Response to the Notice of Disapproval for the Phase II Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50, Los Alamos National Laboratory EPA ID No: NM0890010515, HWB-LANL-09-017, Dated August 31, 2009

INTRODUCTION

To facilitate review of this response, the New Mexico Environment Department's (NMED's) comments are included verbatim. The comments are divided into general and specific categories, as presented in the notice of disapproval. Los Alamos National Laboratory's (LANL's or the Laboratory's) responses follow each NMED comment. This response contains data on radioactive materials, including source, special nuclear, and byproduct material. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with U.S. Department of Energy policy.

GENERAL COMMENTS

NMED Comment

1. *The Permittees identified, subsequent to submittal of this Report, a systematic low bias in tritium pore-gas concentrations. The properties of the silica gel cartridges were not considered when calculating the final tritium results. The Permittees must therefore revise the Report to correct all instances where tritium pore-gas values were affected by this bias.*

LANL Response

1. Sections F-1.3.5 and F-3.6, Tables 2.4-7, 6.3-2, F-1.3-6, and F-2.8-1, and Plates 3 and 7 have been revised and present the corrected tritium results. The text in sections 1.4, D-1.0, and F-1.0 have also been revised to include the following text:

   "A systematic low bias in previously reported tritium pore-vapor measurements has been identified (Whicker et al. 2009, 106429); tritium data presented in this report have been corrected for this bias (Marczak 2009, 106500). The bias resulted from the properties of silica gel, the medium used to collect water vapor from pore-gas samples. Silica gel contains water bound to the silica gel molecules that cannot be completely removed by drying, before it is used in sampling, without degrading the silica gel properties. Thus, when water vapor is collected from the pore gas, the tritiated water vapor is diluted into the water bound to the silica gel molecules. The tritium results in this report were corrected using the percent moisture value determined by the analytical laboratory. When percent moisture data are not available for a sample, a conservative correction factor of 2 is applied. This correction factor was selected based on an analysis of 2 yr of tritium pore-vapor correction values."

NMED Comment

2. *To ensure consistency at all sites across the Laboratory, this comment provides direction and clarification as to the procedure(s) that should be used in future reports for comparing site data to background. The following general method is preferred by NMED for evaluating background whether the constituent of concern is naturally occurring or a radionuclide. Additional guidance may be found*

in Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites (http://www.epa.gov/oswer/riskassessment/pdf/background.pdf).

a. As an initial screen, the maximum detected site concentration for each medium (soil, sediment, and tuff) should be compared to the appropriate background reference datum. This background datum is defined as the upper tolerance limit (UTL) in the LANL document Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandalier Tuff at Los Alamos National Laboratory. If the site maximum is less than the background UTL for a given medium, then a conclusion may be drawn that the detected site concentrations are representative of background.

b. If the initial screen indicates that the maximum detected concentration is greater than the background UTL, and sufficient data are available, a statistical comparison (site attribution analysis) of site concentrations to background should be conducted. The statistical evaluation will provide results to assess whether the site data are significantly different from the background population. It is recommended that the statistical test be based on the distribution of the data sets. While either parametric or nonparametric tests may be used, the most commonly applied test for comparing site data to background is the nonparametric Wilcoxon Rank Sum (WRS) test.

c. Additional methods may be used in conjunction with the statistical tests, including box and whisker plots, histograms, and/or geochemical analyses.

d. If sufficient data are not available to conduct a robust statistical evaluation, additional site samples may be required to support either the determination of nature and extent or to support human health or ecological risk assessments. However, graphical methods, comparison to the background range(s) of data, and other lines of evidence may be evaluated on a case by case basis.

LANL Response

2. Comment noted. This approach to identifying chemicals of potential concern (COPCs) through statistical comparisons to background has been implemented in investigation reports submitted after the Material Disposal Area (MDA) C Phase II investigation report.

NMED Comment

3. Sections 7.2.1, 7.2.2, 7.2.3, 7.3.1, and 7.3.2 describe the Permittees' conclusions regarding nature and extent of inorganic, organic and radionuclide contamination in tuff and pore-gas. Additionally, these sections reference Appendix F, specifically sections F-3.2, F-3.3, F-e.5, F-3.4, and F-3.6. The information provided in Appendix F appears to be a reiteration of sections 7.2.1, 7.2.2, 7.2.3, 7.3.1, and 7.3.2. The Permittees must revise the Report to remove Appendix F. Any information in Appendix F that is not duplicative of sections 7.2.1, 7.2.2, 7.2.3, 7.3.1, and 7.3.2 must be incorporated into the appropriate section in the main text of the Report.

LANL Response

3. Appendix F has not been removed because it is a key part of investigation reports and has been included in all previous reports. The appendix presents a detailed evaluation of data to identify COPCs and the assessment of the extent of contamination at the site. Therefore, sections 7.2.1,

7.2.2, 7.2.3, 7.3.1, and 7.3.2 of the main text are summaries of the detailed data evaluations presented in Appendix F sections F-3.2, F-3.3, F-3.4, F-3.5, and F-3.6.

NMED Comment

4. The Permittees state that the vertical and lateral extent of inorganics, organics, and radionuclides in tuff as well as the vertical and lateral extent of VOCs and tritium in pore gas are defined. While some trends showing decreasing concentrations with distance are apparent, this is not the case for VOCs in pore gas in boreholes 50-27437, 50-27444, 50-27445, 50-27446, 50-24783/50-603472, 50-603367, 50-603063, 50-24771/50-603471, 50-603468, 50-24822; the lateral extent for VOCs to the south and east of MDA C; the vertical extent of inorganics in tuff in boreholes 50-603468, 50-603470, 50-24822; and the vertical extent of tritium in pore gas in boreholes 50-27446 and 50-603383. The Permittees state in Section 7.2.1 on page 22 of the Report that inorganics were "infrequently detected, and their concentrations were generally less than twice the BVs." Again in Section 7.3.1 on page 23 of the Report, the Permittees state that "[t]he lateral extent of VOCs is defined at MDA C because the VOCs detected generally decrease in concentration with increasing distance from the disposal units or the central portion of MDA C." These broad generalizations do not comport with the data from the aforementioned boreholes. The Permittees must revise the Report, where appropriate, to provide explanation supporting the conclusion that "vertical and lateral extent of contamination is defined" at MDA C, or propose additional work to achieve such determination, or both.

LANL Response

4. Responses are provided below for specific items discussed in the NMED's comment.
   Figures F-3.4-1 through F-3.4-5, F-3.6-1, and F-3.6-2 have been added to Appendix F to include cross-sections of MDA C boreholes with pore-gas concentrations of tetrachloroethene (PCE), trichloroethene (TCE), and tritium. These figures illustrate that lateral and vertical trends in concentration decrease away from the center of MDA C and decrease with increasing depth.

   However, it should be noted the data in this report represent the conditions at one point in time. In some boreholes, the samples were collected before a vapor-monitoring system was installed during the Phase I investigation. Additional monitoring of volatile organic compounds (VOCs) and tritium in pore gas is appropriate to ensure concentrations are representative, and no significant changes in concentrations have occurred over time. Quarterly collection of vapor samples from all sampling ports at the 14 Phase II boreholes is recommended in section 8.0. Only after monitoring is complete and additional data are available to supplement the conclusion that vertical and lateral extent of contamination is defined should a decision be made to conduct any additional work at this site other than monitoring.

   a. NMED states, "While some trends showing decreasing concentrations with distance are apparent, this is not the case for VOCs in pore gas in boreholes 50-27437, 50-27444, 50-27445, 50-27446, 50-24783/50-603472, 50-603367, 50-603063, 50-24771/50-603471, 50-603468, 50-24822…."

      Boreholes 50-27437, 50-27444, 50-27445, and 50-27446 are the shallower boreholes drilled between Pits 2 and 3 during the Phase I investigation. The total depth (TD) of borehole 50-27444 was 335.5 ft below ground surface (bgs) and the TD of the other three boreholes was 82.5 ft bgs. These shallow boreholes were not drilled to determine the vertical extent of contamination across the site but were drilled at NMED's direction to determine if a potential release had occurred below the pits. Section F-1.3.4, which discusses the VOCs in pore-gas between Pits 2 and 3, states that "[p]ore-gas samples from other boreholes at MDA C provide additional data to evaluate trends in VOC concentrations with depth (sections F-2.5 and F-3.4)."

Section F-3.4 presents a detailed explanation on how vertical extent of VOCs in pore-gas is defined at locations 50-24783/50-603472, 50-603063, 50-24771/50-603471, 50-603467, 50-603468, and 50-24822. Location ID 50-603367 does not exist. The lateral extent of VOCs in pore gas is also discussed below.

b. NMED states, "While some trends showing decreasing concentrations with distance are apparent, this is not the case for…the lateral extent for VOCs to the south and east of MDA C…."

   Higher concentrations of VOCs were detected in boreholes located within MDA C. Using TCE as an example, the highest concentrations are in boreholes located in the central portion of MDA C. At locations 50-24769/50-603470, 50-24771/50-603471, and 50-24783/50-603472, TCE concentrations are 57,000 $\mu g/m^3$, 91,000 $\mu g/m^3$, and 30,000 $\mu g/m^3$, respectively. The highest concentration of TCE in the western corner of MDA C at location 50-24784 is 1600 $\mu g/m^3$, and it is 78,000 $\mu g/m^3$ in the southeastern corner of the MDA C boundary at location 50-24813.

   The highest concentrations of TCE in the boreholes to the west, north, and northeast of MDA C, which are farthest away from the MDA C boundary, are lower by an order of magnitude: 2200 $\mu g/m^3$ (boreholes 50-603060/50-603503), 1600 $\mu g/m^3$ (borehole 50-24784 located within MDA C boundary but in the far west corner), 1700 $\mu g/m^3$ (borehole 50-603383), 3400 $\mu g/m^3$ (borehole 50-603061), and 5100 $\mu g/m^3$ (borehole 50-603062). These concentrations demonstrate the lateral extent of VOCs in pore gas is defined by decreasing concentrations to the west, north, and northeast of MDA C.

   The highest concentrations of TCE in the boreholes to the south and southeast of the MDA C boundary are 21,000 $\mu g/m^3$ (borehole 50-603467), 32,000 $\mu g/m^3$ (borehole 50-603468), and 12,000 $\mu g/m^3$ (borehole 50-24822). These concentrations are lower by approximately 50% or more than those in the boreholes located within MDA C (57,000 $\mu g/m^3$ in boreholes 50-24769/50-603470; 91,000 $\mu g/m^3$ in boreholes 50-24771/50-603471; and 78,000 $\mu g/m^3$ in borehole 50-24813). These concentrations demonstrate the lateral extent of VOCs in pore gas is also defined by decreasing concentrations to the south and southeast of MDA C.

c. NMED states, "While some trends showing decreasing concentrations with distance are apparent, this is not the case for…the vertical extent of inorganics in tuff in boreholes 50-603468, 50-603470, 50-24822…."

   The text in section F-3.2 has been revised to clarify the conclusion that the vertical extent of inorganic chemicals is defined at MDA C. The changes are included below.

   The vertical extent of inorganic chemicals can more clearly be seen to decrease with depth when both Phase I and Phase II samples are viewed together for each borehole, including concentrations that are below background and not detected (see Table 1 of this response).

   At locations 50-24769/50-603470, concentrations of aluminum, beryllium, cadmium, lead, nitrate, perchlorate, selenium, silver, and zinc decrease with depth from the maximum concentration (Table 1). The evaluation of the vertical extent of some inorganic chemicals is complicated by the deepest sample from the Tschicoma Formation (Tt), which has no established background values (BVs) for inorganic chemicals. Twelve inorganic chemicals had the highest concentration in the deepest sample: arsenic, barium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, and vanadium (Table F-2.2-1 and Plate 5). The concentrations likely represent the natural geology of the Tschicoma Formation. Several of these inorganic chemicals are common and naturally occurring (aluminum, calcium, iron, magnesium, and potassium) and are not indicative of contamination associated with Laboratory operations. Apart from the deepest sample, each of the 12 inorganic chemicals listed above has concentrations that decreased with depth. The elevated concentrations in the Tschicoma Formation likely reflect the natural chemical composition of the dacite that is substantially different than the overlying rock units (as indicated by the elevated concentrations of aluminum, calcium, iron, magnesium, and potassium). In addition, because the sample of Tschicoma Formation was collected in the upper portion of the formation, the material is possibly more weathered, resulting in higher concentrations than detected in units above this sample. Because 21 inorganic chemicals decrease with depth until the deepest sample is reached, there is a clear decreasing trend with depth for inorganic chemicals at this location (see response to Specific Comment 9).

At locations 50-24821/50-603468, concentrations of aluminum, arsenic, beryllium, chromium, cobalt, iron, lead, manganese, nickel, nitrate, perchlorate, selenium, silver, vanadium, and zinc decrease with depth from the maximum concentration (Table 1). Only one inorganic chemical, barium, did not decrease with depth but had its highest concentration in the TD sample, and that concentration (29.5 mg/kg) is only slightly above the BV (25.7 mg/kg) and is a reflection of the natural variability of the Otowi Member.

At location 50-24822, concentrations of arsenic, iron, lead, manganese, nickel, nitrate, and perchlorate decrease with depth from the maximum concentration (Table 1). Only chromium does not decrease with depth, and its highest concentration (7.01 mg/kg in the deepest interval) is less than 3 times the BV (2.6 mg/kg). Because the Otowi Member background data set is limited, this concentration is likely naturally occurring; it is not related to Laboratory releases given the depth and location of the borehole (over 100 ft outside the eastern boundary of MDA C boundary).

d. NMED states, “While some trends showing decreasing concentrations with distance are apparent, this is not the case for…the vertical extent of tritium in pore gas in boreholes 50-27446 and 50-603383.”

Borehole 50-27446 is one of the shallower boreholes drilled between Pits 2 and 3 during the Phase I investigation. The TD of borehole 50-27446 was 82.5 ft bgs. This shallow borehole was not drilled to determine the vertical extent of tritium contamination in pore gas but was drilled at NMED’s direction to determine if a potential release had occurred below the pits.

See response to Specific Comment 11 for the discussion of the vertical extent of tritium in pore gas in borehole 50-603383.

SPECIFIC COMMENTS

NMED Comment

5. ***Executive Summary, page v, paragraph 4:***

   Permittees' Comment: *"The maximum concentrations of most organic chemicals in pore gas 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, but especially in, deeper boreholes. The vertical extent of both VOCs and tritium in pore gas is defined."*

   NMED Comment: *The Permittees' statement that "[t]he vertical extent of both VOCs and tritium in pore-gas is defined" is inaccurate. The Permittees must revise the text or provide a stronger foundation for the assertion. See General Comment # 4.*

LANL Response

5. The evaluation of vertical extent of VOCs uses data from the deepest boreholes to illustrate that concentrations decrease with depth. The definition of the vertical extent of VOC contamination does not require vertical extent to be defined in every borehole used to characterize the site. While the vertical extent of VOCs is not defined for every individual borehole, the deepest boreholes show VOCs (particularly TCE and PCE) are lower in the deepest samples than in samples shallower than 125 ft bgs. In the deepest borehole, 50-24769/50-603470, the TCE concentration decreased by more than 300 times from the highest concentration (60,000 µg/m^3) at 300 ft bgs to the deepest sample (180 µg/m^3). The TCE concentration in the deepest sample is more than an order of magnitude less than the work plan–established target level for TCE (2100 µg/m^3). Additionally, TCE concentrations decrease with depth from the maximum concentrations at the following locations.

   - location 50-24771/50-603471: 91,000 µg/m^3 (250 ft bgs) to 34,000 µg/m^3 (450 ft bgs)
   - location 50-24783/50-603472: 30,000 µg/m^3 (300 ft bgs) to 6500 µg/m^3 (450 ft bgs)
   - location 50-24784: 1600 µg/m^3 (362 ft bgs) to 350 µg/m^3 (450 ft bgs)
   - location 50-24813: 78,000 µg/m^3 (200 ft bgs) to 2400 µg/m^3 (600 ft bgs)
   - location 50-603467: 21,000 µg/m^3 (287 ft bgs) to 6900 µg/m^3 (600 ft bgs)
   - location 50-603061: 3400 µg/m^3 (228 ft bgs) to 230 µg/m^3 (450 ft bgs)
   - location 50-603062: 5100 µg/m^3 (100 ft bgs) to 400 µg/m^3 (450 ft bgs)
   - location 50-603063: 14,000 µg/m^3 (200 ft bgs) to 5000 µg/m^3 (450 ft bgs)
   - location 50-603064: 24,000 µg/m^3 (176 ft bgs) to 6 µg/m^3 (500 ft bgs)

Concentrations of PCE also decreased with depth. The PCE concentrations were much lower overall (maximum concentration of 2500 µg/m^3 at location 50-24771) and were less than the work plan-established target level for PCE (3800 µg/m^3). Figures F-3.4-1 and F-3.4-2 illustrate the decrease in PCE concentrations with depth across the site.

Tritium concentrations decreased with depth from the maximum concentrations in all boreholes (see response to Specific Comment 11).

Sections F-3.4 and F-3.6 have been revised to clarify the basis for the statement that the vertical extent of VOCs and tritium in pore-gas is defined.

NMED Comment

6. ***Section 1.3, Phase II Site Investigation Conducted, page 2, 1*st *paragraph, bullet three:***

   Permittees' Statement*: "[e]xtended eight existing boreholes (locations 50-24769, 50-24771, 50-24783, 50-24784, 50-24813, 50-24817, 50-24820, and 50-24822)"*

   NMED Comment*: The Permittees state in the first paragraph of Section 1.3 that nine boreholes (locations 50-24769, 50-24771, 50-24783, 50-24784, 50-24813, 50-24817, 50-24820,* ***50-24821****, and 50-24822) were extended as part of the Phase II investigation. Additionally, the approved Work Plan also states that nine boreholes would be extended as part of the Phase II activities. The Permittees must revise the text to resolve this discrepancy.*

LANL Response

6. Borehole 50-24821 was not extended as part of the Phase II investigation. During the pilot study activities (LANL 2008, 102651, p. 3), two boreholes were drilled next to borehole 50-24821. Borehole 50-603373 was drilled with an auger rig to 300 ft bgs, and borehole 50-603468 was drilled to 460 ft bgs using the air-rotary method. Borehole 50-603468 was the replacement borehole for extending 50-24821 to 450 ft bgs, as indicated in the pilot study investigation report (LANL 2008, 102651, p. 3). The deviations section in Appendix B has been revised to clarify this condition.

NMED Comment

7. ***Section 3.4.5, Collection of Pore-Gas Samples, page 9, paragraph 3:***

   Permittees' Statement: *"After a 30-min purge, a pore-gas sample for VOCs analysis was collected in a SUMMA canister."*

   NMED Comment: *The Permittees state in Section 3.4.1, Drilling, that "[t]he pore-gas screening sample was collected in a SUMMA canister following a 60-min purge." The Permittees must revise the text to resolve this discrepancy.*

LANL Response

7. Section 3.4.1 refers to the collection of pore-gas screening samples used to determine TD of the Phase II boreholes, while section 3.4.5 refers to collection of the analytical pore-gas samples presented in the investigation report. Screening samples were collected after a 60-min purge, which was later determined to be longer than necessary to purge the entire collection system, so the purge time was decreased to 30 min for the analytical pore-gas sampling. Because there is no discrepancy in the text, the text has not been revised.

NMED Comment

8. ***Section 5.3, Cleanup Standards, page 18, paragraph 1:***

   Permittees' Statement: *"Because the current and reasonably foreseeable future land use is industrial, industrial SSLs/SALs are the cleanup levels for MDA C."*

   NMED Comment: *Selection of the cleanup standards that apply to the site in the Report is premature and therefore will not be evaluated until the Corrective Measures Evaluation (CME) is submitted.*

LANL Response

8. Risk was evaluated for MDA C to determine whether any potential unacceptable risks or doses currently exist, which is consistent with the intent of the report and the presentation provided in the other reports involving MDAs. Industrial is the current and reasonably foreseeable future land use of MDA C, and therefore the industrial SSLs/SALs are the appropriate cleanup levels for the evaluation of present-day risk or dose if remediation were deemed necessary. The risk/dose evaluation is not intended to determine the final disposition of the site but rather to ensure current conditions at MDA C are not subject to unacceptable risk or dose that require remediation.

NMED Comment

9. ***Section 7.2.1, Nature and Extent of Contamination in Tuff, Inorganic Chemicals in Tuff, page 22, paragraph 1:***

   Permittees' Statement: *Concentrations of all TAL metals decreased with depth at locations 50-24784, 50-24820, 50-603060, 50-603061, and 50-603063. In the rest of the Phase II boreholes, concentrations of one or more TAL metals did not show decreasing concentrations with depth. However, they were infrequently detected in the TD sample of borehole 50-603470 at 650 to 653 ft bgs in media TT (Tschicoma Formation) where no BV is available. The overall decreasing concentration with depth to this tuff layer does not indicate contaminant releases."*

   NMED Comment: *The order of magnitude increase in several metals in the Tschicoma Formation (TT) at borehole location 50-603470 may indicate contaminant migration via fracture flow. An "overall" decreasing trend is not sufficient. Based on the concentrations of metals at 650-feet at this location, the Permittees must provide additional information about the TT Formation to evaluate whether or not the detected concentrations of metals are consistent with those found at other locations within the TT Formation.*

LANL Response

9. Section 4.3.1 of the investigation report presents a fracture analysis at MDA C, as required by the approved investigation work plan (LANL 2005, 091493; NMED 2005, 090165). As was concluded in section 4.3.1, fractures within the Bandelier Tuff beneath MDA C do not have a controlling impact on contaminant fate and transport at the site.

   The Tschicoma Formation dacite from borehole 50-603470 contains high levels of several metals when analyzed by U.S. Environmental Protection Agency (EPA) Method 3050, the acid-leach method. It should be noted that the EPA Method 3050 is designed to analyze soil and not silicate rock; by design, elements bound in silicate structures are not normally dissolved by this procedure.

However, the acid-leach method will attack silicate grain surfaces, fractured or weathered silicate grains, oxide phases in the rock, and both silicate and nonsilicate alteration phases. The extent of digestion of this complex set of minerals results in partial metal releases that are only indirectly related to the bulk rock composition. Moreover, partial digestion results will vary from sample to sample of the same lithology, depending on fracturing, particle size, relative alteration, and other variables. For these reasons the EPA Method 3050 is not routinely used to analyze rock, and no comparable data are available for Tschicoma Formation dacite. However, as part of a background chromium study currently being incorporated into the Sandia Canyon report, several samples of Cerros del Rio basalt have been analyzed by the EPA Method 3050. Ten basalt samples were selected from core or cuttings at locations without chromium contamination; the results of the basalt acid leach analysis are summarized in Table 2 of this response, along with Tschicoma Formation dacite data from borehole 50-603470. Although the basalt samples are more mafic (higher magnesium and transition metal content, lower silica, alumina, and alkali content) than the dacite, the acid-leach results can be compared with these differences in mind. Elements elevated in the dacite relative to the basalt are highlighted in red. The higher dacite concentrations for aluminum and potassium are expected because of the higher content of these elements in dacite than in basalt.

It is important to note that the dacite from borehole 50-603470 was collected from the top of the Tschicoma Formation (i.e., the top several inches). It is possible, therefore, that the interval sampled may have been more highly weathered than if it had been collected deeper in the formation. If so, the naturally occurring concentrations of elements in the weathered dacite may be more typical of those in soil than in unweathered dacite. The concentrations of inorganic chemicals detected in this sample are similar to their BVs or background concentrations in soil. In addition, several of these inorganic chemicals are common and naturally occurring (aluminum, calcium, iron, magnesium, and potassium) and are not indicative of contamination associated with Laboratory operations. The elevated concentrations in the Tschicoma Formation likely reflect the natural chemical composition of the dacite in that formation, which is substantially different than the overlying rock units (as indicated by the elevated concentrations of aluminum, calcium, iron, magnesium, and potassium). Higher values for arsenic, calcium, chromium, lead, and selenium are less likely attributable to lithologic differences, but many of these elements could be associated with pedogenic carbonate that may be present at the top of the dacite.

This discussion has been added to section 7.2.1 of the revised investigation report.

NMED Comment

10. ***Section 7.3.1, Nature and Extent of Contamination in Subsurface Pore Gas, Volatile Organic Compounds in Subsurface Pore Gas, page 23:***

    Permittees' Statement: *"The vertical extent of n-heptane and tetrahydrofuran is not defined at locations 50-24820 and 50-603468, respectively. Both organic chemicals were infrequently detected at the site and were not detected in the deepest sample collected at MDA C at 650 ft at location 50-603470. The lateral extent of VOCs is defined at MDA C because the VOCs detected generally decrease in concentration with increasing distance from the disposal units or the central portion of MDA C."*

    NMED Comment: *Section F-1.3.4, VOCs in Pore Gas between Pits 2 and 3, states that vertical extent is defined for n-heptane, contrary to the statement in Section 7.3.1. Section F-1.3.4 goes on to state that "[t]he vertical extent of the remaining VOCs have not been defined because their concentrations were relatively unchanged with depth or increased with depth in one or more* *boreholes." NMED agrees that the vertical extent of several VOCs in pore-gas has not been defined. See General Comment # 4.*

LANL Response

10. See response to General Comment 4. The statement made in section 7.3.1 regarding the extent of n-heptane does not contradict the statement in F-1.3.4. The statements refer to different boreholes at different locations at MDA C. Section F-1.3.4 refers to the vertical extent of VOCs in the boreholes drilled between Pits 2 and 3, which are the locations 50-27437, 50-27444, 50-27445, and 50-27446. The conclusion that extent of n-heptane in these boreholes is defined is correct. The text in section 7.3.1 refers to Phase II boreholes at two other borehole locations outside of the MDA C boundary and is also correct. However, the borehole location in section 7.3.1 where the extent of n-heptane is not defined should be 50-603467, not 50-24820. The borehole location has been corrected in sections F-3.4 and 7.3.1.

NMED Comment

11. ***Section 7.3.2, Nature and Extent of Contamination in Subsurface Pore Gas, Tritium in Subsurface Pore Gas, page 23:***

    Permittees' Statement: *"Concentrations of tritium decreased with depth at all Phase II boreholes or grouped boreholes, except at location 50-603064 and 50-603383. However, tritium concentrations in boreholes that are deeper than those two boreholes show decreasing concentrations with depth. Therefore, the vertical extent of tritium is defined. The lateral extent of tritium is defined for MDA C as a whole because the concentrations in boreholes outside MDA C are substantially lower than concentrations detected in boreholes located in the central area of MDA C."*

    NMED Comment: *The objective of the phase II investigation was to define vertical and lateral extent of contamination, particularly in vapor-phase. Vertical extent of tritium, an important tracer, is not defined in boreholes 50-603383 and 50-24783. See General Comment # 4.*

LANL Response

11. The text in Appendix F, section F-3.6, and section 7.3.2 is revised as follows to accurately reflect the definition of extent for tritium.

    Borehole 50-24783 is "paired" with borehole 50-603472, meaning borehole 50-24783 was drilled to 300 ft and 50-603472 is the extension of that borehole to 450 ft. The vertical extent of tritium in the grouped boreholes 50-24783/50-603472 is defined because tritium concentrations decreased with depth from 2,738,130 pCi/L in 50-24783 at 200 ft to 2967 pCi/L in 50-603472 at 450 ft (Table F-2.8-1).

    At borehole 50-603383, which is paired with borehole 50-24817 (Figure F-3.4-1), vertical extent is also defined. Borehole 50-24817 was drilled and sampled for pore gas to 250 ft during the Phase I investigation (LANL 2006, 094688). Borehole 50-603383 was drilled during Phase II and sampled to 450 ft. The tritium concentrations decreased with depth from a maximum of 501,606 pCi/L at 140 ft in borehole 50-24817 to 52,007 pCi/L at 450 ft in borehole 50-603383. In addition, the corrected tritium values in Table F-2.8-1 show a decrease in tritium concentrations from 70,989 pCi/L at 408 ft to 52,007 pCi/L at 450 ft in borehole 50-603383. Therefore, the vertical extent of tritium in this borehole is defined.

Borehole 50-603064 is a perimeter borehole located at the northern edge of MDA C at the head of Ten Site Canyon. This borehole was designed primarily to evaluate the lateral extent of pore-gas contamination. The tritium concentrations in this borehole are less than those reported for boreholes within the MDA C boundary. Tritium concentrations in borehole 50-603064 fluctuate along the vertical profile from 612 pCi/L at 66 ft to 1476 pCi/L at 113 ft to 525 pCi/L at 250 ft to 2078 pCi/L at 500 ft. This fluctuation of tritium concentrations is similar to that observed at other perimeter boreholes (i.e., 50-603060/50-603503, 50-603061, 50-603062, and 50-603063) as well as to those detected in the deepest samples in boreholes within the MDA C boundary (Table F-2.8-1). These fluctuations are typical of the lower concentrations of tritium across the site and do not indicate increasing concentrations with depth. Therefore, the vertical extent of tritium in this borehole is defined.

The decreasing concentrations of tritium laterally from the central portion of MDA C are illustrated in Figures F-3.6-1 and F-3.6-2.

Subsequent monitoring of pore gas (as recommended in the investigation report) will more clearly illustrate the concentrations of tritium over time in these boreholes and will be a more accurate depiction of lateral and vertical extent across the MDA C site.

NMED Comment

12. Section 7.4, Summary of Risk Screening Assessments, page 23, paragraph 3:

Permittees' Statement: *"Several chemicals of potential ecological concern (COPECs) were identified. All of the COPECs were eliminated following evaluations based on one or more lines of evidence, including minimum ESLs, HI analysis, comparisons to background, potential effects to populations, infrequent detection, and comparison to previous field and laboratory canyon investigations."*

NMED Comment: *The calculation of risk is premature at this stage of the investigation for MDA C. In any event, the Permittees may not eliminate contaminants of potential concern (COPC) or contaminants of potential ecological concern (COPEC) on the basis of infrequent detection. The Permittees must clarify whether or not they eliminated any COPCs/COPECs due to infrequent detection.*

LANL Response

12. For this investigation, no chemicals of potential ecological concern (COPECs) were eliminated based on infrequent detection. In the analysis of COPECs, the fact that some COPECs were detected in only 2 or 3 samples out of 59 samples collected across the 11.8-acre site, coupled with the low hazard quotients (<1.0), supports the conclusion that the potential exposure and risk to receptors was overestimated and are not likely to impact receptor populations. The actual lines of evidence used to determine if risk to ecological receptors exists is described in Appendix G, section G-6.6. Infrequent detection is no longer used in section 7.4 and in Appendix G, section G-6.6, as a basis for eliminating COPECs because it is not a line of evidence.

NMED Comment

13. Section 8.0, Recommendations, page 24:

Permittees' Statement: *"Because the lateral and vertical extent of contamination are defined, additional drilling and characterization sampling are not recommended for MDA C. Human Health and* *ecological risk screening assessments indicate that current conditions do not warrant immediate corrective actions to reduce the risk or dose."*

NMED Comment: *See General Comment # 4.*

LANL Response

13. See response to General Comment 4.

NMED Comment

14. Figure 4.5-1, Elevations of the top of the regional aquifer beneath the Laboratory, page 39:

NMED Comment: *The Permittees must revise this figure to include the locations of regional wells R-17 and R-46.*

LANL Response

14. Figure 4.5-1 has been revised to include regional wells R-17 and R-46.

NMED Comment

15. Table 6.3-2, Tritium Detected in Pore Gas in Phase II Boreholes at MDA C, page 95:

NMED Comment: *The Permittees state in Section 3.4.5 of the Report that pore-gas samples were obtained at the same depth intervals where tuff samples were collected. Because non-detects are not included in Table 6.3-2, it is difficult for NMED to determine whether or not pore-gas samples were collected at appropriate intervals. NMED acknowledges that Table 3.4-1 (Tuff and Pore-Gas Samples Collected and Analyses Requested in Phase II Boreholes at MDA C) provides the depth intervals and analyses requested for each borehole; however, including this information in Table 6.3-2 will facilitate NMED's review of the Report. The Permittees must revise Table 6.3-2 to include the depth intervals for non-detects.*

LANL Response

15. Text in section 3.4.5 has been revised to state that "[p]ore-gas samples were collected at the same or similar depth intervals or sometimes between two depth intervals where tuff samples were collected." Table 6.3-2 has been revised to include the depth intervals where tritium was not detected.

NMED Comment

16. Section B-5.4, Total Depth Determination, page B-5:

Permittees' Statement: *"The screening sample was submitted for 24-h screening analysis or trichloroethylene (TCE); 1,1,1-trichloroethane (TCA), and tetrachloroethene (PCE) by standard gas chromatographic methods. As specified in the MDA C Phase II Work Plan, drilling would continue in 50-ft intervals until concentrations were below the target levels of 2100 μg/m^3 for TCE and 3800 μg/m^3 for PCE. Screening sample results are listed in Table B-5.4-1."*

NMED Comment: *The Permittees must revise Table B-5.4-1 to include the 1,1,1-trichloroethane (TCA) screening results. Also, as stated in the approved Work Plan, drilling would continue in 50-ft* *intervals until concentrations were below the target levels of 2100 μg/m^3 for TCE and 3800 μg/m^3 for PCE. Borehole 50-24771 had a TCE screening result of 5,000 μg/m^3. The Permittees must explain why the borehole was not extended at 50-foot intervals until screening results for TCE were below the target level of 2100 μg/m^3. Additionally, the Permittees must provide this explanation for boreholes 50-603472= 2300 μg/m^3 TCE and 50-603468= 7200 μg/m^3 TCE.*

LANL Response

16. Although trichloroethane[1,1,1-] (TCA) results were received with the screening results for TCE and PCE, TCA was not used for screening because no target concentration for TCA was identified in the work plan. TCA was not detected in most screening samples and therefore was not a useful indicator for determining TD of boreholes. Therefore, Table B-5.4-1 has not been revised.

    In evaluating TCE and PCE results from screening samples, generally a stronger correlation exists between PCE screening results and final analytical data than for TCE. In borehole 50-24771, the TCE result of 5000 μg/m^3 contrasted with a PCE result of 74 μg/m^3, which is far below the PCE target concentration of 3800 μg/m^3. The decision not to extend the borehole beyond that depth was based on the low screening concentration of PCE and the stronger correlation between screening and final results for PCE than for TCE.

    At borehole 50-603472, the TCE screening result was only slightly above the target concentration (2300 μg/m^3), and the PCE concentration was far below the target concentration (110 μg/m^3). At borehole 50-603468, although the TCE screening result was above the target concentration, PCE was below the target concentration (96 μg/m^3). Based on the correlation between screening and final concentrations for PCE, the decision was made not to extend the boreholes.

    Comparison of the results of the screening samples and the samples collected after the boreholes were completed as monitoring wells shows poor correlation, especially for TCE. For example, at location 50-603470, the screening sample collected at 450 ft had 24,000 μg/m^3 TCE, whereas the sample collected from the completed well at this depth had 150 μg/m^3 TCE. In this case, the screening sample substantially overestimated the TCE concentration. At location 50-24771, the concentration of TCE in the screening sample collected at 450 ft was 5000 μg/m^3, and concentration in the sample from the completed well was 34,000 μg/m^3. Overall, the results indicate the TCE screening was not a useful indicator of borehole TD.

NMED Comment

17. ***Section F-3.0, Nature and Extent of Contamination, page F-7, paragraph 1:***

    Permittees' Statement: *"The COPCs identified at MDA C include a total of 21 inorganic COPCs, 92 organic COPCs (including 16 dioxins and furans), and 15 radionuclide COPCs. Dioxins and furans are not evaluated for extent because they were detected only at very low concentrations that are not indicative of a contaminant release."*

    NMED Comment: *The Permittees must revise the Report to evaluate the extent of dioxins and furans.*

LANL Response

17. The statement made in section F-3.0, Nature and Extent of Contamination (p. F-7, paragraph 1) is incorrect. Dioxin and furan congeners were evaluated for extent in the original report (Appendix F,

section F-3.3.2, p. F-16) and the extent of dioxin and furan congeners is defined (LANL 2006, 094688, p. F-16). The Phase II report evaluated only the extent of the data from Phase II sampling, and Phase II samples were not analyzed for dioxins and furans. Therefore, the text in section F-3.0 has been revised to delete the dioxin and furan statement and replace it with a sentence that states the extent of COPCs previously defined in the investigation report are not presented again in the Phase II report.

NMED Comment

18. Section F-3.4, VOCs in Subsurface Vapor, page F-11:

NMED Comment: *See General Comment # 4.*

LANL Response

18. See response to General Comment 4.

NMED Comment

19. Section F-3.6, Tritium in Subsurface Vapor, page F-13-F-14:

NMED Comment: *See General Comment # 4.*

LANL Response

19. See response to Specific Comment 11.

NMED Comment

20. Appendix G, Risk Assessments:

NMED Comment: *As stated in specific comment # 12, NMED considers calculation of risk to be premature at this stage of the investigation at MDA C. However, a review of the overall methodology and assumptions of the risk assessment was conducted. Several volatile organic compounds (VOCs) were detected in pore gas samples. An evaluation of whether VOC concentrations were sufficient to potentially migrate to groundwater was conducted, but an evaluation of inhalation of vapors migrating from soil into indoor air was not addressed. The evaluation of this pathway is not dependent on depth of contaminant detections in soil, as typically applied in residential and industrial scenarios. Further, neither the NMED soil screening levels nor the regional screening levels account for the vapor intrusion pathway. Application of generic screening levels is adequate if the screening levels account for all potentially complete exposure pathways. At MDA C, the vapor intrusion pathway is complete and must be evaluated. It is suggested that the Johnson and Ettinger model be used to evaluate risk. Results from this analysis should be added to the risks determined from the comparison to the generic screening levels for assessment of overall risk. Inhalation of VOCs by ecological receptors is typically not evaluated in ecological risk assessments due to the lack of inhalation data for the various receptors. Therefore, the inclusion of the vapor intrusion scenario will only apply to the human health risk assessment.*

LANL Response

20. The assessment of current risk and dose in the investigation report for MDA C is consistent with the assessments in previous reports. To date, investigation reports for all MDAs, including MDAs H, L, and G, have presented risk-screening assessments to evaluate whether the current and reasonably foreseeable future land use conditions present potential unacceptable risks or doses to receptors to determine if remediation is necessary at this stage of the investigation. It is not intended to influence the need or objective of a corrective measures evaluation (CME) for MDA C but rather to address site issues before a CME process is implemented.

    Because no buildings are present on the site and no construction of any buildings is planned in the reasonably foreseeable future, the evaluation of the vapor-intrusion pathway is not warranted in this report. The exposure pathway for pore gas in an industrial scenario where end-use conditions are controlled is incomplete. The risk-screening evaluates current or reasonably foreseeable future conditions and risks so a decision can be made regarding the status of the site. The current and reasonably foreseeable future land use of MDA C is industrial, with restricted access and controls on future construction activities. The screening assessment in the report provides the basis for a decision regarding the status of the site and allows the process to proceed to a CME. Land-use controls currently in place at MDA C require residual contamination remaining at the site to be considered in determining whether a structure could be constructed at the site. Depending upon the results of the CME, the selected remedy for MDA C, and any changes in land use as a result of the implemented remedy, the potential for a vapor-intrusion pathway may need to be reevaluated.

    In addition, EPA's draft guidance (EPA 2002, 094114, p. 2) for evaluating subsurface vapor intrusion specifically states the approaches are primarily designed to ensure protection in residential settings. The possible adjustment for other land uses, in this case industrial, is also discussed in the document (EPA 2002, 094114, p. 3). The draft guidance indicates the Occupational Safety and Health Administration generally takes the lead in addressing occupational exposures (EPA 2002, 094114, p. 3). The document further states that workers generally understand the workplace regulations (and monitoring, as needed) that already apply and are provided for their protection. In general, therefore, EPA does not expect this guidance to be used for settings that are primarily occupational.

    Appendix G, section G-3.1, has been revised as follows to explain the rationale for excluding the exposure pathway for pore gas at MDA C:

    "The primary exposure for human receptors is from surface soil and subsurface soil/tuff that may be brought to the surface through intrusive activities. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (approximately 1300 ft below ground surface [bgs]) at the site. Human receptors may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, dermal contact, and external irradiation pathways. The exposure pathway for pore gas is incomplete because no buildings are present or planned to be constructed at the site. The current and reasonably foreseeable future land use for MDA C is industrial, with access restricted by a fence and land-use controls currently in place to remain. The conceptual site model for human receptors at MDA C is shown in Figure G-3.1-1."

NMED Comment

21. ***Plate 6, Organic Chemicals Detected in Tuff and Pore-Gas in Phase II Boreholes:***

    NMED Comment: *The "Notes" section beneath the legend on each Plate indicates that the data qualifier "NA" represents a pore-gas sample rather than a tuff sample. On Plate 6 there are instances* *where a pore-gas sample is misrepresented as a tuff sample. For example, borehole 50-603470, the 351-foot interval is correctly labeled with a “NA” because it is a pore-gas sample; however, the 650-foot to 653-foot interval is not labeled as being a pore-gas sample (no “NA”). It is labeled with the “TT” (Tschicoma Formation), incorrectly indicating that this is a tuff sample. The Permittees must revise Plate 6 to resolve all such discrepancies.*

LANL Response

21. The sample from the 650–653-ft bgs interval (MD50-08-7441) is a tuff sample, while the sample collected at 650 ft bgs (MD50-08-7461) is a pore-gas sample. The label of “TT” for sample MD50-08-7441 at 650–653 ft interval is correct. However, Plate 6 incorrectly placed the VOC data for pore-gas sample MD50-08-7461 under the tuff sample MD50-08-7441 and omitted the label for sample MD50-08-7461. Plate 6 has been revised to show the correct sample IDs and labels.

REFERENCES

EPA (U.S. Environmental Protection Agency), November 2002. “OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance),” EPA530-D-02-004, Washington, D.C. (EPA 2002, 094114)

LANL (Los Alamos National Laboratory), September 22, 1998. “Inorganic and Radionuclide Background Data for Soils, Canyon Sediments, and Bandelier Tuff at Los Alamos National Laboratory,” Los Alamos National Laboratory document LA-UR-98-4847, Los Alamos, New Mexico. (LANL 1998, 059730)

LANL (Los Alamos National Laboratory), October 2005. “Investigation Work Plan for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50, Revision 2,” Los Alamos National Laboratory document LA-UR-05-7363, Los Alamos, New Mexico. (LANL 2005, 091493)

LANL (Los Alamos National Laboratory), December 2006. “Investigation Report for Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50,” Los Alamos National Laboratory document LA-UR-06-8096, Los Alamos, New Mexico. (LANL 2006, 094688)

LANL (Los Alamos National Laboratory), July 2008. “Pilot Test Investigation Report for Evaluating Vapor-Sampling Systems at Material Disposal Area C, Solid Waste Management Unit 50-009, at Technical Area 50,” Los Alamos National Laboratory document LA-UR-08-4814, Los Alamos, New Mexico. (LANL 2008, 102651)

NMED (New Mexico Environment Department), April 6, 2005. “Approval with Modifications, 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 D. Gregory (DOE LASO) and G.P. Nanos (LANL Director) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2005, 090165)

Table 1
Concentrations of Inorganic Chemicals in Phase I and Phase II Samples at MDA C Boreholes 50-24769/50-603470, 50-24821/50-603468, and 50-24822

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Iron	Lead	Magnesium	Manganese	Nickel	Nitrate	Perchlorate	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
Soil BV[a]				29200	0.83	8.17	295	1.83	0.4	6120	19.3	8.64	14.7	0.5	21500	22.3	4610	671	15.4	na[b]	na	3460	1.52	1	915	39.6	48.8
Qbt 2, Qbt 3 BV[a]				7340	0.5	2.79	46	1.21	1.63	2200	7.14	3.14	4.66	0.5	14500	11.2	1690	482	6.58	na	na	3500	0.3	1	2770	17	63.5
Qbt 1v BV[a]				8170	0.5	1.81	26.5	1.7	0.4	3700	2.24	1.78	3.26	0.5	9900	18.4	780	408	2	na	na	6670	0.3	1	6330	4.48	84.6
Qbt 1g, Qct, Qbo BV[a]				3560	0.5	0.56	25.7	1.44	0.4	1900	2.6	8.89	3.96	0.5	3700	13.5	739	189	2	na	na	2390	0.3	1	4350	4.59	40
TT BV[a]				na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
MD50-06-64699	50-24769	18.1-20	QBT3	2190	0.414 (U)	1.93	16.4	0.358	0.506 (U)[c]	359	2.32	0.452	1.63	0.26 (U)	4620	4.52	409	209	1.9	6.99	0.00085	394	9.09	0.207 (U)	156	2.58	28.2
MD50-06-64700	50-24769	37.5-39.9	QBT3	981	0.404 (U)	1.63	10.9	0.189	0.5 (U)	306	3.14	0.264	0.996	0.26 (U)	4190	3.85	103	206	0.571	2.9	0.000893	467	8.4	0.202 (U)	482	1.01	21.2
MD50-06-64682	50-24769	97.5-99.3	QBT3	25400	0.412 (U)	4.76	87.2	0.292	0.242	3970	14.8	3.63	9.25	0.26 (U)	15600	12.6	4000	205	0.369	1.02	0.00118	2640	1.49 (U)	0.206 (UJ)	600	27.1	41
MD50-06-64683	50-24769	122.5-124.5	QBT2	2640	0.402 (U)	1.6	26.9	1.06	0.118	510	2.58	0.729	1.47	0.26 (U)	6410	2.03	409	286	1.21	1.22	0.00174	361	1.5 (U)	0.201 (UJ)	119	3.97	42.5
MD50-06-64701	50-24769	147.9-149.8	QBT2	764	0.396 (U)	1.53	16.1	0.37	0.499 (U)	226	2.73	0.447	0.862	0.25 (U)	4880	2.83	132	279	0.653	0.979 (U)	0.00202 (U)	277	1.5 (U)	0.198 (UJ)	187	2.55	37.4
MD50-08-7442	50-24769	198-200	QBT1V	333	0.394 (U)	0.715	13.8	0.471	0.494 (U)	197	0.866	0.849	1.68	0.254	6920	4.22	108	329	0.419	1.01 (U)	0.00203 (U)	159	5.26	0.197 (U)	130	2.41	51.8
MD50-08-7443	50-24769	248-250	QBT1G	3080	0.433 (U)	1.18	42.2	1.3	0.526 (U)	396	0.746	0.445	1.36	0.261	6550	6.71	198	233	0.593	1.08 (U)	0.00219 (U)	498	4.6	0.0806	276	1.87	38
MD50-08-7444	50-24769	298-300	QBT1G	1260	0.433 (U)	0.649	4.22	0.467	0.526 (U)	325	0.303	0.526	0.905	0.265	1950	3.35	107	99.1	0.179	1.07 (U)	0.00218 (U)	308	1.39	0.216 (U)	246	0.755	8.88
MD50-08-7445	50-603470	360-362	QCT	1770	0.422 (U)	15.7	17.5	0.254	0.523	778	7.79	1.37	2.06	0.256	4970	5.52	663	132	2.41	1.05	0.00215	413	1.57	0.211	239	5.64	19.8
MD50-08-7446	50-603470	400-402	QBO	1120	0.424 (U)	1.58	14.5	0.635	0.527	587	6.37	0.507	1.33	0.264	4850	3.06	421	124	0.851	1.08	0.00215	372	1.38	0.212	355	2.11	13.1
MD50-08-7447	50-603470	450-452.5	QBO	2100	0.426 (U)	1.61	25.5	0.454	0.535	906	6.34	0.756	3.24	0.266	4780	4.28	592	140	1.83	1.05	0.00219	508	1.61	0.213	406	3.28	10.4
MD50-08-7448	50-603470	500-502	QBO	1610	0.44 (U)	7.91	26.2	0.316	0.527	911	3.59	0.644	2.91	0.276	3720	3.78	763	122	2.01	0.715	0.00221	497	1.58	0.22	334	3.81	13.1
MD50-08-7449	50-603470	550.5-552.5	QBO	2690	0.438 (U)	8.15	24.9	0.263	0.543	1820	6.78	1.57	5.5	0.257	5310	6.71	1330	153	3.67	1.1	0.0022	664	1.63	0.219	384	8.12	12.4
MD50-08-7450	50-603470	600-602	QBO	1620	0.425 (U)	7.99	14.2	0.22	0.533	790	2.82	0.531	2.64	0.27	2740	3.48	565	69.7	1.19	1.1	0.00221	423	1.6	0.213	421	3.39	9.53
MD50-08-7441	50-603470	650-653	TT	17200	0.427 (U)	12.6	151	0.749	0.333	22000	25.4	9.13	14.7	0.254	19300	7.46	6590	366	40.2	1.11	0.00222	4250	3.69	0.124	331	28.8	34.8
RE50-05-61456	50-24821	18.6-20	QBT3	643	0.413 (U)	1.16	9.13	0.224	0.514 (U)	233	1.68	0.514 (U)	0.835	0.246 (U)	3040	0.634	133	169	1.23	0.692	0.00207 (U)	233	1.54 (U)	0.207 (U)	141	0.854	26.4
RE50-05-61457	50-24821	48.6-50	QBT3	1060	0.41 (U)	1.04	10.6	0.233	0.517 (U)	229	2.89	0.517 (U)	1.25	0.243 (U)	5160	1.78	124	154	1.18	0.685	0.00208 (U)	523	1.55 (U)	0.205 (U)	453	1.39	23.4
RE50-05-61458	50-24821	98.4-100	QBT3	772	0.423 (U)	0.675	8.1	0.339	0.528 (U)	374	0.859	0.528 (U)	0.632	0.251 (U)	2330	0.455	79.5	163	0.432	1.06 (U)	0.00213 (U)	398	1.58 (U)	0.212 (U)	382	0.606	13.7
RE50-05-61460	50-24821	137.5-140	QBT2	5970	0.423 (U)	4.21	15.3	1.2	0.533 (U)	734	14.9	1.65	3.15	0.252 (U)	6920	7.43	832	333	2.12	0.862	0.00216 (U)	666	1.6 (U)	0.0785	174	4.31	36.1
RE50-05-61459	50-24821	157.5-160	QBT2	2270	0.431 (U)	1.58	18	0.855	0.537 (U)	535	3.69	1.07	1.49	0.253 (U)	2870	2.64	215	299	1.24	1.07	0.00216 (U)	714	1.61 (U)	0.0903	550	2.15	23.6
RE50-05-61461	50-24821	248.6-250	QBT1G	929	0.415 (U)	1.56 (U)	11.3	0.485	0.519 (U)	579	3.8	0.519 (U)	0.664	0.241 (U)	5260	2.72	128	264	0.738	0.708	0.00062	369	1.56 (U)	0.208 (U)	318	0.836	19.3
MD50-08-7888	50-603468	300-301.5	QBT1G	849	0.422	0.674	19.2	0.318	0.541 (U)	505	2.69	0.541 (U)	1.28	0.253 (U)	3100	48.8	187	-[d]	0.334	1.1 (U)	0.0022 (U)	192	1.23	0.211 (U)	282	0.997	68.7 (J-)
MD50-08-7889	50-603468	350-351	QCT	1760	0.419	1.52	12.4	0.342	0.52 (U)	746	5.78	0.754	2.82	0.252 (U)	4660	2.77	584	-	2.64	1.06 (U)	0.00212 (U)	436	2.46	0.218	181	5.38	16.3
MD50-08-7890	50-603468	400-401.5	QBO	756	0.419	1.56 (U)	9.94	0.5	0.519 (U)	443	2.2	0.228	0.95	0.253 (U)	3540	1.59	186	130	0.587	1.08 (U)	0.00216 (U)	254	1.56 (U)	0.21 (U)	309	1.24	7.98
MD50-08-7891	50-603468	450-451.5	QBO	2150	0.435	1.11	29.5	0.451	0.541 (U)	1140	7.57	0.947	3.31	0.273 (U)	4930	5.01	675	153	1.47	1.09 (U)	0.00219 (U)	564	1.94	–	364	4.18	9.55
RE50-05-61474	50-24822	18.6-20	QBT3	585	0.398 (U)	1.13	2.95	0.125	0.5 (U)	232	2.52	0.5 (U)	2.16	0.238 (U)	2940	17.8	178	253	0.311	1.01 (U)	0.000658	214	1.5 (U)	0.199 (U)	146	1.35	16.1
RE50-05-61475	50-24822	47.5-49.1	QBT3	5430	0.408 (U)	2.56	26.8	1.36	0.511 (U)	730	3.01	0.595 (U)	4.48	0.258 (U)	4470	20.3	767	199	2.74	1.03 (U)	0.00504	611	1.53 (U)	0.0652	114	6.36	31.5
RE50-05-61476	50-24822	98.6-100	QBT3	344	0.151	1.98	12.5	0.63	0.502 (U)	307	0.995 (U)	0.212 (U)	1.27	0.247 (U)	2710	50.9	83.3	271	0.342	1.01 (U)	0.00202 (U)	135	1.51 (U)	0.201 (U)	129	1.65	27.7
RE50-05-61477	50-24822	137.5-139.2	QBT2	2420	0.416 (U)	1.84	23	0.868	0.525 (U)	424	2.64	0.566	1.7	0.251 (U)	3730	3.74	270	306	1.32	0.726	0.00211 (U)	272	1.58 (U)	0.0732	97	2.55	42.3
RE50-05-61478	50-24822	198.5-200	QBT1V	576	0.407 (U)	0.943	11.4	0.602	0.499 (U)	233	1.69	0.499	1.22	0.242 (U)	4960	5.04	131	303	0.63	1.02 (U)	0.00203 (U)	147	1.5 (U)	0.203 (U)	119	1.3	40.1

Table 1 (continued)

Sample ID	Location ID	Depth (ft)	Media	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Cyanide (Total)	Iron	Lead	Magnesium	Manganese	Nickel	Nitrate	Perchlorate	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
Soil BV[a]				29200	0.83	8.17	295	1.83	0.4	6120	19.3	8.64	14.7	0.5	21500	22.3	4610	671	15.4	na[b]	na	3460	1.52	1	915	39.6	48.8
Qbt 2, Qbt 3 BV[a]				7340	0.5	2.79	46	1.21	1.63	2200	7.14	3.14	4.66	0.5	14500	11.2	1690	482	6.58	na	na	3500	0.3	1	2770	17	63.5
Qbt 1v BV[a]				8170	0.5	1.81	26.5	1.7	0.4	3700	2.24	1.78	3.26	0.5	9900	18.4	780	408	2	na	na	6670	0.3	1	6330	4.48	84.6
Qbt 1g, Qct, Qbo BV[a]				3560	0.5	0.56	25.7	1.44	0.4	1900	2.6	8.89	3.96	0.5	3700	13.5	739	189	2	na	na	2390	0.3	1	4350	4.59	40
TT BV[a]				na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
RE50-05-61479	50-24822	248.7-250	QBT1G	2660	0.41 (U)	0.643 (U)	20.8	1.24	0.519 (U)	271	2.76	0.519 (U)	1.2	0.253 (U)	4520	6.3	144	257	0.657	1.04 (U)	0.00209 (U)	426	1.56 (U)	0.0557	368	1.15	32.4
MD50-08-7940	50-24822	300-302	QBT1G	679	1.08 (U)	0.818	2.83	0.379	0.54 (U)	207	1.1	0.54 (U)	0.972	0.268 (U)	2390	1.89	73.7	98	0.283	1.1 (J-)	0.00217 (U)	277	1.07 (U)	0.54 (U)	227	0.582	9.5
MD50-08-7941	50-24822	350-352	QBT1G	1540	0.444	1.11	14.5	0.195	0.546 (U)	812	3.43	0.736	1.7	0.108 (U)	2830	4.5	443	82.6	1.86	1.15 (J-)	0.00222 (U)	423	1.11 (U)	0.546 (U)	431	3.25	12.8
MD50-08-7942	50-24822	400-402	QBO	1390	0.676 (U)	1.43	13.1	0.412	0.519 (U)	644	6.36	0.387	2.16	0.268 (U)	4280	3.12	325	117	1.15	1.04 (U)	0.00214 (U)	351	1.04 (U)	0.121	450	2.09	10.3
MD50-08-7943	50-24822	450-452.5	QBO	1940	0.487	1.72	16.5	0.454	0.534 (U)	898	7.01	0.569	2.99	0.269 (U)	4330	2.76	566	99.7	2.05	1.08 (U)	0.0022 (U)	457	1.09 (UJ)	0.534 (U)	343	3.59	6.63

Note: Results are in mg/kg. Bolded values denote concentrations above BV or detected with no BVs.

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

[b] na = Not available.

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

[d] – = Not detected or not detected above BV.

Table 2

EPA Method 3050 Leach Results of the Cerros del Rio Basalt Compared with the Tschicoma Dacite at MDA C Borehole 50-603470

Unit	Antimony	Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Mercury	Magnesium	Manganese	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Unaltered basalt flow	4.87	1320	0.98	11	0.047	0.49	2930	3.7	16	21	22100	0.97	0.01	8640	302	25	83.1	0.98	0.57	477	0.197	37	26
Unaltered basalt flow	4.95	1380	0.97	6.7	0.128	0.5	5490	2.7	17	42	26500	0.92	0.01	10800	439	39	56.1	0.97	0.73	462	0.193	43	35
Basalt perched zone	1.01	12200	1.48	133	1.53	0.51	6940	10	24	66	30300	6.1	0.012	18600	739	132	1170	0.98	0.94	832	0.101	39	58
Fracture, basalt perched zone	0.97	911	0.95	13	0.386	0.48	3820	1.9	8.4	29	16200	1	0.011	7330	271	36	60.8	0.95	0.42	317	0.191	16	22
Altered basalt flow top	5.02	3200	0.56	90	0.341	0.5	4190	7.8	17	22	24500	5.05	0.011	11000	453	39	368	0.99	0.62	367	0.063	53	37
Unaltered basalt flow	4.96	1460	0.99	43	0.187	0.5	2890	5	24	26	28700	0.67	0.011	11800	401	41	132	0.99	0.53	402	0.198	59	41
Unaltered basalt flow	1	1620	0.96	6.1	0.069	0.5	4110	5.3	12	28	19800	1	0.011	8930	309	34	62	0.96	0.46	492	0.191	31	24
Unaltered basalt flow	0.96	2390	0.98	24	0.081	0.48	4140	5.9	12	36	20200	0.42	0.012	9390	376	31	104	0.98	0.52	748	0.195	32	26
Unaltered basalt flow	0.98	1670	0.34	12	0.198	0.49	5190	4.6	11	35	21000	1.06	0.012	9010	333	31	105	0.95	0.69	688	0.084	35	27
Unaltered basalt flow	0.95	2980	0.33	14	0.569	0.48	5410	13	10	31	18900	0.95	0.01	9750	329	48	301	0.96	0.24	2420	0.081	26	18
Dacite at MDA C	—[a]	17200	12.6	151	0.749	0.333	22000	25.4	9.13	14.7	19300	7.46	NA[b]	6590	366	40.2	4250	3.69	0.124	331	NA	28.8	34.8

Note: Results are in mg/kg. Elements elevated in the dacite relative to the basalt are highlighted in red.

[a] — = Not detected.

[b] NA = Analysis not requested.