	—	—	—	—	—	—	—
MD50-10-27166	50-603472	247–247	—	—	—	—	—	—	—	220	—	—	—	—	62	—	—
MD50-10-27174	50-603472	292–292	—	—	—	—	—	—	—	7.2	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Chloromethane	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene
MD50-10-27169	50-603472	364–364	—	48	—	—	—	38 (J)	—	18	—	33	—	—	—	—	—
MD50-10-27167	50-603472	414–414	35	22	—	—	—	—	—	—	—	2.4	—	—	—	—	23
MD50-10-27173	50-603472	450–450	—	—	—	—	—	2.7 (J)	—	—	—	4.6	—	—	—	—	—
MD50-10-27243	50-603503	25–25	—	—	—	—	—	—	—	52	—	—	—	—	—	—	—
MD50-10-27237	50-603503	80–80	75	—	—	55	—	99	—	160	—	46	—	—	18	33	—
MD50-10-27244	50-603503	133–133	—	—	—	—	—	59	—	98	—	—	—	—	—	24	—
MD50-10-27238	50-603503	198–198	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—
MD50-10-27245	50-603503	237–237	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-10-27239	50-603503	278–278	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-10-27241	50-603503	347–347	—	—	—	—	—	24	—	43	—	—	—	—	—	—	—
MD50-10-27240	50-603503	397–397	40	100	—	—	—	21	—	24	—	12	—	—	—	4.2	7.5
MD50-10-27242	50-603503	450–450	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Ethyltoluene[4-]	Hexanone[2-]	Methylene Chloride	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Vinyl Chloride	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-10-27179	50-24784	25–25	—	—	—	2300	—	—	62	990	—	—	—	—	—	—	—
MD50-10-27176	50-24784	96–96	—	—	—	3000	—	130	70	2800	—	—	—	—	—	—	—
MD50-10-27175	50-24784	155–155	42	—	23	1600	—	130	57	3700	—	—	—	—	31	31	—
MD50-10-27181	50-24784	215–215	—	—	37	2800	—	110	55	5400	—	—	—	—	—	—	—
MD50-10-27180	50-24784	244–244	—	—	37	2600	—	96	—	5100	—	—	—	—	—	—	—
MD50-10-27178	50-24784	289–289	—	—	41	2400	—	94	—	4800	—	—	—	—	—	—	—
MD50-10-27182	50-24784	362–362	—	—	—	1500	—	45	—	3000	—	—	—	—	—	—	—
MD50-10-27177	50-24784	411–411	—	—	—	870	—	—	—	2100	—	—	—	—	—	—	—
MD50-10-27183	50-24784	450–450	—	—	—	520	—	—	—	1200	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Ethyltoluene[4-]	Hexanone[2-]	Methylene Chloride	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Vinyl Chloride	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-10-27186	50-24813	25–25	—	—	—	500	—	—	—	13000	—	—	—	—	—	—	—
MD50-10-27189	50-24813	99–99	—	—	—	—	—	—	—	26000	—	—	—	—	—	—	—
MD50-10-27185	50-24813	150–150	—	—	600 (J)	560	—	—	—	31000	—	—	—	—	—	—	—
MD50-10-27190	50-24813	207–207	—	—	12	—	—	—	—	1200	—	—	—	—	—	—	—
MD50-10-27193	50-24813	241–241	—	—	330	—	—	—	—	15000	—	—	—	—	—	—	—
MD50-10-27194	50-24813	241–241	—	—	250	—	—	—	—	10000	—	—	—	—	—	—	—
MD50-10-27191	50-24813	286–286	—	—	27	—	—	—	—	1300	—	—	—	—	—	—	—
MD50-10-27343	50-24813	358–358	—	—	32	—	4.6	—	—	120	33	—	—	1.1	—	—	—
MD50-10-27192	50-24813	408–408	—	—	330	—	—	—	—	32000	—	—	—	—	—	—	—
MD50-10-27188	50-24813	450–450	—	—	48 (J)	—	98	—	—	5300	—	—	—	—	—	—	—
MD50-10-27195	50-24813	600–600	—	—	—	—	1.4	—	—	12	—	—	—	—	—	—	—
MD50-10-27227	50-24822	25–25	—	—	—	—	—	—	—	7000	—	—	—	—	—	—	—
MD50-10-27232	50-24822	81–81	—	—	—	—	—	—	—	11000	—	—	—	—	—	—	—
MD50-10-27235	50-24822	142–142	—	—	220	—	110	—	—	9000	—	—	—	—	—	—	—
MD50-10-27229	50-24822	204–204	—	—	300	—	—	—	—	28000	—	—	—	—	—	—	—
MD50-10-27233	50-24822	235–235	—	—	350	—	—	—	—	32000	—	—	—	—	—	—	—
MD50-10-27231	50-24822	280–280	—	—	280	—	—	—	—	32000	—	—	—	—	—	—	—
MD50-10-27230	50-24822	351–351	—	—	91	—	—	—	—	14000	—	—	—	—	—	—	—
MD50-10-27228	50-24822	450–450	—	—	—	—	—	—	—	11000	—	—	—	—	—	—	—
MD50-10-27249	50-603061	25–25	—	—	—	—	—	11000	1300	290	—	—	—	—	—	—	—
MD50-10-27251	50-603061	76–76	—	—	—	210	—	25000	3900	1900	—	—	—	—	—	—	—
MD50-10-27247	50-603061	128–128	—	—	—	—	—	32000	5800	2500	—	—	—	—	—	—	—
MD50-10-27255	50-603061	190–190	—	—	150	—	—	35000	5800	4000	—	—	—	—	—	—	—
MD50-10-27248	50-603061	228–228	—	—	—	—	—	23000	3600	3200	—	—	—	—	—	—	—
MD50-10-27253	50-603061	274–274	—	—	—	—	—	14000	1500	2000	—	—	—	—	—	—	—
MD50-10-27252	50-603061	347–347	—	—	—	86	—	6500	410	1200	—	—	—	—	—	—	—
MD50-10-27254	50-603061	397–397	—	—	—	48	—	3100	140	960	—	—	—	—	—	—	—
MD50-10-27250	50-603061	450–450	—	—	—	22	1.3	1500	34	550	10	—	—	—	—	—	—
MD50-10-27262	50-603062	25–25	—	—	—	—	—	120	29	1200	—	—	—	—	—	—	—
MD50-10-27265	50-603062	64–64	—	—	—	—	—	180	42	2400	—	—	—	—	—	—	—
MD50-10-27257	50-603062	122–122	—	—	—	—	—	400 (J)	60 (J)	7200 (J)	—	—	—	—	—	—	—
MD50-10-27263	50-603062	184–184	—	—	—	—	—	410	50	5900	—	—	—	—	—	—	—
MD50-10-27260	50-603062	217–217	—	—	11 (J)	24 (J)	16 (J)	380 (J)	47 (J)	5700	14 (J)	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Ethyltoluene[4-]	Hexanone[2-]	Methylene Chloride	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Vinyl Chloride	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-10-27264	50-603062	263–263	—	—	—	—	—	550	51	6300	—	—	—	—	—	—	—
MD50-10-27259	50-603062	337–337	—	—	—	—	—	92	—	1900	—	—	—	—	—	—	—
MD50-10-27261	50-603062	387–387	—	—	—	—	—	71	—	1900	—	—	—	—	—	—	—
MD50-10-27258	50-603062	450–450	—	—	—	—	—	—	—	700	—	—	—	—	—	—	—
MD50-10-27267	50-603063	25–25	—	—	—	370	—	3500	450	2100	—	—	—	—	—	—	—
MD50-10-27272	50-603063	76–76	—	—	—	550	—	3800	560	5400	—	—	—	—	—	—	—
MD50-10-27275	50-603063	128–128	—	—	—	810	—	5200	830	9600	—	—	—	—	—	—	—
MD50-10-27268	50-603063	190–190	—	—	—	1400	—	5400	690	22000	—	—	—	—	—	—	—
MD50-10-27273	50-603063	228–228	580	—	180	950	820	4800	540	22000	—	1300	—	—	1600	320	1300
MD50-10-27269	50-603063	274–274	—	—	—	1000	—	1700	—	25000	—	—	—	—	—	—	—
MD50-10-27274	50-603063	347–347	—	—	92	400	—	640	—	9900	—	—	—	—	—	—	—
MD50-10-27271	50-603063	450–450	—	—	—	350	—	—	—	8200	—	—	—	—	—	—	—
MD50-10-27280	50-603064	25–25	—	—	—	230	—	3600	700	3600	—	—	—	—	—	—	—
MD50-10-27285	50-603064	66–66	—	—	—	360	—	8700	1600	7300	—	—	—	—	—	—	—
MD50-10-27279	50-603064	113–113	—	—	—	520	—	13000	2700	28000	—	—	—	—	—	—	—
MD50-10-27283	50-603064	176–176	—	—	450	530	—	14000	2400	40000	—	—	—	—	—	—	—
MD50-10-27277	50-603064	214–214	—	—	390	460	—	13000	2000	36000	—	—	—	—	—	—	—
MD50-10-27281	50-603064	259–259	—	—	270	—	—	8000	860	27000	—	—	—	—	—	—	—
MD50-10-27278	50-603064	332–332	—	—	86	170	—	3200	150	13000	—	—	—	—	—	—	—
MD50-10-27282	50-603064	400–400	—	—	—	100	—	1300	—	8700	—	—	—	—	—	—	—
MD50-10-27284	50-603064	500–500	—	—	—	—	—	150	—	1600	—	—	—	—	—	—	—
MD50-10-27199	50-603383	26–26	—	—	—	260	—	240	53	690	—	—	—	—	—	—	—
MD50-10-27197	50-603383	85–85	—	—	19	620	—	830	170	2600	—	—	—	—	—	—	—
MD50-10-27205	50-603383	139–139	—	—	54	1200	—	1000	230	5200	—	—	—	—	—	—	—
MD50-10-27204	50-603383	206–206	—	—	74	1400	—	780	190	6700	—	—	—	—	—	—	—
MD50-10-27203	50-603383	244–244	—	—	—	66	—	20	—	510	—	—	—	—	—	—	—
MD50-10-27201	50-603383	286–286	—	—	42	530	—	210	77	3300	—	—	—	—	—	—	—
MD50-10-27202	50-603383	359–359	—	—	42	880	—	340	95	4000	—	—	—	—	—	—	—
MD50-10-27200	50-603383	408–408	—	—	—	220	—	—	—	1400	—	—	—	—	—	—	—
MD50-10-27214	50-603467	26–26	—	—	110	380	—	—	—	9400	—	—	—	—	—	—	—
MD50-10-27210	50-603467	91–91	—	—	110	280	—	—	—	7400	—	—	—	—	—	—	—
MD50-10-27211	50-603467	143–143	—	—	260	580	—	—	—	18000	—	—	—	—	—	—	—
MD50-10-27215	50-603467	206–206	—	—	400	860	—	—	—	25000	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Ethyltoluene[4-]	Hexanone[2-]	Methylene Chloride	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Vinyl Chloride	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-10-27207	50-603467	244–244	—	—	720	840	—	—	—	26000	—	—	—	—	—	—	—
MD50-10-27213	50-603467	287–287	—	—	520	700	—	—	—	22000	—	—	—	—	—	—	—
MD50-10-27212	50-603467	360–360	—	—	310	650	—	—	—	26000	—	—	—	—	—	—	—
MD50-10-27208	50-603467	409–409	—	—	160	400	—	—	—	15000	—	—	—	—	—	—	—
MD50-10-27206	50-603467	500–500	—	—	70	280	—	—	—	8100	—	—	—	—	—	—	—
MD50-10-27209	50-603467	600–600	—	430	27	97	—	—	—	3700	—	—	—	—	—	—	—
MD50-10-27220	50-603468	92–92	—	—	—	—	—	—	—	5700	—	—	—	—	—	—	—
MD50-10-27217	50-603468	142–142	—	—	91 (J)	100	—	—	—	5500	—	—	—	—	—	—	—
MD50-10-27218	50-603468	198–198	—	—	510 (J)	310	—	—	—	20000	—	—	—	—	—	—	—
MD50-10-27219	50-603468	233–233	—	—	630 (J)	340	—	—	—	23000	—	—	—	—	—	—	—
MD50-10-27226	50-603468	282–282	—	—	510 (J)	360	—	—	—	23000	—	—	—	—	—	—	—
MD50-10-27223	50-603468	354–354	—	—	400 (J)	330	—	—	—	20000	—	—	—	—	—	—	—
MD50-10-27221	50-603468	403–403	—	—	370 (J)	350	—	—	—	22000	—	—	—	—	—	—	—
MD50-10-27222	50-603468	450–450	—	—	130 (J)	200	—	—	—	12000	—	—	—	—	—	—	—
MD50-10-27145	50-603470	30–30	—	—	—	980	—	240	—	14000	—	—	—	—	—	—	—
MD50-10-27149	50-603470	83–83	—	—	92 (J)	730	—	310	—	13000	—	—	—	—	—	—	—
MD50-10-27144	50-603470	143–143	—	—	190	720	—	440	—	33000	—	—	—	—	—	—	—
MD50-10-27151	50-603470	203–203	—	—	98	100 (J)	—	—	—	9200	—	—	—	—	—	—	—
MD50-10-27147	50-603470	233–233	—	—	610	—	—	—	—	50000	—	—	—	—	—	—	—
MD50-10-27153	50-603470	278–278	—	—	640	—	—	—	—	55000	—	—	—	—	—	—	—
MD50-10-27146	50-603470	351–351	—	—	360	—	—	—	—	37000	—	—	—	—	—	—	—
MD50-10-27152	50-603470	450–450	—	—	—	—	—	—	—	12000	—	—	—	—	—	—	—
MD50-10-27148	50-603470	600–600	—	—	—	—	33	—	—	1700	—	—	—	—	30	—	30
MD50-10-27115	50-603470	650–650	4.4	—	—	—	15	—	—	12	—	5.3	—	—	14	3.9	10
MD50-10-27158	50-603471	30–30	—	—	220	910	—	—	—	20000	—	—	—	—	—	—	—
MD50-10-27155	50-603471	90–90	—	—	440	1300	—	—	—	28000	—	—	—	—	—	—	—
MD50-10-27157	50-603471	146–146	—	—	98	79	—	—	—	4300	—	—	—	—	—	—	—
MD50-10-27162	50-603471	209–209	—	—	910	860	—	—	—	48000	—	—	—	—	—	—	—
MD50-10-27161	50-603471	242–242	—	—	1900	1300	—	—	—	72000	—	—	—	—	—	—	—
MD50-10-27160	50-603471	288–288	—	—	1700	1300	—	—	—	70000	—	—	—	—	—	—	—
MD50-10-27156	50-603471	360–360	—	—	690	640	—	—	—	34000	—	—	—	—	—	—	—
MD50-10-27163	50-603471	410–410	—	—	400	620	—	—	—	34000	—	—	—	—	—	—	—
MD50-10-27159	50-603471	450–450	—	—	250	350	—	—	—	23000	—	—	—	—	—	—	—

Table 6.2-1 (continued)

Sample ID	Location ID	Depth (ft)	Ethyltoluene[4-]	Hexanone[2-]	Methylene Chloride	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Vinyl Chloride	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-10-27165	50-603472	27–27	—	—	25 (J)	630	—	46	46	3000	—	—	—	—	—	—	—
MD50-10-27168	50-603472	93–93	15	—	—	—	78	—	—	19	—	16	4.3	—	74	18	55
MD50-10-27170	50-603472	146–146	11	—	1.2	—	55	—	—	29	—	12	3.5	—	51	13	38
MD50-10-27172	50-603472	210–210	—	—	10	—	—	—	—	110	—	—	—	—	—	—	—
MD50-10-27166	50-603472	247–247	—	—	270 (J)	500	—	—	—	7100	—	—	—	—	—	—	—
MD50-10-27174	50-603472	292–292	—	—	7.9	13	—	—	—	240	—	—	—	—	—	—	—
MD50-10-27169	50-603472	364–364	—	—	25	70	42	—	—	910	—	—	—	—	—	—	—
MD50-10-27167	50-603472	414–414	23	—	—	—	110	—	—	20	—	24	7.6	—	120	28	88
MD50-10-27173	50-603472	450–450	—	—	—	—	—	—	—	56	—	—	—	—	—	—	—
MD50-10-27243	50-603503	25–25	—	—	—	240	—	—	—	1300	—	—	—	—	—	—	—
MD50-10-27237	50-603503	80–80	—	—	34	590	180	77	—	2000	—	—	—	—	—	—	—
MD50-10-27244	50-603503	133–133	—	—	24	360	—	99	—	2300	—	—	—	—	—	—	—
MD50-10-27238	50-603503	198–198	—	—	—	220	—	—	—	2200	—	—	—	—	—	—	—
MD50-10-27245	50-603503	237–237	—	—	—	1300	—	—	—	12000	—	—	—	—	—	—	—
MD50-10-27239	50-603503	278–278	—	—	—	460	—	—	—	5600	—	—	—	—	—	—	—
MD50-10-27241	50-603503	347–347	—	—	14	190	—	—	—	1200	—	—	—	—	—	—	—
MD50-10-27240	50-603503	397–397	—	—	7.5	130	120	—	—	1100	—	—	—	—	23	—	18
MD50-10-27242	50-603503	450–450	—	—	—	130	—	—	—	2000	—	—	—	—	—	—	—

Notes: Results are in $\mu g/m^3$. Data qualifiers are defined in Appendix A.

* — = Analysis not requested.

Table 6.2-2
VOCs Detected in Vapor Samples in Second Quarter FY2011

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-4012	50-24784	25–25	—*	—	—	—	55 (J-)	—	210	—	39	—	—	—	—	—	—
MD50-11-4010	50-24784	96–96	—	—	—	—	110	—	530	79	100	—	—	—	34	—	—
MD50-11-4009	50-24784	155–155	—	—	—	—	190	—	220	72	150	—	—	—	34	—	—
MD50-11-4006	50-24784	215–215	—	—	—	—	77 (J-)	—	160	—	170	—	—	—	—	—	—
MD50-11-4004	50-24784	244–244	—	—	—	—	380 (J)	—	99	—	160	—	—	—	—	—	—
MD50-11-4008	50-24784	289–289	—	—	—	—	510 (J)	—	58	—	—	—	—	—	—	—	—
MD50-11-4007	50-24784	362–362	—	—	—	—	480 (J-)	—	—	—	180	—	—	—	—	—	—
MD50-11-4005	50-24784	411–411	—	—	—	—	370	—	—	—	190	—	—	—	—	—	—
MD50-11-4003	50-24784	450–450	—	—	—	—	—	—	—	—	22	—	—	—	—	—	—
MD50-11-4023	50-24813	25–25	—	—	—	—	3000	—	3400	—	980	—	—	550	—	—	—
MD50-11-4021	50-24813	99–99	—	—	—	—	880	—	950	—	1100	—	—	350	—	—	—
MD50-11-4095	50-24813	150–150	—	—	—	—	1400	—	2300	—	1000 (J)	—	—	550	—	—	—
MD50-11-4019	50-24813	207–207	—	—	—	—	33	—	41	—	25	—	—	9.3	—	—	—
MD50-11-4018	50-24813	241–241	—	10	—	—	7.7	—	8.9	—	12	—	—	—	—	5.8	—
MD50-11-4017	50-24813	286–286	—	—	—	—	190	—	190	—	200	—	—	—	—	—	—
MD50-11-4014	50-24813	358–358	—	—	—	—	—	—	370	—	920	—	—	—	—	—	—
MD50-11-4013	50-24813	408–408	—	—	—	—	270	—	130	—	400	—	—	—	—	—	—
MD50-11-4015	50-24813	450–450	—	—	—	—	270	—	—	—	410	—	—	—	—	—	—
MD50-11-4016	50-24813	600–600	5.2	—	—	—	11 (J+)	—	—	—	22	—	—	—	—	—	—
MD50-11-4058	50-24822	25–25	—	—	—	—	—	—	210	—	160	—	—	—	—	—	—
MD50-11-4057	50-24822	142–142	—	—	—	—	—	—	7.6	—	11	—	—	—	—	—	—
MD50-11-4055	50-24822	204–204	—	—	—	—	—	—	440	—	870	—	—	—	—	—	—
MD50-11-4060	50-24822	235–235	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-4061	50-24822	280–280	—	—	—	—	—	—	250	—	580	—	—	—	—	—	—
MD50-11-4056	50-24822	351–351	14	2.7	8.9	—	—	—	—	—	2.7	—	—	—	—	1.9	—
MD50-11-4080	50-603061	25–25	—	—	—	—	—	—	—	—	520	—	220	—	—	—	—
MD50-11-4081	50-603061	76–76	—	—	—	—	—	—	—	—	480	—	700	—	—	—	—
MD50-11-4083	50-603061	128–128	—	—	—	—	—	—	—	—	350	—	1500	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-4082	50-603061	190–190	—	—	—	—	—	—	—	—	280	—	1500	—	—	—	—
MD50-11-4084	50-603061	228–228	—	—	—	—	170 (J)	—	—	—	180	—	1000	—	—	—	—
MD50-11-4076	50-603061	274–274	—	—	—	—	84	—	—	—	220	—	460	—	—	—	—
MD50-11-4077	50-603061	347–347	52	—	—	—	110	—	—	—	230	—	230	—	—	—	—
MD50-11-4078	50-603061	397–397	—	—	—	—	100	—	—	—	180	—	120	—	—	—	—
MD50-11-4079	50-603061	450–450	—	—	—	—	63 (J)	—	—	—	64	—	29	—	—	—	—
MD50-11-4092	50-603062	25–25	—	—	—	—	—	—	24	—	62	—	—	—	—	—	—
MD50-11-4091	50-603062	64–64	—	—	—	—	—	—	50	—	240 (J)	—	—	—	—	—	—
MD50-11-4093	50-603062	122–122	—	—	—	—	—	—	69	—	—	—	—	—	—	—	—
MD50-11-4090	50-603062	184–184	—	—	—	—	—	—	45	—	190 (J)	—	—	—	—	—	—
MD50-11-4089	50-603062	217–217	13	1.2	—	—	11	—	7.8	—	39	—	1.4	2	—	—	—
MD50-11-4087	50-603062	263–263	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-4086	50-603062	337–337	—	—	—	—	26	—	—	—	110	—	—	—	—	—	—
MD50-11-4088	50-603062	387–387	—	—	—	—	39	—	—	—	140	—	—	—	—	—	—
MD50-11-4085	50-603062	450–450	—	—	—	—	12	—	—	—	45	—	—	—	—	—	—
MD50-11-4103	50-603063	25–25	—	—	—	—	40	—	36	—	210	—	9.5	—	—	—	—
MD50-11-4102	50-603063	76–76	—	—	—	—	89	—	180	—	—	—	260	—	—	—	—
MD50-11-4101	50-603063	128–128	—	—	—	—	—	—	230	—	700 (J)	79	390	—	—	—	—
MD50-11-4100	50-603063	190–190	—	—	—	—	290	—	460	—	890 (J)	—	450	120	—	—	—
MD50-11-4099	50-603063	228–228	—	34	—	—	—	—	—	—	2.4	—	—	—	—	3.2	—
MD50-11-4098	50-603063	274–274	—	—	—	—	350 (J-)	—	430	—	830 (J)	—	—	170	—	—	—
MD50-11-4096	50-603063	347–347	—	—	—	—	—	—	85	—	210 (J)	—	—	—	—	—	—
MD50-11-4104	50-603063	397–397	—	11	—	—	12	—	16	—	15	—	—	—	—	—	—
MD50-11-4097	50-603063	450–450	—	—	—	—	190 (J-)	—	120	—	430 (J)	—	—	—	—	—	—
MD50-11-4113	50-603064	25–25	—	—	—	—	—	—	220	—	60	—	71	22	—	—	—
MD50-11-4112	50-603064	66–66	—	—	—	—	—	—	250	—	—	—	210	38	—	—	—
MD50-11-4111	50-603064	113–113	—	—	—	—	—	—	850	—	470	—	510	220	—	—	—
MD50-11-4109	50-603064	176–176	—	—	—	—	—	—	670	—	750	—	1000	230	—	—	—
MD50-11-4110	50-603064	214–214	—	—	—	—	270 (J+)	—	270	—	71	—	160	26	—	—	—
MD50-11-4105	50-603064	259–259	—	—	—	—	360 (J)	—	—	—	410	—	240	—	—	—	—
MD50-11-4106	50-603064	332–332	—	—	—	—	300 (J)	—	—	—	400	—	82	—	—	—	—
MD50-11-4107	50-603064	400–400	—	—	—	—	160 (J)	—	—	—	240	—	—	—	—	—	—
MD50-11-4108	50-603064	500–500	—	—	—	29	120 (J)	—	—	—	210	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-4024	50-603383	26–26	—	—	—	—	98 (J+)	—	83	—	200	—	14	—	49	—	—
MD50-11-4029	50-603383	85–85	—	—	—	—	120	—	120	—	240	—	29	—	110	—	—
MD50-11-4025	50-603383	139–139	160	—	450	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-4030	50-603383	206–206	—	—	—	—	280	—	110	—	220	—	49	62	360	—	—
MD50-11-4026	50-603383	244–244	—	—	—	—	370	—	120	—	280	—	59	75	370	—	—
MD50-11-4031	50-603383	286–286	5.6	—	—	—	—	1.7	—	—	—	—	1.2	1.8	8.6	—	—
MD50-11-4027	50-603383	359–359	10	—	—	43	16	—	3.1	—	9.9 (J)	—	1.2	1.5	2.3	—	—
MD50-11-4032	50-603383	408–408	—	—	—	—	260	—	—	—	170 (J)	—	—	—	—	—	—
MD50-11-4028	50-603383	450–450	27	—	—	—	280	—	—	—	200	—	—	—	—	—	—
MD50-11-4038	50-603467	91–91	—	—	—	—	820 (J+)	—	670	—	200	—	—	110	—	—	—
MD50-11-4039	50-603467	206–206	—	—	—	—	440 (J+)	—	280	—	—	—	—	77	—	—	—
MD50-11-4042	50-603467	287–287	—	—	—	—	340 (J-)	—	170 (J-)	—	—	—	—	—	—	—	—
MD50-11-4040	50-603467	409–409	—	—	—	—	300 (J+)	—	—	—	—	—	—	—	—	—	—
MD50-11-4043	50-603467	500–500	—	—	—	—	330 (J+)	—	—	—	180	—	—	—	—	—	—
MD50-11-4041	50-603467	600–600	200 (J-)	—	330 (J-)	—	260 (J-)	—	—	—	78 (J-)	—	—	—	—	—	—
MD50-11-4047	50-603468	92–92	37	15	8	—	—	—	1.7	—	4.9	—	—	—	—	11	7.5
MD50-11-4046	50-603468	142–142	37	15	6.4	—	—	—	—	—	3.4	—	—	—	—	9.8	5.3
MD50-11-4045	50-603468	198–198	—	—	—	—	330 (J)	—	210	—	—	—	—	71	—	—	—
MD50-11-4054	50-603468	233–233	29	12	6.5	—	—	—	—	—	3	—	—	—	—	7.7	5.4
MD50-11-4050	50-603468	282–282	—	—	—	—	700 (J)	—	330	—	410	—	—	—	—	—	—
MD50-11-4051	50-603468	354–354	—	—	—	—	1200 (J)	—	400	—	630	—	—	150	—	—	—
MD50-11-4052	50-603468	403–403	—	—	—	—	680 (J)	—	—	—	440	—	—	—	—	—	—
MD50-11-4053	50-603468	450–450	—	—	—	—	550 (J)	—	—	—	350	—	—	—	—	—	—
MD50-11-3980	50-603470	83–83	—	—	—	—	—	—	390	—	140	—	—	75	—	—	—
MD50-11-3975	50-603470	143–143	—	—	—	—	—	—	970	—	—	—	—	—	—	—	—
MD50-11-3973	50-603470	203–203	—	—	—	—	—	—	250	—	240	—	—	—	—	—	—
MD50-11-3972	50-603470	233–233	—	2.4	—	—	—	—	—	—	2.8	—	—	—	—	—	—
MD50-11-3974	50-603470	278–278	—	—	—	—	—	—	590	—	—	—	—	—	—	—	—
MD50-11-3979	50-603470	351–351	4.9	58	—	—	—	—	—	—	2.8	—	—	—	—	10	6.3
MD50-11-3978	50-603470	450–450	20	15	—	—	2.2	—	—	—	7.6	—	—	—	—	8.1	7.4
MD50-11-3977	50-603470	600–600	34	14	4.1	—	—	—	—	—	4.8	—	—	—	—	10	15
MD50-11-3976	50-603470	650–650	—	22	10	—	2.9	—	—	—	18	—	—	—	—	4.9	3.2
MD50-11-3983	50-603471	30–30	—	—	—	—	—	—	350	—	—	—	—	45	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-3992	50-603471	90–90	—	—	—	—	210 (J)	—	400	—	65	—	—	48	—	—	—
MD50-11-3990	50-603471	146–146	—	—	—	—	—	—	930	—	600	—	—	400	—	—	—
MD50-11-3988	50-603471	209–209	—	—	—	—	150 (J)	—	480	—	160	—	—	110	—	—	—
MD50-11-3989	50-603471	242–242	—	—	—	—	210 (J)	—	360	—	320	—	—	110	—	—	—
MD50-11-3987	50-603471	288–288	—	—	—	—	460 (J)	—	1700	—	480	—	—	440	—	—	—
MD50-11-3986	50-603471	360–360	—	—	—	—	—	—	310	—	370	—	—	—	—	—	—
MD50-11-3984	50-603471	410–410	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-3985	50-603471	450–450	—	—	—	—	—	—	280	—	550	—	—	—	—	—	—
MD50-11-4002	50-603472	27–27	—	—	—	—	—	—	330	—	41	—	—	24	—	—	—
MD50-11-4000	50-603472	93–93	—	35	—	—	43	—	170	—	45	—	—	20	—	—	—
MD50-11-4001	50-603472	146–146	—	—	—	—	—	—	450	—	—	—	—	94	—	—	—
MD50-11-3998	50-603472	210–210	—	—	—	—	—	—	170	—	72	—	—	56	—	—	—
MD50-11-3999	50-603472	247–247	—	—	—	—	—	—	96	—	—	—	—	27	—	—	—
MD50-11-3993	50-603472	364–364	10	1.4	3.1	—	11	—	3.8	—	13	—	—	1.1	—	—	—
MD50-11-3994	50-603472	414–414	—	—	—	—	—	—	—	—	350	—	—	—	—	—	—
MD50-11-3995	50-603472	450–450	—	—	—	—	190 (J)	—	—	—	270	—	—	—	—	—	—
MD50-11-4071	50-603503	25–25	—	—	—	—	82 (J)	—	52	—	32	—	—	—	—	—	—
MD50-11-4072	50-603503	80–80	—	—	—	—	95 (J)	—	61	—	40	—	—	—	—	—	—
MD50-11-4069	50-603503	133–133	—	—	—	—	120 (J)	—	84	—	41	—	—	—	28	—	—
MD50-11-4073	50-603503	198–198	—	—	—	—	190 (J)	—	120	—	50	—	—	22	52	—	—
MD50-11-4070	50-603503	237–237	—	—	—	—	220 (J)	—	120	—	50	—	—	25	36	—	—
MD50-11-4067	50-603503	278–278	—	—	—	—	140 (J)	—	85	—	—	—	—	—	—	—	—
MD50-11-4066	50-603503	347–347	—	—	—	—	76 (J)	—	53	—	—	—	—	—	—	—	—
MD50-11-4068	50-603503	397–397	—	—	—	—	100 (J)	—	34	—	43	—	—	—	—	—	—
MD50-11-4065	50-603503	450–450	—	—	—	—	140 (J)	—	—	—	63	—	—	—	—	—	—
MD50-11-3943	50-613182	550–550	9.7	70	—	—	—	—	—	—	5.1	—	—	—	—	40	16
MD50-11-3942	50-613182	600–600	5.4	29	—	3.3	—	—	—	—	4.2	—	—	—	—	4	2.6
MD50-11-3953	50-613182	620–620	—	—	—	—	27 (J+)	—	—	—	48	—	—	—	—	—	—
MD50-11-3941	50-613182	632.5–632.5	—	1300	—	—	—	—	—	—	—	—	—	—	—	180	100
MD50-11-3947	50-613183	30–30	—	—	—	—	3900 (J+)	—	2700	—	310	—	—	160	—	—	—
MD50-11-3948	50-613183	500–500	—	—	—	—	640 (J-)	—	—	—	500 (J-)	—	—	—	—	—	—
MD50-11-3949	50-613183	550–550	—	—	—	—	220	—	—	—	550 (J)	—	—	—	—	—	—
MD50-11-3950	50-613183	600–600	—	—	—	—	76	—	—	—	150	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chlorobenzene	Chloroform	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethane[1,1-]	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-3951	50-613183	630–630	—	—	—	—	110	—	—	—	210	—	—	—	—	—	—
MD50-11-3952	50-613183	642.5–642.5	—	—	9.4	110	4.7 (J+)	—	—	—	11	—	—	—	—	2.1	—
MD50-11-3959	50-613184	30–30	—	—	—	64 (J-)	89 (J-)	—	120 (J-)	—	82 (J-)	—	—	19 (J-)	—	—	—
MD50-11-3956	50-613184	500–500	—	—	—	—	120 (J-)	—	—	—	330 (J)	—	—	—	—	—	—
MD50-11-3958	50-613184	550–550	—	—	—	66 (J-)	120 (J-)	—	—	—	200 (J-)	—	—	—	—	—	—
MD50-11-3954	50-613184	600–600	—	—	—	—	58 (J-)	—	—	—	120 (J-)	—	—	—	—	—	—
MD50-11-3957	50-613184	652–652	68 (J-)	4 (J-)	8.8 (J-)	140 (J-)	18 (J-)	—	—	—	29 (J-)	—	—	—	—	2 (J-)	2.6 (J-)
MD50-11-3955	50-613184	664.5–664.5	25 (J-)	5.9 (J-)	7.8 (J-)	94 (J-)	3.8 (J-)	—	—	—	8.6 (J-)	—	—	—	—	2.8 (J-)	—
MD50-11-3962	50-613185	145–145	—	—	—	—	80	—	85	—	95	—	—	—	—	—	—
MD50-11-3963	50-613185	205–205	35	14	11	—	—	—	—	—	4.3	—	—	—	—	10	6.6
MD50-11-3964	50-613185	235–235	—	97	—	—	—	—	—	—	—	—	—	—	—	35	15
MD50-11-3965	50-613185	280–280	8.8	3.6	—	—	—	—	—	—	3.4	—	—	—	—	3.2	3.2
MD50-11-3966	50-613185	350–350	7.2	2.5	—	—	—	—	—	—	3.4	—	—	—	—	—	—
MD50-11-3967	50-613185	450–450	—	—	—	—	40	—	—	—	44	—	—	—	—	—	—
MD50-11-3969	50-613185	600–600	9.8	1.6	2.9	18	16	—	—	—	34	—	—	—	—	1.9	—
MD50-11-3968	50-613185	675–675	6.9	—	—	—	—	—	—	—	2.6	—	—	—	—	—	—
MD50-11-3970	50-613185	688–688	7.9	9.6	—	62	5.8	—	2.2	—	16	—	—	—	—	7.5	6.4

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-4012	50-24784	25–25	—	14	—	1800	—	43	57	920	—	—	—	—	—	—
MD50-11-4010	50-24784	96–96	—	—	—	2800	—	150 (J+)	62	2600	—	—	—	—	—	—
MD50-11-4009	50-24784	155–155	—	—	—	2000	—	150 (J+)	50	3000	—	—	—	—	—	—
MD50-11-4006	50-24784	215–215	—	120	—	2500	—	140	—	5000	—	—	—	—	—	—
MD50-11-4004	50-24784	244–244	—	55	—	2400	—	120	—	4600	—	—	—	—	—	—
MD50-11-4008	50-24784	289–289	—	68	—	2400	—	99	—	5000	—	—	—	—	—	—
MD50-11-4007	50-24784	362–362	—	26	—	1200	—	43	—	2600	—	—	—	—	—	—
MD50-11-4005	50-24784	411–411	—	—	—	630	—	—	—	—	—	—	—	—	—	—
MD50-11-4003	50-24784	450–450	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-4023	50-24813	25–25	—	230 (J+)	—	820	—	—	—	37000	—	—	—	—	—	—
MD50-11-4021	50-24813	99–99	—	570 (J+)	—	530	—	—	—	42000	—	—	—	—	—	—
MD50-11-4095	50-24813	150–150	—	430	—	590	—	—	—	39000	—	—	—	—	—	—
MD50-11-4019	50-24813	207–207	—	330	—	—	—	—	—	1100	—	—	—	—	—	—
MD50-11-4018	50-24813	241–241	—	77	—	—	32	—	—	360	—	—	—	14	—	14
MD50-11-4017	50-24813	286–286	—	81 (J+)	—	120	—	—	—	9900	—	—	—	—	—	—
MD50-11-4014	50-24813	358–358	—	3900 (J)	—	490	—	—	—	43000	—	—	—	—	—	—
MD50-11-4013	50-24813	408–408	—	180 (J+)	—	210	—	—	—	15000	—	—	—	—	—	—
MD50-11-4015	50-24813	450–450	—	120 (J+)	—	150	—	—	—	13000	—	—	—	—	—	—
MD50-11-4016	50-24813	600–600	—	—	—	—	—	—	—	170	2.7	—	—	—	—	—
MD50-11-4058	50-24822	25–25	—	—	—	—	—	—	—	6100	—	—	—	—	—	—
MD50-11-4057	50-24822	142–142	—	—	—	—	—	—	—	500	—	—	—	—	—	—
MD50-11-4055	50-24822	204–204	—	640 (J)	—	—	—	—	—	28000	—	—	—	—	—	—
MD50-11-4060	50-24822	235–235	—	470 (J)	—	—	—	—	—	32000	—	—	—	—	—	—
MD50-11-4061	50-24822	280–280	—	190	—	—	—	—	—	17000	—	—	—	—	—	—
MD50-11-4056	50-24822	351–351	2.9	—	—	—	9.6	—	—	11	—	—	—	4.3	—	4.3
MD50-11-4080	50-603061	25–25	—	—	—	—	—	15000	1700	380	—	—	—	—	—	—
MD50-11-4081	50-603061	76–76	—	—	—	250	—	22000	3400	1900	—	—	—	—	—	—
MD50-11-4083	50-603061	128–128	—	—	—	—	—	28000	5800	2500	—	—	—	—	—	—
MD50-11-4082	50-603061	190–190	—	—	—	—	—	28000	4800	3700	—	—	—	—	—	—
MD50-11-4084	50-603061	228–228	—	—	—	—	160	22000	3200	2700	—	—	—	—	—	—
MD50-11-4076	50-603061	274–274	—	—	—	72	—	9100	1200	1500	—	—	—	—	—	—
MD50-11-4077	50-603061	347–347	—	—	—	—	—	6600	430	1000	24	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-4078	50-603061	397–397	—	—	—	55	11	4000	180	1300	—	—	—	—	—	—
MD50-11-4079	50-603061	450–450	—	—	—	18	—	1100	24	390	—	—	—	—	—	—
MD50-11-4092	50-603062	25–25	—	—	—	—	—	120	26	1400	—	—	—	—	—	—
MD50-11-4091	50-603062	64–64	—	—	—	—	—	530	—	7400	—	—	—	—	—	—
MD50-11-4093	50-603062	122–122	—	—	—	—	—	500	—	6100	—	—	—	—	—	—
MD50-11-4090	50-603062	184–184	—	—	—	—	—	410	—	6000	—	—	—	—	—	—
MD50-11-4089	50-603062	217–217	—	2.4	—	3.8	1.5	75	7.8	1100	3.5	—	—	—	—	—
MD50-11-4087	50-603062	263–263	—	—	—	—	—	280	—	5700	—	—	—	—	—	—
MD50-11-4086	50-603062	337–337	—	—	—	—	—	61	—	1400	—	—	—	—	—	—
MD50-11-4088	50-603062	387–387	—	—	—	—	—	—	—	1700	—	—	—	—	—	—
MD50-11-4085	50-603062	450–450	—	—	—	—	—	8.7	—	320	—	—	—	—	—	—
MD50-11-4103	50-603063	25–25	—	—	—	360	—	3500	450	1700	—	—	—	—	—	—
MD50-11-4102	50-603063	76–76	—	41	—	810	—	6100	850	6500	—	—	—	—	—	—
MD50-11-4101	50-603063	128–128	—	72	—	890	—	6900	920	8700	—	—	—	—	—	—
MD50-11-4100	50-603063	190–190	—	200	—	1600	—	7300	900	20000	—	—	—	—	—	—
MD50-11-4099	50-603063	228–228	—	—	—	—	42	—	—	3.3	3.8	—	—	11	2.6	8.5
MD50-11-4098	50-603063	274–274	—	270	—	1400	—	3200	—	22000	—	—	—	—	—	—
MD50-11-4096	50-603063	347–347	—	60	—	220	—	650	—	4600	—	—	—	—	—	—
MD50-11-4104	50-603063	397–397	—	9.4	—	38	12	—	—	910	—	—	—	—	—	—
MD50-11-4097	50-603063	450–450	—	95	—	380	—	150	—	8400	—	—	—	—	—	—
MD50-11-4113	50-603064	25–25	—	—	—	210	—	2600	630	3900	—	—	—	—	—	—
MD50-11-4112	50-603064	66–66	—	—	—	190	—	5300	950	3700	—	—	—	—	—	—
MD50-11-4111	50-603064	113–113	—	—	—	570	—	12000	2500	31000	—	—	—	—	—	—
MD50-11-4109	50-603064	176–176	—	590 (J)	—	500	—	18000	2600	34000	—	—	—	—	—	—
MD50-11-4110	50-603064	214–214	—	—	—	220	—	4200	820	3800	—	—	—	—	—	—
MD50-11-4105	50-603064	259–259	—	190	—	—	—	5200	620	21000	—	—	—	—	—	—
MD50-11-4106	50-603064	332–332	—	—	—	—	—	2400	120	11000	—	—	—	—	—	—
MD50-11-4107	50-603064	400–400	—	—	—	—	—	590	—	4800	—	—	—	—	—	—
MD50-11-4108	50-603064	500–500	—	—	—	—	—	110	—	1500	—	—	—	—	—	—
MD50-11-4024	50-603383	26–26	—	—	—	690	—	880 (J+)	170	2000	31	—	—	—	—	—
MD50-11-4029	50-603383	85–85	—	—	—	800	—	1100	210	1900	—	—	—	—	—	—
MD50-11-4025	50-603383	139–139	—	—	—	—	1700	—	—	250	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-4030	50-603383	206–206	—	77 (J+)	—	1200	—	720	180	4600	—	—	—	—	—	—
MD50-11-4026	50-603383	244–244	—	91 (J+)	—	1500	—	750	220	5900	—	—	—	—	—	—
MD50-11-4031	50-603383	286–286	—	2.3	—	48	1.2	22	5.9	—	2.6	—	—	—	—	—
MD50-11-4027	50-603383	359–359	—	1.8	—	38	2.8	12 (J+)	4.8	300	—	—	—	—	—	—
MD50-11-4032	50-603383	408–408	—	—	—	200	—	70 (J+)	—	1500	—	—	—	—	—	—
MD50-11-4028	50-603383	450–450	—	—	—	280	—	75	—	1500	—	—	—	—	—	—
MD50-11-4038	50-603467	91–91	—	130	—	390	—	—	—	12000	—	—	—	—	—	—
MD50-11-4039	50-603467	206–206	—	140	—	340	—	—	—	11000	—	—	—	—	—	—
MD50-11-4042	50-603467	287–287	—	170 (J-)	—	250 (J-)	—	—	—	8800 (J-)	—	—	—	—	—	—
MD50-11-4040	50-603467	409–409	—	—	—	—	—	—	—	7200	—	—	—	—	—	—
MD50-11-4043	50-603467	500–500	—	—	—	—	—	—	—	6000	—	—	—	—	—	—
MD50-11-4041	50-603467	600–600	1500 (J-)	—	—	110 (J-)	—	—	—	3400 (J-)	—	—	—	—	—	—
MD50-11-4047	50-603468	92–92	—	—	—	—	60	—	—	33	3.4	7.4	—	39	9.5	29
MD50-11-4046	50-603468	142–142	—	—	—	—	57	—	—	55	3.3	4.1	—	34	8.2	26
MD50-11-4045	50-603468	198–198	—	210	—	—	—	—	—	11000	—	—	—	—	—	—
MD50-11-4054	50-603468	233–233	—	—	—	—	43	—	—	21	2.8	5.4	—	27	6.7	20
MD50-11-4050	50-603468	282–282	—	380	—	—	—	—	—	23000	—	—	—	—	—	—
MD50-11-4051	50-603468	354–354	—	450	—	490	—	—	—	38000	—	—	—	—	—	—
MD50-11-4052	50-603468	403–403	—	200	—	—	—	—	—	19000	—	—	—	—	—	—
MD50-11-4053	50-603468	450–450	—	—	—	—	—	—	—	15000	—	—	—	—	—	—
MD50-11-3980	50-603470	83–83	—	—	—	260	—	130	—	6000	—	—	—	—	—	—
MD50-11-3975	50-603470	143–143	—	890 (J)	—	—	—	—	—	41000	—	—	—	—	—	—
MD50-11-3973	50-603470	203–203	—	—	—	—	—	—	—	12000	—	—	—	—	—	—
MD50-11-3972	50-603470	233–233	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-3974	50-603470	278–278	—	770 (J)	—	—	—	580	—	39000	—	—	—	—	—	—
MD50-11-3979	50-603470	351–351	—	—	5.5	—	89	—	—	32	—	6.7	—	43	9.9	33
MD50-11-3978	50-603470	450–450	—	—	—	—	44	—	—	120	4.7	7.9	—	27	7.3	20
MD50-11-3977	50-603470	600–600	—	—	—	—	38	—	—	19	4.7	17	4.2	38	11	28
MD50-11-3976	50-603470	650–650	—	—	1.7	—	34	—	—	—	—	3.6	—	18	4.4	14
MD50-11-3983	50-603471	30–30	—	—	—	330	150	160	—	5900	—	—	—	100	—	100
MD50-11-3992	50-603471	90–90	—	67	—	190	—	—	—	3700	—	—	—	—	—	—
MD50-11-3990	50-603471	146–146	—	1400 (J)	—	1000	—	—	—	46000	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-3988	50-603471	209–209	—	370	—	240	—	—	—	11000	—	—	—	—	—	—
MD50-11-3989	50-603471	242–242	—	530 (J)	—	270	—	—	—	12000	—	—	—	—	—	—
MD50-11-3987	50-603471	288–288	—	1000 (J)	—	1000	—	—	—	37000	—	—	—	—	—	—
MD50-11-3986	50-603471	360–360	—	570 (J)	—	500	—	—	—	24000	—	—	—	—	—	—
MD50-11-3984	50-603471	410–410	—	610 (J)	—	—	—	—	—	23000	—	—	—	—	—	—
MD50-11-3985	50-603471	450–450	—	480 (J)	—	670	—	—	—	31000	—	—	—	—	—	—
MD50-11-4002	50-603472	27–27	—	23	—	570	—	40	46	3200	—	—	—	—	—	—
MD50-11-4000	50-603472	93–93	—	36	—	170	36	—	—	2200	—	—	—	—	—	—
MD50-11-4001	50-603472	146–146	—	360	—	610	—	—	—	11000	—	—	—	—	—	—
MD50-11-3998	50-603472	210–210	—	230 (J)	—	410	—	—	—	7100	—	—	—	—	—	—
MD50-11-3999	50-603472	247–247	—	160	—	180	—	—	—	3700	—	—	—	—	—	—
MD50-11-3993	50-603472	364–364	—	5.3	—	19	—	—	—	310	2.4	—	—	—	—	—
MD50-11-3994	50-603472	414–414	—	220 (J)	—	850	—	—	—	15000	—	—	—	—	—	—
MD50-11-3995	50-603472	450–450	—	99	—	510	—	—	—	11000	—	—	—	—	—	—
MD50-11-4071	50-603503	25–25	—	—	—	200	—	—	—	1900	—	—	—	—	—	—
MD50-11-4072	50-603503	80–80	—	18	—	210	—	—	—	1900	—	—	—	—	—	—
MD50-11-4069	50-603503	133–133	—	32	—	290	—	—	—	2600	—	—	—	—	—	—
MD50-11-4073	50-603503	198–198	—	94	—	440	—	—	—	5600	—	—	—	—	—	—
MD50-11-4070	50-603503	237–237	—	110	—	480	—	—	—	6600	—	—	—	—	—	—
MD50-11-4067	50-603503	278–278	—	85	—	390	—	—	—	4000	—	—	—	—	—	—
MD50-11-4066	50-603503	347–347	—	26	—	220	—	—	—	1800	—	—	—	—	—	—
MD50-11-4068	50-603503	397–397	—	21	—	200	—	—	—	2100	—	—	—	—	—	—
MD50-11-4065	50-603503	450–450	—	—	—	190	—	—	—	2400	—	—	—	—	—	—
MD50-11-3943	50-613182	550–550	—	—	—	—	130	—	—	31	—	11	—	120	28	89
MD50-11-3942	50-613182	600–600	—	—	2.2	—	38	—	—	2.2	—	2.7	—	17	3.9	13
MD50-11-3953	50-613182	620–620	—	—	—	15	—	—	—	290	—	—	—	—	—	—
MD50-11-3941	50-613182	632.5–632.5	—	—	100	—	1700	—	—	—	—	110	35	750	170	590
MD50-11-3947	50-613183	30–30	—	—	—	1100	—	—	—	14000	—	—	—	—	—	—
MD50-11-3948	50-613183	500–500	—	—	—	270 (J-)	—	—	—	16000 (J-)	—	—	—	—	—	—
MD50-11-3949	50-613183	550–550	—	—	—	130	—	—	—	6500	—	—	—	—	—	—
MD50-11-3950	50-613183	600–600	—	—	—	—	—	—	—	1400	—	—	—	—	—	—
MD50-11-3951	50-613183	630–630	—	—	—	—	—	—	—	1400	—	—	—	—	—	—

Table 6.2-2 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-3952	50-613183	642.5–642.5	2.3	—	4.3	—	—	—	—	—	—	—	—	1.4	1.4	—
MD50-11-3959	50-613184	30–30	—	—	—	57 (J-)	—	—	—	2700 (J-)	—	—	—	—	—	—
MD50-11-3956	50-613184	500–500	—	28	—	64	—	—	—	3400	—	—	—	—	—	—
MD50-11-3958	50-613184	550–550	—	—	—	—	—	—	—	2000 (J-)	—	—	—	—	—	—
MD50-11-3954	50-613184	600–600	—	—	—	—	—	—	—	680 (J-)	—	—	—	—	—	—
MD50-11-3957	50-613184	652–652	2.4 (J-)	—	40 (J-)	—	5.2 (J-)	—	—	150 (J-)	2.6 (J-)	2.9 (J-)	—	5.8 (J-)	1.7 (J-)	4.1 (J-)
MD50-11-3955	50-613184	664.5–664.5	—	—	—	—	8.1 (J-)	—	—	31 (J-)	—	4.3 (J-)	—	7.7 (J-)	2.1 (J-)	5.6 (J-)
MD50-11-3962	50-613185	145–145	—	—	—	—	—	—	—	3500	—	—	—	—	—	—
MD50-11-3963	50-613185	205–205	—	1.5	1.8	—	88	—	—	—	—	7.6	—	49	12	36
MD50-11-3964	50-613185	235–235	—	—	—	—	300	—	—	—	—	15	—	110	25	87
MD50-11-3965	50-613185	280–280	—	—	—	—	14	—	—	27	—	3.6	—	11	2.8	7.8
MD50-11-3966	50-613185	350–350	—	—	—	—	1.1	—	—	29	—	—	—	—	—	—
MD50-11-3967	50-613185	450–450	—	—	—	—	—	—	—	930	—	—	—	—	—	—
MD50-11-3969	50-613185	600–600	—	—	—	—	3.1	—	—	110	—	—	—	—	1.3	—
MD50-11-3968	50-613185	675–675	—	—	—	—	4	—	—	—	—	—	—	—	—	—
MD50-11-3970	50-613185	688–688	—	—	—	2.8	14	—	—	18	—	7.2	2.9	18	6.9	11

Notes: Results are in µg/m^3. Data qualifiers are defined in Appendix A.

* — = Analysis not requested.

Table 6.2-3
VOCs Detected in Vapor Samples in Third Quarter FY2011

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-6010	50-24784	25–25	—*	—	—	—	—	37 (J)	270	—	—	38	—	—	—	—	—
MD50-11-6007	50-24784	96–96	—	—	—	—	—	130 (J)	640	—	—	85	—	—	58	—	—
MD50-11-6011	50-24784	155–155	—	—	—	—	—	140 (J)	140	—	—	67	—	—	25	—	—
MD50-11-6005	50-24784	215–215	—	—	—	—	—	250	100	—	—	100	—	—	—	—	—
MD50-11-6009	50-24784	244–244	—	—	—	—	—	180 (J)	—	—	—	81	—	—	—	—	—
MD50-11-6006	50-24784	289–289	—	—	—	—	—	520	87	—	—	—	—	—	—	—	—
MD50-11-6008	50-24784	362–362	16	46	—	—	—	76 (J)	4.9	—	—	8.6	0.96	—	—	23	22
MD50-11-6004	50-24784	411–411	—	—	—	—	—	300	—	—	—	150	—	—	—	—	—
MD50-11-6003	50-24784	450–450	—	—	—	—	—	320	—	—	—	170	—	—	—	—	—
MD50-11-6022	50-24813	25–25	—	—	—	—	—	—	2100	—	—	1900	—	—	—	—	—
MD50-11-6021	50-24813	99–99	—	—	—	—	—	—	2300	—	—	1900	—	—	—	—	—
MD50-11-6019	50-24813	150–150	—	—	—	—	—	1900	2500	—	—	890	—	450	—	—	—
MD50-11-6020	50-24813	207–207	—	—	—	—	—	2600	2700	—	—	670	—	360	—	—	—
MD50-11-6018	50-24813	241–241	—	—	—	—	—	1500	1000	—	—	500	—	—	—	—	—
MD50-11-6017	50-24813	286–286	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6013	50-24813	358–358	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6015	50-24813	408–408	—	—	—	—	—	—	—	—	—	720	—	—	—	—	—
MD50-11-6016	50-24813	450–450	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6014	50-24813	600–600	—	—	—	—	—	—	—	—	—	260	—	—	—	—	—
MD50-11-6062	50-24822	25–25	—	—	—	—	—	—	62	—	—	43 (J-)	—	—	—	—	—
MD50-11-6059	50-24822	81–81	—	—	—	—	—	—	100	—	—	—	—	16	—	—	—
MD50-11-6061	50-24822	142–142	—	10	—	—	—	—	30	—	—	35 (J-)	—	—	—	—	—
MD50-11-6058	50-24822	204–204	—	—	—	—	—	—	540	—	—	1200 (J)	—	—	—	—	—
MD50-11-6060	50-24822	235–235	—	—	—	—	—	—	110	—	—	170 (J-)	—	—	—	—	—
MD50-11-6055	50-24822	280–280	—	—	—	—	—	—	270	—	—	1200 (J)	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-6056	50-24822	351–351	—	—	—	—	—	130 (J-)	110	—	—	870 (J)	—	—	—	—	—
MD50-11-6063	50-24822	402–402	9.8	—	—	—	3.2	—	—	—	—	2.4	—	—	—	—	—
MD50-11-6057	50-24822	450–450	—	—	—	—	—	61 (J-)	—	—	—	—	—	—	—	—	—
MD50-11-6083	50-603061	25–25	—	—	—	—	—	—	—	—	—	690	230	—	—	—	—
MD50-11-6080	50-603061	76–76	5.8	5.9	—	—	—	—	—	—	—	3.2	—	—	—	3.6	2.8
MD50-11-6079	50-603061	128–128	—	—	—	—	—	—	12	—	—	65	330	—	—	—	—
MD50-11-6078	50-603061	190–190	7.7 (J)	5	—	—	—	—	—	—	—	5.8	18	—	—	—	—
MD50-11-6081	50-603061	228–228	—	—	—	—	—	—	—	—	—	290	1400	—	—	—	—
MD50-11-6077	50-603061	274–274	—	—	—	—	—	93 (J)	—	—	—	130	400	—	—	—	—
MD50-11-6082	50-603061	347–347	—	—	—	—	—	—	—	—	—	320	1400	—	—	—	—
MD50-11-6076	50-603061	397–397	—	14	—	—	—	66 (J)	—	—	—	95	75	—	—	—	—
MD50-11-6075	50-603061	450–450	6.6 (J)	—	—	—	—	73 (J)	—	—	—	120	51	—	—	—	—
MD50-11-6088	50-603062	25–25	14	—	—	—	—	—	24	—	—	45	—	—	—	—	—
MD50-11-6085	50-603062	64–64	—	—	—	—	—	—	41	—	—	78	—	—	—	—	—
MD50-11-6087	50-603062	122–122	—	—	—	—	—	—	44	—	—	250 (J)	—	—	—	—	—
MD50-11-6092	50-603062	184–184	—	—	—	—	—	—	—	—	—	200	—	—	—	—	—
MD50-11-6086	50-603062	217–217	—	—	—	—	—	—	—	—	—	250 (J)	—	—	—	—	—
MD50-11-6090	50-603062	263–263	—	—	—	—	—	—	—	—	—	200	—	—	—	—	—
MD50-11-6094	50-603062	337–337	—	—	—	—	—	30	—	—	—	110	—	—	—	—	—
MD50-11-6091	50-603062	387–387	—	—	—	—	—	20 (J)	—	—	—	80	—	—	—	—	—
MD50-11-6089	50-603062	450–450	—	—	—	—	—	20 (J)	—	—	—	79	—	—	—	—	—
MD50-11-6102	50-603063	25–25	—	—	—	—	—	—	190	—	—	290	170	—	—	—	—
MD50-11-6100	50-603063	76–76	—	—	—	—	—	220 (J+)	210	—	—	340	210	—	—	—	—
MD50-11-6099	50-603063	128–128	—	—	—	—	—	—	260	—	—	440	280	—	—	—	—
MD50-11-6097	50-603063	190–190	5	—	—	—	—	3.9 (J)	4.5	—	—	7.8	2.7	—	—	—	—
MD50-11-6098	50-603063	228–228	—	—	—	—	—	—	230	—	—	—	—	—	—	—	—
MD50-11-6103	50-603063	274–274	—	—	—	—	—	480 (J+)	200	—	—	300	—	—	—	—	—
MD50-11-6095	50-603063	347–347	—	—	—	—	—	—	120	—	—	170 (J)	—	—	—	—	—
MD50-11-6101	50-603063	397–397	—	—	—	—	—	160 (J+)	79	—	—	130	—	—	—	—	—
MD50-11-6096	50-603063	450–450	—	—	—	—	—	200	130	—	—	210	—	—	—	—	—
MD50-11-6108	50-603064	25–25	—	—	—	—	—	—	150	—	—	41	—	—	—	—	—
MD50-11-6107	50-603064	66–66	—	—	—	—	—	—	350	—	—	240	250	—	—	—	—
MD50-11-6105	50-603064	113–113	—	—	—	—	—	—	880	—	—	600	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-6110	50-603064	176–176	—	—	—	—	—	—	580	—	—	970	560	—	—	—	—
MD50-11-6111	50-603064	214–214	—	—	—	—	—	—	500	—	—	970	—	—	—	—	—
MD50-11-6112	50-603064	259–259	—	—	—	—	—	—	280	—	—	800	—	—	—	—	—
MD50-11-6113	50-603064	332–332	—	—	—	—	—	—	—	—	—	470	—	—	—	—	—
MD50-11-6109	50-603064	482–482	—	—	—	—	—	—	—	—	—	310	—	—	—	—	—
MD50-11-6106	50-603064	500–500	9.7	8.9	—	—	—	29	—	—	—	100	—	—	—	—	—
MD50-11-6027	50-603383	26–26	—	—	—	—	—	100 (J)	88	—	—	90	21	—	72	—	—
MD50-11-6025	50-603383	85–85	—	—	—	—	—	110 (J)	100	—	—	—	37	11	120	—	—
MD50-11-6024	50-603383	139–139	—	—	—	—	—	44 (J)	38	—	—	60	12	—	66	—	—
MD50-11-6032	50-603383	206–206	5.1	—	—	—	—	—	—	—	—	2.6	—	—	—	—	—
MD50-11-6026	50-603383	244–244	—	—	—	—	—	440 (J+)	110	—	—	250 (J)	—	72	350	—	—
MD50-11-6029	50-603383	286–286	—	—	—	—	—	87 (J)	23	—	—	60	—	—	53	—	—
MD50-11-6028	50-603383	359–359	—	—	—	—	—	170 (J)	—	—	—	160	16	—	—	—	—
MD50-11-6030	50-603383	408–408	—	—	—	—	—	230 (J)	—	—	—	140	—	—	—	—	—
MD50-11-6031	50-603383	450–450	—	—	—	—	—	170 (J)	43	—	—	91	—	15	97	—	—
MD50-11-6041	50-603467	26–26	—	—	—	—	—	360 (J)	360	—	—	—	—	—	—	—	—
MD50-11-6043	50-603467	91–91	—	—	—	—	—	—	660	—	—	—	—	—	—	—	—
MD50-11-6038	50-603467	143–143	—	—	—	—	—	670 (J)	570	—	—	210	—	—	—	—	—
MD50-11-6042	50-603467	206–206	—	—	—	—	—	—	630	—	—	—	—	—	—	—	—
MD50-11-6037	50-603467	244–244	—	—	—	—	—	930 (J)	640	—	—	330	—	—	—	—	—
MD50-11-6039	50-603467	287–287	—	—	—	—	—	—	360	—	—	—	—	—	—	—	—
MD50-11-6040	50-603467	360–360	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6036	50-603467	409–409	—	—	—	—	—	140 (J)	—	—	—	220	—	—	—	—	—
MD50-11-6035	50-603467	500–500	—	—	—	—	—	110 (J+)	—	—	—	92 (J)	—	—	—	—	—
MD50-11-6034	50-603467	600–600	98	—	—	200	—	200 (J)	—	—	—	170	—	—	—	—	—
MD50-11-6051	50-603468	92–92	—	—	90	—	—	240	260	31	—	93	—	60	—	—	—
MD50-11-6050	50-603468	142–142	—	—	—	—	—	—	270	—	—	—	—	88	—	—	—
MD50-11-6052	50-603468	198–198	—	—	—	—	—	—	540	—	—	340	—	200	—	—	—
MD50-11-6049	50-603468	233–233	—	—	—	—	—	400 (J)	510	—	—	410	—	—	—	—	—
MD50-11-6047	50-603468	282–282	—	—	—	—	—	—	570	—	—	680 (J)	—	210	—	—	—
MD50-11-6046	50-603468	354–354	—	—	—	—	—	400 (J)	400	—	—	1100 (J)	—	180	—	—	—
MD50-11-6045	50-603468	403–403	—	—	—	—	—	220 (J)	—	—	—	770 (J)	—	—	—	—	—
MD50-11-6048	50-603468	450–450	—	—	—	—	—	130 (J)	—	—	—	320 (J)	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-5978	50-603470	30–30	—	—	—	—	—	—	760	—	—	350	—	—	—	—	—
MD50-11-5980	50-603470	83–83	—	—	—	—	—	—	820	—	—	160	—	110	—	—	—
MD50-11-5982	50-603470	143–143	—	—	—	—	—	—	1300	—	—	700	—	—	—	—	—
MD50-11-5977	50-603470	203–203	—	—	—	—	—	—	1100	—	—	1100	—	—	—	—	—
MD50-11-5976	50-603470	233–233	—	—	—	—	—	—	630	—	—	590	—	—	—	—	—
MD50-11-5979	50-603470	278–278	—	—	—	—	—	—	840	—	—	1100	—	—	—	—	—
MD50-11-5973	50-603470	351–351	—	—	—	—	—	280	190	—	—	590	—	70	—	—	—
MD50-11-5972	50-603470	450–450	—	—	—	—	—	—	—	—	—	520	—	—	—	—	—
MD50-11-5975	50-603470	600–600	—	—	—	—	—	84	—	—	—	250	—	—	—	—	—
MD50-11-5974	50-603470	650–650	9.1	2.3	—	—	—	11	—	—	—	52	—	—	—	—	—
MD50-11-5990	50-603471	90–90	—	—	—	—	—	1400	1600	—	—	—	—	—	—	—	—
MD50-11-5989	50-603471	146–146	—	—	—	—	—	—	1300	—	—	—	—	—	—	—	—
MD50-11-5988	50-603471	209–209	—	—	—	—	—	—	72	—	—	—	—	—	—	—	—
MD50-11-5987	50-603471	242–242	18	6.9	—	—	—	—	26	—	—	17	—	—	—	—	—
MD50-11-6156	50-603471	288–288	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-5986	50-603471	360–360	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-5983	50-603471	410–410	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-5985	50-603471	450–450	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6000	50-603472	27–27	—	—	—	—	—	—	320	—	—	—	—	—	—	—	—
MD50-11-5998	50-603472	93–93	—	—	—	—	—	—	340	—	—	62	—	40	47	—	—
MD50-11-6001	50-603472	146–146	—	—	—	—	—	—	380	—	—	—	—	—	—	—	—
MD50-11-5997	50-603472	210–210	—	—	—	—	—	—	370	—	—	—	—	—	—	—	—
MD50-11-5999	50-603472	247–247	—	—	—	—	—	—	250	—	—	—	—	—	—	—	—
MD50-11-5995	50-603472	292–292	—	—	—	—	—	—	360	—	—	—	—	—	—	—	—
MD50-11-5994	50-603472	364–364	—	—	—	—	—	—	82	—	—	200	—	—	—	—	—
MD50-11-5993	50-603472	414–414	—	—	—	—	—	—	—	—	—	220	—	—	—	—	—
MD50-11-5996	50-603472	450–450	—	—	—	—	—	—	—	—	—	310	—	—	—	—	—
MD50-11-6072	50-603503	25–25	15	1.6	—	5.8	—	41 (J)	58	1.9	—	31	—	5.9	7.1	—	—
MD50-11-5992	50-603503	80–80	—	—	—	—	—	—	86	—	—	—	—	—	—	—	—
MD50-11-6073	50-603503	133–133	—	—	—	—	—	64	86	—	39	45	—	—	22	—	—
MD50-11-6069	50-603503	198–198	—	—	—	—	—	74 (J)	99	—	—	46	—	19	34	—	—
MD50-11-6068	50-603503	237–237	—	—	—	—	—	120 (J)	140	—	—	74	—	28	41	—	—
MD50-11-6070	50-603503	278–278	—	—	—	—	—	110	110	—	—	—	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Acetone	Benzene	Bromomethane	Butanone[2-]	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloromethane	Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	Dichlorodifluoromethane	Dichloroethene[1,1-]	Dichloroethene[cis-1,2-]	Dichloropropane[1,2-]	Ethylbenzene	Ethyltoluene[4-]
MD50-11-6065	50-603503	347–347	—	—	—	—	—	42	42	—	—	29	—	—	—	—	—
MD50-11-6066	50-603503	397–397	—	—	—	—	—	38	21	—	—	25	—	—	—	—	—
MD50-11-6067	50-603503	450–450	—	—	—	—	—	100	—	—	—	69	—	—	—	—	—
MD50-11-5933	50-613182	500–500	—	—	—	—	—	230	—	—	—	—	—	—	—	—	—
MD50-11-5934	50-613182	550–550	—	—	—	—	—	180	—	—	—	82	—	—	—	—	—
MD50-11-5936	50-613182	600–600	5	27	—	—	—	—	—	—	—	4.2	—	—	—	3.3	2.6
MD50-11-5937	50-613182	620–620	4.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-5935	50-613182	632.5–632.5	13	—	—	—	—	2.8	—	—	—	4	—	—	—	—	—
MD50-11-5942	50-613183	30–30	—	—	—	—	—	250 (J-)	—	—	—	780 (J)	—	—	—	—	—
MD50-11-5939	50-613183	500–500	—	—	—	—	—	80	—	—	—	150	—	—	—	—	—
MD50-11-5943	50-613183	550–550	—	—	—	—	—	3000 (J-)	3200	—	—	630 (J)	200	180	—	—	—
MD50-11-5941	50-613183	600–600	—	—	—	—	—	220 (J-)	—	—	—	660 (J)	—	—	—	—	—
MD50-11-5944	50-613183	630–630	—	—	—	—	—	230 (J-)	—	—	—	660 (J)	—	—	—	—	—
MD50-11-5940	50-613183	642.5–642.5	—	21	—	—	110	2.8	—	—	—	7	—	—	—	5.9	5.6
MD50-11-5948	50-613184	30–30	—	—	—	—	—	100 (J+)	110	—	—	61	—	—	—	—	—
MD50-11-5951	50-613184	500–500	—	—	—	—	—	260 (J+)	—	—	—	180	—	—	—	—	—
MD50-11-5946	50-613184	550–550	—	—	—	—	—	180 (J+)	—	—	—	180	—	—	—	—	—
MD50-11-5947	50-613184	600–600	10	4.2	—	—	—	49	—	—	—	90	—	—	—	—	—
MD50-11-5950	50-613184	652–652	73	—	—	—	250	19	—	—	—	47	—	—	—	—	—
MD50-11-5949	50-613184	664.5–664.5	12	1.5	—	3.7	52	7.2	—	—	—	13	—	—	—	2.1	—
MD50-11-5960	50-613185	85–85	—	—	—	—	—	19	11	—	—	16 (J-)	—	—	—	—	—
MD50-11-5961	50-613185	145–145	—	—	—	—	—	98 (J)	73	—	—	120	—	—	—	—	—
MD50-11-5957	50-613185	205-205	—	—	—	—	—	65 (J)	38	—	—	91	—	—	—	—	—
MD50-11-5962	50-613185	235–235	—	—	—	—	—	250 (J)	65	—	—	230	—	—	—	—	—
MD50-11-5959	50-613185	280–280	—	—	—	—	—	94 (J)	—	—	—	—	—	—	—	—	—
MD50-11-5955	50-613185	350–350	—	—	—	—	—	86	—	—	—	100	—	—	—	—	—
MD50-11-5954	50-613185	450–450	—	—	—	—	200	66	—	—	—	96	—	—	—	—	—
MD50-11-5953	50-613185	600–600	17	3.4	—	—	12	18	—	—	5.4	40	—	—	—	2	—
MD50-11-5958	50-613185	675–675	—	1.6	—	—	35	7.8	—	—	—	5.8	—	—	—	1.8	—
MD50-11-5956	50-613185	688–688	15	1.5	—	4.3	50	5.3	—	—	—	17	—	—	—	2.5	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-6010	50-24784	25–25	—	—	—	2600	—	43	61	1100	—	—	—	—	—	—
MD50-11-6007	50-24784	96–96	—	—	—	3400	—	140	73	3200	—	—	—	—	—	—
MD50-11-6011	50-24784	155–155	—	—	—	1400	—	80	32	2300	—	—	—	—	—	—
MD50-11-6005	50-24784	215–215	—	—	—	2000	—	89	40	3600	—	—	—	—	—	—
MD50-11-6009	50-24784	244–244	—	—	—	280	5	—	—	630	7.2	—	—	—	—	—
MD50-11-6006	50-24784	289–289	—	—	—	3200	—	110	47	5000	—	—	—	—	—	—
MD50-11-6008	50-24784	362–362	—	1.2	4.8	240	120	13	3.9	510	6.4	25	7.5	91	23	68
MD50-11-6004	50-24784	411–411	—	—	—	630	—	—	—	1400	—	—	—	—	—	—
MD50-11-6003	50-24784	450–450	—	—	—	530	—	—	—	1200	—	—	—	—	—	—
MD50-11-6022	50-24813	25–25	—	1600	—	—	—	—	—	93000	—	—	—	—	—	—
MD50-11-6021	50-24813	99–99	—	1200	—	—	—	—	—	93000	—	—	—	—	—	—
MD50-11-6019	50-24813	150–150	—	540	—	—	—	—	—	48000	—	—	—	—	—	—
MD50-11-6020	50-24813	207–207	—	—	—	580	—	—	—	39000	—	—	—	—	—	—
MD50-11-6018	50-24813	241–241	—	—	—	370	—	—	—	15000	—	—	—	—	—	—
MD50-11-6017	50-24813	286–286	—	—	—	—	—	—	—	79000	—	—	—	—	—	—
MD50-11-6013	50-24813	358–358	—	—	—	—	—	—	—	52000	—	—	—	—	—	—
MD50-11-6015	50-24813	408–408	—	—	—	—	—	—	—	36000	—	—	—	—	—	—
MD50-11-6016	50-24813	450–450	—	—	—	—	—	—	—	16000	—	—	—	—	—	—
MD50-11-6014	50-24813	600–600	—	—	—	—	—	—	—	3100	—	—	—	—	—	—
MD50-11-6062	50-24822	25–25	—	—	—	15	—	—	—	1500	—	—	—	—	—	—
MD50-11-6059	50-24822	81–81	—	—	—	—	—	—	—	2400	—	—	—	—	—	—
MD50-11-6061	50-24822	142–142	—	—	—	—	13	—	—	1100	—	—	—	—	—	—
MD50-11-6058	50-24822	204–204	—	440	—	—	—	—	—	33000	—	—	—	—	—	—
MD50-11-6060	50-24822	235–235	—	—	—	—	—	—	—	6900	—	—	—	—	—	—
MD50-11-6055	50-24822	280–280	—	360	—	—	—	—	—	28000	—	—	—	—	—	—
MD50-11-6056	50-24822	351–351	—	190	—	—	—	—	—	18000	—	—	—	—	—	—
MD50-11-6063	50-24822	402–402	—	1.7	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6057	50-24822	450–450	—	—	—	—	—	—	—	4300	—	—	—	—	—	—
MD50-11-6083	50-603061	25–25	—	—	—	—	—	19000	1900	390	—	—	—	—	—	—
MD50-11-6080	50-603061	76–76	—	—	—	—	21	20	—	5.1	3.7	—	—	14	3.3	11

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-6079	50-603061	128–128	—	—	—	48	—	5400	1000	580	—	—	—	—	—	—
MD50-11-6078	50-603061	190–190	—	—	—	—	18	330	48	38	7.2	—	—	8.6	—	8.6
MD50-11-6081	50-603061	228–228	—	—	—	200	—	19000	5200	3600	—	—	—	—	—	—
MD50-11-6077	50-603061	274–274	—	—	—	81	—	11000	1100	1600	—	—	—	—	—	—
MD50-11-6082	50-603061	347–347	—	—	—	180	—	25000	5500	2100	—	—	—	—	—	—
MD50-11-6076	50-603061	397–397	—	—	—	32	30	2500	90	760	11	—	—	—	—	—
MD50-11-6075	50-603061	450–450	—	—	—	26	—	1800	41	650	12	—	—	—	—	—
MD50-11-6088	50-603062	25–25	—	—	—	—	—	110	25	1500	—	—	—	—	—	—
MD50-11-6085	50-603062	64–64	—	—	—	—	—	150	32	2400	—	—	—	—	—	—
MD50-11-6087	50-603062	122–122	—	—	—	—	—	470	—	5700	—	—	—	—	—	—
MD50-11-6092	50-603062	184–184	—	—	—	—	—	460	—	—	—	—	—	—	—	—
MD50-11-6086	50-603062	217–217	—	42	—	—	—	440	—	5800	—	—	—	—	—	—
MD50-11-6090	50-603062	263–263	—	—	—	—	—	270	—	4700	—	—	—	—	—	—
MD50-11-6094	50-603062	337–337	—	—	—	—	—	75	—	2000	—	—	—	—	—	—
MD50-11-6091	50-603062	387–387	—	—	—	—	—	34	—	1000	—	—	—	—	—	—
MD50-11-6089	50-603062	450–450	—	—	—	—	—	15	—	580	—	—	—	—	—	—
MD50-11-6102	50-603063	25–25	—	—	—	720	—	5300	830	6300	—	—	—	—	—	—
MD50-11-6100	50-603063	76–76	—	—	—	840	—	6200	950	7400	—	—	—	—	—	—
MD50-11-6099	50-603063	128–128	—	—	—	960	—	6400	1000	11000	—	—	—	—	—	—
MD50-11-6097	50-603063	190–190	—	—	—	13	—	63	8.1	220	—	—	—	—	—	—
MD50-11-6098	50-603063	228–228	—	82	—	610	—	2600	300	9700	—	—	—	—	—	—
MD50-11-6103	50-603063	274–274	—	86 (J-)	—	840	—	2000	240	14000	—	—	—	—	—	—
MD50-11-6095	50-603063	347–347	—	91	—	330	—	860	—	7500	—	—	—	—	—	—
MD50-11-6101	50-603063	397–397	—	67 (J-)	—	260	—	640	—	5800	—	—	—	—	—	—
MD50-11-6096	50-603063	450–450	—	68	—	310	—	—	—	7900	—	—	—	—	—	—
MD50-11-6108	50-603064	25–25	—	—	—	150	—	1500	380	2600	—	—	—	—	—	—
MD50-11-6107	50-603064	66–66	—	—	—	320	—	8100	1300	7000	—	—	—	—	—	—
MD50-11-6105	50-603064	113–113	—	—	—	560	—	13000	2800	32000	—	—	—	—	—	—
MD50-11-6110	50-603064	176–176	—	350	—	460	—	13000	2300	39000	—	—	—	—	—	—
MD50-11-6111	50-603064	214–214	—	350	—	—	—	13000	1900	37000	—	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-6112	50-603064	259–259	—	—	—	—	—	10000	940	30000	—	—	—	—	—	—
MD50-11-6113	50-603064	332–332	—	—	—	150	—	3700	160	7200	—	—	—	—	—	—
MD50-11-6109	50-603064	482–482	—	—	—	91	—	960	—	6500	—	—	—	—	—	—
MD50-11-6106	50-603064	500–500	—	—	—	—	15	51	—	600	—	—	—	—	—	—
MD50-11-6027	50-603383	26–26	—	—	—	750	—	960	180	2400	—	—	—	—	—	—
MD50-11-6025	50-603383	85–85	—	—	—	730	—	1100	190	2800	—	—	—	—	—	—
MD50-11-6024	50-603383	139–139	—	—	—	240	—	340	53	1100	—	—	—	—	—	—
MD50-11-6032	50-603383	206–206	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-6026	50-603383	244–244	—	100	—	1400	—	790	200	6400	—	—	—	—	—	—
MD50-11-6029	50-603383	286–286	—	—	—	260	—	120	34	1300	—	—	—	—	—	—
MD50-11-6028	50-603383	359–359	—	—	—	230	—	220	32	1500	—	—	—	—	—	—
MD50-11-6030	50-603383	408–408	—	—	—	260	—	52	—	1600	—	—	—	—	—	—
MD50-11-6031	50-603383	450–450	—	22	—	500	—	230	62	2700	—	—	—	—	—	—
MD50-11-6041	50-603467	26–26	—	—	—	190	—	—	—	6300	—	—	—	—	—	—
MD50-11-6043	50-603467	91–91	—	—	—	—	—	—	—	12000	—	—	—	—	—	—
MD50-11-6038	50-603467	143–143	—	140	—	370	—	—	—	16000	—	—	—	—	—	—
MD50-11-6042	50-603467	206–206	—	290	—	670	—	—	—	25000	—	—	—	—	—	—
MD50-11-6037	50-603467	244–244	—	560	—	660	—	—	—	29000	—	—	—	—	—	—
MD50-11-6039	50-603467	287–287	—	390	—	500	—	—	—	21000	—	—	—	—	—	—
MD50-11-6040	50-603467	360–360	—	—	—	—	—	—	—	11000	—	—	—	—	—	—
MD50-11-6036	50-603467	409–409	—	120	—	290	—	—	—	11000	—	—	—	—	—	—
MD50-11-6035	50-603467	500–500	—	—	—	79	—	—	—	3300	—	—	—	—	—	—
MD50-11-6034	50-603467	600–600	1200	—	—	95	—	—	—	4300	—	—	—	—	—	—
MD50-11-6051	50-603468	92–92	—	—	—	81	—	—	—	5300	—	—	—	—	—	—
MD50-11-6050	50-603468	142–142	—	—	—	160	—	—	—	12000	—	—	—	—	—	—
MD50-11-6052	50-603468	198–198	—	—	—	310	—	—	—	24000	—	—	—	—	—	—
MD50-11-6049	50-603468	233–233	—	—	—	—	—	—	—	26000	—	—	—	—	—	—
MD50-11-6047	50-603468	282–282	—	730	—	450	—	—	—	29000	—	—	—	—	—	—
MD50-11-6046	50-603468	354–354	—	—	—	530	—	—	—	34000	—	—	—	—	—	—
MD50-11-6045	50-603468	403–403	—	320	—	330	—	—	—	20000	—	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-6048	50-603468	450–450	—	99	—	140	—	—	—	10000	—	—	—	—	—	—
MD50-11-5978	50-603470	30–30	—	—	—	680	—	260	—	13000	—	—	—	—	—	—
MD50-11-5980	50-603470	83–83	—	—	—	430	—	—	—	13000	—	—	—	—	—	—
MD50-11-5982	50-603470	143–143	—	—	—	570	—	—	—	34000	—	—	—	—	—	—
MD50-11-5977	50-603470	203–203	—	550	—	—	—	—	—	55000	—	—	—	—	—	—
MD50-11-5976	50-603470	233–233	—	350	—	—	—	—	—	32000	—	—	—	—	—	—
MD50-11-5979	50-603470	278–278	—	690	—	—	—	—	—	58000	—	—	—	—	—	—
MD50-11-5973	50-603470	351–351	—	190	—	160	—	280	—	25000	—	—	—	—	—	—
MD50-11-5972	50-603470	450–450	—	—	—	—	—	—	—	16000	—	—	—	—	—	—
MD50-11-5975	50-603470	600–600	—	—	—	—	—	—	—	1800	—	—	—	—	—	—
MD50-11-5974	50-603470	650–650	—	4.5	—	—	36	—	—	35	3.6	—	—	—	—	—
MD50-11-5990	50-603471	90–90	—	—	—	820	—	—	—	20000	—	—	—	—	—	—
MD50-11-5989	50-603471	146–146	—	1500	—	—	—	—	—	63000	—	—	—	—	—	—
MD50-11-5988	50-603471	209–209	—	50	—	—	58	—	—	1800	—	—	—	—	—	—
MD50-11-5987	50-603471	242–242	—	31	—	16	29	—	—	890	—	—	—	—	—	—
MD50-11-6156	50-603471	288–288	—	2000	—	—	—	—	—	67000	—	—	—	—	—	—
MD50-11-5986	50-603471	360–360	—	300	—	—	—	—	—	15000	—	—	—	—	—	—
MD50-11-5983	50-603471	410–410	—	—	—	—	—	—	—	21000	—	—	—	—	—	—
MD50-11-5985	50-603471	450–450	—	—	—	—	—	—	—	31000	—	—	—	—	—	—
MD50-11-6000	50-603472	27–27	—	—	—	550	—	—	51	3200	—	—	—	—	—	—
MD50-11-5998	50-603472	93–93	—	48	—	450	—	—	—	3800	—	—	—	—	—	—
MD50-11-6001	50-603472	146–146	—	250	—	510	—	—	—	6900	—	—	—	—	—	—
MD50-11-5997	50-603472	210–210	—	410	—	680	—	—	—	14000	—	—	—	—	—	—
MD50-11-5999	50-603472	247–247	—	310	—	510	—	—	—	10000	—	—	—	—	—	—
MD50-11-5995	50-603472	292–292	—	590	—	850	—	—	—	18000	—	—	—	—	—	—
MD50-11-5994	50-603472	364–364	—	120	—	470	—	—	—	10000	—	—	—	—	—	—
MD50-11-5993	50-603472	414–414	—	100	—	570	—	—	—	12000	—	—	—	—	—	—
MD50-11-5996	50-603472	450–450	—	—	—	610	—	—	—	14000	—	—	—	—	—	—
MD50-11-6072	50-603503	25–25	—	9.1	—	250	2.2	38	9.8	1300	4.1	—	—	—	—	—
MD50-11-5992	50-603503	80–80	—	—	—	280	—	93	—	2300	—	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-6073	50-603503	133–133	—	28	—	280	—	61	—	2500	—	—	—	—	—	—
MD50-11-6069	50-603503	198–198	—	66	—	370	—	—	—	3400	—	—	—	—	—	—
MD50-11-6068	50-603503	237–237	—	110	—	600	—	—	—	5700	—	—	—	—	—	—
MD50-11-6070	50-603503	278–278	—	110	—	480	—	—	—	6300	—	—	—	—	—	—
MD50-11-6065	50-603503	347–347	—	20	—	160	—	—	—	1800	—	—	—	—	—	—
MD50-11-6066	50-603503	397–397	—	12	—	120	—	—	—	1600	—	—	—	—	—	—
MD50-11-6067	50-603503	450–450	—	17	—	210	—	—	—	3400	—	—	—	—	—	—
MD50-11-5933	50-613182	500–500	—	—	—	200	—	—	—	4500	—	—	—	—	—	—
MD50-11-5934	50-613182	550–550	—	—	—	150	—	—	—	3600	—	—	—	—	—	—
MD50-11-5936	50-613182	600–600	—	—	2.1	—	31	—	—	5.2	—	2.7	—	—	—	—
MD50-11-5937	50-613182	620–620	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MD50-11-5935	50-613182	632.5-632.5	—	—	—	—	—	—	—	4.6	—	—	—	—	—	—
MD50-11-5942	50-613183	30–30	—	120	—	110	—	—	—	11000	—	—	—	—	—	—
MD50-11-5939	50-613183	500–500	—	—	—	27	—	—	—	1500	—	—	—	—	—	—
MD50-11-5943	50-613183	550–550	—	130	—	1200	—	310	—	15000	—	—	—	—	—	—
MD50-11-5941	50-613183	600–600	—	45	—	150	—	—	—	7000	—	—	—	—	—	—
MD50-11-5944	50-613183	630–630	—	—	—	170	—	—	—	7500	—	—	—	—	—	—
MD50-11-5940	50-613183	642.5-642.5	—	—	3.9	—	31	—	—	39	—	5.8	—	21	5.5	15
MD50-11-5948	50-613184	30–30	—	—	—	42	—	—	—	2100	—	—	—	—	—	—
MD50-11-5951	50-613184	500-500	—	—	—	38	—	—	—	3000	—	—	—	—	—	—
MD50-11-5946	50-613184	550–550	—	—	—	—	—	—	—	1800	—	—	—	—	—	—
MD50-11-5947	50-613184	600–600	—	—	—	—	5.9	—	—	580	—	—	—	—	—	—
MD50-11-5950	50-613184	652-652	—	—	10	—	—	—	—	160	—	—	—	—	—	—
MD50-11-5949	50-613184	664.5-664.5	—	—	—	—	3	—	—	61	—	—	—	—	—	—
MD50-11-5960	50-613185	85–85	—	—	—	7.5	—	—	—	460	—	—	—	—	—	—
MD50-11-5961	50-613185	145-145	—	100 (J)	—	—	—	—	—	3700	—	—	—	—	—	—
MD50-11-5957	50-613185	205–205	—	130 (J)	—	—	—	—	—	2900	—	—	—	—	—	—
MD50-11-5962	50-613185	235–35	—	120 (J)	—	100	—	—	—	7100	—	—	—	—	—	—
MD50-11-5959	50-613185	280–280	—	—	—	—	—	—	—	4500	—	—	—	—	—	—
MD50-11-5955	50-613185	350–350	—	—	—	—	—	—	—	3100	—	—	—	—	—	—

Table 6.2-3 (continued)

Sample ID	Location ID	Depth (ft)	Hexanone[2-]	Methylene Chloride	Styrene	Tetrachloroethene	Toluene	Trichloro-1,2,2-trifluoroethane[1,1,2-]	Trichloroethane[1,1,1-]	Trichloroethene	Trichlorofluoromethane	Trimethylbenzene[1,2,4-]	Trimethylbenzene[1,3,5-]	Xylene (Total)	Xylene[1,2-]	Xylene[1,3-]+Xylene[1,4-]
MD50-11-5954	50-613185	450–450	—	—	—	—	—	—	—	1400	—	—	—	—	—	—
MD50-11-5953	50-613185	600–600	2	—	—	2.7	4.9	—	—	120	—	—	—	4.7	1.5	3.1
MD50-11-5958	50-613185	675–675	—	—	—	—	3.3	—	—	26	—	—	—	1.3	1.3	—
MD50-11-5956	50-613185	688–688	—	8.9	—	—	3.4	—	—	16	—	—	—	2	2	—

Notes: Results are in $\mu g/m^3$. Data qualifiers are defined in Appendix A.

* — = Analysis not requested.

Table 6.2-4
Tritium Detected in Vapor Samples in First Quarter FY2011

Sample ID	Location ID	Depth (ft)	Tritium
MD50-10-27179	50-24784	25–25	3424.39
MD50-10-27176	50-24784	96–96	26930.3
MD50-10-27175	50-24784	155–155	4811.13
MD50-10-27181	50-24784	215–215	4376.64
MD50-10-27180	50-24784	244–244	3410.01
MD50-10-27178	50-24784	289–289	2637.69
MD50-10-27182	50-24784	362–362	1527.11
MD50-10-27177	50-24784	411–411	2133.35
MD50-10-27183	50-24784	450–450	1295.11
MD50-10-27186	50-24813	25–25	1461.9
MD50-10-27189	50-24813	99–99	15322.2
MD50-10-27185	50-24813	150–150	150165
MD50-10-27190	50-24813	207–207	6088.51
MD50-10-27193	50-24813	241–241	3376.21
MD50-10-27194	50-24813	241–241	4271.92
MD50-10-27191	50-24813	286–286	3649.94
MD50-10-27343	50-24813	358–358	2722
MD50-10-27192	50-24813	408–408	2592.53
MD50-10-27188	50-24813	450–450	1793.02
MD50-10-27195	50-24813	600–600	932.357
MD50-10-27227	50-24822	25–25	661.459
MD50-10-27229	50-24822	204–204	702.357
MD50-10-27233	50-24822	235–235	2341.01
MD50-10-27231	50-24822	280–280	587.23
MD50-10-27230	50-24822	351–351	1058.96
MD50-10-27249	50-603061	25–25	1149.9
MD50-10-27251	50-603061	76–76	2314.69
MD50-10-27247	50-603061	128–128	2606.74
MD50-10-27255	50-603061	190–190	1941.01
MD50-10-27248	50-603061	228–228	1504.95
MD50-10-27253	50-603061	274–274	3534.92
MD50-10-27252	50-603061	347–347	2654.12
MD50-10-27254	50-603061	397–397	839.172
MD50-10-27265	50-603062	64–64	914.559
MD50-10-27257	50-603062	122–122	5527.48
MD50-10-27259	50-603062	337–337	1850.9

Table 6.2-4 (continued)

Sample ID	Location ID	Depth (ft)	Tritium
MD50-10-27267	50-603063	25–25	2260.32
MD50-10-27272	50-603063	76–76	2094.8
MD50-10-27275	50-603063	128–128	1262.6
MD50-10-27268	50-603063	190–190	2335.43
MD50-10-27273	50-603063	228–228	1491.42
MD50-10-27269	50-603063	274–274	4126.76
MD50-10-27274	50-603063	347–347	1338.88
MD50-10-27271	50-603063	450–450	1640.14
MD50-10-27280	50-603064	25–25	761.357
MD50-10-27285	50-603064	66–66	733.386
MD50-10-27279	50-603064	113–113	2930.26
MD50-10-27283	50-603064	176–176	906.704
MD50-10-27277	50-603064	214–214	3015.69
MD50-10-27281	50-603064	259–259	2794.56
MD50-10-27278	50-603064	332–332	938.64
MD50-10-27282	50-603064	400–400	1691.06
MD50-10-27284	50-603064	500–500	620.463
MD50-10-27199	50-603383	26–26	260604
MD50-10-27197	50-603383	85–85	686091
MD50-10-27205	50-603383	139–139	949038
MD50-10-27204	50-603383	206–206	111487
MD50-10-27203	50-603383	244–244	307955
MD50-10-27201	50-603383	286–286	269984
MD50-10-27202	50-603383	359–359	228848
MD50-10-27200	50-603383	408–408	587105
MD50-10-27196	50-603383	450–450	455279
MD50-10-27210	50-603467	91–91	1308.37
MD50-10-27211	50-603467	143–143	837.86
MD50-10-27215	50-603467	206–206	553.942
MD50-10-27213	50-603467	287–287	718.525
MD50-10-27212	50-603467	360–360	1515.59
MD50-10-27218	50-603468	198–198	821.823
MD50-10-27219	50-603468	233–233	966.29
MD50-10-27226	50-603468	282–282	788.433
MD50-10-27223	50-603468	354–354	676.651
MD50-10-27222	50-603468	450–450	1056.93
MD50-10-27145	50-603470	30–30	56635.6
MD50-10-27149	50-603470	83–83	2948440
MD50-10-27144	50-603470	143–143	9032.82

Table 6.2-4 (continued)

Sample ID	Location ID	Depth (ft)	Tritium
MD50-10-27151	50-603470	203–203	15685.5
MD50-10-27147	50-603470	233–233	2004.08
MD50-10-27153	50-603470	278–278	2597.51
MD50-10-27146	50-603470	351–351	2016.49
MD50-10-27152	50-603470	450–450	802.788
MD50-10-27158	50-603471	30–30	18442.4
MD50-10-27155	50-603471	90–90	26565.2
MD50-10-27157	50-603471	146–146	6009.75
MD50-10-27162	50-603471	209–209	13236.6
MD50-10-27161	50-603471	242–242	7222.64
MD50-10-27160	50-603471	288–288	9746.33
MD50-10-27156	50-603471	360–360	7716.89
MD50-10-27163	50-603471	410–410	4170.76
MD50-10-27159	50-603471	450–450	5956.37
MD50-10-27165	50-603472	27–27	299759
MD50-10-27168	50-603472	93–93	6351.23
MD50-10-27170	50-603472	146–146	2794.7
MD50-10-27172	50-603472	210–210	13209.7
MD50-10-27166	50-603472	247–247	2747.59
MD50-10-27174	50-603472	292–292	9694.81
MD50-10-27167	50-603472	414–414	2046.2
MD50-10-27173	50-603472	450–450	5655.52
MD50-10-27243	50-603503	25–25	769.383
MD50-10-27237	50-603503	80–80	1015.89
MD50-10-27244	50-603503	133–133	1486.69
MD50-10-27238	50-603503	198–198	2338.17
MD50-10-27245	50-603503	237–237	1326.68
MD50-10-27239	50-603503	278–278	980.152
MD50-10-27242	50-603503	450–450	1326.62

Note: Results are in pCi/L.

Table 6.2-5
Tritium Detected in Vapor Samples in Second Quarter FY2011

Sample ID	Location ID	Depth (ft)	Tritium
MD50-11-4012	50-24784	25–25	3568.8
MD50-11-4010	50-24784	96–96	4038.74
MD50-11-4009	50-24784	155–155	6174.87
MD50-11-4006	50-24784	215–215	7007.02
MD50-11-4004	50-24784	244–244	3074.5
MD50-11-4008	50-24784	289–289	1871.12
MD50-11-4007	50-24784	362–362	3507.55
MD50-11-4005	50-24784	411–411	1516.3
MD50-11-4003	50-24784	450–450	1725.77
MD50-11-4023	50-24813	25–25	30450.9
MD50-11-4021	50-24813	99–99	40040.7
MD50-11-4020	50-24813	150–150	187502
MD50-11-4019	50-24813	207–207	4343.06
MD50-11-4018	50-24813	241–241	2738.5
MD50-11-4017	50-24813	286–286	4468.2
MD50-11-4014	50-24813	358–358	686.167
MD50-11-4013	50-24813	408–408	720.983
MD50-11-4015	50-24813	450–450	3375.43
MD50-11-4058	50-24822	25–25	873.3
MD50-11-4059	50-24822	81–81	1078.76
MD50-11-4057	50-24822	142–142	1510.41
MD50-11-4055	50-24822	204–204	938.98
MD50-11-4060	50-24822	235–235	1362.39
MD50-11-4061	50-24822	280–280	734.991
MD50-11-4056	50-24822	351–351	645.717
MD50-11-4064	50-24822	450–450	663.654
MD50-11-4080	50-603061	25–25	480.376
MD50-11-4081	50-603061	76–76	1890.98
MD50-11-4083	50-603061	128–128	972.27
MD50-11-4082	50-603061	190–190	2034.15
MD50-11-4084	50-603061	228–228	1536.53
MD50-11-4076	50-603061	274–274	3698.88
MD50-11-4077	50-603061	347–347	3038.69
MD50-11-4078	50-603061	397–397	1269.1
MD50-11-4092	50-603062	25–25	310.845
MD50-11-4091	50-603062	64–64	619.661
MD50-11-4090	50-603062	184–184	492.612
MD50-11-4103	50-603063	25–25	789.72
MD50-11-4102	50-603063	76–76	1669.9
MD50-11-4101	50-603063	128–128	1050.58
MD50-11-4100	50-603063	190–190	2965.12
MD50-11-4099	50-603063	228–228	3672.71
MD50-11-4098	50-603063	274–274	2331.5

Table 6.2-5 (continued)

Sample ID	Location ID	Depth (ft)	Tritium
MD50-11-4096	50-603063	347–347	1785.02
MD50-11-4104	50-603063	397–397	1438.22
MD50-11-4097	50-603063	450–450	1488.64
MD50-11-4113	50-603064	25–25	1124.85
MD50-11-4112	50-603064	66–66	1514.99
MD50-11-4111	50-603064	113–113	2126.53
MD50-11-4109	50-603064	176–176	2070.25
MD50-11-4110	50-603064	214–214	1795.68
MD50-11-4105	50-603064	259–259	3051.3
MD50-11-4106	50-603064	332–332	722.173
MD50-11-4107	50-603064	400–400	620.817
MD50-11-4024	50-603383	26–26	170258
MD50-11-4029	50-603383	85–85	655179
MD50-11-4025	50-603383	139–139	945513
MD50-11-4030	50-603383	206–206	317623
MD50-11-4026	50-603383	244–244	368727
MD50-11-4031	50-603383	286–286	59677.4
MD50-11-4027	50-603383	359–359	69096.1
MD50-11-4032	50-603383	408–408	559319
MD50-11-4028	50-603383	450–450	471537
MD50-11-4034	50-603467	26–26	1200.31
MD50-11-4038	50-603467	91–91	1439.81
MD50-11-4035	50-603467	143–143	1637.15
MD50-11-4039	50-603467	206–206	1620.96
MD50-11-4036	50-603467	244–244	822.644
MD50-11-4042	50-603467	287–287	1818.76
MD50-11-4037	50-603467	360–360	2881.15
MD50-11-4040	50-603467	409–409	1354.94
MD50-11-4041	50-603467	600–600	5444.75
MD50-11-4045	50-603468	198–198	1866.98
MD50-11-4050	50-603468	282–282	798.412
MD50-11-4051	50-603468	354–354	5156.85
MD50-11-4052	50-603468	403–403	7596950
MD50-11-3980	50-603470	83–83	2079590
MD50-11-3975	50-603470	143–143	3086.77 (J)
MD50-11-3973	50-603470	203–203	5540.36 (J)
MD50-11-3972	50-603470	233–233	9826.54
MD50-11-3974	50-603470	278–278	6310.42 (J)
MD50-11-3978	50-603470	450–450	3167.54 (J)
MD50-11-3983	50-603471	30–30	48419.2
MD50-11-3992	50-603471	90–90	38944.5
MD50-11-3990	50-603471	146–146	563784
MD50-11-3988	50-603471	209–209	885.424
MD50-11-3989	50-603471	242–242	10224.1
MD50-11-3987	50-603471	288–288	13906.1

Table 6.2-5 (continued)

Sample ID	Location ID	Depth (ft)	Tritium
MD50-11-3986	50-603471	360–360	598709
MD50-11-3984	50-603471	410–410	836701
MD50-11-3985	50-603471	450–450	73835
MD50-11-3947	50-613183	30–30	2092660
MD50-11-3948	50-613183	500–500	3082.7
MD50-11-3949	50-613183	550–550	917.003
MD50-11-3950	50-613183	600–600	2402.05
MD50-11-3951	50-613183	630–630	2702.14
MD50-11-4002	50-603472	27–27	375685
MD50-11-4000	50-603472	93–93	6535.31
MD50-11-4001	50-603472	146–146	5783.15
MD50-11-3998	50-603472	210–210	14784.1
MD50-11-3999	50-603472	247–247	10880.1
MD50-11-3996	50-603472	292–292	10481.8
MD50-11-3993	50-603472	364–364	1204.52
MD50-11-3994	50-603472	414–414	6132.84
MD50-11-3995	50-603472	450–450	1283.42
MD50-11-3944	50-613182	500–500	3407.76
MD50-11-3942	50-613182	600–600	1549.87
MD50-11-4071	50-603503	25–25	3187.04
MD50-11-4072	50-603503	80–80	1799.89
MD50-11-4069	50-603503	133–133	2876.99
MD50-11-4073	50-603503	198–198	2567.89
MD50-11-4070	50-603503	237–237	1914.86
MD50-11-4067	50-603503	278–278	1834.19
MD50-11-4066	50-603503	347–347	1553.13
MD50-11-4068	50-603503	397–397	2823.19
MD50-11-4065	50-603503	450–450	2377.86
MD50-11-3963	50-613185	205–205	885.976
MD50-11-3964	50-613185	235–235	4551.9
MD50-11-3969	50-613185	600–600	1468.83

Notes: Results are in pCi/L. Data qualifiers are defined in Appendix A.

Table 6.2-6
Tritium Detected in Vapor Samples in Third Quarter FY2011

Sample ID	Location ID	Depth (ft)	Tritium
MD50-11-6010	50-24784	25–25	4015.08
MD50-11-6007	50-24784	96–96	2759.61
MD50-11-6011	50-24784	155–155	1096.21
MD50-11-6005	50-24784	215–215	3507.57
MD50-11-6009	50-24784	244–244	3346.95
MD50-11-6006	50-24784	289–289	2628.94
MD50-11-6008	50-24784	362–362	1352.25
MD50-11-6004	50-24784	411–411	1407.69
MD50-11-6022	50-24813	25–25	3587.27
MD50-11-6021	50-24813	99–99	48049.3
MD50-11-6019	50-24813	150–150	195977
MD50-11-6020	50-24813	207–207	4138.01
MD50-11-6018	50-24813	241–241	2289.83
MD50-11-6017	50-24813	286–286	1081.82
MD50-11-6013	50-24813	358–358	463.481
MD50-11-6015	50-24813	408–408	623.879
MD50-11-6062	50-24822	25–25	1816.19
MD50-11-6059	50-24822	81–81	4098.9
MD50-11-6061	50-24822	142–142	896.287
MD50-11-6058	50-24822	204–204	3233.39
MD50-11-6060	50-24822	235–235	1491.71
MD50-11-6055	50-24822	280–280	535.226
MD50-11-6056	50-24822	351–351	286691
MD50-11-6080	50-603061	76–76	936.944
MD50-11-6079	50-603061	128–128	929.158
MD50-11-6078	50-603061	190–190	3186.9
MD50-11-6081	50-603061	228–228	1013.65
MD50-11-6077	50-603061	274–274	3994.15
MD50-11-6082	50-603061	347–347	2192.69
MD50-11-6076	50-603061	397–397	1094.76
MD50-11-6075	50-603061	450–450	1833.15
MD50-11-6085	50-603062	64–64	3661.06
MD50-11-6087	50-603062	122–122	1046.93
MD50-11-6092	50-603062	184–184	2461.43
MD50-11-6086	50-603062	217–217	591.543
MD50-11-6090	50-603062	263–263	1154.53
MD50-11-6094	50-603062	337–337	729.532

Table 6.2-6 (continued)

Sample ID	Location ID	Depth (ft)	Tritium
MD50-11-6091	50-603062	387–387	2412.41
MD50-11-6089	50-603062	450–450	5192.59
MD50-11-6102	50-603063	25–25	3219.01
MD50-11-6100	50-603063	76–76	8294.67
MD50-11-6099	50-603063	128–128	1158.67
MD50-11-6097	50-603063	190–190	4292.39
MD50-11-6098	50-603063	228–228	3825.28
MD50-11-6103	50-603063	274–274	5154.91
MD50-11-6095	50-603063	347–347	5913.95
MD50-11-6101	50-603063	397–397	3133.2
MD50-11-6096	50-603063	450–450	2119.51
MD50-11-6108	50-603064	25–25	676.519
MD50-11-6107	50-603064	66–66	1192.13
MD50-11-6105	50-603064	113–113	1443.41
MD50-11-6110	50-603064	176–176	1094.69
MD50-11-6111	50-603064	214–214	2587.17
MD50-11-6109	50-603064	482–482	1428.95
MD50-11-6027	50-603383	26–26	254478
MD50-11-6025	50-603383	85–85	761943
MD50-11-6024	50-603383	139–139	971640
MD50-11-6032	50-603383	206–206	113930
MD50-11-6026	50-603383	244–244	219669
MD50-11-6029	50-603383	286–286	80416.5
MD50-11-6028	50-603383	359–359	518598
MD50-11-6030	50-603383	408–408	439230
MD50-11-6031	50-603383	450–450	350433
MD50-11-6041	50-603467	26–26	411.024
MD50-11-6043	50-603467	91–91	1005.32
MD50-11-6038	50-603467	143–143	1192.99
MD50-11-6042	50-603467	206–206	1372.98
MD50-11-6037	50-603467	244–244	1670.36
MD50-11-6039	50-603467	287–287	647.931
MD50-11-6040	50-603467	360–360	550.912
MD50-11-6035	50-603467	500–500	573.867
MD50-11-6034	50-603467	600–600	547.748
MD50-11-6051	50-603468	92–92	3980.49
MD50-11-6050	50-603468	142–142	900.385
MD50-11-6052	50-603468	198–198	1420.04
MD50-11-6049	50-603468	233–233	853.235
MD50-11-6047	50-603468	282–282	604.306
MD50-11-6046	50-603468	354–354	2795.39
MD50-11-6048	50-603468	450–450	793.816
MD50-11-5978	50-603470	30–30	64701.4
MD50-11-5980	50-603470	83–83	2502750
MD50-11-5982	50-603470	143–143	9259.65

Table 6.2-6 (continued)

Sample ID	Location ID	Depth (ft)	Tritium
MD50-11-5977	50-603470	203–203	2180.77
MD50-11-5976	50-603470	233–233	3224.03
MD50-11-5979	50-603470	278–278	1137.7
MD50-11-5973	50-603470	351–351	1039.58
MD50-11-5990	50-603471	90–90	53054.6
MD50-11-5989	50-603471	146–146	6877.24
MD50-11-5988	50-603471	209–209	5606.71
MD50-11-5987	50-603471	242–242	4053.82
MD50-11-6156	50-603471	288–288	5846.41
MD50-11-5986	50-603471	360–360	4461.89
MD50-11-5983	50-603471	410–410	2093.01
MD50-11-5985	50-603471	450–450	4506.41
MD50-11-6000	50-603472	27–27	420066
MD50-11-5998	50-603472	93–93	6523.26
MD50-11-6001	50-603472	146–146	4411.23
MD50-11-5997	50-603472	210–210	3990.94
MD50-11-5999	50-603472	247–247	6414.21
MD50-11-5995	50-603472	292–292	5292.12
MD50-11-5994	50-603472	364–364	681.137
MD50-11-5993	50-603472	414–414	2371.69
MD50-11-5996	50-603472	450–450	568.81
MD50-11-6072	50-603503	25–25	934.732
MD50-11-6071	50-603503	80–80	1136.84
MD50-11-6073	50-603503	133–133	1512.3
MD50-11-6069	50-603503	198–198	1746.6
MD50-11-6068	50-603503	237–237	1922.34
MD50-11-6070	50-603503	278–278	1418.69
MD50-11-6066	50-603503	397–397	625.523
MD50-11-5933	50-613182	500-500	555.9
MD50-11-5934	50-613182	550-550	555.569
MD50-11-5937	50-613182	620-620	669.695
MD50-11-5942	50-613183	30-30	2525710
MD50-11-5941	50-613183	600-600	431.214
MD50-11-5944	50-613183	630-630	2524.53
MD50-11-5946	50-613184	550-550	4429.21

Note: Results are in pCi/L.

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Table 8.0-1
Recommended Vapor-Monitoring Locations and Frequencies

Location	Ports	Frequency	Rationale
50-24784	All (25 ft, 96 ft, 155 ft, 215 ft, 244 ft, 289 ft, 362 ft, 411 ft, and 450 ft bgs)	Annual	Monitor western boundary of site.
50-24813	Qct and below (358 ft, 408 ft, 450 ft, and 600 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor Qbo for vertical migration near southern end of plume. Location exceeds Tier II for TCE.
	Qbt 1g and above (25 ft, 99 ft, 150 ft, 207 ft, 241 ft, and 286 ft bgs)	Annual	Monitor potential new releases. Location exceeds Tier II for TCE.
50-24822	All (25 ft, 81 ft, 142 ft, 204 ft, 235 ft, 280 ft, 351 ft, 402 ft, and 450 ft bgs)	Annual	Monitor eastern boundary of site. Location approaching Tier II for TCE.
50-603064	All (25 ft, 66 ft, 113 ft, 176 ft, 214 ft, 259 ft, 332 ft, 482 ft, and 500 ft bgs)	Annual	Monitor northern boundary of site. Location approaching Tier II for TCE.
50-603383	All (26 ft, 85 ft, 139 ft, 206 ft, 244 ft, 286 ft, 359 ft, 408 ft, and 450 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor northern boundary of site. Location approaching Tier II for tritium.
50-603468/50-613184	Qct and below (354 ft, 403 ft, 450 ft, 500 ft, 550 ft, 600 ft, 652 ft, and 664.5 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor Qbo and Qbog for vertical migration near southern end of plume. Location approaching Tier II for TCE.
	Qbt 1g and above (30 ft, 92 ft, 142 ft, 198 ft, 233 ft, and 282 ft bgs)	Annual	Monitor potential migration in upper units. Location approaching Tier II for TCE.
50-603470	Qct and below (351 ft, 450 ft, 600 ft, and 650 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor Qbo and Qbog for vertical migration near eastern end of plume. Location exceeds Tier II for TCE, approaching Tier II for tritium.
	Qbt 1g and above (30 ft, 83 ft, 143 ft, 203 ft, 233 ft, and 278 ft bgs)	Annual	Monitor potential new releases. Location exceeds Tier II for TCE, approaching Tier II for tritium.
50-603471/50-613183	Qct and below (360 ft, 410 ft, 450 ft, 500 ft, 550 ft, 600 ft, 630 ft, and 642.5 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor Qbo and Qbog for vertical migration near center of plume. Location exceeds Tier II for TCE, approaching Tier II for tritium.
	Qbt 1g and above (30 ft, 90 ft, 146 ft, 209 ft, 242 ft, and 288 ft bgs)	Annual	Monitor potential new releases. Location exceeds Tier II for TCE, approaching Tier II for tritium.
50-603472/50-613182	Qct and below (364 ft, 414 ft, 450 ft, 500 ft, 550 ft, 600 ft, 620 ft, and 632.5 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor Qbo and Qbog for vertical migration near center of plume.
	Qbt 1g and above (27 ft, 93 ft, 146 ft, 210 ft, 247 ft, and 292 ft bgs)	Annual	Monitor potential new releases.

Table 8.0-1 (continued)

Location	Ports	Frequency	Rationale
50-613185	Qct and below (350 ft, 450 ft, 600 ft, 675 ft, and 688 ft bgs)	Quarterly for 1 yr, biannual thereafter	Monitor Qbo and Qbog for migration to south.
	Qbt 1g and above (85 ft, 145 ft, 205 ft, 235 ft, and 280 ft bgs)	Annual	Monitor upper units for migration to south.

Appendix A

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

A-1.0 ACRONYMS AND ABBREVIATIONS

3-D	three dimensional
%RSD	percent relative standard deviation
AES	atomic emission spectroscopy
AK	acceptable knowledge
AOC	area of concern
bgs	below ground surface
BNM	Bandelier National Monument
BV	background value
CCV	continuing calibration verification
CME	corrective measures evaluation
COC	chain of custody
Consent Order	Compliance Order on Consent
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
DGPS	differential global positioning system
DOE	Department of Energy (U.S.)
dpm	disintegrations per minute
EPA	Environmental Protection Agency (U.S.)
FLUTe	Flexible Liner Underground Technology
FY	fiscal year
GIC	Green Is Clean
HI	hazard index
ICPES	inductively coupled plasma mass spectrometry
ICV	initial calibration verification
I.D.	inside diameter
IDW	investigation-derived waste
LAL	lower acceptance limit
LANL	Los Alamos National Laboratory
LASL	Los Alamos Scientific Laboratory
LCS	laboratory control sample
LLW	low-level waste
MCL	maximum contaminant level
MDA	material disposal area
MS	matrix spike
MSW	municipal solid waste

NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
O.D.	outside diameter
PAH	polycylic aromatic hydrocarbons
PCE	tetrachloroethene
PID	photoionization detector
PPE	personal protective equipment
QA	quality assurance
QC	quality control
RCT	radiation control technician
RFI	Resource Conservation and Recovery Act facility investigation
RP	Radiation Protection (Laboratory division)
RPD	relative percent difference
RPF	Records Processing Facility
SCL	sample collection log
SL	screening level
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SV	screening value
SWMU	solid waste management unit
TA	technical area
TAL	target analyte list
TCE	trichloroethene
TD	total depth
UAL	upper acceptance limit
UTL	upper tolerance limit
VOC	volatile organic compound
WCSF	waste characterization strategy form
WDC	Water Development Company

A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. 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-3.0 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

Field Methods

B-1.0 INTRODUCTION

This appendix summarizes field methods used for the Phase III investigation at Material Disposal Area (MDA) C at Technical Area 50 (TA-50), also referred to as Solid Waste Management Unit 50-009, at Los Alamos National Laboratory (the Laboratory). Table B-1.0-1 summarizes the methods used, and the following sections provide more detailed descriptions of the field methods. All activities were conducted in accordance with the applicable Environmental Programs Directorate standard operating procedures (SOPs) listed in Table B-1.0-2 and available at http://www.lanl.gov/environment/all/qa.shtml.

B-2.0 EXPLORATORY DRILLING CHARACTERIZATION

No exploratory drilling characterization was conducted during the Phase III investigation. All drilling was conducted for the purpose of collecting investigation samples, establishing vapor-monitoring wells, and collecting vapor samples.

B-3.0 FIELD-SCREENING METHODS

This section summarizes the field-screening methods used during the Phase III investigation. Field screening for volatile organic compounds (VOCs) and radioactivity was performed on solid samples. Field screening for percent methane, percent carbon dioxide, and percent oxygen was performed on subsurface vapor before samples were collected.

B-3.1 Field Screening for VOCs

Field screening for VOCs was conducted for solid samples only. Screening was conducted using a MiniRAE 2000 photoionization detector (PID) equipped with an 11.7 electronvolt lamp, in accordance with SOP 06.33, Headspace Vapor Screening with a Photoionization Detector. Screening was performed on the sampled material for each subsurface dacite sample and on cuttings as they were extracted from the borehole. Screening measurements were recorded in each sample collection log (SCL) or vapor-sample screening log. SCLs are provided in Appendix D. The screening results are presented in Table 3.1-1 of the investigation report.

B-3.2 Field Screening for Radioactivity

During collection of solid samples from air rotary drill cuttings, each sample was screened for radioactivity immediately upon collection, targeting alpha and beta/gamma emitters. Screening was conducted by a Laboratory radiation control technician (RCT) using an Eberline E-600 radiation meter with an SHP-380AB alpha/beta scintillation detector. The Eberline E-600 with attachment SHP-380AB consists of a dual phosphor plate covered by two mylar windows housed in a light-excluding metal body. The phosphor plate is a plastic scintillator for detecting beta emissions and is thinly coated with zinc sulfide for to detect alpha emissions. The operational range varies from trace emissions to 1 million disintegrations per minute. The SCLs are provided in Appendix D. The screening results are presented in Table 3.1-1 of the investigation report.

B-3.3 Field Screening for Subsurface Vapor

Subsurface vapor was screened before each vapor sample was collected. A LANDTEC GEM-500 gas extraction meter was connected to the formation airflow. During the purge, percent methane, percent

carbon dioxide, and percent oxygen readings were recorded every several minutes. Screening measurements were recorded in each vapor-sample screening log. Additionally, before sampling began, a Laboratory RCT screened the port openings for wells located within the MDA using an Overhoff 394-C tritium monitor.

B-3.4 Borehole Logging

Because of the proximity of previously logged boreholes at all locations, continuous core was not extracted from four the boreholes drilled during the Phase III investigation. Borehole logs were recorded based on inspection of drill cuttings. Throughout drilling, cuttings were inspected regularly for changes in lithology and other relevant observations, which were recorded in field logs. Borehole logs for the four boreholes drilled during the Phase III investigation are included in Attachment B-1. The as-built diagrams for the boreholes are included in Attachment B-2.

B-3.5 Borehole Abandonment

No boreholes were abandoned as part of the Phase III investigation.

B-4.0 FIELD-INSTRUMENT CALIBRATION

All instruments were calibrated by the manufacturer before use. Daily calibration checks of the MiniRAE 2000 PID and LANDTEC GEM-500 were conducted at least daily by the site crew. Calibration of the Eberline E-600 and was conducted by the RCT. All calibrations and daily checks were performed according to the manufacturers' specifications and requirements.

Radiological screening instruments were provided by the Laboratory's radiation instrumentation and calibration team, which is part of the Health Physics and Measurements group of the Radiation Protection Division (RP-1). Calibration records can be obtained using the Laboratory's Health Safety and Radiation Protection instrument identification numbers recorded in the weekly performance test logs. The performance check records are also on file at RP-1 and are available upon request.

B-4.1 MiniRAE 2000 Instrument Calibration

The MiniRAE 2000 PID was calibrated both to ambient air and a standard reference gas (100 ppm isobutylene). The ambient-air calibration determined the zero point of the instrument sensor calibration curve in ambient air. Calibration with the standard reference gas determined a second point of the sensor calibration curve. Each calibration was within 10% of 100 ppm isobutylene, qualifying the instrument for use.

The following calibration information was recorded daily on field calibration logs:

- instrument identification number
- final span settings
- date and time
- concentration and type of calibration gas used (100 ppm isobutylene)
- name of the personnel performing the calibration

All daily calibration procedures for the MiniRAE 2000 PID met the manufacturer's specifications for standard reference gas calibration and the requirements of SOP-5006, Control of Measuring and Test Equipment.

B-4.2 Eberline E-600 Instrument Calibration

The Eberline E-600 was calibrated daily by the RCT before local background levels for radioactivity were measured. The instrument was calibrated using plutonium-239 and chloride-36 sources for alpha and beta emissions, respectively. The following five checks were performed and recorded in daily field calibration logs as part of the calibration procedures:

- calibration date
- physical damage
- battery
- response to a source of radioactivity
- background

All calibrations performed for the Eberline E-600 met the manufacturer's specifications and the applicable radiation detection instrument manual.

B-4.3 LANDTEC GEM-500 Instrument Calibration

The LANDTEC GEM-500 was calibrated by the manufacturer and did not require daily check/calibration.

B-5.0 SUBSURFACE SAMPLING

This section summarizes the methods used for collecting subsurface dacite and vapor samples, according to the approved MDA C Phase III investigation work plan (LANL 2008, 101653; NMED 2008, 101113; LANL 2010, 109260; NMED 2010, 109695). Procedures for collecting groundwater samples from wells R-46 and R-60 are described in the Laboratory's Interim Facility-Wide Groundwater Monitoring Plan (LANL 2010, 109830).

B-5.1 Subsurface Dacite Sampling Methods

Air-rotary drilling was used in Phase III activities. The subsurface dacite samples were collected from the drill cuttings in accordance with SOP-06.26, Core Barrel Sampling for Subsurface Earth Materials.

Samples were collected from the drill cuttings by placing stainless-steel bowl in the path of the cuttings as they exited the Hurricane 655 Dust Vacuum. The samples were field screened for VOCs and radioactivity and were visually inspected and logged. Following inspection, the sample was passed through a sieve to remove fine material, and the dacite was segregated. The samples were placed in sterile sample containers as required for each analysis, sealed, and labeled. Each sample was labeled with the borehole location number, date, time, depth interval, analyses requested, and sample identification number.

B-5.2 Phase III Subsurface Vapor-Sampling Methods

Vapor sampling was conducted using both the Flexible Liner Underground Technology (FLUTe) system and the stainless-steel tubing system at the start of the Phase III investigation, following an approved

subcontractor procedure technically equivalent to SOP-5074, Sampling of Sub-Atmospheric Air. The operation of the two vapor-sampling systems is described below.

The FLUTe system uses a flexible liner that provides a seal against the borehole wall. The sampling ports and the nylon tubing are installed in the interior sleeves of the liner. The liner is lowered into the borehole while the borehole is supported by a temporary casing, and it is filled with sand as the casing is withdrawn. The pressure of the sand inside the liner seals the liner against the borehole wall, pressing the sampling ports against the formation. Vapor is drawn through a permeable spacer material between the liner and the borehole wall and into the tubing. A diffusion barrier is installed in the permeable spacer material to minimize the potential for interactions with the material that could affect analyte concentrations.

The stainless-steel tubing system uses continuous lengths of 0.25-in.-outside diameter (O.D.) stainless-steel tubing with a single port installed at the target depth of each tube. Bentonite is used above and below each sampling port to seal off the interval to be sampled. The 5-ft space between the bentonite seals at each sampling interval is filled with sand. Sampling is performed by extracting the formation air through the sand layer and into the stainless-steel tubing. The stainless-steel tubing system is used in the new wells installed during the Phase III investigation.

After the vapor-sampling system was installed, the system was purged to ensure formation air was extracted. During the purge, percent oxygen, percent carbon dioxide, and percent methane readings from the sample train exhaust were collected every several minutes using a LANDTEC GEM-500 gas-extraction meter. At the end of every purge cycle, a PID reading was collected from the airflow in the sample train apparatus. Vapor samples for VOC analysis were collected in SUMMA canisters, one sample per canister. A silica gel sampler was used to collect the tritium sample after the SUMMA canister sample was collected. Samples were submitted to the Laboratory's Sample Management Office (SMO) for shipment to contract analytical laboratories for VOC analysis by U.S. Environmental Protection Agency (EPA) Method TO-15, and for tritium analysis by EPA Method 906.0.

B-5.3 Quality Assurance/Quality Control Samples

Quality control (QC) samples were collected in accordance with an approved subcontractor procedure technically equivalent to SOP-5059, Field Quality Control Samples. QC samples included field duplicates, equipment rinsate, and field trip blanks. The field duplicate sample was collected to evaluate the reproducibility of field-sampling techniques. The equipment rinsate was used to evaluate field decontamination procedures.

Field duplicate samples were collected at a frequency of approximately 1 duplicate sample for every 10 vapor samples. One field duplicate sample and one equipment rinsate sample were collected with the four dacite samples. Field trip blanks were collected at a frequency of 1 per 10 investigation samples or 1 per borehole (collected only when vapor samples were being collected for VOCs). Field trip blanks were collected by drawing nitrogen through the sampling apparatus into SUMMA canisters.

B-5.4 Sample Documentation and Handling

SCLs and chain-of-custody (COC) forms were completed for each sample. Sample containers were sealed with signed COC seals and placed in coolers at approximately 4°C. Samples were handled in accordance with approved subcontractor procedures technically equivalent to SOP-5057, Handling, Packaging, and Transporting Field Samples, and SOP-5056, Sample Containers and Preservation. Swipe samples were collected and analyzed by the RCT before the sample containers were removed from the site. Samples were transported to the SMO before they were shipped to the analytical laboratory. The SMO reviewed and approved the SCL/COC forms and accepted custody of the samples.

B-5.5 Decontamination of Sampling Equipment

All sampling equipment that made (or could have made) contact with sample material was decontaminated after each sample was retrieved and logged. Decontamination included wiping the equipment with Fantastik and paper towels. Decontamination of the drilling equipment was conducted before the drill rig was mobilized to another borehole to avoid cross-contamination between samples and borehole locations. Residual material adhering to equipment was removed using dry decontamination methods such as the use of wire brushes and scrapers. Decontamination activities were performed in accordance with approved subcontractor procedures technically equivalent to SOP-5061, Field Decontamination of Equipment, and SOP-5059, Field Quality Control Samples. All decontamination was achieved using dry decontamination methods.

Decontaminated equipment was surveyed by the RCT before it was released from the site.

B-6.0 GEODETIC SURVEYING

Geodetic surveys of all boreholes and sampled locations were performed using a Trimble RTK 5800 differential global positioning system (DGPS) referenced from published and monumented external Laboratory survey control points in the vicinity of MDA C. All borehole and sampling locations were surveyed according to an approved subcontractor procedure technically equivalent to SOP-5028, Coordinating and Evaluating Geodetic Surveys. Horizontal accuracy of the monumented control points is within 0.1 ft. The DGPS instrument referenced from Laboratory control points is accurate within 0.2 ft. The surveyed coordinates are presented in Table 3.2-1 of the investigation report.

B-7.0 INVESTIGATION-DERIVED WASTE STORAGE AND DISPOSAL

All investigation-derived waste (IDW) generated during the MDA C Phase III field investigation was managed in accordance with an approved subcontractor procedure technically equivalent to SOP-5238, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable EPA and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy orders, and Laboratory implementation requirements.

Before field investigation activities began, a waste characterization strategy form (WCSF) was prepared, reviewed, and approved. The WCSF provided information on IDW characterization, management, containerization, and estimated volumes. The IDW characterization was completed through a combination of review of existing documentation, review of analytical data from samples collected from the media being investigated, and direct sampling of containerized waste. The WCSF and related waste management documentation, such as the waste profile form and chemical waste disposal requests, are included in Appendix E of this investigation report. Appendix E also includes details of types and volumes of waste generated, and the disposition of all wastes as of the date of publication of this investigation report.

Waste minimization was practiced by evaluating drill cuttings for suitability for land application. All cuttings that met the requirements for land application were land applied to drill site access roads and drill pads.

B-8.0 DEVIATIONS FROM PHASE III WORK PLAN

Deviations from the approved Phase III investigation work plan (LANL 2010, 109260; NMED 2010, 109695) are as follows.

- At location 50-603471, the sampling port at 30 ft bgs became partially plugged before sampling in the second quarter of fiscal year (FY) 2011. For this reason, when the extended-depth monitoring well was installed at nearby location 50-613183, a single port was added at 30 ft below ground surface (bgs) to allow continued sampling at the 30-ft depth. However, during second quarter FY2011 sampling, samples were inadvertently collected from the partially plugged port at location 50-603471 (sample MD50-11-3983) and were also collected from the replacement port at location 50-603183 (sample MD50-11-3947). Because the original port was partially plugged, the results from sample MD50-11-3983 are considered suspect and have been removed from the dataset for the second quarter of FY2011. The results from sample MD50-11-3947 are included in the data set.
- The Phase III investigation work plan (LANL 2010, 109260) proposed analyzing samples of archived dacite core collected elsewhere at the Laboratory. This approach was proposed because it was not known whether the drill rigs used for vapor-well installation could penetrate the dacite. The sample collected during the Phase II investigation at location 50-603470 was collected from the top of the dacite because the drill rig met refusal at that depth. During installation of the first Phase III vapor well at MDA C, it was determined that it would be possible to drill into the dacite and collect samples. Therefore, rather than analyze archived samples, the Laboratory collected site-specific background samples from the two Phase III boreholes drilled to the south of MDA C. Based on the results of the Phase II investigation, these locations are outside of areas potentially impacted by releases of inorganic chemicals from MDA C and are representative of background for inorganic chemicals.

B-9.0 VAPOR-MONITORING WELL INSTALLATION

Stainless-steel vapor-monitoring systems were installed at the four Phase III monitoring wells using the same system design installed at the other monitoring wells during the Phase II investigation (LANL 2009, 107389). The following general guidelines were used to construct each Phase III monitoring well:

- Install a 20-ft-long surface casing and cement in place.
- Place a layer of bentonite clay at the bottom of the borehole and hydrate for a minimum of 1 h.
- Set a 0.25-in. × 12-in.-long cylindrical stainless-steel screen in filter-pack sand and connect the screen to 0.25-in. stainless-steel tubing.
- Place a layer of bentonite clay above the sand filter-pack and hydrate for a minimum of 1 h.
- Repeat above for the installation of additional vapor-monitoring ports based upon geological logging.

Borehole logs of the four vapor-monitoring wells drilled during the Phase III investigation are included in Attachment B-1, and the as-built diagrams are included in Attachment B-2.

B-10.0 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), March 2008. "Pilot Test Work Plan for Evaluating Vapor-Sampling Systems at Material Disposal Area C," Los Alamos National Laboratory document LA-UR-08-1614, Los Alamos, New Mexico. (LANL 2008, 101653)

LANL (Los Alamos National Laboratory), October 2009. "Phase II Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50, Revision 1," Los Alamos National Laboratory document LA-UR-09-6266, Los Alamos, New Mexico. (LANL 2009, 107389)

LANL (Los Alamos National Laboratory), April 2010. "Phase III Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50, Revision 1," Los Alamos National Laboratory document LA-UR-10-2468, Los Alamos, New Mexico. (LANL 2010, 109260)

LANL (Los Alamos National Laboratory), June 2010. "2010 Interim Facility-Wide Groundwater Monitoring Plan," Los Alamos National Laboratory document LA-UR-10-1777, Los Alamos, New Mexico. (LANL 2010, 109830)

NMED (New Mexico Environment Department), March 28, 2008. "Approval with Modification, Pilot Test Work Plan for Evaluating Vapor-Sampling Systems at Material Disposal Area C," New Mexico Environment Department letter to D. Gregory (DOE-LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2008, 101113)

NMED (New Mexico Environment Department), May 11, 2010. "Approval with Modifications, Phase III Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50, Revision 1," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 109695)

Table B-1.0-1
Brief Description of Field Investigation Methods

Method	Summary
Handling, Packaging, and Shipping of Samples	Field team members labeled samples before packing and ensured the sample containers and the transport containers were free of external contamination. Field team members packaged all samples to minimize the possibility of breakage during transportation. After all environmental samples were collected, packaged, and preserved, a field team member transported them to the SMO. The SMO arranged to ship the samples to analytical laboratories.
Sample Control and Field Documentation	The collection, screening, and transport of samples were documented on standard forms generated by the SMO. These included SCLs, COC forms, and sample container labels. SCLs were completed at the same time as sample collection, and the logs were signed by the sampler and a reviewer who verified the logs for completeness and accuracy. Corresponding labels were applied to each sample container. COC forms were completed and assigned to verify the samples were not left unattended.
Field QC Samples	Field QC samples were collected as follows: *Field Duplicate*: At a frequency of 10%; collected at the same time as a regular sample and submitted for the same analyses. *Equipment Rinsate*: At a frequency of 10%; collected by rinsing sampling equipment with deionized water that is collected in a sample container and submitted for laboratory analysis. *Trip Blanks*: Required for all field events that included the collection of samples for VOC analysis. For vapor sampling, trip blanks were collected by drawing nitrogen through the sampling apparatus into SUMMA canisters.
Field Decontamination of Drilling and Sampling Equipment	Dry decontamination was used to minimize the generation of liquid waste. Dry decontamination included the use of a wire brush or other tool for removal of soil or other material adhering to the sampling equipment, followed by use of Fantastik and paper wipes.
Management of IDW	All IDW was characterized and managed according to an approved WCSF. Potential waste streams and volumes were identified before the start of field activities, with a proposed characterization method, management strategy, and likely disposal path for each waste stream. To minimize waste, drill cuttings were land applied to drill pads or drill site access roads when they met all applicable requirements for land application.
Containers and Preservation of Samples	Specific requirements/processes for sample containers, preservation techniques, and holding times are based on EPA guidance for environmental sampling, preservation, and quality assurance. Specific requirements for each sample were printed on the SCLs provided by the SMO (size and type of container, i.e. glass, amber glass, polyethylene, preservative, etc.). Dacite samples were preserved by placing in insulated containers with ice to maintain a temperature of 4°C.

Table B-1.0-1 (continued)

Method	Summary
Subsurface Vapor Sampling for Volatile Organic Compounds	The FLUTe system uses a flexible liner that provides a seal against the borehole wall. The sampling ports and the nylon tubing were installed in the interior sleeves of the liner. The liner was lowered into the borehole while the borehole was supported by a temporary casing, then filled with sand as the casing was withdrawn. The pressure of sand inside the liner sealed the liner against the borehole wall, pressing the sampling ports against the formation. Vapor was drawn through a permeable spacer material between the liner and the borehole wall and into the tubing. A diffusion barrier was installed in the permeable spacer material to minimize the potential for interactions with the material that could affect analyte concentrations. The stainless-steel tubing system uses continuous lengths of 0.25-in.-O.D. stainless-steel tubing with a single port installed at the end of each tube at the target depth. Bentonite was used above and below each sampling port to seal off the interval to be sampled. The 5-ft space between the bentonite seals at each sampling interval was filled with sand. Sampling was performed by extracting the formation air through the sand layer and into the stainless-steel tubing. Purge time is the time required to purge the entire tubing volume for the FLUTe and stainless-steel tubing systems and the tubing volume plus the packer void space for the packer system. A 30-min purge time was used before vapor samples were collected. During the purge, percent oxygen, percent carbon dioxide, and percent methane readings from the sample train exhaust were collected every several minutes using a LANDTEC GEM-500 gas-extraction meter to ensure all ambient air was evacuated from the system. At the end of every purge cycle, a PID reading was collected from the air in the sample train apparatus. Subsurface vapor samples were collected in SUMMA canisters and submitted to the SMO for shipment to the analytical laboratory for VOC analysis using EPA Method TO-15.
Subsurface Vapor Sampling for Tritium	The process for sampling moisture in subsurface vapor for tritium is performed using the vapor-sampling system used for VOC sampling. Following the purge of the vapor-sampling system, a Teflon tube filled with silica gel was used to capture the moisture in the vapor. The silica-gel-filled tube was sent to an analytical laboratory for analysis for moisture and tritium using EPA Method 906.0.

Table B-1.0-2
SOPs Used for MDA C Phase III Investigation Activities

EP-DIR-QAP-0001, Quality Assurance Plan for the Environmental Programs
EP-DIR-SOP-2011, Personnel Training and Qualification
EP-DIR-AP-10001, Document Control
EP-DIR-SOP-5006, Control of Measuring and Test Equipment
EP-DIR-SOP-8001, Inspection, Test, and Acceptance
SOP-5238, Characterization and Management of Environmental Program Waste
SOP-5028, Coordinating and Evaluating Geodetic Surveys
SOP-5034, Monitor Well and RFI Borehole Abandonment
SOP-5055, General Instructions for Field Investigations
SOP-5056, Sample Containers and Preservation
SOP-5057, Handling, Packaging, and Transporting Field Samples
WES-EDA-QP-219, Sample Control and Field Documentation
SOP-5059, Field Quality Control Samples
SOP-5061, Field Decontamination of Equipment
SOP-5074, Sampling of Subsurface Air
SOP-5077, Field Sampling of Core and Cuttings for Geological Analysis
SOP-5181, Notebook and Logbook Documentation for Environmental Directorate Technical and Field Activities
SOP-01.12, Field Site Closeout Checklist
SOP-06.33, Headspace Vapor Screening with a Photoionization Detector
SOP-12.01, Field Logging, Handling, and Documentation of Borehole Materials

Note: These procedures are available at http://www.lanl.gov/environment/all/qa.shtml.

Attachment B-1

Borehole Logs

Los Alamos Technical Associates, Inc.
Vapor Monitoring Well/Borehole Log

Project: MDA C Phase III Investigation **Page 1 of 5**

Vapor-Monitoring Well ID: 50-613182 **Date Installed:** 11//30/2010

Extension of Phase II Well ID: 50-603472 **Attitude:** Vertical

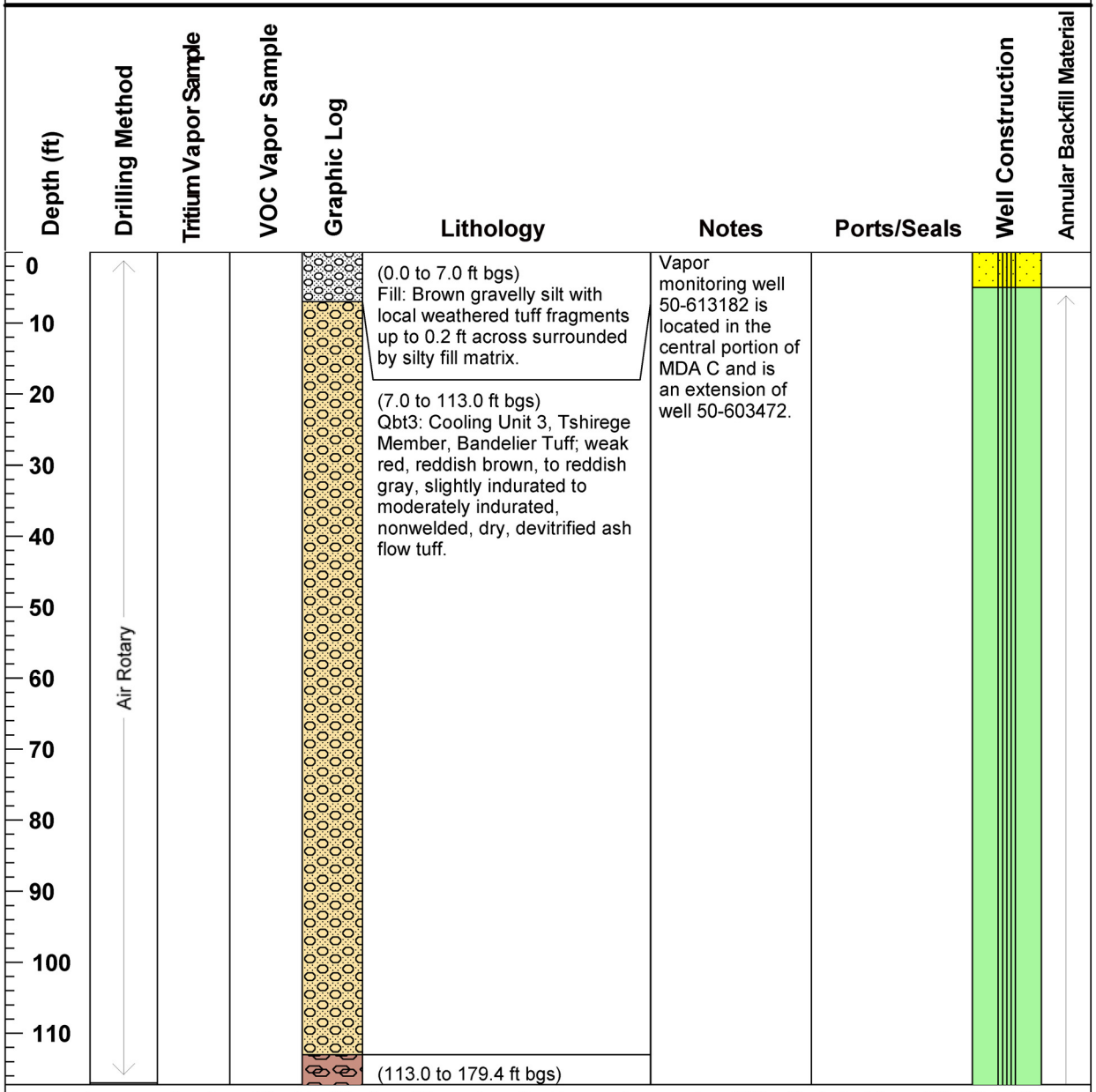
TA- 50 **AOC/SWMU: 50-009** **Drill Operator:** Everett Applegarth

Drilling Company: Layne-Christiansen Co. **Depth to Perched Saturation (ft):** NA

Drilling equipment: Schramm T130VD Rotodrill **Depth to Regional Saturation (ft):** NA

Geologist: Ali Furmall **Total Depth (ft):** 646

Vapor-Monitoring well type: discrete 1/4-inch stainless steel tube from each port



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

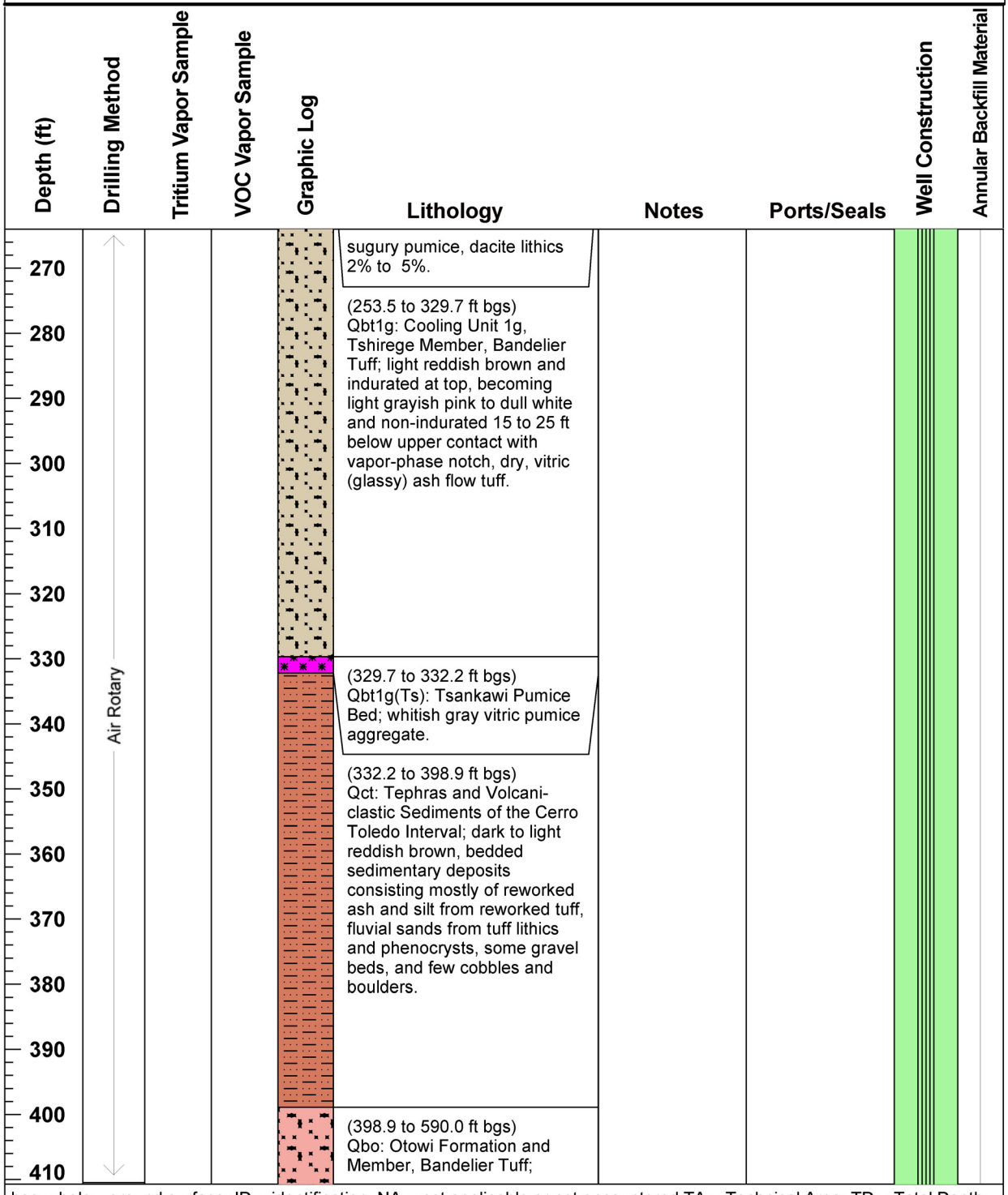
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613182 **Page 2 of 5**

Depth (ft)	Drilling Method	Tritium Vapor Sample	VOC Vapor Sample	Graphic Log	Lithology	Notes	Ports/Seals	Well Construction	Annular Backfill Material
120	Air Rotary				Qbt2: Cooling Unit 2, Tshirege Member, Bandelier Tuff; pale red, strongly indurated, slightly welded, dry, devitrified ash flow tuff with 20% quartz phenocrysts from 0.1 - 1.0 mm and 10% sanidine phenocrysts up to 1.0 mm showing Schiller blue iridescence.				
130									
140									
150									
160									
170									
180					(179.4 to 239.9 ft bgs) Qbt1v: Cooling Unit 1v, Tshirege Member, Bandelier Tuff; light pinkish gray to dull grayish white, non-indurated, nonwelded, dry devitrified ash flow tuff.				
190									
200									
210									
220									
230									
240					(239.9 to 253.5 ft bgs) Qbt1v(c): Subunit of Cooling Unit 1v, Tshirege Member, Bandelier Tuff; light redddish gray to orangish brown, moderately indurated, nonwelded, dry devitrfied ash flow tuff with chocolate brown,	"Colonnade" subunit of Cooling Unit 1v after Broxton & Reneau, 1975. Qbt1v(c)/Qbt1g contact is the Vapor Phase Notch.			3/8-in bentonite chips
250									
260									

bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613182 **Page 3 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

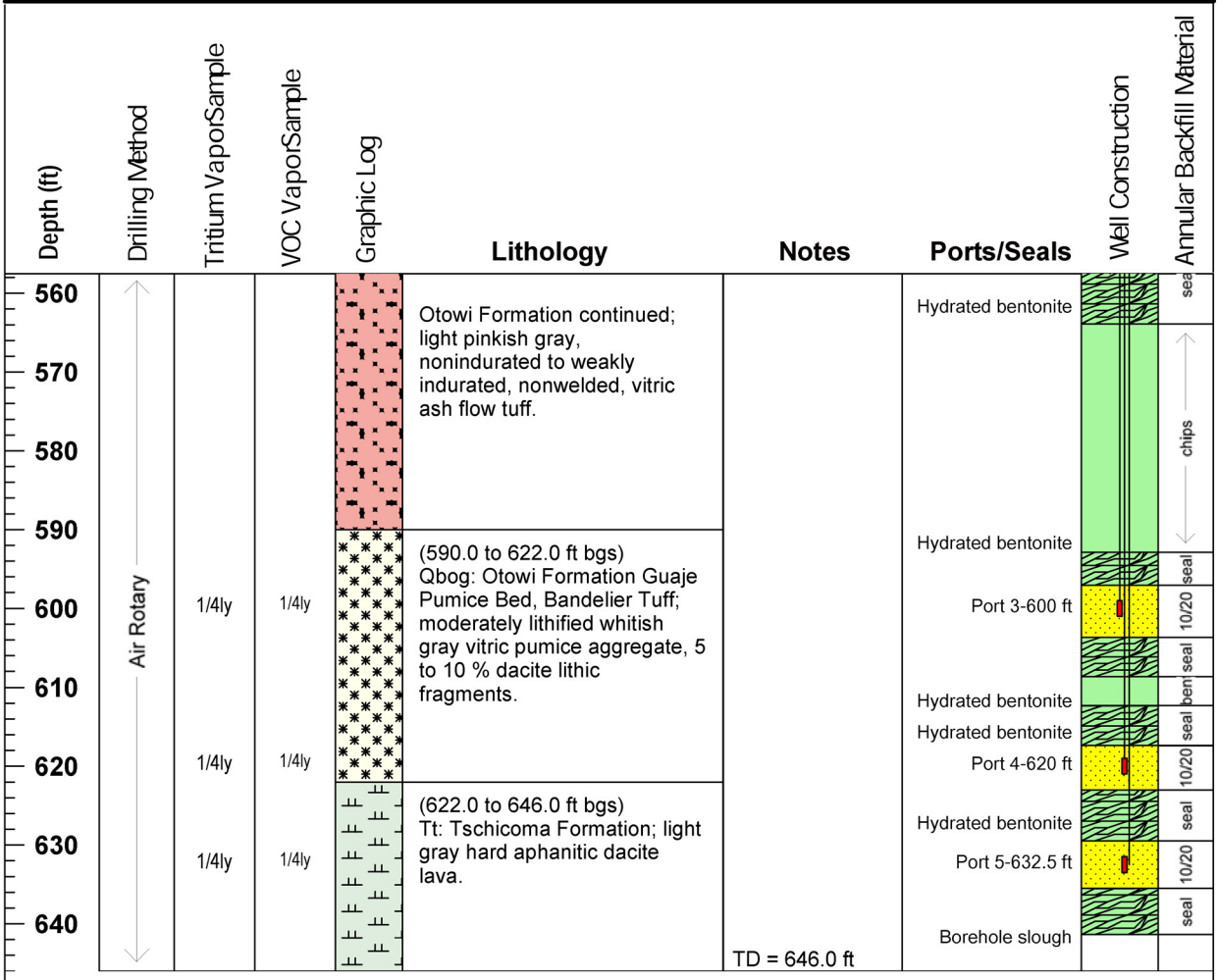
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613182 **Page 4 of 5**

Depth (ft)	Drilling Method	Tritium Vapor Sample	VOC Vapor Sample	Graphic Log	Lithology	Notes	Ports/Seals	Well Construction	Annular Backfill Material
410	Air Rotary				Otowi Formation continued; light pinkish gray, nonindurated to weakly indurated, nonwelded, vitric ash flow tuff.				
420									
430									
440									
450									
460									
470									
480									
490							Hydrated bentonite		seal
500		1/4ly	1/4ly				Port 1-500 ft		10/20
510							Hydrated bentonite		seal
520									3/8-in bentonite chips
530									
540							Hydrated bentonite		seal
550		1/4ly	1/4ly				Port 2-550 ft		10/20

bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613182 **Page 5 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Vapor Monitoring Well/Borehole Log

Project: MDA C Phase III Investigation **Page 1 of 5**

Vapor Monitoring Well ID: 50-613183 **Date Installed:** 01/04/2011

Extension of Phase II Well ID: 50-603471 **Attitude:** Vertical

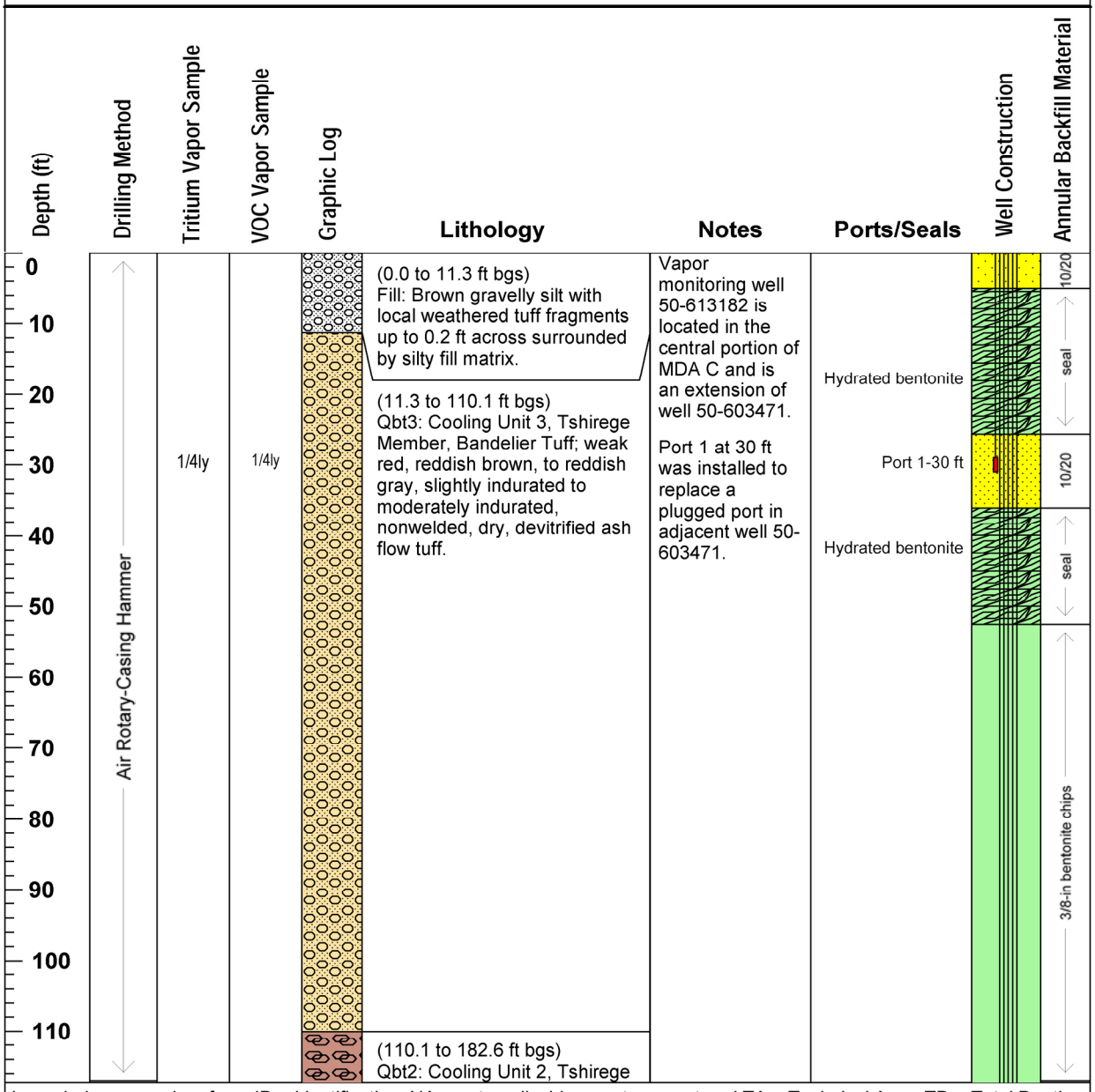
TA- 50 **AOC/SWMU: 50-009** **Drill Operator:** Del Leavitt

Drilling Company: WDC Exploration and Wells **Depth to Perched Saturation (ft):** NA

Drilling equipment: Speedstar 50K **Depth to Regional Saturation (ft):** NA

Geologist: Ali Furmall **Total Depth (ft):** 652

Vapor monitoring well type: discrete 1/4-inch stainless-steel tube from each port



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613183 **Page 2 of 5**

Depth (ft)	Drilling Method	Tritium Vapor Sample	VOC Vapor Sample	Graphic Log	Lithology	Notes	Ports/Seals	Well Construction	Annular Backfill Material
120 – 260	Air Rotary-Casing Hammer				Member, Bandelier Tuff; pale red, strongly indurated, slightly welded, dry, devitrified ash flow tuff with 20% quartz phenocrysts from 0.1 - 1.0 mm and 10% sanidine phenocrysts up to 1.0 mm showing Schiller blue iridescence.				3/8-in bentonite chips
					(182.6 to 235.1 ft bgs) Qbt1v: Cooling Unit 1v, Tshirege Member, Bandelier Tuff; light pinkish gray to dull grayish white, non-indurated, nonwelded, dry devitrified ash flow tuff.				
					(235.1 to 250.1 ft bgs) Qbt1v(c): Subunit of Cooling Unit 1v, Tshirege Member, Bandelier Tuff; light redddish gray to orangish brown, moderately indurated, nonwelded, dry devitrfied ash flow tuff with chocolate brown, sugury pumice, dacite lithics 2% to 5%.	"Colonnade" subunit of Cooling Unit 1v after Broxton & Reneau, 1975. Qbt1v(c)/Qbt1g contact is the Vapor Phase Notch.			

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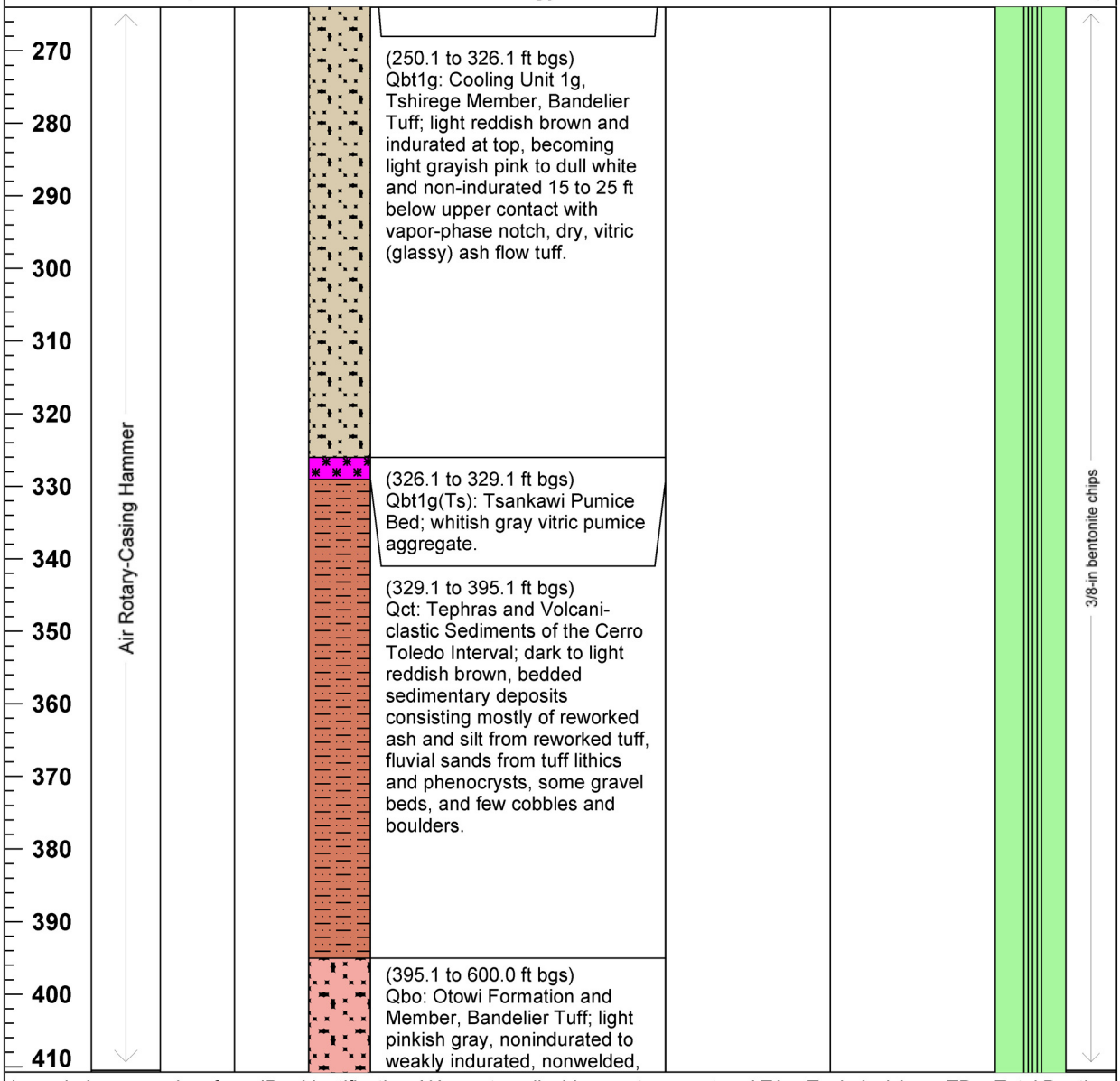
Los Alamos Technical Associates, Inc.
Borehole Log

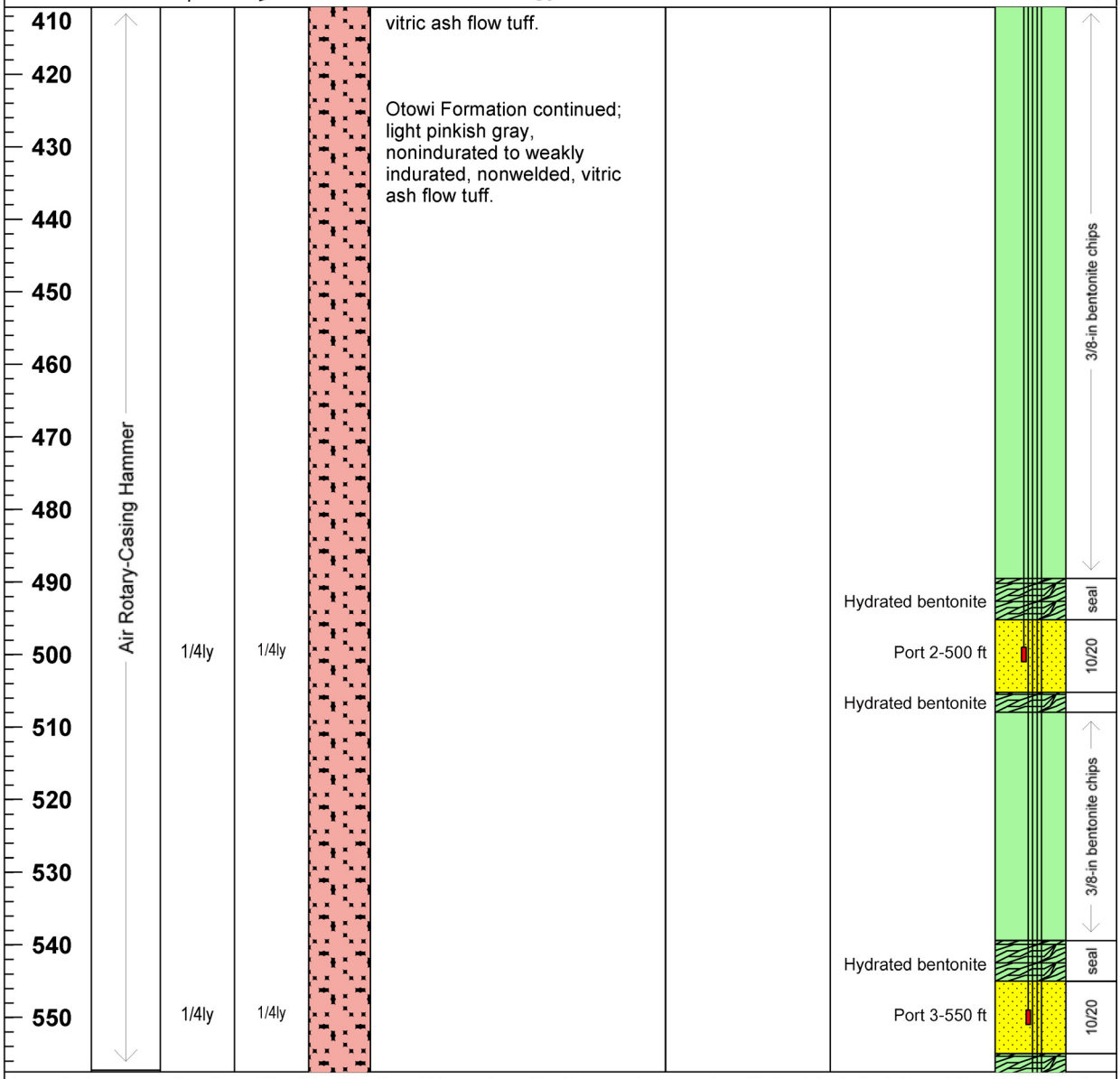
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613183 **Page 3 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

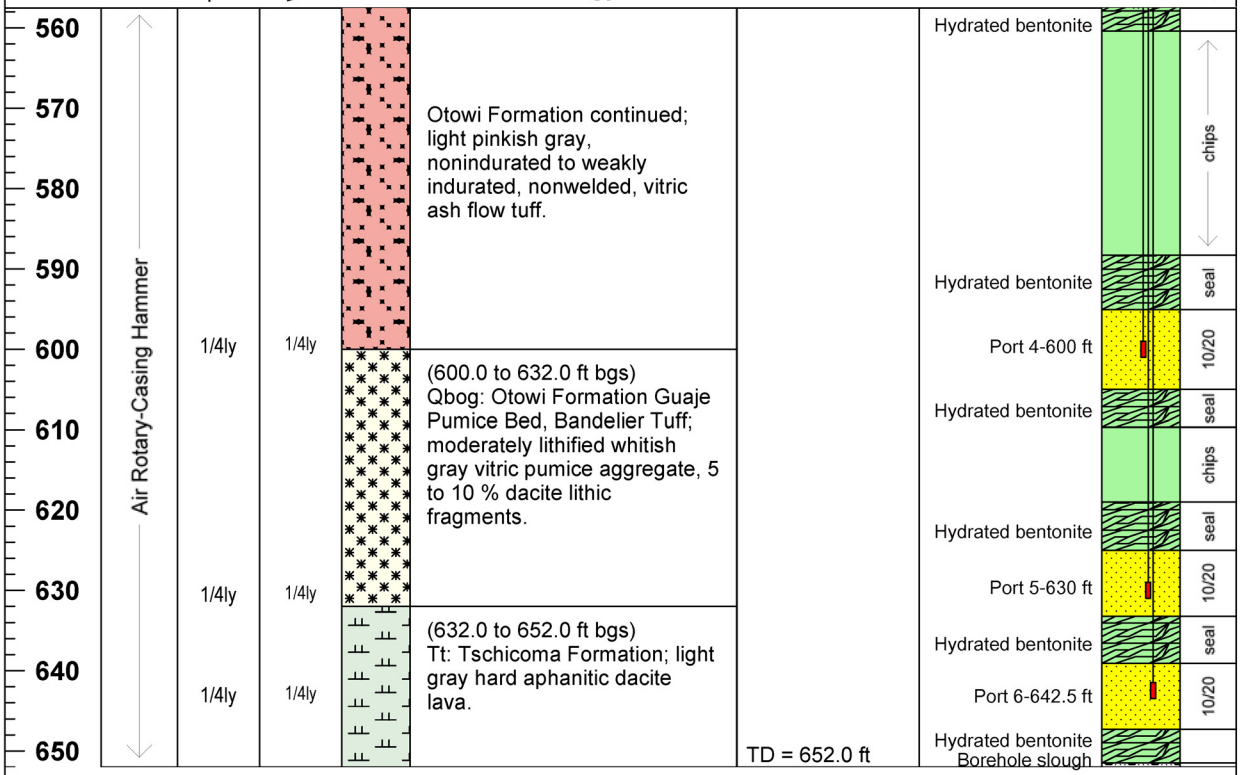
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613183 **Page 4 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613183 **Page 5 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Vapor Monitoring Well/Borehole Log

Project: MDA C Phase III Investigation **Page 1 of 5**

Vapor Monitoring Well ID: 50-613184 **Date Installed:** 01/18/2011

Extension of Phase II Well ID: 50-603468 **Attitude:** Vertical

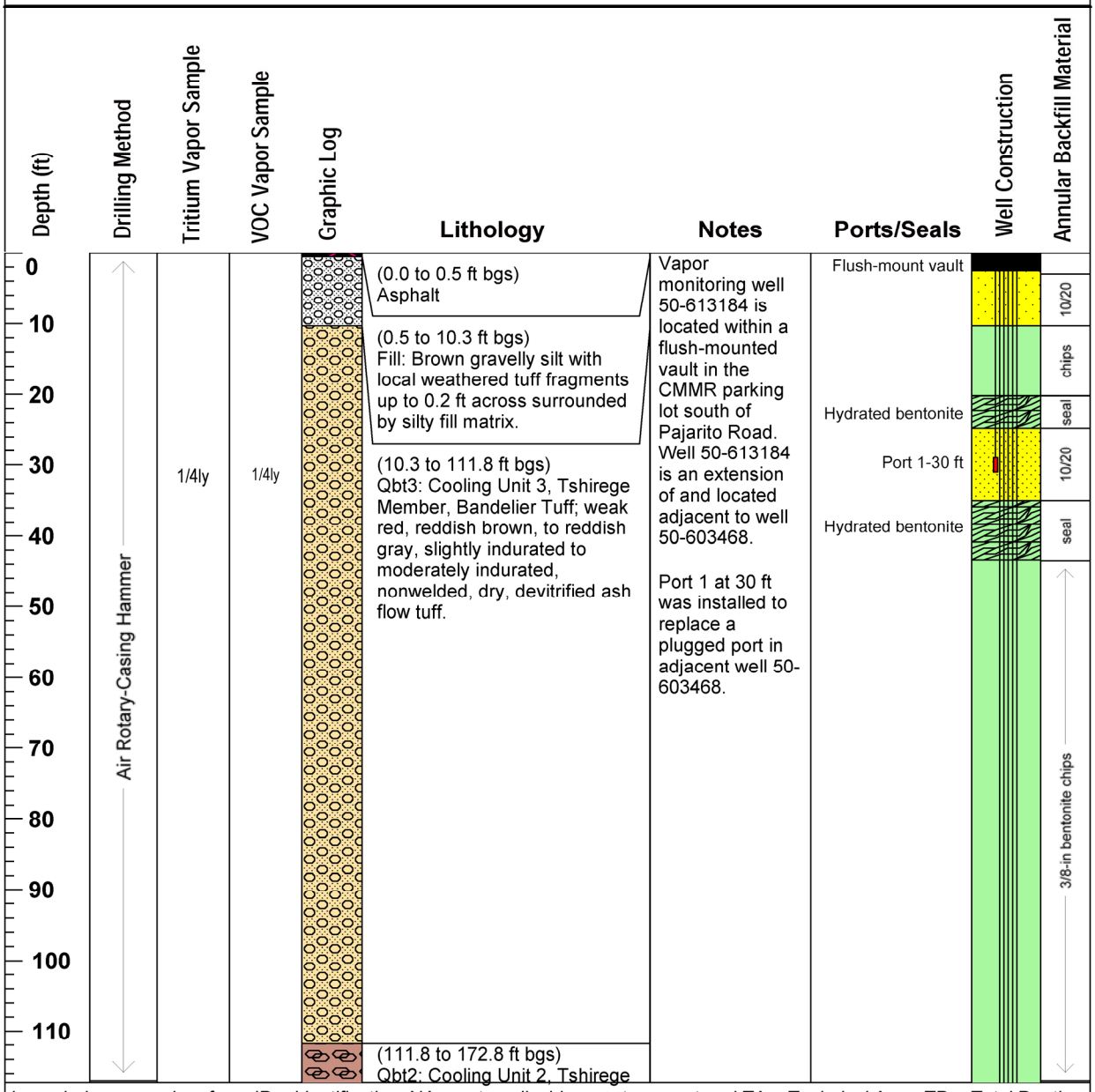
TA- 50 **AOC/SWMU: 50-009** **Drill Operator:** Del Leavitt

Drilling Company: WDC Exploration and Wells **Depth to Perched Saturation (ft):** NA

Drilling equipment: Speedstar 50K **Depth to Regional Saturation (ft):** NA

Geologist: Ali Furmall **Total Depth (ft):** 676

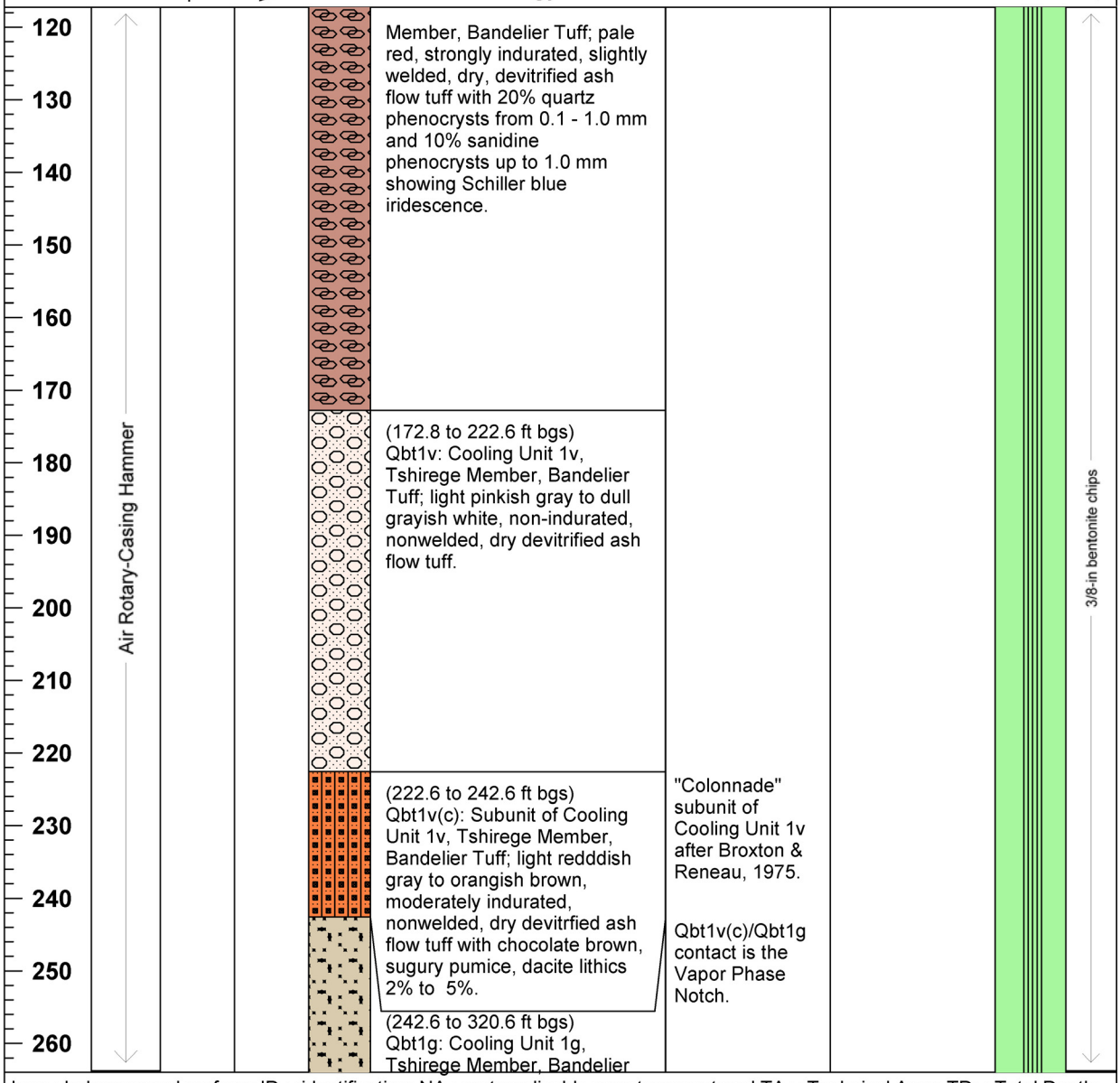
Vapor monitoring well type: discrete 1/4-inch stainless-steel tube from each port



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

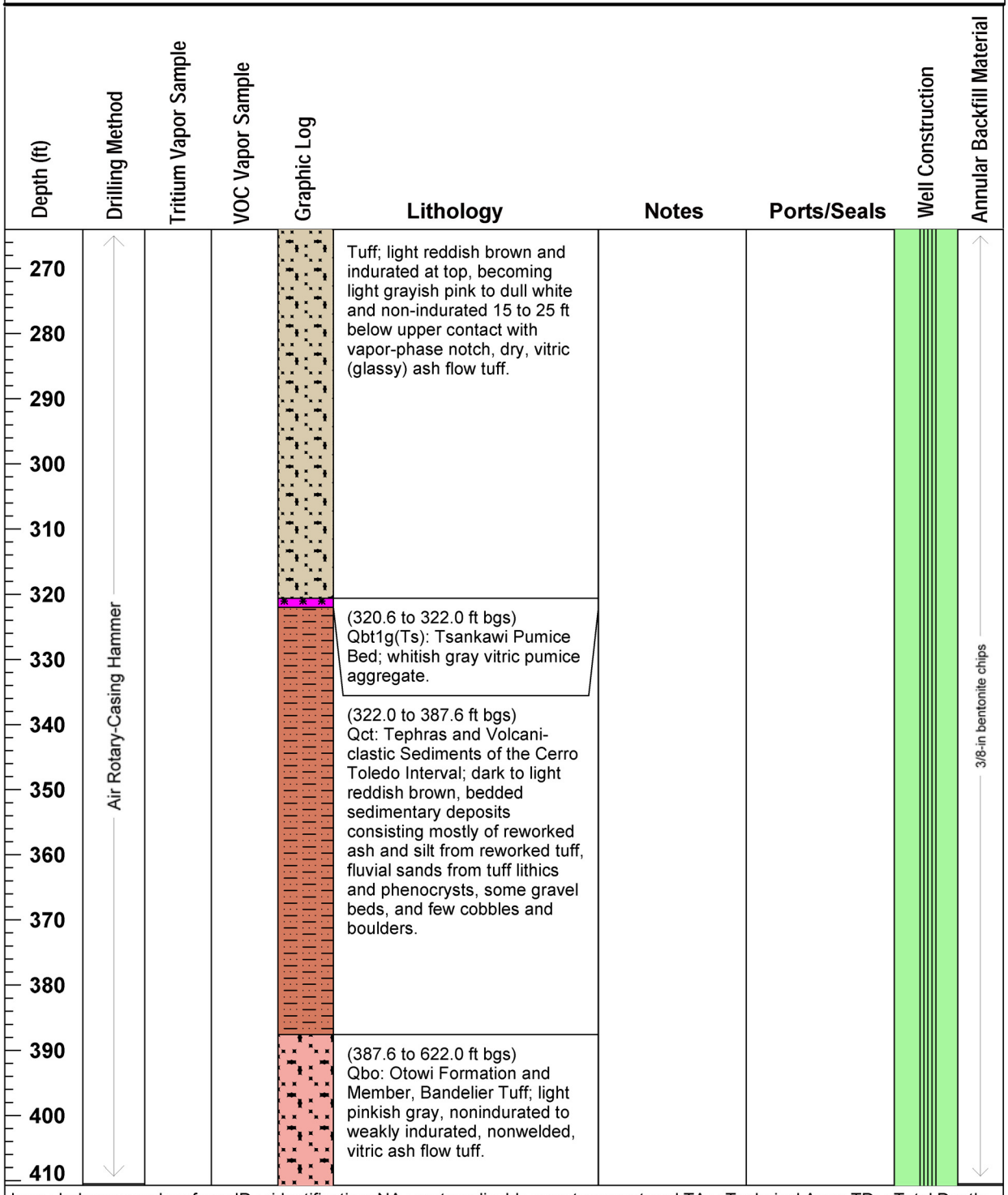
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613184 **Page 2 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

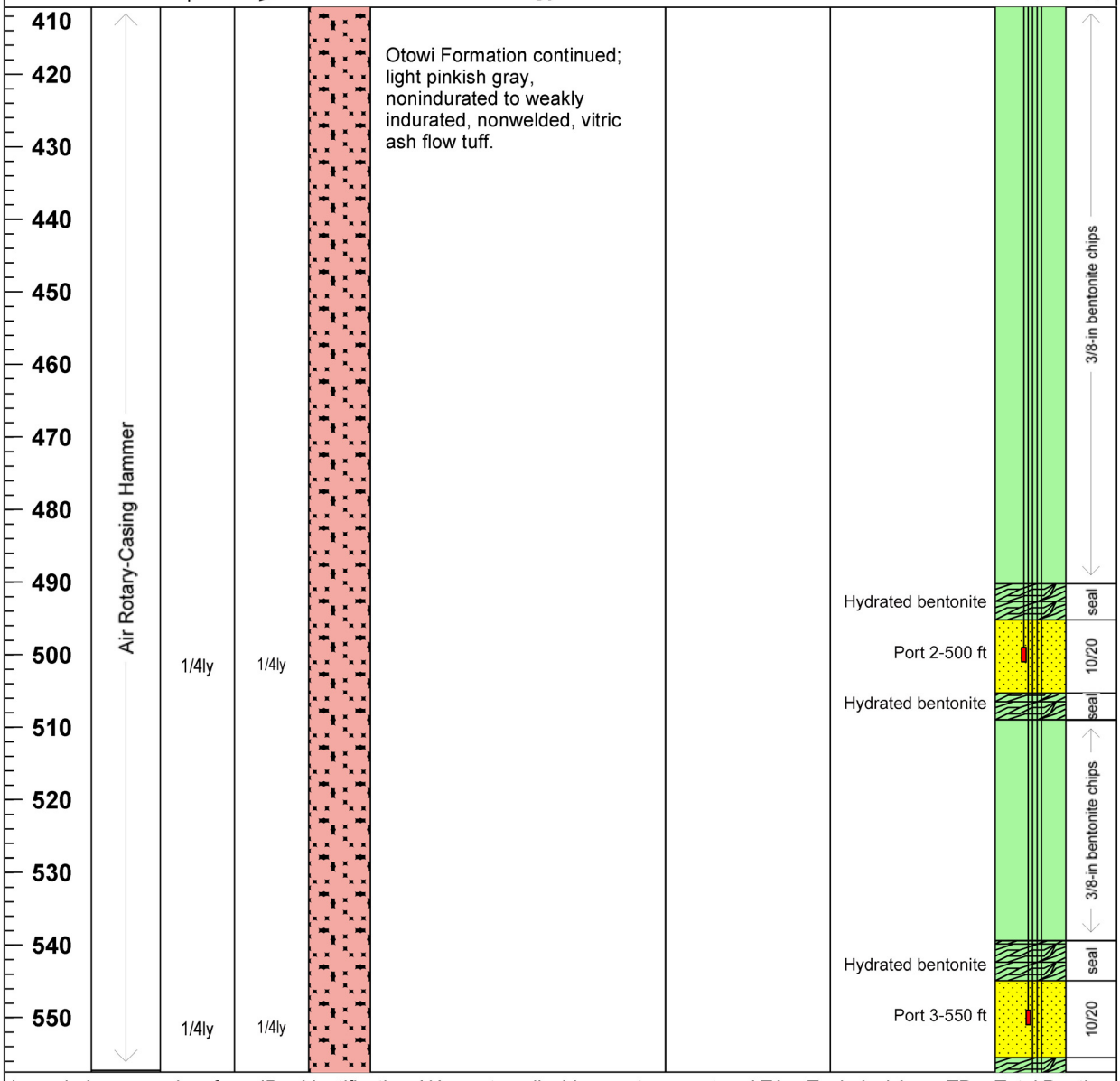
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613184 **Page 3 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

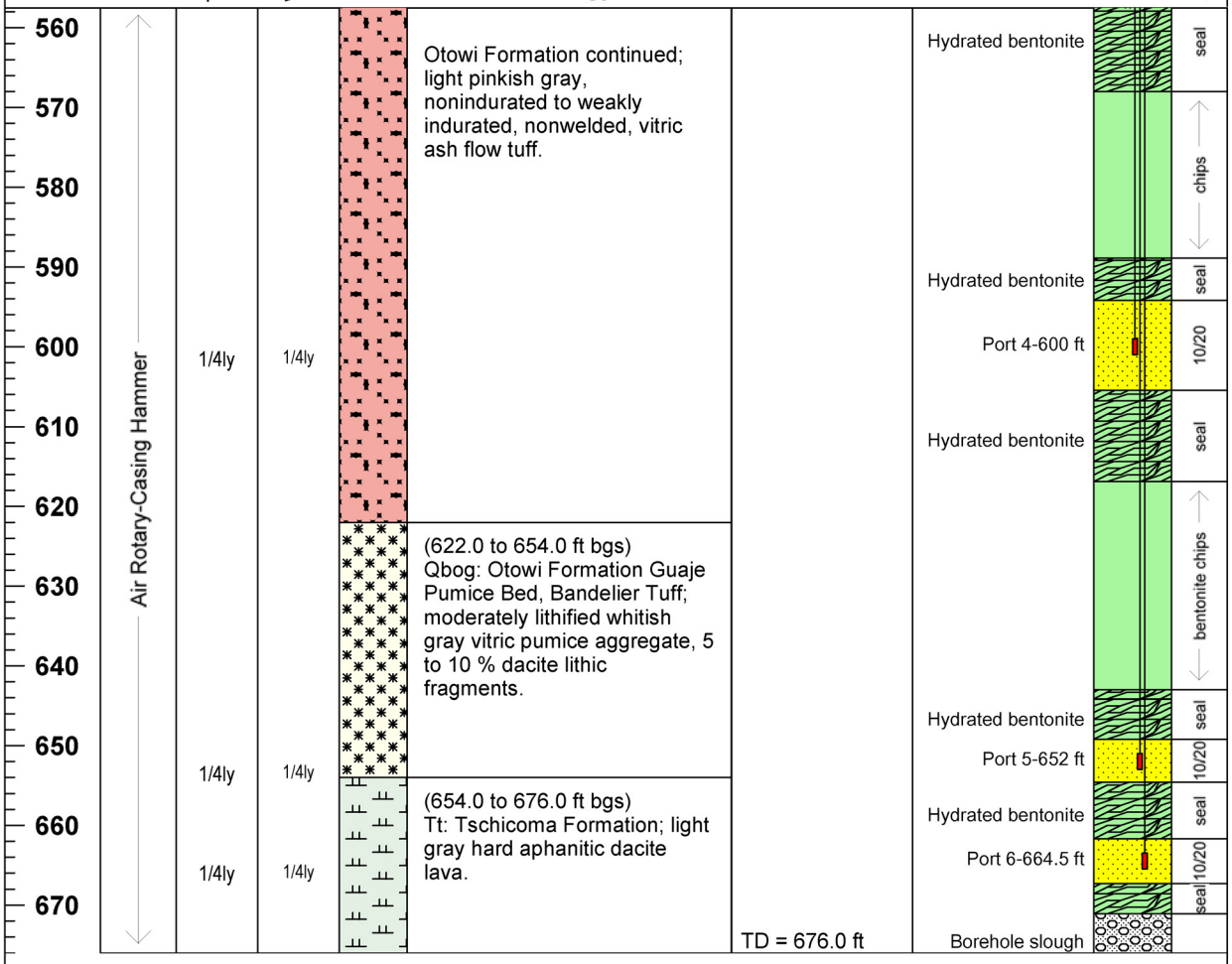
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613184 **Page 4 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613184 **Page 5 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Vapor Monitoring Well/Borehole Log

Project: MDA C Phase III Investigation **Page 1 of 5**

Vapor Monitoring Well ID: 50-613185 **Date Installed:** 12/09/2010

Extension of Phase II Well ID: NA **Attitude:** Vertical

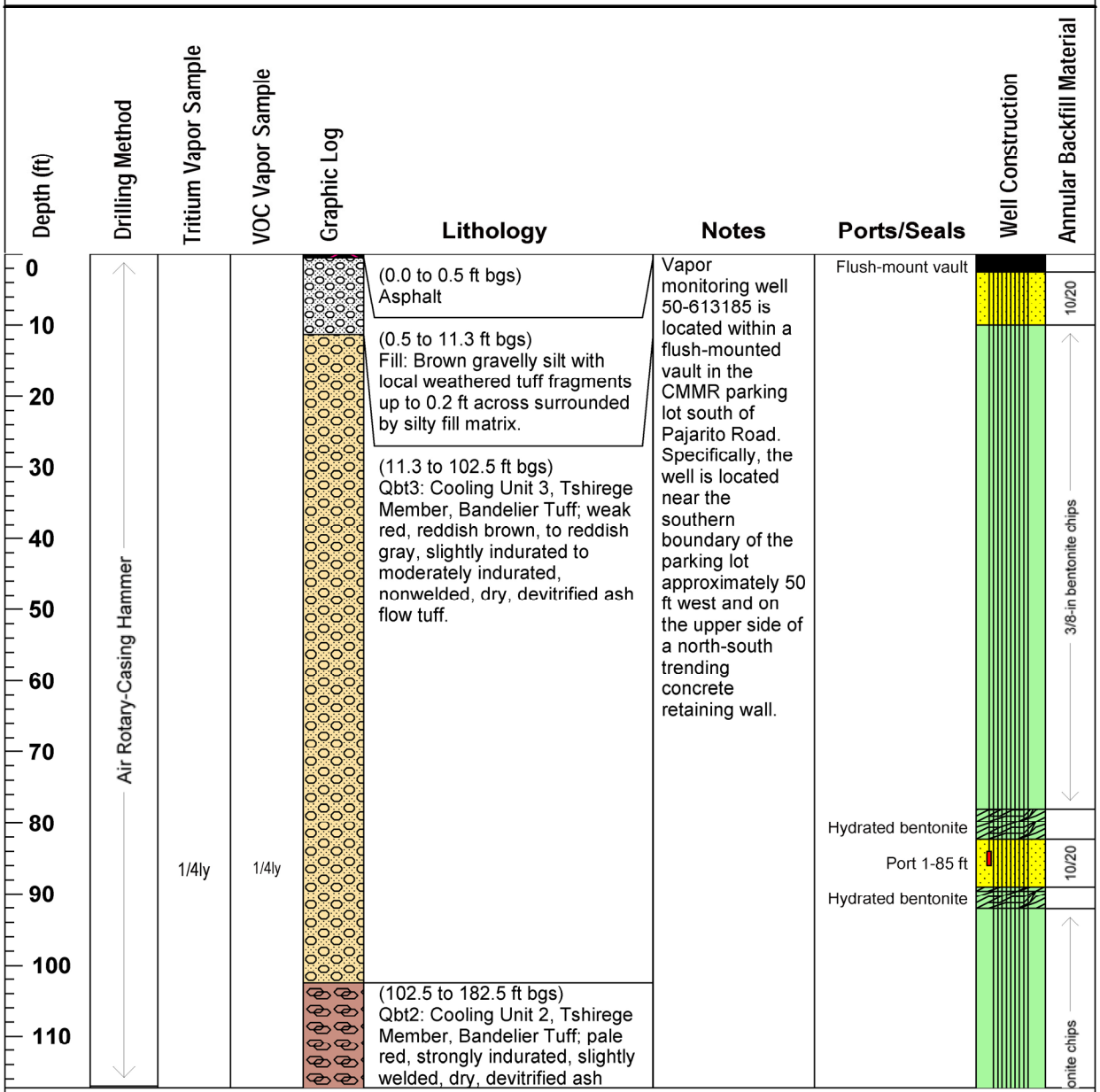
TA- 50 **AOC/SWMU: 50-009** **Drill Operator:** Del Leavitt

Drilling Company: WDC Exploration and Wells **Depth to Perched Saturation (ft):** NA

Drilling equipment: Speedstar 50K **Depth to Regional Saturation (ft):** NA

Geologist: Ali Furmall **Total Depth (ft):** 697.0

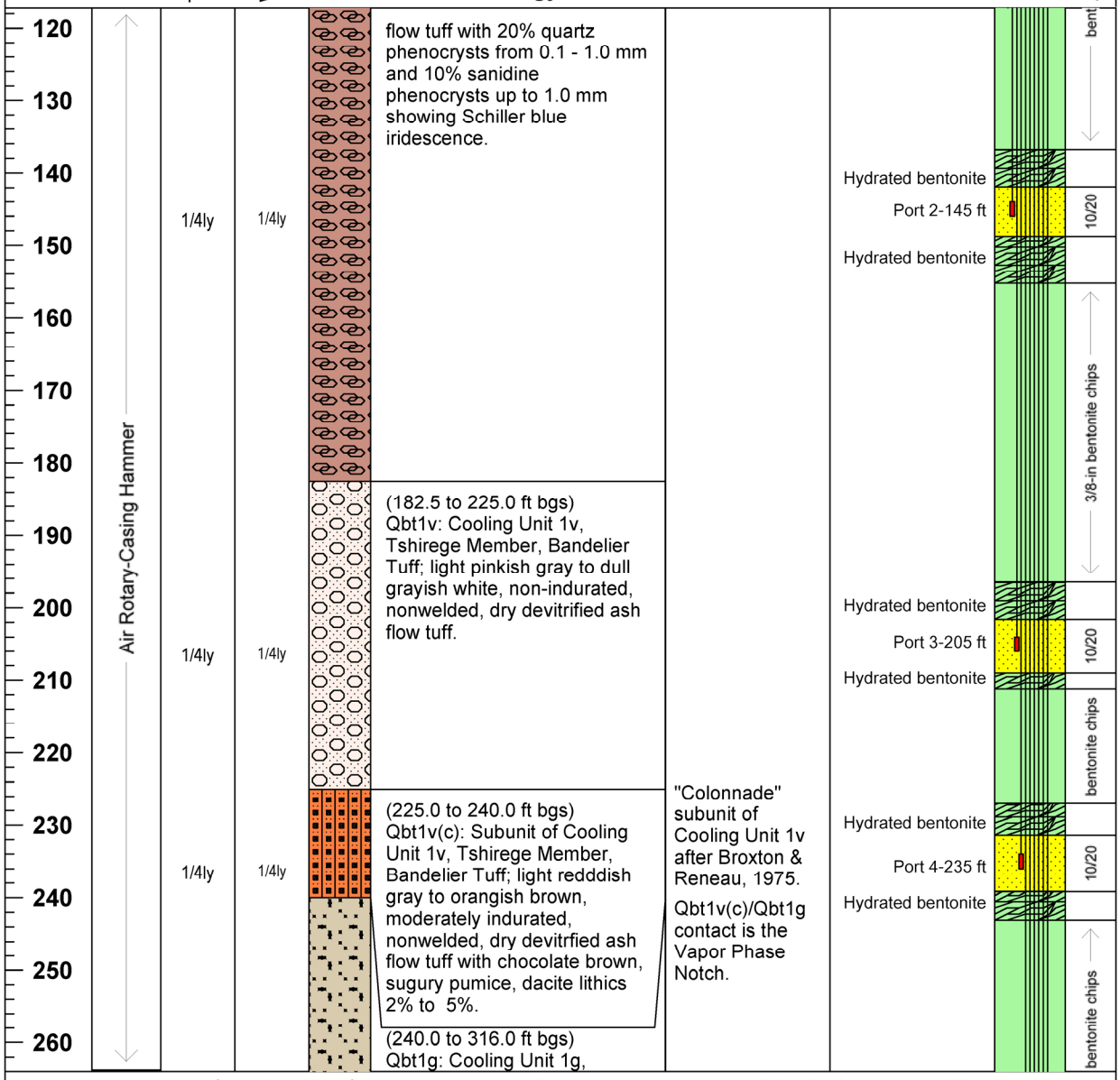
Vapor monitoring well type: discrete 1/4-inch stainless-steel tube from each port



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

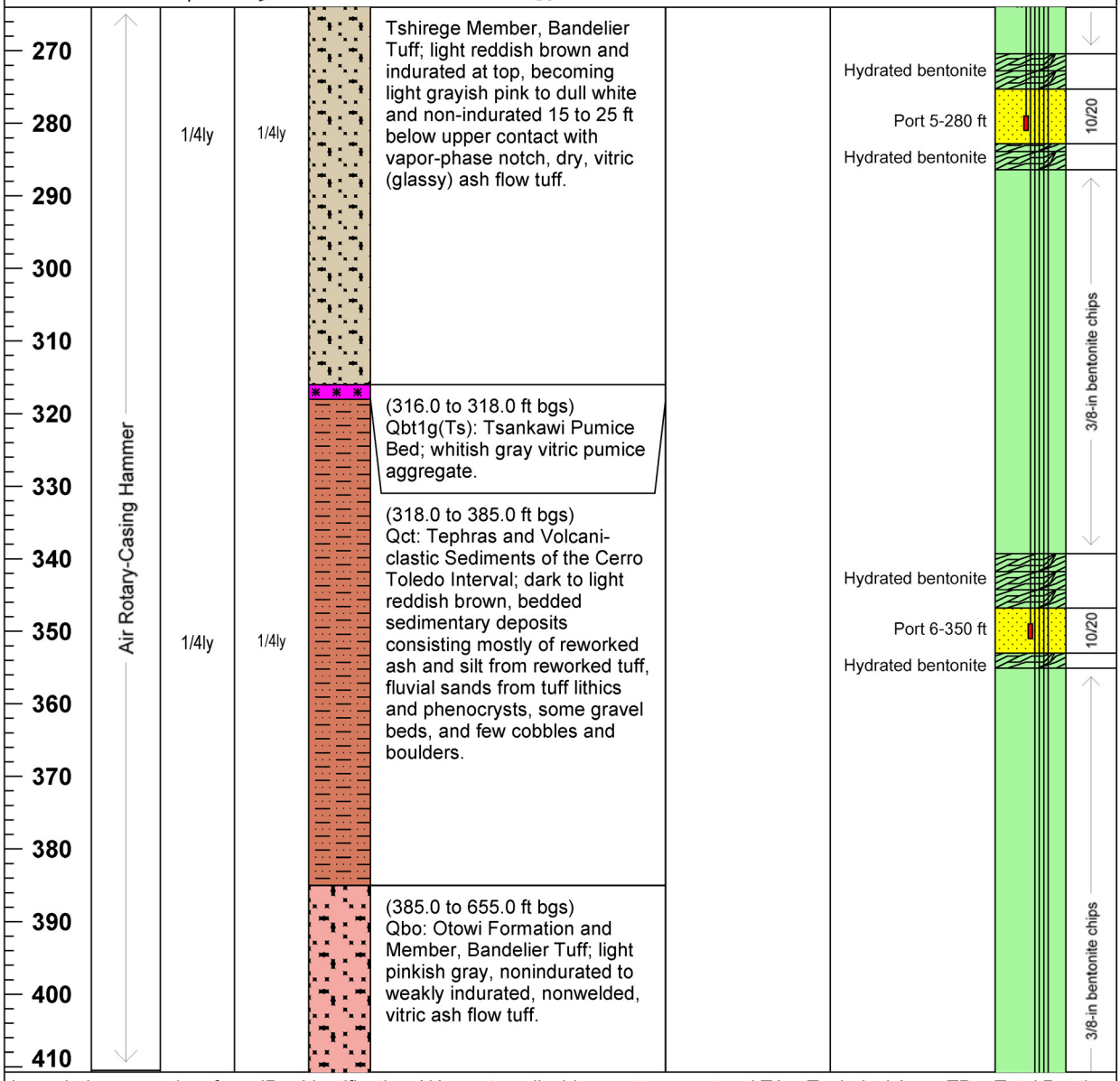
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613185 **Page 2 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

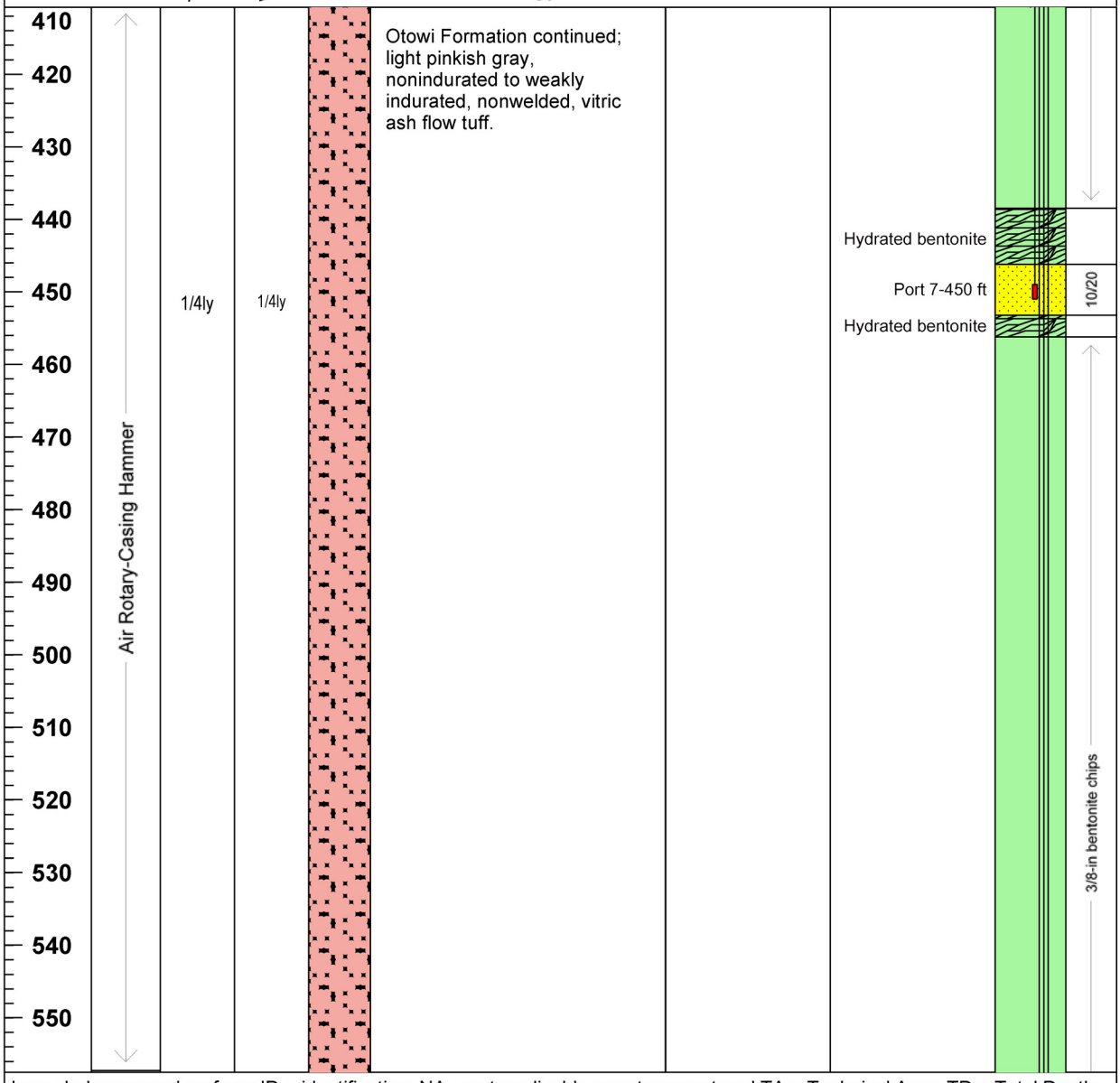
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613185 **Page 3 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

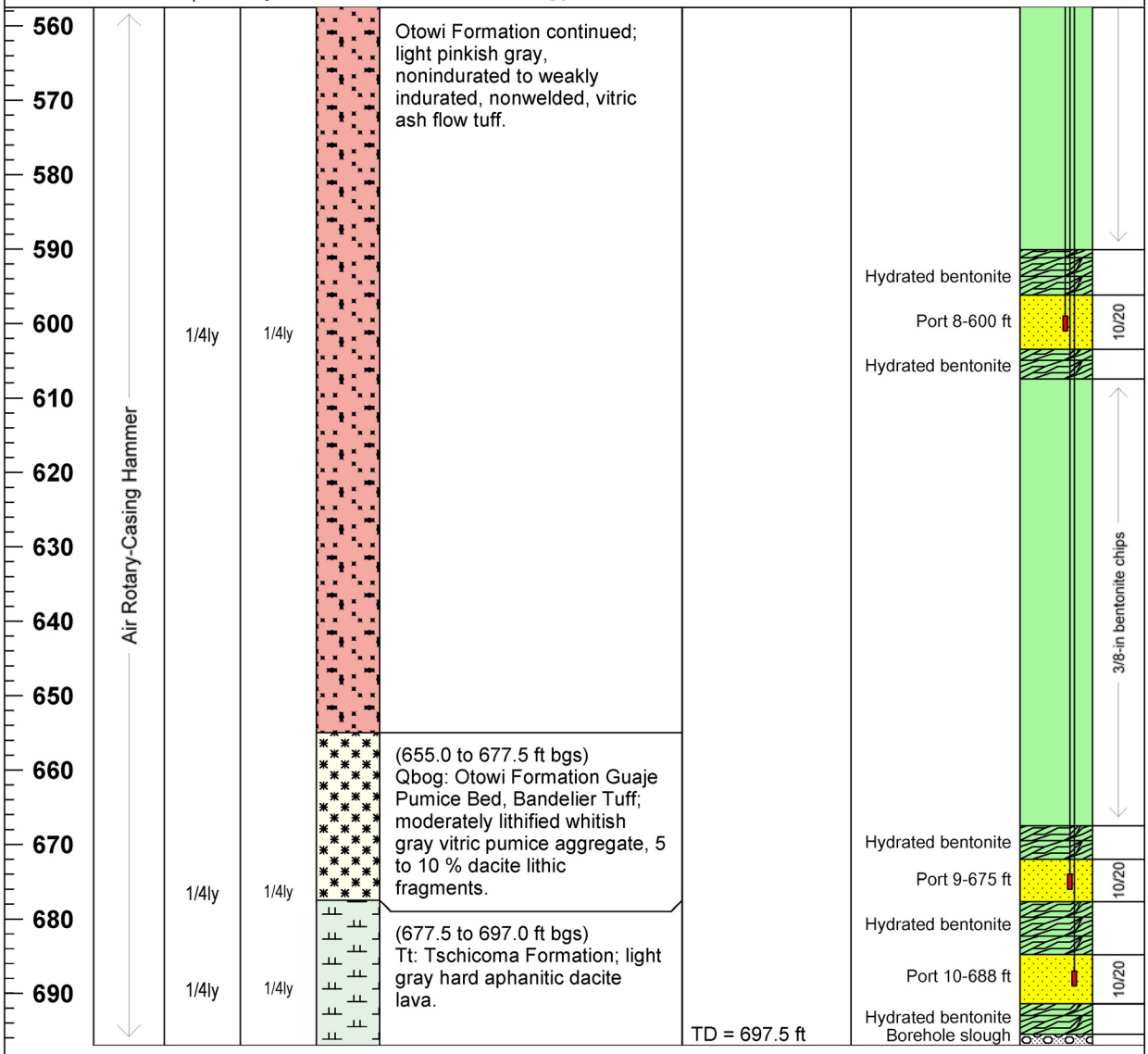
MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613185 **Page 4 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Los Alamos Technical Associates, Inc.
Borehole Log

MDA C Phase III Investigation
Vapor Monitoring Well Location ID: 50-613185 **Page 5 of 5**



bgs = below ground surface; ID = identification; NA = not applicable or not encountered;TA = Technical Area; TD = Total Depth; WDC = Water Development Company.

Attachment B-2

As-Built Diagrams

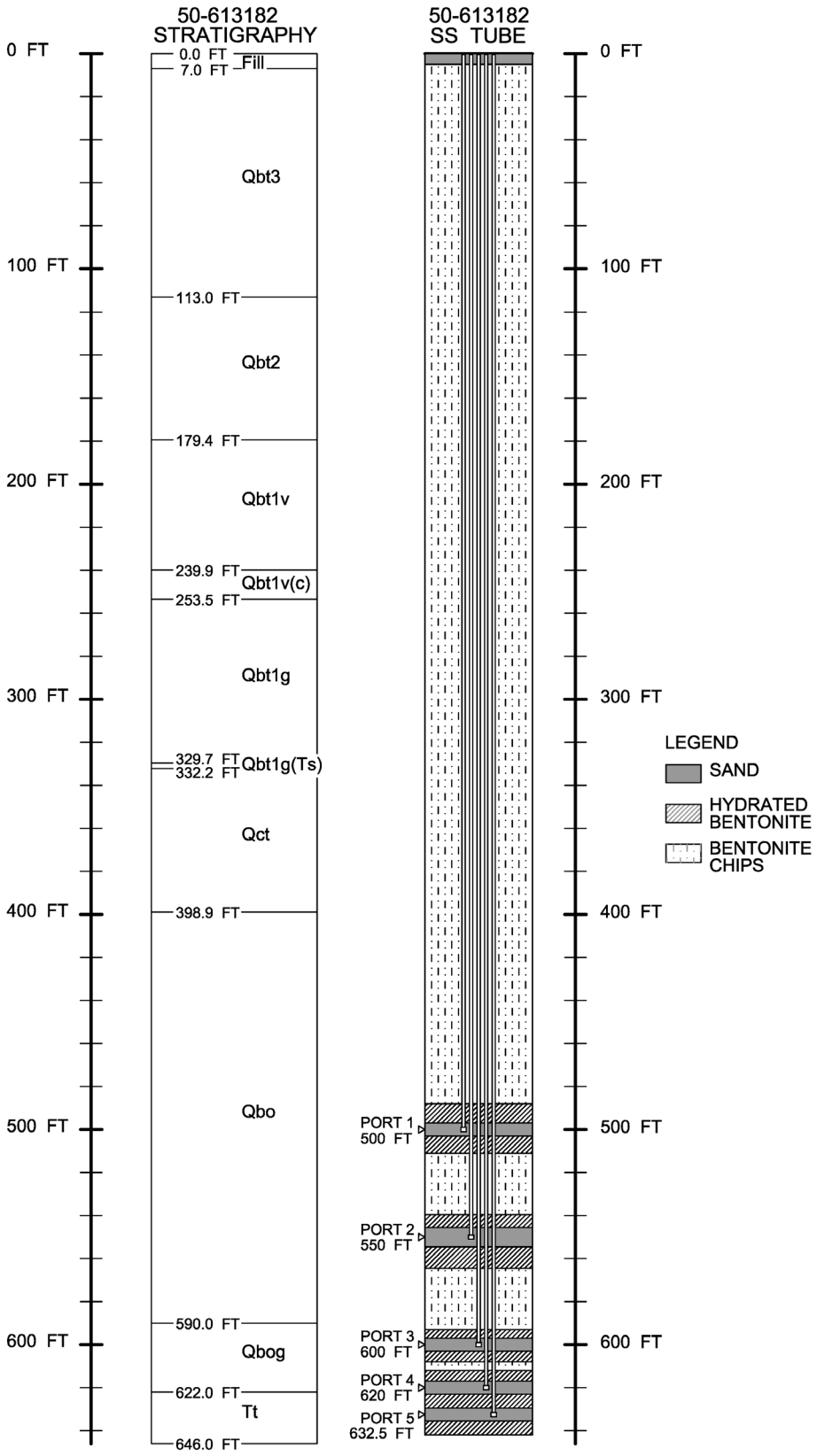


Figure B2-1 As-built diagram of borehole 50-613182

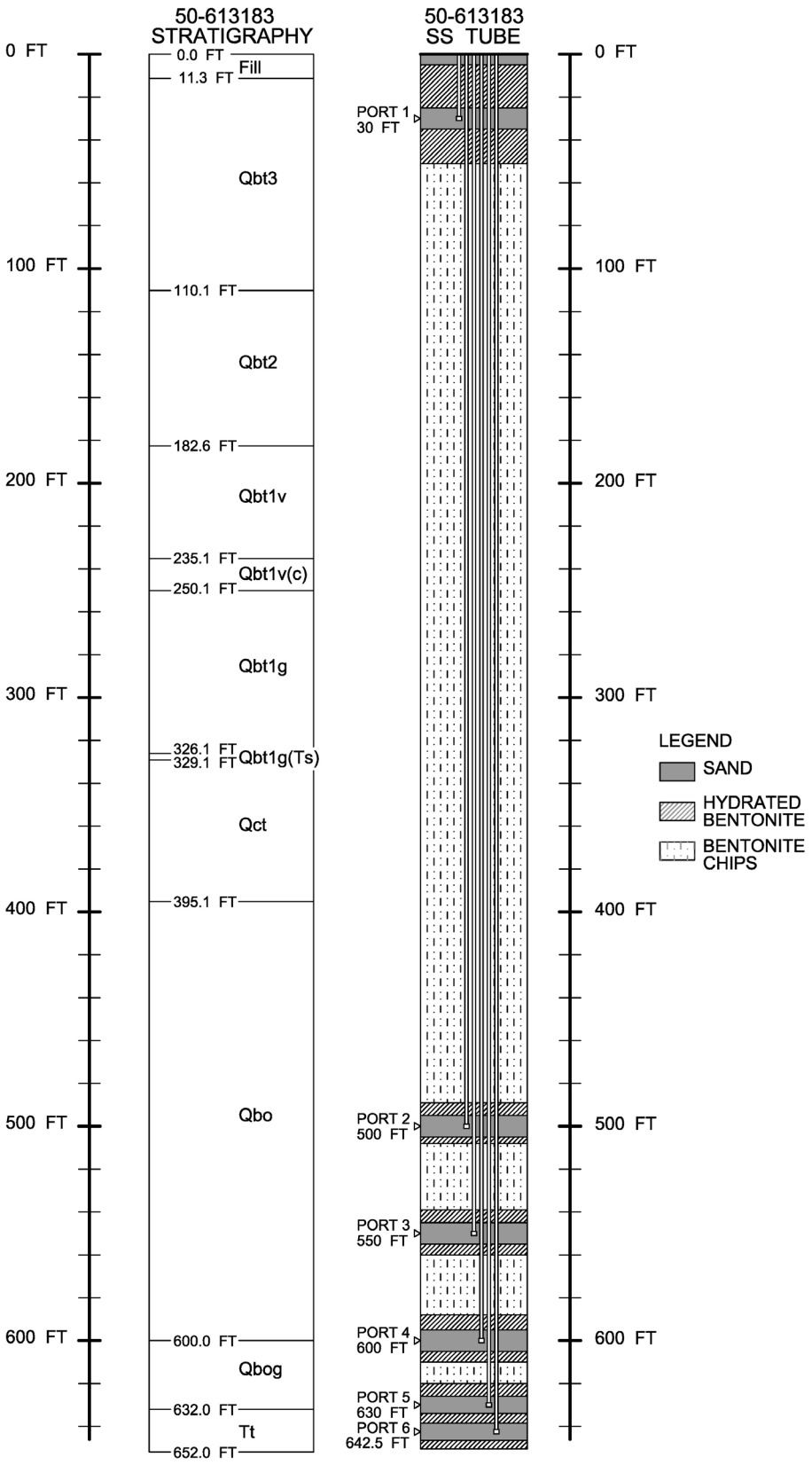


Figure B2-2 As-built diagram of borehole 50-613183

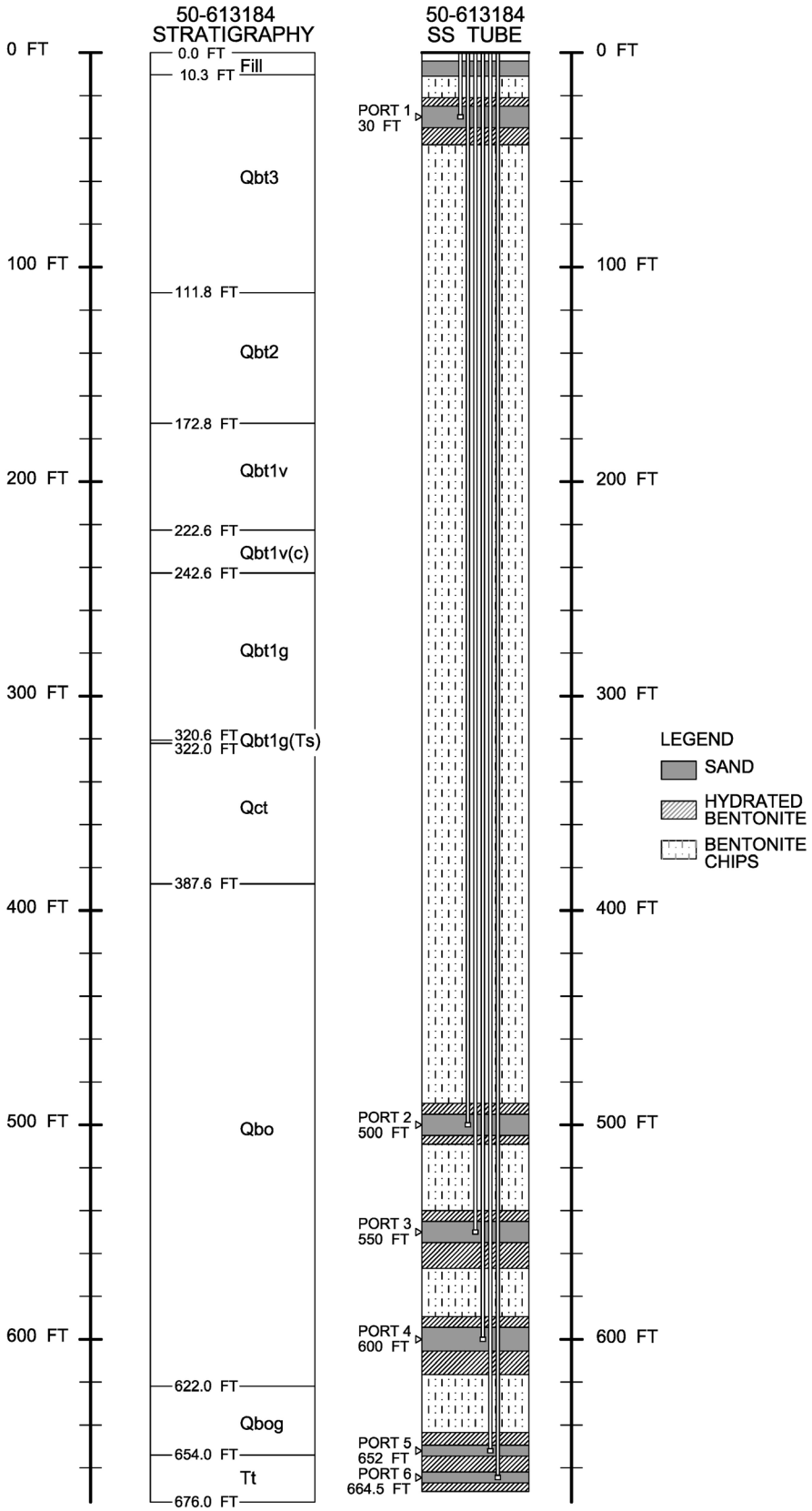


Figure B2-3 As-built diagram of borehole 50-613184

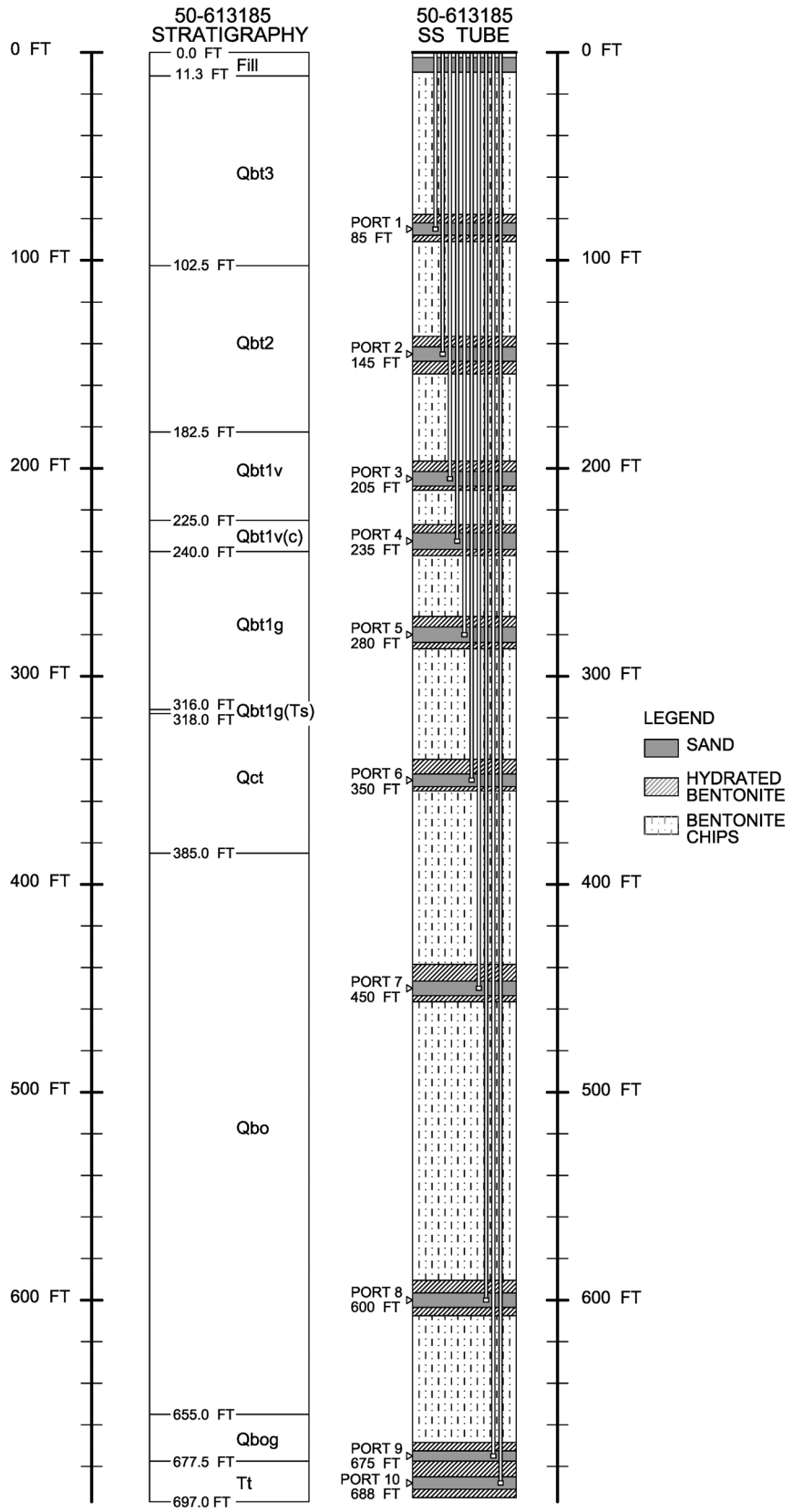


Figure B2-4 As-built diagram of borehole 50-613185

Appendix C

Analytical Program

C-1.0 INTRODUCTION

This appendix presents the analytical methods used and the data-quality review of the samples collected in the Phase III investigation conducted in 2010–2011 at Material Disposal Area (MDA) C at Los Alamos National Laboratory (the Laboratory).

Quality assurance (QA), quality control (QC), and data validation procedures were implemented in accordance with the Quality Assurance Project Plan Requirements for Sampling and Analysis (LANL 1996, 054609), and the Laboratory's statements of work (SOWs) for analytical laboratories (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962). The results of the QA/QC procedures were used to estimate the accuracy, bias, and precision of the analytical measurements. Samples for QC include method blanks, matrix spikes (MSs), laboratory control samples (LCSs), internal standards, initial calibration verifications (ICVs) and continuing calibration verifications (CCVs), surrogates, and tracers.

The type and frequency of QC analyses are described in the analytical service SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962), along with the applicable analytical methods. Other QC factors such as sample preservation and holding times were also assessed in accordance with the requirements outlined in Standard Operating Procedure (SOP) 5056, Sample Containers and Preservation. Evaluating these QC indicators allows estimates to be made of the accuracy, bias, and precision of the analytical suites. A focused data validation was also performed for all the data packages (also referred to as request numbers).

The following SOPs were used for data validation:

- SOP-5161, Routine Validation of Volatile Organic Compound (VOC) Data;
- SOP-5165, Routine Validation of Metals Analytical Data; and
- SOP-5166, Routine Validation of Gamma Spectroscopy, Chemical Separation Alpha Spectrometry, Gas Proportional Counting, and Liquid Scintillation Analytical Data

The focused validation included a more detailed review of the data generated by the analytical laboratory. The analytical data and instrument printouts used during focused validation are provided in Appendix D.

Routine data validation was performed for each data package, and analytical data were reviewed and evaluated based on U.S. Environmental Protection Agency (EPA) National Functional Guidelines, where applicable (EPA 1994, 048639; EPA 1999, 066649). As a result of the data validation and assessment efforts, qualifiers are assigned to the analytical records as appropriate. The data-qualifier definitions are provided in Appendix A. Sample collection logs (SCLs) and chain-of-custody (COCs) forms are provided in Appendix D. The analytical data, instrument printouts, and data validation reports are provided in Appendix D.

C-2.0 INORGANIC CHEMICAL ANALYSIS SUMMARY

Four samples (plus one field duplicate) collected at MDA C in 2010 were analyzed for target analyte list (TAL) metals. The analytical methods used for inorganic chemicals are listed in Table C-2.0-1.

C-2.1 Inorganic Chemical QA/QC Summary

All procedures were followed as required by the analytical service SOW (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962) and applicable corresponding EPA SW-846 methods.

Four TAL metal results were qualified as estimated (J) because the sample and the duplicate sample results were greater than or equal to 5 times the reporting limit, and the duplicate relative percent difference (RPD) was greater than 35% for soil samples.

Ten TAL metal results were qualified as estimated (J) by the analytical laboratory because the result was less the practical quantitation limit but greater than the method detection limit.

Twenty-one TAL metal results were qualified as not detected (U) by the analytical laboratory.

C-2.1.1 Maintenance of COC

COC forms were properly maintained for all samples (Appendix D).

C-2.1.2 Sample Documentation

Samples were properly documented on SCLs/ COC forms in the field (Appendix D).

C-2.1.3 Sample Dilutions

Some samples were diluted for inorganic chemical analyses. No qualifiers were assigned to any sample results because of issues related to sample dilution.

C-2.1.4 Sample Preservation

Preservation criteria were met for all samples analyzed for inorganic chemicals.

C-2.1.5 Holding Times

Holding-time requirements were met for all inorganic chemical analyses.

C-2.1.6 Initial and Continuing Calibration Verifications

One TAL metal result was qualified as not detected (U) because the sample result was less than or equal to 5 times the concentration of the analyte in the instrument blank and continuing calibration blank.

C-2.1.7 Analyte Identification

Analyte identification criteria were met for all samples analyzed for inorganic chemicals.

C-2.1.8 Interference Check Sample and/or Serial Dilutions

No qualifiers were assigned to inorganic chemical analysis results because of interference check sample or serial dilution problems.

C-2.1.9 Laboratory Duplicates

No qualifiers were assigned to any sample results because of issues related to laboratory duplicates.

C-2.1.10 Preparation Blanks

No qualifiers were assigned to any sample results because of issues related to preparation blanks.

C-2.1.11 Method Blanks

Six TAL metal results were qualified as estimated (J) because the analyte was identified in the method blank, but the sample result is greater than 5 times the concentration of the analyte in the method blank.

Two TAL metal results were qualified as not detected (U) because the sample result is less than or equal to 5 times the concentration of the analyte in the method blank.

C-2.1.12 MSs

Five TAL metal results were qualified as estimated and potentially biased low (J-) because the associated MS recovery was below the lower acceptance limit (LAL) but greater than 10%.

Seven TAL metal results were qualified as estimated and potentially biased high (J+) because the associated MS recovery was above the upper acceptance limit (UAL).

C-2.1.13 Laboratory Control Sample Recoveries

No qualifiers were assigned to any sample results because of issues related to laboratory control sample recoveries.

C-3.0 ORGANIC CHEMICAL ANALYSIS SUMMARY

Samples collected at MDA C in 2010–2011 were analyzed for organic chemicals. A total of 427 vapor samples (plus 47 field duplicates) were analyzed for volatile organic compounds (VOCs). The analytical methods used for organic chemicals are listed in Table C-3.0-1.

C-3.1 Organic Chemical QA/QC Summary

All QC procedures were followed as required in the analytical service SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962) and applicable corresponding EPA SW-846 methods.

Eighteen VOC results were qualified as estimated (J) because the analyte was identified in the method blank, but the sample result was greater than 5 times the amount in the method blank.

A total of 35,655 VOC results were qualified as not detected (U) by the analytical laboratory.

C-3.1.1 Maintenance of COC

COC forms were maintained properly for all samples analyzed for organic chemicals (Appendix D).

C-3.1.2 Sample Documentation

Samples were properly documented on SCLs/COCs in the field (Appendix D).

C-3.1.3 Sample Dilutions

Some samples were diluted for organic chemical analyses. No qualifiers were applied to any organic chemical results because of dilutions.

C-3.1.4 Sample Preservation

Preservation criteria were met for all samples analyzed for organic chemicals.

C-3.1.5 Holding Times

A total of 120 VOC results were qualified as estimated and potentially biased low (J-) because the holding time was greater than1 time and less than or equal to 2 times the applicable holding-time requirement.

A total of 790 VOC results were qualified as estimated not detected (UJ) because the holding time was greater than 1 time and less than or equal to 2 times the applicable holding-time requirement.

C-3.1.6 ICV and CCV

A total of 154 VOC results were qualified as estimated (J) because the affected analytes were analyzed with an initial calibration curve that exceeded the percent relative standard deviation (%RSD) criteria and/or the associated multipoint calibration correlation coefficient was less than 0.995.

A total of 152 VOC results were qualified as estimated (J) because the ICV and/or CCV was recovered outside the method-specific criteria.

A total of 28 VOC results were qualified as estimated (J) because the ICV and/or CCV was not analyzed at the appropriate method frequency.

A total of 830 VOC results were qualified as estimated not detected (UJ) because the affected analytes were analyzed with an initial calibration curve that exceeded the %RSD criteria, and/or the associated multipoint calibration correlation coefficient was less than 0.995.

Two VOC results were qualified as estimated not detected (UJ) because the affected analytes were analyzed with a relative response factor of less than 0.05 in the ICV and/or the CCV.

A total of 708 VOC results were qualified as estimated not detected (UJ) because the ICV and or CCV were recovered outside the method-specific criteria.

A total of 154 VOC results were qualified as estimated not detected (UJ) because the ICV and/or CCV were not analyzed at the appropriate method frequency.

C-3.1.7 Analyte Identification

No qualifiers were assigned because of issues related to analyte identification.

C-3.1.8 Method Blanks, Trip Blanks, and Rinsates

Forty-four VOC results were qualified as not detected (U) because the sample result was less than or equal to 5 times (10 times for acetone, methylene chloride, and 2-butanone) the concentration of the related analyte in the method blank, which indicates the reported detection is considered indistinguishable from contamination in the blank.

Ninety-six VOC results were qualified as not detected (U) because the result was less than or equal to 5 times the concentration of the related analyte in the trip blank and/or rinsate.

C-3.1.9 Surrogate Recoveries and Internal Standard Responses

No qualifiers were assigned because of issues related to surrogate recoveries or internal standard responses.

C-3.1.10 LCS Recoveries

A total of 63 VOC results were qualified as estimated and potentially biased low (J-) because the LCS percent recovery was less than the LAL but greater than 10%.

A total of 62 VOC results were qualified as estimated and potentially biased high (J+) because the LCS percent recovery was greater than the UAL.

A total of 113 VOC results were qualified as estimated not detected (UJ) because the LCS percent recovery was less than the LAL but greater than 10%.

C-3.1.11 Laboratory and Field Duplicates

Laboratory and field duplicates collected for organic chemical analyses indicated acceptable precision for all samples.

C-4.0 RADIOCHEMICAL ANALYSIS SUMMARY

A total of 435 vapor samples (plus 47 field duplicates) collected at MDA C in 2010–2011 were analyzed for tritium. The analytical method used for tritium is listed in Table C-4.0-1.

C-4.1 Radionuclide QA/QC Summary

All procedures were followed as required by the analytical service SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962).

Four tritium results were qualified as estimated (J) because the analyte was identified in the method blank, but the sample result was greater than 5 times the concentration of the analyte in the method blank.

Two tritium results were qualified as not detected (U) because the sample result is less than or equal to 5 times the concentration of the analyte in the method blank.

A total of 93 tritium results were qualified as not detected (U) because the amount reported was less than the minimum detectable concentration.

C-4.1.1 Maintenance of COC

COC forms were maintained properly for all samples (Appendix D).

C-4.1.2 Sample Documentation

All samples were properly documented on SCLs/COCs in the field (Appendix D).

C-4.1.3 Sample Dilutions

No samples were diluted for analysis of tritium.

C-4.1.4 Sample Preservation

Preservation criteria were met for all samples analyzed for tritium.

C-4.1.5 Holding Times

Holding-time criteria were met for all samples analyzed for tritium.

C-4.1.6 Preparation Blanks

No qualifiers were assigned to any sample results because of issues related to preparation blanks.

C-4.1.7 MSs

No qualifiers were assigned to any sample results because of issues related to matrix spikes.

C-4.1.9 LCS Recoveries

No qualifiers were assigned to any sample results because of issues related to LCS recoveries.

C-4.1.10 Laboratory and Field Duplicates

No qualifiers were assigned to any sample results because of issues related to laboratory or field duplicates.

C-5.0 REFERENCES

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

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

EPA (U.S. Environmental Protection Agency), February 1994. "USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review," EPA-540/R-94/013, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1994, 048639)

EPA (U.S. Environmental Protection Agency), October 1999. "USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review," EPA540/R-99/008, Office of Emergency and Remedial Response, Washington, D.C. (EPA 1999, 066649)

LANL (Los Alamos National Laboratory), March 1996. "Quality Assurance Project Plan Requirements for Sampling and Analysis," Los Alamos National Laboratory document LA-UR-96-441, Los Alamos, New Mexico. (LANL 1996, 054609)

LANL (Los Alamos National Laboratory), December 2000. "University of California, Los Alamos National Laboratory (LANL), I8980SOW0-8S, Statement of Work for Analytical Laboratories," Rev. 1, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2000, 071233)

Table C-2.0-1
Analytical Methods for Inorganic Chemical Analyses

Analytical Method	Analytical Description	Target Analyte List
SW-846:6010B	Inductively coupled plasma mass spectrometry (ICPES)–atomic emission spectroscopy (AES)	Aluminum, antimony, arsenic, barium, beryllium, boron, calcium, cadmium, cobalt, chromium, copper, iron, lead, lithium, magnesium, manganese, mercury, nickel, potassium, selenium, silicon, sodium, silver, thallium, titanium, uranium, vanadium, and zinc (TAL metals)
SW-846:6020	ICPES	Arsenic, beryllium, nickel, selenium, and thallium
SW-846:7471A	Graphite furnace atomic absorption	Mercury (TAL metal)
CLP:ILM03.0-200.7	ICPES-AES	Aluminum, antimony, arsenic, barium, beryllium, boron, calcium, cadmium, cobalt, chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, selenium, sodium, silver, thallium, titanium, vanadium, and zinc. (TAL metals)
CLP:ILM03.0-245.1	Cold vapor atomic absorption	Mercury

Table C-3.0-1
Analytical Method for Organic Chemical Analysis

Analytical Method	Analytical Description	Target Compound List
EPA Method TO-15	VOCs (vapor only) by gas chromatography/ mass spectrometry	Analytical service SOWs (LANL 1995, 049738; LANL 2000, 071233; LANL 2008, 109962)

Table C-4.0-1
Analytical Method for Radionuclide Analysis

Analytical Method	Analytical Description	Target Analyte List
EPA Method: 906.0	Liquid scintillation	Tritium (vapor)

Appendix D

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

Appendix E

Investigation-Derived Waste Storage and Disposal

E-1.0 INTRODUCTION

This appendix contains the waste management records for the investigation-derived waste (IDW) generated during the Phase III investigation of Material Disposal Area (MDA) C, also known as Solid Waste Management Unit 50-009, at Technical Area 50 (TA-50) of Los Alamos National Laboratory (LANL or the Laboratory).

All IDW generated during the MDA C Phase III field investigation was managed in accordance with Standard Operating Procedure (SOP) 5238, Characterization and Management of Environmental Program Waste. This procedure incorporates the requirements of all applicable U.S. Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) regulations, U.S. Department of Energy (DOE) orders, and Laboratory implementation requirements.

Consistent with Laboratory procedures, a waste characterization strategy form (WCSF) was prepared to address characterization approaches, on-site management, and final disposition options for wastes. Information from previous investigation wastes and analytical data and/or acceptable knowledge (AK) were used to complete the WCSF. The WCSF is included as Attachment E-1 to this appendix. Also included are the waste profile forms and manifests available at the time of submittal of this report.

The selection of waste containers was based on appropriate U.S. Department of Transportation requirements, waste types, and estimated volumes of IDW to be generated. Immediately following containerization, each waste container was individually labeled with a unique identification number and with information regarding waste classification, contents, and date generated.

Wastes were staged in clearly marked, appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements were based on the type of IDW and its classification. Container and storage requirements were detailed in the WCSF and approved before waste was generated.

Investigation activities were conducted in a manner that minimizes the generation of waste. Waste minimization was accomplished by implementing the most recent version of the "Los Alamos National Laboratory Hazardous Waste Minimization Report." Waste minimization included evaluating drill cuttings relative to requirements for land application. Cuttings that met the requirements were land applied to the drill site access roads and drill pads.

E-2.0 WASTE STREAMS

The IDW streams generated and managed during the Phase III investigation of MDA C are described below and summarized in Table E-2.0-1. Waste management records for the IDW generated are included in Attachment E-1.

- *WCSF Waste #1*: Municipal solid waste (MSW) consists of noncontact trash and debris and empty sample preservation containers. The MSW was determined to be nonhazardous, nonradioactive municipal solid waste. It was stored in plastic-lined trash cans and disposed of at the Los Alamos County landfill.
- *WCSF Waste #2*: This waste stream includes soil and tuff cuttings from boreholes. The cuttings were stored in plastic lined 20-yd^3 rolloff containers as low-level waste (LLW) within radioactive waste staging areas at MDA C. Borehole cuttings were characterized by direct sampling of each rolloff bin. The borehole cuttings met the criteria of the NMED-approved "NOI [Notice of Intent]

Decision Tree for Land Application of IDW Solids from Construction of Wells and Boreholes and the Radiological Decision Tree (SOP ENV-RCRA-QP-011.1); therefore, all 142 yd^3 of drill cuttings was land applied to the drill site access roads and drill pads.

- *WCSF Waste #3*: IDW includes spent personal protective equipment (PPE), contaminated sampling supplies and decontamination waste. The IDW characteristics were determined using AK and the data collected from characterization of the drill cuttings. This waste was stored in Green Is Clean (GIC) bags and managed within a nonhazardous/nonradioactive waste staging area at MDA C. A total of 27 ft^3 of GIC waste was generated. The waste was determined to be nonhazardous/nonradioactive and it was disposed of as GIC waste at TA-54.

Table E-2.0-1
Summary of IDW Generation and Management

Waste Stream	Waste Type	Volume	Characterization Method	On-Site Management	Disposition
MSW	Nonhazardous/ Nonradioactive	3 yd^3	AK	Plastic bags	Los Alamos County landfill
Drill cuttings	Nonhazardous/ Nonradioactive	142 yd^3	Direct sampling	20-yd^3 rolloff containers	Land application
Spent PPE, disposable sampling supplies, and decontamination waste	Nonhazardous/ Nonradioactive	27 ft^3	AK from analytical results from drill cuttings	GIC bags inside clamshell	Disposed of as GIC at TA-54

Appendix F

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

F-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) C. 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 with SLs is presented in the periodic monitoring reports for vapor-sampling activities at the Los Alamos National Laboratory (LANL or the Laboratory) (e.g., LANL 2010, 109955) and is discussed below as a Tier I screening evaluation. Although most VOCs fall below these SLs at MDA C, a few exceed the SLs and are discussed in this appendix. In addition, a two-tiered screening approach is applied at MDA C to further identify vapor-phase VOCs and vadose-zone concentrations that could potentially affect groundwater at concentrations exceeding applicable cleanup levels (Figure F-1.0-1). The screening approach is demonstrated using the most recent soil-vapor monitoring data from MDA C. This screening approach, referred to in this appendix as the Tier I screening methodology, is extremely conservative and does not consider transport to the aquifer, dilution in the aquifer, or attenuation in the vadose zone or the aquifer. If Tier I SLs are not exceeded, VOCs could not contaminate groundwater above cleanup levels even if the vapor plume were in direct contact with groundwater, and no further screening is necessary. If Tier I SLs are exceeded, a less conservative, more realistic, screening using a Tier II screening analysis is performed.

- For the Tier I screen, the analysis 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 two-tiered screening approach is presented below in section F-2.0 using soil-vapor data collected during the March 2011 to May 2011 sampling event. The result of the Tier I screening process is that three VOCs of potential concern, trichloroethene (TCE), 2-hexanone, and methylene chloride, were identified. The Tier II screening analysis is performed for these three VOCs, and only TCE fails the Tier II screening. The characteristics of the TCE subsurface vapor plume at MDA C are summarized in section F-3.0 based on its distribution as observed using data from five recent vapor-sampling events.

A brief summary of tritium vapor data is included in section F-4.0 for informational purposes only. A two-tiered screening analysis is also performed for tritium.

F-2.0 SCREENING METHODOLOGY FOR VOCS

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

The Tier I screening analysis is conducted using Phase III vapor data from MDA C 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 C 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:

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

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 constants is the New Mexico Environment Department (NMED) technical background document (NMED 2009, 108070) or the U.S. Environmental Protection Agency (EPA) regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm). The following dimensionless form of Henry's law constant is used:

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

Equation F-2.1-2 can be used to calculate the following screening value (SV):

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

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

SL = the screening level (µg/L), and

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

The SLs used in Equation F-2.1-3 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 no MCLs or NMWQCC standards are available, NMED tap water SLs (NMED 2009, 108070) are used. If no NMED SL exists, the EPA regional tap water SL (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) is used and adjusted to 10^{-5} risk for carcinogens. The numerator in Equation F-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 F-2.1-1 presents the calculated concentrations of contaminants in soil vapor corresponding to groundwater SLs for the Tier I screening. Table F-2.1-2 presents the results of the Tier I screen using data from March 2011 to May 2011. Three VOCs have SVs that exceed a value of 1 using the Tier I screen and are identified as having failed the Tier I screen: TCE, 2-hexanone, and methylene chloride maximum vapor concentrations yield calculated SVs of 46.5, 6.67, and 2.46, respectively.

F-2.2 Tier II Soil-Vapor Screen Based on Transport to and Dilution in the Regional Aquifer

TCE, 2-hexanone, and methylene chloride are further evaluated using a Tier II screening analysis. The Tier I SLs presented in Table F-2.1-1 basically assume that vapors present in the vadose zone located several hundred feet above the water table are in equilibrium with groundwater. However, the vapors must actually migrate downward to the water table and then mix with groundwater. When contaminants reach the water table of the regional aquifer, they mix with the clean groundwater flowing under ambient flux conditions, and contaminants are diluted. The resulting contaminant concentration in the groundwater is therefore lower than at the source in the vadose zone. A dimensionless dilution factor is used to account for this process, and its application is described in EPA and 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}):

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

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

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

where

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

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 F-2.2-1, F-2.2-2, and F-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 C in the free air and water phases. These coefficients can be modified to account for diffusion through a porous medium using the following equation (Millington and Quirk 1961, 110521):

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

$$D_{wp} = D_w n^{4/3}$$ **Equation F-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 F-2.1-1. At the water table, Henry's law is expressed using the concentrations of the gas, C_{wt}^g [M/L^3] and the water, C_{wt}^w [M/L^3], phases along the regional water table at equilibrium:

$$C_{wt}^w = \frac{C_{wt}^g}{H}$$ **Equation F-2.2-6**

where *H* is the dimensionless Henry's law constant. Henry's law constant depends on the properties of the VOC, and on the temperature and pressure.

Truex et al. (2009, 108331) have proposed a technique to compute the dimensionless dilution factor of the vapor-phase contaminants (F_{dg}) next to the water table when mixed into the regional aquifer:

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

where the mixing zone depth is calculated as

$$d_m = \sqrt{\frac{2d_a D_{wp}}{kI}}$$ **Equation F-2.2-8**

It is important to note that the mixing zone is created only by molecular diffusion. Truex et al. (2009, 108331) also proposed an approach to compute the dilution factor of the vapor-phase contaminants into the regional aquifer taking into account diffusion of the contaminant in the vadose zone under steady-state conditions:

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

where d_{vz} is the vertical distance between the contaminant source and the regional water table (if the contaminant source is at the ground surface, it will be the thickness of the vadose zone) 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 (~400 m), and available time for contaminant migration through the vadose zone (at least 40 yr). Equation F-2.2-9 takes into account the impact of the contaminant concentration at the water table on the diffusive flux occurring through the vadose zone. However, it does not account for aquifer dispersion. If vertical dispersion causes the plume to exceed the aquifer thickness under consideration in this analysis, the dispersion will increase mixing in the regional aquifer. However, this is not expected to occur within the current range of aquifer thickness values considered (aquifer thickness greater than 3 m). On the other hand, dispersion may increase the vapor-phase contaminant flux since it will decrease the contaminant concentrations near the regional water table. As a result, it is not expected that the vertical dispersion will increase vertical mixing of contaminants in the regional aquifer.

The analysis presented above follows the methodology of Truex et al (2009, 108331), which is based on an assumption that the considered thickness of the regional aquifer (d_a above; U in Truex et al [2009, 108331]) is equal to the lateral length of the source area parallel to groundwater flow (L). However, this is not the case in the present analyses where the considered thickness of the regional aquifer is 3 m (~10 ft), representing the length of a typical monitoring screen in the regional aquifer beneath MDA C, and the source length is considered to be on the order of 90 m (based on spatial analyses of the observed concentrations presented in section F-3.1). As a result, Equation F-2.2-9 is modified accordingly:

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

Equations F-2.2-1 and F-2.2-10 are used to calculate the dilution factors for the TCE, 2-hexanone, and methylene chloride at MDA C. The dilution factors are applied to compute SLs for each of the three VOCs 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 SL is then selected using the lower of the two values for a given VOC. If the currently observed contaminant concentration in the vapor phase is higher than the SL 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 TCE, 2-hexanone, and methylene chloride as COPCs (Tables F-2.1-1 and F-2.1-2). These three VOCs were then analyzed using the Tier II methodology for pore water and vapor migration. Table F-2.2-1 summarizes all the information about the regional aquifer, vadose zone, and contaminant characteristics applied in the Tier II analysis. The Tier II vapor-phase SLs for TCE, 2-hexanone, and methylene chloride are approximately 61,400, 59,200, and 42,000 $\mu g/m^3$, respectively (Table F-2.2-1). The value for 2-hexanone is based on the pore water pathway because of its low Henry's law coefficient (high water solubility), while the SLs for TCE and methylene chloride are derived from the vapor pathway. Based on the obtained SLs, TCE is the single COPC remaining after the Tier II analysis, as shown in Tables F-2.1-2 and F-2.2-1.

F-3.0 CHARACTERISTICS OF THE SUBSURFACE TCE VAPOR PLUME

TCE did not pass the Tier II screen. Therefore, additional data analysis and uncertainty evaluation are performed (Figure F-1.0-1). Additional data analyses are included here to determine 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 its mass (how large is the problem?) may provide additional information on the potential for impacting the regional aquifer.

Figure F-3.0-1 shows all of the vapor data for TCE gathered from March 2011 to May 2011 (third quarter of fiscal year [FY] 2011) plotted as a function of depth and compared to the Tier I and Tier II SLs. The plot illustrates that while most of the data exceed the Tier I SL, only 4 values (out of 158) exceed the Tier II SL and that these are located in the upper 300 ft (90 m) of the vadose zone or 1000 ft (310 m) above the water table. Three of these four data points are from monitoring well 50-24813 near the southeast corner of MDA C.

Section F-3.1 investigates the characteristics of the TCE vapor plume at MDA C by assessing the current distribution of soil-vapor concentrations and corresponding contaminant mass. Defining both the distribution and the mass of VOCs is an important part of understanding the nature and extent of the vapor plume.

F-3.1 Distribution and Mass Estimate of TCE in the Subsurface

This section presents estimates for the distribution of TCE in the subsurface beneath MDA C. These estimates are calculated using data collected from vapor-monitoring wells shown in Figure 1.3-1 of the investigation report and are based on statistical averaging of all samples collected during the second, third, and fourth quarters of FY2010 and third quarter FY2011 and samples collected during the first quarter FY2010 before the start of Phase III vapor-well drilling activities. Drilling occurred from November 5, 2010, to January 13, 2011, which spans the first and second quarters of FY2011 vapor-sampling events. Evaluation of vapor-sampling results collected after the start of drilling indicated that some TCE results from the first and second quarter s ofFY2011 were anomalously low compared with previous results. All anomalously low results from the first quarter of FY2011 had sample collection dates after the start of drilling. It is suspected that these anomalously low results were the result of dilution caused by loss of air into the subsurface during drilling. Samples from the third quarter of FY2011 were all collected more than 2 mo after drilling activities had been completed, and the results were comparable with data collected before drilling began. Therefore, data from all first quarter FY2011 samples collected after the start of drilling and all samples collected during the second quarter of FY2011 were eliminated from the data set. This approach is conservative because it does not include results that would tend to create a low bias in the averaged data set. VOC data for 158 ports in 18 vapor-monitoring wells are used in the analyses.

The TCE mass calculations estimate the TCE mass included in soil vapor, dissolved into pore water, and adsorbed onto solid media, based on chemical partitioning as described in section F-3.1.1. The method estimates the TCE contaminant mass contained within the volume defined by the Tier I, vapor-phase concentration SL of 2000 µg/m^3 (Table F-2.1-1).

F-3.1.1 Mathematical Approach

VOCs present in subsurface media will be as vapors dissolved into pore water and adsorbed onto solid media. Detected concentrations of VOCs in vapor are orders of magnitude less than the vapor pressures of these chemicals, which is evidence that VOCs are not present as a separate, nonaqueous liquid phase. Several equilibrium-partitioning constants describe the relationship between the concentrations of chemicals in these various phases. These constants can be used to develop an expression for the overall concentration of VOC in the bulk medium (i.e., tuff) as a function of the concentration in the vapor phase. Measured vapor-phase concentrations can then be used to calculate the bulk concentration in tuff, which can be used to estimate the overall mass of the inventory based on an assumed volume of affected media.

The first partitioning constant used is the Henry's law constant. The dimensionless form of Henry's law constant describes the equilibrium relationship between the volumetric concentrations of chemicals in air and in water (Equation F-2.1-1).

The second partitioning constant used is the distribution coefficient. The distribution coefficient describes the equilibrium relationship between the concentrations of chemicals dissolved in water and adsorbed on solids assuming a linear-sorption model:

$$K_d = C_{solid} / C_{water}$$

Equation F-3.1-1

where Kd = the distribution coefficient (L^3/M) and

C_{solid} = the mass concentration of contaminant in soil or tuff (M/M).

For organic chemicals, the adsorption of chemicals onto the solid phase is strongly influenced by the amount of organic carbon present in the solid. The distribution coefficient can be estimated from the organic carbon distribution coefficient and the fraction of organic carbon in tuff:

$$K_d = K_{oc}\, f_{oc} \qquad \textbf{Equation F-3.1-2}$$

where K_{oc} is the organic carbon distribution coefficient (L^3/M) and

f_{oc} is the fraction of organic carbon in tuff (M/M).

Rearranging Equation F-3.1-1 and substituting Equation F-2.1-2 and Equation F-3.1-2 gives

$$C_{solid} = {K_{oc}\, f_{oc}\, C_{air}}/{H} \qquad \textbf{Equation F-3.1-3}$$

The bulk concentration of chemical in tuff is equal to the total mass of chemical in all three phases per unit mass of tuff:

$$C_{bulk} = \frac{M_{air} + M_{water} + M_{solid}}{M_{soil}} \qquad \textbf{Equation F-3.1-4}$$

Where C_{bulk} = the bulk concentration of chemical in tuff (M/M),

M_{air} = the mass of chemical present in the vapor phase in pore gas (M),

M_{water} = the mass of chemical present in the liquid phase in pore water (M),

M_{solid} = the mass of chemical present in the solid phase in tuff (M), and

M_{soil} = the mass of the soil or tuff (M).

The mass of chemical present in the vapor phase in pore gas is equal to the product of the concentration in air and the volume of air. The latter is equal to the product of the volumetric air-filled porosity and the volume of tuff. The mass of contaminant present in the liquid phase in pore water is equal to the product of the concentration in water and the volume of water. The latter is equal to the product of the volumetric water-filled porosity and the volume of tuff. The mass of contaminant present in the solid phase in tuff is equal to the product of the concentration in the solid phase and the mass of tuff. The latter is equal to the product of the volume of tuff and the bulk density of tuff. Using the relationships described above, Equation F-3.1-4 can be rewritten as

$$C_{bulk} = \frac{\left(C_{air}\, V_{soil}\, \theta_{air}\right) + \left({C_{air}\, V_{soil}\, \theta_{water}}/{H}\right) + \left({C_{air}\, K_{oc}\, f_{oc}\, V_{soil}\, \rho_{soil}}/{H}\right)}{V_{soil}\, \rho_{soil}} \qquad \textbf{Equation F-3.1-5}$$

where V_{soil} = the volume of tuff (L^3),

θ_{air} = the volumetric air-filled porosity (L^3/L^3),

θ_{water} = the volumetric water-filled porosity (L^3/L^3), and

ρ_{soil} = the bulk density of tuff (M/L^3).

Equation F-3.1-5 can be simplified to

$$C_{bulk} = \frac{C_{air}\left(\theta_{air} + \theta_{water}/H + \left(K_{oc}\, f_{oc}\, \rho_{soil}\right)/H\right)}{\rho_{soil}} \qquad \textbf{Equation F-3.1-6}$$

Equation F-3.1-6 gives the bulk concentration of VOC in tuff as a function of the vapor concentration and properties of the chemical and tuff. The sources of the data used in Equation F-3.1-6 and any associated assumptions are described below.

- C_{air}—The vapor-monitoring results provide the concentration of a particular VOC measured at each sampling point. In this example, the concentration of TCE measured during second quarter FY2010 to third quarter FY2011 vapor sampling at MDA C were used.
- θ_{air}—The volumetric air-filled porosity depends on the total porosity and moisture content of the tuff ($\theta_{air} = porosity - \theta_{water}$), both of which vary depending on geologic unit and depth. The porosity and volumetric moisture content used in this analysis are presented in Table F-3.1-1. These values were selected as being representative of tuff at MDA C, based on a large set of properties measured on samples collected at Technical Area 54 (Hollis et al. 1997, 063131).
- θ_{water}—The volumetric water content varies depending on the physical properties of the geologic unit (Table F-3.1-1).
- H and K_{oc}—The Henry's law constant and organic carbon distribution coefficient are physical properties of the VOC and were obtained from the NMED soil screening level technical background document (NMED 2009, 106420). The values used for H' and K_{oc} are for TCE are 0.4 (dimensionless) and 67.7 L/kg, respectively.
- f_{oc}—The fraction of organic carbon depends on the amount of organic matter present in the tuff and varies depending on the amount of weathering and biological activity. A single value of 0.0005 (0.05%) was assumed to be representative of tuff in the subsurface beneath MDA C. This value is a factor of 3 less than the representative value for soil presented in NMED (2009, 108070) and reflects the lower organic content of tuff.
- ρ_{soil}—The bulk density depends on the total porosity of the tuff and the density of the solids composing the tuff and varies depending on geologic unit. Table F-3.1-1 lists the values used for MDA C (Hollis et al. 1997, 063131).

F-3.1.2 Methodology

Pore-gas concentrations were input into Equation F-3.1-6 to estimate the mass of TCE at MDA C. The following steps and assumptions were used to calculate the estimates:

1. Analytical data (vapor samples collected with SUMMA canisters and analyzed at an analytical laboratory) from the 158 ports listed in Tables 3.3-1 through 3.3-3 of the investigation report were used in the analyses. Data from the second, third, and fourth quarters of FY2010 and third quarter FY2011 and samples collected during the first quarter FY2010 before the start of Phase III vapor well drilling activities were used. Four new vapor wells (27 ports) were only recently installed and provided just one round of data (third quarter of FY2011).
2. The data for each port were first averaged and then interpolated to a three-dimensional (3-D) grid representing the current average 3-D subsurface vapor-phase TCE distribution beneath MDA C. The interpolation was performed using the minimum tension option of the EarthVision 8 software

package by Dynamic Graphics (2009). Previous vapor-plume modeling for MDA C utilized a stratified approach to interpolate the data from each geologic layer separately (LANL 2010, 109082). This technique can lead to extrapolation errors and discontinuities that are not consistent with the radial diffusion conceptual model of vapor transport at this site. The EarthVision's technique accounts for all data, regardless of geologic unit, in a single gridding pass. The resulting ellipsoidal plume does not have any discontinuities at layer contacts.

3. Sixty realizations were performed to examine the sensitivity of the estimated 3-D contaminant distribution to various interpolation settings. Each realization honors the data. These 60 distributions were averaged to derive the final estimated plume distribution. A standard deviation was also calculated from the 60 realizations and used along with the mean to derive estimated plume distributions representing the maximum and minimum plume extents as a measure of uncertainty.
4. The total contaminant mass, accounting for all three phases through equilibrium partitioning, was calculated for the final estimated TCE distribution as well as for the estimated minimum and maximum extents. These estimates account for both the estimated 3-D contaminant plume distribution and the 3-D geologic framework model for MDA C updated with the four new vapor monitoring boreholes. Each 3-D plume was discretized into a series of 3-D concentration isoshells defined for each geologic zone. The volume of each isoshell, the average concentration within each isoshell, and strata-specific physiogeochemical parameters listed in Table F-3.1-1 were then used as input to Equation F-3.1-6 along with the appropriate unit conversions to yield total contaminant mass in kilograms.

F-3.1.3 Summary of Current VOC Distributions

This section includes several illustrations of the modeled 3-D vapor-plume distributions for TCE vapor concentrations as well as the mass estimates derived from the combination of those distributions with the overlapping geologic framework. Plan-view maps illustrating the lateral extent of TCE within several geologic layers, both separate and combined, are presented in Figures F-3.1-1 through F-3.1-5. These maps depict the maximum extent of the vapor plumes within the entire thickness of the geologic unit of interest. Each map also illustrates the locations of three section lines used to produce orthogonal cross-sections passing through the highest observed average concentrations. The cross-sections illustrate the vertical extent of the plume and are presented in Figures F-3.1-6 through F-3.1-8.

Figure F-3.1-1, which represents the maximum extent of TCE within the Bandelier Tuff, shows concentrations elevated to approximately 25 times the Tier I SL of 2000 $\mu g/m^3$ over an area that is approximately 425 ft (130 m) wide and centered on the disposal pits. The concentrations decrease in a radial fashion away from this central area over a distance of approximately 450 ft. The similarity between Figure F-3.1-2, which shows the portion of the plume within unit 1g, and Figure F-3.1-1 reveals that unit 1g is where the center of mass resides. Figures F-3.1-3 through F-3.1-5 show decreasing plume extent with depth depicted for different geologic strata; the Tschicoma dacite is almost devoid of contamination. Figures F-3.1-6 through F-3.1-8 show the distributions of TCE vapor concentrations in cross-section. The TCE plume is ellipsoidal in shape, with lateral extent being greater than vertical. The plume is almost entirely contained within the Bandelier Tuff, with the majority constrained to the Tshirege Member, which makes up the upper 300 ft of the Bandelier Tuff at MDA C. The center of plume mass resides in unit 1g, which represents a transition zone from extremely dry tuff within unit 1g and units above to slightly wetter conditions in the Cerro Toledo and Otowi Member units beneath (Table F-3.1-1). This suggests the elevated moisture in the Cerro Toledo interval and the Otowi Member may hinder vapor transport vertically downward, which results in a greater extent in the Tshirege Member tuff units than in underlying units. The plume is asymmetric with greater extent parallel to the axis of the mesa.

Figures F-3.1-9 and F-3.1-10 are structure contour maps showing the elevation of the top surfaces of the Otowi Member and the Tschicoma dacite, respectively. The surface of each of the units dips to the east-southeast near the eastern end of MDA C, where the respective highest TCE vapor concentrations are located in each of these units (Figures F-3.1-4 and F-3.1-5). Visual inspection of the TCE plumes with respect to the dip of these surfaces indicates the dip of the units does not impose stratigraphic controls on the plume shape. This analysis supports the proposed source areas at the water table assumed for the monitoring network evaluation presented in Appendix G.

Mass estimates were calculated for the final estimated plume extent as well as the minimum and maximum extents depicted in Figure F-3.1-11. The mass estimates are broken down by geologic unit and contaminant phase (gas, aqueous, and adsorbed) and are presented in Table F-3.1-2. These estimates exclude regions where the vapor-phase plume was predicted to be less than the Tier I vapor-phase SL of 2000 $\mu g/m^3$. The estimated total subsurface TCE mass is 167 kg with approximately 25% uncertainty based on the minimum and maximum values determined from analysis of 60 realizations. The breakdown by geologic zone indicates that approximately two-thirds of the mass resides above the Cerro Toledo interval. The breakdown by phase indicates that TCE is dominantly present in the vapor phase (65%) in the drier units above the Cerro Toledo interval and equally divided between the gas and aqueous phases within the deeper wetter units.

F-4.0 CHARACTERISTICS OF THE SUBSURFACE TRITIUM VAPOR PLUME

Tritium vapor is present in the subsurface at MDA C. Figure F-4.0-1 shows all of the vapor data for tritium gathered during March 2011 through May 2011 (third quarter FY2011) plotted as a function of depth. Because virtually all the tritium inventory is present in the liquid phase as opposed to the vapor phase, tritium results are much less likely to be impacted by loss of air to the subsurface during drilling. Therefore, data from samples collected during and after Phase III drilling were included (see section F-3.1). Because tritium is collected in a condensed phase and reported in units of pCi/L, the vapor data can be compared directly with groundwater standards without using a Henry's law coefficient to convert the data. The data in Figure F-4.0-1 are compared with the EPA MCL of 20,000 pCi/L for tritium, and most of the measured activities are less than this value. A Tier II SL of 3,500,000 pCi/L was calculated for tritium using the method described for VOCs in sections F-3.1.1 and F-3.2.2. None of the tritium activities from the third quarter of FY2011 sampling event exceed the Tier II SL. Tritium is present in pore water and as water vapor in pore gas. The vapor pressure of water vapor is low compared with that of VOCs, and the Tier II SL is based on pore water transport rather than on vapor transport (similar to 2-hexanone). The Tier II evaluation for tritium is also conservative because it does not consider radioactive decay. Tritium has a 12.3-yr half-life, which is expected to be short compared with the travel time in the liquid phase to the regional aquifer.

Figures F-4.0-2 through F-4.0-7 illustrate the locations were tritium activities have exceeded 20,000 pCi/L over sampling events from the second quarter of FY2010 to the third quarter of FY2011. Tritium data have shown more variability between sampling events at MDA C than has the TCE. For this reason, the data were not averaged to illustrate an average plume. Tritium was observed over the entire length of vapor monitoring well 50-603383, in nine ports ranging from 26 ft below ground surface (bgs) to 450 ft bgs, during each of the five sampling rounds. This location is north of and outside the boundary of MDA C. The maximum activity is generally observed at the 83-ft deep port in vapor-monitoring well 50-603470. The value has not exceeded the Tier II SL described above, with the maximum activity observed at approximately 3,400,000 pCi/L.

The maximum detected tritium activity was approximately 7,600,000 pCi/L at vapor-monitoring well 50-603468 at the 403-ft-deep port in the sample from the second quarter of FY2011. The maximum detected activity for all other samples from this port, however, was only 509 pCi/L.

F-5.0 SUMMARY

VOC and tritium data collected from vapor-monitoring wells within and around MDA C were screened using a two-tiered process to evaluate potential for contamination of groundwater. The results of this screening indicate levels of contamination currently found in the subsurface at MDA C do not present a risk to groundwater. This conclusion is consistent with the results of groundwater sampling performed at regional wells R-46 and R-60, which are downgradient of MDA C. Concentrations of TCE within the center of the TCE plume exceed Tier I and Tier II SLs, but these high concentration levels are not found in the lower stratigraphic units through which transport to the regional aquifer would have to occur. Similarly, tritium activities above Tier II SLs are not present in the lower stratigraphic units.

The subsurface TCE data were also evaluated to estimate the dimensions and mass of the subsurface plume. This evaluation shows the lateral and vertical extent of the TCE plume to be defined by the existing vapor-monitoring well network. The total mass of TCE in the subsurface is estimated to be in the range of 129 to 209 kg (equivalent to 23 to 38 gal. as liquid). Most of the TCE mass is present in the upper stratigraphic units (i.e., above the Cerro Toledo interval). This distribution of mass is consistent with the conceptual model of vapor diffusion through the lower units being impeded by the relatively higher moisture content of these units (see section 2.4).

F-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.

EPA (U.S. Environmental Protection Agency), May 1996. "Soil Screening Guidance: Technical Background Document," EPA/540/R-95/128, Office of Solid Waste and Emergency Response, Washington, D.C. (EPA 1996, 059902)

Hollis, D., E. Vold, R. Shuman, K.H. Birdsell, K. Bower, W.R. Hansen, D. Krier, P.A. Longmire, B. Newman, D.B. Rogers, and E.P. Springer, March 27, 1997. "Performance Assessment and Composite Analysis for Los Alamos National Laboratory Material Disposal Area G," Rev. 2.1, Los Alamos National Laboratory document LA-UR-97-85, Los Alamos, New Mexico. (Hollis et al. 1997, 063131)

LANL (Los Alamos National Laboratory), March 2009. "Completion Report for Regional Aquifer Well R-46," Los Alamos National Laboratory document LA-UR-09-1338, Los Alamos, New Mexico. (LANL 2009, 105592)

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Millington, R.J., and J.P. Quirk, 1961. "Permeability of Porous Solids," *Transactions of the Faraday Society,* Vol. 57, pp. 1200–1207. (Millington and Quirk 1961, 110521)

NMED (New Mexico Environment Department), June 2006. "Technical Background Document for Development of Soil Screening Levels, Revision 4.0, Volume 1, Tier 1: Soil Screening Guidance Technical Background Document," New Mexico Environment Department, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2006, 092513)

NMED (New Mexico Environment Department), August 2009. "Technical Background Document for Development of Soil Screening Levels, Revision 5.0," New Mexico Environment Department, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2009, 106420)

NMED (New Mexico Environment Department), December 2009. "Technical Background Document for Development of Soil Screening Levels, Revision 5.0," with revised Table A-1, New Mexico Environment Department, Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, Santa Fe, New Mexico. (NMED 2009, 108070)

Springer, E.P., 2005. "Statistical Exploration of Matrix Hydrologic Properties for the Bandelier Tuff, Los Alamos, New Mexico," *Vadose Zone Journal,* Vol. 4, pp. 505–521. (Springer 2005, 098534)

Truex, M.J., M. Oostrom, and M.L. Brusseau, 2009. "Estimating Persistent Mass Flux of Volatile Contaminants from the Vadose Zone to Ground Water," *Ground Water Monitoring and Remediation,* Vol. 29, No. 2, pp. 63–72. (Truex et al. 2009, 108331)

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 and dilution in the aquifer. 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 further define the nature and extent of the plume.

Pore Gas Decision Analysis Flow-Chart

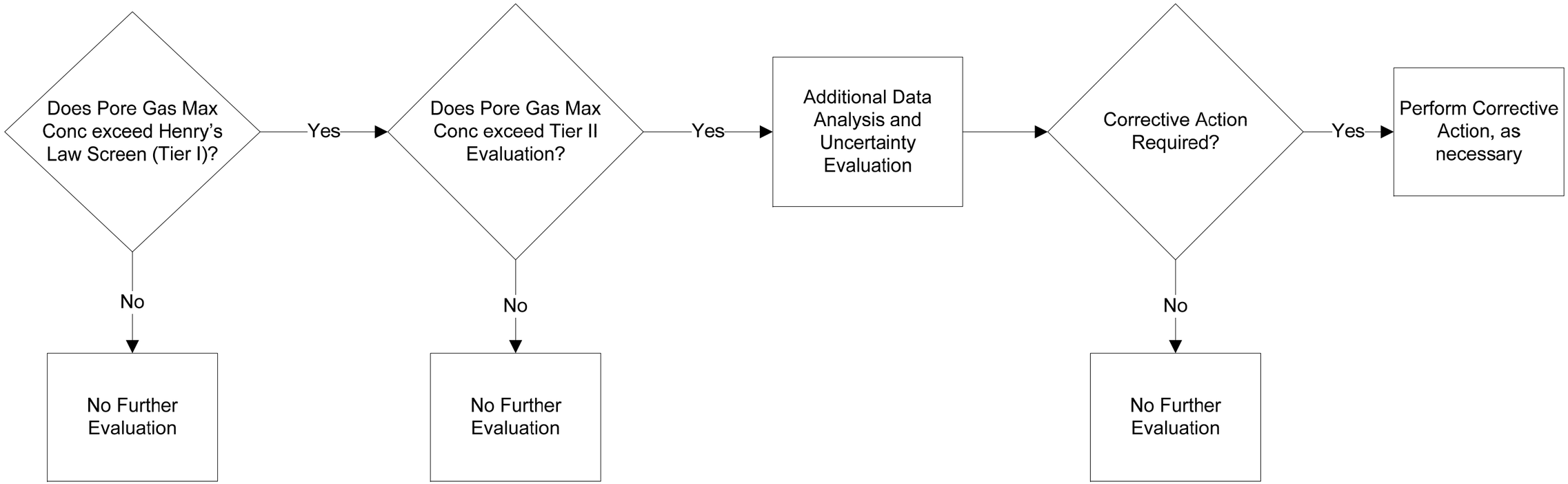

Figure F-1.0-1 Two-tiered screening method to identify vapor-phase VOCs that could potentially affect groundwater

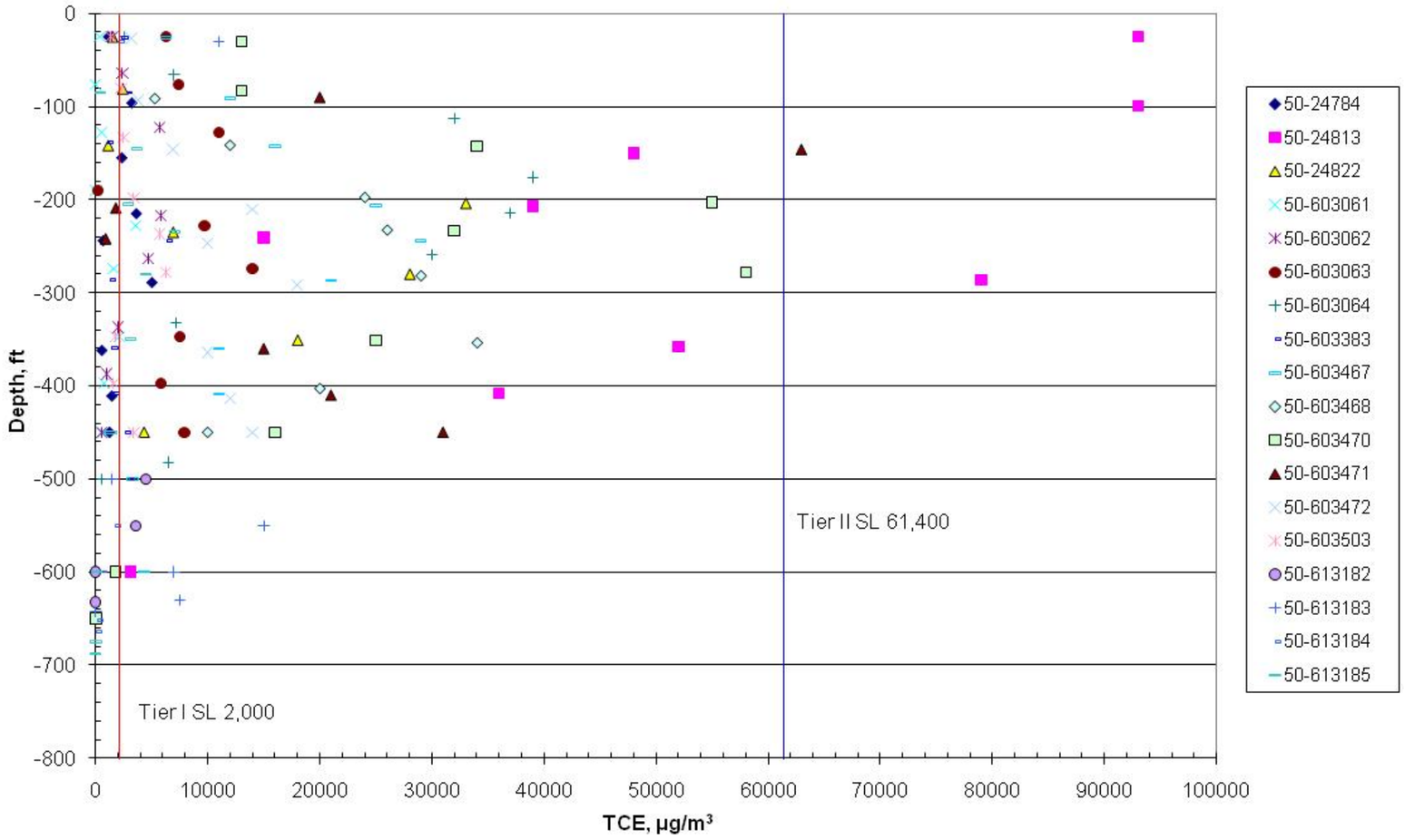

Figure F-3.0-1 TCE vapor concentrations measured during the third quarter FY2011 compared with Tier I and Tier II SLs

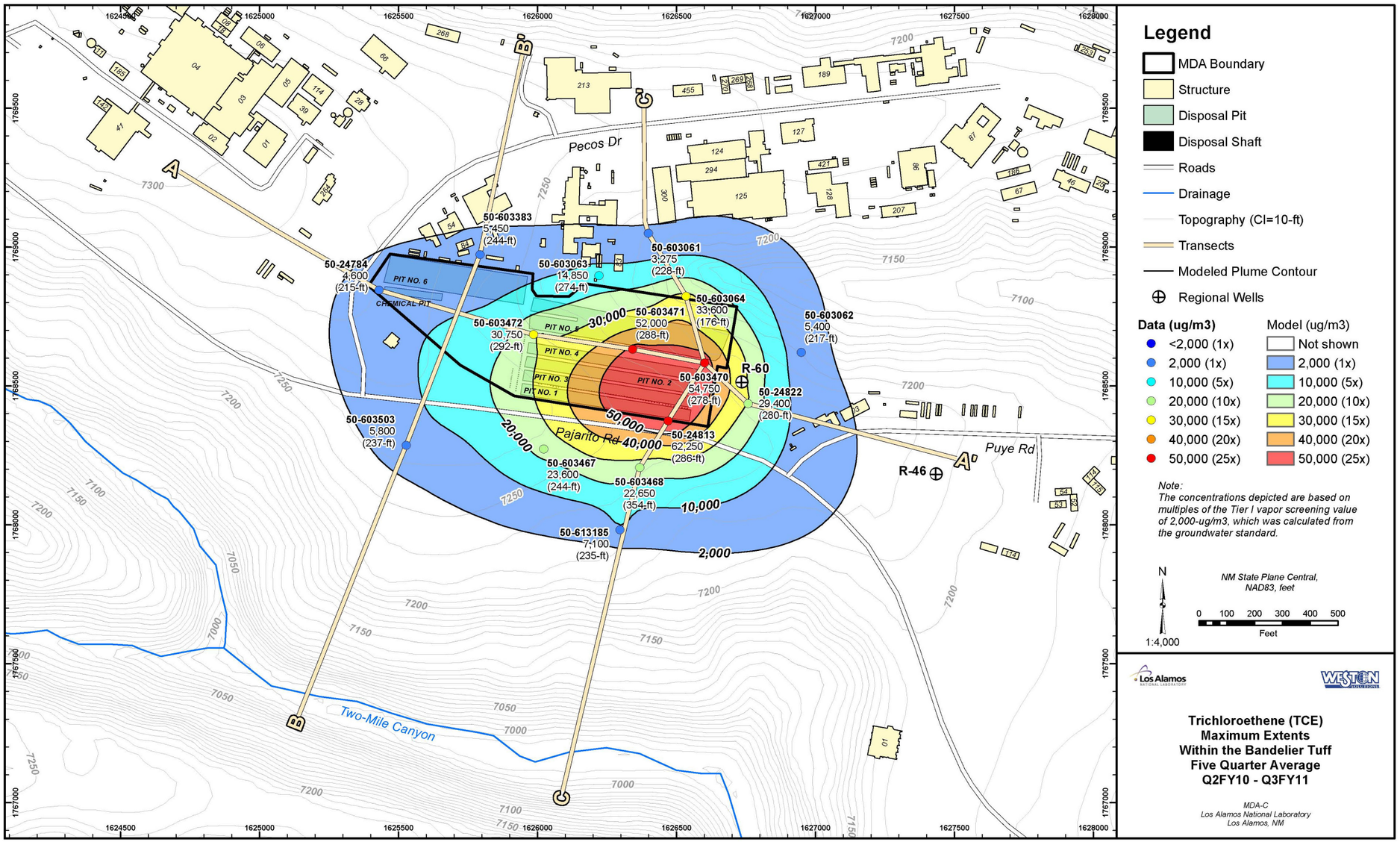

Figure F-3.1-1 Interpolated TCE vapor plume beneath MDA C showing maximum extent within the Bandelier Tuff, based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

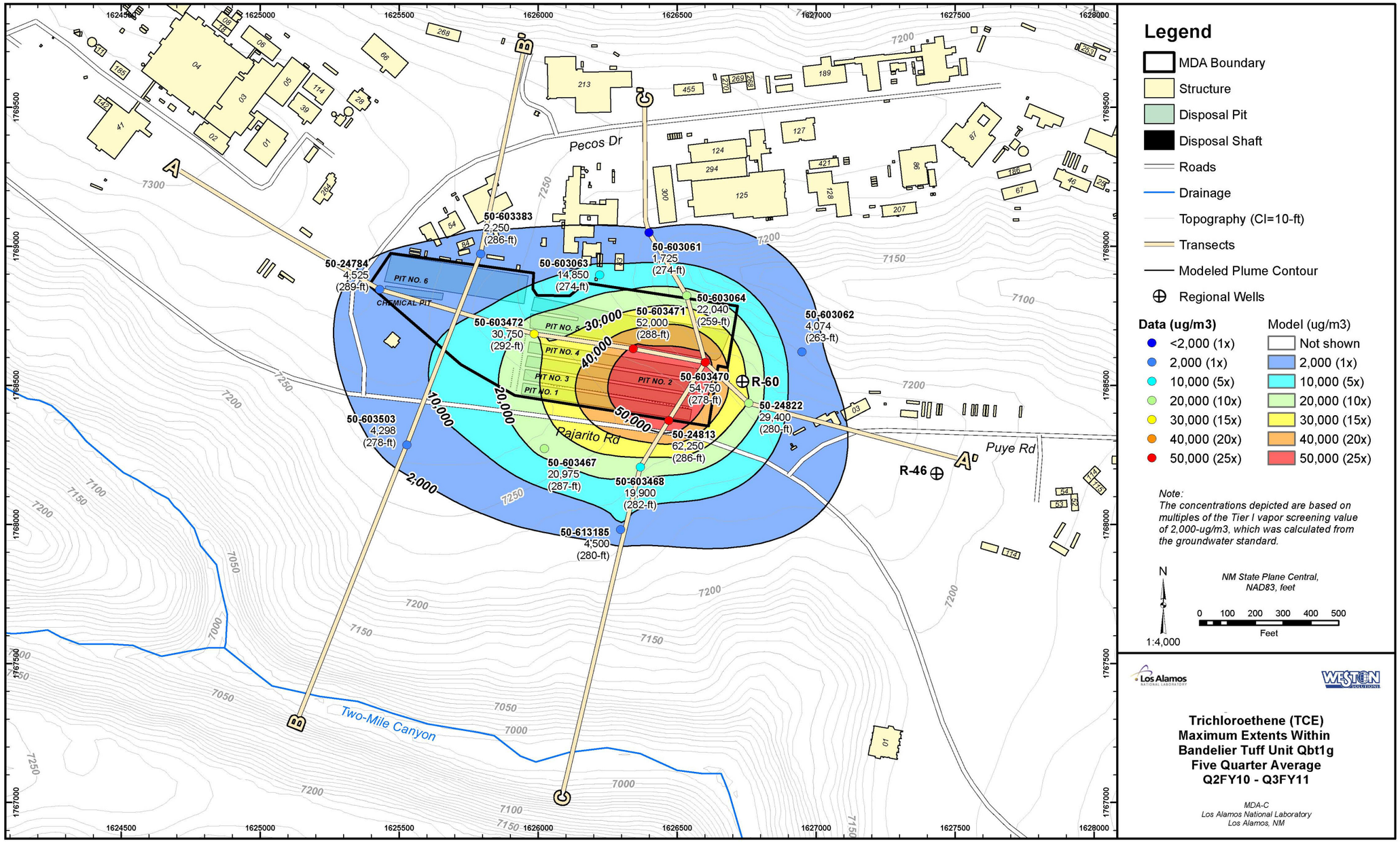

Figure F-3.1-2 Interpolated TCE vapor plume beneath MDA C showing maximum extent within unit Qbt 1g, based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

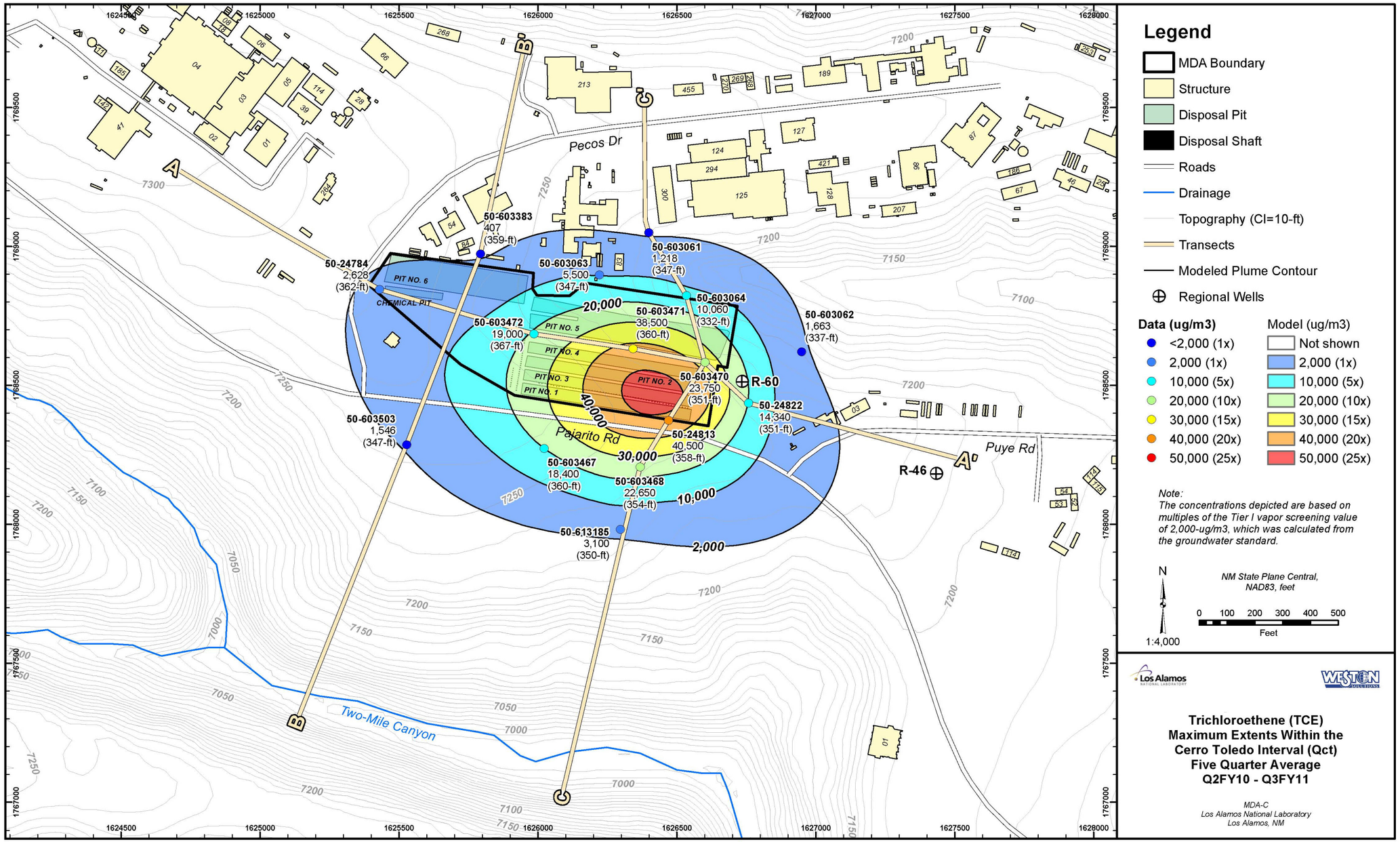

Figure F-3.1-3 Interpolated TCE vapor plume beneath MDA C showing maximum extent within the Cerro Toledo interval (Qct), based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

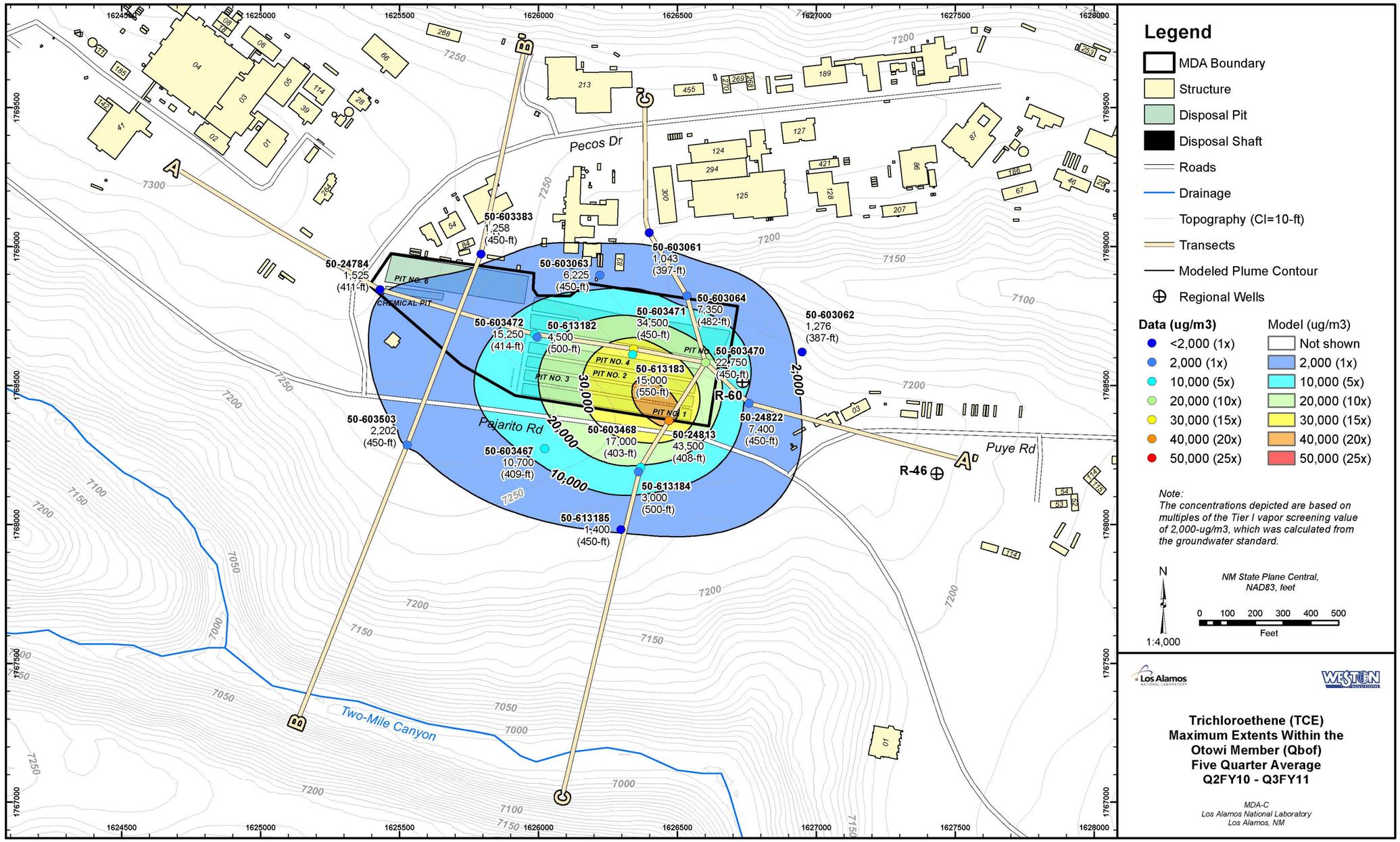

Figure F-3.1-4 Interpolated TCE vapor plume beneath MDA C showing maximum extent within the Otowi Member (Qbof), based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

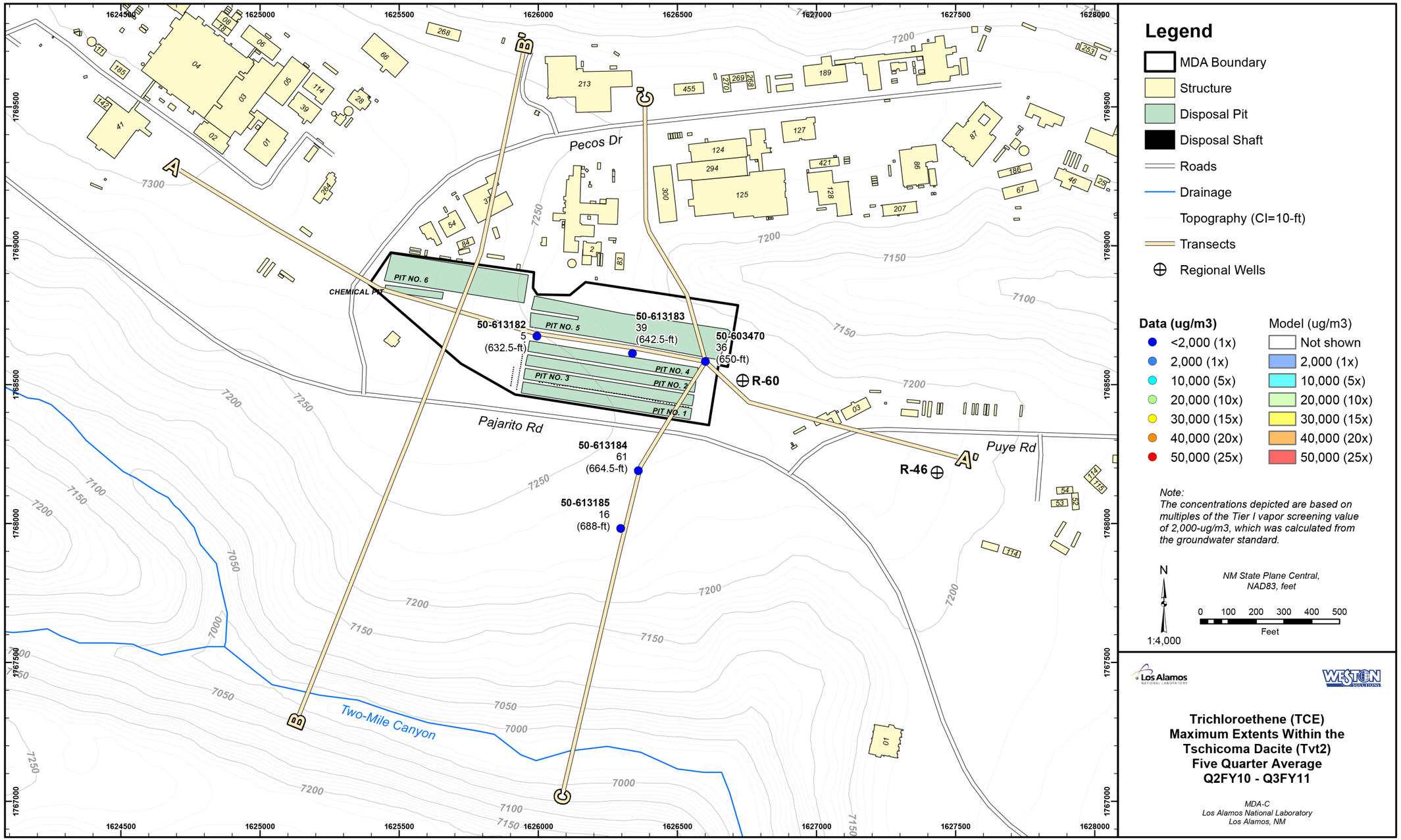

Figure F-3.1-5 Interpolated TCE vapor plume beneath MDA C showing maximum extent within the Tschicoma dacite (Tvt 2), based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

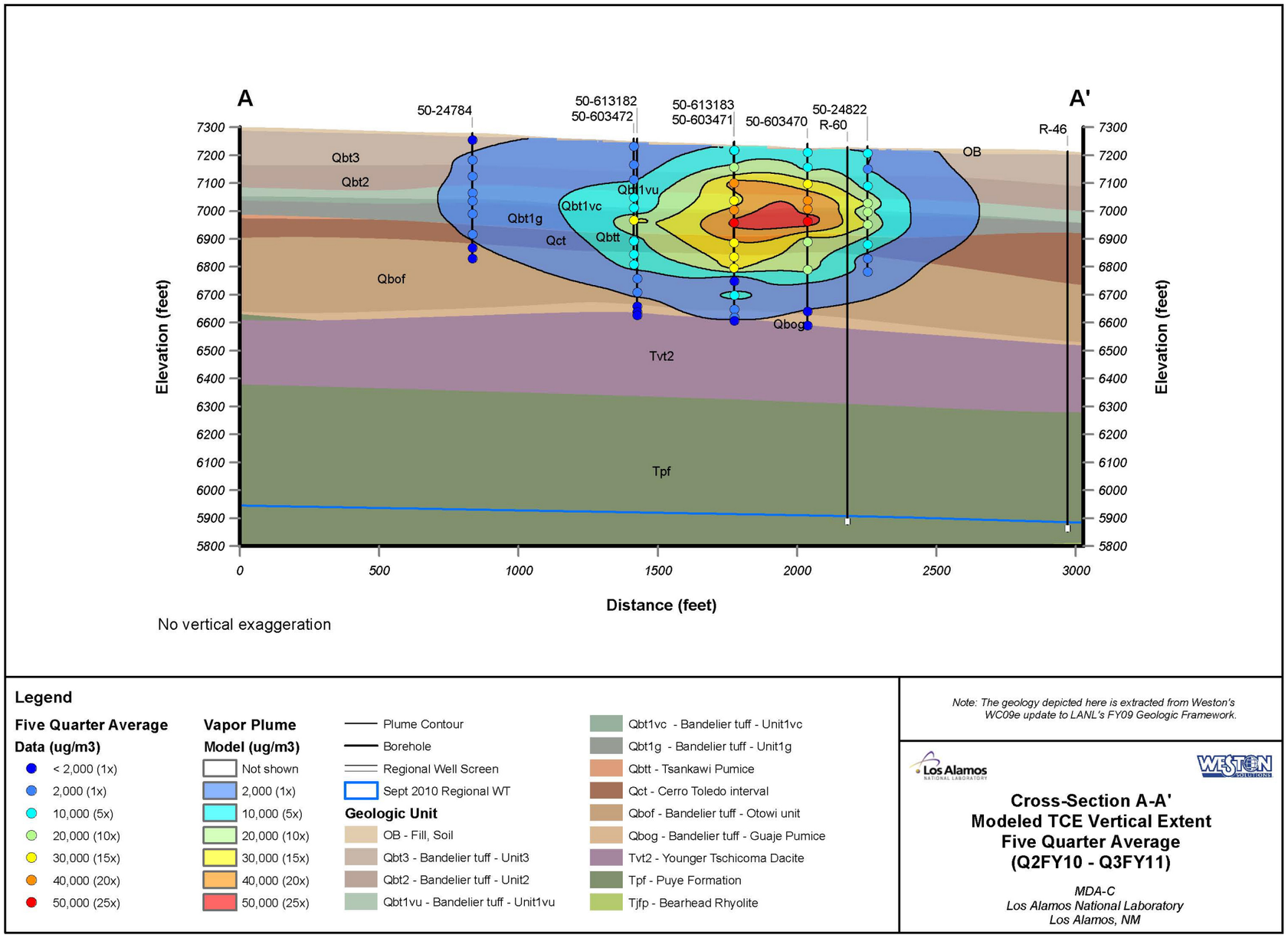

Figure F-3.1-6 East-west cross-section (A-A' in Figure F-3.1-1) through interpolated TCE vapor plume beneath MDA C, based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

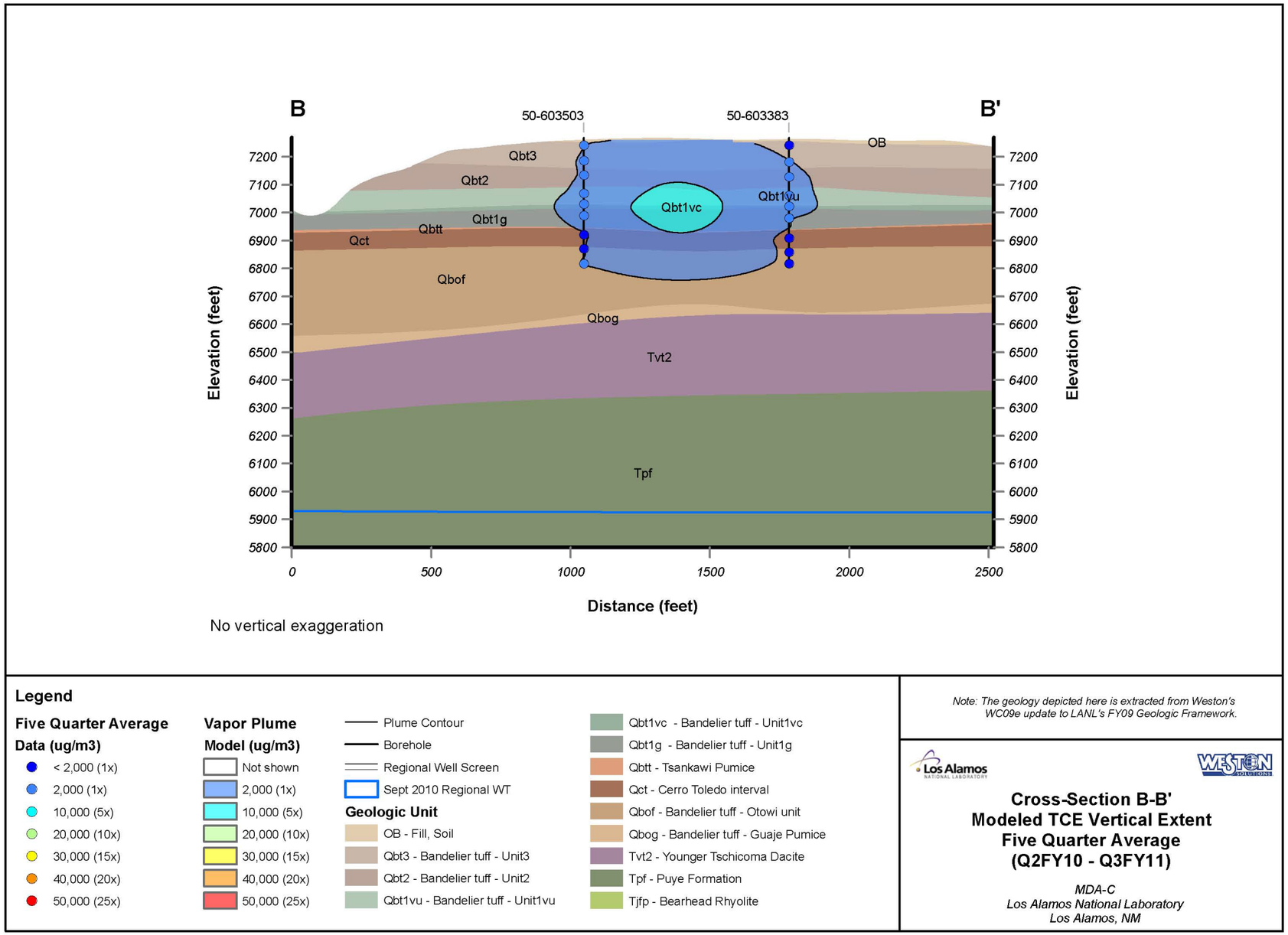

Figure F-3.1-7 North-south cross-section (B-B' in Figure F-3.1-1) through interpolated TCE vapor plume beneath MDA C, based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

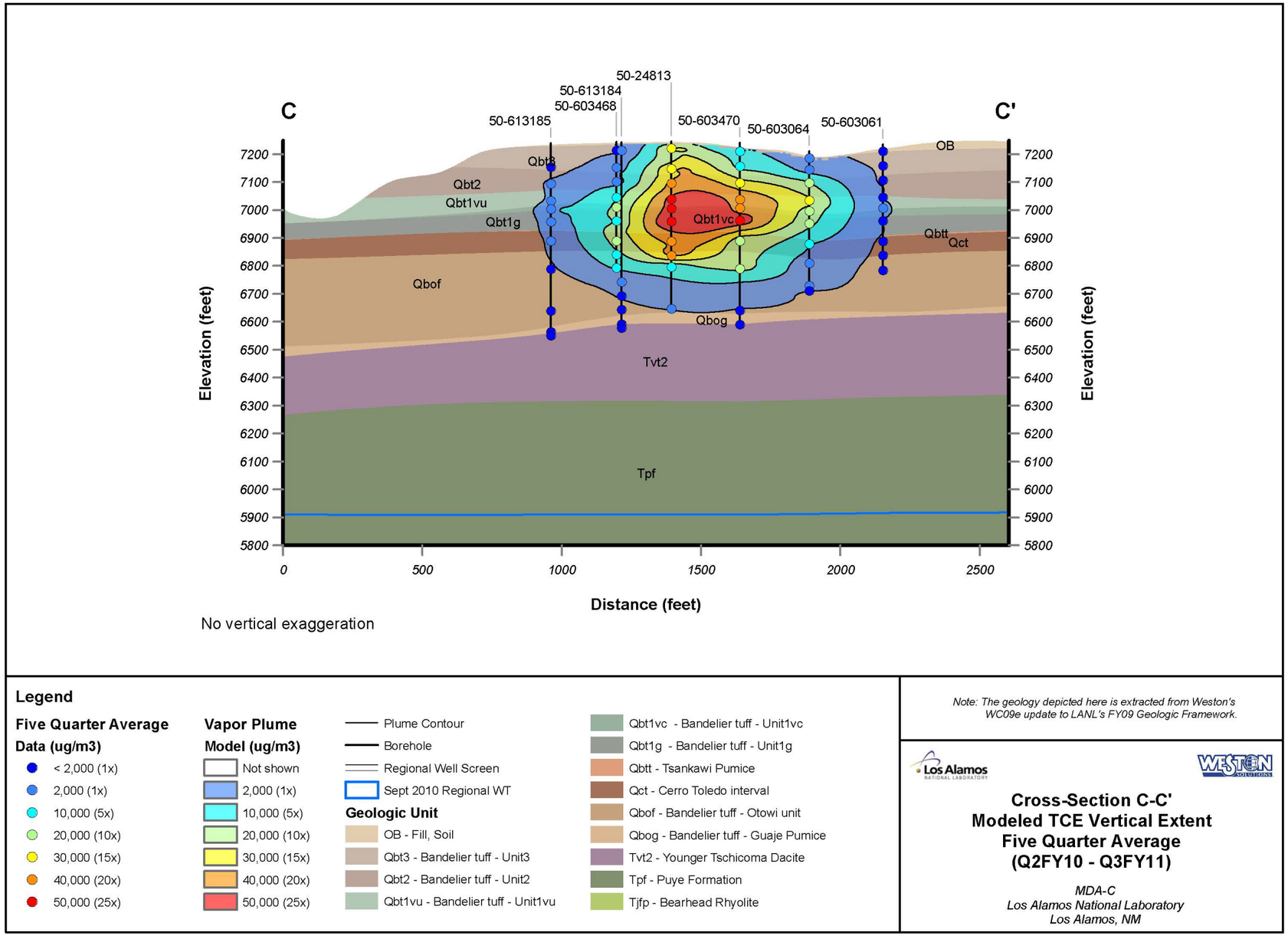

Figure F-3.1-8 North-south cross-section (C-C' in Figure F-3.1-1) through interpolated TCE vapor plume beneath MDA C, based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

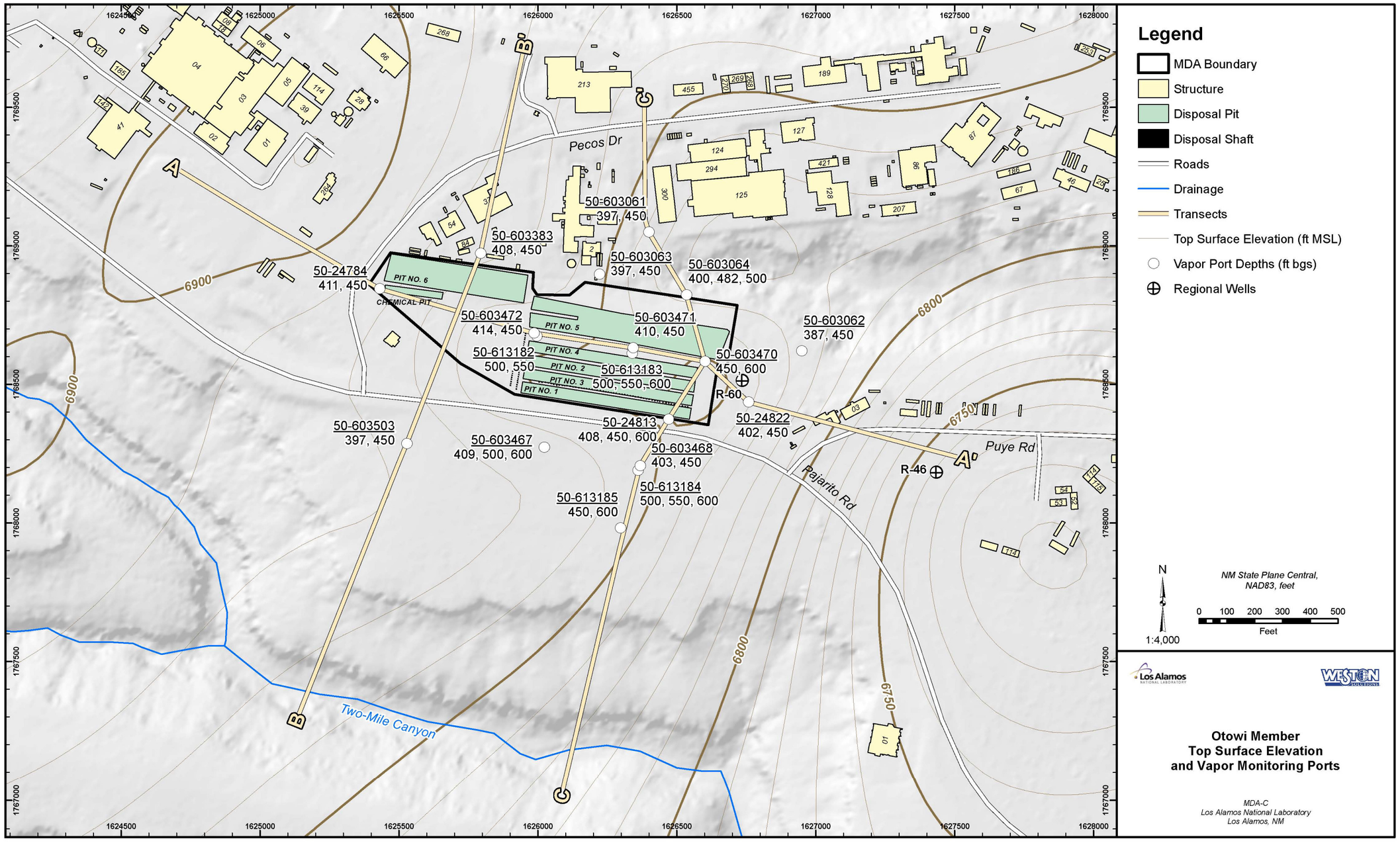

Figure F-3.1-9 Structure contour map showing the elevations of the top surface of the Otowi Member and the vapor-monitoring ports within the Otowi Member

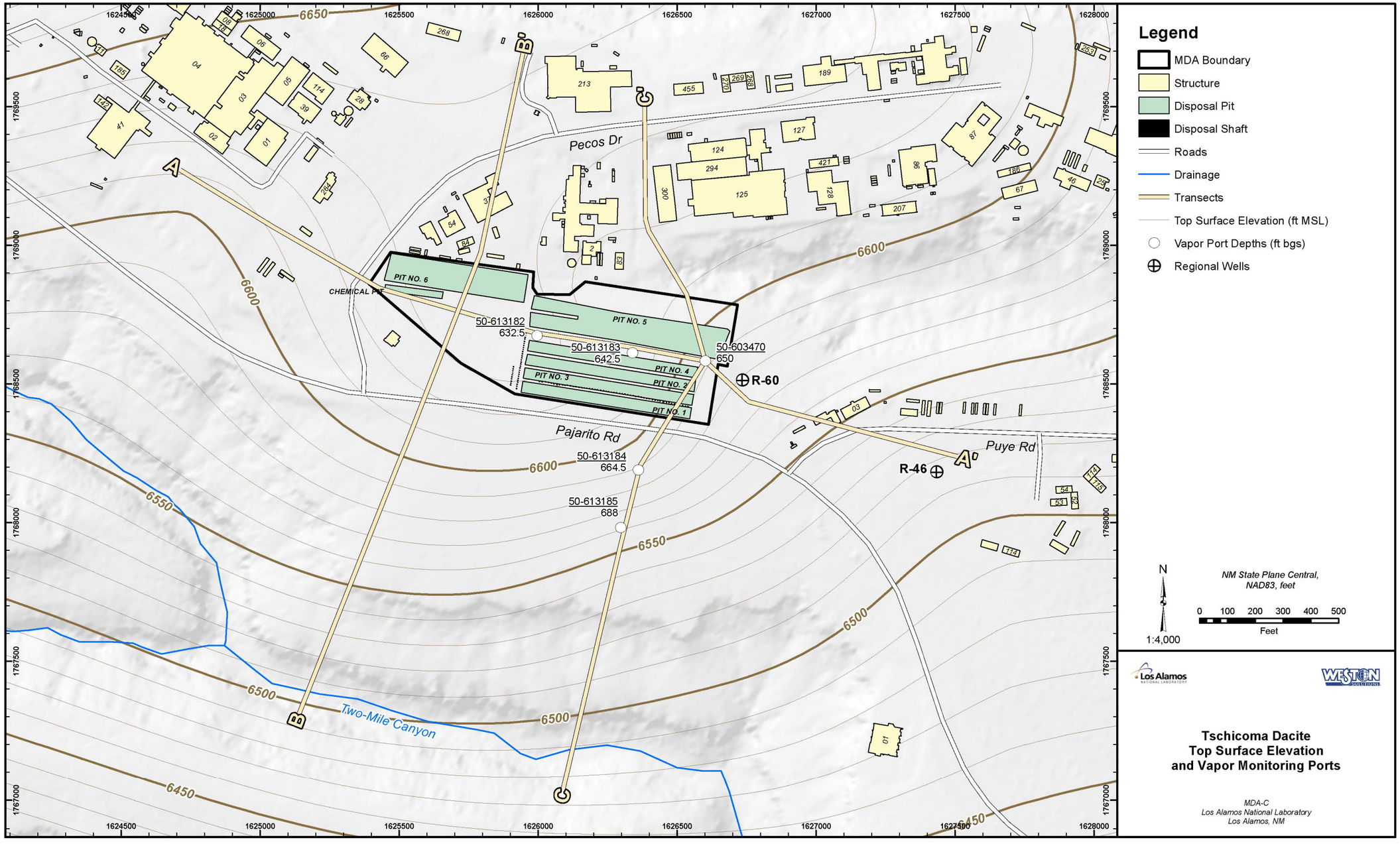

Figure F-3.1-10 Structure contour map showing the elevations of the top surface of the Tschicoma dacite formation and the vapor-monitoring ports within the Tschicoma dacite

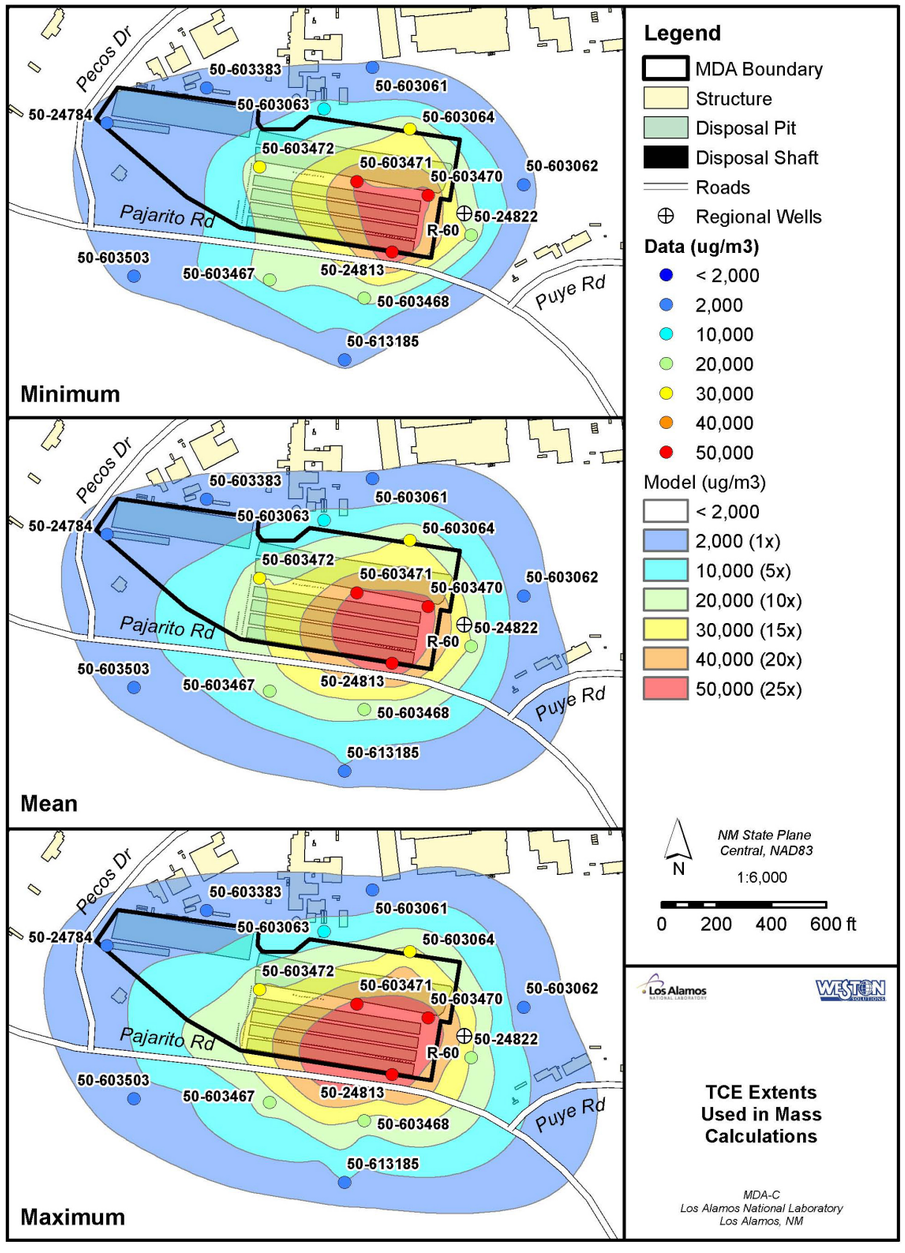

Figure F-3.1-11 Three versions of the interpolated TCE vapor plume beneath MDA C showing maximum extent within the Bandelier Tuff for realizations having the minimum, mean, and maximum extents of TCE, based on averaged concentrations using five quarters of vapor-monitoring data (second quarter FY2010 through third quarter FY2011)

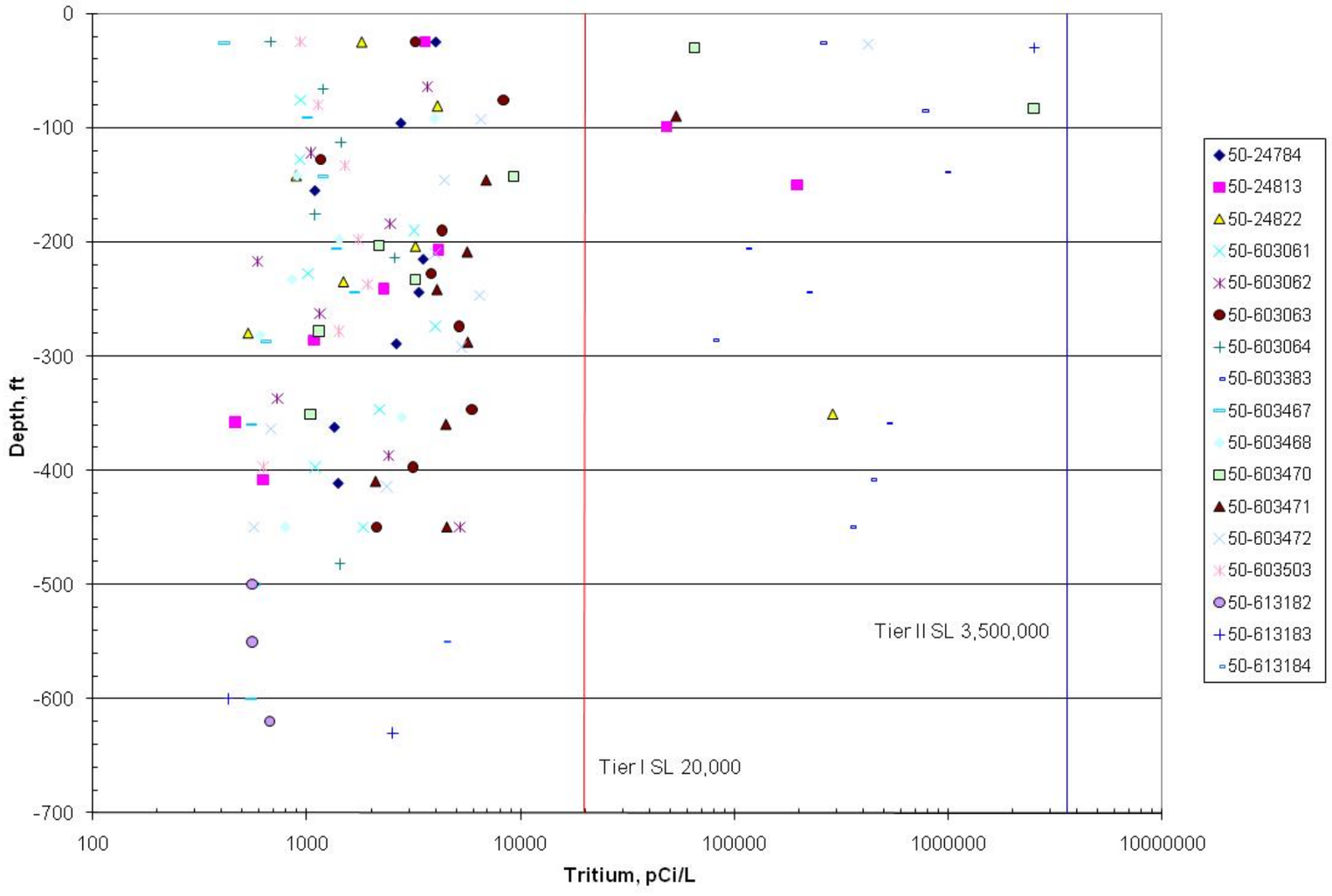

Figure F-4.0-1 Tritium activities measured during the third quarter FY2011 compared with Tier I and Tier II SLs

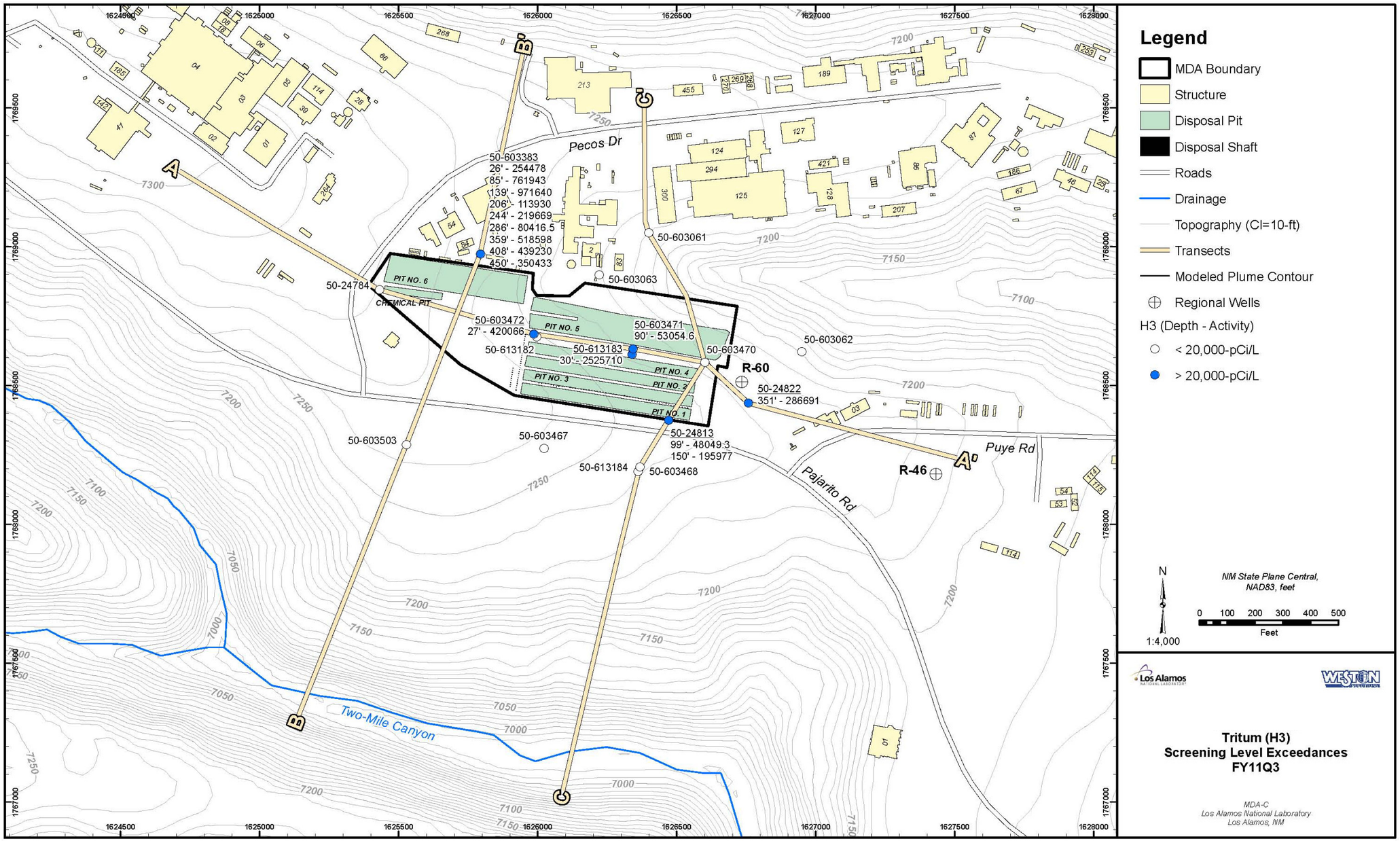

Figure F-4.0-2 Locations where vapor-phase tritium activity measured beneath MDA C exceeded 20,000 pCi/L based on samples collected during the third quarter FY2011

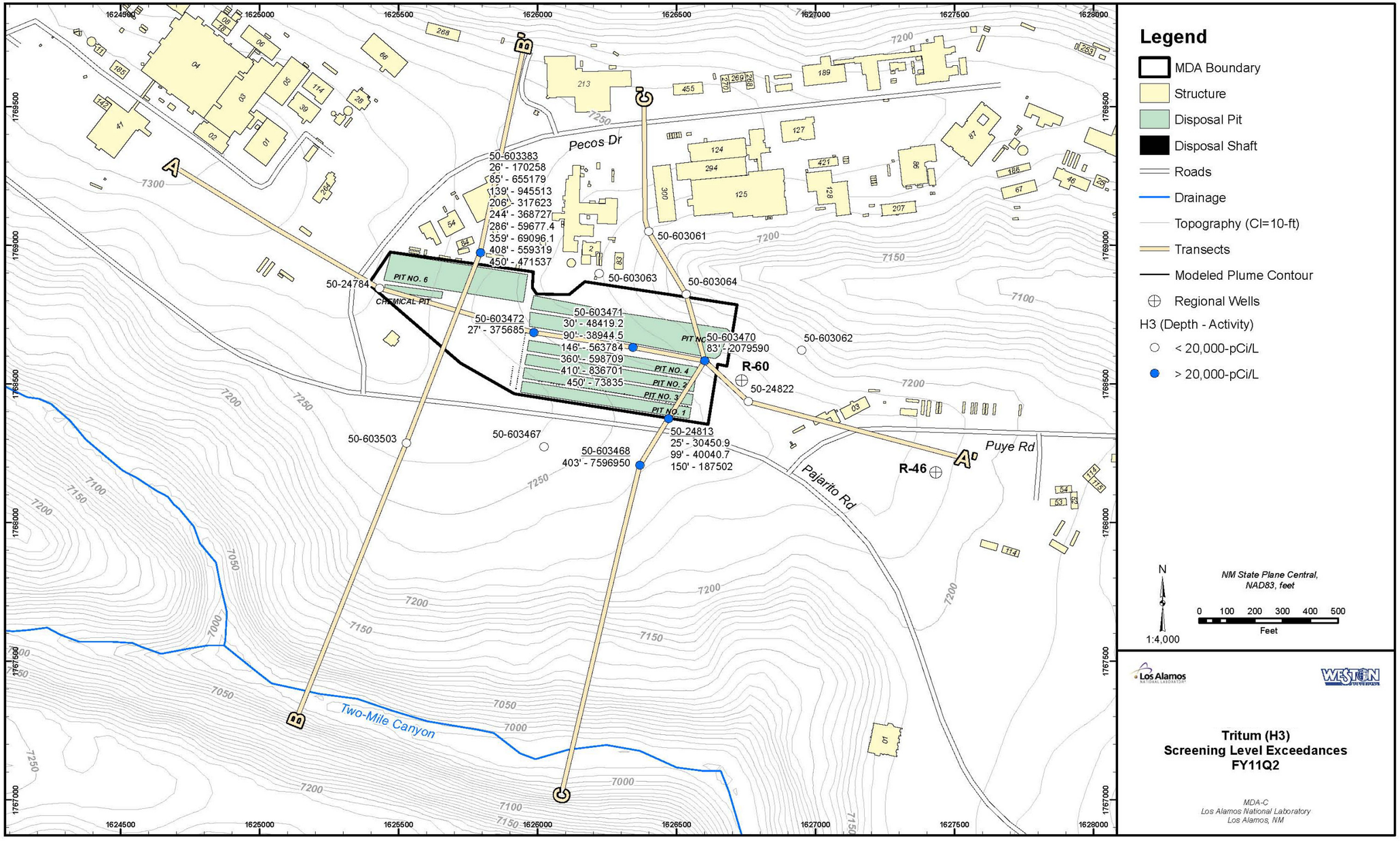

Figure F-4.0-3 Locations where vapor-phase tritium activity measured beneath MDA C exceeded 20,000 pCi/L based on samples collected during the second quarter FY2011

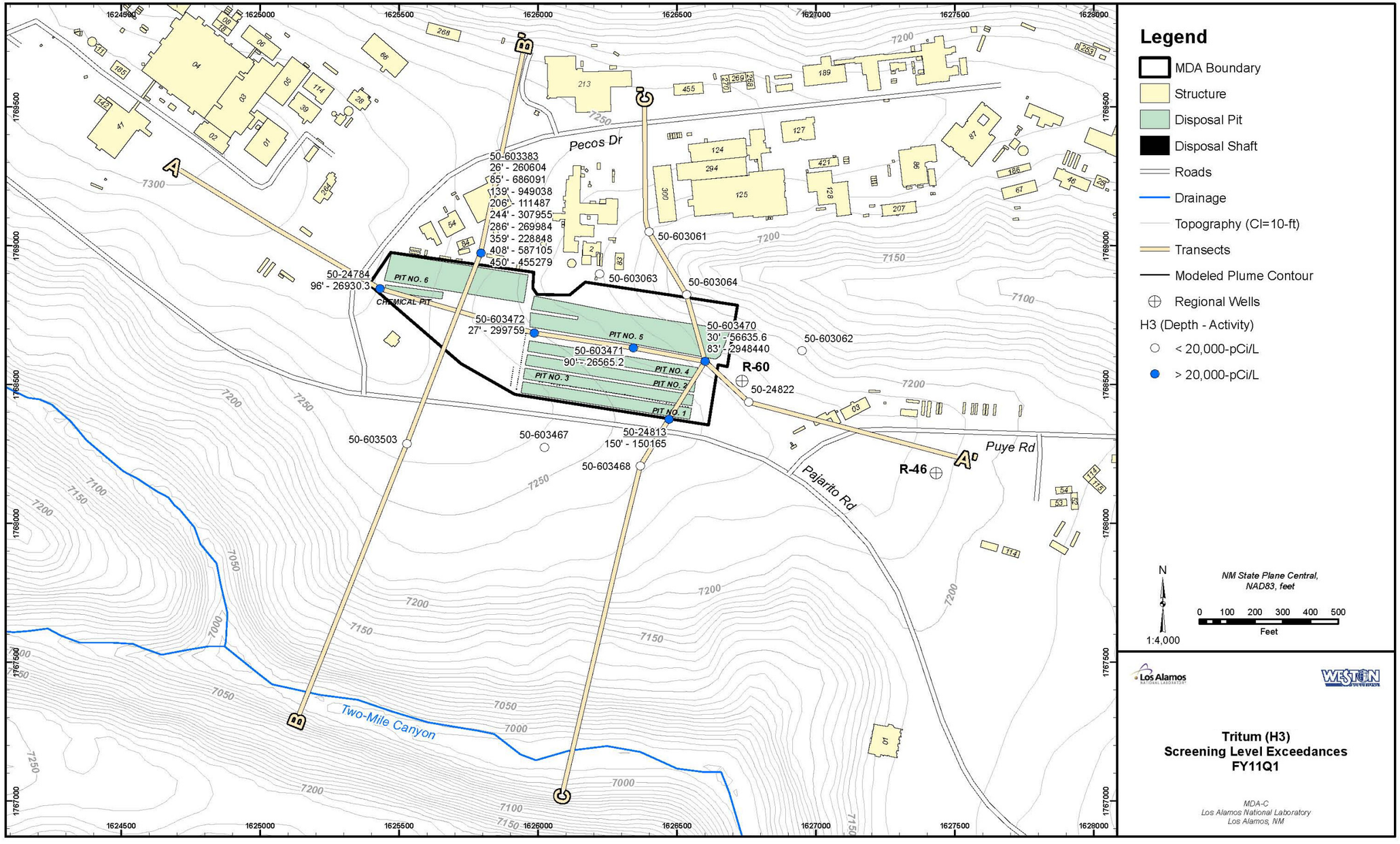

Figure F-4.0-4 Locations where vapor-phase tritium activity measured beneath MDA C exceeded 20,000 pCi/L based on samples collected during the first quarter FY2011

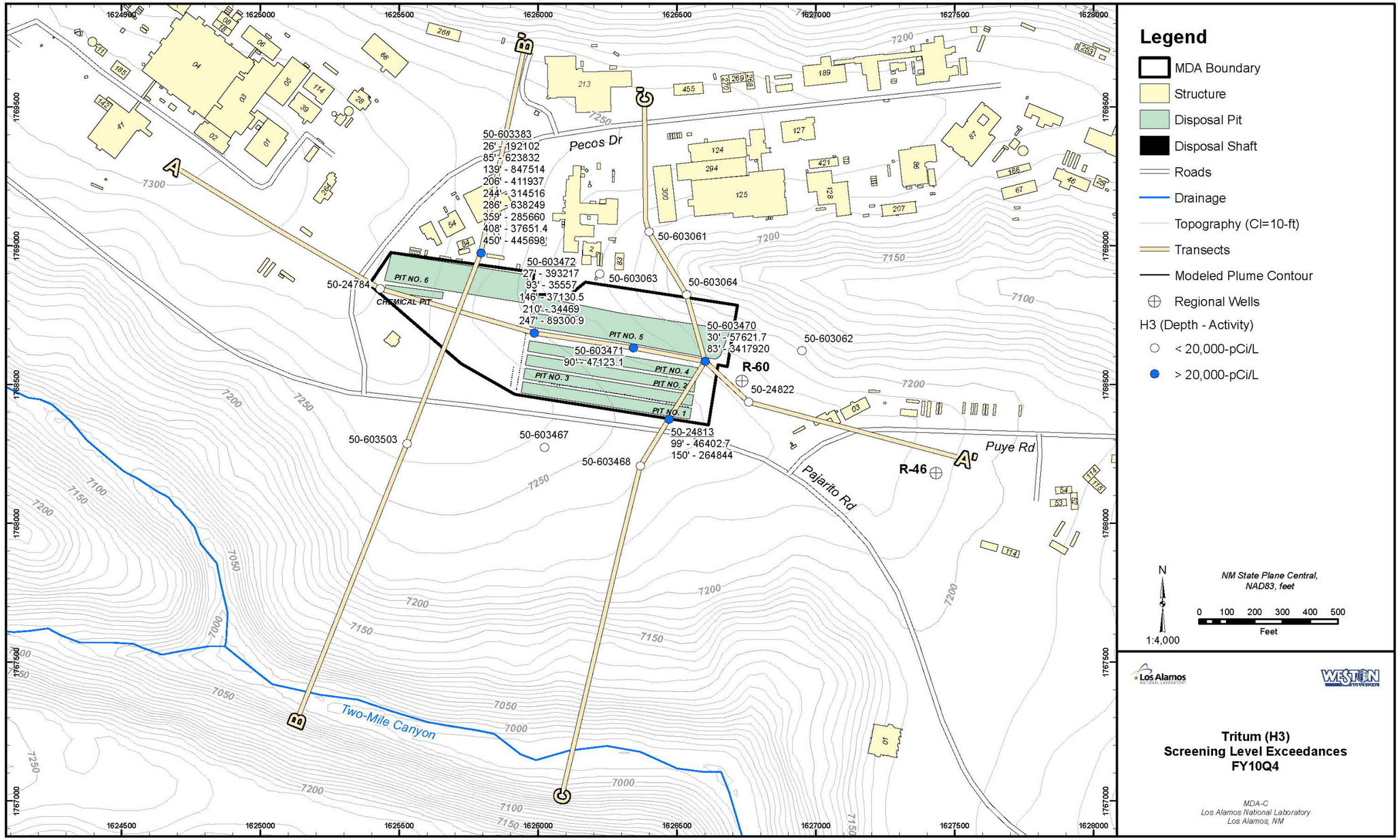

Figure F-4.0-5 Locations where vapor-phase tritium activity measured beneath MDA C exceeded 20,000 pCi/L based on samples collected during the fourth quarter FY2010

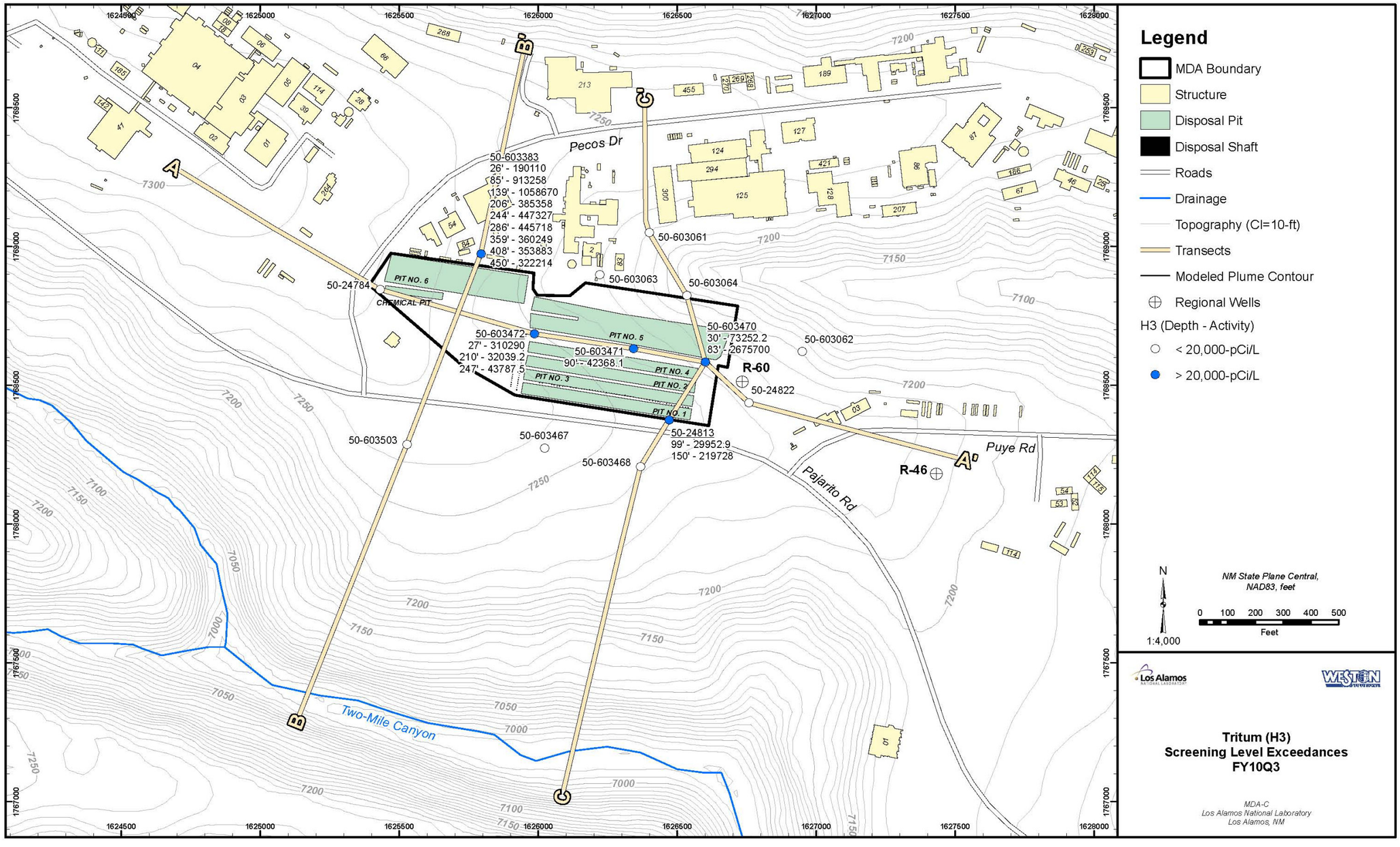

Figure F-4.0-6 Locations where vapor-phase tritium activity measured beneath MDA C exceeded 20,000 pCi/L based on samples collected during the third quarter FY2010

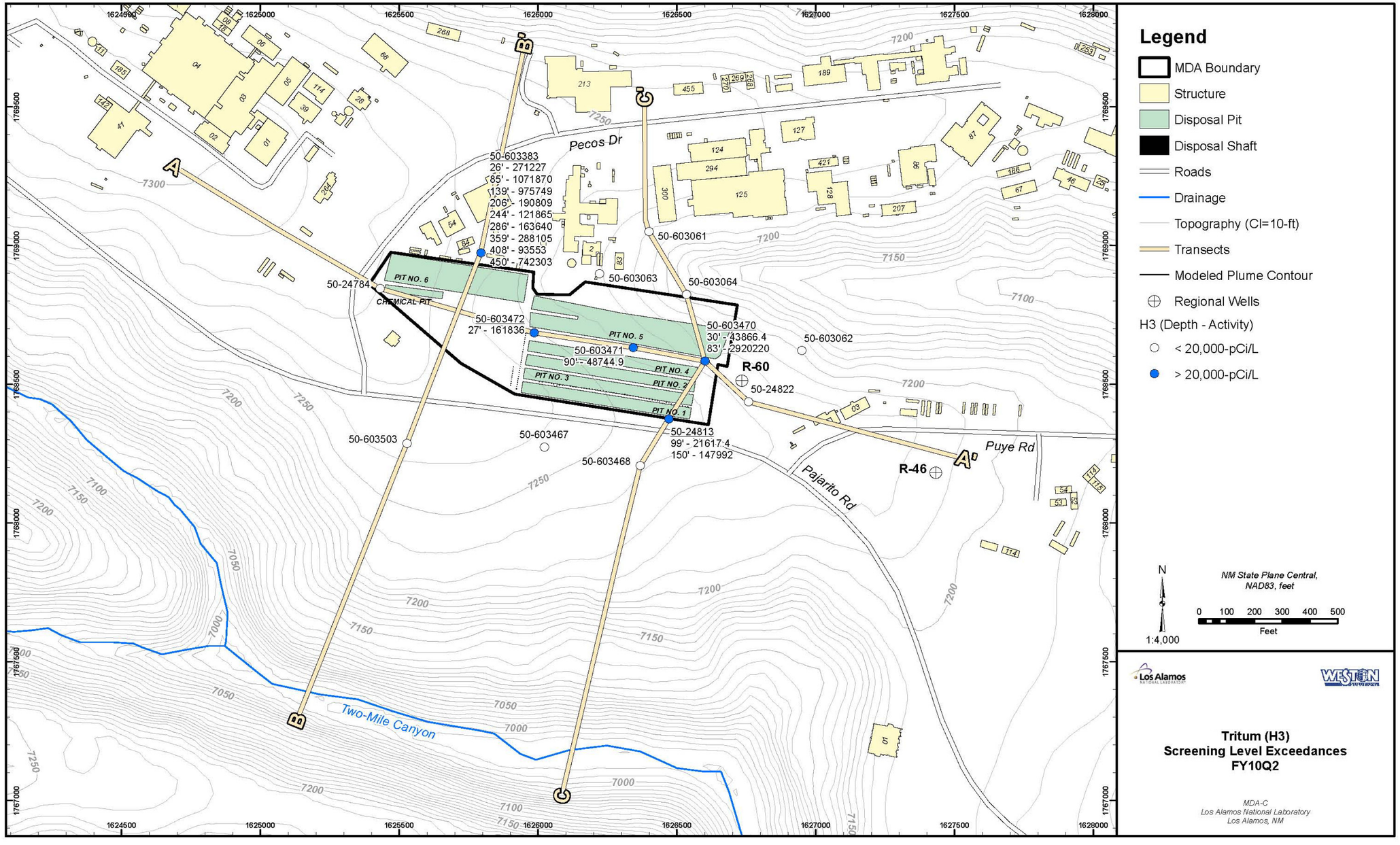

Figure F-4.0-7 Locations where vapor-phase tritium activity measured beneath MDA C exceeded 20,000 pCi/L based on samples collected during the second quarter FY2010

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

VOC	Henry's Law Constant[a] (dimensionless)	Groundwater SL (µg/L)	Source of Groundwater SL	Tier I Vapor Concentrations Corresponding to Groundwater Standard (µg/m^3)
Acetone	0.0016	21,800	NMED SL[b]	34,900
Benzene	0.228	5	EPA MCL[c]	1,140
Bromomethane	0.256	8.66	NMED SL[b]	2,220
Butanone[2-]	0.0023	7,060	NMED SL[b]	16,200
Carbon Disulfide	0.59	1,040	NMED SL[b]	61,400
Carbon Tetrachloride	1.1	5	EPA MCL[c]	5,500
Chloroform	0.15	80	EPA MCL[d]	12,000
Chloromethane	0.36	17.8	NMED SL[b]	6,400
Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	na[e]	na	na	na
Dichlorodifluoromethane	14	395	NMED SL[b]	5,530,000
Dichloroethene[1,1-]	1.1	5	NMWQCC[f]	5,500
Dichloroethene[cis-1,2-]	0.17	70	EPA MCL[c]	11,900
Dichloropropane[1,2-]	0.12	5	EPA MCL[c]	600
Ethylbenzene	0.323	700	EPA MCL[c]	226,100
Ethyltoluene[4-]	na	na	na	na
Hexanone[2-]	0.00381[g]	47	EPA regional SL[h]	180
Methylene Chloride	0.13	5	EPA MCL[c]	650
Styrene	0.11	100	EPA MCL[c]	11,000
Tetrachloroethene	0.72	5	EPA MCL[c]	3,600
Toluene	0.272	750	NMWQCC[f]	204,000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	22	59,200	NMED SL[b]	1.3E+09
Trichloroethane[1,1,1-]	0.705	60	NMWQCC[f]	42,300
Trichloroethene	0.4	5	EPA MCL[c]	2,000
Trichlorofluoromethane	4	1,290	NMED SL[b]	5,160,000
Trimethylbenzene[1,2,4-]	0.252[g]	15	EPA regional SL[h]	3,750
Trimethylbenzene[1,3,5-]	0.358[g]	370	EPA regional SL[h]	132,460
Xylene (Total)	0.27	620	NMWQCC[f]	167,400

Table F-2.1-1 (continued)

VOC	Henry's Law Constant[a] (dimensionless)	Groundwater SL (µg/L)	Source of Groundwater SL	Tier I Vapor Concentrations Corresponding to Groundwater Standard (µg/m^3)
Xylene[1,2-]	0.213	620[i]	NMWQCC[f]	132,060
Xylene[1,3-]+Xylene[1,4-]	0.28[j]	620[i]	NMWQCC[f]	173,600

Notes: Tier 1 screening concentration is the calculated concentration in vapor exceeding groundwater standard derived from the denominator of Equation F-2.1-3 for an SV of 1.0. Tier 2 screening concentration is the lower concentration of that calculated for the pore water or vapor-phase flow path based on Equations F-2.2-1 and F-2.2-10.

[a] From NMED (2009, 108070, Appendix B) unless otherwise noted.

[b] NMED tap water SL (NMED 2009, 108070, Appendix A).

[c] MCL for organic contaminants (40 Code of Federal Regulations [CFR] 141.61).

[d] MCL for total trihalomethanes (40 CFR 141.64).

[e] na = Not available.

[f] NMWQCC standard (20 New Mexico Administrative Code 6.2.3103)

[g] Henry's law constant from EPA regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[h] EPA regional tap water SL (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

[i] SL for xylene[1,3-]+xylene[1,4-] is for total xylenes.

[j] Henry's law constant for xylene[1,4-].

Table F-2.1-2
Screening of VOCs Detected during Second Quarter FY2010 in Vapor at MDA C

VOC	Maximum Vapor Concentration (µg/m³)	Calculated Concentrations in Vapor Corresponding to Groundwater Standard (µg/m³)	Tier I SV (unitless)	Tier I Potential for Groundwater Impact[a]	Tier II Potential for Groundwater Impact
Acetone	98	34900	0.003	No	No
Benzene	46	1140	0.040	No	No
Bromomethane	90	2220	0.041	No	No
Butanone[2-]	200	16200	0.012	No	No
Carbon Disulfide	3.2	61400	0.000	No	No
Carbon Tetrachloride	2600	5500	0.473	No	No
Chloroform	2700	12000	0.225	No	No
Chloromethane	31	6400	0.005	No	No
Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	39	na[b]	na	No	No
Dichlorodifluoromethane	1900	5530000	0.000	No	No
Dichloroethene[1,1-]	1400	5500	0.255	No	No
Dichloroethene[cis-1,2-]	450	11900	0.038	No	No
Dichloropropane[1,2-]	350	600	0.583	No	No
Ethylbenzene	23	226100	0.000	No	No
Ethyltoluene[4-]	22	na	na	No	No
Hexanone[2-]	1200	180	6.667	Yes	No
Methylene Chloride	1600	650	2.462	Yes	No
Styrene	4.8	11000	0.000	No	No
Tetrachloroethene	3400	3600	0.944	No	No
Toluene	120	204000	0.001	No	No
Trichloro-1,2,2-trifluoroethane[1,1,2-]	25000	1.3E+09	0.000	No	No
Trichloroethane[1,1,1-]	5500	42300	0.130	No	No
Trichloroethene	93000	2000	46,500	Yes	Yes
Trichlorofluoromethane	12	5160000	0.000	No	No
Trimethylbenzene[1,2,4-]	25	3750	0.007	No	No
Trimethylbenzene[1,3,5-]	7.5	132460	0.000	No	No
Xylene (Total)	91	167400	0.001	No	No
Xylene[1,2-]	23	132060	0.000	No	No
Xylene[1,3-]+Xylene[1,4-]	68	173600	0.000	No	No

Notes: Calculated concentrations in vapor corresponding to groundwater SLs derived from denominator of Equation F-2.1-3. Tier I SV derived from Equation F-2.1-3. Shaded cells indicate VOCs that did not pass Tier I or Tier II screen.

[a] If the Tier I SV is less than 1, the concentration of the VOC in vapor does not have the potential to exceed the groundwater SL.

[b] na = Not available.

Table F-2.2-1
Tier II Analysis of Chemicals Failing the Tier I Analysis

	Parameters	Symbol	Unit	Hexanone[2-]	Methylene Chloride	TCE
Source Properties	SL/MCL	SL	µg/L	47	5	5
	Maximum contaminant concentration in the gas phase in the vadose zone at the source[a]	C^g_{vz}	µg/m^3	1200	1600	93000
	Henry's law coefficient (dimensionless)	H	—[b]	0.00381	0.13	0.4
	Equivalent contaminant concentration in the water phase in the vadose zone at the source	C^w_{vz}	µg/L	315	12	233
	Distance from the vadose zone source to the water table[c]	d_{vz}	m	230	400	384
	Source length along the regional groundwater flow direction[d]	L	m	107	107	107
Aquifer	Hydraulic conductivity in the regional aquifer[e,f]	k	m/d	2.3	2.3	2.3
	Hydraulic gradient in the regional aquifer[e]	I	m/m	0.014	0.014	0.014
	Considered aquifer thickness (e.g., screen length of a monitoring well)	d_a	m	3	3	3
	Darcy velocity	v	m/d	0.0322	0.0322	0.0322
Pore water-Phase Migration	Infiltration rate through the vadose zone[f]	R	m/a	0.001	0.001	0.001
	Infiltration flux	q_{inf}	m^2/d	2.93E-04	2.93E-04	2.93E-04
	Regional aquifer flux (unit length perpendicular to the groundwater flow)	q_{aq}	m^2/d	9.66E-02	9.66E-02	9.66E-02
	Contaminant flux from the vadose-zone source to the water table under steady-state	q_{ssw}	m/d*µg/m^3	315	12	0.64
	Aquifer mixing zone	d_m	m	3.00	3.00	3.00
	Dilution factor	F_{dw}	—	330.52	330.52	330.52
	Contaminant concentration in the aquifer within the mixing zone	C^w_{aq}	µg/L	1	0	0.70
	SL: acceptable contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vzMAX}	µg/m^3	59187	214840	661047
	COPC based on pore-water migration? [yes/no]		yes/no	no	no	no

Table F-2.2-1 (continued)

	Parameters	Symbol	Unit	Hexanone[2-]	Methylene Chloride	TCE
Gas-phase Migration	Diffusion coefficient of contaminants in air	D_a	m^2/d	0.6078	0.8640	0.5962
	Diffusion coefficient of contaminants in the vadose zone	D_{ap}	m^2/d	0.0316	0.0449	0.0310
	Diffusion coefficient of contaminants in water	D_w	m^2/d	1.00E-04	1.00E-04	1.00E-04
	Diffusion coefficient of contaminants in the aquifer	D_{wp}	m^2/d	2.01E-05	2.01E-05	2.01E-05
	Porosity	n	—	0.3	0.3	0.3
	Volumetric moisture content in the vadose zone	θ	—	0.1	0.1	0.1
	Contaminant concentration in the vadose zone at the water table under steady-state	C^g_{wt}	$\mu g/m^3$	2	68	8326
	Contaminant concentration in the aquifer at the water table under steady-state	C^w_{wt}	$\mu g/m^3$	501	524	20815
	Contaminant flux from the vadose-zone source to the water table under steady-state	q_{ssg}	$m/d*\mu g/m^3$	0.16	0.17	6.83
	Aquifer mixing zone (only from diffusion; if dispersion is included the contaminant flux will increase)	d_m	m	0.06	0.06	0.06
	Dilution factor	F_{dg}	—	6.6	8.4	12.3
	Contaminant concentration in the aquifer within the mixing zone	C^w_{aq}	µg/L	0.2	0.2	7.6
	SL: acceptable contaminant concentration in the gas phase in the vadose zone at the source	C^g_{vzMAX}	$\mu g/m^3$	309380	41990	61434
	COPC based on air-phase migration? [yes/no]		yes/no	no	no	yes

[a] Concentrations are maximum values from March 2011 to May 2011 sampling event.

[b] — = Dimensionless.

[c] Depth of maximum concentration for each VOC from March 2011 data set; depth to water table assumed to be 400 m.

[d] Source length along the regional groundwater flow direction based on EarthVision interpolation for TCE, A-A' cross section, Figure B-3.1-1; conservative estimate for 2-hexanone and methylene chloride.

[e] Hydraulic conductivity and gradient from Appendix G, based on data from R-46 and R-60 pump tests (LANL 2009, 105592).

[f] Infiltration rate of 1 mm/yr representative of a dry mesa.

Table F-3.1-1
MDA C Strata-Specific Properties Affecting Mass Estimates

Geologic Zone	Porosity[a]	Volumetric Water Content[b]	Air-Filled Porosity	Bulk Density[a] (g/cm^3)	Fraction Organic Carbon[c]
Soil	0.4	0.05	0.35	1.5	0.0005
Qbt 3	0.41	0.02	0.39	1.4	0.0005
Qbt 2	0.41	0.02	0.39	1.4	0.0005
Qbt 1vu	0.49	0.01	0.48	1.2	0.0005
Qbt 1vc	0.49	0.1	0.39	1.1	0.0005
Qbt 1g	0.46	0.08	0.38	1.2	0.0005
Qbtt	0.45	0.14	0.31	1.2	0.0005
Qct	0.45	0.14	0.31	1.2	0.0005
Qbof	0.44	0.11	0.33	1.2	0.0005
Qbog	0.67	0.2	0.47	0.8	0.0005
Tvt 2	0.001	0.0005	0.0005	2.7	0.0005

[a] Mean values from Springer (2005, 098534).

[b] Mean values from Hollis et al. (1997, 063131).

[c] Estimate.

Table F-3.1-2
MDA C TCE Mass Estimates by Geologic Zone

Geologic Unit		Gas	Aqueous	Sorbed	Total
		kg (%)	kg (%)	kg (%)	kg (min–max)
Shallow	Soil (OB)	0.1 (58)	0 (21)	0 (21)	0 (0–0)
	Qbt3	11.3 (70)	1.4 (9)	3.4 (21)	16 (12–21)
	Qbt2	15.3 (70)	2 (9)	4.6 (21)	22 (17–28)
	Qbt1vu	19.1 (79)	1 (4)	4 (17)	24 (19–30)
	Qbt1vc	4.6 (53)	2.9 (34)	1.1 (13)	9 (7–11)
	Qbt1g	22.1 (56)	11.6 (29)	5.9 (15)	40 (31–49)
	Qbtt	0.5 (41)	0.6 (46)	0.2 (13)	1 (1–2)
	Subtotal	**72.9 (65)**	**19.6 (18)**	**19.3 (17)**	**112 (87–139)**
Deep	Qct	11.8 (41)	13.3 (46)	3.9 (13)	29 (22–36)
	Qbof	12.2 (47)	10.2 (39)	3.8 (14)	26 (20–33)
	Qbog	0.2 (45)	0.2 (48)	0 (7)	0 (0–1)
	Tvt 2	0 (0)	0 (1)	0 (99)	0 (0–0)
	Subtotal	**24.2 (44)**	**23.7 (43)**	**7.6 (14)**	**56 (42–70)**
Grand Total		**97.1 (58)**	**43.2 (26)**	**26.9 (16)**	**167 (129–209)**

Appendix G

Evaluation of the Locations of Existing Monitoring Wells for Detecting Potential Contaminants in the Regional Aquifer from Material Disposal Area C

G-1.0 INTRODUCTION

This appendix discusses an assessment of the existing groundwater monitoring well network's ability to confidently detect potential contaminant arrival in the regional aquifer from contaminant sources within Material Disposal Area (MDA) C at Los Alamos National Laboratory (LANL or the Laboratory). The current groundwater monitoring network at MDA C includes regional wells R-46 and R-60, both located to the east of MDA C (Figure G-1.0-1). A network evaluation was performed as part of the Phase III investigation work plan for MDA C (LANL 2010, 109260, Appendix C). At that time, only well R-46 had been installed near MDA C. The purpose of the previous network evaluation was to identify the locations for two proposed regional wells near MDA C (R-59 and R-60). Because of construction activities at the proposed location of R-59 to the southeast of MDA C, only well R-60 was installed. The Laboratory submitted a drilling work plan for well R-59 while well R-60 was being installed. The drilling work plan did not specify a location for R-59 but instead recommended proposing a location for R-59 after R-60 was completed and water-level data from R-60 were available (LANL 2010, 110868). Following discussions with the New Mexico Environment Department, the Laboratory recommended deferring decisions related to well R-59 until after the Phase III investigation report is submitted. The Laboratory recommended that decisions regarding R-59 be based on the information to be presented in the Phase III investigation report, including evaluations of water-level data, pore-gas sampling, and groundwater sampling. The evaluation of the monitoring effectiveness of wells R-46 and R-60 in this appendix is part of the information that will help inform the decision of the need for, and location of, well R-59.

G-2.0 CONTAMINANT TRANSPORT THROUGH THE VADOSE ZONE

Contaminant transport through the vadose zone is not explicitly considered in the modeling analyses presented below. Instead, the existing data about spatial distribution of vapor-phase trichloroethene (TCE) and tritium from vapor samples collected in the vadose zone beneath MDA C are applied to evaluate the area of potential contaminant arrival at the top of the regional aquifer. The network efficiency is then evaluated assuming the contaminant is already within the regional aquifer in the hypothesized arrival area.

The conceptual site model of contaminant transport for vapor-phase TCE and tritium in the vadose zone is discussed in section 2.4 of the investigation report. The spatial distribution of TCE within the vadose zone is consistent with radial diffusion from belowground sources. The vertical extent of the TCE plume in excess of screening levels based on groundwater cleanup levels is bounded by the lower portion of the Otowi Member of the Bandelier tuff (Qbof) and the underlying Guaje Pumice Bed (Qbog). Transport through the underlying Tschicoma dacite (Tvt 2) would occur by diffusion through fractures and fracture orientation would affect the lateral transport of the plume. Once below Tvt 2, TCE would continue to diffuse through the Puye Formation sediments (Tpf) to the regional aquifer. The distribution of tritium is more localized near potential source areas rather than as a vapor plume. Transport from these localized areas of high concentration would, however, occur similarly to TCE.

The evaluation presented in this appendix assumes transport of these constituents to the water table is predominantly vertical and downward from the existing source areas near the ground surface at MDA C. However, there is also a potential component of upward and lateral diffusion driven by high concentration gradients toward the adjacent canyons and the mesa top because of the continuous removal by atmospheric air flow. In the deeper sections of the vadose zone (at elevations lower than the elevation of the adjacent canyons bottoms), the transport is expected to be predominantly radial and driven by diffusion. This model also assumes the infiltration recharge from the surface-water flow along the canyon bottoms to the north and to the south of MDA C does not affect contaminant transport. Based on the

existing vapor data for TCE and tritium, two potential breakthrough locations of contaminant arrival at the top of the regional aquifer have been identified for these two different sources. These locations are applied to model contaminant transport in the regional aquifer. The source areas being used are the same as those used in the previous evaluation (LANL 2010, 109260, Appendix C) and agree with updated vapor-phase plume extents presented in Appendix F.

G-3.0 NETWORK EVALUATION OF THE REGIONAL MONITORING WELLS

A major objective of the numerical simulations is to analyze flow and contaminant transport directions near potential breakthrough locations at the regional aquifer beneath MDA C. Through this analysis, the effectiveness of existing wells R-46 and R-60 to detect potential contamination in the regional aquifer originating from MDA C can be evaluated.

The numerical simulation of contaminant transport in the regional aquifer is performed using an analytical model. The model simulates three-dimensional advective-dispersive contaminant transport in the regional aquifer from a contaminant source with a given volume (cf., Wexler 1992, 106994; Wang and Wu 2009, 109751). Previously, this model has been applied to simulate chromium transport in the regional aquifer beneath Sandia Canyon (LANL 2007, 098938). Various hydrogeological parameters characterize the potential contaminant transport in the regional aquifer, and a distribution of values is used for each of the parameters. In the analyses presented below, the parameters include (1) groundwater flow directions, (2) the hydraulic gradient, (3) aquifer permeability and porosity, (4) longitudinal and transverse dispersivities, and (5) the size and location of the breakthrough location at the top of the regional. The model parameters are also listed in Table G-3.0-1. The model analysis incorporates the distribution of possible values for each of the parameters, as discussed below.

Groundwater flow directions and magnitudes 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). However, the groundwater flow directions in the regional aquifer beneath MDA C are uncertain because of the low density of existing wells in the vicinity of MDA C; more specifically, there are limited water-level data for defining regional flow directions west and north of MDA C (Figure G-1.0-1). To the southwest of MDA C near R-47 and to the south near R-17, flow directions appear to be to the northeast. To the east of MDA C near R-1 and R-14, groundwater flow appears to be to the south-southeast. The differences in the water levels observed at monitoring wells R-60 and R-46 downgradient of MDA C confirm the relatively high hydraulic gradients in the regional aquifer beneath MDA C (Table G-3.0-1); the hydraulic gradients decline downgradient from MDA C (Figure G-1.0-1). The relatively high gradients upgradient from MDA C are thought to be caused by mountain front recharge of the regional aquifer to the west of MDA C. Based on the geologic contact information shown in Figure G-1.0-1, the contact of the Puye Formation sediments (Tpf) and Miocene Pumiceous sediments (Tjfp) near and along the regional water table to the northeast of R-60 potentially impacts the flow direction downgradient from MDA C. It is also possible the flow directions are influenced by water-supply pumping at PM-5; however, the current data regarding water-level transients caused by the water-supply pumping (PM-5, PM-4, PM-2, and O-4) suggest that the pumping does not cause a pronounced effect on the groundwater flow direction near the top of the regional aquifer. In conclusion, the existing water-level data indicate a relatively complex structure of the regional flow that may be caused by (1) aquifer recharge, (2) aquifer heterogeneity and anisotropy (stratification) and (3) the influence of water-supply pumping. Based on the current data, the regional flow downgradient from MDA C may be in directions varying between east-northeast and east-southeast, as presented in Figure G-1.0-1. Uncertainties in the flow directions and hydraulic gradients are incorporated in the evaluation of network efficiency (Table G-3.0-1).

Puye Formation sediments within the regional aquifer appear to be highly heterogeneous. Estimates of Puye Formation permeability in the regional aquifer at the monitoring wells downgradient of MDA C vary between 0.3 and 20 m/d (~1–60 ft/d) (Table G-3.0-1). The uncertainty in porosity values for the Puye Formation sediments within regional aquifer units is based on data from the literature (Freeze and Cherry 1979, 088742) and site-specific knowledge (Keating et al. 2001, 095399) (Table G-3.0-1). Dispersion of potential contaminant plumes in the aquifer is represented in the model by longitudinal and transverse dispersivities (cf., Lichtner et al. 2002, 095397). Site-specific data supporting dispersivity values are not available. Based on data from literature, the selected range of values is reasonable for the spatial scale of simulated contaminant transport ([on the order of hundreds of meters] Neuman 1990, 090184) and the properties of the flow medium (Table G-3.0-1).

Contaminant transport in the regional aquifer is modeled from two potential breakthrough locations (Figure G-1.0-1). The selection of the breakthrough locations is based on the shape of the TCE vapor plume and locations where tritium is measured in the upper several hundred feet below the ground surface (see Appendix F). The eastern source area represents a potential arrival location for TCE or tritium (see Figures F-3.1-1 through F-3.1-5 and F-4.0-1 through F-4.0-6); the western source area represents an alternative arrival location for tritium. Using two alternative breakthrough locations allows for a more conservative approach for analyzing monitoring network detection efficiencies. The simulated plumes migrate in the regional aquifer downgradient of these breakthrough locations. In addition, the analysis takes into account the uncertainty associated with the potential size of the breakthrough locations; the uncertainty ranges are presented in Table G-3.0-1.

To estimate uncertainty in the model predictions, a Monte Carlo analysis is performed. A set of 1000 uncorrelated, equally probable, random realizations are generated using a Latin Hypercube sampling technique with the software Crystal Ball. Each realization includes eight random variables representing various model parameters listed in Table G-3.0-1.

Simulated plumes are based on a unit concentration at the potential arrival location for each of the two breakthrough areas. Therefore, the model produces concentrations at the monitoring wells that are relative to the original unit concentration at the breakthrough areas. Transport within the regional aquifer of a nonsorbing, conservative contaminant is then simulated. No analytical detection limits or regulatory limits are used in this analysis because the predicted concentrations are relative, not absolute. Therefore, the modeling results do not indicate whether any of the plumes are associated with concentrations that could exceed regulatory standards or detection limits. However, the simulations yield information about flow directions and about relative magnitudes of concentrations at monitoring wells that are evaluated to determine the efficiency of the network.

This network analysis evaluates the existing R-60 and R-46 monitoring well locations. The well locations are presented in Figure G-1.0-1 and Table G-3.0-2.

G-4.0 MONITORING METRICS

The groundwater monitoring metric set for MDA C for this network evaluation is that the monitoring network must detect potential contaminant plumes in the regional aquifer with detection efficiency higher than 95%. In the model, successful detections are plumes detected by any of the existing monitoring wells near MDA C or a combination of those two wells. The detection efficiency is calculated as the number of successfully detected plumes divided by the number of simulated plumes (1000 plumes). An additional metric is that the wells are located sufficiently close to the assumed breakthrough locations to support early detection (within approximately 5 yr) in the event that a contaminant arrives at the regional aquifer.

G-5.0 RESULTS

The detection efficiency of the regional monitoring wells to detect plumes potentially originating from MDA C is presented in Table G-5.0-1. Average pore (linear) velocity and travel times from the potential sources to the wells are also presented in the table. For the potential TCE and tritium breakthrough locations, the results indicate that the combination of the existing monitoring wells R-60 and R-46 is capable of detecting potential contaminants from the assumed breakthrough locations with detection efficiency above 95%. This efficiency is based on the assumed areas of breakthrough, which are much smaller than the overall plume areas. This results in a conservative analysis since breakthrough over a larger area would be easier to detect.

The average pore (linear) velocities from the two potential source areas to the two wells are listed in Table G-5.0-1. Also presented are the average travel times in the aquifer. The travel times from the two potential source locations to R-60 are less than 5 yr and to R-46 are 7.5 yr or less.

G-6.0 REFERENCES

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

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

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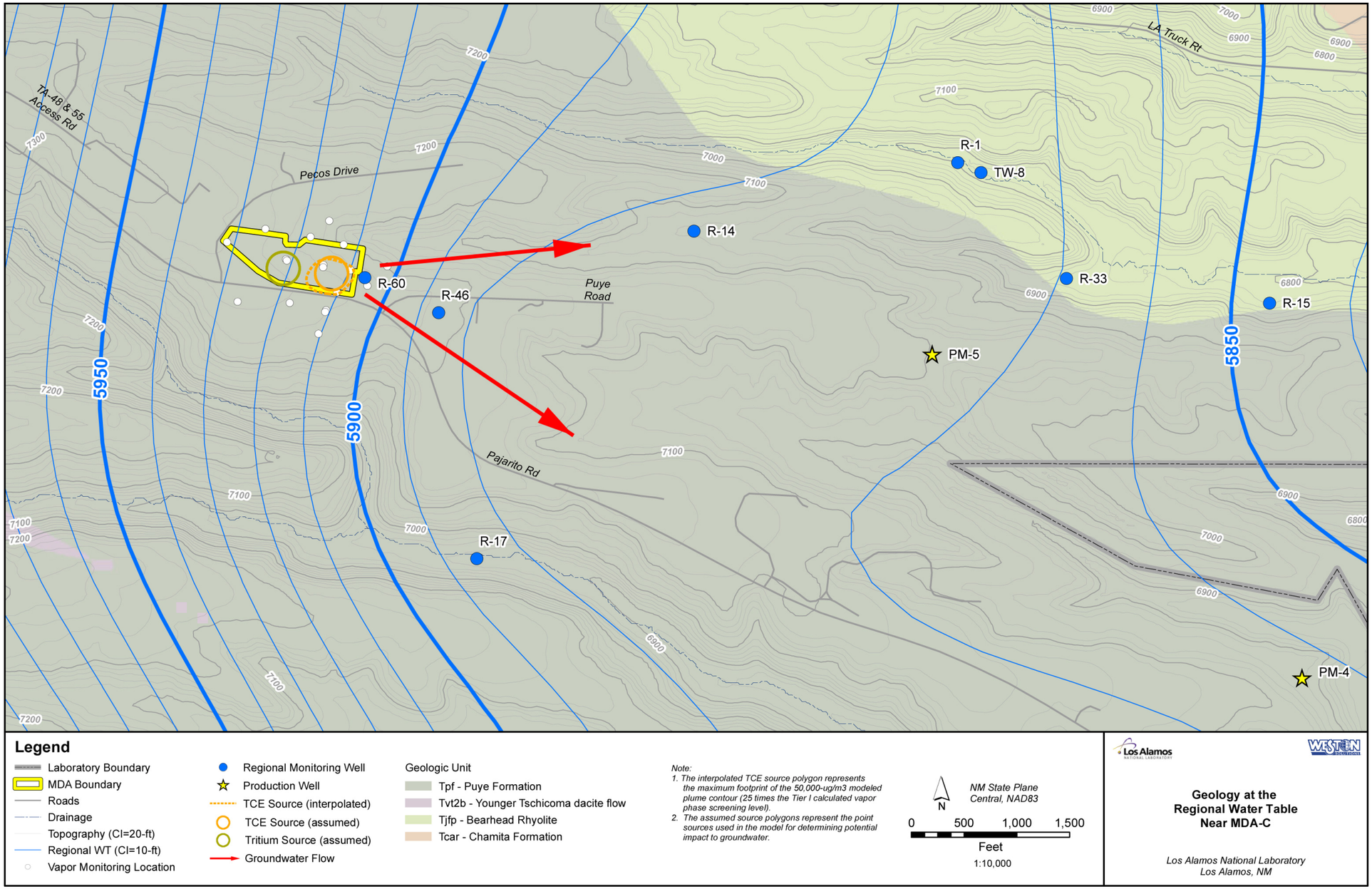

Source: LANL 2011, 201568.

Figure G-1.0-1 Map of the existing regional monitoring wells near MDA C, including the elevation of the regional water table representative of September 2010, the hydrostratigraphic units along the regional water table near MDA C, and two potential source areas

Table G-3.0-1
Model Parameters Evaluating the Monitoring Network of Regional Aquifer Wells Near MDA C

Parameter	Best Estimate	Range	
		Minimum	Maximum
Source x dimension [m]	50	10	100
Source y dimension [m]	50	10	100
Porosity [m^3/m^3]	0.1	0.05	0.15
Flow Angle [degrees]	−5	−30	10
Hydraulic gradient [m/m]	0.014	0.022	0.011
Permeability [m/d]	2.3	0.3	20
Dispersivity longitudinal [m]	10	1	100
Dispersivity transverse [m]	1	1	10

Note: Each parameter has a range of values used in the model runs.

Table G-3.0-2
Locations of Existing Regional Aquifer Monitoring Wells Near MDA C

Well	x (m)	y (m)
R-60	495859.6	539036.1
R-46	496041.8	538942.2

Table G-5.0-1
Detection Efficiency of Monitoring Wells R-60 and R-46

Wells	Eastern Source (TCE or Tritium)			Western Source (Tritium)		
	Detection Efficiency	Average Velocity (m/yr)	Average Travel Time (yr)	Detection Efficiency	Average Velocity (m/yr)	Average Travel Time (yr)
R-60	98.4%	113.1	2.8	90.9%	156.9	4.7
R-46	90.7%	172.5	5.6	83.5%	196.0	7.5
R-60 + R-46	99.7%	142.8	4.2	95.9%	176.5	6.1

Note: Detection efficiency related to two potential source areas is shown in Figure G-1.0-1. Average pore (linear) velocity and travel time from the potential source areas to the monitoring wells are also presented.