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

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EXECUTIVE SUMMARY

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

The MDA L site investigation results are the basis for identifying corrective measure alternatives that will be effective in reducing potential future impacts to human health and the environment. The approved MDA L investigation report and addendum describe the nature and extent of contaminant releases at MDA L and demonstrate that contaminant releases from MDA L pose no present-day potential unacceptable risks to human and ecological receptors. However, a CME is required to ensure that potential risks from future releases from the site are also acceptable.

The objectives of this CME are to (1) provide stakeholders and regulators with an evaluation of corrective measure alternatives that identifies alternatives expected to be protective of human health and the environment, (2) describe how alternatives will be monitored to ensure the effectiveness of the corrective measure implemented, and (3) identify the recommended corrective measure to the regulators. To meet these objectives, the long-term performance of various containment and excavation alternatives was assessed in accordance with U.S. Environmental Protection Agency, U.S. Department of Energy, and New Mexico Environment Department (NMED) risk and dose assessment guidances.

Technologies were first screened for applicability to MDA L and then combined into corrective measure alternatives. Potential technologies were screened to eliminate any technology that (1) did not meet the threshold criteria defined in Section VII.D.4.a of the Compliance Order on Consent (the Consent Order), (2) is not feasible to implement, (3) is unlikely to perform satisfactorily or reliably, or (4) does not achieve the corrective action objectives within a reasonable time frame. The technology screening included a review of site data to identify conditions that limit or promote the use of certain technologies; waste characteristics that limit the effectiveness or feasibility of technologies; and the level of technology development, performance record and inherent construction, and operation and maintenance requirements for each technology considered. The general types of technologies evaluated in this report that may be appropriate for MDA L include containment, in situ treatment, source removal, and ex situ treatment.

Ten preliminary corrective measure alternatives were developed and presented in the MDA L CME plan before the technologies were evaluated. Four corrective measure alternatives were developed for MDA L by combining the best elements of the preliminary alternatives presented in the CME plan with the results of the technology screening process. Each corrective measure alternative was evaluated based on overall site conditions at MDA L, shaft, pit, and impoundment configuration, environmental setting and waste inventory.

The four corrective measure alternatives evaluated during the CME include (1) upgrade of the existing cover, soil vapor extraction (SVE), and monitoring and maintenance; (2) engineered evapotranspiration (ET) cover, SVE, and monitoring and maintenance; (3) partial excavation, engineered ET cover, SVE, and monitoring and maintenance; and (4) complete waste-source excavation, off-site waste disposal, SVE, and monitoring and maintenance. The alternatives assume that all existing surface structures, including concrete foundations and asphalt, will be removed before the selected remedy is implemented.

The corrective measure alternatives that satisfy the screening criteria were evaluated against balancing criteria specified in section VII.D.4.b of the Consent Order and evaluation criteria contained in

Section XI.F.10 of the Consent Order. The results of the screening process were used to select and justify the corrective measure alternative recommended for MDA L. The recommended corrective measure alternative is construction of an engineered ET cover with SVE. This recommended corrective measure alternative best satisfies Consent Order requirements and NMED alternative cover guidance. Operation of SVE units remediates the vapor phase volatile organic chemical plumes.

Should the recommended alternative be selected by NMED, the design of the engineered ET cover will be optimized during the design phase and the design of the SVE system will be based upon the results of the SVE pilot study conducted in 2006.

CONTENTS

Figures

Tables

Appendixes

1.0 INTRODUCTION

This report documents the corrective measures evaluation (CME) conducted for Material Disposal Area (MDA) L, Solid Waste Management Unit (SWMU) 54-006, at Los Alamos National Laboratory (LANL or the Laboratory). MDA L, located within Technical Area (TA) 54, is situated in the east-central portion of the Laboratory on Mesita del Buey (Figures 1.0-1 and 1.0-2). The site contains potential hazardous waste or constituents subject to provisions of the Resource Conservation and Recovery Act (RCRA) and the New Mexico Hazardous Waste Act, as described in the March 1, 2005, Compliance Order on Consent (the Consent Order). It also contains radioactive wastes managed by the U.S. Department of Energy (DOE) pursuant to the Atomic Energy Act of 1954. Although the scope of the CME required by the Consent Order is limited to corrective actions for releases of nonradioactive contaminants, this CME report incorporates all the requirements affecting closure of MDA L into a single document. Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the New Mexico Environment Department (NMED) in accordance with DOE policy.

MDA L is defined as the subsurface disposal units contained within SWMU 54-006, interspersed across Area L (Figure 1.0-2) that are subject to corrective actions under the Consent Order. This CME also addresses the RCRA disposal units, which are referred to as the Area L landfill. The CME does not address Shafts 36 and 37, which are the former lead-stringer storage shafts undergoing RCRA closure.

The pit, impoundments, and shafts at Area L are constructed in the Tshirege Member of the Bandelier Tuff (Qbt), a consolidated tuff unit. The subsurface disposal units range in depth from 10 ft to 65 ft below the original ground surface and are in two units of the Tshirege Member of the Bandelier Tuff: Qbt 2 and Qbt 1vc. The regional aquifer is estimated to be approximately 930 ft below ground surface (bgs), based on data from other wells at the Laboratory and the predictions of the hydrogeologic conceptual model for the Pajarito Plateau (LANL 1998, 059599, pp. 4-59–4-60).

The disposal units at Area L are covered with asphalt to house ongoing waste-management activities conducted at Area L. Operations in the north-half of Area L will cease and structures will be decontaminated and decommissioned (D&D) before the closure of MDA L. Closure of these active units will incorporate the requirements of DOE Order 435.1 and any closure requirements identified in the Laboratory's Hazardous Waste Facility Permit, currently issued in draft form. Table 1.0-1 identifies the individual units at Area L, their regulatory category, and the basis for their closure.

The CME uses recent and historical characterization data as a basis for defining the nature and extent of contamination at MDA L. The present-day risk assessment for MDA L, presented in the MDA L investigation report (LANL 2006, 091888, Appendix G), concluded that surface and subsurface contamination at the site does not currently pose an unacceptable risk to human health or the environment. The CME identifies and evaluates corrective measure alternatives that address potential unacceptable future risk/dose from MDA L and recommends implementing one or more alternatives for implementation. Several of the alternatives considered include a monitoring component to confirm that the corrective measure alternative is effective. Actions to be taken if the corrective measure alternative is ineffective are included in the description of the recommended alternative.

This CME addresses the items in Section VII.D.2 of the Consent Order and complies with the outline required in Section XI.F of the Consent Order. The CME also involves the public in corrective measure alternative selection and implementation to ensure that the proposed remedy addresses public concerns about the site. The Public Involvement Plan (Appendix B) includes public meetings to provide data and discuss the alternatives evaluated in the CME.

The Consent Order schedule for MDA L requires the following activities and associated deadlines, which may be adjusted based on actual document approval dates:

1. submit investigation reports (submitted on September 2005, March 2006, and May 2007 and approved on July 18, 2007);
2. submit the CME report (to be submitted by January 18, 2008);
3. submit the corrective measure implementation (CMI) plan;
4. complete the remedy by October 3, 2010; and
5. submit a remedy completion report within 90 d after completion of the remedy.

This report is organized according to the content requirements for a CME stipulated in Section XI.F of the Consent Order. Table 1.0-2 provides a summary of the Consent Order requirements and where they are addressed in the CME. Following this introduction, section 2 provides background information, including the site history, SWMU description, waste inventory information, and a summary of previous investigations. Section 3 describes surface and subsurface site conditions. The conceptual site model (CSM), including source, pathway, and receptor information, is summarized in section 4. Section 5 discusses the regulatory criteria, including applicable cleanup standards, risk-based screening levels, and risk-based cleanup goals for each pertinent medium at the site. It also describes how criteria from the Consent Order were applied for the screening, evaluation, and selection of the preferred corrective measure alternative. Corrective measure technologies and their screening to determine technologies applicable to the site are detailed in section 6, and the corrective measure alternatives are identified and described in section 7. Section 8 provides an evaluation of corrective measure alternatives, with the selection of the preferred corrective measure alternative presented in section 9. The design criteria to meet cleanup objectives are presented in section 10, the proposed schedule in section 11, and references and map data sources in section 12.

2.0 BACKGROUND INFORMATION

MDA L is situated in the east-central portion of the Laboratory on Mesita del Buey (Figure 1.0-1), with Pajarito Canyon to the south and Cañada del Buey to the north. The subsurface disposal units of MDA L, also referred to as SWMU 54-006, along with the Area L landfill units, are interspersed across the northern half of Area L, a 2.5-acre fenced site currently used for RCRA-permitted hazardous waste storage and for permitted and interim status storage of mixed wastes. MDA L consists of 1 inactive subsurface disposal pit (Pit A), 1 inactive subsurface treatment and disposal impoundment (Impoundment C), and 12 inactive disposal shafts (Shafts 2–12 and 18). The Area L landfill consists of 2 inactive surface impoundments (B and D) and 22 inactive disposal shafts (Shafts 1, 13–17, and 19–34). The Area L landfill units received hazardous wastes after the effective date of RCRA and are hazardous waste disposal units subject to RCRA closure requirements rather than Consent Order requirements. The inactive subsurface disposal units and the existing surface structures used for current waste management activities are shown in Figure 2.0-1. Because the Area L landfill units are situated among SWMUs, releases have occurred, and both the landfill units and SWMUs are likely to have contributed to the releases, the closure of the landfill units will be coordinated with corrective action for the SWMUs in accordance with 40 Code of Federal Regulations (CFR) 264.110(c). Specifically, closure requirements for the landfill units will be established through the CME process for MDA L (SWMU 54-006).

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

2.1 Site History

Area L operated from the early 1960s to 1986 as the designated disposal area for nonradiological liquid chemical wastes, including containerized and uncontainerized liquid wastes; bulk quantities of treated aqueous waste; batch-treated salt solutions and electroplating wastes, including precipitated heavy metals; and small-batch quantities of treated lithium hydride. Laboratory drawings AB113 (LANL 1993, 076052) and ENG-C-45259 (LANL 1987, 025606) identify the location and the dimensions of the pit, impoundments, and shafts at Area L.

The operational history of Area L is summarized in the approved RCRA facility investigation (RFI) work plan for Operable Unit (OU) 1148 (LANL 1992, 007669, pp. 5-139 to 5-178) and in the historical investigation report of the approved work plan for MDA L (LANL 2004, 087624, Appendix B, pp. B-1–B-4; NMED 2004, 089306).

At Area L, 1 pit, 3 impoundments and 34 shafts were excavated into the overlying soil and unit 2 of the Tshirege Member of the Bandelier Tuff. The pit, impoundments, and shafts were unlined. Summaries of operational periods for each pit, impoundment, and shaft are presented in Tables B-1 through B-3 of the approved investigation work plan (LANL 2004, 087624, Appendix B, pp. B-33–B-34; NMED 2004, 089306).

Pit A was excavated into Qbt with three near-vertical walls on the west, north, and south sides. A ramp entrance leading down to the flat bottom was excavated on the east side. Pit A was filled with waste to within 3 ft of the surface and then decommissioned and covered with crushed consolidated tuff. Impoundments B, C, and D were excavated into native tuff with near-vertical walls on the east and west sides. Ramps leading down to the flat bottom were excavated on the north and south sides, and the waste was covered with crushed, consolidated tuff after the impoundments were decommissioned.

The 34 disposal shafts were dry-drilled directly into Qbt. The shafts range from 3 ft to 8 ft in diameter and from 15 ft to 65 ft in depth. To fill cracks and joints, 3 ft of crushed tuff was placed at the bottom of each shaft. When in use, the shafts were covered with a metal cap that could be opened or removed, depending on design, to place the wastes. After it was filled to within approximately 3 ft of the surface, the area below the steel plate was sealed with a 3-ft concrete plug (LANL 1992, 007669, p. 5-108).

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

Surface water runoff from Area L is controlled and diverted to an outfall into Cañada del Buey at the northeast corner of the site (Figure 2.1-1).

2.2 Waste Unit Categorization by Regulatory Driver

The waste management units at Area L are placed into four categories based on their regulatory status. Some of the inactive subsurface units are subject to corrective action requirements under the Consent

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

2.2.1 RCRA Disposal Units

The RCRA disposal units in Area L (referred to as the Area L landfill in the closure/postclosure plan for TA-54 [LANL 2002, 091327]) include Shafts 1, 13–17, 19–34, and Impoundments B and D. These inactive subsurface units were used to dispose of hazardous wastes after the RCRA hazardous waste management regulations went into effect. They are subject to RCRA-closure and postclosure care requirements under 40 CFR 265 Subparts G and N.

In accordance with the draft Hazardous Waste Facility Permit issued by NMED on August 27, 2007, RCRA closure of the Area L landfill units will be coordinated with the corrective action for MDA L being conducted under the Consent Order. Pursuant to 40 CFR 264.110(c), the landfill units shall be closed under alternative closure requirements established under the Consent Order rather than the closure requirements of 40 CFR 264 Subparts G and N. The alternative closure requirements for these landfill units shall be established using the corrective measure evaluation process for MDA L contained in Section VII.D of the Consent Order. Upon NMED’s selection of the remedy for MDA L, LANL will prepare and submit a CMI work plan, which will fulfill the requirements for a closure plan and postclosure plan for the landfill units specified in 40 CFR Sections 264.112 and 264.118.

2.2.2 Corrective Action Disposal Units

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

2.2.3 Aboveground CSU

The aboveground CSU in Area L includes structures 54-215, 54-216, 54-31, 54-32, 54-35, 54-36, 54-58, 54-68, 54-69, 54-70, 54-39, and the paved area. This CSU is used to store hazardous, mixed, and/or other chemical wastes (e.g., polychlorinated biphenyl [PCB]) and was included in the 2003 RCRA permit renewal application for TA-54 (LANL 2003, 091318). It is located on the surface above the subsurface units that will be managed under the Consent Order. The affected CSU will be closed under RCRA-permit or interim-status requirements (whichever is applicable at the time before any corrective actions are conducted at MDA L). The impact to existing operations and the closure schedule of the CSUs caused by implementing the selected remedy is not known at present, but it is reasonable to expect that only a portion of the existing operations may require closure to allow for remedy implementation as the chosen remedy will only apply to the northern half of Area L. The southern part of Area L will continue as an active storage unit.

2.2.4 Belowground CSU—Lead Stringers

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

2.3 Area L Waste Inventory

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

2.4 Summary of Previous Investigations

MDA L has been the subject of two site investigations. The first investigation, the Phase I RFI, was conducted at the site between 1993 and 1995. A Consent Order site investigation was concluded in 2007. The two investigations are summarized in the following sections and in the investigation report (LANL 2005, 092591) and addendum to the investigation report (LANL 2007, 096409). NMED approved the investigation report in 2007 (NMED 2007, 098409). Relevant data from these investigations are included in the sections that follow, as appropriate. Because of the proximity of the Area L landfill units, they were included in the MDA L investigations.

The Investigation Report concluded that the contaminants in the subsurface of MDA L pose no potential unacceptable present-day risk to human health or the environment. However, a CME was recommended to ensure future releases from MDA L do not pose a potential unacceptable risk/dose to receptors.

In addition, a pilot study was conducted in 2006 to determine the effectiveness of SVE for remediation of the subsurface vapor-phase volatile organic compound (VOC) plume (LANL 2006, 094152, and Appendix F).

2.4.1 Phase I RFI

Phase I RFI channel sediment sampling was conducted at MDA L in July 1994. Eight locations within the outfall to Cañada del Buey were selected for sampling to determine if contaminants had migrated from MDA L (Figure 2.4-1). The most likely depositional areas (e.g., low areas behind obstructions) for the channel were determined by an on-site geomorphic survey. These locations included areas with coarse sediment deposition on the upper slope and areas with finer sediment deposition on the lower slope. The sample depths ranged from 0 to 4 in. (0 to 10.16 cm) or 0 to 8 in. (0 to 20.32 cm). Eight sediment samples were collected and field-screened for gross alpha, beta, and gamma radiation. The sample with the highest gross alpha and gross beta, the sample with the highest gross gamma, and two other samples (for a total of four) selected at random were submitted to an off-site contract laboratory for analysis of target analyte list (TAL) metals, PCBs, pesticides, radionuclides (by alpha and gamma spectroscopy), tritium, and strontium-90 (LANL 1996, 054462, pp. 57, A2-1–A2-2).

No inorganic chemicals were detected at concentrations above the sediment background values (BVs) in any of the channel sediment samples. Although cadmium, selenium, and silver were not detected, the detection limits (DLs) for these inorganic chemicals exceeded their respective BVs.

Detected concentrations of radionuclides were compared with the sediment BVs or the sediment fallout values (FVs), depending on whether the radionuclide is naturally occurring or a fallout radionuclide (LANL 1998, 059730, pp. 25-30) (Table 2.4-1). Plutonium-238 was the only radionuclide detected in sediment samples above its respective BV or FV. The highest detected concentration for plutonium-238 (0.011 pCi/g [0.41 Bq/g]) exceeded the associated sediment FV of 0.006 pCi/g (0.2 mBq/g).

The pesticide methoxychlor[4,4'-] was detected in two samples at concentrations of 0.028 mg/kg and 0.063 mg/kg, approximately 1 to 3 times the estimated quantitation limit (EQL) (0.02 mg/kg). No other organic chemicals were detected in the sediment samples (Figure 2.4-2).

From September 9, 1993, to May 8, 1995, during the Phase I RFI, 7 vertical boreholes and 11 angled boreholes were advanced at MDA L (Figure 2.4-3). A total of 184 core samples were collected from these boreholes. Not all samples were analyzed for the same suites, but in general they were analyzed for TAL metals, pesticides, PCBs, semivolatile organic compounds (SVOCs), VOCs, cyanide, pesticides, and radionuclides (americium-241, cesium-137, plutonium and uranium isotopes, and tritium).

Samples from eight boreholes in the vicinity of the disposal shafts, impoundments, and pit were submitted for inorganic chemical analyses. The data review indicated that aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, uranium, vanadium, and zinc were above BVs (Table 2.4-2).

Core samples from seven boreholes were analyzed for tritium; five of these samples were analyzed for americium-241, cesium-137, and plutonium and uranium isotopes. Americium-241, cesium-137, and isotopic plutonium are not compared with FVs but are evaluated only on the basis of detection. Tritium was the only radionuclide identified (Figure 2.4-4, Table 2.4-3).

All 184 core samples were analyzed for VOCs. Samples from eight boreholes drilled near the disposal shafts and the pit were analyzed for SVOCs, pesticides, and PCBs. Nineteen VOCs were detected in core samples, most at trace concentrations (i.e., less than or slightly above the EQLs) (Table 2.4-4).

During the summer of 1994, ambient-air samples were collected in SUMMA canisters for VOC analysis on eight days on the northern perimeter of MDA L (Mischler and Anderson 1994, 063525, p. 2-1) and at a background location adjacent to Bandelier National Monument (Figure 2.4-5).

Measured concentrations of selected aromatic and halogenated hydrocarbons at ambient-air sampling locations 4 and 5 (Figure 2.4-5) are presented in Tables 2.4-5a and 2.4-5b. Only organic chemicals that were consistently detected in four or more samples are presented. The data set collected at the Bandelier National Monument (location 3 of Figure 2.4-5) for the analytes listed in these tables is presented in Table 2.4-5c.

Tritium flux was measured at five locations near MDA L during the summer of 1993 and three locations during the summer of 1994. Tritium flux chamber locations are shown in Figure 2.4-6, and the results are presented in Table 2.4-6 (LANL 2004, 087624).

VOC surface flux was measured across MDA L in two surveys conducted in August 1993 and August 1994 (Figure 2.4-6). Details of the investigation are reported in Quadrel Services reports (Quadrel Services 1993, 063868; Quadrel Services 1994, 063869). The results of the surface flux VOC measurement investigations are summarized in a report issued by Trujillo et al. (Trujillo et al. 1998, 058242). In the first survey in August 1993, 70 locations were sampled, and an additional 32 locations were sampled in the August 1994 survey. The majority of the 1993 sample locations were on the mesa top at MDA L, while most of the 1994 sample locations were in the slopes and drainages on the sides of the mesa. The EMFLUX surface flux measurement locations are shown in Figure 2.4-7.

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

The highest surface flux measurements for TCA, PCE, and TCE were found in samples collected in 1993 from the mesa top. Freon 113 and acetone were also detected in many samples at relatively low levels compared with the three main VOCs: TCA, TCE, and PCE. The 1994 EMFLUX data from the hillsides indicate much lower surface flux than those measured on top of the mesa in 1993; the most prevalent VOCs in the 1994 data were also TCA, PCE, and TCE. The compound 1,1-dichloroethene was also detected at a relatively high frequency in the 1994 samples on the north slope of the mesa. Freon 113 was detected frequently in the 1994 data set at low levels in samples collected on the southern slope of the mesa. A plot showing the TCA surface flux results at MDA L is provided in Figure 2.4-8.

2.4.2 Quarterly Sampling of VOCs in Pore Gas, 1985 through 2004

The MDA L investigation work plan (LANL 2004, 087624, pp. B-12–B-13) presents results of quarterly pore gas sampling for VOCs collected from 1985 to 2004. The methods and resulting data quality have changed substantially over the years, therefore pore-gas data before 1996 were used only semiquantitatively in the MDA L HIR. Data collected from 1997 to the present have been subjected to rigorous quality assurance (QA)/quality control (QC) procedures. The pore-gas monitoring data for MDA L indicate that TCA is the primary VOC detected, followed by TCE. VOCs are the primary chemicals of potential concern (COPCs) in the subsurface at MDA L.

Analyses of the pore-gas monitoring data indicate that two sources of the subsurface vapor-phase VOC plume are present. The two unique sources are identified as shaft field 1 (Shafts 1–28) and shaft field 2 (Shafts 29–34) and are referred to as the eastern source area and the western source area, respectively. Both source areas are dominated by the presence of TCA, but the relative compositions and concentrations of lesser compounds differ (Table 2.4-7). Vertically, the plume extends between ground surface and the top of the basalt (approximately 320 ft bgs [97.5 m bgs]); laterally, the plume extends north-south about 1000 ft (305 m) and east-west to the width of the mesa (approximately 450 ft [137 m]). The plume is changing very little over time in area, contaminant concentrations, or composition (1999 to the present). Additionally, Stauffer et al. (2005, 090537, pp. 770–772) indicated that vapor-phase diffusion modeling fits the measured geographic distribution of TCA concentration and that vapor-phase diffusion is the dominant transport mechanism for VOCs in the subsurface media beneath MDA L.

2.4.3 Summary of 2004–2005 Field Investigation

During the 2004–2005 field investigation, seven shallow boreholes and one deep borehole were drilled at MDA L to collect rock and pore-gas samples to determine the nature and extent of contamination at the site (Figure 2.4-9).

One sediment sample (Figure 2.1-1) was collected to confirm the presence of COPCs from the Phase I RFI. During 2005 sampling, no radionuclide or inorganic chemicals were detected at levels that exceeded

BVs or FVs in channel sediments. The only organic chemical detected in channel sediments during this round of sampling was bis(2-ethylhexyl)phthalate (Aroclor-1260) at a concentration of 0.0013 mg/kg (Figure 2.4-10).

Rock samples confirmed the presence of a number of organic chemicals at trace levels beneath the former disposal units (Figure 2.4-11) and were consistent with the results obtained during the Phase I RFI. The primary organic chemicals detected included trace levels of chlorinated volatile organic compound (CVOCs) and several dioxin and furan congeners. The CVOCs present at low concentrations (µg/kg) are the result of multiphase partitioning from the vapor plume. Other VOCs detected beneath MDA L appear to be isolated occurrences and not the result of an ongoing release from the former waste disposal units.

The dioxin and furan congener data for tuff samples collected at MDA L define vertical extent even though one congener was detected in total depth (TD) samples. Seven congeners of dioxins and furans were detected in tuff samples at MDA L. Six of these congeners were only detected in the upper of the two samples collected in each borehole and were not detected in the TD sample. The other detected congener, octachlorodibenzodioxin[1,2,3,4,6,7,8,9-], was detected in TD samples from boreholes A, B, E, and G. These data clearly show a decreasing trend of concentrations with depth, with up to several orders of magnitude difference between samples.

Concentrations of inorganic chemicals detected beneath MDA L in samples collected during the 2004–2005 investigation were indicative of natural variability within the various stratigraphic layers (Figure 2.4-12). In unit Qbt 2, the unit adjacent to the base of the disposal pit and impoundments, the only inorganic chemical detected above BV was barium at 33 ft to 35 ft bgs in borehole E (54-24238). This value was 12% above the Qbt 2 BV for barium and within the range of background concentrations. In Qbt 1v, the unit below Qbt 2 and underlying the disposal shafts, arsenic, barium, beryllium, copper, nickel, and selenium were detected above BVs in one to seven samples. All detected concentrations were less than two times the Qbt 1v BVs (a few tenths of one mg/kg to several mg/kg above the BVs). Although lithium, fluoride, nitrate, and perchlorate were detected and have no BVs, their concentrations probably reflect naturally occurring levels.

The extent of inorganic chemicals identified as COPCs in the Phase I RFI was bounded by deeper subsurface rock samples collected during the 2004–2005 investigation. Appendix M of the Phase I RFI report presents a comparison of the inorganic chemical data collected during the Phase I RFI and the 2004–2005 investigation. Most of the inorganic chemical data do not indicate a release. Chromium, copper, and nickel results indicate a release beneath disposal units into units Qbt 2 and Qbt 1v. However, these COPC results are bounded by concentrations in deeper samples that are within the background range. Therefore, the extent of inorganic chemicals has been defined.

Only one radionuclide result was above its BV. Uranium-235 was detected at a concentration of 0.144 pCi/g in a Qbt 1v sample compared to its uranium-235 Qbt 1v BV of 0.14 pCi/g.

Analytical results from pore-gas samples collected from the eight boreholes drilled in 2004–2005 confirmed ongoing quarterly pore-gas monitoring results and the presence of a vapor-phase plume consisting primarily of CVOCs (Figure 2.4-13). Pore-gas field screening data are shown in Table 2.4-8. Figure 2.4-14 shows a cross-section from a three-dimensional contour model of subsurface TCA pore-gas measurement results from the most recent SUMMA canister sampling from the 2004–2005 investigation and ongoing quarterly monitoring. This plot shows a distribution of TCA vapor concentration that is consistent with the disposal shafts being the source of the vapor plume, and vapor transport being the dominant transport mechanism. The nature and extent of the VOC plume has been defined. The most prevalent vapor-phase contaminants were TCA, TCE, PCE and Freon 113. Data collected during implementation of the Phase I RFI work plan and ongoing quarterly vapor-plume monitoring indicate that the source areas were centered on the eastern shaft field 1 (Shafts 1–28) and western shaft field 2 (Shafts 29–34). Analytical results from the boreholes drilled under the approved work plan and recent quarterly monitoring data confirmed the shaft fields to be the sources of the plume. Recent sampling data also confirm that the VOC plume is in a near steady state, and the vapor-phase concentrations do not indicate the presence of a free liquid source in the subsurface beneath MDA L. The TCA was detected at 200 $\mu g/m^3$ in a pore-gas sample collected in the Cerros del Rio basalt layer at a depth of 550 ft to 608 ft (168 m to 185 m).

Tritium was detected in moisture extracted from pore-gas samples collected from all eight boreholes (Figure 2.4-15). The highest concentration, 153,000 pCi/L, was detected beneath the eastern portion of MDA L.

Subsurface samples were collected from boreholes D-1 (54-24241) and D-2 (54-24399) to evaluate moisture properties and to determine if perched water zones are present beneath MDA L. Detailed lithological logging of core did not identify visibly saturated zones to a depth of 400 ft. Fifty-one samples, collected at approximately 5-ft intervals, were analyzed for moisture content and matric potential analyses. The results of gravimetric moisture analyses showed moisture levels ranging from 1.3% to 27.9% moisture by weight, with all samples, except one, showing moisture levels less than, or equal to, 11.3% (Table 2.4-9). Laboratory matric potential readings confirmed all samples collected beneath MDA L contained moisture levels below saturation.

Perched groundwater was not encountered during drilling beneath MDA L. Samples collected to a depth of 400 ft in boreholes D-1 ([54-24241] from 0 to 250 ft bgs) and D-2 ([54-24399] from 385 to 400 ft bgs) identified no saturated intervals. Because sample recovery was low, moisture samples were not collected in borehole D-2 (54-24399) from 400 to 660 ft bgs. Camera logging conducted in this borehole from approximately 560 to 660 ft showed no signs of a perched zone within the Cerros del Rio basalts.

2.4.4 2007 Field Investigation (Addendum to the 2005 Field Investigation)

The Laboratory drilled three additional boreholes (BH-H [location 54-27641], BH-I [location 54-27642] and BH-J [location 54-27643]), shown in Figure 2.4-16) to define the vertical extent of VOCs and inorganic chemical concentrations.

The results of inorganic chemical analysis of core samples indicate natural variability within the various stratigraphic layers (Figure 2.4-17). Comparisons of results to BVs are limited by the background data set, which contains a relatively small number of samples for units Qbt 1g, Cerro Toledo interval rocks (Qct), and Qbo. The sample containing the highest inorganic chemical concentrations was collected from a unit Qct sample with a high proportion of silt. Higher naturally occurring concentrations of inorganic chemicals have historically correlated with samples containing higher proportions of silt. Concentrations of inorganic chemicals in this sample were below all soil and sediment BVs. Although no BVs exist for Qbog, concentrations of inorganic chemicals in Qbog are less than Qbo BVs; thus, they likely represent naturally occurring levels of inorganic chemicals. Background values for inorganic chemicals in the other lower Qbo units are exceeded by factors of approximately 2 or less. Lithium was detected in all samples but has no BV. Lithium concentrations are similar to, but less than, the concentrations detected during 2004–2005 investigation activities and likely reflect naturally occurring levels.

Detected activities of tritium in the 2007 investigation are below the U.S. Environmental Protection Agency (EPA) drinking water guideline of 20,000 pCi/L [Figure 2.4-18]). The tritium sample results indicate that tritium does not pose a potential threat of groundwater contamination. Tritium collected at BH-H (location 54-27641) near the western shaft field exhibits a decreasing concentration trend from the surface to TD. Tritium concentrations in BH-I (location 54-27642) maximize at the 113.5- to 118.5-ft interval, then decrease to not detected at TD. Tritium concentrations at BH-J (location 54-27643) do not exhibit a clear trend but are near DLs. The tritium results indicate that tritium does not pose a potential threat of groundwater contamination.

Acetone was detected in eight core samples, methylene chloride was detected in one sample, toluene was detected in four samples, and TCE was detected in two samples (Figure 2.4-19). No other VOCs were detected in core. Acetone concentrations in samples and trip blanks were similar, indicating contamination during handling, shipping, storage, and/or analyses. Concentrations of the four VOCs detected in MDA L core samples were near DLs and are not indicative of ongoing releases from the former waste disposal unit.

An evaluation of the pore-gas data from the three new boreholes and additional samples from the old boreholes confirm the presence of vapor-phase VOCs associated with sources in the eastern and western disposal shaft fields. Six VOCs, including dichloroethane (DCA), dichloroethylene (DCE), TCA, TCE, PCE, and Freon 113, were detected in each pore-gas sample collected. Concentrations of these VOCs reach their maximum concentrations in the shallower Qbt 2, Qbt 1v, and Qbt 1g units of the Bandelier Tuff. Concentrations of each VOC decrease in the unit Qct and unit Qbo of the Bandelier Tuff. Concentrations of VOCs are lowest in the Tcb unit sampled from periodic monitoring boreholes (Tables 2.4-10 and 2.4-11). These analytical results confirm the conclusions of the 2004–2005 investigation, which reported that the plumes are in a near-steady state, and that vapor-phase concentrations do not indicate the presence of a free liquid source in the subsurface beneath MDA L.

The concentrations of VOCs in pore-gas samples collected from the deeper Qbo and Tcb units were screened to evaluate the potential for groundwater contamination. The results of this screening are presented in Appendix F and indicate that the pore-gas VOCs do not pose a potential threat of groundwater contamination.

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

3.0 SITE CONDITIONS

The site conditions at MDA L are described in detail in the approved investigation work plans (LANL 2004, 087624, pp. 15–23; LANL 2006, 094673, pp. 1–4) and the approved investigation reports for MDA L (LANL 2006, 091888, pp. 9, 11–15; LANL 2007, 096409, pp. 7–9; NMED 2007, 098409).

The following subsections summarize the surface and subsurface conditions at MDA L.

3.1 Surface Conditions

Area L is located in the central area of Mesita del Buey northwest of MDA G at TA-54 (Figure 1.0-2). Mesita del Buey is a 100- to 140-ft-high finger-shaped mesa that trends southeast. The elevation of Mesita del Buey ranges from 6775 to 6800 ft at Area L. The mesa is approximately 500 ft wide and is bounded by the basin of Cañada del Buey (450 ft to the north) and the basin of Pajarito Canyon (360 ft to the south). The topography at Area L slopes gently from west to northeast, gradually steepening in the northeast quadrant of MDA L toward Cañada del Buey. The surface of Area L is covered with a layer of asphalt.

3.1.1 Soils

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

In general, soils on the mesa surface are thin and poorly developed; they tend to be sandy near the surface and more clay-like beneath the surface. More highly developed soil profiles exist on the north-facing slopes and they tend to be richer in organic matter. Soil profiles on the south-facing slopes tend to be poorly developed. Soil-forming processes have been identified along fractures in the upper part of the mesa, and the translocation of clay minerals from surface soils into fractures has been described at Mesita del Buey. A discussion of soils in the Los Alamos area can be found in the approved installation work plan (LANL 1998, 062060, pp. 2-6–2-21).

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

Canyon bottoms (Cañada del Buey and Pajarito Canyon) near Area L are covered with colluvium and alluvium that has eroded from the tuff and soils on the mesa top and canyon walls. The canyon rims and slopes are composed of soils from the Hackroy-Rock outcrop complex; the canyon bottoms are composed of the Tocal, a very fine, sandy loam. Since disposal activities began at Area L, Cañada del Buey has experienced a period of accretion, and eroded soils from Area L as well as other areas at TA-54 have been deposited on the canyon bottom and stream banks. Potentially, these soils may be redistributed downstream during storm runoff events. The drainages between the mesa and canyon bottoms were sampled during the Phase I RFI; the canyon bottoms will be investigated under separate canyon work plans.

3.1.2 Surface Water

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 the north and the south. Stormwater flows at a number of points along the perimeter of TA-54, as identified and characterized in the “TA-54 Storm W

+ater Pollution Prevention Plan” (LANL 2002, 074009, pp. 37–43), prepared for the Laboratory’s National Pollutant Discharge Elimination System Storm Water Multi-Sector General Permit. Therefore, flooding at the site is not a concern. As a result of runoff, surface erosion occurs primarily as shallow sheet erosion on the relatively flat parts of the mesa and as channel erosion in major drainages from the mesa top. Runoff from summer storms reaches a maximum in less than 2 h and lasts less than 24 h. By contrast, runoff from spring snowmelt occurs over a period of several weeks at a low discharge rate. The amount of eroded material transported in runoff waters is generally higher during summer rainfall events than during snowmelt (Hollis et al. 1997, 063131, pp. 2–33).

3.1.3 Historic Preservation and Archaeology

Known archaeological sites exist in the immediate vicinity of the Area L, which has been thoroughly characterized for archaeological sites and structures that may be subject to historic preservation (LANL 1992, 007669). The exact locations of existing archaeological sites are not identified in this report to protect their cultural resources. The locations of these archeological sites were considered in development and selection of the preferred corrective measure alternative presented in section 9 of this report.

3.2 Subsurface Conditions

3.2.1 Stratigraphy beneath Mesita del Buey

Detailed descriptions of the stratigraphy beneath Area L were presented in the approved work plan (LANL 2004, 087833, pp. 16–19) and in the approved investigation report (LANL 2006, 091888, pp. 11–14; NMED 2007, 098409). The borehole logs confirm that the general stratigraphy beneath Area L is consistent with what was encountered during previous drilling at MDA L and with the regional geology described by Broxton and Reneau (1995, 049726, pp. 8–19). The Bandelier Tuff stratigraphy encountered is summarized in section 3.2.2. The locations of surface structures and subsurface utilities are shown in Figure 3.2-1.

3.2.1.1 Bandelier Tuff (Qb)

With reference to the Bandelier Tuff, the term *welding* is used to distinguish between tuffs that are uncompacted and porous (nonwelded) and those that are more compacted and dense (welded). In the field, the degree of welding in tuff is quantified by the degree of flattening of pumice fragments (a higher degree of flattening and elongation equals a higher degree of welding). Petrographically, welded tuffs show adhesion (welding) of grains, but nonwelded tuffs do not. The term *devitrified* is applied to tuff whose volcanic glass has crystallized. Figure 3.2-2 shows the generalized stratigraphy of the Bandelier Tuff.

3.2.1.2 Tshirege Member (Qbt)

The Tshirege Member of the Bandelier Tuff is a compound-cooling unit that resulted from several successive ash-flow deposits separated by periods of inactivity, which allowed for partial cooling of each unit. Properties related to water flow and contaminant migration (e.g., density, porosity, degree of welding, fracture content, and mineralogy) vary both vertically and laterally as a result of localized emplacement temperature, thickness, gas content, and composition.

3.2.1.3 Tshirege Member Unit 2 (Qbt 2)

Unit 2 of the Tshirege Member of the Bandelier Tuff is a competent, resistant unit that forms the surface of Mesita del Buey. Its thickness varies from 35 ft (10.7 m) to 40 ft (12.2 m) at Area L. Where it is exposed, unit 2 forms nearly vertical cliffs on the sides of the mesa. The rock is described as a moderately welded ash-flow tuff composed of crystal-rich, devitrified pumice fragments in a matrix of ash, shards, and phenocrysts (primarily potassium feldspar [sanidine] and quartz).

Unit 2 is extensively fractured as a result of contraction during post-depositional cooling. The cooling-joint fractures are visible on mesa edges and on the walls of pits. In general, the fractures dissipate at the bottom of unit 2. On average, fractures in unit 2 are nearly vertical. The spacing between fractures ranges between 1.9 ft and 2.6 ft (0.6 m and 0.9 m), and the fracture width ranges between less than 0.03 in. and 0.51 in. (1 mm and 13 mm) with a median width of 0.12 in. (3 mm). The fractures are typically filled with clays to a depth of about 9.9 ft (3 m); smectites are the dominant clay minerals present. Smectites are known for their tendency to swell when water is present and for their ability to strongly bind certain elements, both of which have implications for the transport of metals and radionuclides in fractures. Opal and calcite can be found throughout the fractured length, usually in the presence of tree and plant roots (live and decomposed); the presence of both the minerals and the roots indicates some water at depth in fractures.

At the base of unit 2 is a series of thin, less than 3.9-in.- (10-cm-) thick, discontinuous, crystal-rich, fine- to coarse-grained surge deposits. Bedding structures are often observed in these deposits. The surge beds mark the base of unit 2.

3.2.1.4 Tshirege Member Unit 1v (Qbt 1v)

Tshirege Member unit 1v is a vapor-phase-altered cooling unit underlying unit 2. This unit forms both sloping outcrops and cliffs, which contrast with the near-vertical cliffs of unit 2. Unit 1v is further subdivided into units 1vu and 1vc. Typically, Unit 1vu forms slopes and Unit 1vc forms cliffs

Unit 1vu. The uppermost portion of unit 1v is devitrified and vapor-phase-altered ash-fall and ash-flow tuff; it has been designated unit 1vu, where u signifies upper. Its thickness varies from 60 ft (18.3 m) to 75 ft (22.9 m) at Area L. Unit 1vu is unconsolidated at its base and becomes moderately welded nearer the overlying unit 2. Only the more prominent cooling fractures originating in unit 2 continue into the more welded upper section of unit 1vu but die out in the lower, less consolidated section. More typically, fractures in unit 2 do not extend into unit 1vu.

Unit 1vc. Beneath unit 1vu is unit 1vc, where c stands for colonnade, named for the columnar jointing visible in cliffs formed from this unit. Unit 1vc is a poorly welded, devitrified ash-flow tuff at its base and top, and becomes more welded in its interior. Unit 1vc is approximately 25 ft (7.6 m) thick at Area L.

3.2.1.5 Tshirege Member Unit 1g (Qbt 1g)

The basal contact of unit 1vc is marked by a rapid change (within 0.7 ft [0.2 m] vertical) from devitrified (crystallized) matrix in unit 1vc to vitric (glassy) matrix in the underlying unit 1g. Vitric pumices in unit 1g stand out in relief on weathered outcrops, but devitrified pumices above this interval are weathered out. In outcrop, this devitrification interval forms a prominent erosional recess termed the *vapor-phase notch*. No depositional break is associated with the vapor-phase notch; the abrupt transition indicates this feature is the base of the devitrification that occurred in the hot interior of the cooling ash-flow sheet after emplacement.

Unit 1g is a vitric, pumiceous, nonwelded ash-flow tuff underlying the devitrified unit 1vc. It is about 140 ft (42.7 m) thick at Area L. Few fractures are observed in the visible outcrops of this unit, and weathered cliff faces have a distinctive Swiss-cheese appearance because of the softness of the tuff. The uppermost 5 to 20 ft (1.5 to 6.1 m) of unit 1g are iron-stained and slightly welded. This portion of unit 1g is resistant to erosion, helping to preserve the vapor-phase notch in the outcrops. A distinctive pumice-poor surge deposit forms the base of unit 1g.

3.2.1.6 Tsankawi Pumice Bed

The Tsankawi Pumice Bed is the basal air-fall deposit of the Tshirege Member of the Bandelier Tuff. It is a thin bed of gravel-sized vitric pumice. It is about 3 ft (1 m) thick at Area L.

3.2.1.7 Cerro Toledo Interval (Qct)

The Cerro Toledo interval consists of thin beds of tuffaceous sandstones, paleosols, siltstones, ash, and pumice falls; the Cerro Toledo interval separates the Tshirege and Otowi Members of the Bandelier Tuff. The Cerro Toledo interval also includes localized gravel- and cobble-rich fluvial deposits predominantly derived from intermediate composition lavas eroded from the Jemez Mountains west of the Pajarito Plateau. This interval varies in thickness between 15 ft (4.6 m) to 30 ft (9.1 m) at Area L.

3.2.1.8 Otowi Member (Qbo) including the Guaje Pumice Bed (Qbog)

The Otowi Member tuffs are about 80 ft (24.4 m) thick at Area L. The tuffs are a massive, nonwelded, pumice-rich, and mostly vitric ash flow. The pumices are fully inflated, supporting tubular structures that have not collapsed as a result of welding. The matrix is an unsorted mix of glass shards; phenocrysts; perlite clasts; and minute, broken pumice fragments.

The Guaje Pumice Bed is the basal air-fall deposit of the Otowi Member of the Bandelier Tuff. The thickness of the unit has been measured at 10 ft (3.1 m) beneath Area L. The pumice bed is nonwelded but brittle. Pumice tubes are partially filled with silica cement.

3.2.1.9 Cerros del Rio Basalts (Tcb)

In the vicinity of TA-54, the Cerros del Rio basalts lie directly beneath the Otowi Member of the Bandelier Tuff (Figure 3.2-2). In regional well R-32, the basalts are 636 ft (193.9 m) thick; in regional well R-22 the basalts are 983 ft (299.6 m) thick (Figure 3.2-3). In both wells, the regional water table occurs within these basalts. Local borehole cores at Area L show that the basalts consist of both angular rubble and dense, fractured masses, with zones of moderately to very porous lavas. Deeper drilling at R-22 showed a wide variety of lithologies within the basalts, including massive flows; interflow rubble; or scoria zones, sediments, and paleosols (Ball et al. 2002, 071471).

3.2.1.10 Puye Formation (Tpf, Tpp) and Older Fanglomerate

The Puye Formation is a conglomerate deposit derived primarily from volcanic rocks to the west, with varying lithologies, including stream channel and overbank deposits, ash and pumice beds, debris flows and lahar deposits. Well tests on the plateau confirm that the unit is very heterogeneous with both high and low permeability zones present (Nylander 2003, 076059.1, pp. 4-17–4-20). The formation is poorly lithified, and as such is unlikely to sustain open fractures.

The Puye Formation thins from west to east beneath TA-54. At well PM-2, the Puye Formation (including fanglomerate, pumiceous units, and ancestral Rio Grande deposits) is approximately 800 ft (243.8 m) thick; at regional well R-23 it is completely absent (LANL 2003, 079601). Recent drilling across the plateau indicates that the Puye Formation is frequently underlain by alluvial fan deposits similar in lithology to the Puye, but considerably older. These deposits are of considerable thickness at PM-2, were penetrated at R-22 (approximately 80 ft [24.4 m] thick [LANL 2003, 071471]) and were absent at R-23 (LANL 2003, 079602). The Puye Formation was also encountered at regional well R-16 (351 ft [106.9 m] thick); the water table occurs within the Puye Formation at this location (LANL 2003, 076061).

3.2.1.11 Totavi Lentil Deposits (Tpt)

The Totavi Lentil is an ancestral Rio Grande deposit consists of coarse gravels and sands with abundant quartzite. The deposit has been alternatively conceptualized as a series of distinct north-south trending ribbons as well as a continuous thin sheet at the base of the Puye Formation. Like the overlying Puye Formation it has both high- and low-permeability zones (Nylander 2003, 076059.1pp. 4-17–4-20).

3.2.1.12 Santa Fe Group (Tsf, Tf, and Ts) and Santa Fe-Age Basalts (Tb 1 and Tb 2)

The Santa Fe Group is an alluvial-fan deposit comprised of medium to fine sands and clays. Numerous north-south trending faults are present in the Santa Fe Group. The Santa Fe Group is deep below TA-54 (1500 ft [457.2 m] bgs at PM-2) and was not penetrated by R-20, R-32, or R-22 (Ball et al. 2002, 071471; LANL 2003, 079600; LANL 2003, 079602). Basaltic lava flows occurred during the time that the Santa Fe Group was deposited; these basalts occur both within the Santa Fe Group and within the pre-Puye sands, gravels, and conglomerates. These old basalts appear to have fewer open fractures than the younger Cerros del Rio basalts.

3.2.2 Hydrogeology

The proposed hydrogeologic conceptual model for the Pajarito Plateau (LANL 1998, 059599, pp. 53–55) is presented in Figure 3.2-4. The following sections provide an overview of infiltration rates and groundwater occurrence in the vicinity of Area L.

Mesita del Buey is one of the drier mesas at the Laboratory and on the Pajarito Plateau. Infiltration occurs into the shallow subsurface mostly during snowmelts or following intense summer thunderstorms. Moisture from the shallow subsurface of the mesa is removed by ET. Percolation into the deeper subsurface of the mesa appears to be very low, approximately 0.04 in./yr (1 mm/yr) (Hollis et al. 1997, 063131, pp. 2-67-2-70). The conceptual site model for contaminant migration through the unsaturated zone at TA-54 is presented in detail in Appendix E of the MDA G CME plan, Revision 2 (LANL 2007, 098608), and summarized in section 4.2.1 of this report for MDA L.

Field moisture content was measured at 5-ft intervals in borehole 54-24241 in the upper 250 ft of tuff at Area L and was less than 11.3%, g/g. At these moisture contents, most of the fractures beneath MDA L are dry, and pore water occurs in the tuff matrix.

Although intermediate-depth perched groundwater has been observed in locations elsewhere on the plateau (Robinson et al. 2005, 091682), these perched zones are generally observed beneath wet canyons and none were observed during drilling of the regional wells in the direct vicinity of MDA L [R-20, R-21, R-22, and R-32 (Ball et al. 2002, 071471; Kleinfelder 2003, 090047; LANL 2003, 079600; LANL 2003, 079602)]. No intermediate-depth perched groundwater was observed in 650 ft of drilling in the deepest MDA L borehole to date (borehole 54-24399) (LANL 2006, 093910, p. 14). Intermediate-depth perched water does occur in wells R-23 and R-23i, located in Pajarito Canyon east of Area L (LANL 2003, 079601; Kleinfelder 2006, 092495). This water is thought to be localized beneath the canyon floor and results from infiltration along the canyon, which has a large drainage area.

The regional aquifer of the Pajarito Plateau is the only local aquifer capable of supplying municipal water on a large scale (Purtymun 1984, 006513, p. 1). The regional aquifer extends throughout the Española Basin (an area roughly 2300 mi^2 or 5957 km^2) and reaches its maximum thickness beneath the Pajarito Plateau (over 9800 ft or 2987 m thick) (Cordell 1979, 076049, pp. 59-64). Depths to the regional aquifer range between 1200 ft (366 m) along the western edge of the plateau and about 600 ft (183 m) along the eastern edge. Beneath Area L, the water-table elevation is approximately 5810 ft (5767 ft above sea level

[asl] at R-22; 5860 ft asl at R-32) or approximately 930 ft (283 m) bgs in the Cerros del Rio basalts (Figure 3.2-5).

The structure of the groundwater flow in the regional aquifer near Area L (Figure 3.2-6) suggests that any contaminants reaching the regional aquifer will be transported to the south-west toward the Rio Grande. A recent analysis of the regional-aquifer monitoring network near TA-54 demonstrated that contaminants originating at Area L and potentially arriving at the regional aquifer would not travel toward the production wells on the Pajarito Plateau (LANL 2007, 098548). Instead, the report confirmed that the primarily concern is potential flow to the south-east toward the Rio Grande. A combination of the existing and two additional regional monitoring wells (proposed in the report) provide high probability (>99%) for successful detection of any contaminant originating from Area L and flowing toward the Rio Grande (LANL 2007, 098548).

4.0 CONCEPTUAL SITE MODEL FOR MDA L

CSMs are based on the existing site knowledge and observations. They describe potential contaminants, exposure pathways, transport mechanisms to potential receptors, current and reasonably foreseeable land uses, and any currently uncontaminated media that may become contaminated in the future because of contaminant migration (EPA 1989, 008021, pp. 4-10). The current CSM for MDA L is detailed in the approved MDA L investigation report (LANL 2006, 091888, Appendix G, pp. G-4–G 14; NMED 2007, 098409). The potential sources, pathways, and receptors are illustrated schematically in Figure 3.2-4. They are also summarized below.

4.1 Sources

The known sources of environmental contamination, documented in the MDA L investigation report (LANL 2006, 091888, Appendix G, p. G-4) are as follows:

- vapor-phase releases of tritium and VOCs from subsurface SWMU;
- methoxychlor, Aroclor-1260, and plutonium-238 in drainage channel sediment; and
- metals and radionuclides present in the tuff located below the disposal units.

4.2 Pathways

4.2.1 Contaminant Transport Pathways

As described in the approved MDA L investigation report (LANL 2006, 091888, pp. G-6–G-7; NMED 2007, 098409), the relevant release and transport processes are a function of chemical-specific properties, the physical form and/or container associated with a waste, and the nature of the transport process.

The CSM includes the following modes of contaminant release:

- leaching (dissolution) by water infiltrating at the ground surface, then seeping through the covers and into the waste volume;
- volatilization or vaporization and diffusion of certain contaminants within the waste;
- incorporation into plants whose roots grow into the waste;
- excavation by animals burrowing into the waste; and

- exposure of wastes because of erosional processes (wind, water, and mass wasting).

Contaminants released from the disposed waste may be redistributed within and beyond the site by the following primary transport pathways:

- vapor-phase transport of volatile chemicals (VOCs and tritium) into the surrounding unsaturated zone with potential for transport to the regional aquifer;
- vapor-phase transport of volatile chemicals (VOCs and tritium) into the atmosphere;
- surface-water transport of contaminated surface soils as eroded sediment into adjacent canyons by runoff;
- airborne transport of small particulates brought to the surface by biointrusion or erosion;
- unsaturated transport of contaminants with infiltrating water through the thick (900 to 1000 ft) unsaturated zone;
- saturated-zone transport of contaminants if contaminants reach the regional aquifer; and
- biointrusion transport via plant roots and burrowing animals.

With respect to the transport pathways, the pathway through the unsaturated zone below MDA L is of concern because contaminants may eventually reach the regional aquifer, which is the water supply for Los Alamos County and the Laboratory. Unsaturated-zone monitoring will address the effectiveness of the corrective measures and verify infiltration rates. Current site characterization data indicate that the tuff beneath MDA L is unsaturated and that the moisture contents are consistent with mesa-top infiltration rates of 0.04 in./yr (1mm/yr) (Hollis et al. 1997, 063131, p. 2-51). Unsaturated-zone flow and transport simulations indicated predominantly vertical transport. Travel times for liquid-phase unsaturated-zone transport are predicted to be several thousand years for peak concentrations of nonadsorbing species to reach the water table (Stauffer et al. 2005, 097432). The moisture contents increase slightly above the Cerros del Rio basalt, especially in the Guaje Pumice Bed. The contrast in hydrologic properties between the pumice and basalt may cause some laterally spreading along the paleotopography of the Cerros del Rio basalt, which slopes to the south towards Pajarito Canyon (LANL 2007, 098172). It is noted that a very small volume of water (approximately 1 c) was produced within the Cerros del Rio basalt during drilling of borehole 54-01016 at MDA L in 1995. Three porous cup lysimeters, one at the depth of the observed saturation and two at deeper depths, were subsequently installed in this borehole to monitor any water that might accumulate. These lysimeters were monitored annually through 2005, and no further accumulation of free water has occurred over 10 yr of monitoring (LANL 2003, 087572.1114). Greater percolation rates likely exist beneath the canyon because of channelized canyon runoff and perched alluvial water. If contaminants are laterally diverted atop the basalt to beneath the canyon, faster transport rates toward the aquifer would likely occur. The conceptual site model for contaminant migration through the unsaturated zone for TA-54 is presented in more detail in Appendix E of the MDA G CME plan, Revision 2 (LANL 2007, 098608). Various modeling studies supporting this summary are also referenced in Appendix F.

In addition to unsaturated-zone monitoring, groundwater monitoring near MDA L will be used to sample for contamination in the regional aquifer and any perched intermediate zones in accordance with the Laboratory's Interim Facility-Wide Groundwater Monitoring Plan (LANL 2007, 096665). Regional aquifer samples are currently collected at wells R-20, R-21, R-22, R-23 and R-32, and perched-intermediate zone water from Pajarito Canyon is collected in well R-23i. In addition, five new regional monitoring wells and two new perched-intermediate monitoring wells in Pajarito Canyon were proposed in the report "TA-54 Well Evaluation and Network Recommendations" (LANL 2007, 098548) to further bolster the monitoring network at TA-54. This report was approved by NMED on December 7, 2007. The five new regional wells and one of the new perched-intermediate wells will be installed by the Laboratory during 2008. The locations of existing and planned wells for the enhanced monitoring network are shown in Figures 3.2-3 and 4.2-1. The combined monitoring network, including unsaturated zone monitoring, will supply data to determine whether any corrective measures that are implemented are effective at reducing infiltration and preventing migration of contaminants to the regional aquifer. The intermediate-depth monitoring wells will provide additional information on contamination in perched intermediate water, if it is present, beneath Pajarito Canyon.

Vapor-phase transport accounts for the observed migration to depth of VOCs in pore gas within the Bandelier Tuff. Extensive analyses of the VOC contamination in pore gas beneath MDA L have shown that vapor-phase transport accounts for the migration of VOCs, for which vapor-phase concentrations are in equilibrium with water concentrations as determined by Henry's Law partitioning. Vapor migration of VOCs in the subsurface can be described by diffusive behavior that is unaffected by preferential air flow or barometric pumping within the mesa (Stauffer et al. 2005, 090537). Diffusion theoretically spreads contamination in a spherical direction along concentration gradients. However, topography plays an important role in vapor transport at TA-54. With low vapor concentrations occurring at the top and sides of the mesas, the steepest concentration gradients are toward the surface. These steep gradients preferentially lead to vapor transport toward these external boundaries rather than downward toward the regional aquifer.

Stratigraphy is a less important control for vapor-phase transport than for liquid-phase transport because rather than being gravity-driven, the plume tends to spread in all directions. Rapid transport by advective vapor flow is not a likely transport mechanism within the fractured Cerros del Rio basalt because vapor-phase densities are low enough that gravity-driven downward flow in fractures should not occur. Additionally, if vapor-phase transport of VOCs were to reach the regional aquifer by diffusing through the fractured Cerros del Rio basalt, the effect of partitioning calculated in Henry's Law would result in extremely low groundwater concentrations based on current observed vapor concentrations (LANL 2005, 092591; LANL 2007, 096409). In the event that VOC vapor-phase transport causes low concentrations to reach the regional aquifer, the area of migration would be centered beneath MDA L. Stratigraphy would have minimal effect on the direction of migration.

Tritium is transported in the subsurface at TA-54 through a multiphase coupled process, primarily the diffusion of water vapor. However, as tritiated water vapor diffuses away from a source area, it readily equilibrates with tritium-free pore water already in the unsaturated zone. The relatively rapid process of vapor-phase diffusion (in the case of tritium, the vapor is water vapor) is effectively slowed by the presence of pore water, which acts as a reservoir for tritium that partitions from the vapor. This interaction with pore water results in a lower effective water-vapor diffusion coefficient than would be observed if no liquid pore water were present. This conceptual model is based on observations of tritium in the subsurface at both MDA G and TA-53 (Vold 1996, 070155; Stauffer 2003, 080930). Data and modeling results indicate that the effective vapor-phase diffusion coefficient for tritium is 25 times lower than for the more volatile vapor-phase VOCs at TA-54, primarily because those VOCs do not partition as readily into pore water. Diffusion of tritium toward the surface leads to some surface flux of tritium to the atmosphere in water vapor. In addition, radioactive decay of tritium (half-life of 12.3 yr) decreases tritium mass as it migrates through the unsaturated zone. Any tritium reaching the water table by water-vapor diffusion would occur directly below the disposal site because this pathway is the shortest diffusive pathway, and the tritium would partition into the groundwater. Tritium activities in the subsurface will undergo radioactive decay in 120 to 240 yr (10 to 20 half-lives). For example, the highest concentration of tritium in pore gas, 153,000pCi/L, would decay to approximately 150 pCi/L in 123 yr. The time of transit allows tritium to decay below maximum contaminant levels (MCLs). The time required for tritium to decay to less than the MCL is short in comparison to the expected travel time to the regional aquifer.

It is possible that a vapor plume of either VOCs or tritium could reach the Guaje Pumice Bed, which is generally present atop the Cerros del Rio basalt at TA-54. Because this unit has higher moisture contents than overlying tuff units, vapor diffusion thought the pumice may be slower. VOC or tritium vapors that reach the Guaje Pumice Bed will partition into the pore water. If lateral flow occurs in the Guaje Pumice Bed atop a dipping basalt unit, this flow could reach Pajarito Canyon where enhanced liquid-phase flow might occur. However, flow rates along this dipping surface are likely to be quite low because of unsaturated permeability relationships.

A better understanding of saturated-zone transport pathways will be achieved by regional groundwater monitoring in accordance with the Laboratory's Interim Facility-Wide Groundwater Monitoring Plan (LANL 2007, 096665). Installation of five new regional wells and one new perched-intermediate well around TA-54 during 2008 will further enhance this understanding. The groundwater monitoring wells (Figures 3.2-3 and 4.2-1) will allow sampling at the regional water table and any potential perched intermediate zones intercepted in Pajarito Canyon to determine if VOCs, tritium or other contaminants from MDA L have reached the water table or a potential intermediate perched zone in the canyon. Appendix E of the revised addendum to the MDA L investigation report (LANL 2007, 098608) contains analytical calculations demonstrating that groundwater-screening criteria in the regional aquifer are not likely to be exceeded for VOCs and tritium if water fluxes through the surface cover remain at or below the design rate of 1 mm/yr.

The two other contaminant transport pathways of the CSM are biointrusion and surface water. Any corrective measures alternative selected must address these two pathways.

5.0 REGULATORY CRITERIA

5.1 Cleanup Standards, Risk-Based Screening Levels, and Risk-Based Cleanup Goals

The cleanup and screening levels described in Section VIII of the Consent Order were followed to determine the preferred corrective measure alternative (Table 5.0-1). The cleanup levels are based on the New Mexico Water Quality Control Commission's (NMWQCC's) groundwater and surface water standards and NMED's cleanup levels for protection of human health and are consistent with the EPA's National Oil and Hazardous Substance Pollution Contingency Plan, 40 CFR Section 300.430(e)(2)(i)(A)(*2*).

NMED has selected a human health target risk level of 10^{-5} and a hazard index (HI) of 1.0 as cleanup goals for establishing site-specific cleanup levels for one or more contaminants for which toxicological data are published. NMED and the EPA have soil screening levels (SSLs) and MCLs, and the NMWQCC has adopted groundwater and surface water standards that are described below. DOE has established a cleanup goal of 15 mrem/yr (0.25 mSv/yr) incremental exposure for radioactively contaminated sites.

Screening for ecological risk for determining the recommended corrective measure alternative used the ecological screening levels (ESLs) (LANL 2004, 087630; LANL 2005, 090032) and the information contained within the ECORISK Database, Version 2.1 (LANL 2004, 087386).

5.1.1 Soil

NMED has specified SSLs that are based on a target total excess cancer risk of 10^{-5} and for noncarcinogenic contaminants a target HI of one (1.0) for residential and industrial land use. Residential and industrial soil screening levels are from NMED's "Technical Background Document for Development of Soil Screening Levels, Revision 4.0" (NMED 2006, 092513). The Laboratory uses the most recent version of the EPA Region 6 human health medium specific screening level (HHMSSL) for residential and industrial soil, if an NMED SSL has not been established for a contaminant for which toxicological information is published.

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

5.1.2 Groundwater

As required by NMED in a letter dated April 5, 2007 (NMED 2007, 095394), a "Technical Area 54 Well Evaluation and Network Recommendations" report (LANL 2007, 098548) was submitted to NMED. This report was approved by NMED and requires the Laboratory to install five new regional wells and one new perched-intermediate well around TA-54 during 2008. The corrective measures alternative chosen will be required to meet the groundwater-quality standards given in Section VIII.A of the Consent Order. These standards include the NMWQCC groundwater standards, including alternative abatement standards (20.6.2.4103 New Mexico Administrative Code [NMAC]), and the drinking water MCLs adopted by EPA under the federal Safe Drinking Water Act (42 U.S. Code [USC] Sections 300f to 300j-26) or the Environmental Improvement Board (20.7.10 NMAC). If both an NMWQCC standard and an MCL have been established for an individual substance, then the lower of the two levels is considered the cleanup level for that substance.

NMED uses the most recent version of the EPA Region 6 HHMSSL for tap water as the screening level, if either an NMWQCC standard or an MCL has not been established for a specific substance. If no NMWQCC groundwater standard or MCL has been established for a contaminant for which toxicological information is published, then the Laboratory uses a target excess cancer risk level of 10^{-5} and/or an HI of 1.0 as the basis for proposing a cleanup level for the contaminant. If the naturally occurring (background) concentration of a contaminant exceeds the standard, then the cleanup goal defaults to the background concentration for that specific contaminant.

5.1.3 Surface Water

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

5.1.4 Pore Gas

There are no regulatory standards applicable to VOCs in pore gas. VOC results from pore-gas sampling were screened (LANL 2007, 096409, Appendix E, p. E-4) to evaluate whether concentrations of VOCs in the subsurface pore gas may be of concern as a potential source of groundwater contamination. Because no screening levels for pore gas address potential for groundwater contamination, the screening evaluation was based on groundwater cleanup levels contained in the Consent Order and Henry's Law constants that describe the equilibrium relationship between vapor and water concentrations. The source of the Henry's Law constants was the NMED SSL technical background document (NMED 2006, 092513). If Henry's Law constants were not available from this source, they were obtained from the Pennsylvania Department of Environmental Protection chemical- and physical-properties database at the following URL: http://www.dep.state.pa.us/physicalproperties/Default.htm. The following dimensionless form of Henry's Law constant was used:

$$H' = \frac{C_{air}}{C_{water}} \quad \textbf{Equation 5-1}$$

where C_{air} is the volumetric concentration of contaminant in air and C_{water} is the volumetric concentration of contaminant in water. Equation 5-1 can be used to calculate the following screening value:

$$SV = \frac{C_{air}}{1{,}000 \times H' \times SL} \quad \textbf{Equation 5-2}$$

where C_{air} is the concentration of VOC in the pore-gas sample ($\mu g/m^3$), H’ is the dimensionless Henry’s Law constant, *SL* is groundwater the screening level (µg/L) and 1000 is a conversion factor from L to m^3. The SLs are groundwater cleanup levels specified in the Consent Order, which are the EPA MCL or the NMWQCC groundwater standard, whichever is lower. As specified in the Consent Order, if no MCL or NMWQCC standard is available, the EPA Region 6 HHMSSL for tap water is used (adjusted to 10^{-5} risk for carcinogens). The numerator in Equation 5-2 is the actual concentration of VOC in pore gas, and the denominator represents the concentration in pore gas that is needed to exceed the SL. Therefore, if the screening value (SV) is less than 1, the concentration of VOC in pore gas is not sufficiently high to cause the water SL to be exceeded, even if the VOC plume were in contact with groundwater.

Equation 5-2 was used to screen the VOC pore-gas data for the supplemental investigation at MDA L. The screening was performed using the maximum detected value from the deepest stratigraphic unit sampled, which is the Cerros del Rio basalt. Data from the deepest unit were used in the screening because this unit is closest to the regional aquifer. 16 VOCs having MCLs, NMWQCC standards, and/or HHMSSLs were detected in samples collected from the Cerros del Rio basalt at MDA L (LANL 2007, 096409, Appendix E, p. E-33). These results show the SV is below 1 in every case. Based on these screening results, the VOCs detected in subsurface pore gas at MDA L do not presently appear to be a potential source of groundwater contamination.

5.2 Consent Order Criteria

The CME plan identified an initial set of corrective measure alternatives for MDA L (LANL 2006, 094805, pp. 14–15) based on evaluation of specific information on site conditions, including the contaminant inventory, the design of the disposal units, the environmental setting, and the nature and extent of contamination. The formal process for alternative identification and screening employed in this CME began with identifying and screening the technologies that could be used to address contaminants at MDA L, either individually or in combination (section 6). The initial set of corrective measures alternatives then were modified resulting in the set of corrective measure alternatives that are analyzed in section 7. Alternatives passing the screening criteria are evaluated in section 8. These results are used in the selection of the preferred alternative discussed in section 9.

A range of corrective measure alternatives was screened and evaluated to determine what corrective measures were most appropriate at MDA L to ensure protection of human health and the environment in the future. A range of alternatives, including contaminant removal were assessed in accordance with NMED, EPA, and DOE risk/dose assessment guidance. The containment alternatives were evaluated to ensure that contaminant concentrations in environmental media do not exceed cleanup levels if the material in the subsurface disposal units is left in place. The benefits, costs, and implementation risks of the alternatives were compared with the no-further-action alternative as a baseline.

Numerous criteria were used in this report for determination of the preferred corrective measure alternative for MDA L. Section VII.D.4.a and VII.D.4.b of the Consent Order provide threshold and balancing criteria for screening and evaluation of corrective measures, respectively. These criteria are listed below in sections 5.6.1 and 5.6.2. Additionally Section XI.F.10 of the Consent Order provides evaluation criteria for the corrective measure alternatives as summarized in section 5.2.3. Furthermore, Section XI.F.11 of the Consent Order mandates justifying the preferred corrective measure based on a fourth set of criteria listed in section 5.2.4 of this report.

5.2.1 Threshold Criteria

As described in Section VII.D.4.a of the Consent Order, all corrective measure alternatives were screened for further analysis based on the following threshold criteria. To be selected, the alternative must

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

This screening process was applied to eight corrective measure alternatives as detailed in section 7.

5.2.2 Balancing Criteria

Section VII.D.4.b of the Consent Order identifies balancing criteria to be applied upon screening of the initial set of corrective measure alternatives. These balancing criteria include

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

These criteria closely overlap with the evaluation criteria described in Section XI.F.9 of the Consent Order. Therefore, these criteria were combined with the evaluation criteria in section 5.2.3. The combined criteria were used to evaluate three corrective measure alternatives that passed the initial screening in section 7. This evaluation is discussed in section 8.

5.2.3 Evaluation Criteria

Section XI.F.10 of the Consent Order required the evaluation of corrective measure alternatives based on the

1. applicability,
2. technical practicability,

3. effectiveness,
4. implementability,
5. human health and ecological protectiveness, and
6. cost.

Overlap between the balancing criteria described in section 5.2.2 with these evaluation criteria was addressed by discussing the balancing criteria within the six corresponding evaluation criteria in section 8.

5.2.4 Selection Criteria

Based on the evaluation of the three final corrective measure alternatives, one alternative was selected as the recommended corrective measure alternative. Compliance of this alternative with a final set of criteria described in Section XI.F.11 of the Consent Order is detailed in section 9 of this report. The criteria used in the description of the final selection were as follows:

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

The justification for the preferred corrective measure alternative includes the supporting rationale for the remedy selection, based on the factors listed in sections 7 and 8 as well as a discussion of short- and long-term objectives for the site and the benefits and possible hazards of the alternative.

5.3 DOE Directives and Criteria for Radioactive Waste and Radiation Protection of the Public and the Environment

Although the hazardous waste component in MDA L is regulated under the Consent Order, the radioactive waste component is regulated under DOE directives, specifically DOE Manual 435.1-1, “Radioactive Waste Manual,” and DOE Order 5400.5, “Radiation Protection of the Public and the Environment.”

MDA L was not used for disposal of radioactive materials. However, previous investigations at MDA L have identified the presence of tritium in soil and pore gas. According to DOE Order 5400.5, DOE must protect the public and the environment from radiation or radioactive material. DOE requirements mandate continued control by DOE of property until the radiological hazard associated with this property is reduced to levels that no longer pose a threat to the public and environment (DOE 2000, 067489). In the 100 yr of active institutional control, the highest reading of tritium, 153,000 pCi/L, would drop to approximately 250 pCi/L, much less than the EPA MCL of 20,000 pCi/L for tritium in water.

5.4 Hazardous Waste Regulations

As specified in the draft Hazardous Waste Facility Permit issued by NMED on August 27, 2007, closure of the Area L landfill units will be coordinated with the corrective action for MDA L being conducted under the Consent Order. Pursuant to 40 CFR 264.110(c), the landfill units will be closed under alternative closure requirements established under the Consent Order rather than the closure requirements of 40 CFR 264 Subparts G and N. The alternative closure requirements for these landfill units will be established using the corrective measure evaluation process for MDA L contained in Section VII.D of the Consent Order. Upon NMED's selection of the remedy for MDA L, the Laboratory will prepare and submit a CMI work plan, which will fulfill the requirements for a closure plan and postclosure plan for the landfill units specified in 40 CFR Sections 264.112 and 264.118.

6.0 CORRECTIVE MEASURE TECHNOLOGIES

The MDA L CME plan (LANL 2006, 094805, pp. 14–15) provided an initial set of alternatives/alternative groupings that were expected to meet the corrective measure goals. Most of the alternatives identified in the CME plan could incorporate a variety of specific technologies to accomplish the corrective actions. To provide additional detail in presenting corrective measure alternatives, this CME initially identifies and screens potential technologies by technology type. Applicable technologies are combined into a preliminary list of alternatives in section 7 and further screened based on comparative analysis.

6.1 Preliminary List of Technologies

General types of corrective measure technologies potentially appropriate to MDA L site conditions and waste types were taken from the comprehensive technology list developed by the Federal Remediation Technologies Roundtable (Table B-1, available at http://www.frtr.gov/matrix2/appd_b/append_b.html). For wastes disposed at MDA L, potentially appropriate technologies fall into the four general categories listed below and shown in the left-most column of Figure 6.1-1:

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

Within the treatment categories, subcategories include biological, chemical, physical, and thermal treatment. To be effective, the technologies must address the site conditions at MDA L, all or a significant portion of the waste matrices present at MDA L (potentially including contaminated environmental media), and the primary contaminants at MDA L, as discussed in section 2.4 and as summarized in the MDA L investigation report (LANL 2006, 091888).

6.1.1 Containment Technologies

Containment technologies are intended to limit migration of contaminants or limit infiltration into the vadose zone. Such technologies can include surface and subsurface barriers and various orientations and compositions of barriers can be used. The general functionality and potential MDA L-specific utility is discussed for each containment technology considered.

6.1.1.1 Vertical Barriers

Vertical barrier technologies are considered of limited benefit for MDA L applications, since the absence of near-surface groundwater at the site already limits lateral migration of most contaminants. Limiting the lateral component of vapor-phase transport of a limited number of volatile contaminants at the site (e.g., TCA and tritium) is one potential application for vertical barriers at MDA L, but downward migration of these contaminants might be enhanced as a result.

Limited applications of vertical barriers near surface could be designed to prevent biointrusion at the edges of surface barriers, such as with an ET cover at MDA L; however, this application of vertical barriers would be incorporated into the design details for such a cover as a biotic barrier.

The following vertical barrier technologies were considered when preparing the CME.

Slurry Wall/Grout Curtain

Slurry walls are formed using slurried bentonite clays or cement-grout or other barrier materials placed in narrow, deep trenches or in a series of adjacent open boreholes surrounding the perimeter or at the migrating edge of a disposal site. Slurry walls are commonly used to intercept contaminants that migrate laterally. The arid environment at MDA L is not compatible with the use of bentonite clays, which become cracked and permeable when desiccated, and the porous nature of grout materials would not significantly impede vapor-phase transport of volatile contaminants at MDA L. This technology was not retained.

Rock-Grout Mixing

Rock-grout barriers are formed by drilling adjacent deep shafts around the perimeter of a disposal site, and then mixing the cut rock with injected grout as the shaft is drilled. Like slurry walls, rock-grout mixing is used to intercept contaminants that migrate laterally. The porous nature of grout materials would not impede vapor-phase transport of volatile contaminants of concern at MDA L. This technology was not retained.

Synthetic Membrane

A synthetic membrane, such as a geosynthetic liner, can be placed in a vertical trench. The membrane forms a barrier that impedes/restricts the lateral migration of contaminants. Although this technology may be adapted to impede lateral migration of vapor-phase contaminants at MDA L, the potential to enhance downward migration of these contaminants is a concern. This technology was not retained.

Reactive Barrier

A chemically active material can be placed in a vertical orientation around the waste disposal area or the reactive materials can be incorporated into another barrier technology. The reactive chemical is chosen for ability to adsorb or chemically degrade one or more of the contaminants of concern, such as zero-valence iron or activated carbon for TCA. However, since the barrier technology is primarily demonstrated in the liquid phase, its applicability to MDA L is uncertain. Therefore, the technology was not retained.

6.1.1.2 Deep Subsurface Horizontal Barriers

The purpose of a horizontal barrier is typically to contain downward aqueous-phase contaminant transport. Such a barrier is suitable for sites with known aqueous-phase releases or with significant infiltration from the surface. These conditions do not exist at MDA L. Therefore, a deep horizontal barrier would not be appropriate for addressing the release and transport pathways of potential concern at MDA L; thus, technologies in this category were not considered further in this CME.

6.1.1.3 Near-Surface Horizontal Barriers

Near-surface horizontal barriers created by a soil-grout mixture or vitrification could enhance MDA L's existing covers by controlling intrusion into the waste by plants, animals, or people and by reducing infiltration of water. Therefore, this technology is retained for further consideration. Additional engineering or modeling studies are required to determine whether and to what extent the physical and hydrological properties of the existing cover materials can be improved over the short- and the long-term by implementing this technology.

Soil-Grout Mix

A concrete/grout mixture containing soil or crushed tuff may be used to replace a subsurface portion of the existing cover materials over MDA L disposal units. This barrier may be safely constructed and has the potential to decrease permeability to water and/or penetrability by plants and animals. However, it does not provide water storage and ET of any water that has the potential to infiltrate. Rainfall that does not infiltrate the soil grout mix will infiltrate at the edges of the treatment creating focused recharge and increased infiltration in that area. Soil grout mixing for drums of solvents in shafts is not applicable. This technology was retained for further consideration for pits and impoundments only because each shaft already has a concrete cap.

Vitrification

In situ vitrification is the process of using electrical resistance to heat soil or rock to temperatures high enough to melt them. When the melted materials cool, a glass-like material is formed. In situ vitrification produces an impermeable, impenetrable horizontal barrier, and has been demonstrated to a depth of 30 ft (9.1 m). Current operational cover soils at MDA L are limited to about 4.9- to 6.6-ft (1.5- to 2-m) thickness over waste. To act as a horizontal barrier over the waste units, the technology will have to be deployed in existing cover materials or in materials to be added as part of a more comprehensive cover system at MDA L. Soil-grout mixing provide similar benefits more cheaply and without the added concern over mobilizing volatile wastes from the application of extreme heating. Therefore, this technology was not retained.

6.1.1.4 Surface Barriers

Barriers placed on the surface of disposal sites provide protection against the infiltration of water, provide resistance to water and wind erosion, prevent or minimize intrusion into wastes by plants or animals, act as a deterrent to inadvertent human intrusion, and limit flux of gas-phase contaminants, such as tritium. The existing surface barriers at MDA L have been effective protection. Enhancements to existing covers could readily allow MDA L to meet the evaluation criteria for protecting human health and the environment. Enhancements would likely be drawn from the following readily available surface barrier technologies.

Asphalt Cover

Asphalt provides a substantial barrier to surface erosion processes, but has been shown at another Laboratory site, MDA AB Area 2 at TA-49 (LANL 1999, 063918, p. 22) to trap moisture that will otherwise be evaporated or transpired from the subsurface. Because maintaining low moisture content is a desirable feature for MDA L, an asphalt cover is not suitable for this site. Therefore, this technology was not retained.

Compacted Clay Cover

Compacted clay covers have successfully controlled excess infiltration at RCRA-regulated landfills located in humid environments. However, clay liners are far less effective in arid and semiarid climates because the clay tends to dry out and crack, allowing moisture to flow directly into disposal units (Mulder and Haven 1995, 071297, p. 7). Hence, compacted clay covers are not suitable for MDA L and the technology was not retained.

Multilayer Cover

Multilayer covers consist of layers of different geologic and synthetic materials placed in specific order to control various potentially detrimental processes and conditions at a site (e.g., infiltration, erosion, and biotic intrusion). RCRA Subtitle C covers fit within this category. Multilayer covers can be compromised if differential settlement occurs or if any of their components is unsuited for the site. At sites with potential for differential settlement, such as sites where significant waste depth has been placed without engineered uniform compaction during placement, and sites where clay components would become desiccated and crack, application of conventional multilayer caps is problematic.

At MDA L, the variation between settlement potential of excavated disposal units and surrounding geologic structures would be dramatic and deeper waste units might have the greatest potential. Although subsidence at MDA L would potentially be a long-term occurrence, its impact on the synthetic or geosynthetic membrane component(s) of a multilayer cover would be significant and could go unnoticed from the surface. The arid nature of the MDA L climate is also considered incompatible with typical clay component layers of the RCRA Subtitle C multilayer cover because of the cracking that occurs in clays with desiccation in a semiarid environment. However, this technology was retained because it meets RCRA requirements.

ET Cover

ET covers are designed to provide infiltration protection for arid environments, where materials such as clays and synthetic/geosynthetic membranes are less reliable. ET covers can consist of a single vegetated soil layer or can be designed with multiple layers of geologic materials suited to achieve the ET criteria necessary. Suitable vegetation is a significant component for most ET covers, to aid in the dewatering of the cover material(s). The vegetated ET cover was developed specifically for landfills located in arid and semiarid environments like Los Alamos (Barnes et al. 1990, 070209, pp. 1201–1202). The earliest research in this area was conducted at Los Alamos, at a test site within 1 mi of MDA L (Nyhan et al. 1984, 008797; Nyhan 1989, 006876; Nyhan et al. 1989, 006874). Cover system design guidance has also been developed that provides requirements and considerations for design of cover systems at the Laboratory (ITRC 2003, 091330; Daniel B. Stephens & Associates Inc. 2005, 089548). An engineered ET cover would enhance the existing MDA L cover. The technology was retained.

Biotic Barriers

Various materials have been used to control the intrusion of plants and/or animals into hazardous landfills. Installation of horizontal barriers constructed of cobble-sized rocks or pea gravel inhibits deep-rooting plants and discourages burrowing animals. Chain link fencing laid on the surface of a cover has been successfully used at a Laboratory site to discourage burrowing animals, while having no observable impact on beneficial vegetation (LANL 1999, 063919). Either of these biobarriers could be used as a stand-alone technology or could be incorporated into enhanced cover designs considered for MDA L. The technology was retained.

6.1.2 In Situ Treatment Technologies

In situ waste treatment technologies are used to reduce the mobility and/or toxicity of wastes or to increase their stability without removing the wastes from their disposal location. The different in situ methods (biological and physical) discussed in this section are appropriate for different contaminants and disposal environments.

6.1.2.1 Biological Treatment Technologies

Biological methods, using various microorganisms, have been effective in metabolizing a variety of organic contaminants and also in changing solubility of certain inorganic chemical and radioactive species in low concentrations in wastewater treatment processes. Unfortunately, uniform delivery of the biological agents into the contaminated soil poses much greater difficulties than in wastewater. Furthermore, the dry soils present at MDA L reduce the transport of necessary nutrients to the biological agents. Biological treatment is also less viable for many chlorine containing organics chemicals and/or can lead to more toxic by-products than the original contaminant, (i.e., TCE to vinyl chloride). Therefore, biological treatment is not viable at MDA L, and the technology was not retained.

6.1.2.2 Chemical Treatment Technologies

None of the available in situ chemical treatments (i.e., soil flushing and chemical oxidation) were considered potentially applicable to the MDA L site setting because of difficulties in delivering the reactive chemicals uniformly to the soil. Incorporating large quantities of hazardous oxidizing materials poses additional concerns for workers and possibly the environment. These technologies were not retained in this screening process.

6.1.2.3 Physical Treatment Technologies

In situ physical treatment technologies are a diverse grouping of technologies that include methods to remove mobile contaminants, to increase mobility of contaminants, to further stabilize contaminants, and to destroy contaminants in place. The benefit derived from most in situ treatments is the reduction in exposure potential for workers over ex situ treatment options. The decision to use in situ treatment may vary from waste unit to waste unit in MDA L, based on the types and orientations of wastes, their potential to produce future risks, and the availability of other options. The following presents in situ physical treatment technologies considered.

Soil-Gas Venting

Soil-gas venting consists of open boreholes drilled into the contaminated matrix that allow the release of subsurface vapors and gases to the atmosphere or through a treatment system. This technology is primarily applicable to VOCs. Therefore, soil venting was retained for further consideration.

Soil-Vapor Extraction

This technology uses vacuum blowers to accelerate the removal of subsurface gases or vapors. The blowers create a negative pressure or vacuum in one or more boreholes. The vacuum removes the gasses or vapors from boreholes by advective transport. This technology commonly requires a treatment system for the vapor that is extracted from the subsurface. An SVE pilot study conducted at MDA L in 2006 (LANL 2006, 094152) supports the retention of this technology for further consideration.

Pneumatic Fracturing

Pneumatic fracturing uses the injection of a fluid under pressure to create open fractures in an area in which a contaminant plume exists. Opening flow paths allows access to the contaminated media for removal or treatment. Pneumatic fracturing has the potential for introducing large amounts of water into a formation that has optimal low moisture content and is not desirable. Therefore, pneumatic fracturing is not a reasonable technology for MDA L.

Electrokinetic Soil Treatment

Electrokinetic soil treatment is an in situ process for the continuous removal of ionic or charged species from soils including heavy metals, radionuclides, and ionized organic chemicals. The technology is implemented by passing a direct current through the soil. The effectiveness of this technology is dramatically reduced in low soil moisture applications, such as MDA L and the use of direct current in the vicinity of the waste unit is problematic because of buried metal objects. The technology was not retained.

Electroacoustic Treatment

In situ electroacoustic soil decontamination is an emerging technology used for decontaminating soils containing organic chemicals. As with electrokinetic soil treatment the effectiveness of this technology is reduced in low soil moisture applications and the use of direct current in the vicinity of the waste unit is problematic because of buried metal objects. This technology was not retained.

Dynamic Compaction

Dynamic compaction is used to compact and consolidate wastes in place to reduce the potential for settling or sinking over time. The technology has been successfully demonstrated on landfills where subsidence (settling) over large areas is possible, leading to potentially significant run-on and infiltration of surface water. The technology is potentially applicable for waste units at MDA L, if it is determined necessary to reduce potential subsidence, in conjunction with a cover technology. The technology was retained for further consideration.

Waste Stabilization

The infiltration and movement of surface water into/through MDA L waste disposal units and the future potential for subsidence of waste and overburden might be reduced by injecting stabilization materials into/around waste to reduce the porosity within and between objects. In one method, grout is injected into holes drilled through the waste, while simultaneously pulverizing the waste and mixing it with the grout. This approach is only applicable for bulk managed soil-like wastes. A second waste stabilization method involves the direct injection of grout into void spaces surrounding waste, such as might be present in some disposal units at MDA L. Another technology, a viscous liquid barrier system, uses low-pressure permeation grouting to deliver a colloidal-silica grout to the subsurface. The grout is pumped as a low viscosity liquid and then the grout gels in place forming a barrier to liquid movement. These stabilization technologies were retained for further consideration for pits and impoundments. They are not applicable to drums containing solvents in shafts.

6.1.2.4 Thermal Treatment Technologies

Thermal treatment technologies have been developed and implemented to decompose heat sensitive contaminants into less toxic or less mobile forms, or to enhance the extractability of a contaminant by heating it into a vapor phase. Heat is generated or delivered using microwave radiation, radio frequency radiation, or thermal radiation energy, or via direct conductance of electricity or injection of already heated materials (such as steam).

Thermal Treatment

In situ heating of media at MDA L by steam or hot-air injection, electrical resistance, electromagnetic, fiber optic, or radio frequency is used to increase the volatilization rate of semivolatiles (and volatiles) and facilitate extraction. Thermal treatment, particularly in combination with SVE, could prove beneficial at several locations at MDA L. However, this technology was not retained because modeling suggests that SVE by itself is sufficient to prevent migration of existing and future sources of VOCs to regional groundwater (Appendix F).

Vitrification

Several in situ vitrification technologies exist for solidifying waste masses in the ground. In situ vitrification uses electrical resistance to heat soil or rock (and waste materials) to temperatures high enough to melt them. When the melted materials cool, a glass-like material is formed. In situ vitrification produces an essentially impermeable mass. Competing vitrification applications achieve waste stabilization by alternative techniques. The surface down melt-in method has the potential to trap volatilized gases under molten waste/matrix and has been prone to catastrophic release in some situations. An alternative method that melts waste and matrix between two electrodes at all depths simultaneously has been shown to achieve similar result more safely. Electrodes are successively moved to create multiple melt planes in parallel until the necessary application coverage is achieved.

In situ stabilization technologies generally achieve similar performance objectives more cheaply than in situ vitrification and without the risk of mobilizing volatile wastes. Therefore, this technology was not retained for further consideration.

6.1.3 Excavation/Removal Technologies

The potential for use of excavation/removal of materials at MDA L varies greatly among waste units based on issues such as their potential to produce long-term environmental risk versus increased short-term risk of excavation, treatment necessary to meet disposal requirements at another site, and costs and risks of shipment of large quantities of material off-site. Complete excavation of the entire area, including the shafts, requires substantial layback of overburden soil as summarized in section 6.1.3.2 and discussed in detail in section 8.3. Partial excavation of the impoundments or pit at MDA L was evaluated.

6.1.3.1 Waste Container Retrieval

Although access to the MDA L disposal shafts can be gained by removing the concrete caps from the tops of the shafts, the small diameter of the shafts provides a limited space for manipulating the shaft contents. A remotely operated backhoe will not be able to access and remove objects located deeper than approximately 10 to 12 ft (3 to 3.6 m). Deep removal can only be accomplished by using a crane and manual rigging equipment, which cannot be done remotely. While not impossible, this type of excavation is not desirable because of potential risks to workers. Use of grappling devices or magnetic lifts is possible for certain inventory items; however, because of size or shape, many items could be removed only by manual rigging. Therefore, the safety hazards of working in the narrow shafts at depths greater than 12 ft (3.6 m) eliminate vertical shaft excavation as a viable technology for MDA L.

6.1.3.2 Trench Excavation

Removal of the wastes from the MDA L shafts could be performed by excavating a large trench access area along the side of shafts, making removal by backhoe and crane more viable. This technology is routinely used at MDA G to excavate trenches to a depth of up to 65 ft (19.8 m) in unit 2 of the Bandelier Tuff. An overburden cut to the north would require removing pits and impoundments, thus providing a complete excavation alternative. Layback of overburden to the south is prohibited by buildings in the area. This technology was retained for further evaluation.

6.1.3.3 Bulk Waste Retrieval (Partial Waste Excavation)

Waste in surface impoundments at MDA L can be removed using large-scale soil moving and excavating equipment and containerization tools. The waste characterization analysis of the samples collected from the former surface impoundments (LANL 2007, 096409, Appendix E) identified the material in the impoundments as hazardous waste. Current overburden will be removed and the waste excavated and stored in new waste containers, directed for waste treatment and/or for off-site disposal. The analysis of the inventory data of the waste in Pit A indicates that no path forward is available for disposal of many of the waste items. This technology was retained for further consideration for the impoundments.

6.1.3.4 Large-Area Containment Structure

Because of the need for any bulk waste retrieval operation to be of a large enough size to permit the activity to be completed relatively quickly, a large containment structure over the operation would be required at MDA L. Containment would enable control of released VOCs and site workers would work in supplied air (level B) personal protective equipment (PPE). An enclosure would allow for multishift operation in most weather conditions and without producing unacceptable levels of airborne particulate and VOCs off-site. Use of a large enclosure would require a VOC destruction technology such a catalytic oxidizer. This technology was retained for further consideration.

6.1.4 Ex Situ Treatment Technologies

If excavated and removed, MDA L waste materials and/or contaminated media require characterization to be recycled or to make a determination as to whether the waste material meets the waste acceptance criteria of both on- and off-site treatment, storage, and disposal (TSD) facilities. Additionally, some of the waste may require treatment before it is recycled or emplaced in an approved on- or off-site facility. General treatment technologies include neutralization, extraction, thermal treatment, stabilization, and the various debris treatments specified under RCRA.

6.1.4.1 Biological Treatment Technologies

The organic concentrations in media at MDA L are sufficiently high to kill or greatly impede the activity of biological agents. No biological treatment options were considered potentially applicable to a significant portion of the MDA L materials that might be excavated and were not considered in the screening process.

6.1.4.2 Physical/Chemical Treatment

Soil Washing

Contaminants preferentially sorbed to particulates can be removed from soils by removing the fine-grained portion of the soil by washing. This technology is not retained because the corrective measure is for waste rather than soil.

6.1.4.3 Chemical Treatment Technologies

Extraction

Acid or solvent extraction technologies permit the separation of specific constituents from the remaining waste mass. Treatment is normally performed in batches so that specific parameters can be controlled for the waste to achieve treatment goals. Extracted material can sometimes be recycled and reused. This technology has the potential to address a variety of MDA L contaminants and has been retained.

Wastewater Treatment

During the installation of any selected corrective measure at MDA L, contaminated wastewater may be generated. Wastewater treatment technologies have been retained for further consideration.

6.1.4.4 Physical Treatment Technologies

Cement Stabilization

Some materials may require stabilization in Portland or other cement matrices before it is disposed of as a hazardous or mixed waste. This technology is well-demonstrated throughout the waste management industry, including customized additives to address unusual contaminants, and may be a suitable technology for a portion of the wastes that might be excavated at MDA L. This technology was retained.

Alternative Stabilization/Encapsulation Technologies

Ex situ stabilization technologies generally address the need to create a waste form that will not allow target contaminants to leach from the waste matrix to potentially impact disposal site groundwaters. Leachable metals and RCRA constituents generally drive this form of treatment. Stabilization and encapsulation technologies beyond cement-based techniques have been developed to reduce overall waste volume, address contaminants not well-stabilized by cement chemistry, or achieve greater waste loading potentials. The range of alternative stabilization/encapsulation technologies was not retained because a large percentage of MDA L wastes would not benefit from these technologies.

Debris Treatment

Much of the waste that would be generated from excavation of MDA L disposal units meets the RCRA definition of debris. The alternative treatment standards for hazardous debris are specified in 20.4.1.800 NMAC, which incorporates 40 CFR Section 268.45. For example, macroencapsulation is one of the immobilization technologies that may be used to reduce potential for leaching of lead or lead-containing debris. A variety of debris treatment technologies could be suitable for MDA L debris.

6.1.4.5 Thermal Treatment Technologies

Ex situ thermal treatment technologies generally include techniques to mobilize contaminants for removal from contaminated media or to destroy contaminants. A wide variety of ex situ thermal treatments exist, including thermal desorption, steam extraction, incineration, catalytic destruction, and vitrification (which is both a thermal and physical treatment). Heat is supplied using microwave, radio frequency, or thermal radiation energy delivered to the contaminant by various means or through direct conduction of electricity.

Thermal Desorption

Although VOCs, SVOCs, and tritium in wastes at MDA L and other volatile constituents can be separated from the wastes using thermal desorption techniques, it is not likely these materials will be removed from their pits. Therefore, this technology was not retained for further consideration.

Thermal Destruction

Pyrolysis and incineration are the two primary technologies that provide thermal destruction of organic materials. Pyrolysis is primarily an anaerobic process, whereas incineration is intended to describe the controlled combustion of materials in an aerobic environment. Pyrolysis may be performed in a refractory-lined rotary kiln, in a fluidized bed, or in a molten salt bed. Combustible gases produced during pyrolysis must generally be burned off as part of the treatment. Incineration may also be performed in a rotary kiln or a fluidized bed, or in other equipment arrangements.

As with thermal desorption, although the technique is possible for use for organic wastes found in the MDA L pit, it is unlikely these materials will be excavated. This technology was not retained for further consideration.

Vitrification

Ex situ vitrification generally includes the mixing of waste with materials that produce glass-like substances when heated sufficiently, especially if the waste matrix does not readily form a glass. Vitrification can often result in a waste volume reduction, especially in comparison with cement-stabilization as an alternative. Vitrification is particularly suited to large homogeneous waste streams, because development costs for waste-specific applications generally far exceed waste minimization paybacks versus cement stabilization for smaller waste streams; therefore, the technology was not retained.

6.2 Screening of Corrective Measure Technologies

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

For the MDA L CME, the screening of technologies included

- a review of site setting and characterization data and the CSM described in the investigation report (LANL 2006, 091888, pp. 9-15, 20-26) identify conditions that may limit or promote the use of certain technologies;

- identification of waste characteristics that limit the effectiveness or feasibility of technologies; and
- identification of the level of technology development, performance record and inherent construction, operation and maintenance problems for each technology considered.

6.3 Optimized List of Technologies

Candidate corrective measure technologies were evaluated above based on site conditions, waste characteristics, technology limitations, and comparative criteria among technologies, such as range of applicability and cost. Technologies considered potentially applicable were retained for further consideration in developing corrective measure alternatives for MDA L.

7.0 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURE ALTERNATIVES

The CME plan identified an initial set of corrective measure alternatives for MDA L (LANL 2006, 094805, p. 15) based on an evaluation of specific information on site conditions, including the contaminant inventory, the design of the disposal units, the environmental setting, and the nature and extent of contamination. The formal process for alternative identification and screening employed in this CME began with the identification and screening of technologies that could be used to address contaminants at MDA L, either individually or in combination (section 6). The following subsections identify potential corrective measure alternatives for MDA L using technologies retained and provide an initial screening to a subset of alternatives that are carried forward into the formal evaluation presented in section 8.

7.1 Activities Before Implementation of Corrective Measures

Before any corrective measure is implemented, the surface structures at the site will be removed and foundations and the asphalt pad characterized and also removed. These activities are not part of the CME.

7.2 Identification of Corrective Measure Alternatives

In addition to the Consent Order requirements applicable to MDA L, the radioactive wastes are regulated under DOE Order 435.1 and DOE Order 5400.5. These orders impose specific annual dose and radioactive gas flux criteria, which must be met at the site if wastes are left in place to ensure protection of the public and the environment. With the exception of the no action/no-further-action alternatives, the potential corrective measure alternatives developed for MDA L emphasize either isolation and containment of source materials left in place or excavation and movement to a more secure or dedicated location off-site.

Based on the exposure routes identified in the MDA L CSM (LANL 2006, 091888, p. G-24), potential future risks to the public may result from exposures to contaminants migrated from the site (sediment and surface water runoff, airborne particulate and gases, and groundwater) or direct exposures to contaminants at MDA L from inadvertent intrusion into the area. Contaminant migration could result from release of gaseous or vapor-phase contaminants from the site surface, exposure of buried waste by erosion or biointrusion processes, or infiltration into buried wastes and contaminated media by surface water. Exposure pathways include food-web contaminant uptake, ingestion/inhalation, dermal contact, and external radiation resulting from contamination of groundwater, surface water, air, or food sources or a combination thereof.

The CME plan presents a total of 10 corrective measure alternatives in 5 general categories (LANL 2006, 094805, p. 15). These preliminary alternatives have been revised and refined to incorporate technology options considered to be supportive of primary alternatives. The revised alternatives incorporate the results of the technology screening described in section 6 and provide additional definition to support initial screening in this section and evaluation in section 8 of the CME.

MDA L contains both intact buried wastes and contaminants that have migrated from waste disposal zones, into adjacent environmental media. The identified corrective measure alternatives were developed to contain and/or remediate the buried waste source materials and adjacent contaminated environmental media.

Based on the results of the MDA L risk assessment presented in the investigation report (LANL 2006, 091888, pp. G-19-G-20), the presence of tritium and organic compounds in the tuff matrix is not a significant risk to human or environmental receptors. Since VOCs in the vadose zone do not decay, SVE has been included as part of all alternatives, except Alternative 1A. Active and/or passive SVE technologies will be operated until cleanup levels for VOCs in subsurface pore gas are achieved. The effectiveness of SVE was demonstrated in a pilot study in 2006 (LANL 2006, 094152). Tritium decays with a 12.3-yr half-life, so soil and air concentrations are reduced over time. Diffusion of tritium from observed concentrations in environmental media and subsequent radioactive decay of tritium will act to further reduce localized risks; therefore, the containment and source removal corrective measure alternatives presented in this section do not include technology options to specifically address tritium.

A list of viable corrective measure alternatives is presented below arranged from the no-further-action alternatives through complete source removal of wastes from the site.

7.2.1 No Further Action Alternatives

- Alternative 1A, No further action, monitoring only
- Alternative 1B, Improved natural cover, SVE, monitoring and maintenance

7.2.2 Enhanced Source Management Alternatives

- Alternative 2A, RCRA Subtitle C final cover, SVE, monitoring and maintenance
- Alternative 2B, Engineered ET Cover, SVE, monitoring and maintenance
- Alternative 3, Engineered ET cover in combination with targeted waste stabilization, SVE, monitoring and maintenance
- Alternative 4, Comprehensive waste stabilization, SVE, monitoring and maintenance

7.2.3 Source-removal Alternatives

- Alternative 5A, Engineered ET cover in combination with partial waste excavation and off-site disposal, SVE, monitoring and maintenance
- Alternative 5B, Complete waste source excavation, waste treatment, off-site disposal, SVE, monitoring and maintenance

7.3 Description of Preliminary Corrective Measure Alternatives

Alternatives in section 7.2 are described more completely in the following subsections and summarized in Table 7.3-1.

Major distinctions between the alternatives include building different kinds of covers, stabilizing waste, and performing either partial or complete waste excavation. Most alternatives include SVE because of the VOC plume in the unsaturated zone and a continuing source from leaking drums in shaft disposal areas.

For the purpose of comparison, two time periods are used. According to 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120, the time of postcare closure monitoring and maintenance is 30 yr. This 30-yr RCRA period is applied to complete excavation alternatives that remove the waste and allow SVE remediation to be completed in that time frame and to the RCRA cover alternative.

The second time period, 45 yr, applies to any alternative that leaves in-place wastes with VOCs. According to Stauffer and Hopkins (2004, 098533, p. 3), the drums containing VOCs are predicted to fail within 70 yr of being emplaced. Because the last drums were placed in shafts in 1985, most drums are predicted to fail by 2055. It is assumed that with a start date of 2010 for the selected corrective measure alternative, the 45 yr time frame for SVE (until 2055) should encompass the predicted drum failure period and the time needed to remediate with SVE. It is anticipated that an active SVE system would operate for the first 30 yr and then covert to a passive SVE system to be monitored for an additional 15 yr. Modeling by Stauffer et al. (presented in Appendix F) indicates that the active SVE system is most effective if operated 2 months on followed by 22 months off.

The active institutional control period for all alternatives is 100 yr as per DOE Order 435.1, “Radiation Waste Management.”

7.3.1 Alternative 1A, No Further Action, Monitoring Only

The monitoring only alternative is considered the no-further-action alternative for MDA L. The surface structures would undergo D&D, the RCRA CSUs decontaminated and closed, and the existing asphalt cover left as is. The baseline alternative includes continued monitoring of the subsurface vapor-phase VOC and tritium plumes and moisture monitoring. Institutional controls that deter intrusion for at least 100 yr following closure are required under DOE Manual 435.1 to verify attainment of the performance objectives.

Continued monitoring may indicate that the existing cover will be sufficient to attain the performance objectives. For this alternative, no effort will be made to maintain the containment systems (i.e., shaft covers) or to control any releases that occur. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr.

7.3.2 Alternative 1B, Improved Natural Cover, SVE, Monitoring and Maintenance

This alternative is similar to Alternative 1A, with the addition of the following items: removal of the asphalt pad and concrete ringwalls, construction, inspection and maintenance of a vegetative cover, operation of a SVE system and monitoring. This alternative includes the monitoring described in Alternative 1A. Any cover damage or releases identified during monitoring will be addressed through maintenance activities to the cover and SVE systems.

This alternative includes postclosure monitoring and maintenance of the facility for 30 yr or more as required for RCRA CSUs under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120.

7.3.3 Alternative 2A, RCRA Subtitle C Final Cover, SVE, Monitoring and Maintenance

RCRA-hazardous waste present in MDA L results in the consideration of a RCRA-compliant cover or equivalent alternate for the waste, if the waste is to remain in place. A RCRA Subtitle C cover design compliant with 40 CFR Section 264.310(a)(5) is prescribed by EPA as a base design and adopted by the State of New Mexico in 20 NMAC 4.1.500. The RCRA Subtitle C standard final cover incorporates the following layers, from base to surface:

- A composite barrier layer consisting of a minimum 2-ft- (60-cm-) thick layer of compacted natural or amended soil with a maximum saturated hydraulic conductivity of 1 x 10^{-7} cm/s in intimate contact with a minimum 40-mil geosynthetic membrane overlying the soil layer. The function of this composite barrier layer is to limit downward moisture movement.
- A drainage layer consisting of a minimum 1-ft- (30-cm-) thick sand layer having a minimum saturated hydraulic conductivity of 1 x 10^{-2} cm/s, or a layer of geosynthetic material having the same characteristics;
- A top vegetation/soil layer consisting of a minimum 2 ft (60 cm) of soil graded at a slope between 3% and 5% with vegetation or an armored top surface.

Engineered covers represent one of the primary containment alternatives for subsurface waste disposal units. The RCRA Subtitle C multilayered landfill cap is a baseline design recommended for use in RCRA hazardous waste landfill applications. This alternative includes postclosure monitoring and maintenance of the facility for 30 yr or more as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120.

NMED requires hazardous waste disposal facilities to meet a set of performance criteria over a 30-yr period following closure, as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120, Alternative 2A includes SVE and monitoring and maintenance. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr per DOE guidelines. Monitoring for this alternative includes the parameters listed for Alternative 1A. Maintenance includes inspection of the cover by site walkover, removal of deep-rooted plant species, repair of damage from animal burrows, and placement of cover materials in any eroded areas following storms of specified magnitude.

7.3.4 Alternative 2B, Engineered ET Cover, SVE, Monitoring and Maintenance

In a semiarid climate, such as that of MDA L, a final waste cover designed to facilitate evaporation and transpiration is a more effective design than the RCRA Subtitle C landfill cover. RCRA regulations provide for consideration of alternative requirements as long as they are protective of human health and the environment (40 CFR Section 264.110 for permitted facilities, although similar consideration is given for interim-status facilities). NMED provides guidance for alternative covers in Guidance for an Alternate Cover Design under Section 502.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) using HELP Modeling (NMED 1998, 071299).

This alternative includes an ET cover placed over existing soil after the asphalt paving has been removed. This approach takes advantage of the semiarid site conditions by evaporating and transpiring water from the cover. The resulting moisture deficit limits infiltration to less than that of a RCRA Subtitle C cover. The surface of the cover has minimum slope to limit erosion. A soil-gravel admixture placed on the surface weathers to create desert paving and protects the cover from high intensity rainfall. Compared to the RCRA Subtitle C cover design, the ET cover includes only small quantities of or no clay and no geosynthetic membrane materials, both of which are considered more likely to fail to protect the wastes from infiltration as a result of clay-desiccation cracking and polymer degradation.

Engineered ET covers have demonstrated effectiveness in reducing infiltration in semi-arid regions (Davenport et al. 1998, 069674, p. 1; Dwyer et al. 2000, 069673, pp. 23–26). Engineered ET cover benefits include, but are not limited to, more readily available construction materials, ease of construction, less complex quality assurance/quality control programs, greater cost-effectiveness, increased long-term sustainability with decreased maintenance (ITRC 2003, 091330, pp. iii–iv), and better integration with the native terrain. ET covers can be adapted to enhance specific desired properties for a given application, such as increased erosion resistance with the addition of gravel surface amendments; enhanced or limited plant growth and types for transpiration by varying depths of enriched soil; modification of the size of the ET reservoir layer above the waste layer by varying the depths of the primary crushed-tuff ET layer; or prevention of biointrusion by using barriers such as cobble, chain-link fencing, or pea-sized gravel.

A preliminary design concept prepared for MDA L includes a 1.5-ft- (0.46-m-) thick vegetated soil-gravel admixture on the surface of the cover. Conceptual design of the soil-gravel admixture (rock mulch) is based on 1000-yr storm conditions and actual slope segments. Below that the rock mulch is a 3.5 ft-thick infiltration layer composed of crushed tuff mixed with soil and amendments to provide water storage and minimize infiltration. The bottom cover layer is contains a filter medium of gravel and a biobarrier of cobbles. Alternative 2B-minimizes upslope run-on, erosion on the top slope, biointrusion and visual impacts.

NMED requires hazardous waste disposal facilities to meet a set of performance criteria over a 30-yr period following closure as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120. Alternative 2B includes SVE and monitoring and maintenance. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr per DOE guidelines. Monitoring for this alternative includes the parameters listed for Alternative 1A. Maintenance includes inspection of the cover by site walkover, removal of deep-rooted plant species, repair of damage from animal burrows, and placement of cover materials in any eroded areas following storms of specified magnitude.

7.3.5 Alternative 3, Engineered ET Cover, Targeted Waste-Type Stabilization, SVE, Monitoring and Maintenance

This alternative includes using in situ waste stabilization technologies for select near-surface wastes to minimize cover thickness. Stabilization of targeted waste areas using soil-grout mixing technology will enhance biotic protection in locations where the technology is deployed and further reduce the potential for waste contaminant migration resulting from infiltration and intrusion. Stabilization would be used for Impoundments A, B, and C in the central portions of MDA L.

NMED requires hazardous waste disposal facilities to meet a set of performance criteria over a 30-yr period following closure, as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120. Alternative 3 includes SVE and monitoring and maintenance. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr as per DOE guidelines. Monitoring for this alternative includes the parameters listed for Alternative 1A. Maintenance includes inspection of the cover by site walkover, removal of deep-rooted plant species, repair of damage from animal burrows, and placement of cover materials in any eroded areas following storms of specified magnitude.

7.3.6 Alternative 4, Comprehensive Waste Stabilization, SVE, Monitoring and Maintenance

Complete stabilization of MDA L wastes, to the extent practicable given the available technologies, is considered an alternative to placing additional cover materials at MDA L. Jet-grouting technologies produce waste forms that predictably limit the availability of contaminants for migration and further restrict the flow of surface water through the waste mass, while effectively shielding the waste contaminants from accessibility to burrowing animals or plants.

Deeper waste disposal areas at MDA L, such as disposal shafts and Pit A, may not be fully stabilized if existing technology is used, but stabilization of the upper fractions of the waste may be achieved. Shafts would be jet grouted at depth.

This alternative includes the grading and extension of operational cover materials as necessary to direct surface runoff to drainage channels away from waste disposal units to further enhance surface water management.

NMED requires hazardous waste disposal facilities to meet a set of performance criteria over a 30-yr period following closure as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120. Alternative 4 includes SVE and monitoring and maintenance. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr per DOE guidelines. Monitoring for this alternative includes the parameters listed for Alternative 1A. Maintenance includes inspection of the cover by site walkover, removal of deep-rooted plant species, repair of damage from animal burrows, and placement of cover materials in any eroded areas following storms of specified magnitude.

7.3.7 Alternative 5A, Engineered ET Cover, Partial Waste Excavation with Off-site Disposal, SVE, Monitoring and Maintenance

This alternative incorporates the advantages of an ET cover for the semiarid climate of MDA L, as presented in Alternative 2B. Partial waste excavation is included in this alternative for wastes within impoundments B through D. Waste would be removed, characterized, and packaged for off-site disposal.

NMED requires hazardous waste disposal facilities to meet a set of performance criteria over a 30-yr period following closure as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120. Alternative 5A includes SVE and monitoring and maintenance. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr per DOE guidelines. Monitoring for this alternative includes the parameters listed for Alternative 1A. Maintenance includes inspection of the cover by site walkover, removal of deep-rooted plant species, repair of damage from animal burrows, and placement of cover materials in any eroded areas following storms of specified magnitude.

7.3.8 Alternative 5B, Complete Waste Source Excavation, Waste Treatment, and Off-site Disposal, SVE and Monitoring

This alternative provides for the complete excavation of wastes from MDA L followed by off-site disposal of the wastes at a permitted commercial hazardous waste disposal site or a site permitted to dispose of

MLLW. Waste treatment, characterization, and packaging requirements for waste acceptance at these off-site locations are included in this alternative.

This alternative includes SVE intermittently for up to 30 yr and monitoring and maintenance for 30 yr. as required under 40 CFR Section 264.310(b)(1) and 40 CFR Sections 264.117 through 264.120 since the waste source has been completely removed. Additional active institutional controls (control of site access and Laboratory administrative controls) are assumed to remain in place for 100 yr as per DOE guidelines.

7.4 Screening of Corrective Measure Alternatives

A screening process was used to reduce the number of alternatives by eliminating those not likely to be as effective as others identified. Screening was based on whether the alternative could meet the regulatory threshold criteria. Threshold criteria for the MDA L corrective action are as follows:

- protect human health and the environment
- attain media cleanup levels
- achieve source control
- meet off-site waste management standards

Additional qualitative screening criteria were used to evaluate alternatives that

- may not prove feasible to implement,
- rely on technologies not likely to perform satisfactorily or reliably, or
- would not achieve the target corrective measure objectives within a reasonable period of time.

This screening process eliminated alternatives with limitations relative to other identified alternatives, based on the waste and site-specific conditions at MDA L. The screening criteria and screening process is explained below, and the results of screening are presented and summarized in Table 7.4-1.

7.5 Corrective Measure Alternatives Retained for Evaluation

As identified in Table 7.4-1, four corrective measure alternatives were retained from the screening review performed for MDA L. The alternatives represent the best elements of the 10 preliminary alternatives presented in the CME plan (LANL 2006, 094805, p. 15) as well as the best technology options available for the site, based on the technology screening process discussed in section 6.2. The alternatives retained for evaluation in Table 7.4-1 meet the Consent Order criteria.

7.5.1 Alternative 1B, Improved Natural Cover, SVE, Monitoring and Maintenance

This alternative, which includes regarding and revegetation of the existing cover, was retained for evaluation because it represents a fully functional alternative for comparison with other more robust alternatives. The alternative may minimally meet all corrective action objectives and can be readily implemented but is not robust after the period of maintenance.

7.5.2 Alternative 2B, Engineered ET Cover, SVE, Monitoring and Maintenance

This alternative was retained because it provides all of the waste containment benefits (including reduced infiltration and biointrusion) and SVE of VOCs in the vadose zone. It eliminates the added short-term risks of in situ treatment associated with pressurization and/or drum rupture because of excavation of the shafts. The alternative is expected to meet all corrective action objectives in an efficient manner, is based entirely on well-demonstrated technologies and engineering principles, and can be readily implemented using materials widely available, many in the vicinity of the Laboratory. Alternative 2B is robust during and after the period of maintenance.

7.5.3 Alternative 5A, Engineered ET Cover, Partial Waste Excavation and Off-site Disposal, SVE, Maintenance and Monitoring

This alternative was retained because it provides the benefits of Alternative 2B and also removes the waste in Impoundments B, C, and D.

7.5.4 Alternative 5B, Complete Waste-Source Excavation, Waste Treatment, and Off-site Disposal, SVE, Monitoring and Maintenance

This alternative was retained because it provides an option to completely remove all waste from MDA L. This alternative is expected to meet all corrective action objectives, is based entirely on well-demonstrated technologies and engineering principles, and can be readily implemented using materials widely available, many in the vicinity of the Laboratory. This alternative is presented for comparison purposes and addresses stakeholder concerns of potential future risks leaving any waste in place.

8.0 EVALUATION OF CORRECTIVE MEASURE ALTERNATIVES

All corrective measure alternatives were screened according to the Consent Order threshold criteria and the additional screening criteria delineated in section 7.4. Four alternatives meeting these criteria were further analyzed based on the evaluation criteria specified in Section XI.F.10 of the Consent Order and in the MDA L CME plan (LANL 2006, 094805, pp. 22–23).

The detailed alternative evaluation was based on the applicability, technical practicability, effectiveness, implementability, human health and ecological protectiveness, and cost of each option. The corrective measure alternatives evaluated are listed below and shown in Table 8.0-1.

- Alternative 1B, improved natural cover, SVE, and monitoring and maintenance
- Alternative 2B, engineered ET cover, SVE, and monitoring and maintenance
- Alternative 5A, engineered ET cover, partial waste-source excavation, SVE, and monitoring and maintenance
- Alternative 5B, complete waste-source excavation and backfilling, off-site waste disposal, SVE, and monitoring and maintenance

SVE is part of each alternative to treat VOCs in pore gas. It is estimated that an active SVE system will operate for a minimum of 30 yr at which time the active extraction boreholes will be converted to a passive SVE system (soil venting) for a period of 45 yr. This CME report describes the pore-gas monitoring network and frequency. After an agreed period of time, the frequency of monitoring and type of SVE system will be reevaluated. The TA-54 groundwater monitoring network evaluation report (LANL 2007, 098548) recommends a groundwater-monitoring network that will characterize groundwater sufficiently to verify the effectiveness of the selected remedy. The control of site access and Laboratory administrative controls for the site are assumed to remain in place for 100 yr for all alternatives.

8.1 Alternative 1B: Improved Natural Cover, SVE, and Monitoring and Maintenance

Alternative 1B proposes revegetation of the site after removal of the asphalt cover, monitoring and maintenance of the cover and installation and operation of SVE.

This alternative was selected for evaluation because

- vegetation on the surface will provide some ET of soil moisture to limit infiltration under average climate conditions;
- the fence surrounding the site, the TA-54 access gate, and Pajarito Road access restrictions provide sufficient control against public access;
- the cover inspection and maintenance program includes measures to protect against severe erosion and to detect any areas of focused recharge; and
- unsaturated zone modeling has predicted no future impacts to groundwater with implementation of SVE (Appendix F).

At closure, the surface structures and concrete and asphalt pads will have been removed. The retaining wall on the north of the site would remain. Waste disposal practices at Pit A required ending waste disposal 3 ft below grade and backfilling with crushed consolidated tuff. Impoundments B, C and D were filled to the existing grade with a minimum of 3 ft of crushed tuff. Disposal shafts range from 3 to 8 ft in diameter and from 15 to 65 ft in depth (LANL 2004, 087624, p. B 1). These shafts were capped with 3 ft (0.9 m) of concrete to the existing grade. The existing slopes range from four to 12% over the waste areas. A topographic map of the final configuration of Alternative 1B is presented in Figure 8.1-1. A small wire-mesh fence would be buried around the perimeter of the site to limit access by small burrowing animals.

8.1.1 Applicability

Regular inspection of the facility will allow early detection of damage to access barriers and to the cover from biointrusion and erosion, and detection of intruders. These problems can be repaired periodically to maintain the improved natural cover performance.

Except for the release of VOCs (which are addressed by SVE), RCRA waste disposed in the MDA L facility is stable and not prone to migration in the absence of infiltrating precipitation. Downward migration of contaminants is limited in the semiarid environment of northern New Mexico because low precipitation and high potential ET create a moisture deficit. Infiltration modeling, which is summarized in Appendix D, has demonstrated that continuous infiltration through and below the cover is limited to less than 1.2 in./yr for 3 ft of native tuff. However, a cover thickness of 6.6 ft would be required to minimize flux to less than 0.04 in./yr because of the poor water storage capacity of the crushed tuff used as backfill in the pits. Because the improved natural cover is only 3 ft thick, infiltration exceeds the value specified by NMED for a RCRA-equivalent Subtitle C cover. Modeling has shown that VOCs will not migrate to the regional aquifer with implementation of SVE (see Appendix F). It is expected that tritium will not travel as fast as the VOCs since the Henry’s Law constant is low, leading to a much lower effective diffusion coefficient for tritium. Therefore, by the time the tritium reaches the regional water table, it will have decayed below the EPA MCLs (Appendix F). Periodic site inspections will be performed to evaluate erosion and assess the need for maintenance.

SVE provides suitable treatment for VOCs. The technology is typically applicable to volatile compounds with a vapor pressure greater than 0.02 in Hg or a Henry’s law constant greater than 0.01. SVE effectiveness is also influenced by factors such as the soil moisture content, organic content, and air permeability. SVE does not extract heavy oils, metals, PCBs, or dioxins, but it often promotes in situ biodegradation of low-volatility organic compounds because of the continuous flow of air through the soil. A pilot test at MDA L showed that SVE can successfully remove large quantities of VOCs from the unsaturated zone (see Appendix F). Because of the potential for leaking drums, it is assumed that an active SVE system would need to operate for 30 yr intermittently and a passive SVE system for up to 15 yr (unless results showed no need for continued operation). For evaluation purposes, 30 yr of active SVE operation was assumed based on the possibility that the rupture of drums in storage shafts may occur in the future and will require remediation.

Pore-gas monitoring would be conducted in existing boreholes to determine when target remediation goals are met, as described in the long-term subsurface vapor-monitoring plan (Appendix H). SVE operation includes extraction from the two existing 200-ft deep boreholes in the eastern and western areas of the site. Two vacuum blowers and off-gas treatment units would be placed next to each extraction well. The extraction wells would be operated 2 months on and 22 months off and converted to passive venting boreholes when the source is reduced to a mass that can be effectively controlled using passive venting (assumed to be 30 yr).

8.1.2 Technical Practicability

Inspection and maintenance of MDA L is technically practicable and is the method currently employed to ensure the integrity of the disposal units. Native vegetated soil cover has been used for nearly 50 yr at adjacent MDA G with minimal maintenance (LANL 2005, 090513, p. vi). Inspection will include a monthly site walkthrough to find areas where gullies are forming, areas where subsidence has occurred, and areas where focused recharge may occur. Maintenance includes repairing gullies and subsidence areas with rock armor or additional fill. Deep-rooted plant species will be removed from the cover and steps taken to maintain native grass species on the cover. The practicability of inspection and maintenance procedures have been demonstrated at the site during the past 20 yr, where existing procedures ensure that access barriers are inspected and maintained as part of the TA-54 nuclear facility authorization basis.

8.1.3 Effectiveness

Erosion modeling in Appendix E indicated that vegetative soil covers are effective at controlling erosion. However, they are not effective under conditions of bare soil with high erosion potential (i.e., steep slope and soils with low cohesion soil). The corrective measures study report for the MDA H native vegetative cover adjacent to MDA L indicate that a minimally maintained cover has been effective in containing surface and subsurface contaminants to levels that do not pose a potential risk to human health or the environment (LANL 2005, 089332, p. 36). The cover will be irrigated over the first 2 yr to establish a vegetative cover that provides transpiration and erosion control.

Current inspection and maintenance procedures at MDA L enable early detection of damage to access barriers, deterioration of erosion controls, evidence of intruders, or damage from biota. This monitoring is necessary because the cover lacks gravel mulch for erosion protection. The remaining cover has steep slopes (4% to 12%) that are easily eroded under bare soil conditions. The cover will be inspected and repaired after high-intensity storms that have the most deleterious effect on cover performance. Repair of subsided areas will prevent areas of focused recharge, but the remaining cover surface is not optimized for subsidence prevention.

An inspection would occur after every storm with an intensity of 3.9 in/h (9.9 cm/h) or greater. Erosion modeling results from Appendix E indicate an average annual soil loss 28 tons/acre/yr (62 T/ha/yr) for bare soil conditions, which exceeds the design goal of 2 tons/acre/yr (4.5 T/ha/yr). Under bare soil conditions, 14 in. (36 cm) of soil would be eroded every 100 yr. The cover should meet the average annual erosion design goal under vegetated conditions. Erosion after a 100-yr storm with only 30% ground cover is 3.96 tons (3.59 T) of sediment from the entire site, or an average depth of 0.004 in. (0.009 cm).

Implementation of SVE will reduce waste volume.

Moisture monitoring will be performed to ensure the cover is performing as designed.

Alternative 1B does not provide sufficient protection of human health and the environment after the monitoring and maintenance period because it is susceptible to erosion under bare soil (drought) conditions or after high-intensity storms. The performance issues described in section 9.2 include no protection from biointrusion. In addition, Alternative 1B is not protective without maintenance, Therefore, if this alternative were selected, maintenance will be required for an indefinite period.

8.1.4 Implementability

Implementation of Alternative 1B poses no administrative or technical implementation challenges. The equipment and materials required are readily available. Except for installation of the SVE system, asphalt and concrete pad removal, and regrading and revegetation of the cover, no additional construction is required. Therefore, this alternative can be immediately implemented upon closure of MDA L.

However, when RCRA units are intermingled with the units under the Consent Order, the cover must meet the infiltration requirements of a RCRA Subtitle C cover. Because the Alternative 1B cover does not meet these requirements, the alternative can be implemented only if the RCRA units were closed under alternative closure requirements.

8.1.5 Human Health and Ecological Protectiveness

Impacts to human health and the health of ecological receptors from implementation of the remedy are assessed separately as the remedy implementation/installation period (short-term) and the remedy operation period (long-term). This separation distinguishes between hazards associated with construction of the remedy and hazards associated with cover maintenance and SVE operation. The monitoring and maintenance period following completion of the cover installation is assessed under long-term effects.

8.1.5.1 Injuries and Accidents

This alternative is currently protective of human health, as environmental monitoring data has shown that any potential exposures at the MDA L fence line are within applicable standards for protecting human health. Human intrusion to MDA L is prevented by institutional controls.

Upon closure of MDA L, the disposal area surface will be cleared of buildings, structures, asphalt and concrete, regraded, and revegetated. Impacts to human health from accidents and injuries would be associated with the physical hazards of routine erosion control and surface maintenance activities and traffic risks associated with the transportation of raw materials necessary for this maintenance. Exposure to buried waste contaminants is not anticipated during these activities, except for surface flux concentrations of tritium and organic chemical vapors

Worker risks associated with the implementation of the remedy are primarily a function of accident incidence rates for each work type and the number of hours of work required by type. Assuming that all the project work hours are categorized as construction work, an incident rate of 6.3 nonfatal injuries per 100 full-time workers (or per 200,000 work hours) (3.1×10^{-5} nonfatal injuries per work hours) would apply (DOL 2006, 097080). The total of 227,000 work hours estimated for maintenance of the cover surface results in an estimated 7 nonfatal injuries for the cover installation project.

Fatality incidence rates for the same work, based on 2005 statistics for the construction industry (DOL 2006, 097080) at 5.5×10^{-8} per work hour, would result in no fatalities (less than 1 fatality) predicted for the cover installation project.

The risk of vehicle traffic accidents associated with the remedy is considered a function of total miles of travel for the project vehicles. The average fatal accident rate, per vehicle mile for large trucks, of 2.3 fatal accidents per 100 mil mi or 2.3×10^{-8} fatal accidents per mile (DOT 2002, 097082, p. 2).

Using these rates and an estimated maximum of 66,640 truck-transport mi on public roads for delivery of project resources, an overall incident rate for fatal traffic accidents for the project is predicted to be 2.47E^{-02}.

The cover maintenance program will be performed under the rigorous workforce safety awareness program in place for all Laboratory workers and subcontractors, including detailed job planning, job-specific training, and safety monitoring by Laboratory health and safety disciplines. Government project injury incidents rates have typically been lower in relation to the general construction industry. As a result, injury and accident incidence on the project can be expected to achieve the much lower incidence rates historically applicable to the federal government workforce.

8.1.5.2 Short-Term Ecological Effects

Resource field surveys have been conducted for the TA-54 area (including MDAs G, H and L) for compliance with the Federal Endangered Species Act of 1973 Public Law (PL) 93-205; the New Mexico Wildlife Conservation Act; Executive Order (EO) 11990, May 24, 1977, “Protection of Wetlands;” EO 11988, May 24, 1977, “Floodplain Management”; 10 CFR 1022, “Compliance with Floodplain/Wetlands Environmental Review Requirements”; and DOE Order 5400.1, “General Environmental Protection Program.” No wetlands exist in the immediate vicinity of MDA L, but wetlands and floodplains exist in the lower portion of Pajarito Canyon. Possible threatened and endangered (T&E) species for the area were identified, but no species or habitats were located in TA-54. Further information on biological resources is contained in “Biological Assessment of Environmental Restoration Program, Operable Unit 1148, TA-54” (Banar 1996, 058192).

Environmental damage to biological resources resulting from regrading and installation of the Alternative 1B cover would be localized over the already-disturbed MDA L area (the existing footprint of approximately 1 acre). Once vegetation has been established, there will be a beneficial effect to ecological receptors.

A cultural resources survey was conducted during the summer of 1991 at TA-54 (LANL 1992, 007669), as required by the National Historic Preservation Act of 1966. A total of 68 archaeological sites were located within the boundary of the entire technical area. Of this number, 56 are eligible for inclusion on the National Register of Historic Places. These sites were considered in the development of Alternative 1B to prevent impact to these cultural resources (LANL 1992, 007669).

8.1.5.3 Long-Term Human Health Effects

Exposures to Contaminants

During the monitoring and maintenance period, industrial workers would perform site surveillance, maintenance, and monitoring activities. These activities are designed to prevent deep-rooting plants and burrowing animals from transporting buried waste to the surface, to maintain erosion controls, and to repair erosion damage. The site workers will wear PPE that prevents direct dermal absorption and incidental ingestion exposures to contaminated soil particles and inhalation exposure to vapor-phase contaminants or contaminants in suspended soil. Although potential human health impacts include increased risk from carcinogenic and noncarcinogenic chemicals, potential radiation dose from tritium and other radionuclides potentially present in the soil, the risks would not be realized (except in the case of an accident) because of training and protection of workers. The measured and modeled VOC flux to the surface indicates no added risk to workers from this source.

The industrial worker exposure scenario from the MDA L investigation report derives from the anticipated potential exposures to contaminants that come from performing these monitoring and site-maintenance activities. (LANL 2005, 092591, p. G-22). The frequency of monitoring and maintenance activities was assumed to require workers on-site 5 h/wk over a 50-wk work yr for an individual worker or about one-tenth the time-basis used for the site worker scenario.

Worker health impacts are modeled using the industrial scenario identified in the MDA L investigation report, including exposure point concentrations for the six COPCs identified for workers (LANL 2005, 092591, pp. G-14 and G-15). Based on the greatly reduced time workers would spend at the site to conduct cover inspections and maintenance activities, (4 h/wk versus 40 h/wk), the risks and dose to the site worker are correspondingly bounded by one-tenth the site-worker scenario values. The values are already well below target values for risk.

8.1.5.4 Long-Term Ecological Effects

The depth to waste will not be increased because no additional cover soil will be added to the surface at MDA L, so animal burrows may be able to reach buried waste. The Alternative 1B cover provides some ecological protectiveness, except for animals that burrow below 3 ft (0.9 m). Pocket gophers, mice, and harvester ants have the potential to contact waste and bring it to the surface of the cover. Maximum animal burrow depths for pocket gophers, mice, and harvester ants are 4.9 ft (1.5 m), 6.6 ft (2.0 m), and 8.2 ft (2.5 m), respectively (Shuman 1999, 066804, p. 2-37).

Roots of grasses, forbs, shrubs, and trees also have the potential to penetrate to the waste horizon. Plants with high uptake factors increase contaminant concentrations at the cover surface. These uptake factors are 20 times higher for climax vegetation than for early succession plants because deeper shrub and tree roots penetrate wastes. Contaminant concentrations in surface soil are higher with climax vegetation, because trees generate surface litter (Schuman, 1999, 066804, p. 2-17). Thus, deep-rooted plants will be removed from the cover. Also placing new soil on the cover during active erosion maintenance entombs any contaminated material on the cover surface.

During the monitoring and maintenance period, surface maintenance activities performed to ensure cover integrity and to limit potential for biota to reach buried wastes will result in removing undesirable vegetation, removal of burrowing animals, or the filling of extensive animal burrow networks. Disturbances to local fauna will be limited through the use of access restriction fencing around the area (affecting primarily larger animals).

8.1.6 Cost

Costs associated with Alternative 1B have been estimated for all phases of the project, including support activities, site preparation, construction, materials, and continuation of site institutional controls for a 0 to 30 yr period. Significant detailed assumptions about the remedy and about the approach for the construction and sources for materials of construction were made in development of a cover cost estimate. The actual project costs will depend on specific design details and project decisions available during formal design activities, such as erosion minimization, control of stormwater, and stabilization with plant growth, which occurs only if the cover alternative is selected.

Alternative 1B includes SVE construction costs spent at the beginning of a project (e.g., capital costs) and annual operation and maintenance costs required to maintain and monitor the cover after the initial construction period. To compare the Alternative 1B costs with other alternatives that have expenditures over differing time periods, all costs were discounted to a 2007 net present value, as recommended in “A Guide to Developing and Documenting Cost Estimates During the Feasibility Study” (EPA 2000, 071540, pp. 4-1 and 4-2).

Present-value costs for the alternative are given as the sum of all capital costs and continuing costs in the following sections. Determining capital and operating and maintenance costs as present value is consistent with the CME requirements contained in Section VII.D.4.b.v of the Consent Order. The principle is also embraced for federal programs. The Office of Management and Budget (OMB) Circular A-94 states, “The standard criterion for deciding whether a government program can be justified on economic principles is net present value” (Office of Management and Budget 1992, 094804, p. 3). The OMB circular recommends a base-case analysis using a discount rate of 7% for projects that fit the category of public investments. Although it is unclear if the closure of MDA L should be considered a benefit-cost analysis or a cost-effectiveness analysis, analyses including alternative discount rates are encouraged by the circular.

Information contained in the National Institute of Standards and Technology report “Guide to Computing and Reporting the Life Cycle Cost of Environmental Management Projects” (Schultz and Weber 2003, 094782, p. 13) indicates that the Appendix G values from the OMB circular (Office of Management and Budget 1992, 094804, p. 7) should be used as a source of real discount rates for DOE environmental projects.

The present-value analysis method is used to compare different remedial alternatives with different operating time periods on the basis of a single cost figure.

Net present value was calculated according to the following formula:

$$PV_{total} = \sum_{t=1}^{t=n} \frac{1}{(1+i)^t} \cdot C_t$$

Where PV_{total} = present single sum of money

t = specific year

n = final project year

i = the discounted interest rate

C_t = cost in year t in base year dollars

The discount factor, the $1/(1+i)^t$ term from the present value equation, has been calculated for interest rates of 3% and 7.0%.

Contingency cost estimates (from the preliminary status of the design) were developed based on past on DOE experience at Idaho National Laboratory (INL) (Holdren et al. 2007, 098642) and other factors, such as the MDA L site being located near existing operating facilities. Safety and security activities have been estimated but a high degree of cost uncertainty exists until a site-specific health and safety plan (SSHASP) and a security plan are developed.

8.1.6.1 Estimate of Capital Costs

Capital costs consist of direct costs (construction), indirect costs (nonconstruction and overhead), and uncertainty estimates (contingency allowances). Table 8.1-1 summarizes the capital cost for Alternative 1B. Detailed estimates of capital cost in calendar year (CY) 2007 dollars are provided for this alternative in Appendix G. Cost estimates are expected to be within the accepted standard accuracy range of +50% to –30%, established by EPA for remedial alternative estimates at the alternatives screening stage (EPA 2000, 071540, p. 2-4).

8.1.6.2 Estimate of Periodic and Recurring Costs

Annual costs for surface surveillance and maintenance for Alternative 1B are estimated to be based on costs for materials and equipment to maintain the cover for personnel performing cover maintenance, and for maintenance of the monitoring system and data analysis (Appendix G). The operating and maintenance costs for the alternative are limited to the 30-yr active SVE operation period of the 45 yr monitoring and maintenance period.

The following major assumptions were made in development of the cover operating and maintenance cost estimate:

- Inspection and maintenance activities for MDA L will require two personnel working an average of 4 h a week once a year.
- No major reconstructions or repairs of the cover will be required during the 45-yr monitoring and maintenance period. Repairs will be limited to replacing soil removed by erosion and/or subsidence, revegetating eroded areas, and repairing the fence.

The annual costs for monitoring pore gas, dust, stormwater sediment, and groundwater are presented in Table 8.1-1.

8.2 Alternative 2B: Engineered ET Cover, SVE, and Monitoring and Maintenance

Alternative 2B minimizes erosion and stormwater run-on from upslope areas. The waste area is covered by a slightly sloping wedge that thickens towards the northeast. Stormwater run-on from the south is directed into a swale that prevents focused recharge near the cover. The toe of the cover terminates in rock-armored slopes in the northeast. Alternative 2B was optimized using ideas from a value assessment (VA) session for the MDA G CME report. The plan view of the Alternative 2B cover is shown in Figure 8.2-1. Prominent cover features developed during the VA include:

- Asphalt associated with waste storage areas will be removed. Approximately 250 ft (76.2 m) of retaining wall to the north of the site will be removed. The existing site will be regraded to 3 ft above waste. South of the cover, stormwater is directed into an existing drainage swale that will transport run-on away from the cover.

- Cover slopes are less than 2% and slope lengths are minimized. This prevents erosion by allowing most of the run-on to infiltrate into the cover. The resulting plant growth stabilizes the surface and provides ET to remove any moisture. Erosion is minimal, even under even bare soil conditions.
- The top layer of the cover is a 1.5-ft- (0.46-m-) thick vegetated soil-gravel admixture. Conceptual design of the soil-gravel admixture (rock mulch) is based on 1000-yr storm conditions (6.25 cm in 30 min [see Appendix D] and actual slope segments. Below that is a 3.5-ft- (1.1-m-) thick infiltration layer composed of crushed tuff mixed with soil and amendments to provide water storage and to minimize infiltration. The bottom cover layer is a filter medium (natural materials, such as gravel, to provide a filter between the cover soil and biobarrier) over a 1 ft (0.3 m) biobarrier of cobbles. Figure D-3.0-1 in Appendix D presents a schematic of the layers that compose the Alternative 2B cover.
- The cover surface is featureless, with no internal sharp corners to minimize erosion. It also prevents or inhibits deep layer intrusion by plants and animals.
- The optimized ET cover infiltration layer is designed to minimize infiltration to RCRA Subtitle C equivalent levels of 0.04 in/yr (1 mm/yr) (Appendix D, p. D-4). To be conservative, the surface soil-gravel layer will provide additional water-storage capacity.
- Most stormwater is directed to existing drainages. Sheet flow off the side slope to the north of the pile will flow down to the edge of the mesa or cliff. At the base of the mesa cliff, drainage swales will collect runoff and direct it to a sediment basin. The basin will capture suspended contaminants before they are dispersed in the watershed and will provide sampling locations to monitor cover performance.
- Rock-armored soil side slopes connect with the existing grade and minimize the amount of rip-rap required on the southern side of the cover. Rock buttresses are used in some areas on the north side of the cover to eliminate excessively steep soil side slopes.
- A small mesh wire fence will be buried around the perimeter of the site to limit access by small burrowing animals.
- The cover will be monitored and maintained for 30 yr. Alternative 2B includes the operation of an active SVE system for 30 yr followed by passive venting to reduce or eliminate the VOC plume identified at MDA L. Alternative 2B also optimizes the soil texture, soil thickness, and vegetative cover to best suit the conditions at MDA L, determined by modeling presented in Appendix D.

The objectives of the optimized ET cover are (1) to reduce or limit the amount of water that percolates into and through buried wastes (minimizing the potential for subsurface contaminant transport); (2) to reduce or limit erosion to prevent direct exposure of the waste and minimize surface transport of contaminants; and (3) to prevent the intrusion of deep-rooting plants and burrowing animals. To reduce or eliminate the organic vapor plume identified at the site, Alternative 2B proposes operation of an SVE system, as described in section 8.1.1.

8.2.1 Applicability

The Alternative 2B cover is applicable and suitable to the MDA L site. With the exception of VOCs that will be remediated with SVE, waste disposed at MDA L is stable and not prone to migration in the absence of focused recharge. Although infiltration is low in the arid environment of northern New Mexico, the implementation of an ET cover ensures uniformly low infiltration comparable to natural soil profiles. This ET cover alternative also provides additional barriers to human intrusion into the waste and reduces potential exposures from dispersion of waste and contaminants. It also limits biointrusion by plants and animals. The use of SVE provides suitable treatment for VOCs, as described in section 8.1.1.

8.2.2 Technical Practicability

Engineered ET covers with a vegetative component, such as the Alternative 2B ET cover, have proven effective in the arid and semiarid environments of the southwestern United States (Nyhan et al. 1998, 071345, p. 1; Dwyer et al. 2000, 069673, pp. 23–26). Dwyer et al. monitored soil moisture flux rates over a 4-yr period in an alternative cover comparison demonstration program at Sandia National Laboratories. Their study measured flux rates through an ET cover that are less than the rates through RCRA Subtitle C prescriptive covers and a cover with a geosynthetic clay liner.

Engineered ET covers are reliable because they rely on “natural” conditions at the site to protect the soil surface from erosion while storing infiltration water for vegetative growth. The result minimizes downward water movement. Engineered ET covers have been installed at several locations in the southwest where their successful performance has been demonstrated when properly maintained (Dwyer et al. 2000, 069673; Nyhan et al. 1998, 071345).

The Alternative 2B cover is relatively simple, easy to construct and maintain, uses readily available native tuff in combination with other available construction materials, and is an appropriate selection for the semiarid climate in Los Alamos. Using local materials for construction reduces transportation costs. It also provides the opportunity to inspect the durability and performance of natural materials under similar climatic conditions.

The Alternative 2B cover promotes vegetation that will work in conjunction with evaporation to transpire moisture and maximize available moisture storage for subsequent precipitation events. Vegetation also limits soil erosion and establishes the cover as a natural part of the mesa environment. The native seed mix planted in the cover will foster additional local plant species to produce predictable, long-term cover stability.

8.2.3 Effectiveness

The Alternative 2B cover reduces erosion potential and minimizes the amount of cover soil required. The cover can resist erosion under 1000-yr storm conditions. Gradual 2% slopes limit erosion under bare soil and vegetative conditions. Removing deep-rooted plants during the maintenance period ensures the low erosion rates by preserving a grassy cover. Holes in the cover created by uprooted trees and shrubs could be repaired. Alternative 2B has the best aesthetics of the engineered covers because it resembles natural landforms. It is constructed from readily available materials. In addition, the cover thickness is designed to minimize infiltration to stay below RCRA Subtitle C-equivalent levels. Most stormwater impacting the cover would be directed to a sediment basin. The basins will capture suspended contaminants before they are dispersed in the watershed and can also provide sampling locations for cover performance monitoring. This optimized ET cover provides added protection from biointrusion and erosion. Monitoring and maintenance of the cover will continue during the SVE operation period. Active institutional controls will continue for 100 yr after placement of the cover.

For this alternative, an inspection (in addition to routinely scheduled inspections) would occur after every storm with an intensity of 3.9 in./h (9.9 cm/h) or greater. Erosion modeling in Appendix E indicates an average annual soil loss 0.7 tons/acre/yr (1.6 tonnes/ha/yr) for bare soil conditions, which is much lower than the design goal of 2 tons/acre/yr (4.5 tonnes/ha/yr). Under bare soil conditions, 0.37 in. (0.93 cm) of soil could be eroded every 100 yr. The cover meets the average annual erosion design goal under both vegetative and bare soil conditions. Erosion from a 100-yr storm with only 30% ground cover is estimated at 0.55 tons (0.5 T) for the entire site, at an average depth of 0.0006 in. (0.002 cm). To address concerns that cliff retreat might expose waste along the edge of the mesa in the future, Laboratory personnel evaluated cliff retreat within 10,000 yr and possibly much longer. They determined that cliff retreat is not an issue in any of the corrective measure alternatives time frames (Reneau 1995, 050143, p. 65; Reneau 2003, 074014).

The use of SVE will reduce waste volume. Chemical degradation will have minimal effect on the toxicity of the VOC plume. An active SVE system will be operated for 2 months on and 22 months off to remediate the VOC plume for approximately 30 yr when the extraction boreholes will be converted to a passive SVE system (soil venting). The 2-months-on and 22-months-off period for active SVE operation maximizes removal of VOCs during operation and then allows for contaminant rebound.

8.2.4 Implementability

The Alternative 2B ET cover alternative is readily implementable since it requires no advanced construction techniques and no complex engineering design. Standard surveying and earth-moving equipment are adequate to prepare, mix, and place the component layers of the cover in required thicknesses with the desired slopes. Materials for construction are readily available. Standard construction techniques are adequate for installing the cover, ditches/swales, rock armor, and fences. The SVE and monitoring systems may be installed using standard environmental construction methods. This alternative meets RCRA closure and postcare requirements for the interspersed RCRA units in MDA L.

Some of the performance properties of the cover (soil compaction, surface gradients, and overall thickness) depend upon proper installation. Other performance properties are inherent in the earthen materials. Monitoring, inspection, and repairs conducted during a 45-yr monitoring and maintenance period ensures that the cover performs as expected. This monitoring period will allow any damage identified to be addressed, potentially extending the overall life of the remedy. Inspections will include a site walkthrough every month to find areas where gullies are forming, areas where subsidence has occurred, areas where focused recharge may occur, and areas where cliff retreat may impinge on waste in trenches. Maintenance would include repairing gullies and subsidence areas with rock armor or additional fill. Waste and contaminated soil maybe removed from a pit or impoundment if a cliff retreat is expected to impact a waste disposal area. Damage to the cover from uprooted trees can be repaired on an as-needed basis following inspections. An inspection would occur monthly and after every storm with an intensity of 3.9 in./h (9.9 cm/h) or greater. Erosion modeling results discussed in Appendix E show that the cover has minimal erosion potential from 25-yr storms under high and moderate erosion conditions.

8.2.5 Human Health and Ecological Protectiveness

Impacts to human health and the health of ecological receptors from implementation of the remedy are assessed separately as the remedy implementation/installation period (short-term) and the remedy operation period (long-term). This separation differentiates between hazards associated with construction of the remedy versus hazards associated with cover maintenance and SVE operation. The monitoring and maintenance period following completion of the cover installation is assessed under long-term effects.

8.2.5.1 Short-Term Human Health Effects

Injuries and Accidents

Short-term injury and accidents predicted are associated with the physical hazards of construction activities and traffic risks associated with the transportation of raw materials to the site for the cover construction. Exposure to buried waste is not anticipated during cover construction activities. The present-day risk assessment in the MDA L investigation report (LANL 2006, 091888, Appendix G, p. G-15) showed no risk to an industrial worker at MDA L in the breathing zone.

Worker risks associated with the implementation of the remedy would primarily be a function of accident incidence rates for each work type and the number of hours of work required by type. Following the method described in section 8.1.5, the total of 240,000 field-work hours estimated for installing the cover would result in an estimated 8 nonfatal injuries for a project of the magnitude of the cover installation.

Fatality incidence rates for the same work, based on 2005 statistics for the construction industry (DOL 2006, 097080) at 5.5×10^{-8} per work hour would result in less than 1 fatality predicted for the cover installation project.

The risk of vehicle traffic accidents associated with implementation of the remedy is generally a function of total miles of travel for the project vehicles. Based on an average fatal accident rate per vehicle mile for large trucks of 2.3 fatal accidents per 100 mil mi (DOT 2002, 097082) or 2.3×10^{-8} fatal accidents per mi and an estimated maximum of 66,640 truck-transport mi on public roads for delivery of project resources, an overall incident rate for fatal traffic accidents for the project would be less than 1 (2.47×10^{-2}).

The cover installation project will be conducted under the rigorous workforce safety awareness program in place for all Laboratory workers and subcontractors, including detailed job planning, job-specific training, and safety monitoring by Laboratory health and safety disciplines. Government project injury incidents rates have typically been lower in relation to the general construction industry. As a result, injury and accident incidence on the project can be expected to achieve the much lower incidence rates historically applicable to the federal government workforce.

8.2.5.2 Short-Term Ecological Effects

Resource field surveys have been conducted for the TA-54 area (including MDAs G, H, and L) for compliance with the Federal Endangered Species Act of 1973, PL 93-205; the New Mexico Wildlife Conservation Act; EO 11990, May 24, 1977, “Protection of Wetlands;” EO 11988, May 24, 1977, “Floodplain Management”; 10 CFR 1022, “Compliance with Floodplain/Wetlands Environmental Review Requirements”; and DOE Order 5400.1, “General Environmental Protection Program.” No wetlands exist in the immediate vicinity of MDA L, but wetlands and floodplains exist in the lower portion of Pajarito Canyon. Possible T&E species for the area were identified, but no species or habitats were located in TA-54. Further information is contained in “Biological Assessment of Environmental Restoration Program, Operable Unit 1148, TA-54” (Banar 1996, 058192).

Environmental damage to biological resources resulting from installation of the Alternative 2B ET cover would be localized over the already-disturbed MDA L area (the existing footprint of approximately 1 acre) along with a new project lay-down/staging area and a project management area totaling approximately 1.5 acres. Once work is completed, the surface of the site will be revegetated. Noise associated with implementing this alternative will be managed within applicable limits based on workday duration. Disturbances to local fauna will be limited partly through the continued use of access restriction fencing around the area (affecting primarily larger animals) and because work activities will be focused on the already-disturbed waste disposal area and have minimal impacts outside this area. Disturbances will be of a limited duration, tied to the estimated 12-month projection for cover installation.

A cultural resources survey was conducted during the summer of 1991 at TA-54 (LANL 1992, 007669), as required by the National Historic Preservation Act of 1966. A total of 68 archaeological sites were located within the boundary of the entire technical area. Of this number, 56 are eligible for inclusion on the National Register of Historic Places. These sites were considered in the development of Alternative 2B to prevent impact to these cultural resources (LANL 1992, 007669).

8.2.5.3 Long-Term Human Health Effects

Exposure to Contaminants

The results of human health risk assessments indicated that the present-day noncarcinogen and carcinogenic risks (an HI of 0.001 and a cancer risk of 2×10^{-9}, respectively) for an industrial scenario were less than NMED's target levels of 1.0 and 10^{-5}, respectively (NMED 2006, 092513). Potential dose for an industrial scenario is calculated to approximate 0.0007 mrem/yr (7×10^{-6} mSv/yr), which is below the DOE's target clean-up dose of 15 mrem/yr (0.15mSv/yr) (DOE 2000, 067489). The risk to the public at the site boundary will be less than the risk to the industrial worker. Increasing the depth of the cover and implementing SVE will further reduce the risk to the public at the site boundary.

8.2.5.4 Long-Term Ecological Effects

The depth to waste will be increased through the addition of cover soil to the surface at MDA L, so animal burrows are not likely to be able to reach buried wastes. These layers will also limit the likelihood that deep-rooting plant species can reach the buried waste. Also, the biobarrier further prevents plant roots and animals from intruding into the waste, where they may create conduits for water to move downward into the waste units or transport waste to the surface. Maintenance will remove deep-rooted tree and shrub species that, if uprooted, could cause a breach in the cover. This most probable cause of cover failure is minimized in this alternative. Removing undesirable vegetation, filling animal burrow networks, and eradicating burrowing animals are required to preserve the integrity and performance of the ET cover.

8.2.6 Cost

Costs associated with the Alternative 2B ET cover have been estimated for all phases of the project, including support activities, site preparation, construction, materials, analytical costs, and a 45-yr monitoring and maintenance period following cover installation. Significant detailed assumptions about the remedy and about the construction approach and material sources were made in development of the optimized ET cover cost estimate. Actual project costs will depend on specific design details and project decisions that would only be made if the ET cover alternative is selected.

The Alternative 2B ET cover includes construction costs spent at the beginning of a project (e.g., capital costs) and annual operation and maintenance costs required to maintain and monitor the cover after the initial construction period. To compare costs with other alternatives that have expenditures over differing time periods, all costs were discounted to a 2007 net present value, as described in section 8.1.6. The present-value analysis is provided in Table 8.2-1.

8.2.6.1 Estimate of Capital Costs

Capital costs consist of direct costs (construction and materials), indirect costs (nonconstruction and overhead), and uncertainty estimates (contingency allowances) for the optimized ET cover alternative. Table 8.2-1 summarizes the capital cost for the cover alternative by major project activity. Detailed estimates of capital cost in CY2007 dollars are provided for the Alternative 2B cover in Appendix G.

The following major assumptions were made in development of the capital cost estimate for the Alternative 2B cover:

- D&D and RCRA closure costs of the aboveground units are not in the cover cost estimates.
- Bandelier Tuff required for the cover will be quarried from TA-61 and trucked to TA-54, where the materials will be stockpiled.
- New project management and worker change-out/shower facilities will be installed at MDA L for construction-project activities.
- Installation activities will require 12 months.

8.2.6.2 Estimate of Periodic and Recurring Costs

Inspection, maintenance and monitoring costs following installation of the base ET cover/SVE remedy include associated material and energy costs, cost for construction waste management, management and administrative costs, other indirect costs, and contingency estimates. Detailed estimates of operating and maintenance cost in CY2007 dollars are provided for the Alternative 2B cover in Appendix G. The operating and maintenance costs for the alternative are limited to the 45-yr monitoring and maintenance period following the implementation of the alternative.

The following major assumptions were made in developing the cover operating and maintenance cost estimate:

- Inspection and maintenance activities for MDA L will require two personnel working an average of 4 h a week yearly.
- No major reconstructions or repairs of the cover will be required during the 30-yr monitoring and maintenance period. Repairs will be limited to replacing soil removed by erosion and/or subsidence, revegetating eroded areas, and repairing the fence.

The annual costs for monitoring pore gas, dust, stormwater sediment, and groundwater are presented in Table 8.2-1.

8.3 Alternative 5A: Engineered ET Cover, Partial Excavation, SVE, and Monitoring and Maintenance

Alternative 5A has the same components as Alternative 2B and also adds a source removal component (i.e., removal of the waste in Impoundments B, C, and D). The three impoundments were sampled in 2007 to characterize the waste. The total capacity of the three impoundments is 740 yd^3. Analytical results for toxicity characteristic leaching procedure (TCLP) analyses for RCRA metals and VOCs are provided in Appendix H of the addendum to the MDA L investigation report (LANL 2007, 096409). The data show only minor exceedances of TCLP regulatory levels for RCRA metals. VOCs were detected in 31 core samples. The waste characterization data indicate that part of the waste would be characterized as MLLW and part as hazardous waste. Therefore, a range of disposal cost was calculated.

The estimate for containers, transportation, treatment/disposal of 740 yd^3 of MLLW from Area L to Energy Solutions at Clive, Utah, is presented in Table 8.3-1 and includes the following:

1. Waste will be containerized in intermodals for off-site transportation.
2. MLLW will not meet land disposal restrictions requirements and will require treatment before disposal.
3. Intermodals will require a layover at Clive, Utah, before treatment and disposal.
4. Approximately 40 intermodals will be used for this activity.
5. Only one container will be transferred per truck because of weight limitations.

The rough order of magnitude cost is $1,852,500.

The estimate for hazardous waste includes the following.

1. An estimated 740 yd^{3}of hazardous soils will be generated and will require treatment and disposal at the Clean Harbors in Aptus, Utah, facility.
2. Rolloff bins (or more likely intermodels) will be used for containerization and transportation.
3. A total of 50 containers will be generated at 15 yd^3 per container (weight restrictions).
4. Mobilization and demobilization will be based on renting 20 containers and reusing them as the waste is generated and disposal occurs.
5. The 20 containers will be rented for 6 months.
6. Additional investigation will occur to determine the tritium threshold levels at a facility such at Clean Harbors in Aptus, Utah, to ensure that the waste acceptance criteria are within the levels that may be present within the waste.

The total rough order of magnitude estimate is $950,000.

8.4 Alternative 5B: Complete Waste-Source Excavation and Backfilling, Off-site Disposal, SVE, and Monitoring and Maintenance

Alternative 5B includes complete waste-source excavation and backfilling, off-site disposal, SVE for 30 yr, and monitoring and maintenance for 30 yr. The waste units at MDA L will be excavated and the waste shipped to an off-site licensed facility for disposal.

For this alternative, excavation of Pit A and Impoundments B, C, and D will be performed using a tiered approach based on hazard level and assessment of specific inventory. Excavation of these areas would be accomplished using standard excavation methods unless potential or real hazards dictated remote handling. The need for remote handling is expected for some of the materials in Pit A. Excavated quantities of overburden and waste mentioned throughout this section were evaluated using the computer aided drafting program MicroStation. The program was used to develop estimates of excavated waste and overburden using the depths of shafts, pit, and impoundments and excavation of side slopes described in the following section. These quantities are listed in Appendix G and have not been adjusted for swell.

Excavation of shafts will be conducted using a parallel trench approach. In general, trenching would be conducted parallel to the line of the shafts and would take place in 6-ft (1.8-m) increments to expose the line of shafts. Waste will be removed from the shafts at each 6-ft (1.8-m) interval and a minimum 1.5:1 side slope would be maintained on the outside edge during excavation operations.

For the area with Shafts 29 through 34, the tuff (overburden) adjacent to the shafts will be excavated to a depth of 65 ft (20 m) bgs at the minimum slope of 1.5:1 starting along the north and east edges of the shaft area. The 1:5:1 ratio is for a crushed-tuff scenario; the native rock excavation will be much steeper. Shafts 33 and 34 would be accessed from the northeast to avoid disturbing existing facilities that must remain in use. Some shoring of cut slopes could be necessary where the minimum 1.5:1 cannot be met. The complete footprint of the excavation would measure approximately 165 ft x 190 ft (50.3 m × 57.9 m) at the ground surface. From this footprint, 342 yd^3 (261 m^3) of waste would be removed from the shafts. This includes the 3 ft (0.9 m) deep concrete plug at the top of each shaft. The remaining volume of the excavation would be approximately 38,560 yd^3 (29,481 m^3) of overburden. Assuming that 10% of this overburden is contaminated and combining that with the volume of waste, approximately 4210 yd^3 (3,218 m^3) of material would need to be removed. These volumes assume that only the facilities 54-0050, 54-0062, 54-0068, 54-0069, and 54-1058 located between shafts 29 through 34 and Impoundment D will be removed before excavation. No facilities outside of the MDA L closure will be affected.

For the excavation area including Pit A, Impoundments B through D, and Shafts 1 through 28, the excavation depth of the adjacent tuff will vary. All shafts in this area are 60 ft (18 m) deep; therefore, this depth would be the minimum excavation depth immediately around the shafts. All the impoundments are 10 ft (3 m) deep and Pit A is 12 ft (3.6 m) deep. In excavating the shafts there will be a minimum 1.5:1 side slope for the crushed-tuff while slopes excavated in native rock will be steeper. During the excavation of the shafts, the majority of the impoundments and pit will also be excavated. Shoring could be necessary to avoid the existing structures along the south of the buried waste in this area. The following volumes assume that these facilities cannot be disturbed. The footprint of the excavation will consist of two rectangular areas to avoid the southern facilities. The first will run along the top of the buried waste and measure approximately 400 ft × 140 ft (122 m × 43 m) at the ground surface. The second would begin at about Shaft 19 and measure approximately 230 ft × 80 ft (70 m × 24 m). From this footprint, 2530 yd^3 (1934 m^3) of waste would be removed. This volume includes the 3 ft (0.9 m) deep concrete plug at the top of each shaft. The remaining volume of the excavation would be approximately 88,660 yd^3 (67,785 m^3) of overburden. Assuming that 10% of this overburden is contaminated and combining that number with the volume of waste, approximately 11,400 yd^3 (8716 m^3) of material would need to be removed from this area.

Waste shipped off-site must meet DOT shipping requirements and TSD-specific waste acceptance criteria and permit conditions before shipment and disposal occurs. The radioactive nonhazardous wastes can be disposed of at a number of permitted radioactive waste disposal facilities.

The most likely facility for disposal of nonradiologically contaminated RCRA waste is Envirocare in Utah. All waste requiring off-site disposal would be transported on Pajarito Road. An estimated maximum 15,600 yd^3 (11,935 m^3) of waste and contaminated overburden material would be transported on public roads. In addition, approximately 114,500 yd^3 (87,541 m^3) of clean overburden material (10% of contaminated over burden subtracted) would be removed from the excavation area. Any of the removed overburden materials that are characterized as solid, hazardous, mixed waste or low-level waste will be managed according to applicable waste management and disposal requirements. Removed overburden materials determined to be contaminated would be taken off-site and replaced by clean fill. For the purpose of evaluating corrective measure alternatives, it is assumed that 10% of the removed overburden materials will be replaced with clean fill.

The facilities required for the excavation alternative include a facility for waste sorting, a tent over the excavation for security purposes and protection from the elements, a waste declassification facility, a storage vault, and a storage area for removed materials. Periodically, samples of the intermingled fill material will be collected and screened for both radioactive constituents and VOCs. Appropriate level B PPE would be used in areas of material sorting, declassification, characterization, and packaging. The facility will be a tent under positive pressure and off-gas will be treated because of the VOCs in the soil.

To reduce or eliminate the vapor plume, Alternative 5B proposes using SVE techniques as described in section 8.1.1. The period of SVE operation and monitoring and maintenance are 30 yr, as required for RCRA postclosure-care periods. This alternative involves monitoring for the same parameters as Alternatives 1B, 2B, and 2C. It is assumed that excavation will remove the waste and expedite the time required for SVE.

8.4.1 Applicability

Excavation and off-site disposal is applicable to the complete range of contaminant groups with no particular target group. Although it does not reduce the volume or eliminate any of the waste, it is frequently considered an option because it relocates the waste to a different (and presumably safer) site. This alternative does not address non-VOC contamination of environmental media at the site. SVE provides suitable treatment for VOCs is described in section 8.1.1.

8.4.2 Technical Practicability

According to data obtained from the Federal Remediation Technology Roundtable, excavation and off-site disposal is a proven and readily implementable technology. Before the mid-1980s, excavation, and off-site disposal was the most common method for cleanup of hazardous waste sites.

In the long-term, the performance, reliability, and minimization of hazards at the site are optimal because no waste remains at MDA L. This alternative does, however, present significant short-term considerations. The large volume of material to be transported for off-site disposal may impact the practicability of this alternative. The estimated volume of material, both waste and contaminated overburden, in the ground to be transported is 15,600 yd^3 (11,935 m^3) and does not account for swell after removal. This estimate assumes that 10% of the overburden is contaminated and will be removed with the waste. In addition, many of the waste disposed in Pit A may be shock-sensitive, requiring remote excavation and strict handling procedures.

Waste removal will probably reduce the time of operation for SVE to remove VOCs from the remaining material, if SVE should be needed.

8.4.3 Effectiveness

Complete excavation of wastes and SVE of the surrounding contaminated tuff is effective in eliminating the potential long-term impacts of wastes to the areas surrounding MDA L. Complete excavation eliminates the need for long-term maintenance and/or monitoring at the location.

The sorting and segregation of the excavated materials could potentially increase the quantity of waste to be disposed of by increasing the amount of packaging materials necessary for transport and disposal at various locations depending on the waste type.

The Federal Remediation Technology Roundtable estimates typical excavation times of about 2 months for the excavation of 4000 tons of contaminated soil (available at http://www.frtr.gov/matrix2/top_page.html). However, wastes at MDA L are not comparable to Roundtable estimates, and the excavation times are expected to be significantly longer.

This alternative is the least effective of the three in the short-term at mitigating the impact of contamination. Disturbance and excavation of the disposal units increase the possibility of accidental release of hazardous and/or radioactive materials. The possibility of release upon disturbance of the units containing unknown waste materials increases the short-term risk and dose of dispersal of contamination.

8.4.4 Implementability

Implementation of this alternative requires

- conducting a hazard categorization and hazard analysis to identify requirements associated with unknown wastes materials and
- using engineering controls and/or PPE up to level B (supplied air) and possibly remote handling to reduce risks associated with unknown chemicals materials

Approximately 114,500 yd^3 (87,541 m^3) of clean material (overburden) would be removed from the excavation and transported for temporary storage to a preapproved site located within 2000 ft (610 m) of the excavation site. This estimate assumes that 10% of the overburden will be contaminated and removed with the waste. After excavation is completed, the overburden material would be transported back to the MDA L area and used as backfill. Additional clean fill would be hauled to the site to replace the volume of the removed waste. It is estimated that these activities would result in the transportation of approximately 500 truckloads of material back and forth over the newly constructed haul road. Most of the overburden material could be replaced in the excavation, but some (an estimated 10%) of the overburden would be characterized as LLW, hazardous waste, and/or mixed waste. In this case, the existing overburden would be replaced by clean fill and subject to appropriate disposal laws and requirements. Once the excavated area has been backfilled, the site would be regraded and revegetated.

The time to design Alternative 5B is estimated to be 12 months and to implement and complete this alternative will be an estimated 2.5 yr.

This alternative would involve clean closure of the RCRA units interspersed among the corrective action units.

8.4.5 Human Health and Ecological Protectiveness

8.4.5.1 Short-Term Human Health Effects

Injuries and Accidents

Worker risk associated with the implementation of Alternative 5B is based on the requirement that all workers adhere to rigorous DOE, state, and federal worker-safety regulations and that engineered barriers are designed to protect workers. During planning and implementation, engineering controls will be emplaced that are designed to ensure that no worker would be exposed to risks above the levels specified by DOE, New Mexico, and federal worker-safety regulations. This alternative involves workers spending approximately 811,000 field-worker hours on site resulting in an estimated 26 nonfatal injuries.

Potential accidents resulting from extensive excavation, remote excavation and associated waste handling include industrial hazards/accidents and transport accidents. In addition, workers at off-site disposal locations would be exposed to hazards associated with the handling and disposal of the waste materials.

Both unmitigated and mitigated worker and transportation risks associated with Alternative 5B are assessed. Unmitigated risk refers to the risk from postulated accident scenarios for which no controls are credited in reducing either the likelihood or consequences of an accident, while mitigated risk is based on crediting the reduction of the likelihood or consequences of an accident to the implementation of controls preestablished for all remediation activities.

A risk assessment of all remediation activities was performed according to various accident categories (Omicron 2001, 070229, p. ES-1). These remediation activities include the following:

1. site preparation
2. site excavation
3. sorting/segregation
4. declassification
5. packing/loading
6. transportation
7. site restoration

Accident categories include industrial hazards/accidents, spills of chemical materials, and inadvertent exposures hazardous materials. The evaluation goals were to determine (1) the overall worker dominant risk remediation activity, (2) the dominant worker risk accident category for each of the remediation activities, (3) the risk to the public from remedial activities, and (4) major controls that could be instituted to prevent or mitigate the dominant risk.

Of the more than 150 accidents postulated from remedial activities, the total potential risk is dominated by standard or industrial types of accidents (58%). For most remedial activities, the second-most dominant risk is from explosions (27%), followed by excavation (26%) and transportation (7%).

Implementing a variety of administrative and engineered controls (i.e., mitigating risks) reduces the risk for nonstandard industrial accidents by nearly 43%. Proposed controls include shaft and pit stabilization and monitors for ionizing radiation.

The risk to the public from all activities is negligible. If Alternative 5B is selected, a safety analysis would be required to detail the risks from potential hazards before designing administrative and engineering controls.

Some removal activities might be performed as a remote operation because of the combination and configuration of the material in the shafts and pit. All workers involved in excavating waste will use suitable PPE (level B or as needed) to complete the work.

Modeling the risk to the public from a transportation accident was dominated by standard, industrial accidents such as vehicle crashes and accidents associated with transportation activities in which serious or fatal consequences could occur to members of the public as a result of the vehicle accident alone. Drivers responsible for transporting the waste to off-site disposal locations would be at risk of having traffic accidents. The probability of a fatal crash involving a large truck would be 0.5×10^{-8}/mi (3.1×10^{-10}/km. Assuming 1.34×10^{6} truck mi (2.16×10^{6} truck m) estimated to be traveled, the probability of a fatal crash is 7.26×10^{-1} for Alternative 5B. Other members of the public (i.e., not nearby residents) would be exposed to the risk of transporting the wastes across the nation's highways.

For all accident scenarios of concern, the total average (between the unmitigated and mitigated) risk to workers from all remediation activities is 22 times greater than risk to the public; in other words, the risk to the public is less than 5% of the risk to the worker.

Because of the extensive excavation and waste handling required at the site, Alternative 5B poses the highest potential exposure to workers, and only Alternative 5B potentially exposes the public to transportation of waste on public roads.

8.4.5.2 Short-Term Ecological Effects

The environmental impacts of Alternative 5B are evaluated in terms of the potential biological and cultural resource damage that may be incurred during implementation. An environmental assessment would need to be prepared under separate cover to address National Environmental Policy Act compliance.

As discussed in Section 8.2.5.1, resource field surveys have been conducted for the TA-54 area (MDAs G, H, and L) for compliance with the Federal Endangered Species Act of 1973 PL 93-205; the New Mexico Wildlife Conservation Act; EO 11990, May 24, 1977, “Protection of Wetlands;” EO 11988, May 24, 1977, “Floodplain Management;” 10 CFR 1022, “Compliance with Floodplain/Wetlands Environmental Review Requirements;” and DOE Order 5400.1, “General Environmental Protection Program.” No wetlands exist in the immediate vicinity of MDA L, but wetlands and floodplains exist in the lower portion of Pajarito Canyon. Possible T&E species for the area were identified, but no species or habitats were located. Further information is contained in “Biological Assessment of Environmental Restoration Program, Operable Unit 1148, TA-54” (Banar 1996, 058192) and in Appendix B of the MDA H RFI report (LANL 2001, 070158; LANL 2002, 073270).

A cultural resources survey was conducted during the summer of 1991 at TA-54 (LANL 1992, 007669), as required by the National Historic Preservation Act of 1966. A total of 68 archaeological sites were located within the boundary of the entire technical area. Of this number, 56 are eligible for inclusion on the National Register of Historic Places. These sites were considered in the development of Alternative 5B to prevent impact to these cultural resources (LANL 1992, 007669).

8.4.5.3 Long-Term Human Health Effects

No local long-term potential human health impacts are associated with excavation because the material in the MDA L disposal units will be removed, decontaminated or treated as necessary, and disposed in either off-site facilities or recycled, where appropriate.

8.4.5.4 Long-Term Ecological Effects

No long-term ecological risks are associated with excavation at MDA L because the material in the MDA L units would be removed and disposed of in permitted units or recycled, as appropriate.

8.4.6 Cost

8.4.6.1 Estimate of Capital Costs

Capital costs consist of direct costs (construction), indirect costs (nonconstruction and overhead), and uncertainty estimates (contingency allowances). Table 8.4-1 summarizes the capital cost for this alternative. Detailed estimates of capital cost in CY2007 dollars are provided for each alternative in Appendix G. Cost estimates are expected to be within the accepted standard accuracy range of +50% to

-30% established by EPA for remedial alternative estimates at the alternatives screening stage (EPA 2000, 071540, p. 2-4).

Cost estimates were developed based on past on-site removal actions (MDA P), estimates made at INL and other DOE site experience (Sandia, Hanford, Rocky Flats), and factors such as the MDA L site location near existing operating facilities.

Alternative 5B has additional contingency added because of the uncertainty of shaft contents and degradation of shaft material. Safety and security activities have been estimated but a high degree of cost uncertainty exists until site-specific health, safety, and security plans are established.

Capital Costs for Monitoring

Costs for the analysis of monitoring pore gas, dust, and runoff/sediment are included in this estimate because they will be required at least until excavation is complete and probably some time after waste removal. Pore-gas monitoring will use existing boreholes. Dust and runoff/sediment sampling will be conducted at the new installations. Analytical costs for waste characterization, waste profiling, and confirmation sampling are presented in Appendix G.

8.4.6.2 Estimate of Periodic and Recurring Costs

Inspection, maintenance, and monitoring costs following completion of remedy construction include associated material and energy costs, the cost for managing wastes produced after the initial construction is completed, management and administrative costs, other indirect costs, and contingency costs. Detailed estimates of operating and maintenance cost in CY2007 dollars are provided for the Alternative 5B in Appendix G and Table 8.4-1. The operating and maintenance costs for the alternative are limited to the 30-yr monitoring and maintenance period after the alternative is implemented.

9.0 SELECTION OF THE PREFERRED CORRECTIVE MEASURE ALTERNATIVE

A detailed corrective measures analysis was made of four possible alternatives. These alternatives are:

- Alternative 1B, improved natural cover, SVE, monitoring and maintenance
- Alternative 2B, engineered ET cover, SVE, monitoring and maintenance
- Alternative 5A, engineered ET cover, partial waste-source excavation, SVE, monitoring and maintenance
- Alternative 5B, complete waste-source excavation and backfilling, off-site waste disposal, SVE, monitoring and maintenance

Selection of the preferred alternative is based on the criteria listed in Table 9.0-1. Table 9.0-2 gives a summary comparison of the estimated costs associated with each alternative. The numeric ranking ranged from 1 (poorest ability to meet the criteria) to 5 (most readily meeting the selection criteria). This table provides a summary of the corrective measure alternatives based on the six evaluation criteria defined in XI.F.10 of the Consent Order and addressed in section 8 of this report. It also includes six selection criteria defined in Section XI.F.11 of the Consent Order and discussed in section 9.2 of this report. Ranking order indicates that Alternatives 2B, 2C, 1B, and 5B accrued points of 51, 49, 38, and 36, respectively. Alternative 2B is the recommended corrective measure alternative.

9.1 Ranking with Evaluation Criteria

Alternative 2B has the highest ranking from CME evaluation criteria 1 through 6 from Table 9.0-1 on evaluation of the performance issues described in this section and in section 8.

For costs (criteria 6), waste removal (Alternative 5B) is the most expensive. However, the costs are slightly mitigated by the shorter period of monitoring and operation of SVE.

9.2 Ranking with CME Selection Criteria

In Table 9.0-1, criteria 7 to 12, which associated with Section XI.F.11 of the Consent Order, were ranked on a scale of 1 to 5, with 1 having the poorest ability to meet the criteria and 5 most readily meeting the selection criteria.

9.2.1 Achieving Cleanup Objectives in a Timely Manner

With respect to timeliness, Alternative 5B, complete excavation and off-site disposal, would probablt achieve the clean-up objective the fastest because it includes source removal.

9.2.2 Protect Human Health and Ecology

Results of the evaluation discussed in section 8 indicate that in addition to the best possible cover design, inspection and maintenance and monitoring will guarantee the performance of Alternative 2B. Alternative 5B also provides this level of assurance without long-term inspection, maintenance, and monitoring. However, hazards are associated with excavation of wastes and transportation off-site because of the significant number of work hours and transportation miles. While best management practices can be employed to minimize risk, there is greater statistical risk of nonfatal injuries for Alternative 5B than for the other alternatives.

9.2.3 Control or Eliminate Sources of Contamination

Alternatives 2B, 5A, and 5B control or eliminate sources of contamination. Alternative 1B is adequate with monitoring and maintenance for 30 yr but provides limited protection after the maintenance period. SVE provides control and eliminates source material, and when combined with complete excavation in Alternative 5B, SVE reduces the period of operations and monitoring. However, there is a possibility of a release of contamination if a high-intensity storm occurs during excavation and removal or if a transportation accident occurs during Alternative 5B. Alternative 5A removes the waste in Impoundments B, C, and D, but waste characterization data show only minor exceedances of TCLP metals in the impoundments.

9.2.4 Control Migration of Released Contaminants

Alternative 2B is superior to Alternative 1B because it directs top-slope runoff into one watershed and captures sediment eroded from the cover in a sediment basin. Therefore, the potential for release of contaminated sediments into watersheds is minimized by Alternative 2B. Maintenance for both cover alternatives will repair covers to minimize erosion of waste as sediment or airborne transport. Alternative 5B is most protective of groundwater and ensures that no migration of VOCs will occur because of waste removal and the application of SVE.

9.2.5 Manage Remediation Waste in Accordance with State and Federal Regulations

Alternative 1B probably does not meet the equivalent infiltration requirement for a RCRA Subtitle C cover. Therefore, it is given the lowest ranking. Alternatives 2B, 5A, and 5B provide the required long-term protection. Complete waste removal in Alternative 5B makes compliance with transportation and disposal requirements more difficult. Alternative 2B is effective for the full 30-yr monitoring and maintenance period and into the foreseeable future; thus, it is given a high ranking.

9.2.6 Benefits and Possible Hazards

Alternative 1B has the lowest cost and allows for future action based on technological advances. Maintenance gives the required degree of protectiveness, but may not continue beyond the proposed 45-yr monitoring and maintenance period. Alternative 2B requires greatest use of off-site soils and creates the greatest visual impact to surrounding communities. Alternative 5A removes some source material. Alternative 5B has some risk of accidents because of the excavation and transportation of hazardous materials across public highways. It also is most protective of groundwater. Overall, Alternative 2B provides the greatest benefit with the least amount of hazard.

10.0 DESIGN CRITERIA TO MEET CLEANUP OBJECTIVES

As required in Section XIF.12 of the Consent Order, this section presents a preliminary plan and key specifications to illustrate the ET cover technology and its anticipated implementation. The preliminary design information includes a discussion of the design life of the alternative and provides reference to engineering calculations for any proposed remediation system.

10.1 Design Approach

Selection of the preferred alternative, Alternative 2B, requires designing an engineered ET cover during the CMI phase for MDA L. The design process will include the following steps:

1. Identify critical infiltration events, including identification of the design precipitation event (maximum precipitation event that the design can endure) or series of events.
2. Determine the minimum required water-storage capacity of MDA L soil based on design infiltration events identified in Step 1.
3. Determine the minimum soil thickness required.
4. Identify the seed mixture to be used, the surface treatment to be employed before seeding, and the frequency of watering necessary to establish vegetation on the ET cover; meet with representatives of San Ildefonso Pueblo to review the seed mixture to ensure the mixture has no effect on adjacent Pueblo lands.
5. Determine the design requirements for the biobarrier.
6. Verify that this design will perform in compliance with the requirements of 20 NMAC 9.1 for alternative cover design.
7. Design an SVE system that compliments the existing pilot test system for extracting VOCs from the vadose zone and can be converted to a passive venting system.
8. Develop a long-term monitoring plan for VOCs and for the first 5 yr, including a plan for a 5-yr review of data by NMED (VOCs) and DOE. During the proposed 5-yr review, NMED will

determine whether operation of the SVE system and monitoring for VOCs should continue. DOE will determine whether monitoring for tritium should continue. If monitoring continues, reviews will occur at least every 5 yr.

9. Develop an operation and maintenance manual based on design and monitoring requirements that will be reviewed during final design meetings and submitted to NMED for approval.

10.2 Preliminary Design Criteria and Rationale

Preparation of the CMI plan includes a schedule for design, including development of design calculations and documentation that will be submitted to NMED according to the CMI schedule. Design calculations will include, but not be limited, to the following.

- The cover will have sufficient capacity to store the “maximum” infiltration quantity resulting from the worst-case precipitation event until it can be removed through ET.
- The cover design will perform in compliance with the requirements of 20 NMAC 9.1 for alternative cover design.
- The proposed seed mixture used to stabilize the cover with vegetation will closely emulate the local plant community, ensure the vegetative cover remains viable, and has no detrimental effect on neighboring Pueblo lands.
- The surface treatment method will encourage native vegetation establishment and growth and reduce erosion.
- The proposed SVE system will effectively limit VOC migration.
- The proposed moisture-monitoring system will verify that volumetric water content levels below the cover surface do not exceed a level negotiated with the NMED (LANL 2005, 089332, pp. J-12 and J-13). This monitoring criterion is applicable to unit Qbt 1 vu from depths of 60 ft (18 m) to 100 ft (30.5 m) and will ensure that downward aqueous-phase transport through the vadose zone is sufficiently slow to inhibit migration to the regional aquifer. Monitoring will identify contaminant migration and verify that the transport is sufficiently slow enough to prevent drinking water MCLs from being exceeded. Pore-gas monitoring results for VOCs and tritium will be reviewed to determine data trends and whether VOCs and tritium are migrating to the regional aquifer.

Figure 8.2-1 presents a preliminary plan view of the final ET cover surface of the preferred corrective measure alternative, Alternative 2B.

Preliminary specifications, sufficient for evaluating the approximate cost of the alternative, are included for

- cover vegetation;
- surface treatment (gravel admixture - typical soil-gravel admixture, gravel size);
- cover soil (water-storage medium thickness, unsaturated hydraulic conductivity, erodibility);
- filter medium (natural materials, such as gravel used as a filter between the cover soil and biobarrier); and
- biobarrier (cobble size and uniformity, thickness).

Key elements of the material specifications are presented in Table 10.0-1 for layers based on imported soil and rock.

10.2.1 Surface Treatment

Surface treatments, such as soil nutrients, a gravel layer, or a soil-gravel admixture, may be warranted in the semiarid climate at the Laboratory to assist native vegetation establishment and reduce erosion. During the CMI design phase, a seed mix will be specified to stabilize the cover with vegetation consisting of plant communities that closely resemble the undisturbed and well-established plant communities inhabiting Mesita del Buey. Specifications on the surface treatment are provided in Appendix D.

The addition of a 1.5-ft- (0.46-m-) thick layer of gravel-soil admixture on the surface of the cover provides erosion protection for the 1000-yr storm and promotes ET from nonclimax vegetation composed mostly of native species of grasses (Appendix D). Erosion and water-balance studies at the Laboratory indicate that moderate amounts of gravel mixed into the cover topsoil will control both water and wind erosion with little effect on the vegetation or the soil-water balance (Appendix D). As wind and water flow over the cover surface, some winnowing of fines from the admixture is expected, creating a vegetated, erosion-resistant surface (Appendix D).

The design of a soil-gravel admixture layer is based primarily on the need to protect the soil cover from erosion. A soil-gravel admixture protects a cover from long-term wind erosion. The protection from water erosion depends on the depth, velocity, and duration of stormwater flowing across the MDA L cover. Flow values can be established from the physical properties of the cover (slope, convex or concave grading, slope uniformity, and length of flow paths) and the intensity of the precipitation (precipitation rates, infiltration versus runoff relationships, snowmelt, and off-site flows).

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

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

10.2.2 Cover Soil

The performance of the engineered ET cover relies on its thickness. The engineered ET cover for MDA L will be of sufficient thickness to ensure that the water-storage capacity of the cover is sufficient to store the maximum infiltration quantity resulting from the design precipitation event (1000 yr) until it may be removed through ET. Specifications on the cover soil are provided in Appendix D.

10.2.3 Filter Media

Inclusion of a filter-media layer with a particle size between the cover soil and the biobarrier cobbles will enhance the effectiveness of the biobarrier. It will also improve the waste-storage capacity of the cover by providing a capillary break. Specifications for filter media are provided in Appendix D.

10.2.4 Biobarrier

When the cover depth is established, biobarrier requirements will be evaluated to optimize its performance. The biobarrier must prevent plant roots and animals from intruding into the waste, where they may create conduits for water to move downward into the waste units or transport waste to the surface. Specifications for the biobarrier are provided in Appendix D.

10.3 General Operation and Maintenance Requirements

Subject-matter experts will be used to establish appropriate requirements for irrigating the cover. Irrigation is needed during the 2 yr following construction to aid in the germination and establishment of the vegetative cover. Vegetation establishment will be offset by keeping infiltration below the storage capacity of the cover. The Laboratory will implement the irrigation plan.

During the first 2 yr after construction, the Laboratory will inspect the cover monthly and after significant precipitation events to identify erosion indicators on the cover. Any eroded areas will be repaired. After the cover is established, it will be inspected annually in the fall after the monsoon season has ended, and any cover erosion will be repaired.

During the CMI design phase, an area will be designated within the MDA L fence to store the soil-gravel admixture used for cover maintenance. A small shed will be placed in this area for storing tools and grass seed.

The SVE system will be operated for 2 months on with 22 months off based on the results of the pilot test at MDA L (Appendix F).

10.3.1 Long-Term Monitoring Requirements

Groundwater monitoring of the regional aquifer beneath MDA L will be consolidated with the Laboratory-wide groundwater-monitoring program. One new groundwater well is proposed to be installed at a location near the MDA L site.

VOCs will be monitored for 30 yr in the selected boreholes on site or until NMED determines that monitoring is not necessary. Tritium will be monitored in the subsurface until DOE determines that no future potential risk exists.

Additional monitoring will be performed for contaminants in dust and sediment in surface water runoff.

10.4 Additional Engineering Data Required

Before the CMI design is completed, additional data is required, including

- verifying the existing depths to the top of waste in each unit to properly determine the operational cover thickness and whether additional clean fill may be required to establish a graded base for the biobarrier; and
- testing the geotechnical properties of all materials used for the infiltration layer, biobarrier, filter media, soil-gravel admixture, and rock armor.

10.5 Additional Requirements

10.5.1 Access, Easements, Right-of-Way

These agreements are internal to the Laboratory and will be developed as required once the corrective measure is selected.

10.5.2 Health and Safety Requirements

A SSHASP will be prepared to describe the health and safety requirements to be followed during construction of the MDA L cover, during construction of the SVE-monitoring system, during operation and maintenance activities, and during monitoring activities.

10.5.3 Community-Relations Activities

A community-relations program will be implemented to keep stakeholders, including the White Rock community, San Ildefonso Pueblo, Northern New Mexico Citizen Advisory Board, and other interested parties aware of project activities and progress.

11.0 SCHEDULE FOR COMPLETION OF ACTIVITIES

The Consent Order requires that a schedule for completion of activities be submitted in the CME report that includes specific and intermediate milestones. Activities leading to completion of the remedy include removal of existing paving; planning, design, and construction of the ET cover; and installation and testing of monitoring systems. Several milestones for completion of the corrective measure at MDA L are presented in the Consent Order along with schedule updates. In addition to these milestones, the Consent Order requires the CME report to include a proposed schedule for remedy-related activities such as bench tests, pilot tests, and other remedial actions. The schedule identifies the duration of corrective action operations, the frequency of monitoring and sampling activities, Dates for submittal of inspection and monitoring reports to the NMED, including all status reports and preliminary data. The overall schedule for completion of the corrective action is presented in Figure 11.0-1.

11.1 Specific Consent Order Milestones

Specific Consent Order milestones include the following.

- The Laboratory will submit the MDA L CME report to NMED by January 18, 2008, and NMED will approve the CME report by June 30, 2009.
- NMED will prepare a Statement of Basis for remedy selection and issue the statement for public comment.
- NMED will receive public comments on the Statement of Basis for at least 60 d following public notice and will select a final remedy and issue a response to comments within 90 d of the end of the comment period, or at another appropriate time. NMED will provide an opportunity for a public hearing that may extend the public comment period.
- The Laboratory will submit a CMI plan within 1 yr after NMED selects a final remedy. The plan will contain detailed engineering design drawings and system specifications for all elements of the remedy and a schedule for implementation of the corrective action.
- The corrective measure will be implemented according to the schedule in the CMI plan.
- The Laboratory will complete the remedy by March 31, 2012.
- The Laboratory will submit a remedy completion report within 90 d after completion of the remedy.
- NMED will approve the remedy completion report by September 30, 2012.

11.2 Intermediate Milestones

In addition to milestones directly specified in the Consent Order other intermediate milestones may be established. Consent Order requirements for the CMI plan identify documents and an associated schedule for deliverables. The schedule for CMI-identified documents that are beyond the scope of the CME report schedule include the following:

- construction work plan
- operation and maintenance plan
- remedy pilot tests
- waste management plan
- health and safety plan
- Public Involvement Plan (meeting held on February 28, 2007)
- progress reports

Other remedial action activities that are within the scope of the CME schedule include the Laboratory's initiating D&D activities for some aboveground structures on October 1, 2008. No bench-scale or pilot tests were identified as required at this site and thus are not included in the schedule.

The schedule for inspection and monitoring report submittal to NMED is based on the long-term subsurface vapor monitoring plan and sitewide groundwater monitoring plans for the Laboratory. Inspection and monitoring reports will be submitted annually.

12.0 REFERENCES AND MAP DATA SOURCES

12.1 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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12.2 Map Data Sources

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

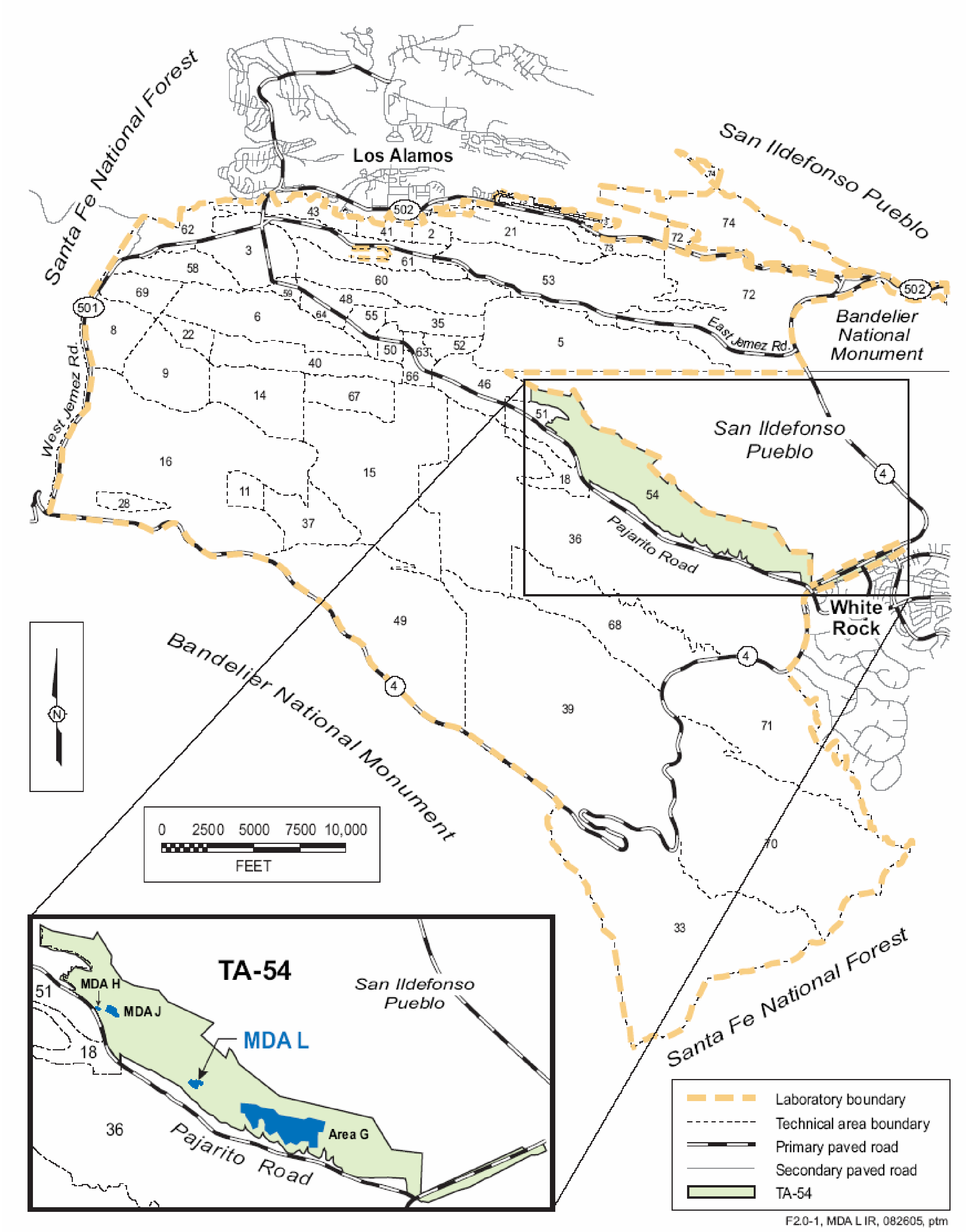
LANL DOE Boundary; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; Development Edition of 05 January 2005

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

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

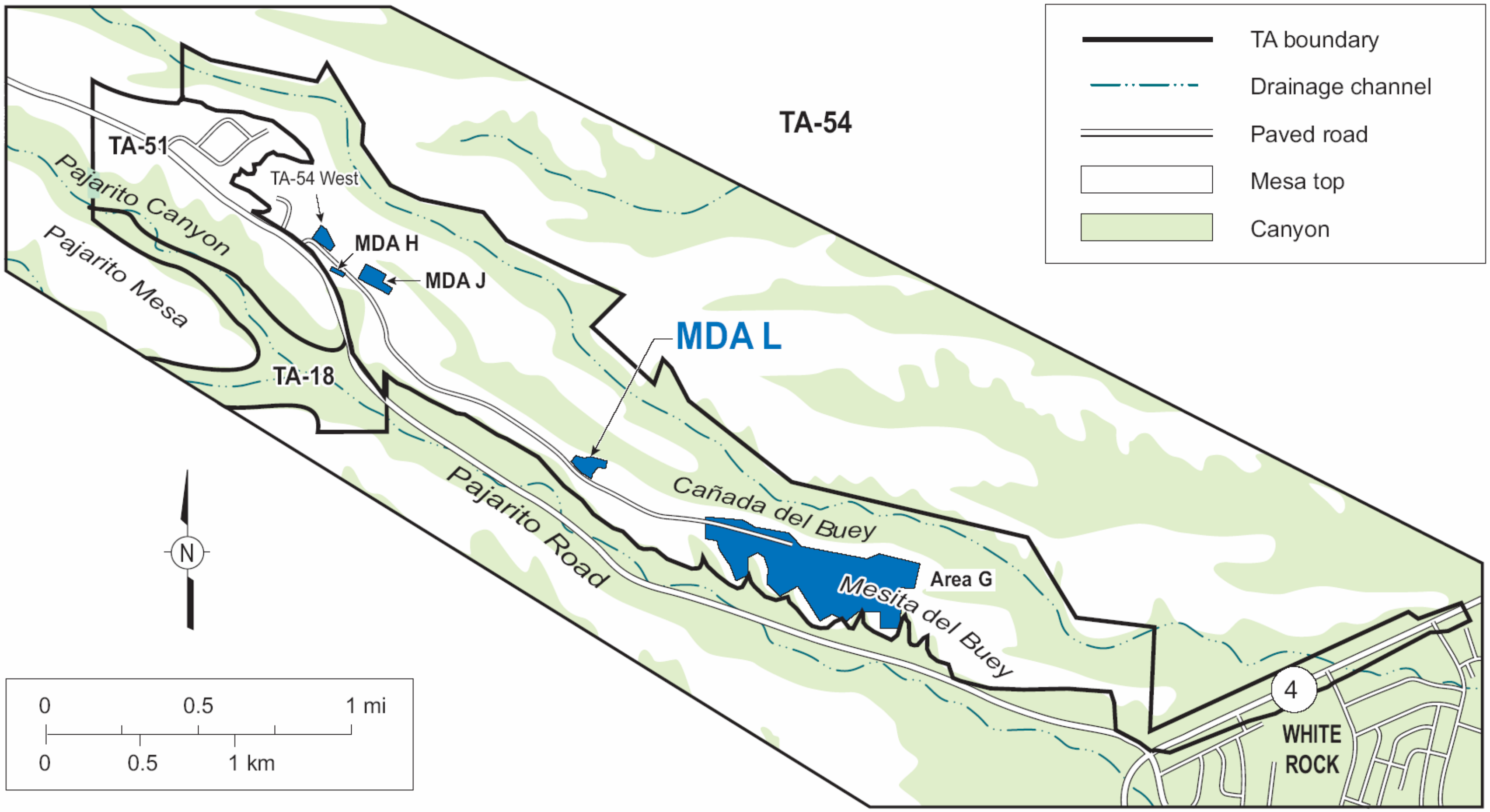
Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; Development Edition of 17 January 2006

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



F2.0-1, MDA L IR, 082605, ptm

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



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

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

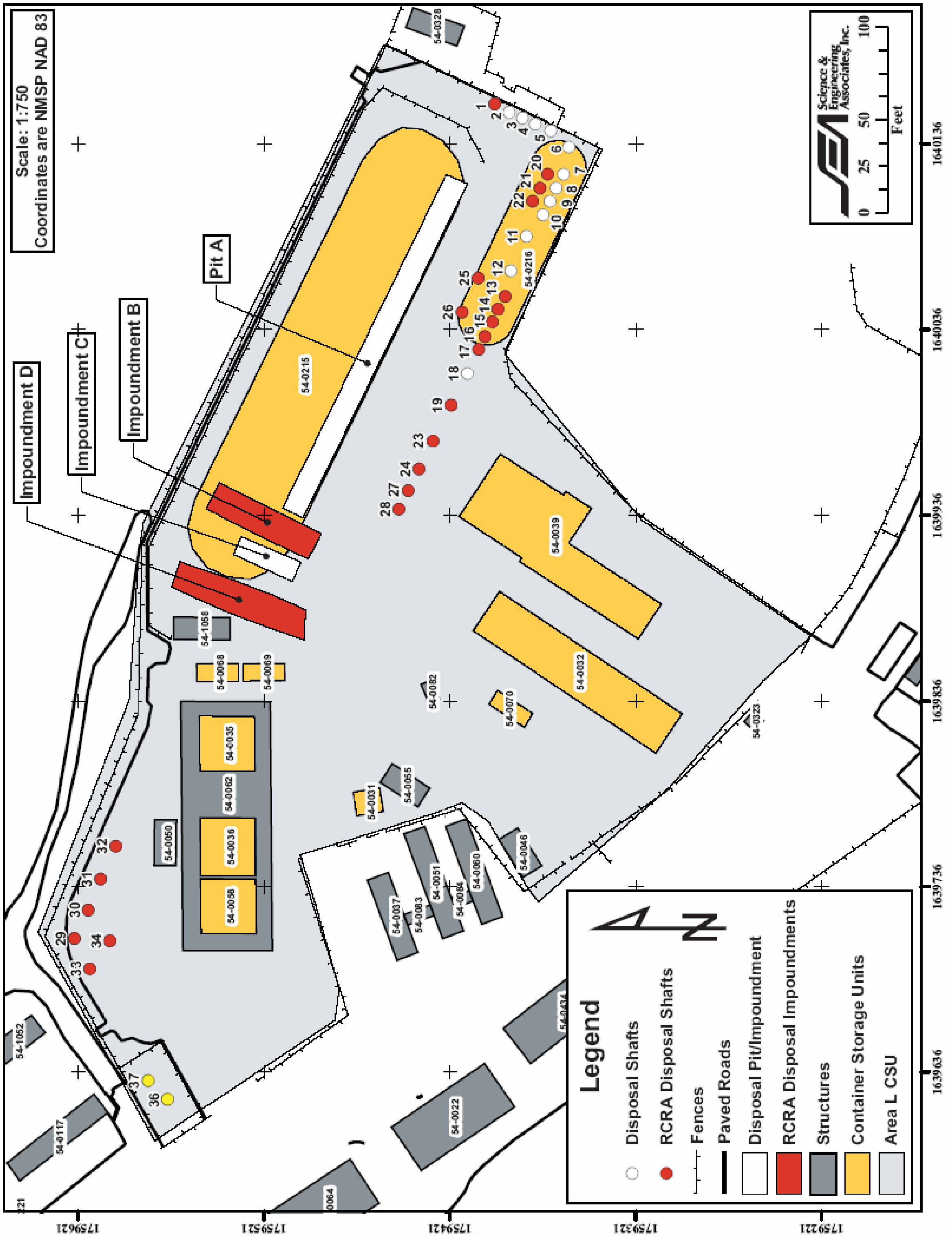


Figure 2.0-1 Inactive subsurface disposal units and existing surface structures at MDA L

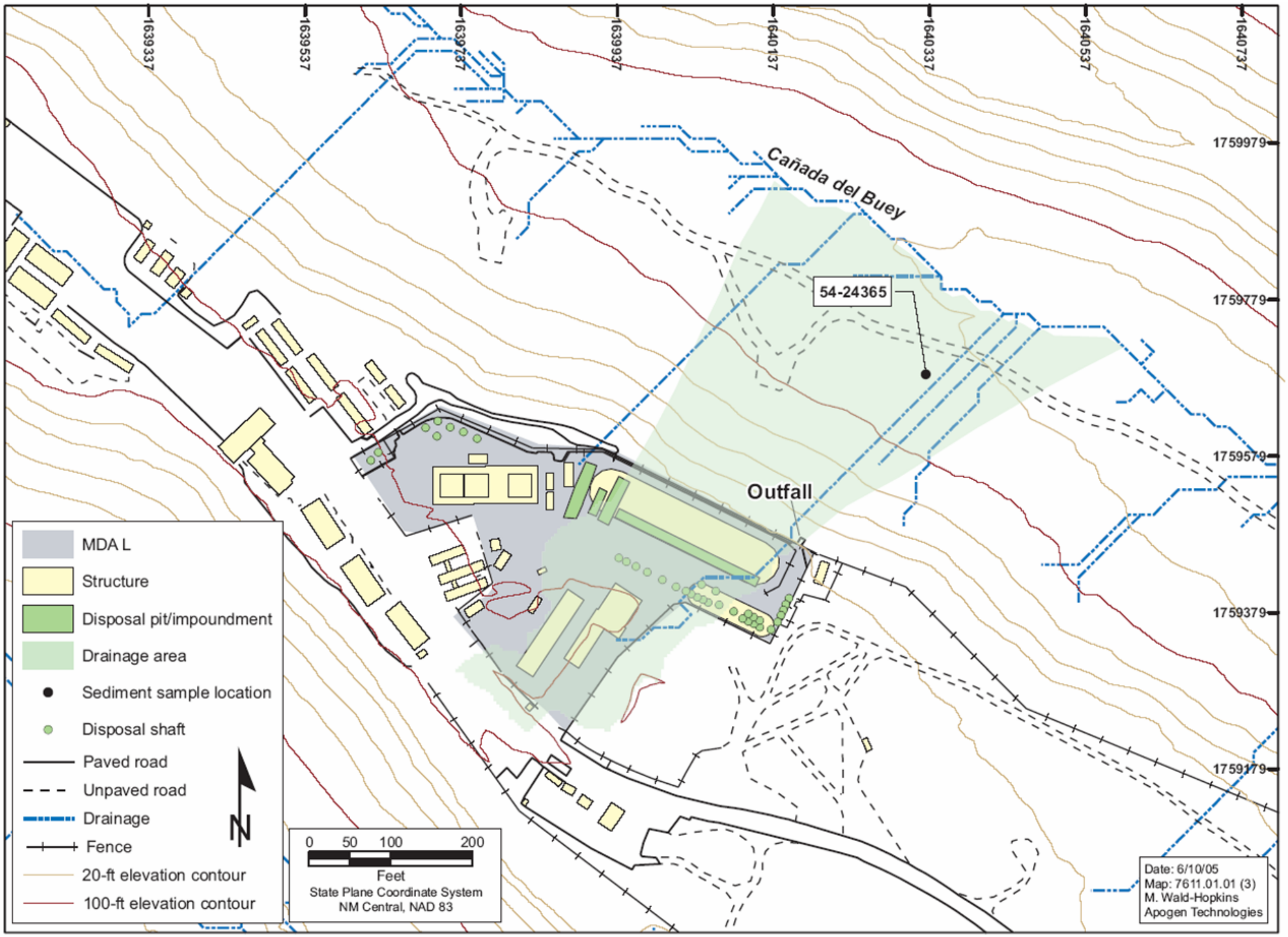
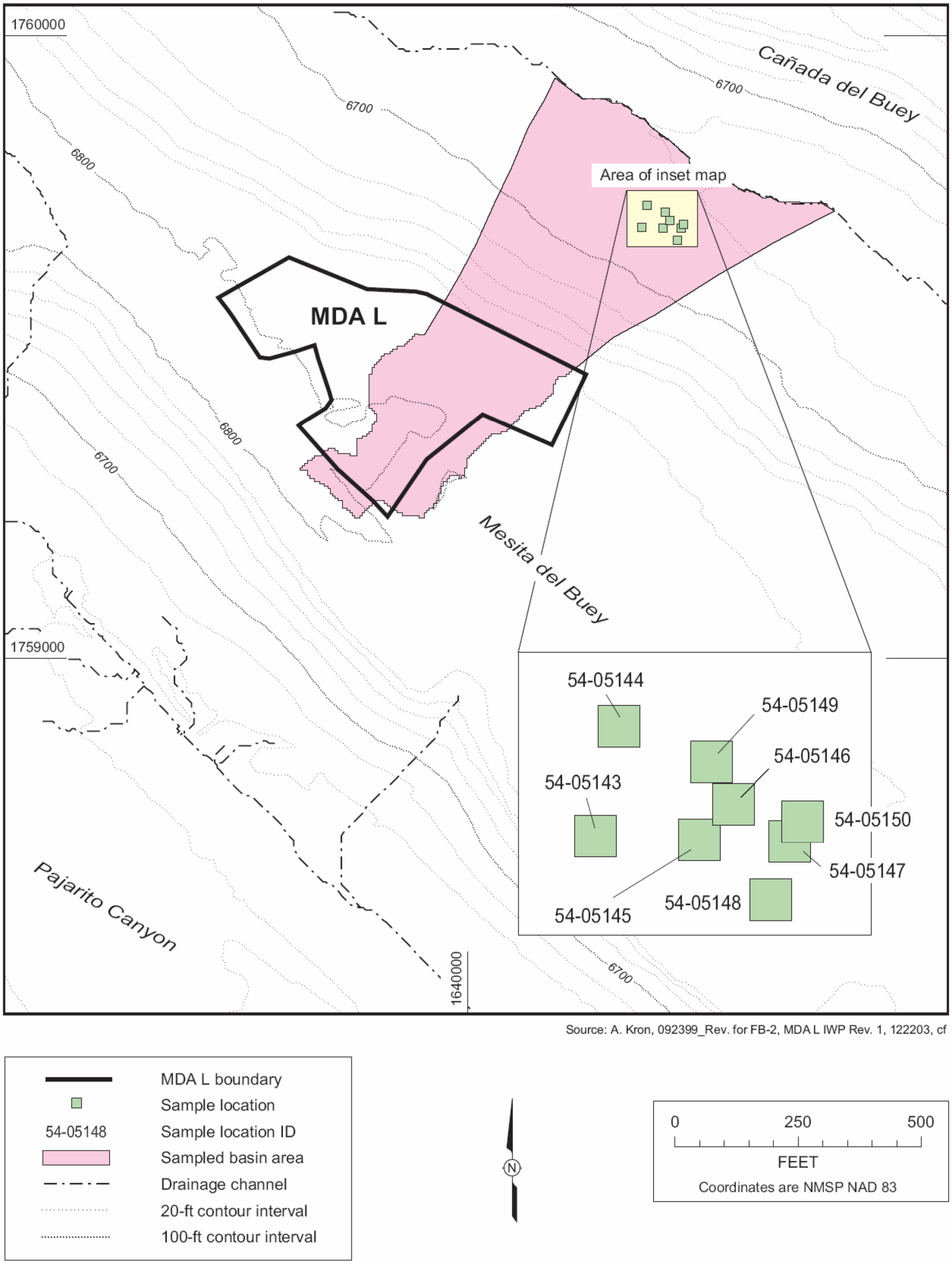
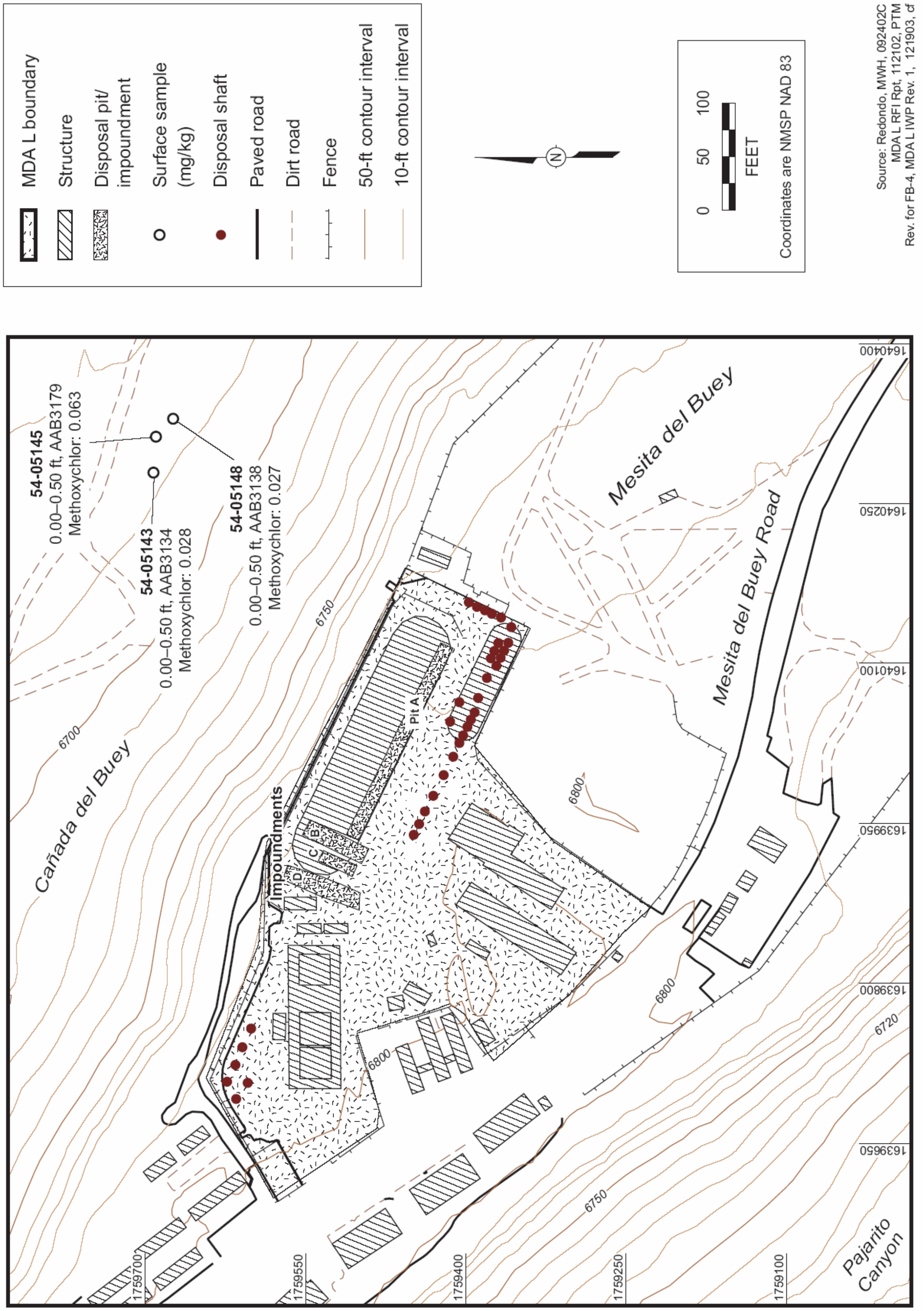


Figure 2.1-1 MDA L drainage area and 2004–2005 channel sediment sampling location



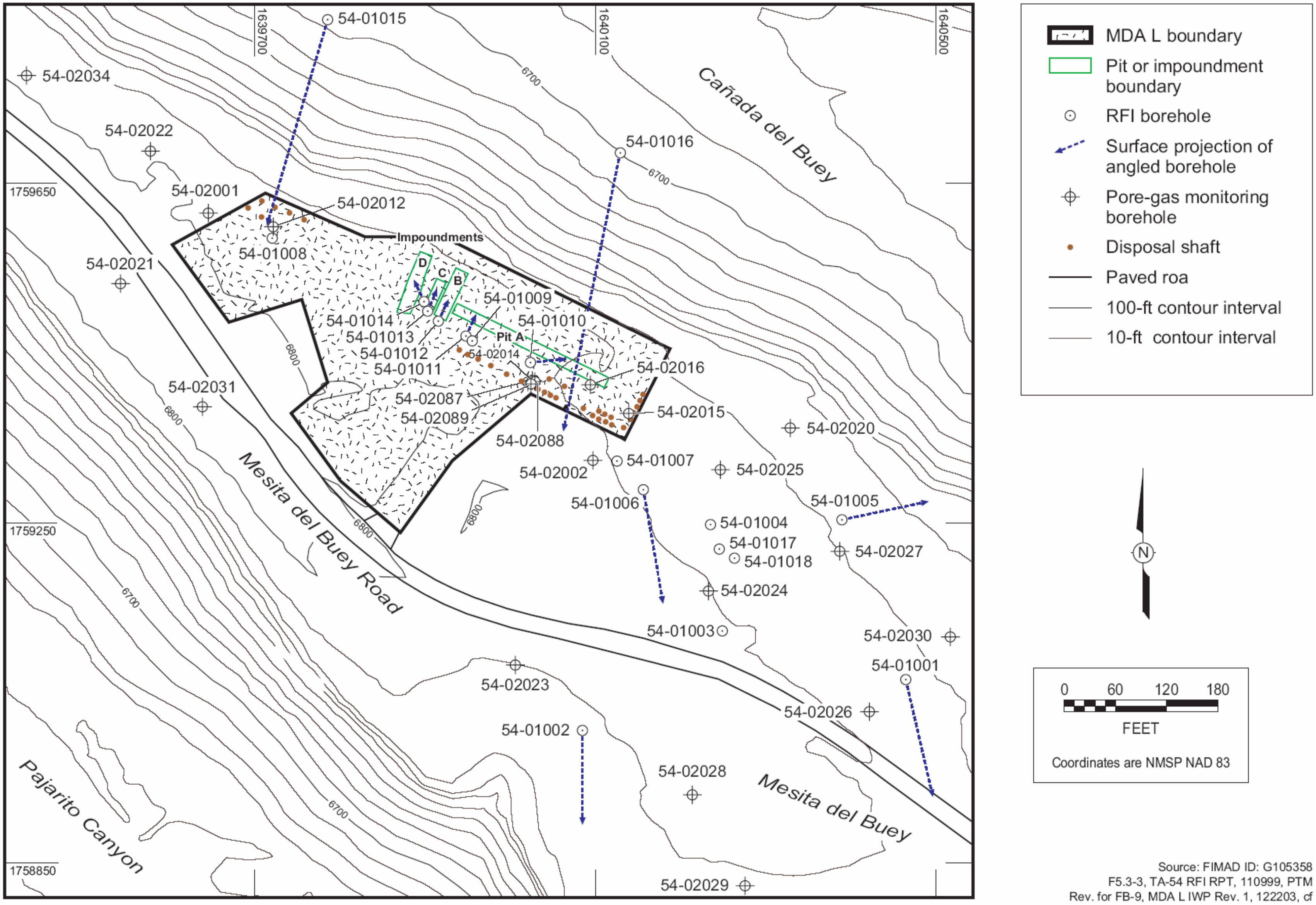
Source: A. Kron, 092399_Rev. for FB-2, MDA L IWP Rev. 1, 122203, cf

Figure 2.4-1 Phase I RFI sediment sampling locations at MDA L



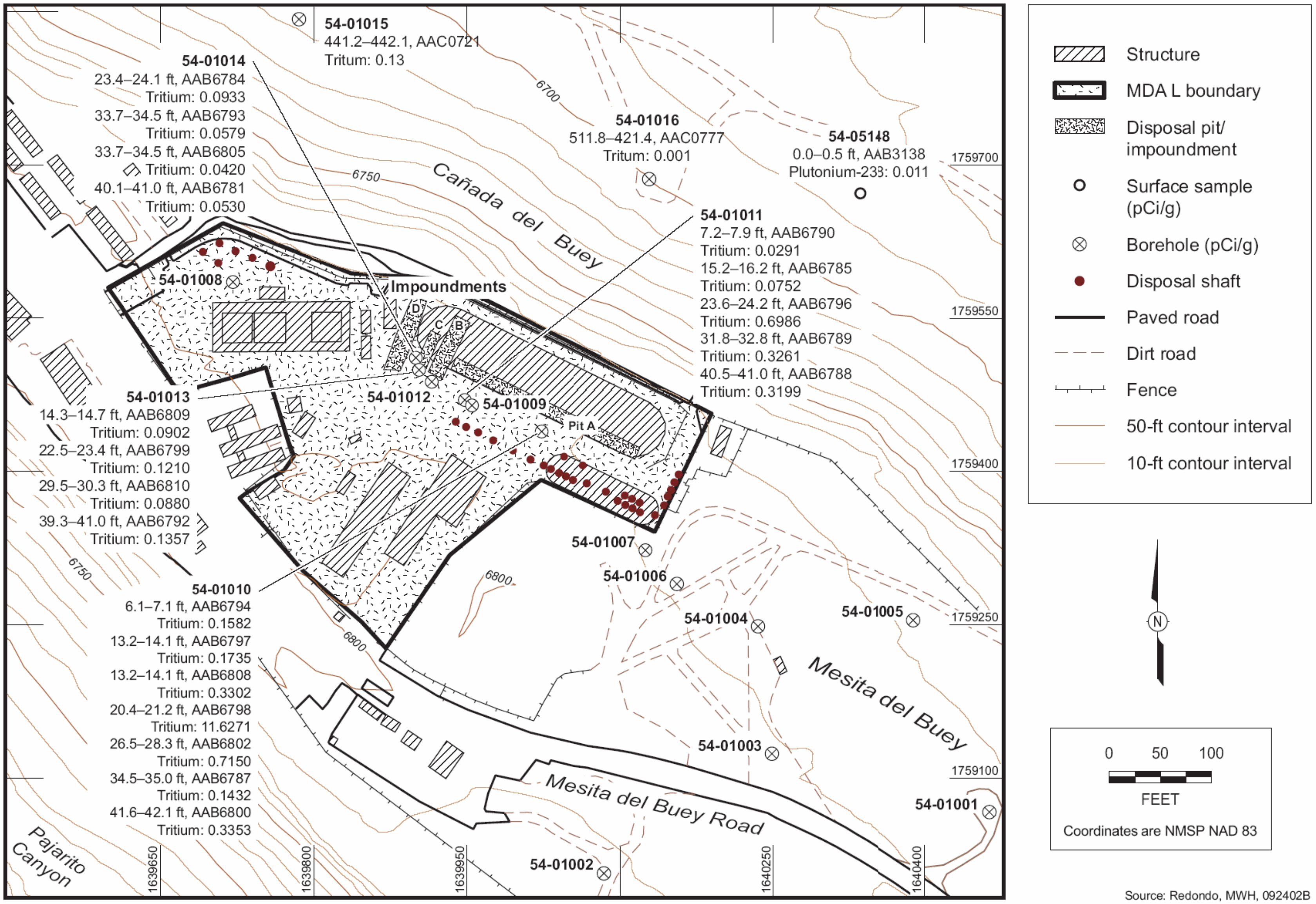
Source: Redondo, MWH, 092402C
MDA L RFI Rpt, 112102, PTM
Rev. for FB-4, MDA L IWP Rev. 1, 121903, cf

Figure 2.4-2 Organic chemicals detected in channel sediments at MDA L



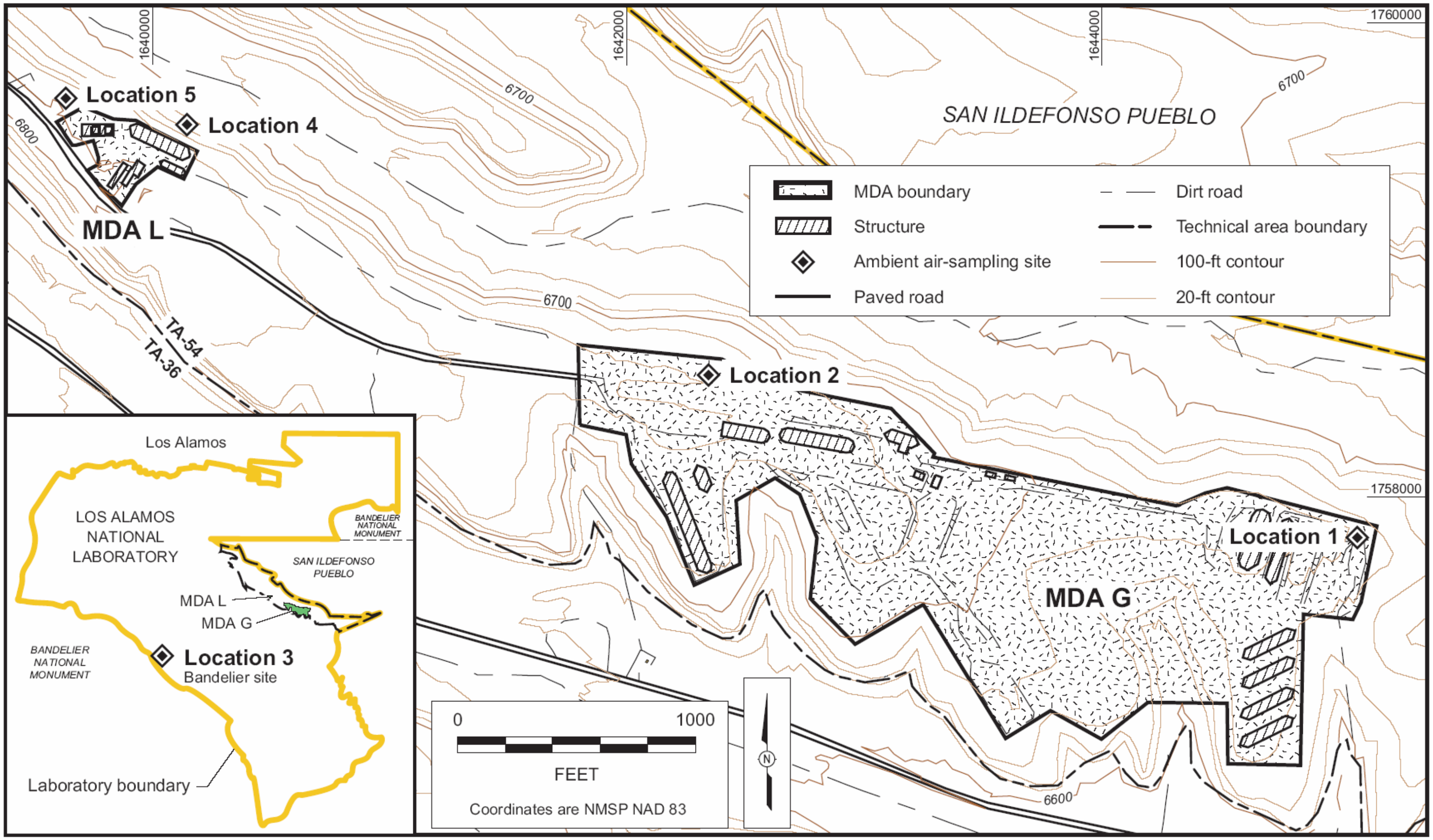
Source: FIMAD ID: G105358
F5.3-3, TA-54 RFI RPT, 110999, PTM
Rev. for FB-9, MDA L IWP Rev. 1, 122203, cf

Figure 2.4-3 Locations of Phase I RFI boreholes at MDA L



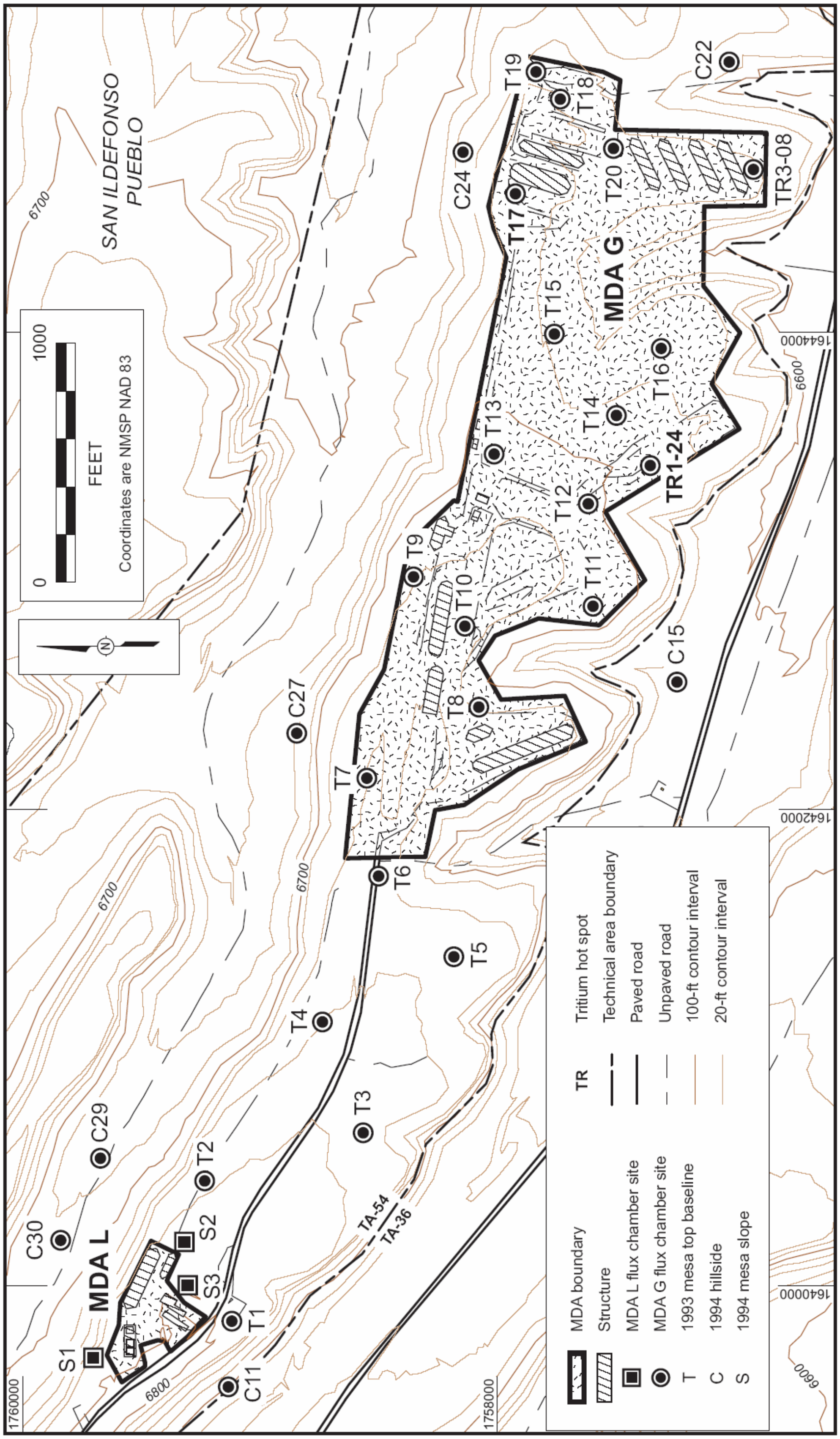
Source: Redondo, MWH, 092402B
MDA L RFI Rpt, 120302, PTM
Rev. for FB-3, MDA L IWP, 082803, cf
Revisions for MDA L Rev. 1 by MH, SEA, 120403

Figure 2.4-4 Radionuclide detections above BVs/FVs at MDA L



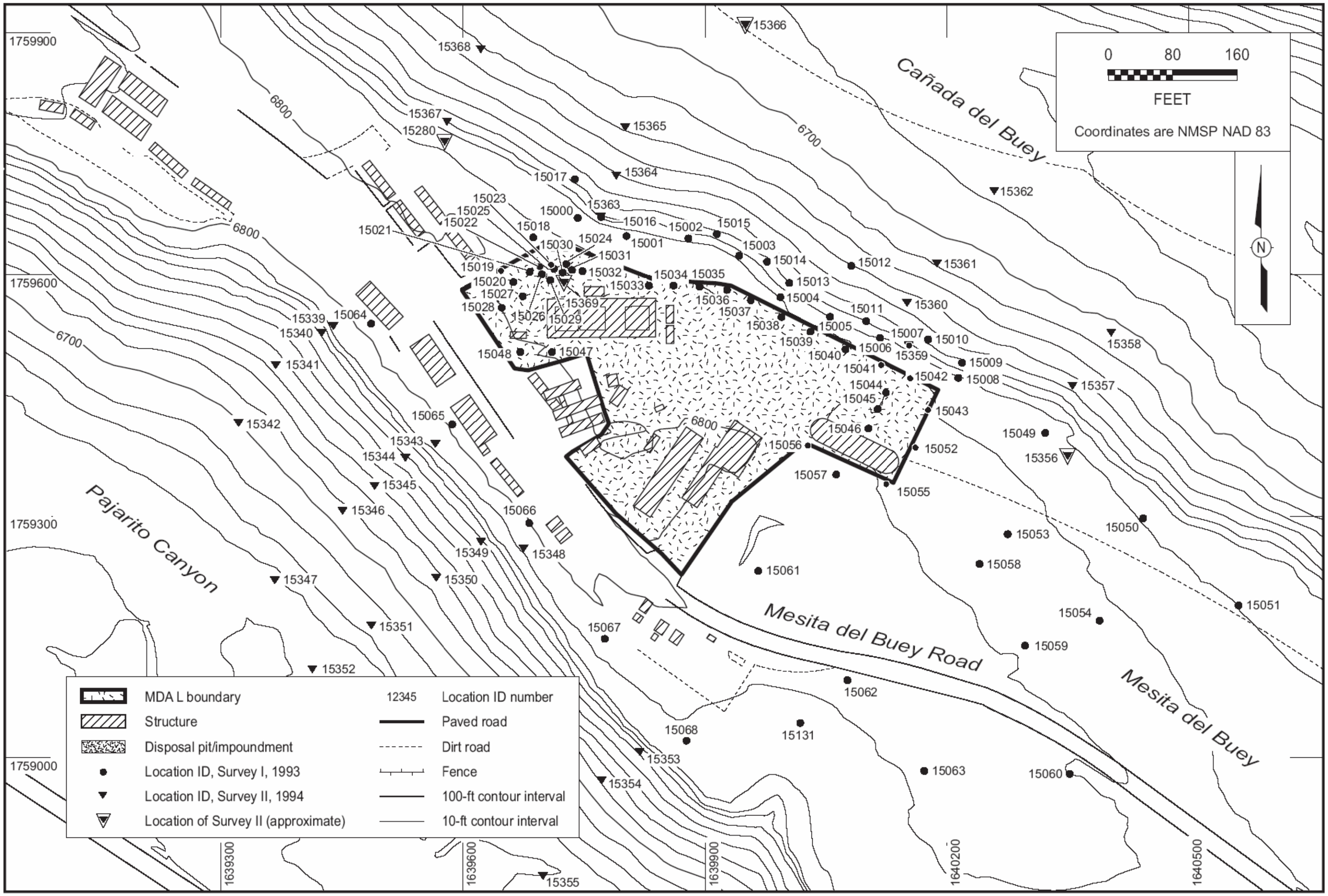
Source: FIMAD map G107980, 072999_MDA L RFI r, 120302, PTM_Rev. for FB-5, MDA L IWP Rev. 1, 121903, cf

Figure 2.4-5 Ambient air VOC sampling locations at MDAs G and L



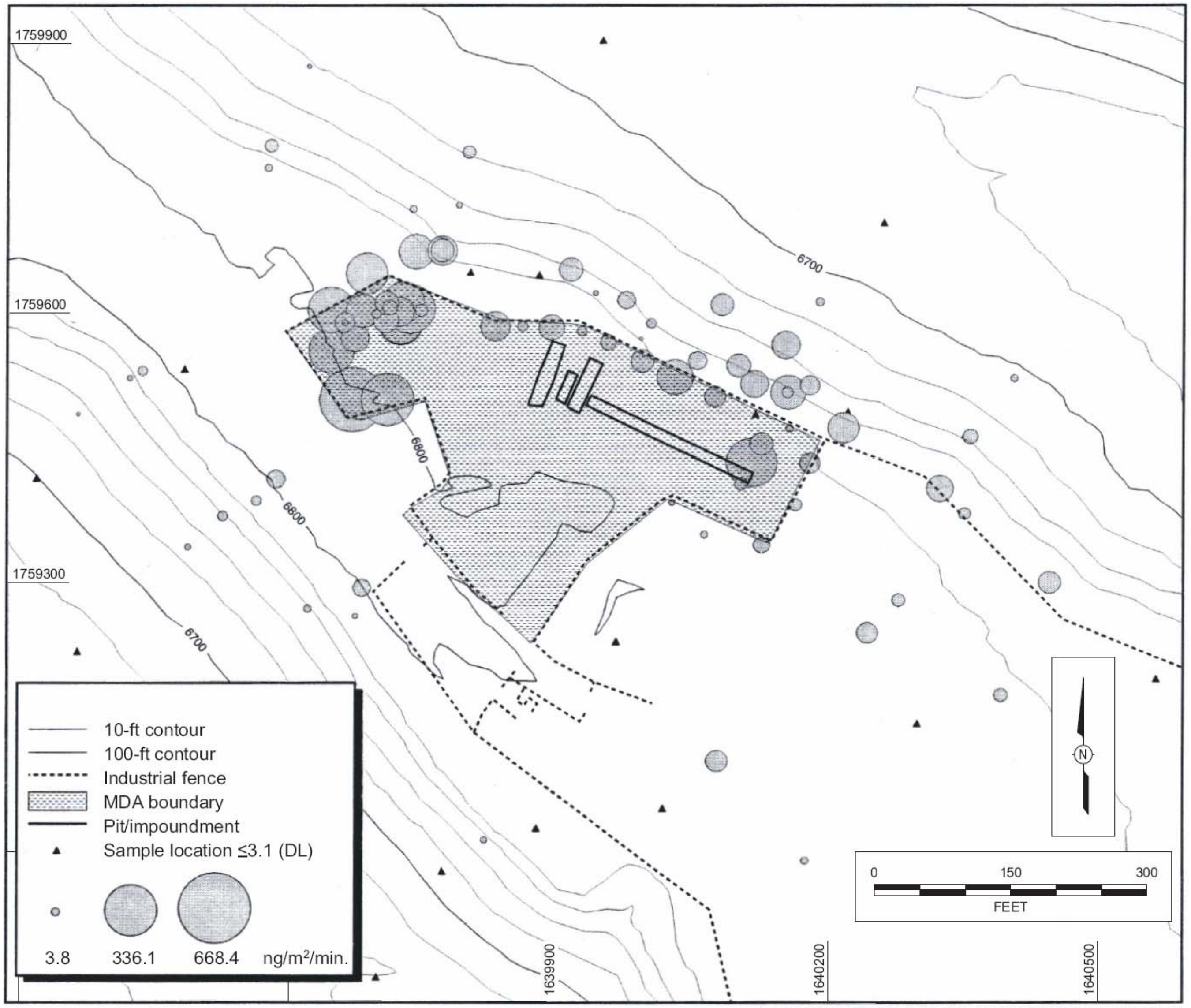
Source: FIMAD map G107980, 072999
MDA L RFI rpt, 121902, PTM_Rev. for FB-6, MDA L IWP Rev. 1, 122203, cf

Figure 2.4-6 Locations of VOC and tritium flux chamber samples at MDAs G and L



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

Figure 2.4-7 EMFLUX sampling locations at MDA L



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

Figure 2.4-8 Surface flux concentrations of TCA at MDA L

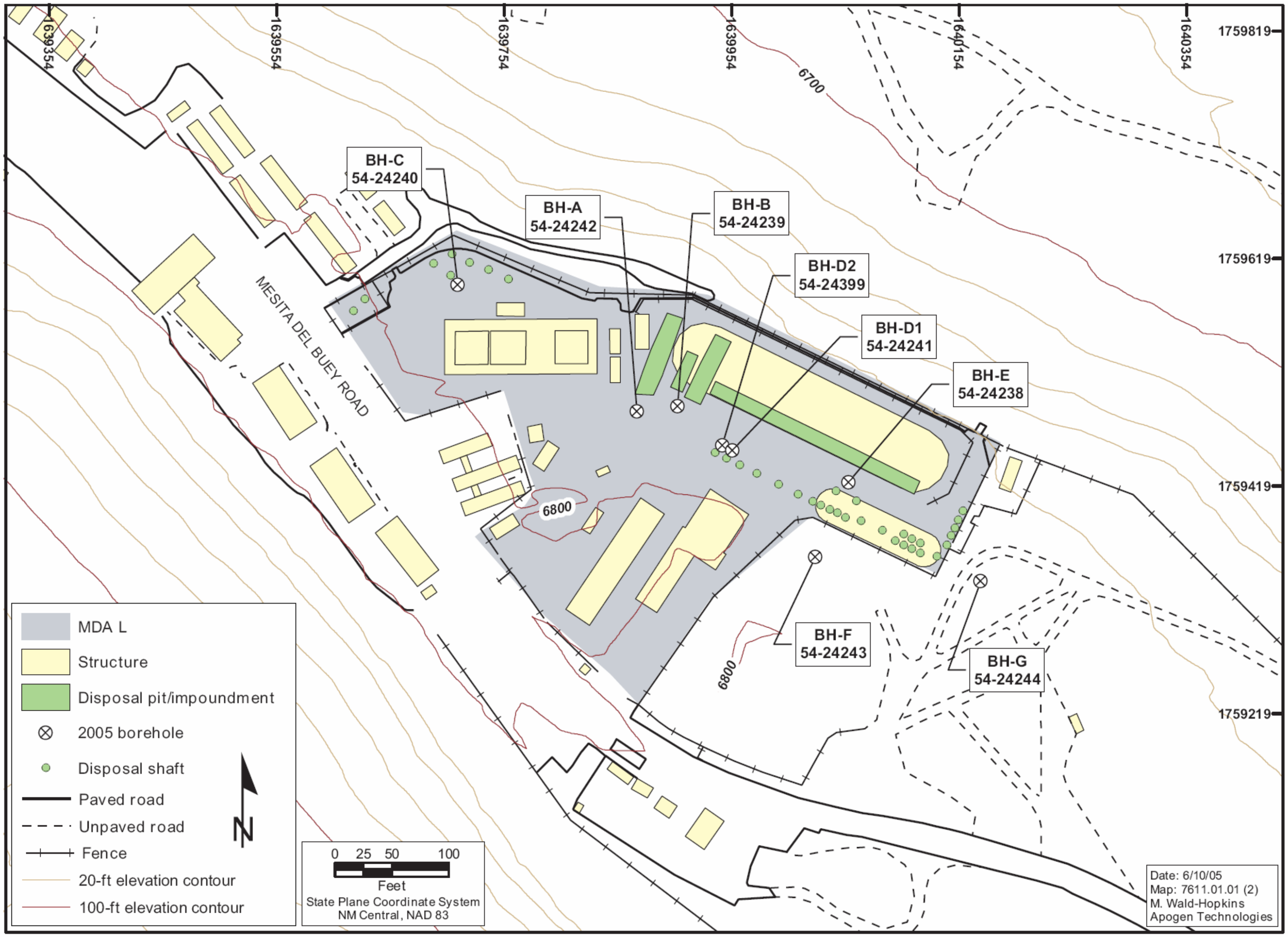


Figure 2.4-9 Locations of boreholes drilled during the MDA L investigation in 2004 and 2005

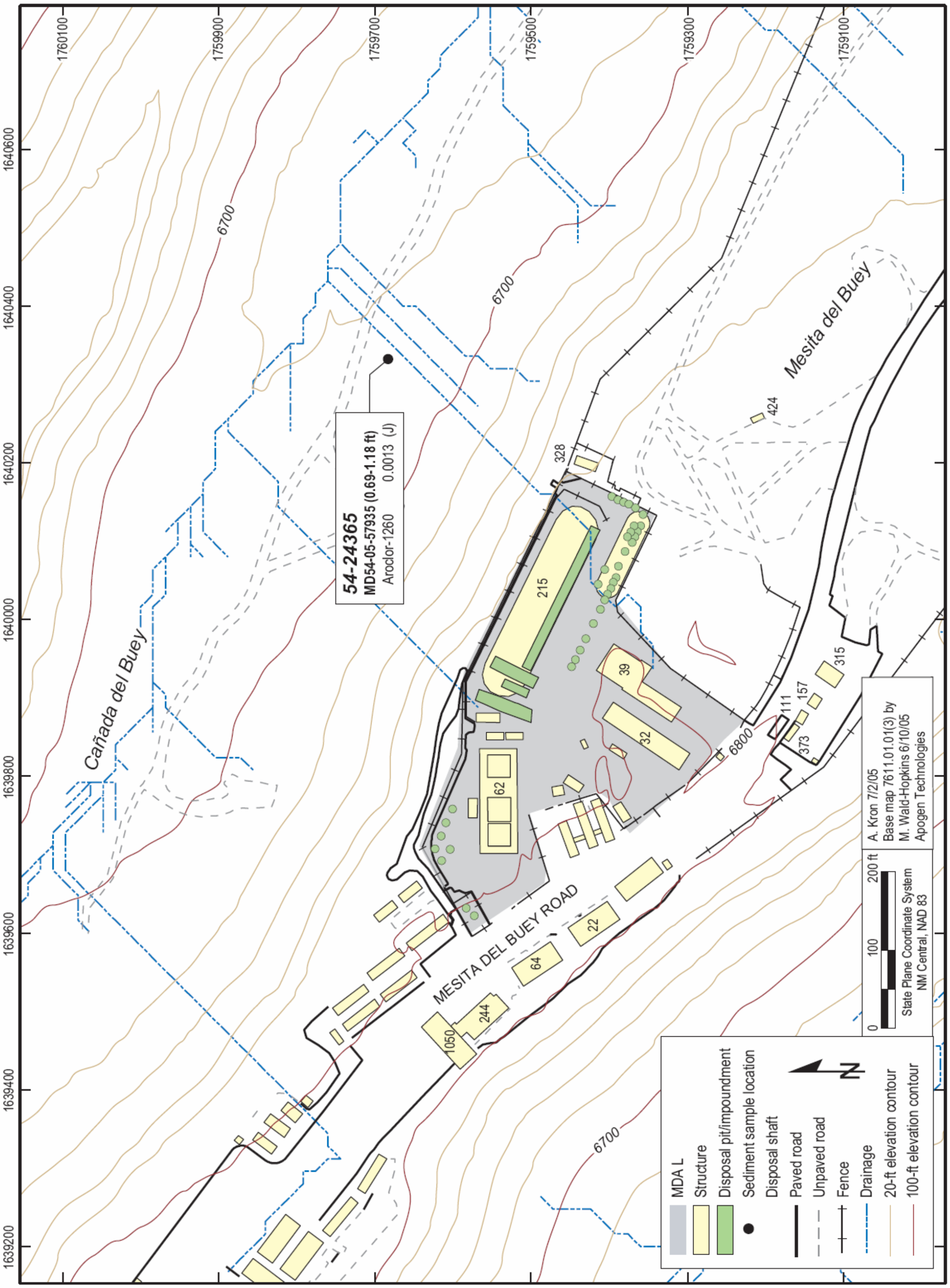


Figure 2.4-10 Organic chemicals (mg/kg) detected in channel sediments at MDA L

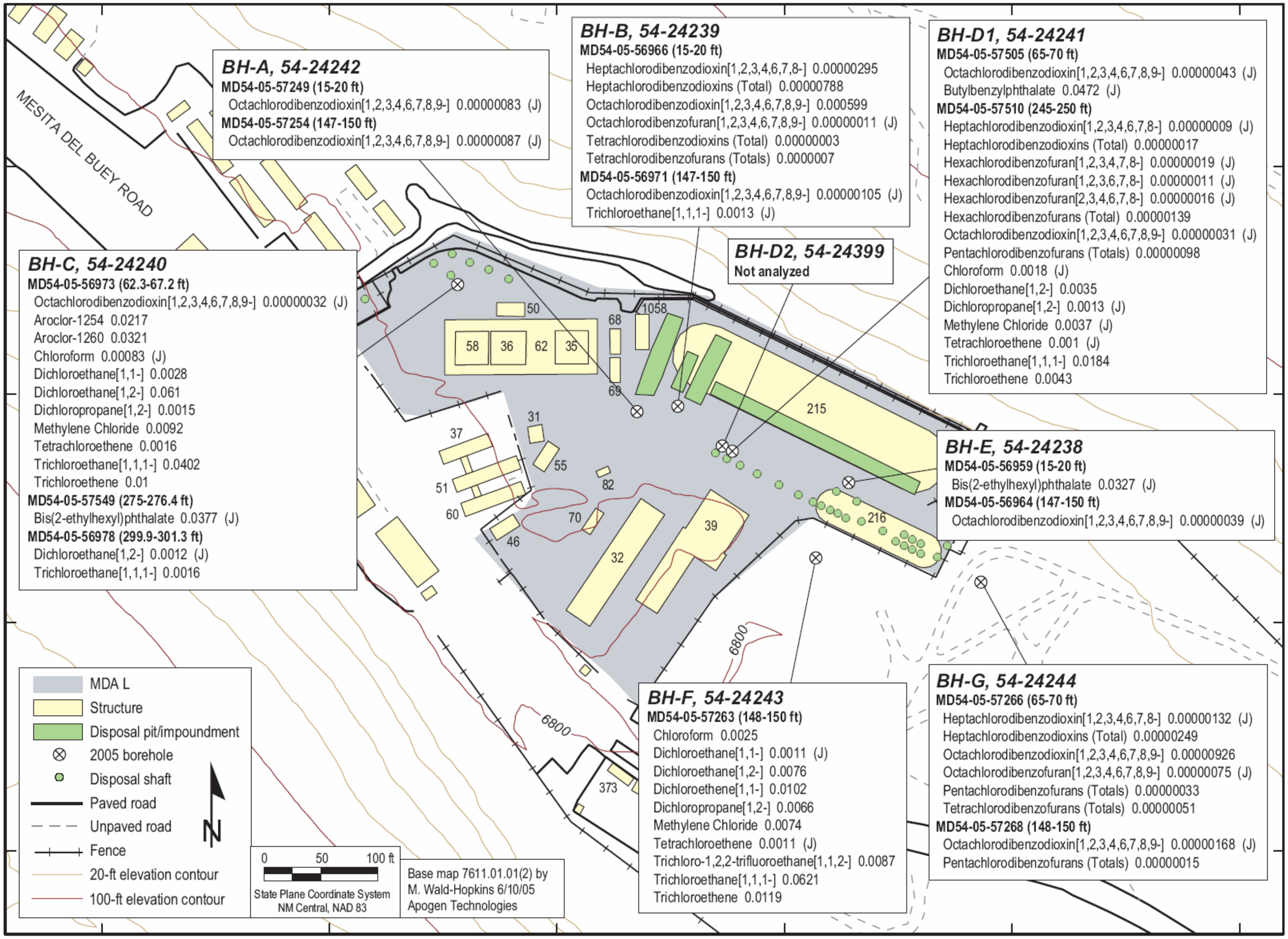
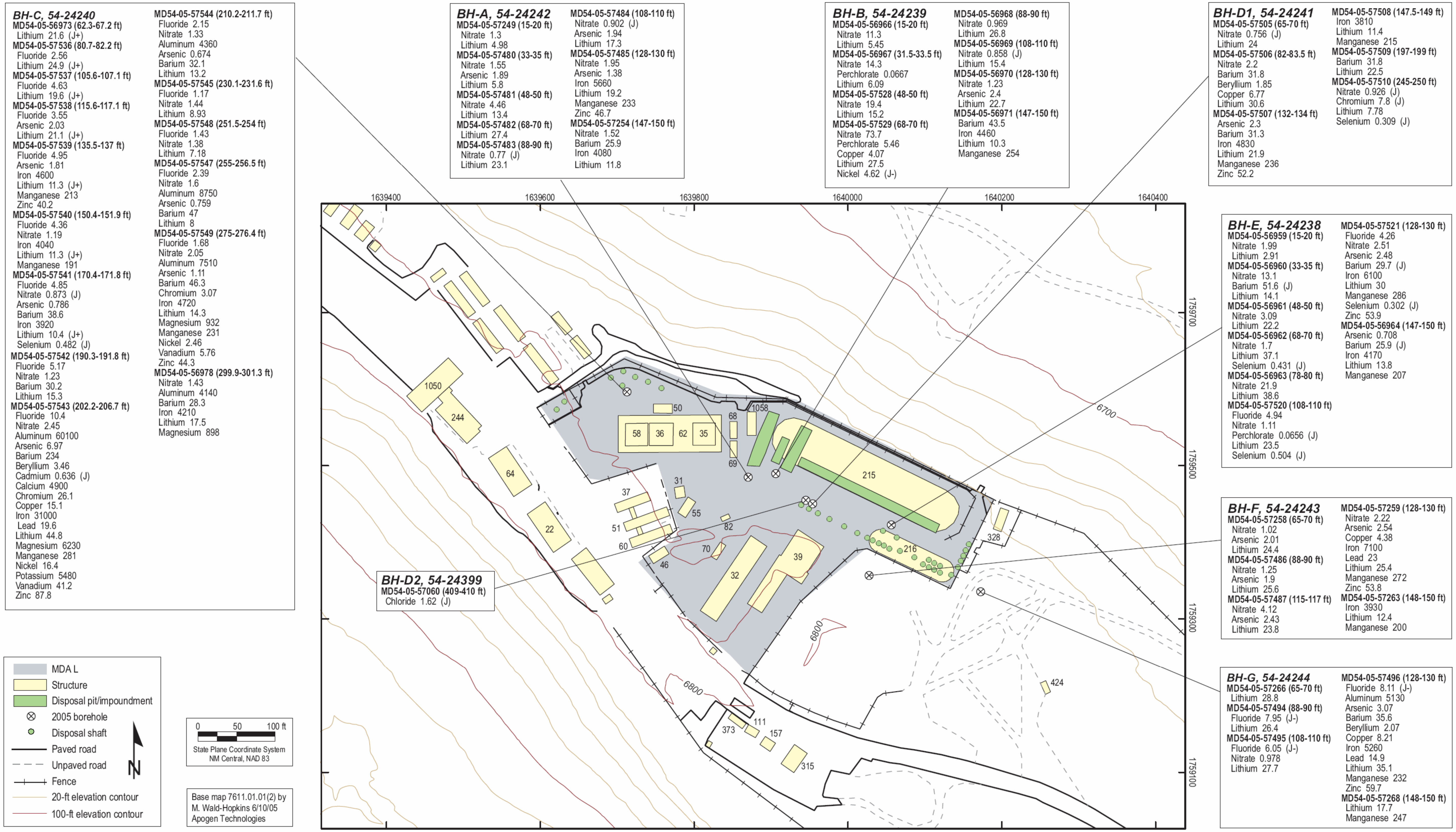


Figure 2.4-11 Organic chemicals (mg/kg) detected in subsurface tuff at MDA L



Base map 7611.01.01(2) by
M. Wald-Hopkins 6/10/05
Apogen Technologies

BH-C, 54-24240
MD54-05-56973 (62.3-67.2 ft)
Lithium 21.6 (J+)
MD54-05-57536 (80.7-82.2 ft)
Fluoride 2.56
Lithium 24.9 (J+)
MD54-05-57537 (105.6-107.1 ft)
Fluoride 4.63
Lithium 19.6 (J+)
MD54-05-57538 (115.6-117.1 ft)
Fluoride 3.55
Arsenic 2.03
Lithium 21.1 (J+)
MD54-05-57539 (135.5-137 ft)
Fluoride 4.95
Arsenic 1.81
Iron 4600
Lithium 11.3 (J+)
Manganese 213
Zinc 40.2
MD54-05-57540 (150.4-151.9 ft)
Fluoride 4.36
Nitrate 1.19
Iron 4040
Lithium 11.3 (J+)
Manganese 191
MD54-05-57541 (170.4-171.8 ft)
Fluoride 4.85
Nitrate 0.873 (J)
Arsenic 0.786
Barium 38.6
Iron 3920
Lithium 10.4 (J+)
Selenium 0.482 (J)
MD54-05-57542 (190.3-191.8 ft)
Fluoride 5.17
Nitrate 1.23
Barium 30.2
Lithium 15.3
MD54-05-57543 (202.2-206.7 ft)
Fluoride 10.4
Nitrate 2.45
Aluminum 60100
Arsenic 6.97
Barium 234
Beryllium 3.46
Cadmium 0.636 (J)
Calcium 4900
Chromium 26.1
Copper 15.1
Iron 31000
Lead 19.6
Lithium 44.8
Magnesium 6230
Manganese 281
Nickel 16.4
Potassium 5480
Vanadium 41.2
Zinc 87.8
MD54-05-57544 (210.2-211.7 ft)
Fluoride 2.15
Nitrate 1.33
Aluminum 4360
Arsenic 0.674
Barium 32.1
Lithium 13.2
MD54-05-57545 (230.1-231.6 ft)
Fluoride 1.17
Nitrate 1.44
Lithium 8.93
MD54-05-57548 (251.5-254 ft)
Fluoride 1.43
Nitrate 1.38
Lithium 7.18
MD54-05-57547 (255-256.5 ft)
Fluoride 2.39
Nitrate 1.6
Aluminum 8750
Arsenic 0.759
Barium 47
Lithium 8
MD54-05-57549 (275-276.4 ft)
Fluoride 1.68
Nitrate 2.05
Aluminum 7510
Arsenic 1.11
Barium 46.3
Chromium 3.07
Iron 4720
Lithium 14.3
Magnesium 932
Manganese 231
Nickel 2.46
Vanadium 5.76
Zinc 44.3
MD54-05-56978 (299.9-301.3 ft)
Nitrate 1.43
Aluminum 4140
Barium 28.3
Iron 4210
Lithium 17.5
Magnesium 898

BH-A, 54-24242
MD54-05-57249 (15-20 ft)
Nitrate 1.3
Lithium 4.98
MD54-05-57480 (33-35 ft)
Nitrate 1.55
Arsenic 1.89
Lithium 5.8
MD54-05-57481 (48-50 ft)
Nitrate 4.46
Lithium 13.4
MD54-05-57482 (68-70 ft)
Lithium 27.4
MD54-05-57483 (88-90 ft)
Nitrate 0.77 (J)
Lithium 23.1
MD54-05-57484 (108-110 ft)
Nitrate 0.902 (J)
Arsenic 1.94
Lithium 17.3
MD54-05-57485 (128-130 ft)
Nitrate 1.95
Arsenic 1.38
Iron 5660
Lithium 19.2
Manganese 233
Zinc 46.7
MD54-05-57254 (147-150 ft)
Nitrate 1.52
Barium 25.9
Iron 4080
Lithium 11.8

BH-B, 54-24239
MD54-05-56966 (15-20 ft)
Nitrate 11.3
Lithium 5.45
MD54-05-56967 (31.5-33.5 ft)
Nitrate 14.3
Perchlorate 0.0667
Lithium 6.09
MD54-05-57528 (48-50 ft)
Nitrate 19.4
Lithium 15.2
MD54-05-57529 (68-70 ft)
Nitrate 73.7
Perchlorate 5.46
Copper 4.07
Lithium 27.5
Nickel 4.62 (J-)
MD54-05-56968 (88-90 ft)
Nitrate 0.969
Lithium 26.8
MD54-05-56969 (108-110 ft)
Nitrate 0.858 (J)
Lithium 15.4
MD54-05-56970 (128-130 ft)
Nitrate 1.23
Arsenic 2.4
Lithium 22.7
MD54-05-56971 (147-150 ft)
Barium 43.5
Iron 4460
Lithium 10.3
Manganese 254

BH-D1, 54-24241
MD54-05-57505 (65-70 ft)
Nitrate 0.756 (J)
Lithium 24
MD54-05-57506 (82-83.5 ft)
Nitrate 2.2
Barium 31.8
Beryllium 1.85
Copper 6.77
Lithium 30.6
MD54-05-57507 (132-134 ft)
Arsenic 2.3
Barium 31.3
Iron 4830
Lithium 21.9
Manganese 236
Zinc 52.2
MD54-05-57508 (147.5-149 ft)
Iron 3810
Lithium 11.4
Manganese 215
MD54-05-57509 (197-199 ft)
Barium 31.8
Lithium 22.5
MD54-05-57510 (245-250 ft)
Nitrate 0.926 (J)
Chromium 7.8 (J)
Lithium 7.78
Selenium 0.309 (J)

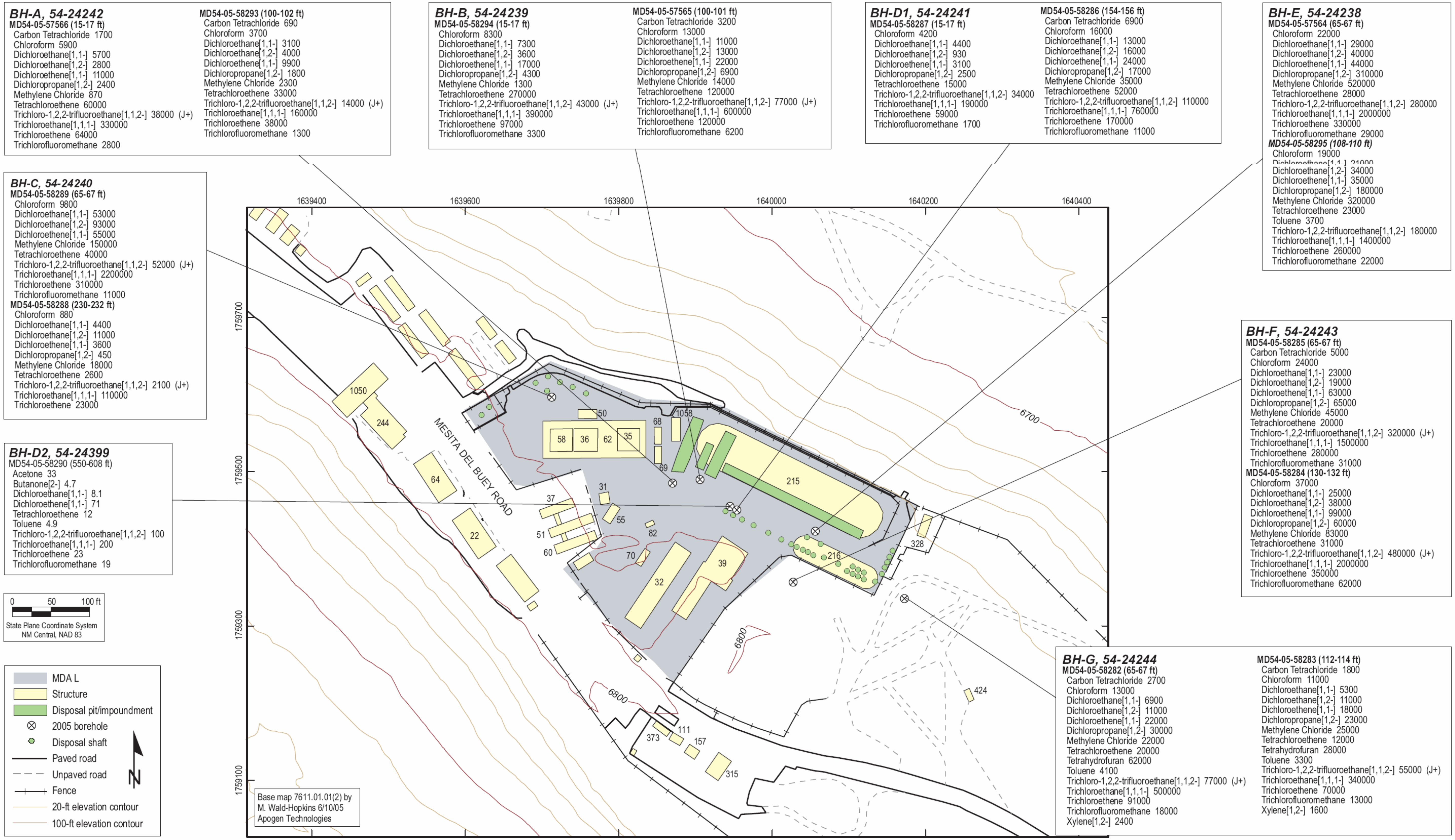
BH-E, 54-24238
MD54-05-56959 (15-20 ft)
Nitrate 1.99
Lithium 2.91
MD54-05-56960 (33-35 ft)
Nitrate 13.1
Barium 51.6 (J)
Lithium 14.1
MD54-05-56961 (48-50 ft)
Nitrate 3.09
Lithium 22.2
MD54-05-56962 (68-70 ft)
Nitrate 1.7
Lithium 37.1
Selenium 0.431 (J)
MD54-05-56963 (78-80 ft)
Nitrate 21.9
Lithium 38.6
MD54-05-57520 (108-110 ft)
Fluoride 4.94
Nitrate 1.11
Perchlorate 0.0656 (J)
Lithium 23.5
Selenium 0.504 (J)
MD54-05-57521 (128-130 ft)
Fluoride 4.26
Nitrate 2.51
Arsenic 2.48
Barium 29.7 (J)
Iron 6100
Lithium 30
Manganese 286
Selenium 0.302 (J)
Zinc 53.9
MD54-05-56964 (147-150 ft)
Arsenic 0.708
Barium 25.9 (J)
Iron 4170
Lithium 13.8
Manganese 207

BH-F, 54-24243
MD54-05-57258 (65-70 ft)
Nitrate 1.02
Arsenic 2.01
Lithium 24.4
MD54-05-57486 (88-90 ft)
Nitrate 1.25
Arsenic 1.9
Lithium 25.6
MD54-05-57487 (115-117 ft)
Nitrate 4.12
Arsenic 2.43
Lithium 23.8
MD54-05-57259 (128-130 ft)
Nitrate 2.22
Arsenic 2.54
Copper 4.38
Iron 7100
Lead 23
Lithium 25.4
Manganese 272
Zinc 53.8
MD54-05-57263 (148-150 ft)
Iron 3930
Lithium 12.4
Manganese 200

BH-G, 54-24244
MD54-05-57266 (65-70 ft)
Lithium 28.8
MD54-05-57494 (88-90 ft)
Fluoride 7.95 (J-)
Lithium 26.4
MD54-05-57495 (108-110 ft)
Fluoride 6.05 (J-)
Nitrate 0.978
Lithium 27.7
MD54-05-57496 (128-130 ft)
Fluoride 8.11 (J-)
Aluminum 5130
Arsenic 3.07
Barium 35.6
Beryllium 2.07
Copper 8.21
Iron 5260
Lead 14.9
Lithium 35.1
Manganese 232
Zinc 59.7
MD54-05-57268 (148-150 ft)
Lithium 17.7
Manganese 247

BH-D2, 54-24399
MD54-05-57060 (409-410 ft)
Chloride 1.62 (J)

Figure 2.4-12 Inorganic chemicals (mg/kg) detected above BVs in subsurface tuff at MDA L



BH-A, 54-24242

MD54-05-57566 (15-17 ft)

Carbon Tetrachloride	1700
Chloroform	5900
Dichloroethane[1,1-]	5700
Dichloroethane[1,2-]	2800
Dichloroethene[1,1-]	11000
Dichloropropane[1,2-]	2400
Methylene Chloride	870
Tetrachloroethene	60000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	38000 (J+)
Trichloroethane[1,1,1-]	330000
Trichloroethene	64000
Trichlorofluoromethane	2800

MD54-05-58293 (100-102 ft)

Carbon Tetrachloride	690
Chloroform	3700
Dichloroethane[1,1-]	3100
Dichloroethane[1,2-]	4000
Dichloroethene[1,1-]	9900
Dichloropropane[1,2-]	1800
Methylene Chloride	2300
Tetrachloroethene	33000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	14000 (J+)
Trichloroethane[1,1,1-]	160000
Trichloroethene	38000
Trichlorofluoromethane	1300

BH-B, 54-24239

MD54-05-58294 (15-17 ft)

Chloroform	8300
Dichloroethane[1,1-]	7300
Dichloroethane[1,2-]	3600
Dichloroethene[1,1-]	17000
Dichloropropane[1,2-]	4300
Methylene Chloride	1300
Tetrachloroethene	270000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	43000 (J+)
Trichloroethane[1,1,1-]	390000
Trichloroethene	97000
Trichlorofluoromethane	3300

MD54-05-57565 (100-101 ft)

Carbon Tetrachloride	3200
Chloroform	13000
Dichloroethane[1,1-]	11000
Dichloroethane[1,2-]	13000
Dichloroethene[1,1-]	22000
Dichloropropane[1,2-]	6900
Methylene Chloride	14000
Tetrachloroethene	120000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	77000 (J+)
Trichloroethane[1,1,1-]	600000
Trichloroethene	120000
Trichlorofluoromethane	6200

BH-D1, 54-24241

MD54-05-58287 (15-17 ft)

Chloroform	4200
Dichloroethane[1,1-]	4400
Dichloroethane[1,2-]	930
Dichloroethene[1,1-]	3100
Dichloropropane[1,2-]	2500
Tetrachloroethene	15000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	34000
Trichloroethane[1,1,1-]	190000
Trichloroethene	59000
Trichlorofluoromethane	1700

MD54-05-58286 (154-156 ft)

Carbon Tetrachloride	6900
Chloroform	16000
Dichloroethane[1,1-]	13000
Dichloroethane[1,2-]	16000
Dichloroethene[1,1-]	24000
Dichloropropane[1,2-]	17000
Methylene Chloride	35000
Tetrachloroethene	52000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	110000
Trichloroethane[1,1,1-]	760000
Trichloroethene	170000
Trichlorofluoromethane	11000

BH-E, 54-24238

MD54-05-57564 (65-67 ft)

Chloroform	22000
Dichloroethane[1,1-]	29000
Dichloroethane[1,2-]	40000
Dichloroethene[1,1-]	44000
Dichloropropane[1,2-]	310000
Methylene Chloride	520000
Tetrachloroethene	28000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	280000
Trichloroethane[1,1,1-]	2000000
Trichloroethene	330000
Trichlorofluoromethane	29000

MD54-05-58295 (108-110 ft)

Chloroform	19000
Dichloroethane[1,1-]	21000
Dichloroethane[1,2-]	34000
Dichloroethene[1,1-]	35000
Dichloropropane[1,2-]	180000
Methylene Chloride	320000
Tetrachloroethene	23000
Toluene	3700
Trichloro-1,2,2-trifluoroethane[1,1,2-]	180000
Trichloroethane[1,1,1-]	1400000
Trichloroethene	260000
Trichlorofluoromethane	22000

BH-C, 54-24240

MD54-05-58289 (65-67 ft)

Chloroform	9800
Dichloroethane[1,1-]	53000
Dichloroethane[1,2-]	93000
Dichloroethene[1,1-]	55000
Methylene Chloride	150000
Tetrachloroethene	40000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	52000 (J+)
Trichloroethane[1,1,1-]	2200000
Trichloroethene	310000
Trichlorofluoromethane	11000

MD54-05-58288 (230-232 ft)

Chloroform	880
Dichloroethane[1,1-]	4400
Dichloroethane[1,2-]	11000
Dichloroethene[1,1-]	3600
Dichloropropane[1,2-]	450
Methylene Chloride	18000
Tetrachloroethene	2600
Trichloro-1,2,2-trifluoroethane[1,1,2-]	2100 (J+)
Trichloroethane[1,1,1-]	110000
Trichloroethene	23000

BH-F, 54-24243

MD54-05-58285 (65-67 ft)

Carbon Tetrachloride	5000
Chloroform	24000
Dichloroethane[1,1-]	23000
Dichloroethane[1,2-]	19000
Dichloroethene[1,1-]	63000
Dichloropropane[1,2-]	65000
Methylene Chloride	45000
Tetrachloroethene	20000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	320000 (J+)
Trichloroethane[1,1,1-]	1500000
Trichloroethene	280000
Trichlorofluoromethane	31000

MD54-05-58284 (130-132 ft)

Chloroform	37000
Dichloroethane[1,1-]	25000
Dichloroethane[1,2-]	38000
Dichloroethene[1,1-]	99000
Dichloropropane[1,2-]	60000
Methylene Chloride	83000
Tetrachloroethene	31000
Trichloro-1,2,2-trifluoroethane[1,1,2-]	480000 (J+)
Trichloroethane[1,1,1-]	2000000
Trichloroethene	350000
Trichlorofluoromethane	62000

BH-D2, 54-24399

MD54-05-58290 (550-608 ft)

Acetone	33
Butanone[2-]	4.7
Dichloroethane[1,1-]	8.1
Dichloroethene[1,1-]	71
Tetrachloroethene	12
Toluene	4.9
Trichloro-1,2,2-trifluoroethane[1,1,2-]	100
Trichloroethane[1,1,1-]	200
Trichloroethene	23
Trichlorofluoromethane	19

BH-G, 54-24244

MD54-05-58282 (65-67 ft)

Carbon Tetrachloride	2700
Chloroform	13000
Dichloroethane[1,1-]	6900
Dichloroethane[1,2-]	11000
Dichloroethene[1,1-]	22000
Dichloropropane[1,2-]	30000
Methylene Chloride	22000
Tetrachloroethene	20000
Tetrahydrofuran	62000
Toluene	4100
Trichloro-1,2,2-trifluoroethane[1,1,2-]	77000 (J+)
Trichloroethane[1,1,1-]	500000
Trichloroethene	91000
Trichlorofluoromethane	18000
Xylene[1,2-]	2400

MD54-05-58283 (112-114 ft)

Carbon Tetrachloride	1800
Chloroform	11000
Dichloroethane[1,1-]	5300
Dichloroethane[1,2-]	11000
Dichloroethene[1,1-]	18000
Dichloropropane[1,2-]	23000
Methylene Chloride	25000
Tetrachloroethene	12000
Tetrahydrofuran	28000
Toluene	3300
Trichloro-1,2,2-trifluoroethane[1,1,2-]	55000 (J+)
Trichloroethane[1,1,1-]	340000
Trichloroethene	70000
Trichlorofluoromethane	13000
Xylene[1,2-]	1600

Figure 2.4-13 Organic chemicals (µg/m^3) detected in subsurface pore gas at MDA L

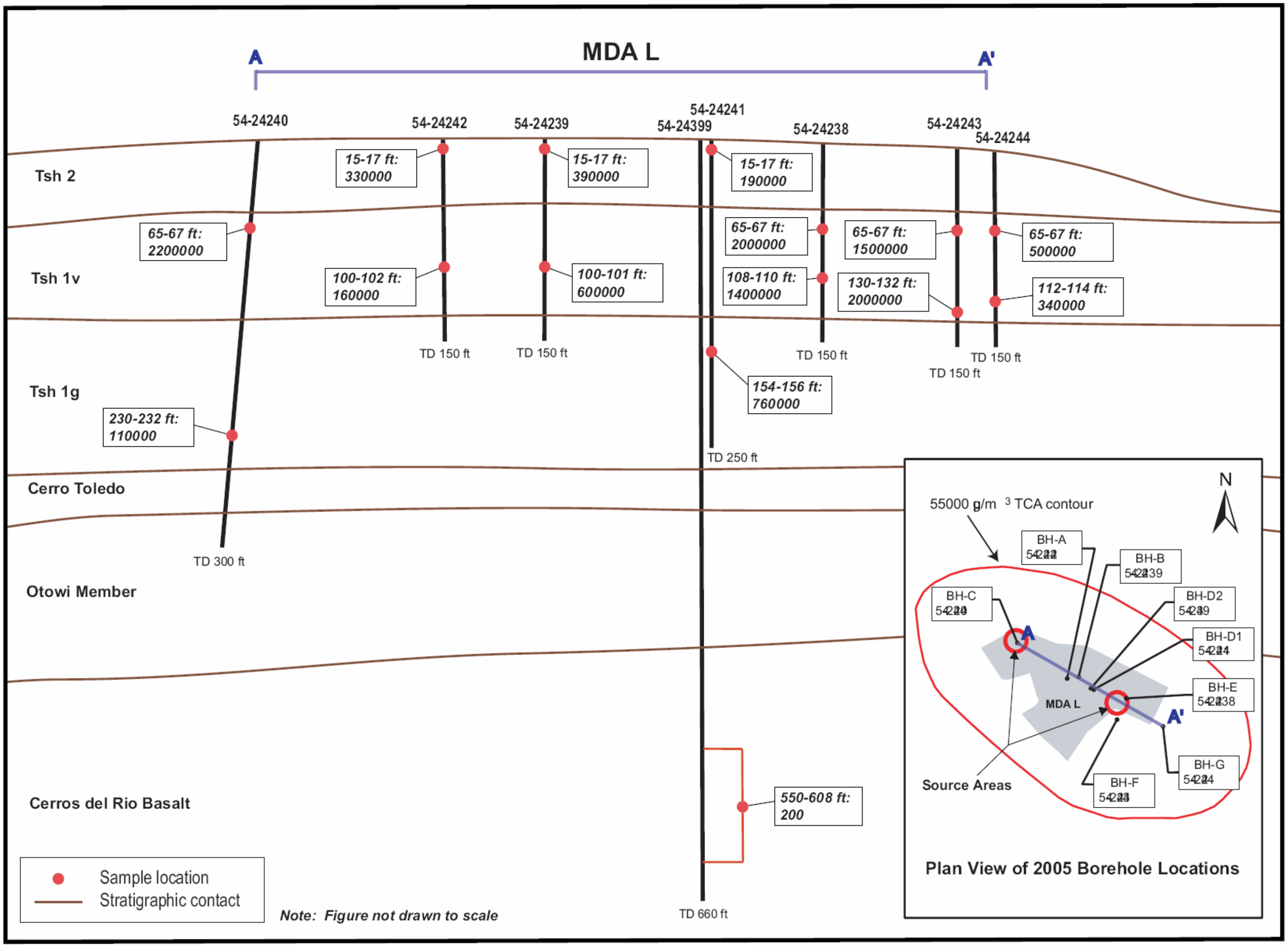


Figure 2.4-14 TCA (µg/m^3) detected in subsurface pore gas at MDA L

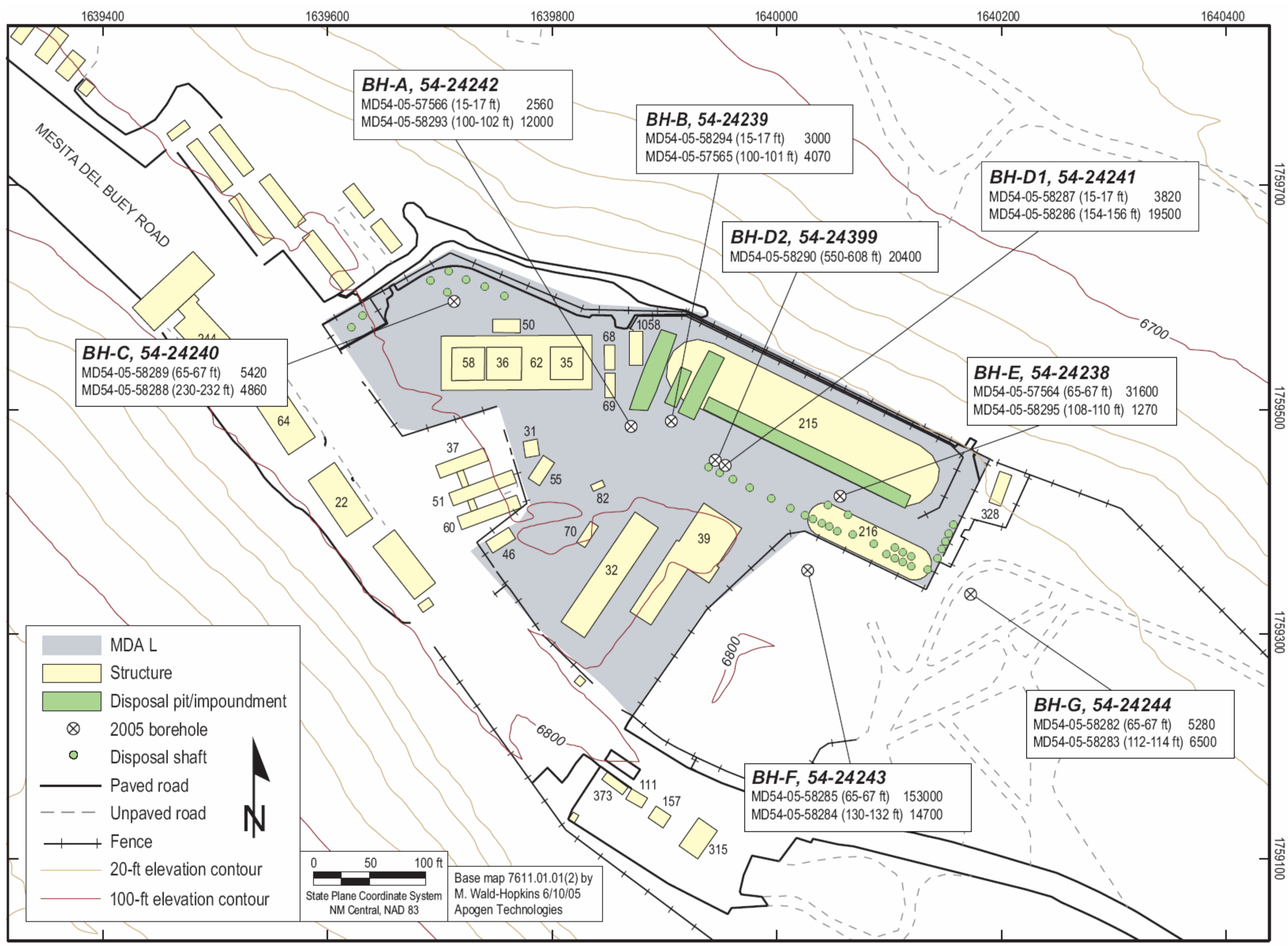


Figure 2.4-15 Tritium (pCi/L) detected in moisture extracted from subsurface pore gas at MDA L

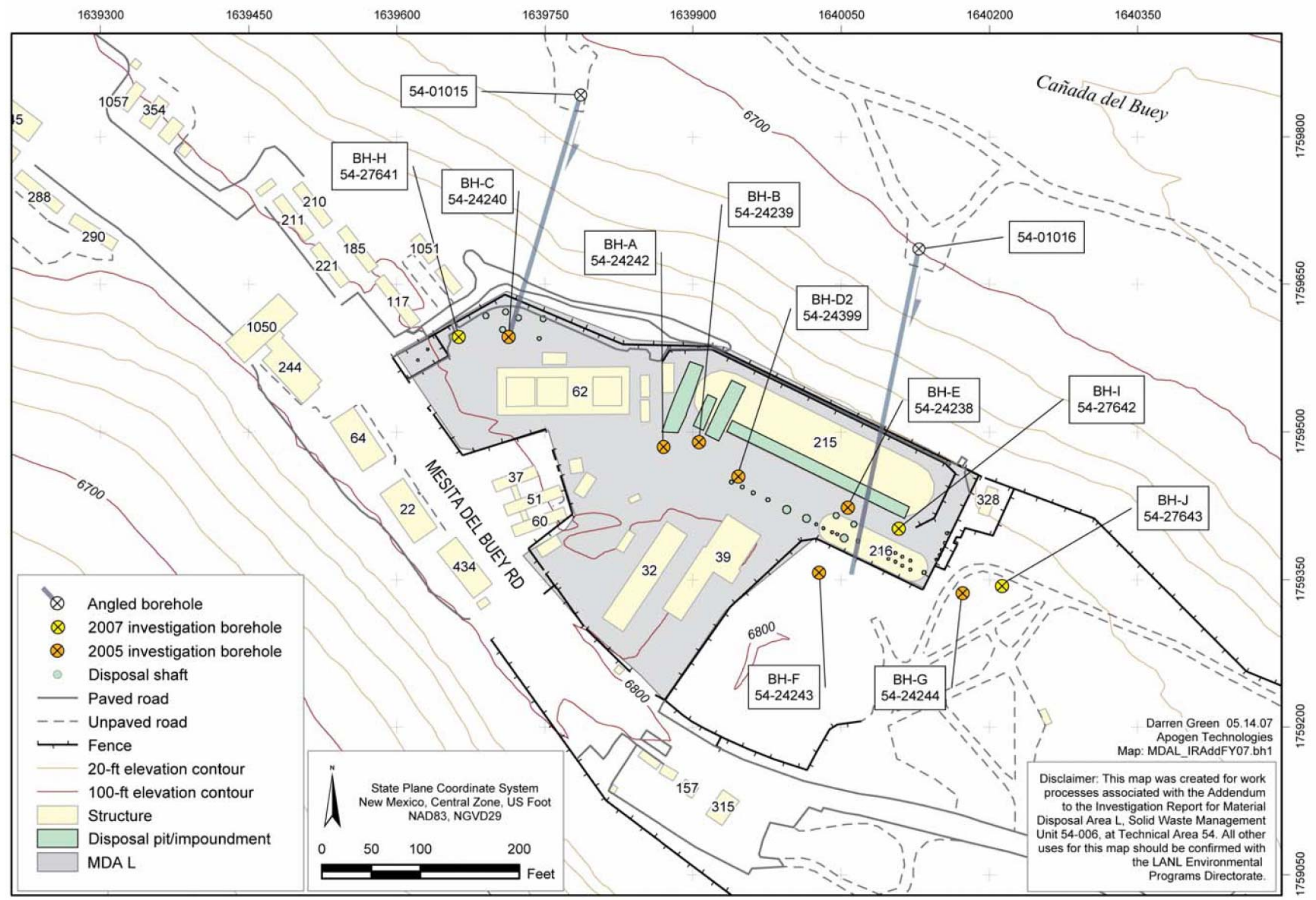


Figure 2.4-16 Locations of existing and supplemental investigation boreholes at MDA L

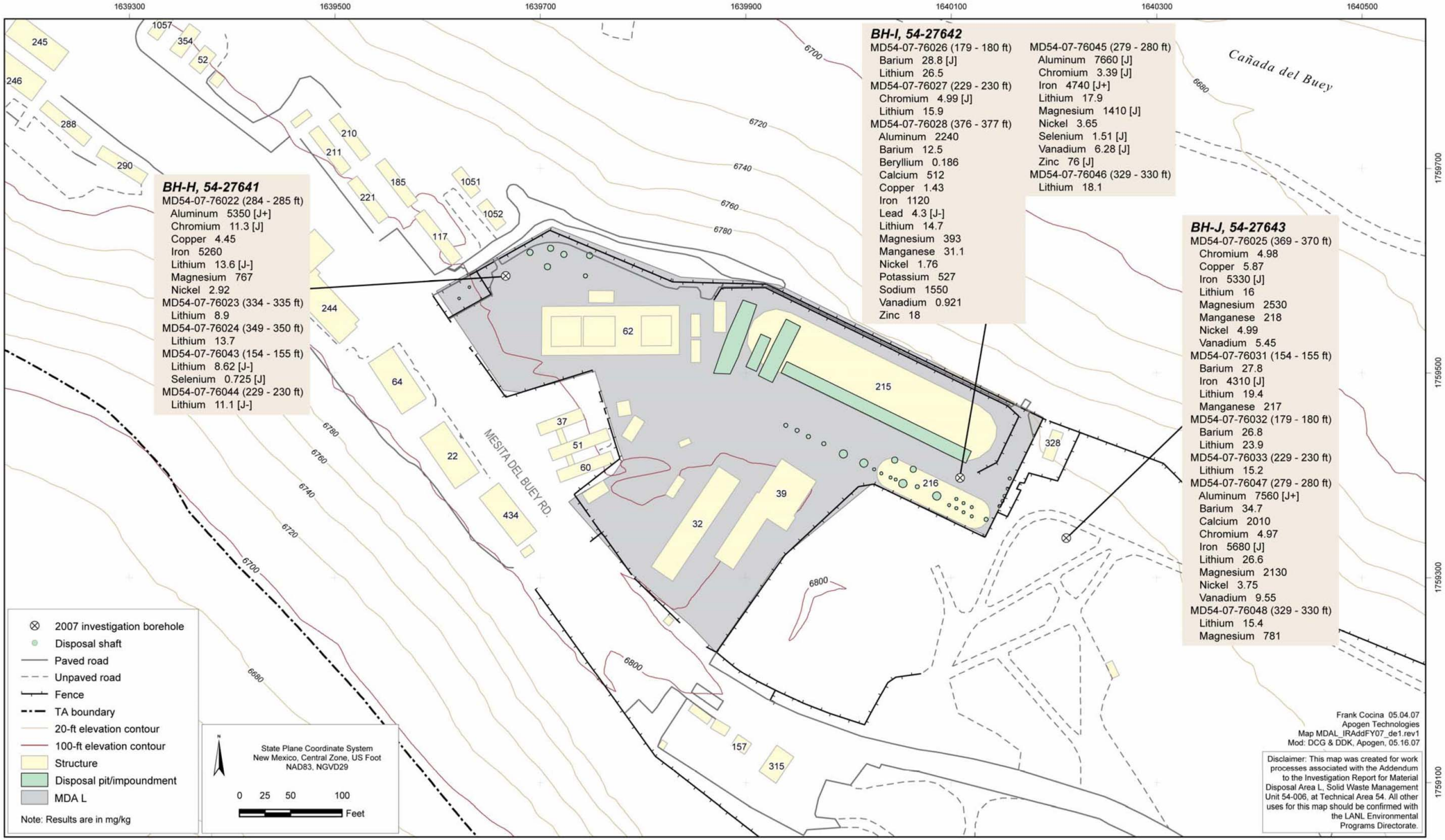


Figure 2.4-17 Supplemental investigation inorganic chemicals detected above BV in tuff at MDA L (mg/kg)

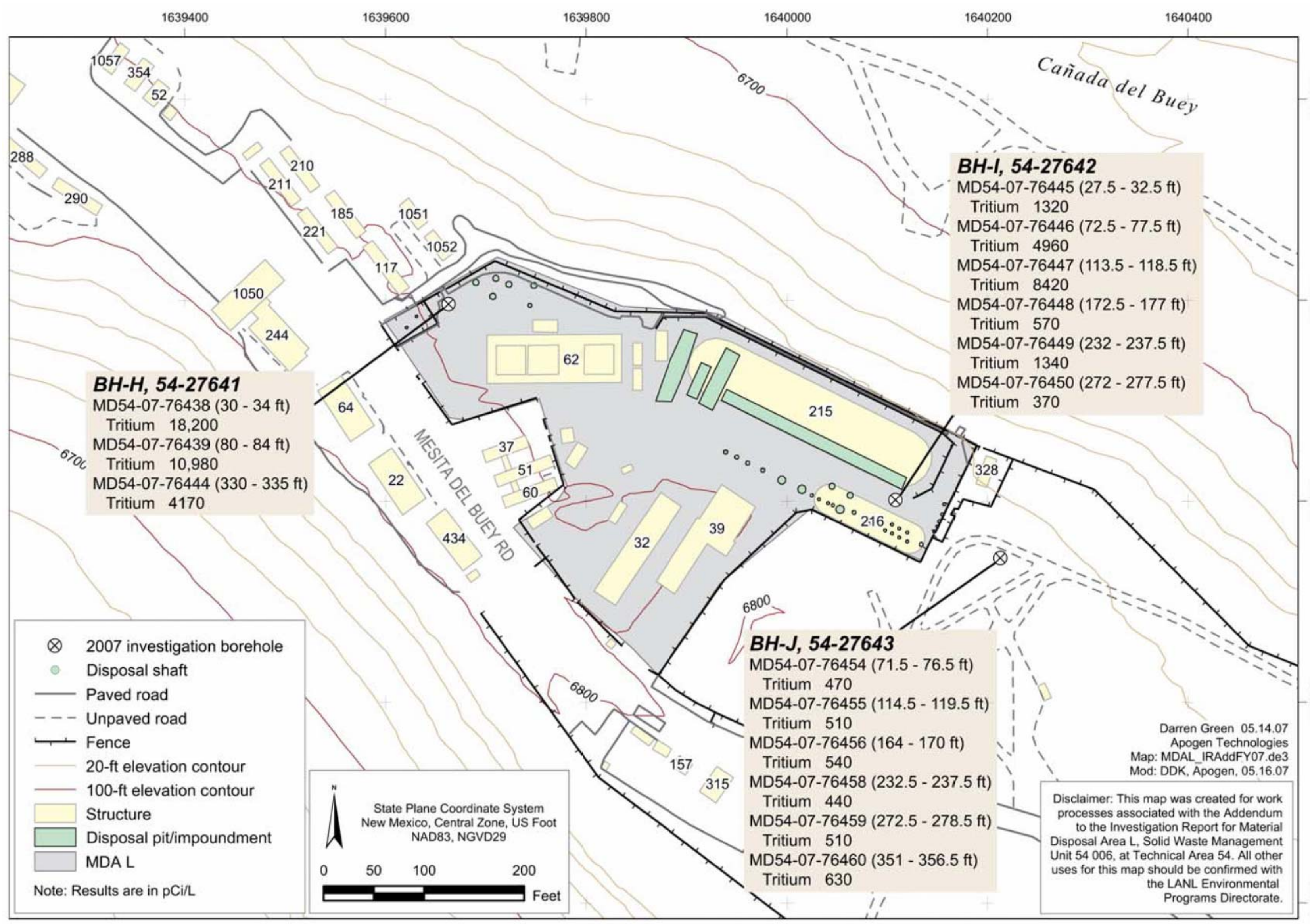


Figure 2.4-18 Supplemental investigation tritium detected in subsurface pore gas at MDA L (pCi/L)

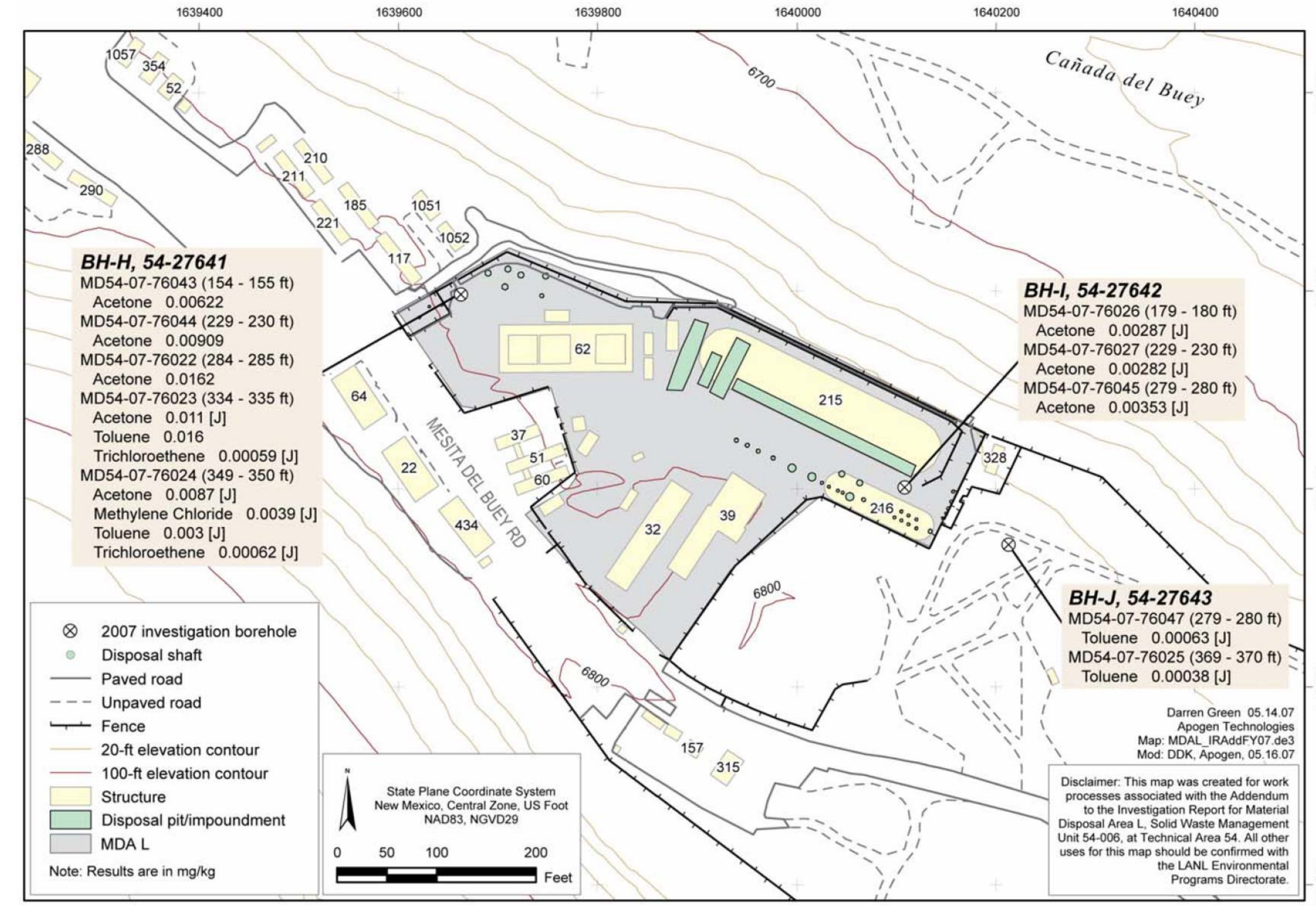


Figure 2.4-19 Supplemental investigation VOCs detected in tuff at MDA L (mg/kg)

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

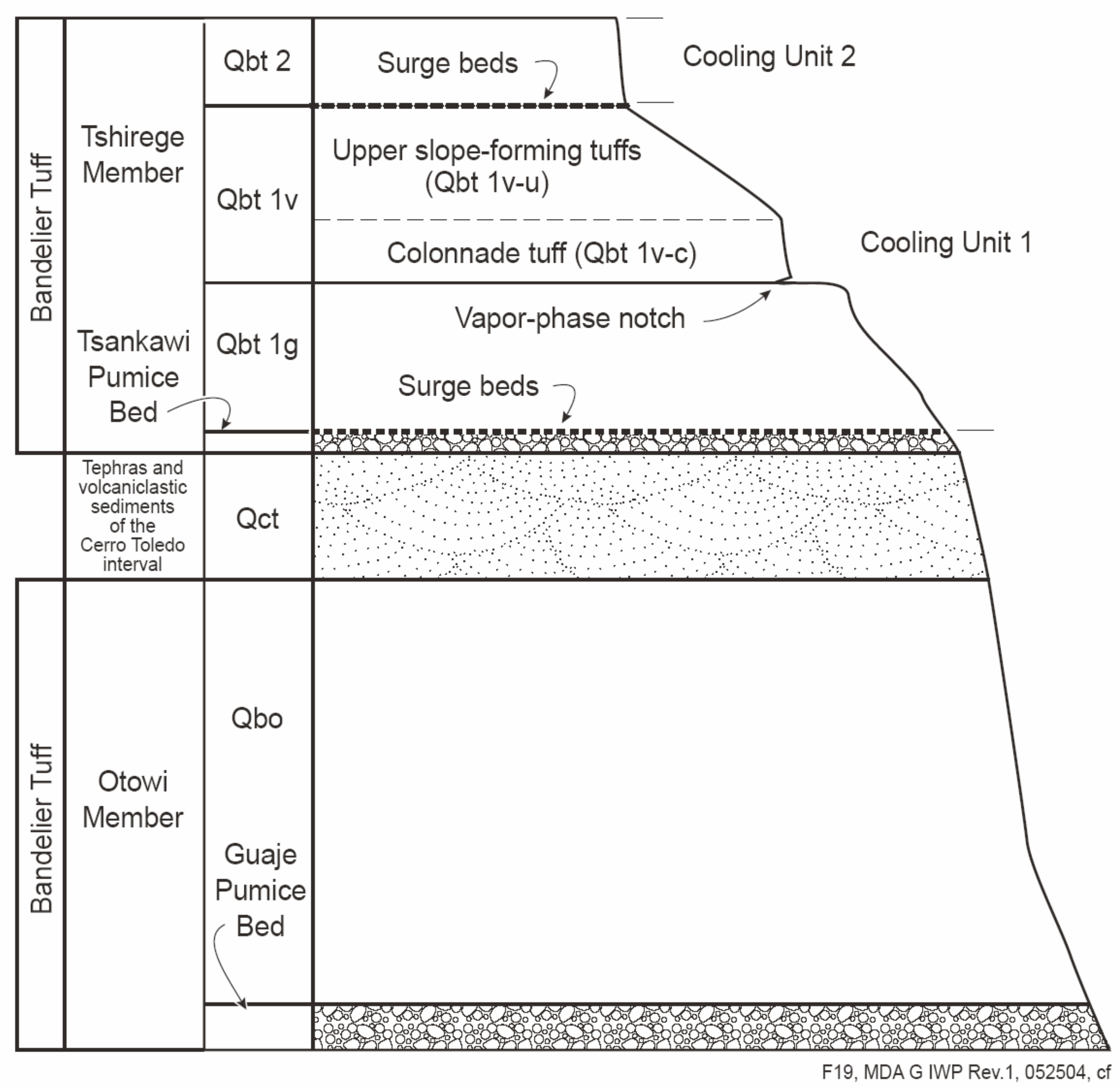


Figure 3.2-2 **Generalized stratigraphy of Bandelier Tuff at TA-54**

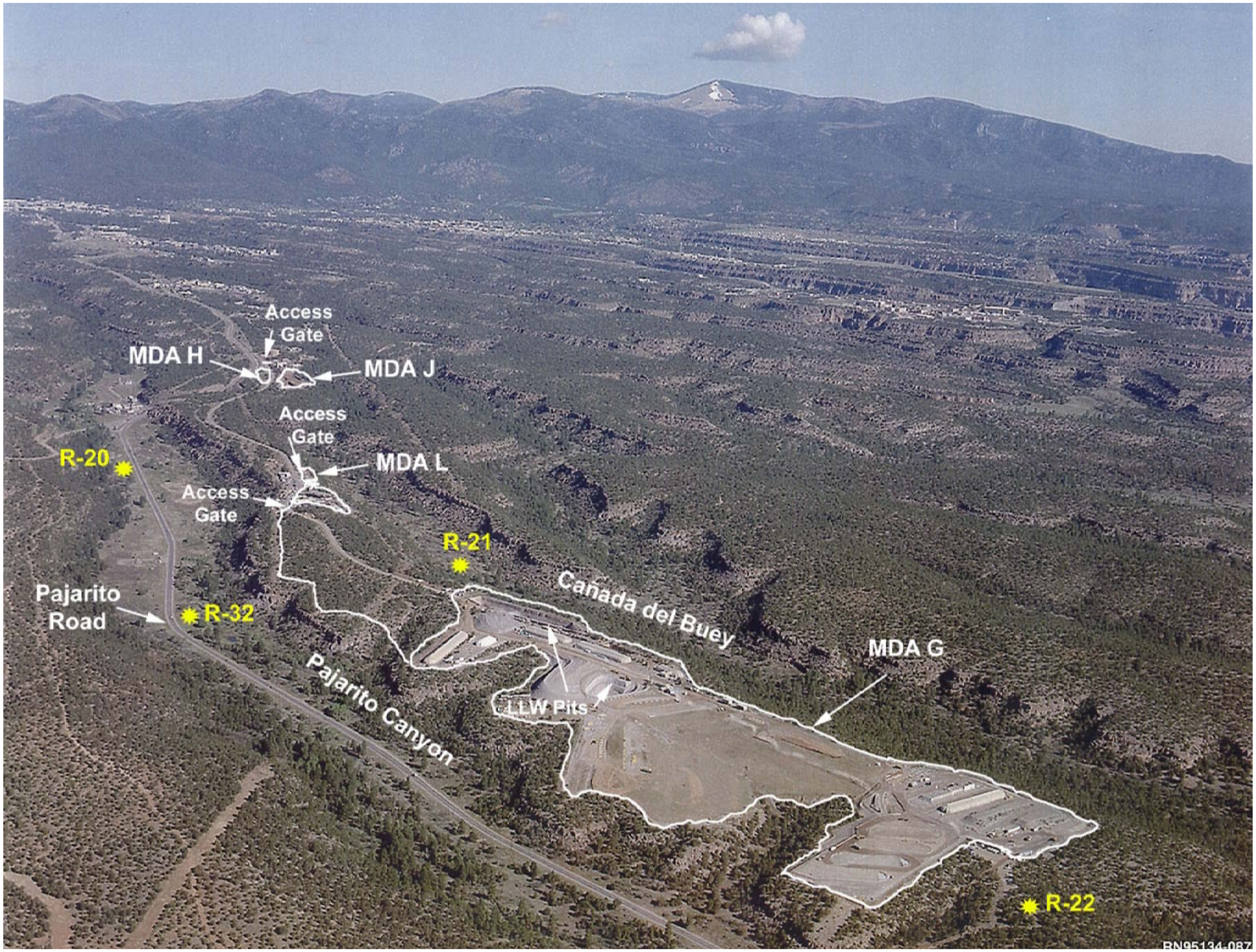
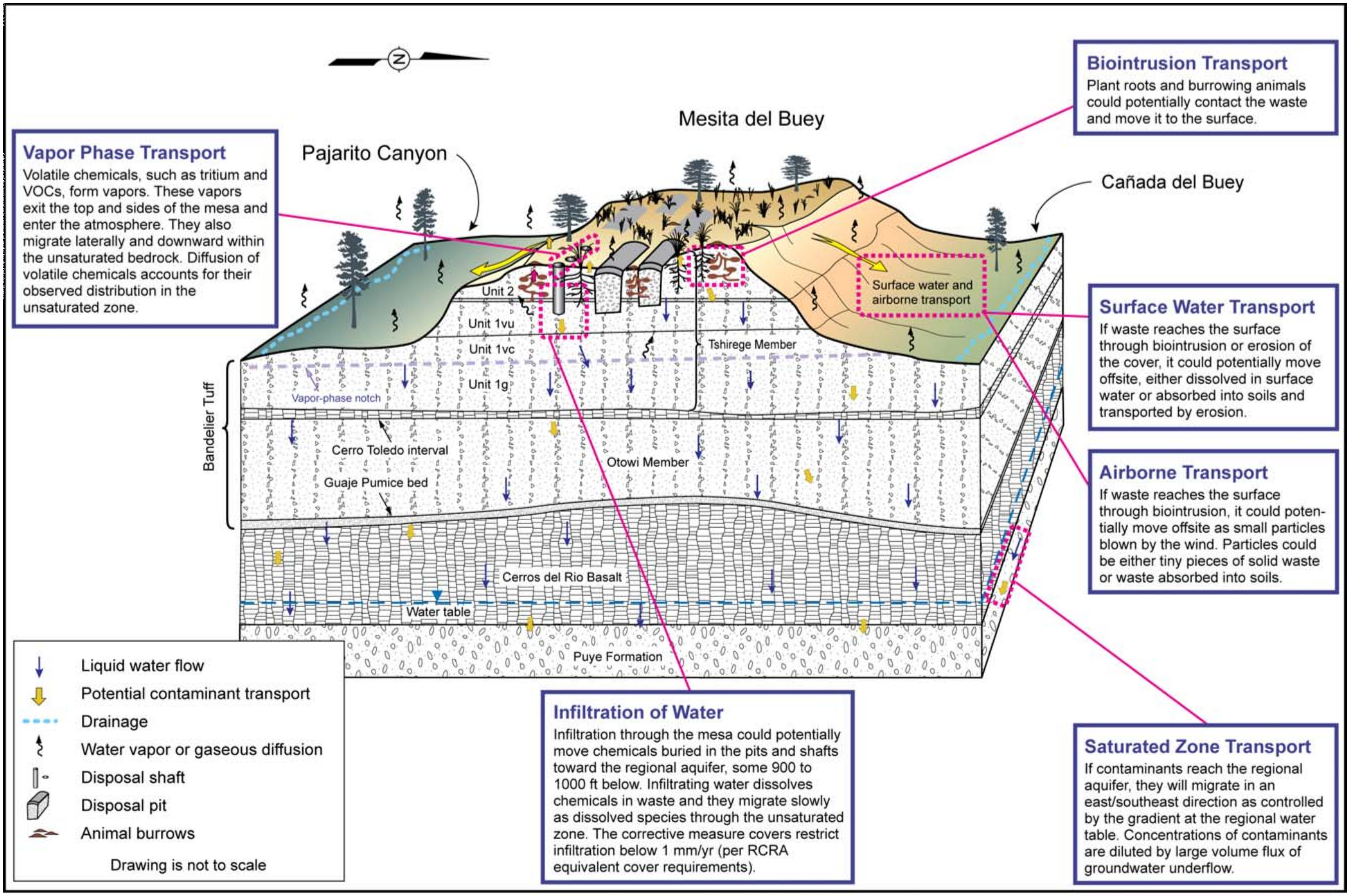


Figure 3.2-3 Aerial photograph of Mesita del Buey showing MDAs, gates, and characterization wells R-20, R-21, R-22, and R-32 in the vicinity of MDA L



Vapor Phase Transport
Volatile chemicals, such as tritium and VOCs, form vapors. These vapors exit the top and sides of the mesa and enter the atmosphere. They also migrate laterally and downward within the unsaturated bedrock. Diffusion of volatile chemicals accounts for their observed distribution in the unsaturated zone.

Biointrusion Transport
Plant roots and burrowing animals could potentially contact the waste and move it to the surface.

Surface Water Transport
If waste reaches the surface through biointrusion or erosion of the cover, it could potentially move offsite, either dissolved in surface water or absorbed into soils and transported by erosion.

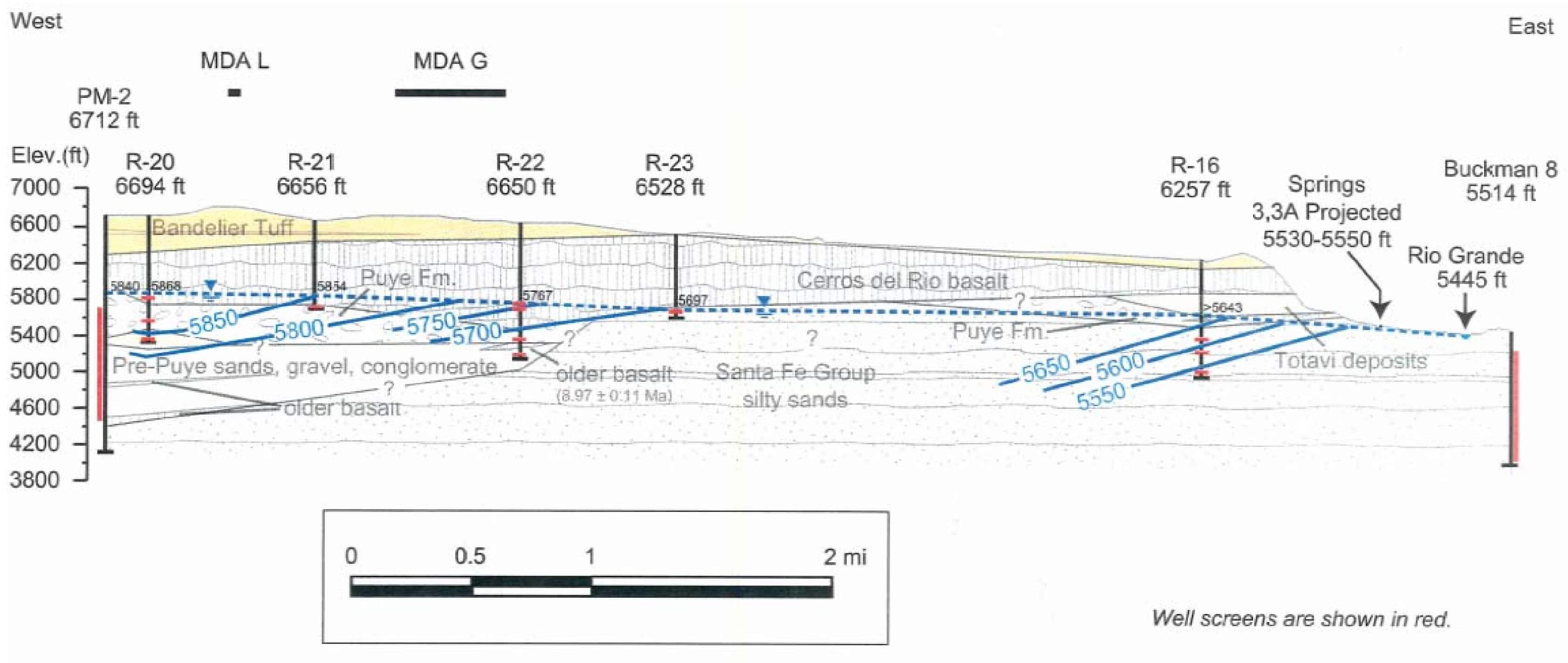
Airborne Transport
If waste reaches the surface through biointrusion, it could potentially move offsite as small particles blown by the wind. Particles could be either tiny pieces of solid waste or waste absorbed into soils.

Infiltration of Water
Infiltration through the mesa could potentially move chemicals buried in the pits and shafts toward the regional aquifer, some 900 to 1000 ft below. Infiltrating water dissolves chemicals in waste and they migrate slowly as dissolved species through the unsaturated zone. The corrective measure covers restrict infiltration below 1 mm/yr (per RCRA equivalent cover requirements).

Saturated Zone Transport
If contaminants reach the regional aquifer, they will migrate in an east/southeast direction as controlled by the gradient at the regional water table. Concentrations of contaminants are diluted by large volume flux of groundwater underflow.

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

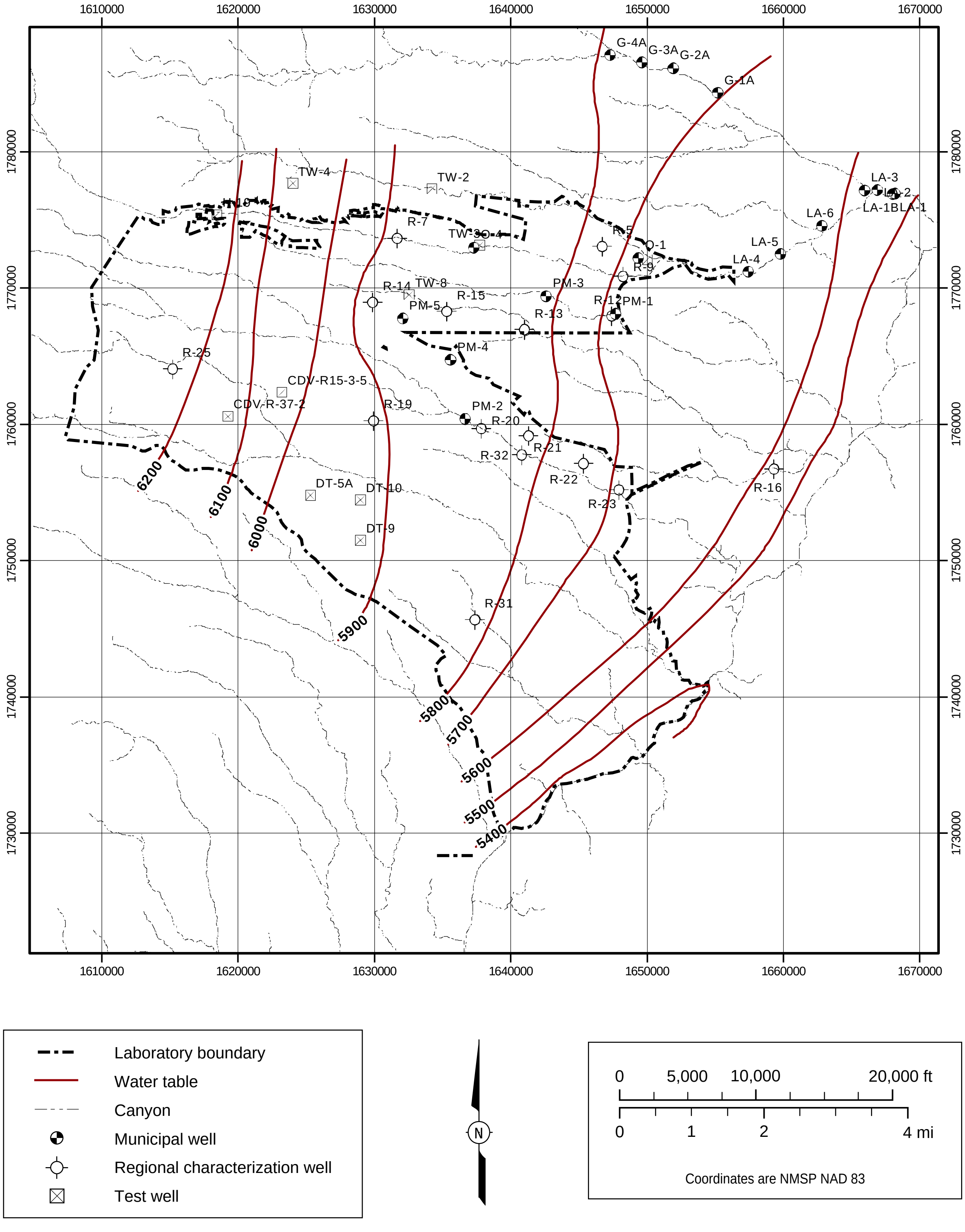
Figure 3.2-4 Hydrogeologic conceptual site model for MDA L



Well screens are shown in red.

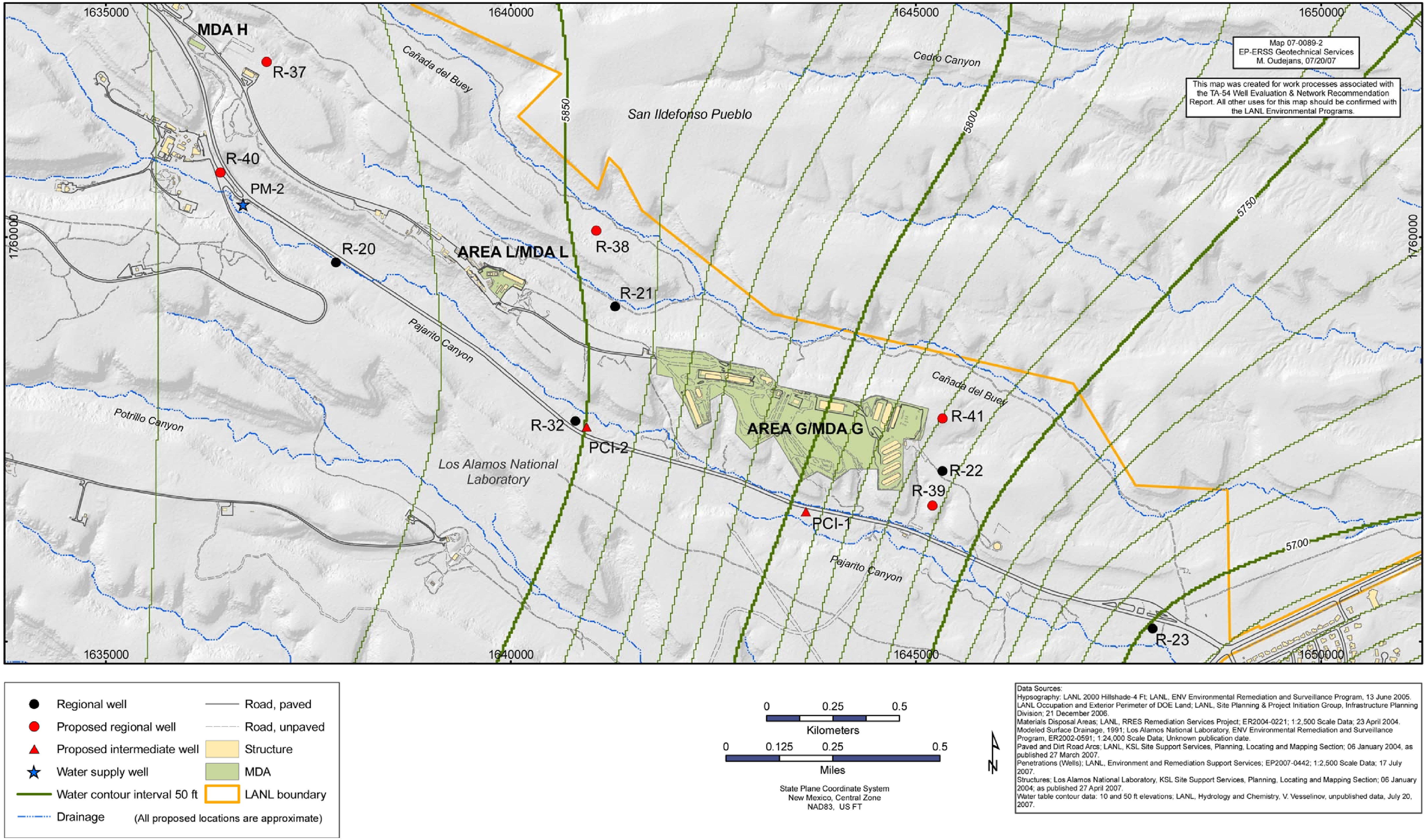
Source: Dave Broxton, 2003_Rev. for F20, MDA L IWP Rev.1, 122203, cf

Figure 3.2-5 Hydrogeologic cross-section through Pajarito Plateau near TA-54



Source: GIS Lab m200714, REK, 061703_Rev. for F23, MDA L IWP Rev.1, 121803, cf

Figure 3.2-6 Regional groundwater surface elevations at the Laboratory

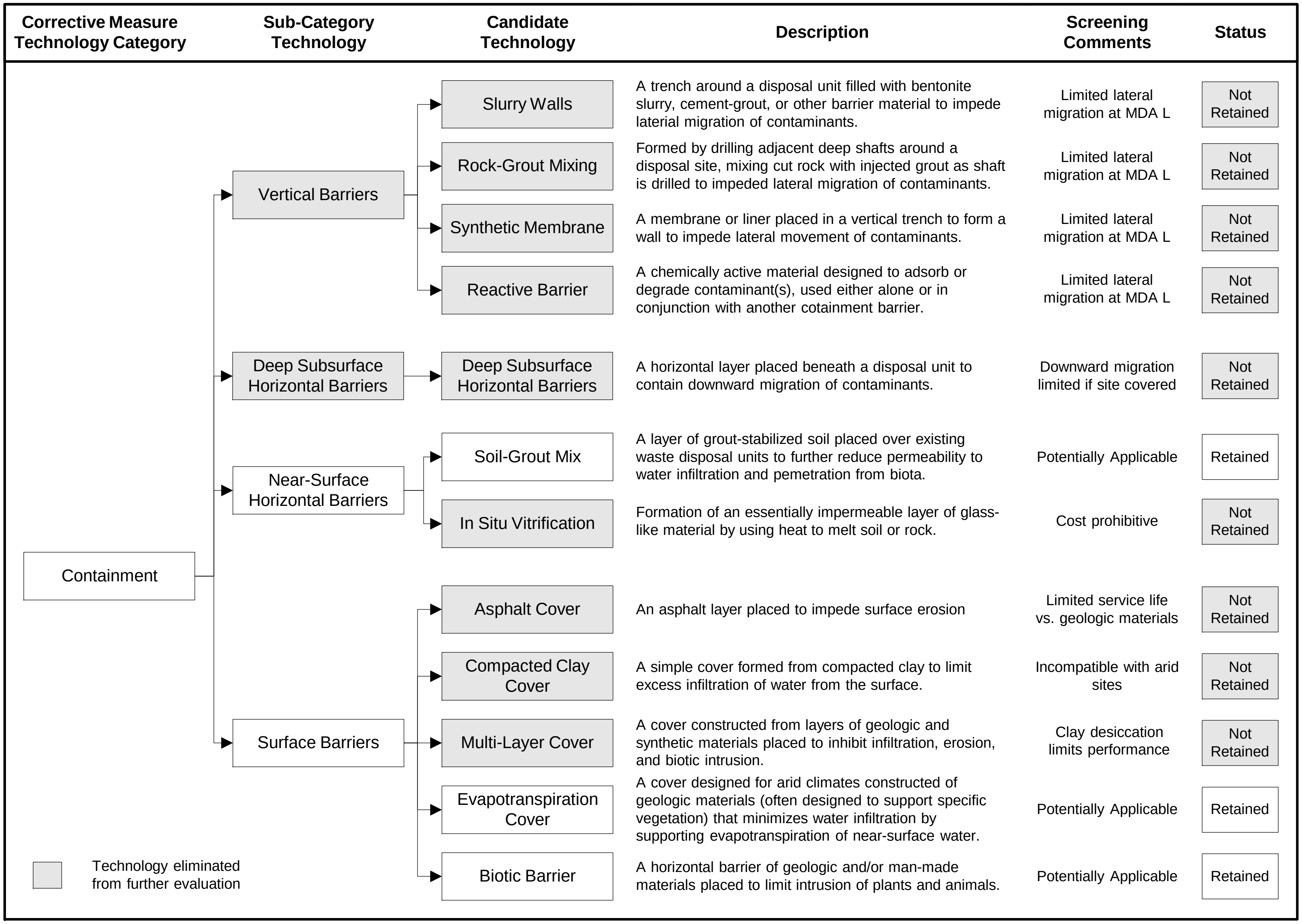


Map 07-0089-2
EP-ERSS Geotechnical Services
M. Oudejans, 07/20/07

This map was created for work processes associated with the TA-54 Well Evaluation & Network Recommendation Report. All other uses for this map should be confirmed with the LANL Environmental Programs.

Data Sources:
Hypsography: LANL 2000 Hillshade-4 Ft; LANL, ENV Environmental Remediation and Surveillance Program, 13 June 2005.
LANL Occupation and Exterior Perimeter of DOE Land; LANL, Site Planning & Project Initiation Group, Infrastructure Planning Division; 21 December 2006.
Materials Disposal Areas; LANL, RRES Remediation Services Project; ER2004-0221; 1:2,500 Scale Data; 23 April 2004.
Modeled Surface Drainage, 1991; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0591; 1:24,000 Scale Data; Unknown publication date.
Paved and Dirt Road Arcs; LANL, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004, as published 27 March 2007.
Penetrations (Wells); LANL, Environment and Remediation Support Services; EP2007-0442; 1:2,500 Scale Data; 17 July 2007.
Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 27 April 2007.
Water table contour data: 10 and 50 ft elevations; LANL, Hydrology and Chemistry, V. Vesselinov, unpublished data, July 20, 2007.

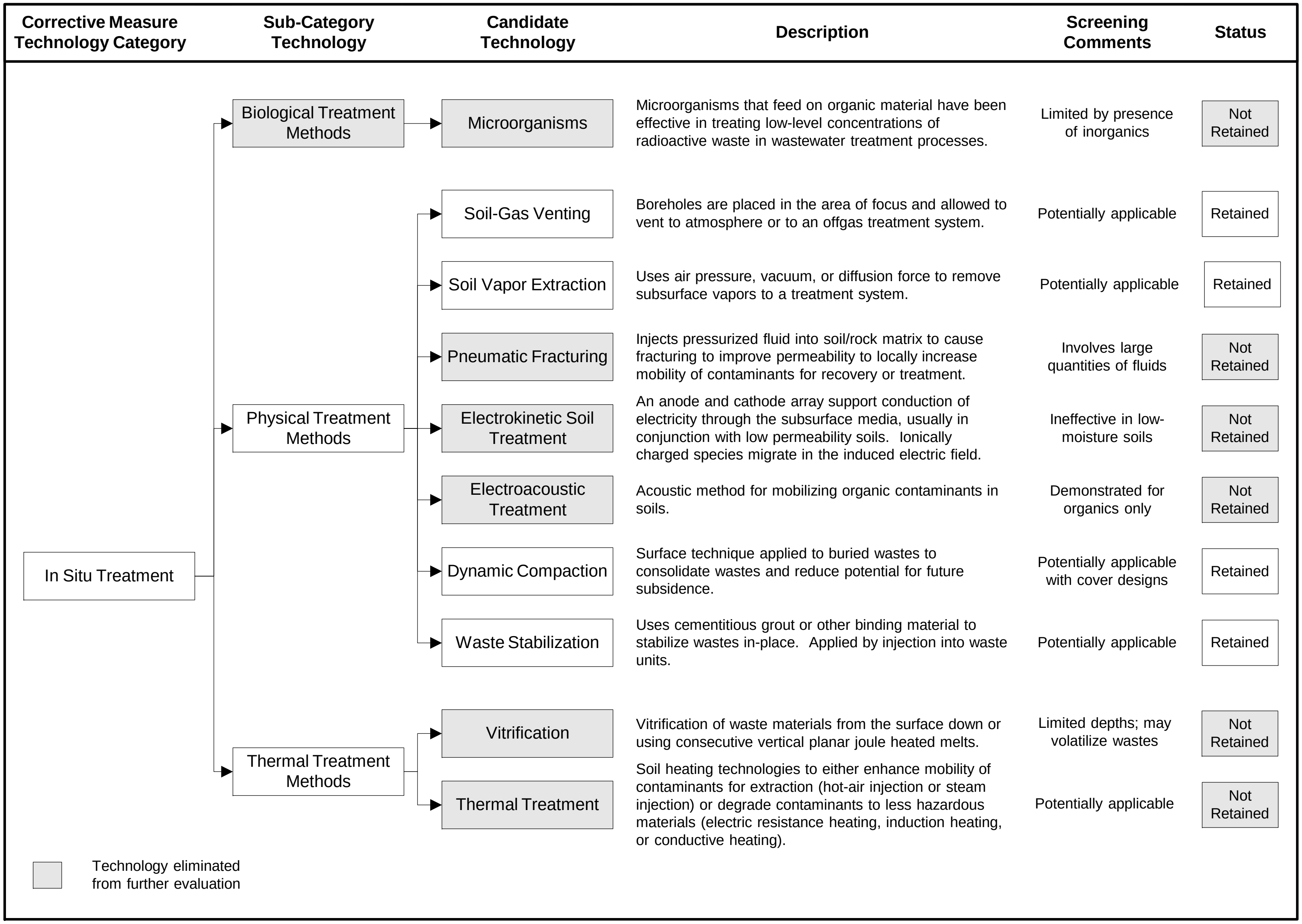
Figure 4.2-1 **Locations of existing water-supply wells and regional wells and proposed locations for new wells and water-table contours**



Corrective Measure Technology Category	Sub-Category Technology	Candidate Technology	Description	Screening Comments	Status
Containment	Vertical Barriers	Slurry Walls	A trench around a disposal unit filled with bentonite slurry, cement-grout, or other barrier material to impede laterial migration of contaminants.	Limited lateral migration at MDA L	Not Retained
		Rock-Grout Mixing	Formed by drilling adjacent deep shafts around a disposal site, mixing cut rock with injected grout as shaft is drilled to impeded lateral migration of contaminants.	Limited lateral migration at MDA L	Not Retained
		Synthetic Membrane	A membrane or liner placed in a vertical trench to form a wall to impede lateral movement of contaminants.	Limited lateral migration at MDA L	Not Retained
		Reactive Barrier	A chemically active material designed to adsorb or degrade contaminant(s), used either alone or in conjunction with another cotainment barrier.	Limited lateral migration at MDA L	Not Retained
	Deep Subsurface Horizontal Barriers	Deep Subsurface Horizontal Barriers	A horizontal layer placed beneath a disposal unit to contain downward migration of contaminants.	Downward migration limited if site covered	Not Retained
	Near-Surface Horizontal Barriers	Soil-Grout Mix	A layer of grout-stabilized soil placed over existing waste disposal units to further reduce permeability to water infiltration and pemetration from biota.	Potentially Applicable	Retained
		In Situ Vitrification	Formation of an essentially impermeable layer of glass-like material by using heat to melt soil or rock.	Cost prohibitive	Not Retained
	Surface Barriers	Asphalt Cover	An asphalt layer placed to impede surface erosion	Limited service life vs. geologic materials	Not Retained
		Compacted Clay Cover	A simple cover formed from compacted clay to limit excess infiltration of water from the surface.	Incompatible with arid sites	Not Retained
		Multi-Layer Cover	A cover constructed from layers of geologic and synthetic materials placed to inhibit infiltration, erosion, and biotic intrusion.	Clay desiccation limits performance	Not Retained
		Evapotranspiration Cover	A cover designed for arid climates constructed of geologic materials (often designed to support specific vegetation) that minimizes water infiltration by supporting evapotranspiration of near-surface water.	Potentially Applicable	Retained
		Biotic Barrier	A horizontal barrier of geologic and/or man-made materials placed to limit intrusion of plants and animals.	Potentially Applicable	Retained

▨ Technology eliminated from further evaluation

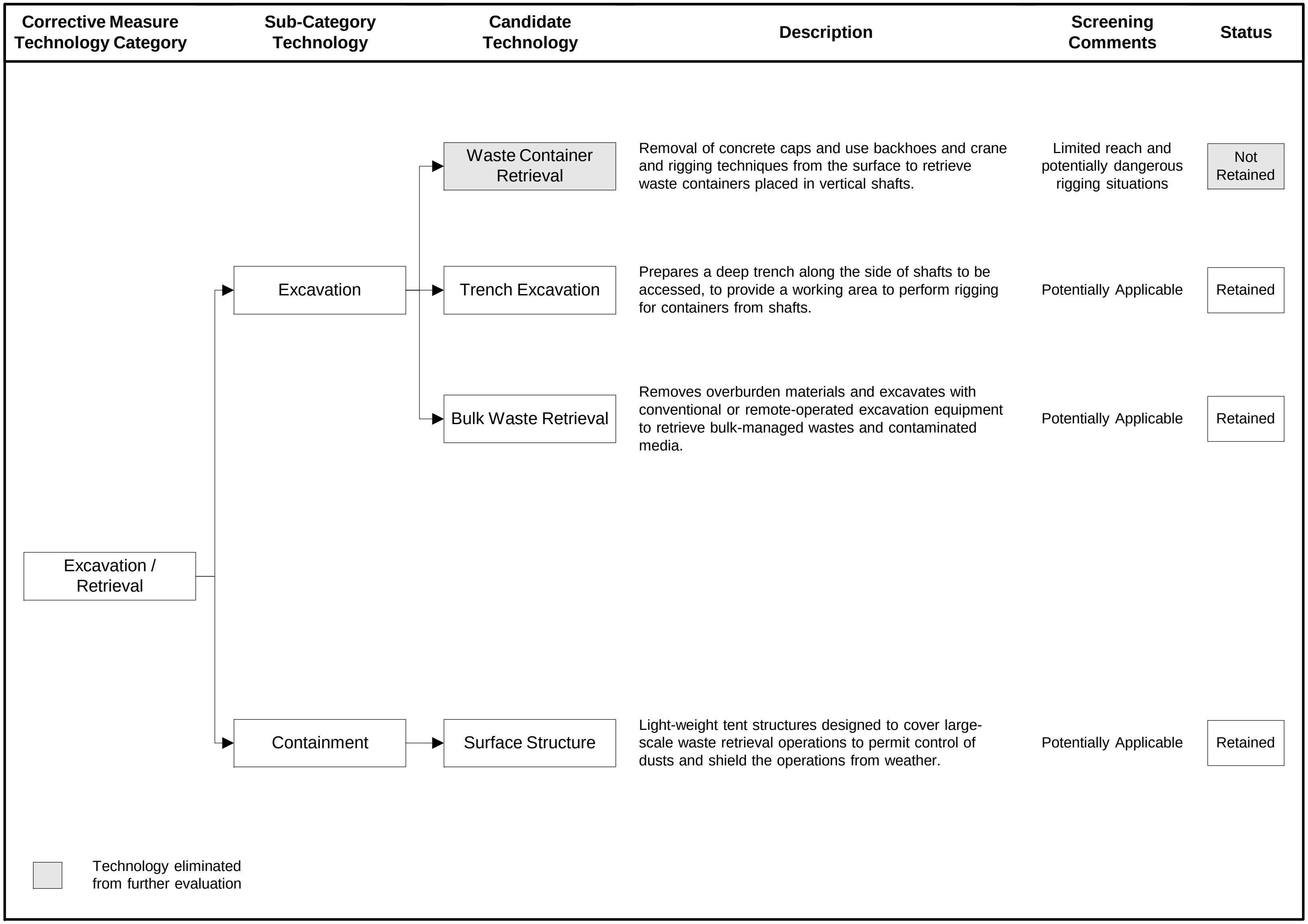
Figure 6.1-1 Screening of corrective measure technologies (page 1 of 4)



Corrective Measure Technology Category	Sub-Category Technology	Candidate Technology	Description	Screening Comments	Status
In Situ Treatment	Biological Treatment Methods	Microorganisms	Microorganisms that feed on organic material have been effective in treating low-level concentrations of radioactive waste in wastewater treatment processes.	Limited by presence of inorganics	Not Retained
	Physical Treatment Methods	Soil-Gas Venting	Boreholes are placed in the area of focus and allowed to vent to atmosphere or to an offgas treatment system.	Potentially applicable	Retained
		Soil Vapor Extraction	Uses air pressure, vacuum, or diffusion force to remove subsurface vapors to a treatment system.	Potentially applicable	Retained
		Pneumatic Fracturing	Injects pressurized fluid into soil/rock matrix to cause fracturing to improve permeability to locally increase mobility of contaminants for recovery or treatment.	Involves large quantities of fluids	Not Retained
		Electrokinetic Soil Treatment	An anode and cathode array support conduction of electricity through the subsurface media, usually in conjunction with low permeability soils. Ionically charged species migrate in the induced electric field.	Ineffective in low-moisture soils	Not Retained
		Electroacoustic Treatment	Acoustic method for mobilizing organic contaminants in soils.	Demonstrated for organics only	Not Retained
		Dynamic Compaction	Surface technique applied to buried wastes to consolidate wastes and reduce potential for future subsidence.	Potentially applicable with cover designs	Retained
		Waste Stabilization	Uses cementitious grout or other binding material to stabilize wastes in-place. Applied by injection into waste units.	Potentially applicable	Retained
	Thermal Treatment Methods	Vitrification	Vitrification of waste materials from the surface down or using consecutive vertical planar joule heated melts.	Limited depths; may volatilize wastes	Not Retained
		Thermal Treatment	Soil heating technologies to either enhance mobility of contaminants for extraction (hot-air injection or steam injection) or degrade contaminants to less hazardous materials (electric resistance heating, induction heating, or conductive heating).	Potentially applicable	Not Retained

▨ Technology eliminated from further evaluation

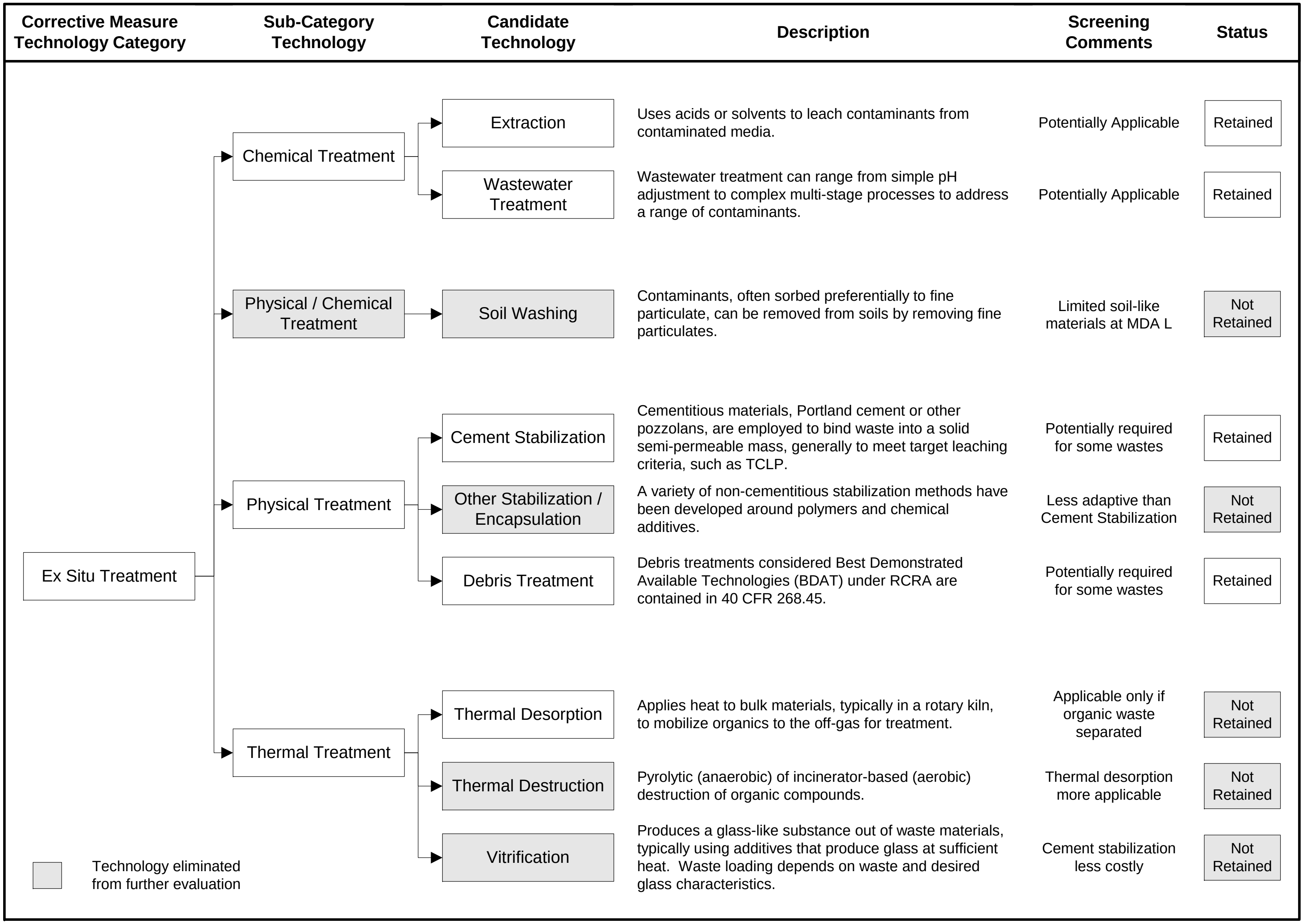
Figure 6.1-1 Screening of corrective measure technologies (page 2 of 4)



Corrective Measure Technology Category	Sub-Category Technology	Candidate Technology	Description	Screening Comments	Status
Excavation / Retrieval	Excavation	Waste Container Retrieval	Removal of concrete caps and use backhoes and crane and rigging techniques from the surface to retrieve waste containers placed in vertical shafts.	Limited reach and potentially dangerous rigging situations	Not Retained
		Trench Excavation	Prepares a deep trench along the side of shafts to be accessed, to provide a working area to perform rigging for containers from shafts.	Potentially Applicable	Retained
		Bulk Waste Retrieval	Removes overburden materials and excavates with conventional or remote-operated excavation equipment to retrieve bulk-managed wastes and contaminated media.	Potentially Applicable	Retained
	Containment	Surface Structure	Light-weight tent structures designed to cover large-scale waste retrieval operations to permit control of dusts and shield the operations from weather.	Potentially Applicable	Retained

▨ Technology eliminated from further evaluation

Figure 6.1-1 Screening of corrective measure technologies (page 3 of 4)



Corrective Measure Technology Category	Sub-Category Technology	Candidate Technology	Description	Screening Comments	Status
Ex Situ Treatment	Chemical Treatment	Extraction	Uses acids or solvents to leach contaminants from contaminated media.	Potentially Applicable	Retained
		Wastewater Treatment	Wastewater treatment can range from simple pH adjustment to complex multi-stage processes to address a range of contaminants.	Potentially Applicable	Retained
	Physical / Chemical Treatment	Soil Washing	Contaminants, often sorbed preferentially to fine particulate, can be removed from soils by removing fine particulates.	Limited soil-like materials at MDA L	Not Retained
	Physical Treatment	Cement Stabilization	Cementitious materials, Portland cement or other pozzolans, are employed to bind waste into a solid semi-permeable mass, generally to meet target leaching criteria, such as TCLP.	Potentially required for some wastes	Retained
		Other Stabilization / Encapsulation	A variety of non-cementitious stabilization methods have been developed around polymers and chemical additives.	Less adaptive than Cement Stabilization	Not Retained
		Debris Treatment	Debris treatments considered Best Demonstrated Available Technologies (BDAT) under RCRA are contained in 40 CFR 268.45.	Potentially required for some wastes	Retained
	Thermal Treatment	Thermal Desorption	Applies heat to bulk materials, typically in a rotary kiln, to mobilize organics to the off-gas for treatment.	Applicable only if organic waste separated	Not Retained
		Thermal Destruction	Pyrolytic (anaerobic) of incinerator-based (aerobic) destruction of organic compounds.	Thermal desorption more applicable	Not Retained
		Vitrification	Produces a glass-like substance out of waste materials, typically using additives that produce glass at sufficient heat. Waste loading depends on waste and desired glass characteristics.	Cement stabilization less costly	Not Retained

▨ Technology eliminated from further evaluation

Figure 6.1-1 Screening of corrective measure technologies (page 4 of 4)

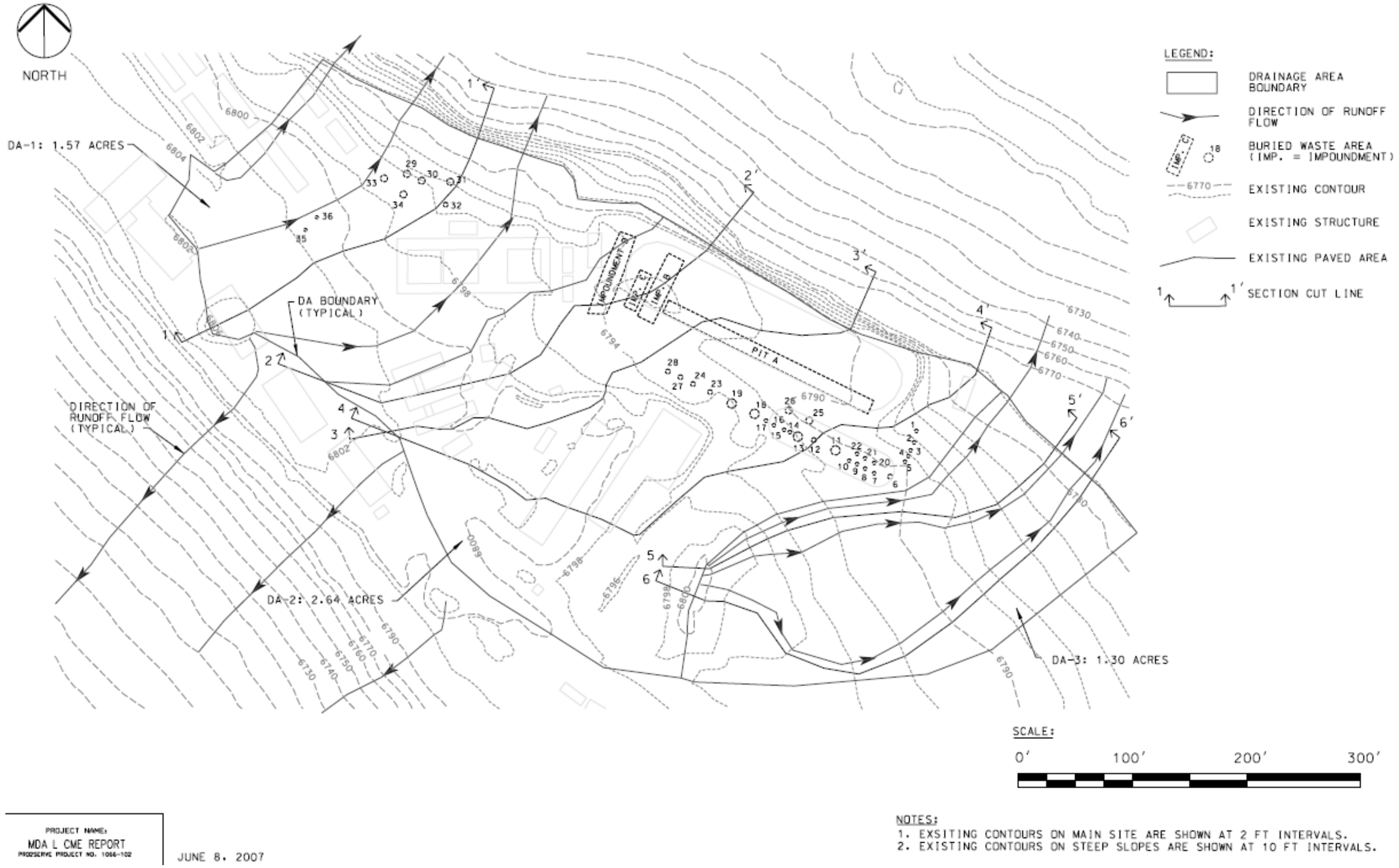


Figure 8.1-1 Surface topography and drainage of Alt 1B maintenance of existing covers

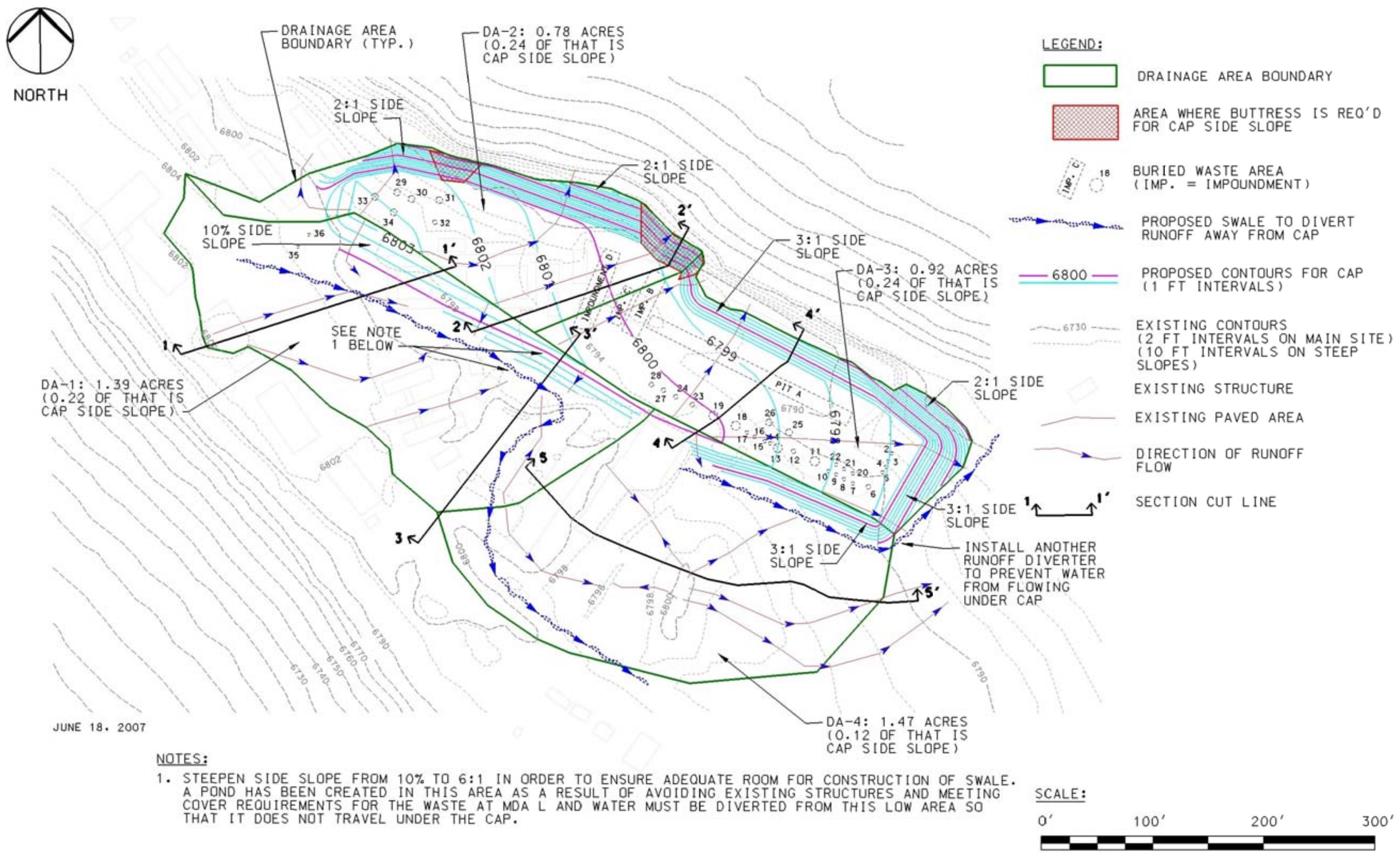


Figure 8.2-1 Surface topography and drainage of Alt 2B 6 ft ET cover

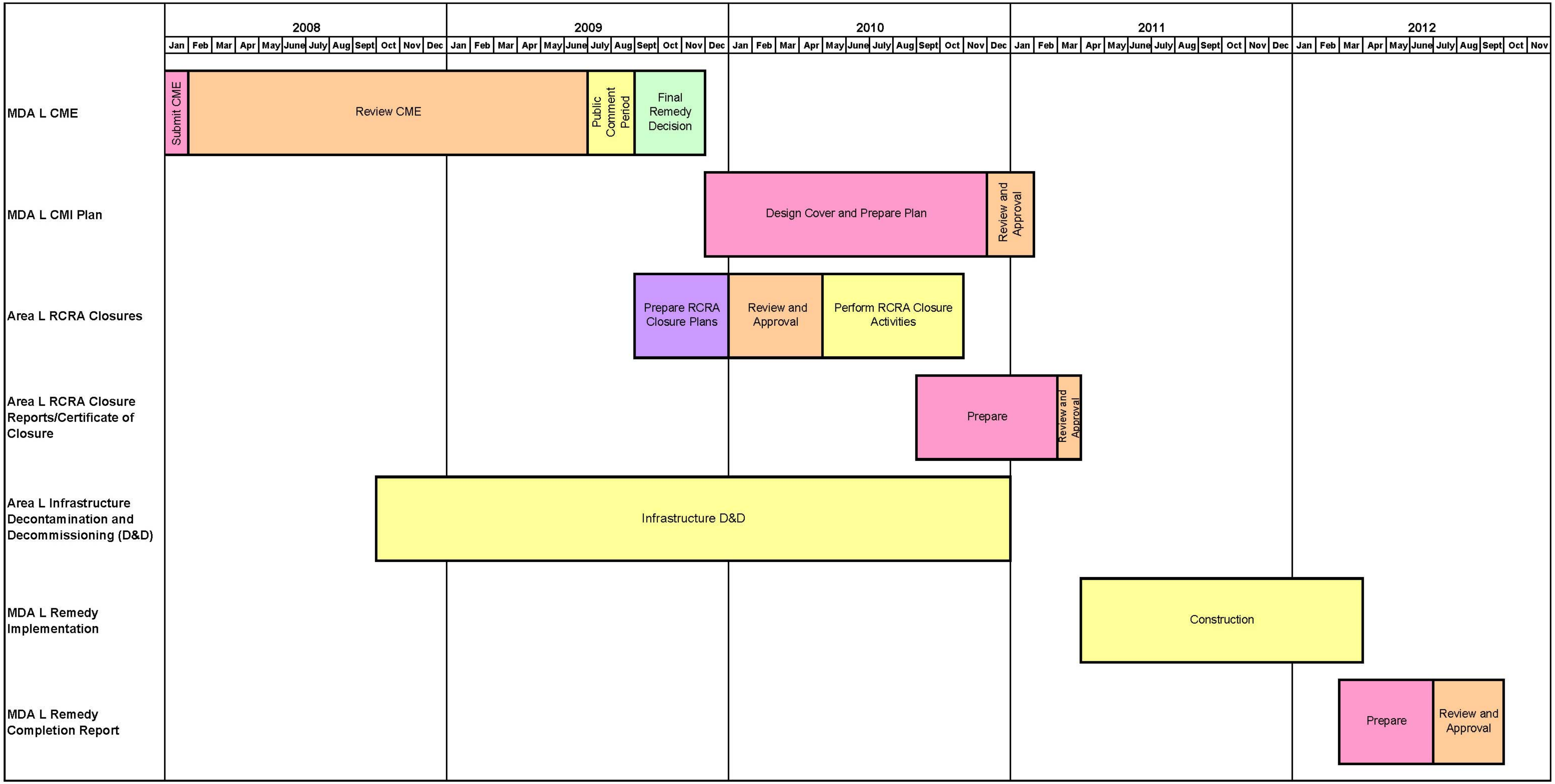


Figure 11.0-1 Implementation schedule for engineered ET cover and SVE at MDA L

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

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

[a] TSCA unit; included in RCRA Permit Application Renewal.

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

Table 1.0-2
Cross-Walk with Consent Order Requirements

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
1	The Respondents shall follow the Corrective Measures Evaluation Report format outlined in Section XI.F of this Consent Order.	VII.D.2	Table of Contents
2	The corrective measures evaluation shall evaluate potential remedial alternatives and shall recommend a preferred remedy that will be protective of human health and the environment and attain the appropriate cleanup goals.	VII.D.2	Sections 5 to 9.2.6.
3	1. A description of the location, status, and current use of the site.	VII.D.2	Sections 1.0, 2.0, 2.1
4	2. A description of the history of site operations and the history of releases of contaminants.	VII.D.2	Section 2.1
5	3. A description of site surface conditions.	VII.D.2	Section 3.1
6	4. A description of site subsurface conditions.	VII.D.2	Section 3.2
7	5. A description of on- and off-site contamination in all affected media.	VII.D.2	Sections 2.4, 4.1
8	6. An identification and description of all sources of contaminants.	VII.D.2	Sections 2.4, 4.1
9	7. An identification and description of contaminant migration pathways.	VII.D.2	Section 4.2
10	8. An identification and description of potential receptors.	VII.D.2	Section 4.3
11	9. A description of cleanup standards or other applicable regulatory criteria.	VII.D.2	Section 5
12	10. An identification and description of a range of remedy alternatives.	VII.D.2	Section 7
13	11. Remedial alternative pilot or bench scale testing results.	VII.D.2	Appendix F
14	12. A detailed evaluation and rating of each of the remedy alternatives, applying the criteria set forth in Section VII.D.4.	VII.D.2	Section 7 and Table 7.3-1
15	13. An identification of a proposed preferred remedy or remedies.	VII.D.2	Section 9
16	14. Design criteria of the selected remedy or remedies.	VII.D.2	Section 10
17	15. A proposed schedule for implementation of the preferred remedy.	VII.D.2	Section 11
18	The Respondents shall select corrective measures that are capable of achieving the cleanup standards and goals outlined in Section VIII of this Consent Order including, as applicable, approved alternate cleanup goals established by a risk assessment.	VII.D.3	Section 5 discusses goals but none were exceeded in the investigation report risk assessment

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
19	The Respondents shall evaluate each of the remedy alternatives for the following threshold criteria. To be selected, the remedy alternative must: 1. Be protective of human health and the environment. 2. Attain media cleanup standards. 3. Control the source or sources of releases so as to reduce or eliminate, to the extent practicable, further releases of contaminants that may pose a threat to human health and the environment. 4. Comply with applicable standards for management of wastes.	VII.D.4.a	Section 7
20	The remedy shall be evaluated for long-term reliability and effectiveness. This factor includes consideration of the magnitude of risks that will remain after implementation of the remedy; the extent of long-term monitoring, or other management that will be required after implementation of the remedy; the uncertainties associated with leaving contaminants in place; and the potential for failure of the remedy. Respondents shall give preference to a remedy that reduces risks with little long-term management, and that has proven effective under similar conditions.	VII.D.4.b.i	Sections 8.1.3, 8.2.3, 8.3.3, 8.4.3
21	The remedy shall be evaluated for its reduction in the toxicity, mobility, and volume of contaminants. Respondents shall give preference to remedy that uses treatment to more completely and permanently reduce the toxicity, mobility, and volume of contaminants.	VII.D.4.b.ii	Sections 8.1.5, 8.2.5, 8.3.5, 8.4.5
22	The remedy shall be evaluated for its short-term effectiveness. This factor includes consideration of the short-term reduction in existing risks that the remedy would achieve; the time needed to achieve that reduction; and the short-term risks that might be posed to the community, workers, and the environment during implementation of the remedy. Respondents shall give preference to a remedy that quickly reduces short-term risks, without creating significant additional risks.	VII.D.4.b.iii	Sections 8.1.3, 8.2.3, 8.3.3, 8.4.3
23	The remedy shall be evaluated for its implementability or the difficulty of implementing the remedy. This factor includes consideration of installation and construction difficulties; operation and maintenance difficulties; difficulties with cleanup technology; permitting and approvals; and the availability of necessary equipment, services, expertise, and storage and disposal capacity. Respondents shall give preference to a remedy that can be implemented quickly and easily, and poses fewer and lesser difficulties.	VII.D.4.b.iv	Sections 8.1.4, 8.2.4, 8.3.4, 8.4.4

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
24	The remedy shall be evaluated for its cost. This factor includes a consideration of both capital costs, and operation and maintenance costs. Capital costs shall include, without limitation, construction and installation costs; equipment costs; land development costs; and indirect costs including engineering costs, legal fees, permitting fees, startup and shakedown costs, and contingency allowances. Operation and maintenance costs shall include, without limitation, operating labor and materials costs; maintenance labor and materials costs; replacement costs; utilities; monitoring and reporting costs; administrative costs; indirect costs; and contingency allowances. All costs shall be calculated based on their net present value. Respondents shall give preference to a remedy that is less costly, but does not sacrifice protection of health and the environment.	VII.D.4.b.v	Sections 8.1.5, 8.2.5, 8.3.5, 8.4.4
25	All investigation summaries, site condition descriptions, corrective action goals, corrective action options, remedial options selection criteria, and schedules shall be included in the corrective measures evaluations.	XI.F	Sections 2.4; 5; 7; 11
26	In general, interpretation of historical investigation data and discussions of prior interim activities shall be presented only in the background sections of the corrective measures evaluations.	XI.F	Section 2.4
27	At a minimum, detections of contaminants encountered during previous site investigations shall be presented in the corrective measures evaluations in table format with an accompanying site plan showing sample locations.	XI.F	Section 2.4 Figures and Tables
28	The other text sections of the corrective measures evaluations shall be reserved for presentation of corrective action-related information regarding anticipated or potential site-specific corrective action options and methods relevant to the project.	XI.F	Section 8
29	The title page shall include the type of document; Facility name; TA designation; SWMU or AOC name, site, and any other unit name; and the submittal date. A signature block providing spaces for the name and title of the responsible DOE and University of California (or co-operator) representative shall be provided on the title page in accordance with 20.4.1.900 NMAC incorporating 40 C.F.R. 270.11(d)(1).	XI.F.1	Title Page
30	This executive summary or abstract shall provide a brief summary of the purpose and scope of the corrective measures evaluation to be conducted at the subject site. The executive summary or abstract shall also briefly summarize the conclusions of the evaluation. The SWMU, AOC, and site names, location, and TA designation shall be included in the executive summary.	XI.F.2	Executive Summary
31	The table of contents shall list all text sections, subsections, tables, figures, and appendices or attachments included in the corrective measures evaluation. The corresponding page numbers for the titles of each section of the report shall be included in the table of contents.	XI.F.3	Table of Contents

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
32	The Introduction section shall include the Facility name, TA designation, site location, and site status (e.g., closed, corrective action). General information on the current site usage and status shall be included in this section. A brief description of the purpose of the corrective measures evaluation and the corrective action objectives for the project also shall be provided in this section.	XI.F.4	Section 1
33	The Background section shall describe the relevant background information. This section shall briefly summarize historical site uses by the U.S. Government and any other entity since the 1940s, including the locations of current and former site structures and features. A labeled figure shall be included in the document showing the locations of current and former site structures and features. The locations of any subsurface features such as pipelines, underground tanks, utility lines, and other subsurface structures shall be included in this section and labeled on the site plan, as appropriate.	XI.F.5	Section 2, Figure 2.0-1 structures and features, Figure 3.2-1 subsurface features
34	This section shall include contaminant and waste characteristics, a brief summary of the history of contaminant releases, known and possible sources of contamination, and the vertical and lateral extent of contamination present in each medium. This section shall include brief summaries of results of previous investigations, including references to pertinent figures, data summary tables, and text in previous reports. References to previous reports shall include page, table, and figure numbers for referenced information. Summary tables and site plans showing relevant investigation locations shall be referenced and included in the Tables and Figures sections of the document, respectively.	XI.F.5	Section 2
35	A section on surface conditions shall describe current and historic site topography, features, and structures, including a description of topographic drainages, man-made drainages, vegetation, and erosional features. It shall also include a description of current uses of the site and any current operations at the site. This section shall also include a description of those features that could potentially influence corrective action option selection or implementation such as archeological sites, wetlands, or other features that may affect remedial activities. In addition, descriptions of features located in surrounding sites that may have an effect on the subject site regarding sediment transport, surface water runoff or contaminant transport shall be included in this section. A site plan displaying the locations of all pertinent surface features and structures shall be included in the Figures section of the corrective measures evaluation.	XI.F.6a	Section 3; Figures 1.0-2, 2.0-1

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
36	A section on subsurface conditions shall describe the site conditions observed during previous subsurface investigations. It shall include relevant soil horizon and stratigraphic information, groundwater conditions, fracture data, and subsurface vapor information. A site plan displaying the locations of all borings and excavations advanced during previous investigations shall be included in the Figures section of the corrective measures evaluation. A brief description of the stratigraphic units anticipated to be present beneath the site may be included in this section if stratigraphic information is not available from previous investigations conducted at the site.	XI.F.6b	Section 3; Figures 2.4-1, -3, -9, -16
37	A section shall provide a list of all sources of contamination at the subject site where corrective measures are to be considered or required. Sources that are no longer considered to be releasing contaminants at the site, but may be the point of origination for contaminants transported to other locations, shall be included in this section.	XI.F.7a	Section 4.1
38	A section shall describe potential migration pathways that could result in either acute or chronic exposures to contaminants. It shall include such pathways as utility trenches, paleochannels, surface exposures, surface drainages, stratigraphic units, fractures, structures, and other features. The migration pathways for each contaminant and each relevant medium should be tied to the potential receptors for each pathway. A discussion of contaminant characteristics relating to fate and transport of contaminants through each pathway shall also be included in this section.	XI.F.7b	Sections 4.2.1, 4.2.2
39	A section shall provide a listing and description of all anticipated potential receptors that could possibly be affected by the contamination present at the site. Potential receptors shall include human and ecological receptors, groundwater, and other features such as pathways that could divert or accelerate the transport of contamination to human receptors, ecological receptors, and groundwater.	XI.F.7c	Section 4.3, receptors, Sections 4.2–4.2.2, pathways to receptors
40	A section shall set forth the applicable cleanup standards, risk-based screening levels, and risk-based cleanup goals for each pertinent medium at the subject site. The appropriate cleanup levels for each site shall be included, if site-specific levels have been established at separate sites or units. A table summarizing the applicable cleanup standards or levels, or inclusion of applicable cleanup standards or levels in the summary data tables shall be included in the Tables section of the document. The risk assessment shall be presented in a separate document or in an appendix to this report. If cleanup or screening levels calculated in a risk evaluation are employed, the risk evaluation document shall be referenced including pertinent page numbers for referenced information.	XI.F.8	Section 5, Table 5.0-1; Risk Assessment: LANL 2005, 092591, Appendix G

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
41	A section shall identify and describe potential corrective measures for source, pathway, and receptor controls. Corrective measures options shall include the range of available options including, but not limited to, a no action alternative, institutional controls, engineering controls, in-situ and on-site remediation alternatives, complete removal, and any combination of alternatives that would potentially achieve cleanup goals.	XI.F.9	Section 7.0
42	A section shall provide an evaluation of the corrective measures options identified in Section XI.F.9 above. The evaluation shall be based on the applicability, technical feasibility, effectiveness, implementability, impacts to human health and the environment, and cost of each option. A table summarizing the corrective measures alternatives and the criteria listed below shall be included in the Tables section of this document.	XI.F.10	Section 8.0
43	The assessment also shall include the anticipated duration for the technology to attain regulatory compliance. In general, all corrective measures described above will have the ability to mitigate the impacts of contamination at the site, but not all remedial options will be equally effective at achieving the desired cleanup goals to the degree and within the same time frame as other options. Each remedy shall be evaluated for both short-term and long-term effectiveness.	XI.F.10.c	Section 8.0
44	Implementability characterizes the degree of difficulty involved during the installation, construction, and operation of the corrective measure. Operation and maintenance of the alternative shall be addressed in this section.	XI.F.10.d	Section 8.0
45	This category evaluates the short-term (remedy installation-related) and long-term (remedy operation-related) hazards to human health and the environment of implementing the corrective measure. The assessment shall include whether the technology will create a hazard or increase existing hazards and the possible methods of hazard reduction.	XI.F.10.e	Section 8.0
46	This section shall discuss the anticipated cost of implementing the corrective measure. The costs shall be divided into: 1) capital costs associated with construction, installation, pilot testing, evaluation, permitting, and reporting of the effectiveness of the alternative; and 2) continuing costs associated with operating, maintaining, monitoring, testing, and reporting on the use and effectiveness of the technology.	XI.F.10.f	Section 8.0

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
47	The Respondents shall propose the preferred corrective measure(s) at the site and provide a justification for the selection in this section. The proposal shall be based upon the ability of the remedial alternative to: (1) achieve cleanup objectives in a timely manner; (2) protect human and ecological receptors; (3) control or eliminate the sources of contamination; (4) control migration of released contaminants; and 5) manage remediation waste in accordance with State and Federal regulations. The justification shall include the supporting rationale for the remedy selection, based on the factors listed in Section XI.F.10 and a discussion of short- and long-term objectives for the site. The benefits and possible hazards of each potential corrective measure alternative shall be included in this section.	XI.F.11	Section 9.0
48	The Respondents shall present descriptions of the preliminary design for the selected corrective measures in this section. The description shall include appropriate preliminary plans and specifications to effectively illustrate the technology and the anticipated implementation of the remedial option at the subject area. The preliminary design shall include a discussion of the design life of the alternative and provide engineering calculations for proposed remediation systems.	XI.F.12	Section 10.0
49	A section shall set forth a proposed schedule for completion of remedy-related activities such as bench tests, pilot tests, construction, installation, remedial excavation, cap construction, installation of monitoring points, and other remedial actions. The anticipated duration of corrective action operations and the schedule for conducting monitoring and sampling activities shall also be presented. In addition, this section shall provide a schedule for submittal of reports and data to the Department, including a schedule for submitting all status reports and preliminary data.	XI.F.13	Section 11.0
50	1. A table summarizing regulatory criteria, background, and/or the applicable cleanup standards.	XI.F.14	Table 5.0-1
51	2. A table summarizing historical field survey location data.	XI.F.14	Not needed; see Figures 2.4-1, -3, -9, -16
52	3. Tables summarizing historical field screening and field parameter measurements of soil, rock, sediments, groundwater, surface water, and air quality data.	XI.F.14	Table 2.4-8 and LANL 2006, 092591, Appendix B
53	4. Tables summarizing historical soil, rock, or sediment laboratory analytical data. The summary tables shall include the analytical methods, detection limits, and significant data quality exceptions that would influence interpretation of the data.	XI.F.14	Tables 2.4-1, -2, -3, -4, -7, -9, -10, -11
54	5. A table summarizing historical groundwater elevation and depth to groundwater data. The table shall include the monitoring well depths and the screened intervals in each well.	XI.F.14	Not applicable; explanation in text of LANL 2004, 087624, p. 20–21; LANL 2006 092591, p. 14

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
55	6. Tables summarizing historical groundwater laboratory analytical data. The analytical data tables shall include the analytical methods, detection limits, and significant data quality exceptions that would influence interpretation of the data.	XI.F.14	Not applicable; no groundwater encountered in any of historical site investigations
56	7. Tables summarizing historical surface water laboratory analytical data. The analytical data tables shall include the analytical methods, detection limits, and significant data quality exceptions that would influence interpretation of the data.	XI.F.14	Not applicable; no surface water at site
57	8. Tables summarizing historical air sample screening and analytical data. The data tables shall include the screening instruments used, laboratory analytical methods, detection limits, and significant data quality exceptions that would influence interpretation of the data.	XI.F.14	Tables 2.4-5a, -5b, -5c, -6
58	9. Tables summarizing historical pilot or other test data, if applicable, including units of measurement and types of instruments used to obtain measurements.	XI.F.14	Data not available
59	10. A table summarizing the corrective measures alternatives and evaluation criteria.	XI.F.14	Table 9.0-1
60	11. A table presenting the schedule for installation, construction, implementation, and reporting of selected corrective measures.	XI.F.14	Not available, text of Section 8 gives general schedule; Figure 11.0-1
61	A section shall present the following figures for each site, as appropriate. All figures must include an accurate bar scale and a north arrow. An explanation shall be provided on each figure for all abbreviations, symbols, acronyms, and qualifiers. All figures shall have a date.	XI.F.15	See Below.
62	1. A vicinity map showing topography and the general location of the subject site relative to surrounding features or properties.	XI.F.15	Figures 1.0-1, 1.0-2
63	2. A unit site plan that presents pertinent site features and structures, underground utilities, well locations, and remediation system locations and details. Off-site well locations and other relevant features shall be included on the site plan if practical. Additional site plans may be required to present the locations of relevant off-site well locations, structures, and features.	XI.F.15	Figures 2.0-1, 3.2-1
64	3. Figures showing historical soil boring or excavation locations and sampling locations.	XI.F.15	Figures 2.4-1, -3, -9, -16
65	4. Figures presenting historical soil sample field screening and laboratory analytical data, if appropriate.	XI.F.15	Description in LANL 2004, 087624, p. B-7
66	5. Figures showing all existing wells including vapor monitoring wells and piezometers. The figures shall present historical groundwater elevation data and indicate groundwater flow directions.	XI.F.15	Not applicable

Table 1.0-2 (continued)

No.	Consent Order Requirement	Consent Order Section Reference	CME Report Section
67	6. Figures presenting historical groundwater laboratory analytical data including past data, if applicable. The analytical data corresponding to each sampling location may be presented as individual concentrations, in table form on the figure or as an isoconcentration map.	XI.F.15	Not applicable; groundwater not encountered in historical investigations.
68	7. Figures presenting historical surface water sample locations and analytical data including past data, if applicable. The laboratory analytical data corresponding to each sampling location may be presented as individual concentrations or in table form on the figure.	XI.F.15	Not applicable, no surface water exists at site
69	8. Figures presenting historical air sampling locations and presenting air quality data. The field screening or laboratory analytical data corresponding to each sampling location may be presented as individual concentrations, in table form on the figure or as an isoconcentration map.	XI.F.15	Figure 2.4-5
70	9. Figures presenting historical pilot or other test locations and data, where applicable, including site plans or graphic data presentation.	XI.F.15	Not applicable (Data not available)
71	10. Figures presenting geologic cross-sections based on outcrop and borehole data, if applicable.	XI.F.15	Figure 3.2-2
72	11. Figures presenting the locations of existing and proposed remediation systems.	XI.F.15	Not applicable
73	12. Figures presenting existing remedial system design and construction details.	XI.F.15	Not applicable
74	13. Figures presenting preliminary design and construction details for preferred corrective measures.	XI.F.15	Figures 8.1-1, 8.2-1, D-3.0-1
75	Each corrective measures evaluation shall include, as appropriate, as an appendix, the management plan for waste, including investigation derived waste, generated as a result of construction, installation, or operation of remedial systems or activities conducted.	XI.F.16	Will be developed as part of CMI
76	Each corrective measures evaluation shall include additional appendices presenting relevant additional data, such as pilot or other test or investigation data, remediation system design specifications, system performance data, or cost analyses as necessary.	XI.F.16	Appendixes D–H

Table 2.4-1
Frequency of Detected Radionuclides above BVs in 1994 Channel Sediment Samples at MDA L

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

[a] Values in square brackets indicate detection limits for nondetects.

[b] Sediment background and fallout values obtained from LANL 1998, 059730.

[c] na = Not available.

Table 2.4-2
Inorganic Chemicals Detected or Detected above BVs in Phase I RFI Subsurface Core Samples at MDA L

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

Table 2.4-2 (continued)

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

Table 2.4-2 (continued)

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

Table 2.4-2 (continued)

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

Table 2.4-2 (continued)

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

Table 2.4-2 (continued)

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

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

[a] Tuff BVs obtained from LANL 1998, 59730.

[b] na = Not available.

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

Table 2.4-3
Frequency of Detected Radionuclides above BV or Detects in Subsurface Core Samples at MDA L

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

[a] Values in brackets indicate detection limits for nondetects.

[b] n/a = Not applicable.

[c] TCB = Tertiary Cerros del Rio basalts.

Table 2.4-4
Organic Chemicals Detected in Phase I RFI Subsurface Core Samples at MDA L

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

Table 2.4-4 (continued)

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

Table 2.4-4 (continued)

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

Table 2.4-4 (continued)

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

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

*Dash indicates that the concentration was not detected.

Table 2.4-5a
Air Concentrations of Selected VOCs at MDA L, Location 4

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

*ND = Not detected.

Table 2.4-5b
Air Concentrations of Selected VOCs at MDA L, Location 5

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

*ND = Not detected.

Table 2.4-5c
Air Concentrations of Selected VOCs at Bandelier National Monument, Location 3 (Background)

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

*ND = not detected.

Table 2.4-6
Calculated Tritium Surface Flux Concentration for Phase I RFI Samples Collected at MDA L

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

*Higher of two duplicate samples.

Table 2.4-7
Frequency of VOCs Detected in Pore Gas at MDA L, Second Quarter FY 1997 through Fourth Quarter 2003

Analyte	Number of Analyses	Number of Detects	Concentration[a] (ppbv[b])	EQL (ppbv)	Frequency of Detects
Acetone	260	38	0.5 to [1100000]	5	38/260
Acetonitrile	148	3	1.8 to [210000]	1	3/148
Acetophenone	69	1	[5 to 10000]	0.2	1/69
Acrylonitrile	151	2	[1.2 to 110000]	0.5	2/151
Benzene	269	71	0.13 to [42000]	0.2	71/269
Benzonitrile	69	5	1.2 to [10000]	0.5	5/69
Bromodichloromethane	259	1	[0.47 to 42000]	0.2	1/259
Bromoform	260	6	[0.47 to 42000]	0.2	6/260
Bromomethane	269	9	[0.47 to 42000]	0.5	9/269
Butadiene[1,3-]	259	2	[0.47 to 42000]	0.2	2/259
Butane[n-]	152	64	[0.48 to 42000]	0.2	64/152
Butanol[1-]	256	3	[1.2 to 110000]	0.5	3/256
Butanone[2-]	260	2	[1.2 to 110000]	0.5	2/260
Butene[1-]	69	41	[1.6] to 2950	0.2	41/69
Butene[cis-2-]	69	33	[0.19] to 8550	0.2	33/69
Butene[trans-2-]	69	23	[0.15 to 1000]	0.2	23/69
Carbon disulfide	260	7	[0.12 to 42000]	0.2	7/260
Carbon Tetrachloride	269	136	0.47 to [42000]	0.2	136/269
Chloro-1,3-butadiene[2-]	68	2	[0.5 to 1000]	0.2	2/68
Chlorobenzene	270	45	0.04 to [42000]	0.2	45/270
Chlorodibromomethane	259	2	0.4 to [42000]	0.2	2/259
Chlorodifluoromethane	191	25	[0.47 to 42000]	0.2	25/191
Chloroethane	269	31	[0.47 to 42000]	0.5	31/269
Chloroform	269	193	0.26 to 46700	0.2	193/269
Chloromethane	269	23	[0.79 to 110000]	0.5	23/269
Cyclohexane	260	61	0.44 to [73000]	0.5	61/260
Cyclohexanone	69	1	[5 to 10000]	0.2	1/69
Cyclopentane	69	41	0.12 to 1340	0.2	41/69
Cyclopentene	69	12	0.2 to [1000]	0.2	12/69
Dibromoethane[1,2-]	232	8	[0.47 to 42000]	0.2	8/232
Dichloro-1,1,2,2-tetrafluoroethane[1,2-]	232	4	[0.47 to 42000]	0.2	4/232
Dichlorobenzene[1,2-]	270	2	0.2 to [42000]	0.2	2/270
Dichlorobenzene[1,4-]	270	22	[0.2 to 42000]	0.2	22/270
Dichlorodifluoromethane	232	153	[2.4 to 42000]	0.2	153/232
Dichloroethane[1,1-]	268	225	0.29 to 287000	0.2	225/268

Table 2.4-7 (continued)

Analyte	Number of Analyses	Number of Detects	Concentration[a] (ppbv)	EQL (ppbv)	Frequency of Detects
Dichloroethane[1,2-]	269	138	0.22 to 240000	0.2	138/269
Dichloroethene[1,1-]	269	247	3.4 to 49000	0.2	247/269
Dichloroethene[cis-1,2-]	269	21	[0.47 to 42000]	0.2	21/269
Dichloroethene[trans-1,2-]	258	21	[0.47 to 42000]	0.2	21/258
Dichloropropane[1,2-]	269	108	[0.47] to 144000	0.2	108/269
Dichloropropene[cis-1,3-]	269	3	[0.47 to 42000]	0.2	3/269
Dichloropropene[trans-1,3-]	268	2	[0.47 to 42000]	0.2	2/268
Diethyl Ether	152	23	[1.2 to 110000]	0.5	23/152
Dimethylbutane[2,2-]	69	37	[0.12 to 1000]	0.2	37/69
Dimethylbutane[2,3-]	69	29	[0.5] to 2370	0.2	29/69
Dimethylpentane[2,3-]	64	29	[0.14] to 1888	0.2	29/64
Dioxane[1,4-]	177	2	[3.2 to 35000]	1	2/177
Ethanol	177	11	1.8 to 58000	0.5	11/177
Ethyl acrylate	69	1	4 to [10000]	0.2	1/69
Ethyl tert-butyl ether	69	3	0.8 to [10000]	0.2	3/69
Ethylbenzene	270	25	0.22 to [42000]	0.2	25/270
Hexachlorobutadiene	270	5	[0.05 to 42000]	0.2	5/270
Hexane	259	55	0.1 to [42000]	0.2	55/259
Hexanone[2-]	259	1	[1.2 to 110000]	0.5	1/259
Hexene[cis-3-]	69	7	[0.5 to 1000]	0.2	7/69
Hexene[trans-2-]	69	6	[0.5 to 1000]	0.2	6/69
Isobutane	69	57	1.13 to 3290	0.2	57/69
Isooctane	69	45	0.02 to 2230	0.2	45/69
Isopentane	68	53	0.4 to 1010	0.2	53/68
Isoprene	69	12	[0.5 to 1000]	0.2	12/69
Isopropylbenzene	152	8	[0.47 to 42000]	0.2	8/152
Methanol	251	19	[2.4 to 2100000]	10	19/251
Methyl methacrylate	69	3	0.05 to [10000]	0.2	3/69
Methyl tert-butyl ether	260	4	[1.2 to 110000]	0.2	4/260
Methyl-1-butene[3-]	69	20	0.2 to [1000]	0.2	20/69
Methyl-1-pentene[2-]	69	13	[0.5 to 1000]	0.2	13/69
Methyl-1-pentene[4-]	69	13	[0.5 to 1000]	0.2	13/69
Methyl-2-butene[2-]	69	24	0.05 to [1000]	0.2	24/69
Methyl-2-pentanone[4-]	260	7	[1.2 to 110000]	0.5	7/260
Methylcyclohexane	69	53	0.2 to 3530	0.2	53/69
Methylcyclopentane	69	60	[0.22] to 3180	0.2	60/69
Methylene chloride	269	210	[0.28] to 660000	0.2	210/269
Methylheptane[2-]	69	18	[0.02 to 1000]	0.2	18/69

Table 2.4-7 (continued)

Analyte	Number of Analyses	Number of Detects	Concentration[a] (ppbv)	EQL (ppbv)	Frequency of Detects
Methylheptane[3-]	69	17	[0.01 to 1000]	0.2	17/69
Methylhexane[2-]	67	15	[0.01 to 1000]	0.2	15/67
Methylhexane[3-]	69	39	[0.13] to 3980	0.2	39/69
Methylpentane[2-]	69	50	[0.17] to 2330	0.2	50/69
Methylpentane[3-]	68	52	0.2 to 2360	0.2	52/68
Methylstyrene[alpha-]	152	1	0.3 to [42000]	0.2	1/152
Naphthalene	83	1	[0.47 to 42000]	na[c]	1/83
n-Heptane	258	23	[0.47 to 42000]	na	23/258
Nitrobenzene	69	1	[5 to 10000]	0.2	1/69
Nitropropane[2-]	69	2	0.8 to [10000]	0.2	2/69
Nonane[1-]	152	14	[0.3 to 42000]	0.2	14/152
Octane[n-]	152	14	[0.47 to 42000]	0.2	14/152
Pentane	151	62	0.68 to [110000]	0.5	62/151
Pentene[1-]	69	17	[0.08 to 1000]	0.2	17/69
Pentene[cis-2-]	69	15	0.2 to [1000]	0.2	15/69
Pentene[trans-2-]	69	12	0.3 to [1000]	0.2	12/69
Pinene[alpha-]	69	7	[0.5 to 1000]	0.2	7/69
Pinene[beta-]	69	7	[0.5 to 1000]	0.2	7/69
Propanol[2-]	177	13	0.6 to 120000	0.5	13/177
Propylbenzene[1-]	152	7	0.4 to [42000]	0.2	7/152
Propylene	176	48	[1.51 to 35000]	0.2	48/176
Styrene	270	6	[0.47 to 42000]	0.2	6/270
Tetrachloroethane[1,1,2,2-]	270	9	[0.47 to 42000]	0.2	9/270
Tetrachloroethene	270	255	[0.48] to 1130000	0.2	255/270
Tetrahydrofuran	177	16	[3.2] to 36600	0.2	16/177
Toluene	269	81	0.41 to [42000]	0.2	81/269
Trichloro-1,2,2-trifluoroethane[1,1,2-] (Freon 113)	269	261	1.5 to 400000	0.2	261/269
Trichlorobenzene[1,2,4-]	270	7	[0.47 to 42000]	0.2	7/270
Trichloroethane[1,1,1-]	269	267	3.9 to 6970000	0.2	267/269
Trichloroethane[1,1,2-]	269	24	[0.47 to 42000]	0.2	24/269
Trichloroethene	269	267	[0.48] to 2600000	0.2	267/269
Trichlorofluoromethane	232	196	2 to 81000	0.2	196/232
Trimethylbenzene[1,2,4-]	270	17	[0.04 to 42000]	0.2	17/270
Trimethylbenzene[1,3,5-]	270	6	[0.47 to 42000]	0.2	6/270
Trimethylpentane[2,3,4-]	69	16	0.4 to [1000]	0.2	16/69
Undecane[n-]	83	1	[0.47 to 42000]	na	1/83
Vinyl acetate	260	3	[1.2 to 110000]	0.5	3/260

Table 2.4-7 (continued)

Analyte	Number of Analyses	Number of Detects	Concentration[a] (ppbv)	EQL (ppbv)	Frequency of Detects
Vinyl chloride	268	33	0.08 to [42000]	0.2	33/268
Xylene (total)	88	6	[0.49 to 42000]	na	6/88
Xylene[1,2-]	270	39	0.3 to [42000]	0.2	39/270
Xylene[1,3-]	81	24	0.4 to [8400]	0.2	24/81
Xylene[1,3-]+xylene[1,4-]	101	9	[0.47 to 27000]	na	9/101

[a] Values in square brackets indicate detection limits for nondetects.

[b] ppbv = Parts per billion by volume.

[c] na = Not available.

Table 2.4-8
MDA L Pore-Gas Field Screening Data

Depth (ft)	TCA (ppm)	TCE (ppm)	Freon-11 (ppm)	PCE (ppm)	CO2 B&K (ppm)	Water Vapor (ppm)	CO_2 Landtec (%)
Borehole A (54-24242)							
15	41.5	7.55	0.664	10.1	3720	13200	0.3
100	31	7.5	0.576	9.55	3000	15800	0.6
Borehole B (54-24239)							
15	93.5	17.2	2.75	75.9	6610	1960	0.5
100	72.7	14	1.74	22.5	6810	18000	0.9
Borehole C (54-24240)							
60	340	52.8	2.02	16.4	7230	16700	0.9
230	31.2	5.64	0.16	1.7	1670	14800	0.6
Borehole D-1 (54-24241)							
Data not collected due to calibration errors							
Borehole D-2 (54-24399)							
550–608	2.58	0.05	0.0	0.0	1200	1760	0.0
Borehole E (54-24238)							
Data not collected due to calibration errors							
Borehole F (54-24243)							
65	278	49.2	11	58.9	12800	9220	1.6
130	222	29.4	10.6	48.7	9870	10100	1.4
Borehole G (54-24244)							
65	108	20.1	3.48	19.7	7180	1330	0.8
130	71.3	14.2	3.02	14.7	5020	13600	0.8

Table 2.4-9
Matric Potential and Gravimetric Moisture Content Summary

Borehole Location	Sample ID	Depth (ft)	Matrix (unit)	Matric Potential (-bars)	Matric Potential (-cm)	Gravimetric Moisture Content (%, g/g)
54-24241	MD54-05-57099	14–15	Qbt2	2.1	2142	6.4
	MD54-05-57100	19–20	Qbt2	3	3059	6.2
	MD54-05-57101	24–25	Qbt2	5.1	5201	7.7
	MD54-05-57102	29–30	Qbt2	2.7	2753	7.0
	MD54-05-57103	34–35	Qbt2	4.2	4283	9.2
	MD54-05-57104	39–40	Qbt1v	4.2	4283	5.8
	MD54-05-57105	44–45	Qbt1v	4.6	4691	7.4
	MD54-05-57106	49–50	Qbt1v	3.5	3569	6.6
	MD54-05-57107	54–55	Qbt1v	4.9	4997	9.1
	MD54-05-57108	59–60	Qbt1v	3.4	3467	7.4
	MD54-05-57109	64–65	Qbt1v	5.2	5303	7.9
	MD54-05-57110	70–71	Qbt1v	4.2	4283	6.4
	MD54-05-57111	75–76	Qbt1v	5.1	5201	4.9
	MD54-05-57112	79–80	Qbt1v	6.3	6425	3.5
	MD54-05-57574	88–90	Qbt1v	7.0	7139	2.1
	MD54-05-57113	84–85	Qbt1v	6.9	7037	2.6
	MD54-05-57115	94–95	Qbt1v	8.2	8362	2.5
	MD54-05-57116	99–100	Qbt1v	7.2	7343	3.0
	MD54-05-57117	104–105	Qbt1v	6.8	6935	3.3
	MD54-05-57118	109–110	Qbt1v	5.9	6017	4.0
	MD54-05-57119	114–115	Qbt1v	5.2	5303	5.7
	MD54-05-57120	119–120	Qbt1v	3.8	3875	6.5
	MD54-05-57121	124–125	Qbt1v	4.5	4589	6.5
	MD54-05-57122	129–130	Qbt1g	5.4	5507	11.3
	MD54-05-57123	134–135	Qbt1g	3.9	3977	9.7
	MD54-05-57124	139–140	Qbt1g	6.0	6119	5.5
	MD54-05-57125	144–145	Qbt1g	2.6	2651	5.9
	MD54-05-57126	149–150	Qbt1g	4.2	4283	6.7
	MD54-05-57127	154–155	Qbt1g	2.8	2855	6.6
	MD54-05-57128	159–160	Qbt1g	4.9	4997	7.0
	MD54-05-57575	162–164	Qbt1g	3.4	3467	6.5
	MD54-05-57130	169–170	Qbt1g	4.5	4589	6.1

Table 2.4-9 (continued)

Borehole Location	Sample ID	Depth (ft)	Matrix (unit)	Matric Potential		Gravimetric Moisture Content (%, g/g)
				(-bars)	(-cm)	
54-24241 (continued)	MD54-05-57131	174–175	Qbt1g	4.6	4691	6.4
	MD54-05-57132	179–180	Qbt1g	4.8	4895	6.7
	MD54-05-57133	184–185	Qbt1g	2.8	2855	6.8
	MD54-05-57134	189–190	Qbt1g	5.4	5507	7.5
	MD54-05-57135	194–195	Qbt1g	4.9	4997	7.9
	MD54-05-57136	199–200	Qbt1g	4.5	4589	8.9
	MD54-05-57137	204–205	Qbt1g	4.8	4895	7.8
	MD54-05-57138	209–210	Qbt1g	5.0	5099	7.4
	MD54-05-57139	214–215	Qbt1g	4.4	4487	7.6
	MD54-05-57140	219–220	Qbt1g	3.8	3875	8.1
	MD54-05-57141	224–225	Qbt1g	4.7	4793	8.2
	MD54-05-57142	229–230	Qbt1g	4.2	4283	8.9
	MD54-05-57143	234–235	Qbt1g	4.3	4385	9.6
	MD54-05-57144	239–240	Qbt1g	4.5	4589	10.3
	MD54-05-57145	244–245	Qbt1g	6.2	6323	9.9
	MD54-05-57146	249–250	Qbt1g	5.0	5099	10.3
54-24399*	MD54-05-57174	385–390	ALLH	6.2	6323	27.9
	MD54-05-57175	390–395	ALLH	<648	<660,830	3.1
	MD54-05-57176	395–400	TCB	7.1	7241	1.3

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

Table 2.4-10
Comparison of VOCs Detected in Pore Gas and Core Samples in New Boreholes at MDA L

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

Table 2.4-10 (continued)

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

Table 2.4-10 (continued)

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

Table 2.4-10 (continued)

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

Table 2.4-11
VOCs Detected in Pore Gas at MDA L (µg/m^3)

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

Table 2.4-10 (continued)

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

Table 2.4-10 (continued)

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

Table 2.4-10 (continued)

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

Table 2.4-10 (continued)

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

Table 2.4-10 (continued)

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

*— = Analyte was not detected.

Table 5.0-1
Summary of Regulatory Criteria and Clean-up Levels

Media	Hazardous Waste
Groundwater	- New Mexico Water Quality Control Commission standards - Safe Drinking Water Act standards
Surface water	- New Mexico Water Quality Control Commission standards - Clean Water Act standards - State of New Mexico Standards for Interstate and Intrastate Surface Waters
Soil	- NMED “Technical Background Document for Development of Soil Screening Levels” - EPA Region 6 Human Health Medium Specific Screening Level

Table 7.3-1

Component Actions of Identified Corrective Measure Alternatives

Alternative	Alternative Component											Notes
	Enhanced Containment/Stabilization					Source Removal		Media	Active Institutional Controls			
	RCRA Cover	ET Cover	Biointrusion Barrier	Waste Stabilization	Subsurface Barrier	Partial Excavation	Complete Excavation	Up to 45-yr Contaminant Extraction (SVE)	30-yr Monitoring & Maintenance	45-yr Monitoring & Maintenance	100-yr Site Access and Administrative Controls	
1A									X[a]		X	No further action, monitoring only
1B								X		X	X	Improved natural cover, SVE, monitoring and maintenance
2A	X							X	X	X	X	RCRA Subtitle C final cover, monitoring
2B		X	X					X		X	X	Engineered ET cover, SVE, maintenance and monitoring
3		X	X	X				X		X	X	Engineered ET cover, targeted waste stabilization, SVE, monitoring/maintenance
4				X				X		X	X	Comprehensive waste stabilization, SVE, monitoring and maintenance
5A		X	X			X		X		X	X	Engineered ET cover, partial waste excavation and off-site disposal, SVE, monitoring and maintenance
5B							X	X[b]	X		X	Complete waste-source excavation, SVE, waste treatment, off-site disposal, monitoring and maintenance

[a] 30-yr monitoring only, no maintenance.

[b] 30-yr SVE operation as per RCRA postclosure-care period length.

Table 7.4-1
Corrective Measure Alternative Qualitative Screening Matrix

Corrective Measure	Description	Screening				Retained?
		Meets Threshold Criteria?[a]	Implementable?	Performance?[b]	Timely?	
Alternative 1A Monitoring Only, No Further Action (NFA)	Includes continued monitoring of the subsurface vapor-phase VOC and tritium plumes and moisture monitoring for 30 yr.	No	Yes	No	Yes	No
Monitoring only, NFA is not responsive to threshold criteria because it is not protective of human health and the environment and does not control sources of releases. Monitoring only NFA is technically and administratively implementable and timely.						
Alternative 1B Improved Natural Cover, SVE, Monitoring and Maintenance	Includes the monitoring described in Alternative 1A and provides for upkeep of the existing containment systems. Any releases identified during monitoring will also be addressed through maintenance activities to the containment systems. SVE operation and maintenance would be conducted for up to 45 yr.	Partial	Yes	Adequate	Yes	Yes
This alternative is generally protective of human health and the environment although surface water infiltration rates will not be minimized to the degree that would be achieved with a landfill final cover. Contaminants would migrate at a faster than desirable rate. Maintenance activities can extend the containment effectiveness and operational life for the existing covers. Long-term maintenance and monitoring controls are effective in maintaining the performance of corrective measures and in identifying unacceptable levels of contaminants in environmental media. Additional corrective measures could be undertaken if necessary in the future.						
Alternative 2A RCRA Subtitle C Final Cover, SVE, Monitoring and Maintenance	Installation of a final cover represents one of the primary containment alternatives for subsurface waste disposal units. This alternative includes installation of a RCRA Subtitle C cover and SVE.	Yes, initially, but long term performance is poor.	Yes	Poor	Yes	No
In the semiarid climate of MDA L, the components prescribed for a regulatory standard design RCRA Subtitle C cover do not perform well over time. The high clay content tends to produce cracking due to desiccation, leading to preferential pathways for surface water infiltration.						

Table 7.4-1 (continued)

<table>
<tr><th rowspan="2">Corrective Measure</th><th rowspan="2">Description</th><th colspan="4">Screening</th><th rowspan="2">Retained?</th></tr>
<tr><th>Meets Threshold Criteria?[a]</th><th>Implementable?</th><th>Performance?[b]</th><th>Timely?</th></tr>
<tr><td>Alternative 2B
Engineered ET Cover, SVE, Monitoring and Maintenance</td><td>This alternative includes an ET cover for the MDA L wastes, which is well-suited for the semiarid climate of MDA L. Effective in reducing infiltration through landfills in semi-arid regions and provides a barrier to erosion and intrusion.</td><td>Yes</td><td>Yes</td><td>Good</td><td>Yes</td><td>Yes</td></tr>
<tr><td colspan="7">The engineered final cover concept is designed to utilize ET and is directly responsive to threshold criteria. The cover thickness acts as a biotic barrier, increasing the responsiveness of the alternative. This alternative is technically and administratively implementable. Materials used to construct an engineered/ET cover are readily available. Performance of ET covers in semi-arid regions is well demonstrated and regulatory acceptance of ET covers as alternative final covers is widespread in arid and semi-arid regions.</td></tr>
<tr><td>Alternative 3
Engineered ET Cover, Targeted Waste Stabilization, SVE, Monitoring and Maintenance</td><td>This alternative includes an ET cover for the MDA L wastes, a biointrusion barrier and limited targeted near-surface waste stabilization to address near-surface wastes with higher release risk potential based on contaminant type and concentration.</td><td>No</td><td>Partially</td><td>Good</td><td>Yes</td><td>No</td></tr>
<tr><td colspan="7">Waste in impoundments could be stabilized but waste in shafts cannot be stabilized by traditional techniques because of the risk of pressurization and rupture of drums containing volatile organic compounds.</td></tr>
<tr><td>Alternative 4
Comprehensive Waste Stabilization, SVE, Monitoring and Maintenance</td><td>The existing operational cover is incorporated into this alternative. To further enhance the protection of the waste from water infiltration and/or biotic intrusion, vertical planar in situ vitrification technology will be deployed but to the depth limitations of the technology. Deeper wastes will be stabilized with jet grouting, as necessary. This alternative includes the grading, extension and augmentation of operational cover materials as necessary to direct surface runoff to drainage channels away from waste disposal units to further enhance surface water management.</td><td>Yes, although near-term risks increase</td><td>Yes, but depth limit of technologies may be reached</td><td>Good</td><td>No</td><td>No</td></tr>
</table>

Table 7.4-1 (continued)

Corrective Measure	Description	Screening				Retained?
		Meets Threshold Criteria?[a]	Implementable?	Performance?[b]	Timely?	
Waste stabilization is responsive to threshold criteria. However, in situ vitrification requires intrusive activity as preparatory steps for containerized buried wastes that could lead to increased site worker exposures. The technology is technically and administratively implementable, but very expensive and relatively time-consuming to implement and at the depth limit of the technology for this application. Vitrification production capacities are approximately 90 tons (~1500 ft^3) per day per unit. Vitrification temperatures up to 2,000ºC have the potential to generate and release radioactive and hazardous vapors to the environment and vitrified materials may retain dangerous levels of heat for more than a year after completion of treatment.						
Alternative 5A ET Cover, Partial Waste Source Excavation, Ex Situ Treatment, Off-site Disposal, SVE, Monitoring and Maintenance	As in Alternative 2B, an ET cover will be constructed. To further enhance the protection of the waste from water infiltration and/or biotic intrusion, the waste disposed in Impoundments B, C and D will be excavated, treated as necessary to meet disposal waste acceptance requirements, and disposed off-site.	Yes, although near-term risks increase	Yes	Good	Yes	Yes
The alternative includes construction of an ET cover, waste retrieval, packaging, and shipment of up to 740 yd^3 of waste via truck to off-site disposal locations. Twenty samples of material in the impoundments were sampled in 2007, and only minor exceedances of TCLP values occurred. A comprehensive waste characterization program will be required to determine the disposal pathway for each impoundment.						

Table 7.4-1 (continued)

<table>
<tr><th rowspan="2">Corrective Measure</th><th rowspan="2">Description</th><th colspan="4">Screening</th><th rowspan="2">Retained?</th></tr>
<tr><th>Meets Threshold Criteria?[a]</th><th>Implementable?</th><th>Performance?[b]</th><th>Timely?</th></tr>
<tr><td>Alternative 5B
Complete Waste Source Excavation Waste Treatment, and Off-site Disposal, SVE, Monitoring and Maintenance</td><td>This alternative includes removal of all buried waste at MDA L with disposal to the maximum extent at alternate locations off-site. Ex situ waste treatment is included as required to meet waste acceptance and regulatory requirements. Future potential risks (long-term) from MDA L can be almost entirely mitigated with removal of wastes from the site. Monitoring of the area would be performed for 5 yr with maintenance of the SVE system being performed for 4 yr.</td><td>Partial, due to significantly increased near-term risks</td><td>Waste retrieval from certain burial configurations is unproven</td><td>Good</td><td>No</td><td>Yes</td></tr>
<tr><td colspan="7">The alternative involves shipment of over 24 mil ft^3 of waste (3.5 mil drum equivalents) via truck to off-site disposal locations. Because of the large number of truck shipments over distance, short-term risks associated with traffic accidents and worker risks associated with retrieving certain configurations of buried wastes could be expected to be high relative to other options for the site. Risks include increased exposures to contaminants for workers and potentially to downwind residents. Long-term risks would be the least of all alternatives considered. The scale of the excavation effort would require the greatest time to implement of all of the alternatives considered.</td></tr>
</table>

[a] Threshold Criteria:

1. Protects human health (e.g., <1 x 10^{-5} excess cancers risk).
2. Protects the environment.
3. Attains media cleanup levels.
4. Provides source control to reduce or eliminate releases that may pose a threat.
5. Complies with waste management standards.

[b] Performance: Likely to perform satisfactorily and/or reliably.

Table 8.0-1
Comparison of Retained Corrective Measure Alternatives

Alternative	Description	Active SVE Duration (yr)	Monitoring and Maintenance Period (yr)	DOE Active Institutional Control Period (yr)
1B	Improved Natural Cover, SVE, Monitoring and Maintenance	30 yr[a]	30 [c]	100
2B	Engineered Alternative ET Cover, SVE, Monitoring and Maintenance	30 yr[a]	30 [c]	100
5A	Engineered ET Cover Partial Waste Excavation with Off-Site Disposal, SVE, Maintenance and Monitoring	30 yr[a]	30 [c]	100
5B	Complete Waste Source Excavation, Waste Treatment, Off-site Disposal, SVE, Monitoring	30[b]	30[c]	100

[a] The extraction boreholes will be converted to passive venting.

[b] After 4 consecutive SVE cycles where no rebound of contaminants is observed, the Laboratory will engage in negotiations with NMED to discontinue SVE operations so this time period may be shorter.

[c] Based on the RCRA postclosure-care period,

Table 8.1-1
Capital, Recurring, and Periodic Cost Estimate for Corrective Measure Alternative 1B in 2007 Dollars and Present Value Analysis Results for Improved Natural Cover, SVE, and Monitoring and Maintenance

Capital - Work Breakdown Structure (WBS) Element	Cost Estimate
WBS 1B.1.1 – Study	$0
WBS 1B.1.2 – Remedial Design	$248,900
WBS 1B.1.3 – Site Preparation	$1,429,600
WBS 1B.1.4 – SVE System Installation	$2,609,100
WBS 1B.1.6 – Remedial Action Cover	$93,100
WBS 1B.1.7 – Remedial Action Monitoring Installation	$69,700
Total Capital Cost	**$4,450,400**
Recurring and Periodic WBS Element –Annual Cost	Cost Estimate
WBS 1B.2.1 – SVE System Operations (30 yr)	$4,500
WBS 1B.2.2 – Cap Maintenance (100 yr)	$7,400
WBS 1B.2.3 – Long-term Monitoring (30 yr)	$56,200
Start-up Cost	$67,400
Total Annual Cost	**$68,100**
Present Value @ 3% 100-yr	**$5,730,000**
Total + 55% Contingency[1]	**$8,881,000**
Present Value @ 7% 100-yr	**$5,459,000**
Total + 55% Contingency*	**$8,462,000**

*Note: Same contingency as that used at INL, “Feasibility Study for Operable Unit 7-13/14” (Holdren et al. 2007, 098642).

Table 8.2-1
Capital, Recurring, and Periodic Cost Estimate for Corrective Measure Alternative 2B in 2007 Dollars and Present Value Analysis Results for Engineered ET Cover, SVE, and Monitoring and Maintenance

Capital - Work Breakdown Structure (WBS) Element	Cost Estimate
WBS 2B.1.1 – Study	$0
WBS 2B.1.2 – Remedial Design	$269,500
WBS 2B.1.3 – Site Preparation	$1,429,600
WBS 2B.1.4 – SVE System Installation	$2,609,100
WBS 2B.1.6 – Remedial Action Cover	$569,500
WBS 2B.1.7 – Remedial Action Monitoring Installation	$69,700
Total Capital Cost	**$4,947,400**
Recurring and Periodic WBS Element – Annual Cost	Cost Estimate
WBS 2B.2.1 – SVE System Operations (30 yr)	$4,500
WBS 2B.2.2 – Cap Maintenance (100 yr)	$7,400
WBS 2B.2.3 – Long-term Monitoring (30 yr)	$56,200
Start-up Cost	$22,800
Total Annual Cost	**$68,100**
Present Value @ 3% 100-yr	**$6,229,000**
Total + 55% Contingency[1]	**$9,654,000**
Present Value @ 7% 100-yr	**$5,958,000**
Total + 55% Contingency*	**$9,234,000**

*Note: Same contingency as that used at INL, “Feasibility Study for Operable Unit 7-13/14” (Holdren et al. 2007, 098642).

Table 8.3-1
Capital, Recurring, and Periodic Cost Estimate for Corrective Measure Alternative 5A in 2007 Dollars and Present Value Analysis Results for Engineered ET Cover, Partial Excavation, SVE, and Monitoring and Maintenance

Capital - Work Breakdown Structure (WBS) Element	Cost Estimate
WBS 5A.1.1 – Study	$0
WBS 5A.1.2 – Remedial Design	$412,700
WBS 5A.1.3 – Site Preparation	$1,429,600
WBS 5A.1.4 – SVE System Installation	$2,609,100
WBS 5A.1.5 – Remedial Action Excavation	$2,479,800
WBS 5A.1.6 – Remedial Action Cover	$569,500
WBS 5A.1.7 – Remedial Action Monitoring Installation	$69,700
Total Capital Cost	**$7,570,400**
Recurring and Periodic WBS Element – Annual Cost	Cost Estimate
WBS 5A.2.1 – SVE System Operations (30 yr)	$4,500
WBS 5A.2.2 – Cap Maintenance (100 yr)	$7,400
WBS 5A.2.3 – Long-term Monitoring (30 yr)	$56,200
Start-up Cost	$43,600
Total Annual Cost	**$68,100**
Present Value @ 3% 100-yr	**$8,851,000**
Total + 55% Contingency[1]	**$13,720,000**
Present Value @ 7% 100-yr	**$8,581,000**
Total + 55% Contingency*	**$13,300,000**

*Note: Same contingency as that used at INL, “Feasibility Study for Operable Unit 7-13/14” (Holdren et al. 2007, 098642).

Table 8.4-1
Capital, Recurring, and Periodic Cost Estimate for Corrective Measure Alternative 5B in 2007 Dollars and Present Value Analysis Results for Complete Waste-Source Excavation and Backfilling, Off-site Disposal, SVE, and Monitoring and Maintenance

Capital - Work Breakdown Structure (WBS) Element	Cost Estimate
WBS 5B.1.1 – Study	$0
WBS 5B.1.2 – Remedial Design	$1,288,000
WBS 5B.1.3 – Site Preparation	$1,429,600
WBS 5B.1.4 – SVE System Installation	$2,609,100
WBS 5B.1.5 – Remedial Action Excavation	$17,367,600
WBS 5B.1.6 – Site Restoration	$380,800
WBS 5B.1.7 – Remedial Action Monitoring Installation	$69,700
Total Capital Cost	**$23,144,800**
Recurring and Periodic WBS Element – Annual Cost	Cost Estimate
WBS 5B.2.1 – SVE System Operations (30 yr)	$4,500
WBS 5B.2.2 – Cap Maintenance	$0
WBS 5B.2.3 –Long-term Monitoring	$58,900
Start-up Cost	$43,600
Total Annual Cost	**$63,400**
Present Value @ 3% 100-yr	**$24,066,000**
Total + 55% Contingency[1]	**$37,303,000**
Present Value @ 7% 100-yr	**$23,931,000**
Total + 55% Contingency*	**$37,094,000**

*Note: Same contingency as that used at INL, “Feasibility Study for Operable Unit 7-13/14” (Holdren et al. 2007, 098642).

Table 9.0-1
Comparative Analysis of Corrective Measure Alternatives

Criteria	1B: Improved Natural Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 2B: Engineered ET Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 5A: Engineered ET Cover, Partial Excavation, SVE, Monitoring and Maintenance (Rank 1 to 5)*	5B: Complete Waste Source Excavation, Backfilling, Off-site Disposal, SVE, Monitoring (Rank 1 to 5)*
1. Applicability **(Consent Order Ref: XI.F.10a)**	Monitoring to date has shown containment of waste. However, annual erosion under bare soil conditions exceeds target goal, cover is not equivalent to RCRA Subtitle C prescribed cover. SVE system is applicable. (Rank = 2)	Cover systems have been shown to be applicable. SVE system is applicable. (Rank = 5)	Cover systems have been shown to be applicable. SVE system is applicable. (Rank = 5)	Excavation has reduced applicability due to handling, transportation, disposal, and esthetics issues. SVE system is applicable. (Rank = 4)
2. Technical Feasibility (Consent Order Ref: XI.F.10b)	Existing cover maintenance and SVE have been shown to be technically feasible. (Rank = 5)	Engineered ET cover and SVE have been shown to be technically feasible. (Rank = 5)	Engineered ET cover and SVE have been shown to be technically feasible. (Rank = 5)	Excavation and SVE have been shown to be technically feasible. However excavation of vertical shafts of drummed liquids without release is not unlikely. (Rank = 2)
3. Effectiveness: short- and long-term (Consent Order Ref: XI.F.10c)	Short term: not effective Long term: not effective (Rank = 2)	Short term: effective Long term: effective (Rank = 5)	Short term: effective Long term: effective (Rank = 5)	Short term: less effective Long term: most effective Removal of the VOC contaminant sources makes SVE more effective and reduces the operation and monitoring period. (Rank = 4)
4. Implementability (Consent Order Ref: XI.F.10d)	Designed and constructed in less than 12 months with normal construction equipment. (Rank = 5)	Designed and constructed in less than 24 months with normal construction equipment. (Rank = 4)	Designed and constructed in less than 24 months with normal construction equipment. (Rank = 4)	Designed and constructed in approximately 42 months. Requires a characterization, sorting and packaging facility. Requires remote excavator and engineered barriers. (Rank =2)

Table 9.0-1 (continued)

Criteria	1B: Improved Natural Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 2B: Engineered ET Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 5A: Engineered ET Cover, Partial Excavation, SVE, Monitoring and Maintenance (Rank 1 to 5)*	5B: Complete Waste Source Excavation, Backfilling, Off-site Disposal, SVE, Monitoring (Rank 1 to 5)*
5. Human Health and Ecological Protectiveness **(Consent Order Ref: XI.F.10e)**	Long-term potential effect on human health and biological resources. No effect on cultural resources. Potential long-term ecological risk. (Rank = 2)	Minimal effect on human health and biological resources. No effect on cultural resources. No long-term ecological risk. Biobarrier prevents biointrusion. (Rank = 4)	Minimal effect on human health and biological resources. No effect on cultural resources. No long-term ecological risk. Biobarrier prevents biointrusion. (Rank = 4)	Significant potential short-term effect on human health and biological resources during excavation. No effect on cultural resources. No long-term ecological risk. (Rank = 3)
6. Cost **(Consent Order Ref: XI.F.10f)**	Lowest total cost. (Rank = 5)	Higher capital cost. (Rank =3)	Higher capital cost. (Rank =3)	Highest total cost. (Rank = 1)
6.1. Capital Cost	$4,450,400	$4,947,400	$7,570,400	$23,144,800
6.2. Annual Costs	$68,100	$68,100	$68,100	$63,400
6.3. Cost Estimate Present Value @ 7% 100-yr	$5,459,000	$5,958,000	$8,581,000	$23,931,000
7. Achieve Cleanup Objectives in a Timely Manner **(Consent Order Ref: XI.F.11-1)**	Timeliness is dependent on long-term release; SVE may need to continue to operate for up to 45 yr to eliminate VOC rebound (Rank = 3)	Timeliness is dependent on long-term release; SVE may need to continue to operate for up to 45 yr to eliminate VOC rebound. (Rank = 3)	Timeliness is dependent on long-term release; SVE may need to continue to operate for up to 45 yr to eliminate VOC rebound. (Rank = 3)	Waste source is removed: probably less time needed to operate SVE to remove remaining contamination (Rank = 5)

Table 9.0-1 (continued)

Criteria	1B: Improved Natural Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 2B: Engineered ET Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 5A: Engineered ET Cover, Partial Excavation, SVE, Monitoring and Maintenance (Rank 1 to 5)*	5B: Complete Waste Source Excavation, Backfilling, Off-site Disposal, SVE, Monitoring (Rank 1 to 5)*
8. Protect Human and Ecological Receptors **(Consent Order Ref: XI.F.11-2)**	HI and dose are unlikely to exceed CAOs over the 30-yr evaluation period because maintenance will correct problems. Since no ET cover, once SVE is shut off, contamination might continue. (Rank = 2)	HI and dose are unlikely to exceed CAOs over the 30-yr evaluation period because maintenance will correct problems. ET cover offers future protection after SVE shut off. (Rank = 5)	HI and dose are unlikely to exceed CAOs over the 30-yr evaluation period because maintenance will correct problems. ET cover offers future protection after SVE shut off (Rank = 5)	HI and dose may be exceeded during the construction period if a high intensity storm occurs. Greater possibility of a work accident. This alternative is most protective of groundwater. (Rank = 3)
9. Control or Eliminate the Sources of Contamination **(Consent Order Ref: XI.F.11-3)**	The existing cover would not eliminate or control sources of contamination once maintenance is discontinued after the 45-yr monitoring and maintenance period. (Rank = 2)	The cover would not eliminate sources of contamination, but would contain sources for an extended time after the 45-yr monitoring and maintenance period. The cover is optimized to prevent run-on/ infiltration of stormwater and minimize erosion potential. (Rank = 4)	The cover would not eliminate sources of contamination, but would contain sources for an extended time after the 45-yr monitoring and maintenance period. The cover is optimized to prevent run-on/ infiltration of stormwater and minimize erosion potential. (Rank = 4)	The excavation with off-site disposal would eliminate sources of contamination. However some risk exists during excavation regarding control of storm events. (Rank = 4)
10. Control Migration of Released Contaminants **(Consent Order Ref: XI.F.11-4)**	The SVE system would control migration of released contaminants during the operating period. After the operating period, however, the cover would not limit infiltration and would not reduce migration potential. (Rank = 2)	The cover would limit infiltration reducing migration potential. The SVE system would control migration of released contaminants during the operating period. (Rank = 5)	The cover would limit infiltration reducing migration potential. The SVE system would control migration of released contaminants during the operating period. (Rank = 5)	The SVE system would control migration of released contaminants during the operating period. (Rank = 4)

Table 9.0-1 (continued)

Criteria	1B: Improved Natural Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 2B: Engineered ET Cover, SVE, Monitoring and Maintenance (Rank 1 to 5)*	Alternative 5A: Engineered ET Cover, Partial Excavation, SVE, Monitoring and Maintenance (Rank 1 to 5)*	5B: Complete Waste Source Excavation, Backfilling, Off-site Disposal, SVE, Monitoring (Rank 1 to 5)*
11. Manage Remediation Waste in Accordance with State and Federal Regulations **(Consent Order Ref: XI.F.11-5)**	Minor wastes generated by SVE would easily be managed within regulations. (Rank = 4)	Minor wastes generated by SVE would easily be managed within regulations. (Rank = 4)	Significant wastes generated would be managed within regulations. (Rank = 2)	Very significant quantities of wastes generated would be more difficult to manage within regulations. (Rank = 1)
12. Benefits and Possible Hazards **(Consent Order Ref: XI.F.11)**	Lowest cost. Maintenance required for protectiveness. Not protective after 45-yr period of monitoring and maintenance. (Rank = 4)	Best balance of cost and protectiveness. (Rank = 4)	Best balance of cost and protectiveness. (Rank = 4)	Causes greatest movement of hazardous waste across public highways. Shortest time of operation for SVE and most protective of groundwater. (Rank = 3)
TOTAL (Average) SCORE	38 (3.2)	51 (4.2)	49 (4.0)	36 (3.0)

*Ranks from 1 being least beneficial to 5 being most beneficial.

Table 9.0-2
Summary of Capital and Recurring Cost Estimates for Corrective Measure Alternatives

Activity	Alt 1B Maintenance of Existing Cover	Alt 2B ET Cover with SVE	Alt 5A ET Cover, Partial Excavation, and SVE	Alt 5B Complete Excavation, Off-Site Disposal, and SVE
Study	$0	$0	$0	$0
Remedial Design	$248,900	$269,500	$412,700	$1,288,000
Site Preparation	$1,429,600	$1,429,600	$1,429,600	$1,429,600
SVE System Installation	$2,609,100	$2,609,100	$2,609,100	$2,609,100
Remedial Action Cover	$93,100	$569,500	$569,500	$0
Remedial Action Excavation	$0	$0	$2,479,800	$17,367,600
Site Restoration	$0	$0	$0	$380,800
Remedial Action Monitoring Installation	$69,700	$69,700	$69,700	$69,700
Total Capital Cost	**$4,450,400**	**$4,947,400**	**$7,570,400**	**$23,144,800**
SVE Operations (30 yr)	$4,500	$4,500	$4,500	$4,500
Cap Maintenance (100 yr)	$7,400	$7,400	$7,400	$0
Long-term Monitoring (30 yr)	$56,200	$56,200	$56,200	$58,900
Total Annual Cost	**$68,100**	**$68,100**	**$68,100**	**$63,400**
Present Value Analyses @ 3%	**$5,730,000 (100-yr)**	**$6,229,000 (100-yr)**	**$8,851,000 (100-yr)**	**$24,066,000 (100-yr)**
Present Value Analyses @ 7%	**$5,459,000 (100-yr)**	**$5,958,000 (100-yr)**	**$8,581,000 (100-yr)**	**$23,931,000 (100-yr)**
Totals + 55% Contingency	**$8,462,000**	**$9,234,000**	**$13,300,000**	**$37,094,000**

Note: Same contingency as that used at INL, “Feasibility Study for Operable Unit 7-13/14” (Holdren et al. 2000, 098642).

Table 10.0-1
Summary of Cover Specifications*

Cover Element	Criteria	Comments
Longevity		
Longevity	30 yr to 100 yr	Specified in 20 NMAC 9.1.
Cover Thickness		
Vegetation	The site is to be seeded with native vegetation composed of both cool and warm weather species (grasses).	The vegetation will help stabilize the cover surface, minimize erosion, and remove infiltrated water via transpiration. Maintenance will prevent establishment of deep-root plants. Cover will be seeded after last frost in the beginning of the second construction season.
Soil–Gravel Admixture Thickness	1.5 ft thick. The gravel is to be mixed into the cover soil at a rate of 33% by weight. The gravel will be 1.75-in. (4.4 cm) to 3-in. (7.6 cm) in diameter. This soil will be amended with nutrients and organic matter	Designed to prevent erosion during a 100-yr storm, promote ET, and resist wind erosion. Gravel will eventually form a type of “desert paving” on surface.
Minimum Amended Soil Thickness	3.5 ft (1m) thick. Hydraulic characteristics are of a typical sandy loams from the TA-61 borrow soils be amended to possess the storage capacity of this soil type. The soil depth was determined using modeling where a depth of soil was determined to minimize flux. The modeling utilized the wettest decade on record as the upper boundary condition.	Minimum cover thickness necessary to limit Infiltration to RCRA subtitle C equivalency when combined with gravel admixture.
Filter Layer	0.5 ft (0.15 m) thick. This layer is composed of sand and gravel that meet determined filter criteria to prevent the overlying finer cover soils from migrating into the underlying biobarrier. A thin layer placed directly on the bio-barrier to serve as a filter medium to prevent the overlying finer soils from migrating into the underlying bio-barrier.	A thin layer placed directly on the bio-barrier to serve as a filter medium to prevent the overlying finer soils from migrating into the underlying biobarrier.
Biobarrier	1 ft (0.3 m) thick. A layer of minimum 6-in. (15-cm) diameter cobble composed of rock or concrete. Because the site requires a 30- to 100-yr performance period, it was estimated that the added storage capacity offered by the inclusion of a biobarrier that creates a capillary barrier was more than adequate to store any infiltration events that would occur .over that period.	Cobbles prevent biointrusion of plants and animals.
Maximum Total Cover thickness	6.5 ft (2 m)	This Includes in ascending order, a biobarrier, filter layer, amended soil, and soil gravel admixture. If a biobarrier is not added, the effective cover could be increased by a minimum of 2 ft (0.6 m) of existing cover above waste.

Table 10.0-1 (continued)

Cover Element	Criteria	Comments
Cover Thickness (continued)		
Subgrade	The upper foot of existing interim cover soil shall be scarified and recompacted to a minimum of 95% of the maximum dry density and dry of the optimum moisture content as determined per ASTM D698.	This provides a firm foundation for the construction of the cover profile. Provide the final grades and slopes for installation of a uniform cover profile.
Cover Top Slopes		
Minimum Slope	2%	EPA design guidance for RCRA/CERCLA final covers, which provides for positive drainage.
Maximum Slope	4%	Maximum slope that still prevents erosion under bare soil conditions under design infiltration events. Slopes are also modeled to minimize fill yet maintain a minimum of 2 ft of existing cover above waste.
Preferred Maximum Slope	2%	Preferred maximum slope reduces erosion rate under bare soil conditions for improved longevity.
Cover Footprint Perimeter, Side Slopes, Buttresses, and Surface-Water Drainage		
Extent of Full Cover Thickness Beyond Edge of Waste	2 times cover thickness	Performance-based approach for ET covers.
Cover Geomorphology	Roofline placed to minimize upslope runon	Grading of site to the south and placement of a drainage swale prevents upslope runon. Precipitation falling on cover flows off to the northeast as sheet flow.
Side Slopes at Cover Edge	Slopes range from 10:1 to 6:1 on south side of cover. These are covered with 1.5 ft of soil gravel admixture. Slopes range 3:1 to 2:1 on North West and East sides of cover. These are covered with 1.5 ft of 1ft diameter rock armor	Variable based on site constraints. Rock armor meets NUREG durability requirements.
Waste Location	As-built drawings	Cover includes shafts, Pit A and Impoundments B through D.
Rock Buttresses	Two rock buttresses are to be placed where existing side slopes are excessive on the North side of the cover. These will have a slope of 1.5:1 and 1.5-ft diameter rock.	Rock durability meets NUREG durability requirements and provides geomorphic stability on excessive slopes.
Drainage Swales	A bifurcated drainage swale will direct surface water runon away to the east from the southern side slopes of the cap. Drainage to the north from the top of the cap will runoff side slopes as sheet flow	Prevents infiltration of upslope surface water runon adjacent to the cover.

Table 10.0-1 (continued)

Cover Element	Criteria	Comments
Cover Footprint Perimeter, Side Slopes, Buttresses, and Surface-Water Drainage (continued)		
Sediment Basin	Sediment collection swales constructed along elevation contours leading to a sediment basin that would be placed at the bottom of the cliff on the north side of the cover.	Allows collection of potentially contaminated sediments for sampling and/or removal and prevents heir dispersal into the water shed. Provides and overall evaluation of cover performance.
Retaining Wall Demotion	Approximately 250 ft of retaining wall would be demolished on the northern side of the cover.	Promotes geomorphic stability of site.

*Additional detail of specifications is provided in Appendix D.

Appendix A

Acronyms and Abbreviations, Glossary, and Metric Conversion and Data Qualifier Definition Tables

A-1.0 ACRONYMS AND ABBREVIATIONS

ACZ	acceptable compaction zone
A/E	architect-engineer
asl	above sea level
ASTM	American Society for Testing and Materials
bgs	below ground surface
B&K	Brüel and Kræjer
BH	borehole
BV	background value
CAO	corrective action objective
CFR	Code of Federal Regulations
CM	construction manager
CME	corrective measures evaluation
CMI	corrective measure implementation
COPC	chemical of potential concern
CSM	conceptual site model
CSU	container storage unit
CVOC	chlorinated volatile organic compound
CY	calendar year
D&D	decontaminated and decommissioned
DCA	dichloroethane
DCE	dichloroethylene
DL	detection limit
DOE	Department of Energy (U.S.)
EO	Executive Order
EP	Environmental Programs Directorate
EPA	Environmental Protection Agency (U.S.)
EQL	estimated quantitation limit
ESL	ecological screening level
ET	evapotranspiration
FV	fallout value
FY	fiscal year
HAZWOPER	Hazardous Waste Operations and Emergency Response
HELP	Hydrologic Evaluation of Landfill Performance

HEM	Hillslope Erosion Model
HHMSSL	human health medium specific screening level
HI	hazard index
HIR	historical investigation report
INL	Idaho National Laboratory
IR	investigation report
K	hydraulic conductivity
LA	Los Alamos
LANL	Los Alamos National Laboratory
LANS	Los Alamos National Security, LLC
LWSP	LANL Water Stewardship Program
MCL	maximum contaminant level
MDA	material disposal area
MDD	maximum dry density
MLLW	mixed low-level waste
NEPA	National Environmental Policy Act
NMAC	New Mexico Administrative Code
NMED	New Mexico Environmental Department
NMWQCC	New Mexico Water Quality Control Commission
NOAA	National Oceanic and Atmospheric Administration
O&M	operations and maintenance
OMB	Office of Management and Budget
OSHA	Occupational Safety and Health Administration
OU	operable unit
PA	performance assessment
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PET	potential evapotranspiration
PL	Public Law
PLS	pure live seed
PPE	personal protective equipment
ppm	part per million
QA	quality assurance
QC	quality control

RCRA	Resource Conservation and Recovery Act
RA	remedial action
RACER	Remedial Action Cost Engineering and Requirement
RD	remedial design
RFI	RCRA facility investigation
RME	reasonable maximum exposure
RUSLE	Revised Universal Soil Loss Equation
SIBERIA	model for predicting evolution of landforms
SL	screening level
SSL	soil screening level
SSHASP	site-specific health and safety plan
SV	screening value
SVOC	semivolatile organic compound
SVE	soil vapor extraction
SWEIS	site-wide environmental impact statement
SWMU	solid waste management unit
SWPPP	stormwater pollution prevention plan
TA	technical area
TAL	target analyte list [EPA]
T&E	threatened and endangered
TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TD	total depth
TDR	time-domain reflectometry
TRU	transuranic
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal (facilities)
UC	University of California
UMTRA	Uranium Mill Tailings Radiation Control Act
UNSAT-H	The Unsaturated Soil Water and Heat Flow Model
VA	value assessment
VOC	volatile organic compound
WBS	work breakdown structure

A-2.0 GLOSSARY

absorption—The uptake of water, other fluids, or dissolved *chemicals* by a cell or organism (e.g., tree roots absorb dissolved nutrients in *soil*).

accuracy—A measure of the closeness of measurements to the true value of the parameter being measured.

administrative controls—Nonphysical or nonengineered mechanisms for managing *risks* to human health and the environment. (Also see *institutional controls*.)

adsorption—The surface retention of solid, liquid, or gas molecules, atoms, or ions by a solid.

alluvial—Pertaining to geologic deposits or features formed by running water.

alluvium—*Soil* deposited by a river or other running water.

alpha radiation—A form of particle *radiation* that is highly ionizing and has low penetration. Alpha radiation consists of two protons and two neutrons bound together into a particle that is identical to a helium nucleus and can be written as He^{2+}.

analysis—A critical evaluation, usually made by breaking a subject (either material or intellectual) down into its constituent parts, then describing the parts and their relationship to the whole. Analyses may include physical analysis, *chemical analysis*, toxicological analysis, and knowledge-of-process determinations.

analyte—The element, nuclide, or ion a *chemical analysis* seeks to identify and/or quantify; the chemical constituent of interest.

aquifer—An underground geological formation (or group of formations) containing water that is the source of *groundwater* for wells and *springs*.

ash-flow tuff—A *tuff* deposited by a hot, dense volcanic current. Ash-flow tuff can be either *welded tuff* or nonwelded tuff.

assessment—(1) The act of reviewing, inspecting, testing, checking, conducting surveillance, auditing, or otherwise determining and documenting whether items, processes, or services meet specified requirements. (2) An evaluation process used to measure the performance or effectiveness of a system and its elements. In this glossary, assessment is an all-inclusive term used to denote any one of the following: *audit*, *performance evaluation*, management system review, *peer review*, *inspection*, or surveillance.

background concentration—Naturally occurring concentrations of an inorganic *chemical* or *radionuclide* in *soil*, *sediment*, or *tuff*.

background data—Data that represent naturally occurring concentrations of inorganic and *radionuclide* constituents in a geologic *medium*. Los Alamos National Laboratory's (the Laboratory's) background data are derived from *samples* collected at locations that are either within, or adjacent to, the Laboratory. These locations (1) are representative of geological media found within Laboratory boundaries, and (2) have not been affected by Laboratory operations.

background level—(1) The concentration of a substance in an environmental *medium* (air, water, or *soil*) that occurs naturally or is not the result of human activities. (2) In exposure *assessment*, the concentration of a substance in a defined control area over a fixed period of time before, during, or after a data-gathering operation.

background value (BV)—A statistically derived concentration (i.e., the upper tolerance limit [UTL]) of a chemical used to represent the background data set. If a UTL cannot be derived, either the detection limit or maximum reported value in the background data set is used.

basalt—A fine-grained, dark volcanic rock comprised chiefly of plagioclase, augite, olivine, and magnetite.

bentonite—An absorbent aluminum silicate clay formed from volcanic ash and used in various adhesives, cements, and ceramic fillers. Because bentonite can absorb large quantities of water and expand to several times its normal volume, it is a common drilling mud additive.

beta radiation—High-energy electrons emitted by certain types of radioactive nuclei, such as potassium-40. The beta particles emitted are a form of ionizing *radiation* also known as beta rays

blank—A s*ample* that is expected to have a negligible or unmeasurable amount of an *analyte*. Results of blank sample analyses indicate whether *field samples* might have been contaminated during the sample collection, *transport*, storage, preparation, or *analysis* processes.

borehole—(1) A hole drilled or bored into the ground, usually for exploratory or economic purposes. (2) A hole into which *casing*, screen, and other materials may be installed to construct a well.

borehole logging—The process of making remote measurements of physical, chemical, or other parameters at multiple depths in a *borehole*.

calibration—A process used to identify the relationship between the true *analyte* concentration or other variable and the response of a measurement instrument, *chemical analysis method*, or other measurement system.

calibration standard—A *sample* prepared to contain known amounts of *analytes* of interest and other constituents required for an *analysis*.

canyon—A stream-cut chasm or gorge, the sides of which are composed of cliffs or a series of cliffs rising from the canyon’s bed. Canyons are characteristic of arid or semiarid regions where downcutting by streams greatly exceeds weathering.

cap—A modern engineered landfill cover that is designed and constructed to minimize or eliminate the release of constituents into the environment.

chemical—Any naturally occurring or human-made substance characterized by a definite molecular composition, including molecules that contain *radionuclides*.

chemical analysis—A process used to measure one or more attributes of a *sample* in a clearly defined, controlled, and systematic manner. Chemical analysis often requires treating a sample chemically or physically before measurement.

chemical of potential concern (COPC)—A detected chemical compound or element that has the potential to adversely affect human receptors as a result of its concentration, distribution, and toxicity.

chemical of potential ecological concern—A detected chemical compound or element that has the potential to adversely affect ecological receptors as a result of its concentration, distribution, and toxicity.

cleanup levels—Media-specific *contaminant* concentration levels that must be met by a selected *corrective action*. Cleanup levels are established by using criteria such as the protection of human health and the environment; compliance with regulatory requirements; reduction of toxicity, mobility, or volume through *treatment*; long- and short-term effectiveness; implementability; and cost.

Code of Federal Regulations (CFR)—A *document* that codifies all rules of the executive departments and agencies of the federal government. The code is divided into 50 volumes, known as titles. Title 40 of the CFR (referenced as 40 CFR) covers environmental regulations.

colluvium—A loose deposit of rock debris accumulated through the action of gravity at the base of a cliff or *slope*.

Compliance Order on Consent (Consent Order)—For the *Environmental Restoration Project*, an enforcement *document* signed by the New Mexico Environment Department, the *U.S. Department of Energy*, and the University of California on March 1, 2005, which prescribes the requirements for *corrective action* at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of *releases* of *contaminants* at, or from, the *facility*; (2) to identify and evaluate, where needed, alternatives for *corrective measures* to clean up contaminants in the environment and prevent or mitigate the *migration* of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the *Hazardous Waste Facility Permit*.

conceptual model—See *site conceptual model*.

Consent Order—See *Compliance Order on Consent*.

contaminant—(1) Any *chemical* (including *radionuclides*) present in environmental media or on structural debris above *background levels*. (2) According to the *Compliance Order on Consent*, any *hazardous waste* listed or identified as characteristic in 40 Code of Federal Regulations (CFR) 261 (incorporated by 20.4.1.200 New Mexico Administrative Code [NMAC]); any *hazardous constituent* listed in 40 CFR 261 Appendix VIII (incorporated by 20.4.1.200 NMAC) or 40 CFR 264 Appendix IX (incorporated by 20.4.1.500 NMAC); any *groundwater* contaminant listed in the Water Quality Control Commission (WQCC) Regulations at 20.6.3.3103 NMAC; any *toxic pollutant* listed in the WQCC Regulations at 20.6.2.7 NMAC; explosive compounds; nitrate; and perchlorate. (Note: Under the *Compliance Order on Consent*, the term “contaminant” does not include radionuclides or the radioactive portion of *mixed waste*.)

corrective action—(1) In the *Resource Conservation and Recovery Act*, an action taken to rectify conditions potentially adverse to human health or the environment. (2) In the *quality assurance* field, the process of rectifying and preventing *nonconformances*. (Also see *accelerated corrective action*.)

corrective measure—An action taken at a *solid waste management unit* or *area of concern* to protect human health or the environment in the event of a *release* of *contaminants* into the environment. (Also see *accelerated corrective measure*.)

corrective measures evaluation—An evaluation of potential remedial alternatives undertaken to identify a preferred remedy that will be protective of human health and the environment and that will attain appropriate *cleanup* goals.

decontamination—The removal of unwanted material from the surface of, or from within, another material.

detect (detection)—An analytical result, as reported by an analytical laboratory, that denotes a *chemical* or *radionuclide* to be present in a *sample* at a given concentration.

detection limit—The minimum concentration that can be determined by a single measurement of an instrument. A detection limit implies a specified statistical confidence that the analytical concentration is greater than zero.

disposal— The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into, or on, any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

document—A written or pictorial compilation of information that describes, defines, specifies, reports, or certifies activities, requirements, procedures, or results (e.g., plan, report, proposal, regulatory response, *permit modification* request, document addendum or update, or procedure) and that must be submitted to the *administrative authority* or that has significance to the operations of the *Environmental Restoration Project*. Document types are shown in Quality Procedure 4.9, Document Development and Approval Process.

dose (dosage)—(1) The actual quantity of a *chemical* that is administered to an organism or to which it is exposed. (2) The amount of a substance that reaches a specific tissue (e.g., the liver). (3) The amount of a substance that is available for interaction with metabolic processes after it has crossed an organism's outer boundary.

ecological screening levels—*Soil*, sediment, or water concentrations that are used to screen for potential ecological effects. The concentrations are based on a *chemical*'s no-observed-adverse-effect level for a *receptor*, below which no *risk* is indicated.

Environmental Restoration (ER) Project— A Los Alamos National Laboratory project established in 1989 as part of a U.S. Department of Energy nationwide program, and precursor of today's Environmental Remediation and Surveillance (ERS) Program. This program is designed (1) to investigate hazardous and/or radioactive materials that may be present in the environment as a result of past Laboratory operations, (2) to determine if the materials currently pose an unacceptable risk to human health or the environment, and (3) to remediate (clean up, stabilize, or restore) those sites where unacceptable risk is still present.

evapotranspiration—(1) The discharge of water from the earth's surface to the atmosphere by evaporation from lakes, streams, and soil surfaces and by transpiration from plants. (2) The loss of water from the soil by evaporation and/or by transpiration from the plants growing in the soil.

exposure pathway—Any path from the sources of *contaminants* to humans and other species or settings via *soil*, water, or food.

facility— All contiguous land (and structures, other appurtenances, and improvements on the land) used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units. For the purpose of implementing a corrective action, a facility is all the contiguous property that is under the control of the owner or operator seeking a permit under Subtitle C of the Resource Conservation and Recovery Act.

fault—A fracture, or zone of fractures, in rock along which vertical or horizontal movement has taken place and adjacent rock layers or bodies have been displaced.

field duplicate (replicate) samples—Two separate, independent *samples* taken from the same source, which are collected as *collocated samples* (i.e., equally representative of a sample matrix at a given location and time).

gamma radiation—A form of electromagnetic, high-energy ionizing *radiation* emitted from a nucleus. Gamma rays are essentially the same as x-rays (though at higher energy) and require heavy shielding, such as concrete or steel, to be blocked.

groundwater—Interstitial water that occurs in saturated earth material and is capable of entering a well in sufficient amounts to be used as a water supply.

hazard index—The sum of hazard quotients for multiple contaminants to which a receptor may have been exposed.

hazardous constituent (hazardous waste constituent)—According to the *Compliance Order on Consent*, any constituent identified in Appendix VIII to 40 Code of Federal Regulations (CFR) 261 (incorporated by 20.4.1.200 New Mexico Administrative Code [NMAC]) or any constituent identified in 40 CFR 264, Appendix IX (incorporated by 20.4.1.500 NMAC).

hazardous waste—(1) *Solid waste* (as defined in 40 Code of Federal Regulations [CFR] 261.2) that is a listed *hazardous waste* (as provided in 40 CFR Subpart D), or a waste that exhibits any of the characteristics of hazardous waste (i.e., ignitability, corrosivity, reactivity, or toxicity, as provided in 40 CFR Subpart C). (2) According to *Compliance Order on Consent*, any solid waste or combination of solid wastes which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, meets the description set forth in New Mexico Statutes Annotated 1978, § 74-4-3(K) and is listed as a hazardous waste or exhibits a hazardous waste characteristic under 40 CFR 261 (incorporated by 20.4.1.200 New Mexico Administrative Code).

Hazardous Waste Facility Permit—The *permit* issued to Los Alamos National Laboratory (the Laboratory) by the New Mexico Environment Department that allows the Laboratory to operate as a *hazardous waste treatment*, storage, and *disposal facility*.

hydraulic conductivity—(1) A coefficient of proportionality that describes the rate at which a fluid can move through a permeable *medium*. The rate is a function of both the medium and the fluid flowing through it. (2) The quantity of water that will flow through a unit of cross-sectional area of a porous material per unit time under a *hydraulic gradient* of 1.00 (measured at right angles to the direction of flow) at a specified temperature. (Also see *unsaturated hydraulic conductivity*.)

“Hydrogeologic Workplan”—The *document* that describes the activities planned by Los Alamos National Laboratory (the Laboratory) to characterize the hydrologic setting beneath the Laboratory and to enhance the Laboratory’s *groundwater* monitoring program.

hydrogeology—The science dealing with the occurrence of surface water and *groundwater*, their utilizations, and their functions in modifying the Earth, primarily by erosion and deposition.

industrial scenario—A land-use condition in which current Los Alamos National Laboratory operations or industrial/commercial operations within Los Alamos County are continued or planned. Any necessary *remediation* involves *cleanup* to standards designed to ensure a safe and healthy work environment for workers.

infiltration—(1) The penetration of water through the ground surface into subsurface *soil*. (2) The technique of applying large volumes of wastewater to land to penetrate the surface and percolate through the underlying soil.

institutional controls—Controls that prohibit or limit access to contaminated media. Institutional controls may include use restrictions, permitting requirements, *standard operating procedures*, laboratory implementation requirements, laboratory implementation guidance, and laboratory performance requirements. (Also see *administrative controls*.)

leaching—The process by which soluble constituents are dissolved and filtered through the *soil* by a percolating fluid. (Also see *leachate*.)

Los Alamos unlimited release (LA-UR) number—A unique identification number required for all *documents* or presentations prepared for distribution outside Los Alamos National Laboratory (the Laboratory). LA-UR numbers are obtained by filling out a technical information release form (http://enterprise.lanl.gov/alpha.htm) and submitting the form together with 2 copies of the document to the Laboratory’s Classification Group (S-7) for review.

material disposal area (MDA)—A subset of all the *solid waste management units* and *areas of concern* at Los Alamos National Laboratory (the Laboratory), including trenches, pits, and shafts, that were historically designated by the Laboratory as MDAs.

matrix—Relatively fine material in which coarser fragments or crystals are embedded; also called "ground mass" in the case of igneous rocks. (Also see *sample matrix*.)

medium (environmental)—Any medium capable of absorbing or transporting constituents. Examples of media include *tuffs*, *soils* and *sediments* derived from these tuffs, surface water, *soil water*, *groundwater*, air, structural surfaces, and debris.

migration—The movement of inorganic and organic chemical species through unsaturated or saturated materials.

migration pathway—A route (e.g., a stream or subsurface flow path) for the potential movement of *contaminants* to environmental *receptors* (plants, humans, or other animals).

mixed waste—Waste containing both hazardous and source, special nuclear, or byproduct materials subject to the Atomic Energy Act of 1954. (Laboratory Implementation Requirement 404-00-03.1)

model—A schematic description of a physical, biological, or social system, theory, or phenomenon that accounts for its known or inferred properties and may be used for the further study of its characteristics.

monitoring well—(1) A well used to obtain water-quality *samples* or to measure *groundwater* levels. (2) A well drilled at a *hazardous waste* management facility or *Superfund site* to collect groundwater samples for the purpose of physical, chemical, or biological analysis and to determine the amounts, types, and distribution of *contaminants* in the groundwater beneath the site.

National Pollutant Discharge Elimination System—The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing *permits* to discharge wastewater or storm water, and for imposing and enforcing pretreatment requirements under the Clean Water Act.

nondetect—A result that is less than the *method detection limit*.

operable units (OUs)—At Los Alamos National Laboratory, 24 areas originally established for administering the *Environmental Restoration Project*. Set up as groups of *potential release sites*, the OUs were aggregated according to geographic proximity for the purposes of planning and conducting *Resource Conservation and Recovery Act (RCRA) facility assessments* and *RCRA facility investigations*. As the project matured, it became apparent that there were too many areas to allow efficient communication and to ensure consistency in approach. In 1994, the 24 OUs were reduced to 6 administrative field units.

perched water—A zone of unpressurized water held above the *water table* by impermeable rock or *sediment*.

perennial stream—Water in a channel or bed that flows continuously throughout the year.

polychlorinated biphenyls (PCBs)—Any chemical substance that is limited to the biphenyl molecule which has been chlorinated to varying degrees, or any combination that contains such substances. PCBs are colorless, odorless compounds that are chemically, electrically, and thermally stable and have proven to be toxic to both humans and other animals.

porosity—The degree to which *soil*, gravel, *sediment*, or rock is permeated with pores or cavities through which water or air can move.

quality assurance/quality control—A system of procedures, checks, *audits*, and *corrective actions* set up to ensure that all *U.S. Environmental Protection Agency* research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

quality control—See *quality assurance/quality control*.

radiation—A stream of particles or electromagnetic waves emitted by atoms and molecules of a radioactive substance as a result of nuclear decay. The particles or waves emitted can consist of neutrons, positrons, alpha particles, beta particles, or *gamma radiation*.

radioactive material—For purposes of complying with U.S. Department of Transportation regulations, any material having a specific activity (activity per unit mass of the material) greater than 2 nanocuries per gram (nCi/g) and in which the *radioactivity* is evenly distributed.

radioactive waste—Waste that, by either monitoring and *analysis*, or acceptable knowledge, or both, has been determined to contain added (or concentrated and naturally occurring) *radioactive material* or activation products, or that does not meet radiological *release* criteria.

radioactivity (radioactive decay; radioactive disintegration)—The spontaneous change in an atom by the emission of charged particles and/or gamma rays.

radionuclide—Radioactive particle (human-made or natural) with a distinct atomic weight number; can have as long a life as *soil* or water pollutants.

RCRA facility investigation (RFI)—A *Resource Conservation and Recovery Act (RCRA)* investigation that determines if a *release* has occurred and characterizes the nature and extent of contamination at a *hazardous waste facility*. The RFI is generally equivalent to the remedial investigation portion of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

receptor—A person, other animal, plant, or geographical location that is exposed to a chemical or physical agent released to the environment by human activities**.**

recharge—The process by which water is added to a zone of saturation, usually by *percolation* from the *soil* surface (e.g., the recharge of an *aquifer*).

record—Any book, paper, map, photograph, machine-readable material, or other documentary material, regardless of physical form or characteristics.

regional aquifer—Geologic material(s) or unit(s) of regional extent whose saturated portion yields significant quantities of water to wells, contains the regional zone of saturation, and is characterized by the regional *water table* or *potentiometric surface*. (Also see *aquifer*.)

release—Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, *leaching*, dumping, or disposing of *hazardous waste* or *hazardous constituents* into the environment.

remediation—(1) The process of reducing the concentration of a *contaminant* (or contaminants) in air, water, or *soil* media to a level that poses an acceptable *risk* to human health and the environment. (2) The act of restoring a contaminated area to a usable condition based on specified standards.

remediation waste— All solid wastes and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris, that are managed for implementing cleanup.

Resource Conservation and Recovery Act—The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (Public Law [PL] 94-580, as amended by PL 95-609 and PL 96-482, United States Code 6901 et seq.).

risk—A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

risk assessment—See *baseline risk assessment.*

runoff—The portion of the precipitation on a drainage area that is discharged from the area either by sheet flow or adjacent stream channels.

run-on—Surface water flowing onto an area as a result of runoff occurring higher up the slope.

sample—A portion of a material (e.g., rock, *soil*, water, or air), which, alone or in combination with other portions, is expected to be representative of the material or area from which it is taken. Samples are typically either sent to a laboratory for *analysis* or *inspection* or are analyzed in the field. When referring to samples of environmental media, the term *field sample* may be used.

sediment—(1) A mass of fragmented inorganic solid that comes from the weathering of rock and is carried or dropped by air, water, gravity, or ice. (2) A mass that is accumulated by any other natural agent and that forms in layers on the Earth's surface (e.g., sand, gravel, silt, mud, fill, or loess). (3) A solid material that is not in solution and is either distributed through the liquid or has settled out of the liquid.

site—An area or place that falls under the jurisdiction of the *U.S. Environmental Protection Agency* and/or a state for *corrective action*.

site conceptual model—A qualitative or quantitative description of sources of contamination, environmental *transport* pathways for contamination, and *receptors* that may be impacted by contamination and whose relationships describe qualitatively or quantitatively the *release* of contamination from the sources, the movement of contamination along the pathways to the exposure points, and the uptake of *contaminants* by the receptors.

slope—A ratio of units of elevation change to units of horizontal change, usually expressed in degrees.

soil—A sample media group that includes soil and can include artificial fill materials. "Soil" refers to a material that overlies bedrock and has been subject to soil-forming processes. The sample media group of soil includes soils from all soil horizons.

soil moisture—The water contained in the pore space of the *unsaturated zone*.

soil screening level (SSL)—The concentration of a *chemical* (inorganic or organic) below which no potential for unacceptable *risk* to human health exists. The derivation of an SSL is based on conservative exposure and land-use assumptions, and on target levels of either a *hazard quotient* of 1.0 for a noncarcinogenic chemical or a cancer risk of 10^{-5} for a carcinogenic chemical.

solid waste—Any garbage, refuse, or sludge from a waste *treatment* plant, water-supply treatment plant, or air-pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from *community* activities. Solid waste does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial *discharges* which are point sources subject to *permits* under section 402 of the Federal Water Pollution Control Act, as amended; or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended.

solid waste management unit (SWMU)—(1) Any discernible site at which *solid wastes* have been placed at any time, whether or not the site use was intended to be the management of solid or hazardous waste. SWMUs include any site at a *facility* at which solid wastes have been routinely and systematically released. This definition includes regulated sites (i.e., landfills, surface impoundments, waste piles, and land *treatment* sites), but does not include passive leakage or one-time spills from production areas and sites in which wastes have not been managed (e.g., product storage areas). (2) According to the *Compliance Order on Consent*, any discernible site at which solid waste has been placed at any time, and from which NMED determines there may be a *risk* of a release of *hazardous waste* or hazardous waste constituents (*hazardous constituents*), whether or not the site use was intended to be the management of solid or hazardous waste. Such sites include any area in Los Alamos National Laboratory at which solid wastes have been routinely and systematically released; they do not include one-time spills.

stratigraphy—The study of the formation, composition, and sequence of *sediments*, whether consolidated or not.

surface sample—A *sample* taken at a collection depth that is (or was) representative of the *medium*'s surface during the period of investigative interest. A typical depth interval for a surface sample is 0 to 6 in. for mesa-top locations, but may be up to several feet in *sediment*-deposition areas within *canyons*.

surrogate (surrogate compound)—An organic compound used in the analyses of organic *target analytes* which is similar in composition and behavior to the target analytes but is not normally found in *field samples*. Surrogates are added to every *blank* and spike *sample* to evaluate the efficiency with which *analytes* are being recovered during extraction and *analysis*.

target analyte—A *chemical* or parameter, the concentration, mass, or magnitude of which is designed to be quantified by a particular test method.

technical area (TA)—At Los Alamos National Laboratory, an administrative unit of operational organization (e.g., TA-21).

topography—The physical or natural features of an object or entity and their structural relationships.

transport (transportation)—(1) The movement of a hazardous waste by air, rail, highway, or water. (2) The movement of a contaminant from a source through a medium to a receptor.

treatment— Any method, technique, or process, including elementary neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, recover energy or material resources from the waste, or to render such waste nonhazardous or less hazardous; safer to transport, store, or dispose of; or amenable for recovery or storage; or reduced in volume.

treatment, storage, and disposal facility—An interim-status or permitted facility in which *hazardous waste* is treated, stored, or disposed.

trend analysis—An analytical or graphical representation used to identify the changes in a variable as it is measured over a period of time.

trip blank—A *sample* of *analyte*-free medium taken from a sampling *site* and returned to an analytical laboratory unopened, along with samples taken in the field; used to monitor cross contamination of samples during handling and storage both in the field and in the analytical laboratory.

tuff—Consolidated volcanic ash, composed largely of fragments produced by volcanic eruptions.

UNSAT-H—A FORTRAN computer code used to simulate the one-dimensional flow of water, vapor, and heat in soils. The code addresses the processes of precipitation, evaporation, plant transpiration, storage, and deep drainage.

unsaturated hydraulic conductivity—A coefficient that describes the rate at which a fluid can potentially move through a permeable, unsaturated *medium*. (Also see *hydraulic conductivity*.)

unsaturated zone—The area above the *water table* where *soil* pores are not fully saturated, although some water may be present.

U.S. Department of Energy—The federal agency that sponsors energy research and regulates nuclear materials for weapons production.

U.S. Environmental Protection Agency (EPA)—The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure the protection of human health and the environment.

vadose zone— The zone between the land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore space also typically contains air or other gases. The capillary fringe is included in the vadose zone.

water content— The amount of water in an unsaturated medium, expressed as the ratio of the weight of water in a sample to the weight of the oven-dried sample (often expressed as a percentage).

watershed—A region or basin drained by, or contributing waters to, a river, stream, lake, or other body of water and separated from adjacent drainage areas by a divide, such as a mesa, ridge, or other geologic feature.

water table—The top of the regional saturated zone; the *piezometric surface* associated with an *unconfined aquifer*.

welded tuff—A volcanic deposit hardened by the action of heat, pressures from overlying material, and hot gases.

work plan—A *document* that specifies the activities to be performed when implementing an investigation or remedy. At a minimum, the work plan should identify the scope of the work to be performed, specify the procedures to be used to perform the work, and present a schedule for performing the work. The work plan may also present the technical basis for performing the work.

A-3.0 METRIC CONVERSION TABLE

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

A-4.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B

Public Involvement Plan for
Material Disposal Areas L and G

Public Involvement Plan for MDA L and MDA G

PUBLIC INVOLVEMENT PLAN

Table of Contents

Purpose of This Plan

Design and plan a series of public involvement opportunities, including events, to keep the public informed investigation outcomes and remedy options for MDA L and MDA G. This is a living document which will be updated as the plan progresses.

Primary Contacts

Name	Organization	Phone	Email	Role
LANL				
Steven M. Paris	Corrective Actions	606-0915	smparis@lanl.gov	Project Leader
Joe Ritchey	Pro2Serve	661-9780 x258	ritcheyj@p2s.com	Author
Joe English		667-9641	cnglish@lanl.gov	Moderator
Phil Stauffer		665-4638	stauffer@lanl.gov	Moderator
Jerry O'Leary		606-1788	goleary@lanl.gov	Program Director, TWDP
Bruce Palmer		665-5663	bpalmer@lanl.gov	Deputy Program Director, TWDP
Gordon Dover	Corrective Actions	665-4681	gldover@lanl.gov	Program Director, CAP
Dave McInroy	Corrective Actions	667-4400	mcinroy@lanl.gov	Deputy Program Director, CAP
Jim Rickman	Media Relations	665-9203	elvis@lanl.gov	Communications lead
Lorrie Bonds Lopez	ADEP	667-0216	lorriel@lanl.gov	Outreach project lead
Deb Hall	ADEP	667-4371	dhall@lanl.gov	Outreach coordinator
DOE				
Edwin P. Worth	LASO	845-5746	EWorth@doeal.gov	
David Gregory	LASO	667-5808	dgregory@doeal.gov	
Bernie Pleau	LASO	667-6691	bpleau@doeal.gov	
George Rael	LASO	606-0397	grael@doeal.gov	
NM Environment Department				
David Cobrain				
Public				
Accord Pueblos				
LA County Council Members				

Goals for Overall Outreach

1. Meet regularly with stakeholders and opinion leaders to report on status and explain issues related to key sites and to listen carefully to community concerns;
2. Collect comments and concerns from citizens on investigation and remedy selection;
3. Ensure that a broad range of citizens are included in meetings;
4. Use a range of locales for public involvement sessions;
5. Involve media to ensure that the laboratory's activities are broadly understood;
6. Address comments and concerns on web and in future meetings;
7. Make a targeted effort to inform accord pueblos; and
8. Obtain public input for closure alternatives.

Drivers for This Public Involvement

DOE/NMED Order on Consent
LANL Hazardous Waste Permit
Informed consent of the public

Target Audience

Target audience	Expected Level of involvement [1]	Possible audience questions and issues
Internal Audience		
Residents who are employees	Consult	
External Audience		
Northern New Mexico Citizen Action Board (NNMCAB)	Collaborate	
White Rock residents	Consult	
Pueblos	Consult	
Los Alamos County	Collaborate	

Project Specific Key Messages

General	• We want public input on remedy alternatives. • LANL performs the investigation and the work on the remedy, determining remedy options. • NMED chooses the final remedy. • All applicable standards are being and will be met.
MDA L	• Part of the site will remain in operation for hazardous waste characterization and staging. • The MDA will be ready for remedy and closure by 2010.
MDA G	• The existing Area G site will be ready for remedy evaluation, remedy selection and closure by 2015. • A new low level waste disposal area is being developed in Zone 4 and is not the subject of this outreach.

Types of Outreach to Use

Opportunity	Frequency
Public Meetings	1. February 2007 2. Attend NMED meeting for remedy selection 3. After remedy selection to inform public of: • Transportation options for 50K truckloads of material for cover • Construction implementation of cover
Web information	Available by February 2007and updated as needed
Mailer to NMED facility list	2 weeks prior to each public meeting
Investigation Report placed in the reading room and on kiosk	When completed
Press releases	When cover is installed [completed implies vegetation established]
Presentations to the NNMCAB	

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[1] "Inform" means information dissemination only; "Consult" means to collect and respond to comments and concerns, "Involve" means use stakeholder input in decisions; "Collaborate" means to ask for direct advice on solutions and to incorporate such; "Empower" means that stakeholders make the decisions.

Key Outreach Milestones

Milestone	Due
Website complete	February 1, 2007
Fact sheets complete	February 1, 2007
Posters complete	February 15, 2007
Public Information Update for MDA L and MDA G	Week of February 28, 2007
NMED Public Comment Period	TBD
Public Information Update for MDA L and MDA G	After NMED remedy selection

Resources: Posters & Handouts

Posters	Handouts
Area G 1. *Site general* 2. *Site investigation—radiological* 3. *Site investigation—chemical* 4. *Cover Alternatives* 5. *Other remedy alternatives* *Area L* 6. *Investigation Report* 7. *SVE alternative* 8. *Remedy Alternatives* *Other* 9. *TRU* 10. *Environmental Remediation at LANL*	• Copy of each poster • MDA G Fact Sheet • MDA L Fact Sheet • Suggestion cards for input on remedy alternatives • Feedback on meeting cards

First Public Meeting Details

Date	February 2007	Catering	None
Venue	Fuller Lodge	Audio Visual Vendor	Santa Fe Audio Visual
Moderator	None	Transportation Vendor	N/A
Speakers	Gordon Dover	Dry Run Date	January 2007

Planning

✓ = Needed   Ø = Not needed

Publicity	Logistics	Audio Visual Needs	Participants
Display Ads ✓	Table Moderators: 7	Microphones & Mixer ✓	Number expected 50
Radio Ø	Posters: 9	Projectors ✓	Room set up: 7 table stations, speaker area
Press Release Ø	Comment Cards ✓	Computer ✓	Special Needs
Mailings ✓	Evaluation Sheets ✓	Recording Ø	Transportation: Ø
Email ✓	Dry Run ✓	Screen ✓	Parking: At facility

Overall Moderator		Gordon Dover
Table	Posters	Moderator
Area G General & Investigation	1,2,3	Steven M. Paris
Area G Cover Alternatives	4	Steve Dwyer
Other Area G Remedy Alternatives	5	Joe Ritchey
Area L General & Investigation	6	Joe English
Area L SVE alternative	7	Phil Stauffer
Area L Remedy Alternatives	8	Shanon Goldberg
TRU	9	Jerry O'Leary or Bruce Palmer

Public Meeting Agenda

Time	Event	Speaker/Facilitator/Moderator/MC
5:00	Poster sessions setup at tables	
5:30	Open	
6:00	Welcome, introductions	Gordon Dover
6:15	Round table discussions	Table moderators
6:45	Welcome, introductions	Gordon Dover
7:00	Continue round table discussions	Table moderators
7:30	Closing	Gordon Dover
8:00	End Poster session	

Project Evaluation

Notes

Second Public Meeting Details

Date		Catering	
Venue		Audio Visual Vendor	
Moderator		Transportation Vendor	

Planning

Publicity	Logistics	Audio Visual Needs	Participants
Display Ads	Speakers	Microphones & Mixer	Number expected
Radio	Posters	Projectors	Room set up
Press Release	Comment Cards	Computer	Special Needs
Mailings	Evaluation Sheets	Recording	Transportation
Email	Dry Run	Screen	Parking

Public Meeting Agenda

Time	Event	Speaker/Facilitator/Moderator/MC

Project Evaluation

Notes

Third Public Meeting Details

Date		Catering	
Venue		Audio Visual Vendor	
Moderator		Transportation Vendor	

Planning

Publicity	Logistics	Audio Visual Needs	Participants
Display Ads	Speakers	Microphones & Mixer	Number expected
Radio	Posters	Projectors	Room set up
Press Release	Comment Cards	Computer	Special Needs
Mailings	Evaluation Sheets	Recording	Transportation
Email	Dry Run	Screen	Parking

Public Meeting Agenda

Time	Event	Speaker/Facilitator/Moderator/MC

Project Evaluation

Notes

Appendix C

Source Term and Batch Waste Source Term Databases for Material Disposal Area L (excerpted from the Operable Unit 1148 Data Report, September 1992)

3.0 Technical Area 54, Area L

3.1 Source Term Data Base Information

3.1.1 Assumptions

The TA-54, Area L, source term data base was constructed from the original waste disposal records found in the TA-54, Area L, logbooks. The inconsistent and often incomplete nature of the original logbook entries required that assumptions be made in order to build the data base effectively. The assumptions used in this section are as follows:

1. Shafts were "active" (i.e., receiving waste) during the entire month they were being drilled.
2. Shafts were "inactive" during the entire month they were being capped.
3. Logbook entries indicating disposal of a material into an inappropriate shaft (e.g., oil into an inorganic shaft) were considered valid.
4. An entry of "0.0000" under "VOLCUFT" indicated a value of zero or a volume of <0.0001 ft^3.
5. When two disposal dates were given, the date associated with the disposal site was used.
6. Disposal locations from logbook entries indicating disposal into a pit or shaft that was not "active" on the date of disposal were considered invalid.
7. When a logbook entry listed only one volume for disposal of multiple items and no disposal location was specified, only one record with a single volume amount was entered in the data base.
8. When a logbook entry listed only one volume for disposal of multiple items and a disposal location was specified for at least one of the multiple items, the volume amount was equally divided between all of the items and multiple records were entered in the data base.
9. When a logbook entry listed only one date with multiple items and provided a volume amount for each item, multiple records were entered in the data base.
10. When a logbook entry indicated disposal of acids or bases into Shaft No. 1, at a time when Shaft No. 1 was "inactive," Shaft No. 2 was entered into the data base.

11. Only logbook entries that specified a unique disposal location were assigned a "Y" in the location field.

3.1.2 Definitions

The definitions of the fields and field variables used in the TA-54, Area L, source term data base are as follows:

ID	The sequential number assigned to a record.
MO	The month of the record; "00" indicates no month was given.
DY	The day of the record; "00" indicates no day was given.
YR	The year of the record; "00" indicates no year was given.
VOLCUFT	The volume of material disposed of (in cubic feet).
WGT	The weight of material disposed of (in pounds).
ITM	The number of cylinders or waste items disposed of.
SHAFT	Specific shaft number.
PIT	Specific pit letter.
DESCRIP	Description of the waste material.
CHEM TYPE	Indicates chemical type—"I" for inorganics, "O" for organics, "M" for metals, or "NA" for insufficient information. A star ("*") indicates an assumed designation.
RCRA CHAR	Indicates Resource Conservation and Recovery Act (RCRA) designation—"I" for ignitable, "C" for corrosive, "R" for reactive, "T" for EP toxic, "NA" for insufficient information, or "TBD" for not yet determined. A star ("*") indicates an assumed designation.
PHYS PHAS	Indicates physical form—"S" for solid, "L" for liquid, "V" for vapor, or "NA" for insufficient information. A star ("*") indicates an assumed designation.
LOC	"Y" indicates that a disposal unit was designated; "N" indicates no disposal unit was not designated.

3.1.3 Data Base

The TA-54, Area L, source term data base is provided at the end of this section.

3.2 Batch Waste Source Term Data Base Information

3.2.1 Assumptions

All available waste disposal records were used to compile the information contained in the TA-54, Area L, batch waste source term data base. In most cases, information was entered into the data base as it appears in logbook records. In some cases an interpretation of original record information was necessary to derive the maximum amount of information from existing records. Where interpretations were necessary (e.g., some chemical compound names required examination to discern the intended meaning of the technician), notes were inserted in the original records. The assumptions used for this section are as follows:

1. When only one volume was written in an entry line and that entry line was followed by others that did not indicate a volume, volume was entered for the first entry only.

2. An entry "0.0000" in the volume field indicates that no volume was given for that record or that the procedure outlined in Item 1 above had been followed. The same procedure applies to MO, DY, and YR fields, as indicated by "00".

3. The date entered in the data base is the <u>date of disposal</u> unless the date of disposal was not listed. In the event that date of disposal was not listed in the records, the <u>date received</u> was used if it was available.

4. If a pit or shaft number was indicated, a "Y" was entered in the LOCATION field indicating that the disposal location is known. If no pit or shaft number was given in the record, an "N" was entered in the LOCATION field indicating that the disposal location is not known.

5. Discrepancies exist between column headings used for information entry in the original records. There are two different forms used to record waste disposal information. The following assumptions were made to correlate information from one recording format to the other.

   - A column heading "SOURCE" is equivalent to "ORIGIN".
   - A column heading "CONTENT" is equivalent to "ANALYSIS".
   - A column heading "REMARKS" is equivalent to "AMOUNT".

3.2.2 Definitions of the Fields and Field Variables

ID	The sequential number assigned to a record.
MO	The month of the record ("00" was entered if no month was given).

DY	The day of the record ("00" was entered if no day was given).
YR	The year of the record ("00" was entered if no year was given).
VOLCUFT	Volume of material disposed of (in cubic feet).
SOURCE	Source location of material disposed of.
PIT	Specific pit letter.
SHAFT	Specific shaft number.
CONTENT	Description of the waste material.
WASTE TYPE	Indicates waste type—"I" for inorganics, "O" for organics, and "M" for metals.
PHYSPHASE	Denotes physical form—"S" for solid or "L" for liquid.
LOCATION	This logical field returns a "Y" if a disposal unit was designated or an "N" if a disposal unit was not designated.
HAZCHAR	RCRA characteristic designation.
RADIOACTIV	"YES" indicates radioactive material.
TREATMENT	Treatment applied to the waste.

3.2.3 Data Base

The TA-54, Area L, batch waste source term data base follows the source term data base at the end of this section.

SOURCE TERM DATA BASE

Page No. 1
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1	7	00	80	0.0000	120.0000	0			CAPACITORS	O	TBD	L	N
2	8	00	80	2.4100	0.0000	0			INORGANIC	I	NA	NA	N
3	8	00	80	3.8900	0.0000	0			ORGANIC	O	NA	L	N
4	08	00	80	68.0700	0.0000	0			ACIDS & BASES	I/O	C*	L	N
5	08	00	80	22.3800	0.0000	0			OIL	O	TBD	L	N
6	08	00	80	2.8000	0.0000	0			CARCINOGEN WASTE	O*	TBD	NA	N
7	08	00	80	4.0000	0.0000	0			BERYLLIUM WASTE	M	TBD	S	N
8	08	00	80	0.0500	0.0000	0			MERCURY	M	T	S*	N
9	08	00	80	16.7500	0.0000	0			POTASSIUM CYANIDE	I	R	S	N
10	08	00	80	0.0000	2.2000	0			SODIUM	I/M	R	S	N
11	09	00	80	11.0000	0.0000	0			INORGANICS	I	NA	NA	N
12	09	00	80	22.0000	0.0000	0			ORGANICS	O	NA	L	N
13	09	00	80	73.7000	0.0000	0			OIL	O	TBD	L	N
14	09	00	80	9.0000	0.0000	0			ACIDS & BASES	I/O	C*	L	N
15	09	00	80	2.0100	0.0000	0			WATER/ASBESTOS	I/M	TBD	L	N
16	09	00	80	2.0000	0.0000	0			FLUORINE CYLINDERS	I	TBD	V	N
17	09	00	80	2.0000	0.0000	0			SODIUM	I/M	R	S	N
18	10	00	80	16.0000	0.0000	0			INORGANIC	I	NA	NA	N
19	10	00	80	29.5000	0.0000	0			ORGANIC	O	NA	L	N
20	10	00	80	14.7400	0.0000	0			OIL	O	TBD	L	N
21	10	00	80	7.9100	0.0000	0			ACIDS & BASES	I/O	C*	L	N
22	10	00	80	14.0000	0.0000	0			ASBESTOS	I	TBD	S	N
23	10	00	80	14.0000	0.0000	0			METAL	M	NA	S	N
24	10	00	80	0.0100	0.0000	0			MERCURY	M	T	S*	N
25	10	00	80	14.7400	0.0000	0			HYDROGEN CYANIDE	I	I/R	L	N
26	10	00	80	2.8000	0.0000	0			CARCINOGEN	O*	TBD	NA	N
27	11	00	80	3.0000	0.0000	0			INORGANIC	I	NA	NA	N
28	11	00	80	5.0000	0.0000	0			ORGANIC	O	NA	L	N
29	11	00	80	4.8200	0.0000	0			ACID	I/O	C*	L	N
30	11	00	80	8.0000	0.0000	0			OIL	O	TBD	L	N
31	11	00	80	0.0000	0.0000	5			CYLINDERS	NA	NA	V	N
32	11	00	80	0.0500	0.0000	0			MERCURY	M	T	S*	N
33	11	00	80	0.0000	0.0000	1			IGNITRON	M	T	S*	N
34	11	00	80	0.0000	0.0000	3			PLASTIC & PYREX CONTAINERS	I	TBD	S	N
35	03	00	80	99.2900	0.0000	0			OIL	O	TBD	L	N
36	03	00	80	17.0000	0.0000	0			ASBESTOS	I	TBD	S	N
37	03	00	80	0.0000	0.0000	112			CYLINDERS	NA	NA	V	N
38	03	00	80	0.1600	0.0000	0			MERCURY	M	T	S*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 2
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
39	03	00	80	20.0000	0.0000	0			MISC.	NA	NA	NA	N
40	04	00	80	2.6800	0.0000	0			ORGANIC	O	NA	L	N
41	04	00	80	2.6800	0.0000	0			INORGANIC	I	NA	NA	N
42	04	00	80	0.0000	7400.0000	0			METAL	M	NA	S	N
43	04	00	80	28.1400	0.0000	0			ACID	I/O	C*	L	N
44	04	00	80	0.0900	0.0000	0			MERCURY	M	T	S*	N
45	04	00	80	0.0000	0.0000	5			CYLINDERS	NA	NA	V	N
46	04	00	80	20.0000	0.0000	0			ASBESTOS	I	TBD	S	N
47	04	00	80	53.6000	0.0000	0			OIL	O	TBD	L	N
48	05	00	80	13.2700	0.0000	0			ORGANIC	O	NA	L	N
49	05	00	80	0.0000	265.0000	0			INORGANIC	I	NA	NA	N
50	05	00	80	19.0000	0.0000	0			BERYLLIUM	M	TBD	S	N
51	05	00	80	73.0300	0.0000	0			ACIDS	I/O	C*	L	N
52	05	00	80	0.1700	0.0000	0			MERCURY	M	T	S*	N
53	05	00	80	118.5900	0.0000	0			OIL	O	TBD	L	N
54	05	00	80	0.0000	0.0000	7			CYLINDERS	NA	NA	V	N
55	06	00	80	11.5200	0.0000	0			ORGANICS	O	NA	L	N
56	06	00	80	7.7700	0.0000	0			INORGANICS	I	NA	NA	N
57	06	00	80	0.0000	55.0000	0			METAL	M	NA	S	N
58	06	00	80	73.7000	0.0000	0			OIL	O	TBD	L	N
59	06	00	80	0.0000	43.0000	0			MERCURY	M	T	S*	N
60	06	00	80	7.0000	0.0000	0			ASBESTOS	I	TBD	S	N
61	06	00	80	15.8100	0.0000	0			ACID	I/O	C*	L	N
62	07	00	80	10.3200	0.0000	0			ORGANIC	O	NA	L	N
63	07	00	80	3.3500	0.0000	0			INORGANIC	I	NA	NA	N
64	07	00	80	0.1000	0.0000	0			LITHIUM	M	R	S*	N
65	07	00	80	0.0170	0.0000	0			BERYLLIUM	M	TBD	S	N
66	07	00	80	67.0000	0.0000	0			OIL	O	TBD	L	N
67	07	00	80	3.0000	0.0000	0			ASBESTOS	I	TBD	S	N
68	07	00	80	33.6300	0.0000	0			ACID	I/O	C*	L	N
69	09	00	79	24.0000	0.0000	0			ORGANICS	O	NA	L*	N
70	09	00	79	10.0000	0.0000	0			INORGANICS	I	NA	NA	N
71	09	00	79	0.1400	0.0000	0			MERCURY	M	T	S*	N
72	09	00	79	4.0000	0.0000	0			ASBESTOS	I	TBD	S	N
73	09	00	79	0.0000	21.0000	0			METAL	M	NA	S	N
74	09	00	79	22.0000	0.0000	0			OIL	O	TBD	L	N
75	09	00	79	3.0000	0.0000	0			ACID	I/O	C*	L	N
76	09	00	79	3.0000	0.0000	0			CARADE ZINC LIQUID	I	TBD	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

ge No.   3
/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
77	11	00	79	3.6200	0.0000	0			ACID	I/O	C*	L	N
78	11	00	79	9.6500	0.0000	0			ORGANICS	O	NA	L*	N
79	11	00	79	0.3000	0.0000	0			INORGANICS	I	NA	NA	N
80	11	00	79	76.2500	0.0000	0			OIL	O	TBD	L	N
81	11	00	79	7.0000	0.0000	0			ASBESTOS	I	TBD	S	N
82	12	00	79	1.8800	0.0000	0			ACIDS & BASES	I/O	C*	L	N
83	12	00	79	6.7000	0.0000	0			ORGANICS	O	NA	L*	N
84	12	00	79	40.0000	0.0000	0			INORGANICS	I	NA	NA	N
85	12	00	79	69.6800	0.0000	0			OIL	O	TBD	L	N
86	12	00	79	1.0000	0.0000	0			MAGNESIUM	M	TBD	S	N
87	12	00	79	1.0000	0.0000	0			MERCURY	M	T	S*	N
88	12	00	79	1.0000	0.0000	0			LITHIUM	M	R	S	N
89	12	00	79	16.0000	0.0000	0			ASBESTOS	I	TBD	S	N
90	01	00	80	600.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
91	01	00	80	150.0000	0.0000	0			BERYLLIUM, LITHIUM, MAGNESIUM, SODIUM	M	R	S	N
92	01	00	80	0.0000	0.0000	225			1 GAL EMPTY CYLINDERS	NA	NA	S	N
93	02	00	80	216.1400	0.0000	0			ORG & INORG LIQUID WASTE	I/O	NA	L	N
94	02	00	80	0.0000	328.0000	0			BARIUM NITRATE	I	T	S	N
95	02	00	80	17.0000	0.0000	0			BERYLLIUM, LITHIUM, MAGNESIUM	M	R	S	N
96	02	00	80	20.0000	0.0000	0			ASBESTOS	I	TBD	S	N
97	02	00	80	16.3500	0.0000	0			OIL	O	TBD	L	N
98	03	00	80	327.0000	0.0000	0			ORGANIC	O	NA	L*	N
99	03	00	80	234.0000	0.0000	0			INORGANIC	I	NA	NA	N
100	03	00	80	300.0000	0.0000	0			BARIUM NITRATE	I	T	S	N
101	03	00	80	0.0000	58.0000	0			METAL	M	NA	S	N
102	03	00	80	180.7700	0.0000	0			ACID	I/O	C*	L*	N
103	07	16	79	3.0000	0.0000	0			CHEMICALS	I/O	NA	NA	N
104	07	17	79	2.0000	0.0000	0			LEAD NITRATE	I	TBD	S	N
105	07	18	79	5.0000	0.0000	0			CHEMICALS; PIPE CONTAMINATED WITH SODIUM	I	R	NA	N
106	07	19	79	3.0000	0.0000	0			ORGANICS	O	NA	L	N
107	07	19	79	2.0000	0.0000	0			INORGANICS	I	NA	NA	N
108	07	19	79	0.1100	0.0000	0			MERCURY	M	T	S*	N
109	07	23	79	20.0000	0.0000	0			SULFURIC ACID	I	C	L	N
110	07	23	79	20.0000	0.0000	0			ORGANICS	O	NA	L	N
111	07	25	79	0.0350	0.0000	0			MERCURY	M	T	S*	N
112	07	25	79	24.0000	0.0000	0			ORGANICS	O	NA	L	N
113	07	25	79	1.0000	0.0000	0			ACID	I/O	C	L	N
114	07	25	79	2.0000	0.0000	0			INORGANICS	I	NA	NA	N

BENCHMARK ENVIRO

age No. 4
0/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
115	07	25	79	2.0000	0.0000	0			ORGANICS	O	NA	L	N
116	08	00	79	24.0000	0.0000	0			OIL	O	TBD	L	N
117	08	00	79	38.0000	0.0000	0			ORGANIC	O	NA	L	N
118	08	00	79	11.0000	0.0000	0			INORGANIC	I	NA	NA	N
119	08	00	79	1.0000	0.0000	0			METAL	M	NA	S	N
120	08	00	79	27.0000	0.0000	0			ASBESTOS	I	TBD	S	N
121	08	00	79	48.0000	0.0000	0			OIL	O	TBD	L	N
122	10	00	79	31.8900	0.0000	0			ACID	I/O	C	L	N
123	10	00	79	3.0000	0.0000	0			INORGANICS	I	NA	NA	N
124	10	00	79	0.0000	500.0000	0			BARIUM NITRATE	I	T	S	N
125	10	00	79	21.3100	0.0000	0			ORGANICS	O	NA	L	N
126	10	00	79	2.0000	0.0000	0			MERCURY	M	T	S	N
127	10	00	79	10.0000	0.0000	0			ASBESTOS	I	TBD	S	N
128	10	00	79	2.0000	0.0000	0			BERYLLIUM CONTAMINATED WASTE	M	TBD	S	N
129	10	00	79	0.0000	0.0000	10			10 EMPTY DRUMS	NA	NA	S	N
130	10	00	79	29.4800	0.0000	0			CHROMIC ACID SOLUTION	I	C	L	N
131	05	01	79	3.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
132	05	03	79	2.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
133	05	04	79	6.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
134	05	09	79	5.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
135	05	14	79	7.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
136	05	14	79	33.0000	0.0000	0			NITRIC ACID	I	C	L	N
137	05	14	79	454.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
138	05	23	79	5.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
139	05	24	79	9.0000	0.0000	0			METAL	M	NA	S	N
140	05	25	79	5.0000	0.0000	0			CHEMICALS & BERYLLIUM CONTAMINATED WOOD	I/O/M	NA	S	N
141	05	29	79	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
142	05	30	79	130.0000	0.0000	0			OIL DRUMS, CHEMICALS	NA	NA	NA	N
143	05	31	79	20.0000	0.0000	0			ASBESTOS	I	TBD	S	N
144	06	05	79	31.0000	0.0000	0			OIL, SPECIAL TUBES, CAPACITORS	NA	NA	NA	N
145	07	02	79	4.0000	0.0000	0			ORGANICS	O	NA	L	N
146	07	02	79	2.0000	0.0000	0			INORGANICS	I	NA	NA	N
147	07	05	79	2.0000	0.0000	0			ASBESTOS	I	TBD	S	N
148	07	05	79	4.0000	0.0000	0			ORGANICS	O	NA		N
149	07	05	79	1.0000	0.0000	0			INORGANICS	I	NA	NA	N
150	07	10	79	5.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
151	07	10	79	21.0000	0.0000	0			BARIUM	M	T	S	N
152	07	11	79	1.0000	0.0000	0			MERCURY BOTTLE	M	T	S	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 5
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	NO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
153	07 11 79	30.0000	0.0000	0			BERYLLIUM METALS	M	TBD	S	N
154	07 13 79	4.0000	0.0000	0			GAS WITH WATER	O	TBD	L	N
155	07 13 79	4.0000	0.0000	0			MERCURY	M	T	S*	N
156	07 13 79	4.0000	0.0000	0			OIL	O	TBD	L	N
157	03 08 79	3.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
158	03 12 79	1.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
159	03 14 79	26.0000	0.0000	0	02		CHROMIC SULFURIC ACIDS	I	C	L	Y
160	03 14 79	10.0000	0.0000	0	02		STRIPPING SOLUTION	O	NA	L	Y
161	03 14 79	20.0000	0.0000	0			CHLORETHANE	O	I	V	N
162	03 21 79	9.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
163	03 27 79	330.0000	0.0000	0			OIL	O	TBD	L	N
164	04 06 79	30.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
165	04 06 79	0.0000	0.0000	1			ONE CYLINDER SULFURIC ACID	I	C	L	N
166	04 09 79	5.0000	0.0000	1			LITHIUM METAL	M	R	S	N
167	04 10 79	39.0000	0.0000	1			WASTE	NA	NA	NA	N
168	04 11 79	4.0000	0.0000	0			WASTE	NA	NA	NA	N
169	04 19 79	65.0000	0.0000	0			WASTE	NA	NA	NA	N
170	04 20 79	6.0000	0.0000	0			WASTE	NA	NA	NA	N
171	04 20 79	4.0000	0.0000	0			WASTE	NA	NA	NA	N
172	04 24 79	10.0000	0.0000	0			WASTE	NA	NA	NA	N
173	04 25 79	54.0000	0.0000	0			LITHIUM HYDRIDE DRUMS	I	R	S	N
174	04 25 79	10.0000	0.0000	0			ASBESTOS	I	TBD	S	N
175	04 26 79	6.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
176	04 30 79	20.0000	0.0000	0			BERYLLIUM CONTAMINATED TRASH	M	TBD	S	N
177	04 30 79	118.0000	0.0000	0			OIL	O	TBD	L	N
178	12 27 78	37.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
179	01 02 79	23.0000	0.0000	0			SHELL TRANSFORMER OIL	O	TBD	L	N
180	01 04 79	14.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
181	01 11 79	18.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
182	01 24 79	52.0000	0.0000	0			LITHIUM HYDRIDE	I	R	S	N
183	02 02 79	61.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
184	02 05 79	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
185	02 26 79	30.0000	0.0000	0			WASTE	NA	NA	NA	N
186	03 01 79	150.0000	0.0000	0			CHEMICALS, OIL	I/O	NA	L/S	N
187	03 01 79	5.0000	0.0000	0			METAL, MERCURY	M	T	S	N
188	03 01 79	2.0000	0.0000	0			BARIUM NITRATE ACID, METALS, CAUSTIC	I/M	T	S/L	N
189	03 05 79	2.0000	0.0000	0			MERCURY	M	T	S*	N
190	03 07 79	2.0000	0.0000	0			WASTE	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

age No. 6
0/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
191	08 11 78	10.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
192	08 23 78	8.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
193	09 20 78	10.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
194	10 04 78	14.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
195	10 12 78	12.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
196	10 24 78	78.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
197	11 08 78	35.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
198	11 09 78	37.0000	0.0000	0			BERYLLIUM CONTAMINATED ETHANOL	I	I	L	N
199	11 22 78	41.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
200	12 13 78	64.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
201	03 22 78	4.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
202	03 29 78	0.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
203	04 05 78	28.5000	0.0000	0			BERYLLIUM WASTE	N/I	TBD	S	N
204	04 05 78	28.5000	0.0000	0	02		MIXED CHEMICALS	NA	NA	NA	Y
205	04 11 78	9.0000	0.0000	0	11		DIRTY OIL	O	TBD	L	Y
206	05 01 78	95.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
207	05 17 78	7.0000	0.0000	0				NA	NA	NA	N
208	05 23 78	100.0000	0.0000	0				NA	NA	NA	N
209	06 07 78	37.0000	0.0000	0				NA	NA	NA	N
210	06 09 78	10.0000	0.0000	0			OLD CHEMICALS	NA	NA	NA	N
211	06 14 78	1.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
212	06 30 78	30.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
213	07 19 78	25.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
214	00 00 00	0.0000	0.0000	0			POLYCHLORINATED BIPHENYL RAGS (7/78)	O	TBD	S	N
215	08 09 78	28.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
216	08 09 78	0.0000	0.0000	1			HYDROGEN CHLORIDE CYLINDER	I	TBD	V	N
217	12 08 77	2.0000	0.0000	1	09		FLUORINE GAS CYLINDER	I	TBD	V	Y
218	12 15 77	46.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
219	12 21 77	4.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
220	12 29 77	1.0000	0.0000	0	02		OSMIUM TEROXIDE	I	TBD	S	Y
221	01 04 78	1.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
222	01 11 78	7.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
223	01 25 78	14.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
224	01 27 78	2.0000	0.0000	0	02		"NITRATED" PLEXIGLASS BOX	I	TBD	S	Y
225	02 02 78	2.0000	0.0000	0			ETCHING SOLUTION	O*	NA	L	N
226	02 14 78	16.0000	0.0000	0			SOLVENT	O	I*	L	N
227	02 22 78	19.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
228	02 24 78	8.0000	0.0000	0			TRICHLOROETHYLENE	O	TBD	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 7
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALSTS.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
229	03 02 78	2.0000	0.0000	0			BROKEN BATTERY	I	C	L/S	N
230	03 06 78	64.0000	0.0000	0			OIL	O	TBD	L	N
231	03 07 78	33.0000	0.0000	0			"SPECIAL PICKUP"	NA	NA	NA	N
232	03 17 78	3.0000	0.0000	0			SODIUM-POTASSIUM ALLOY CONTROLLERS; ORGANIC SOLVENT	I/O	TBD	S/L	N
233	10 21 77	200.0000	0.0000	0	10		OIL, 2 CAPACITORS, SMALL BOTTLE SULFURIC ACID	I/O	TBD	L/S	Y
234	11 03 77	1.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
235	11 04 77	40.0000	0.0000	0	10		DRUMS	NA	NA	NA	Y
236	11 09 77	5.2500	0.0000	0			MISC. ORGANIC CHEMICALS	O	NA	L/S	N
237	11 09 77	5.2500	0.0000	0	10		USED OIL	O	TBD	L	Y
238	11 14 77	32.0000	0.0000	0			SOLVENTS	O	I*	L	N
239	11 17 77	26.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
240	11 17 77	0.0000	0.0000	0	09		OLD GAS CYLINDERS	NA	NA	S	Y
241	11 18 77	22.0000	0.0000	0			DRUMS	NA	NA	NA	N
242	11 18 77	0.0000	0.0000	0	07		1 SMALL CAN/CARDBOARD BOX	NA	NA	S	Y
243	11 21 77	0.5000	0.0000	0	07		HEAT PIPE & LITHIUM	I	R	S	Y
244	11 22 77	53.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
245	11 23 77	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
246	12 01 77	45.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
247	12 02 77	1.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
248	08 10 77	26.0000	0.0000	0	10		DRUMS, SOLVENTS	I/O	NA	S/L	Y
249	08 12 77	24.0000	0.0000	0	10		DRUMS	NA	NA	NA	Y
250	08 15 77	1.0000	0.0000	0	06		2 SODIUM-POTASSIUM VALVES	I	TBD	S	Y
251	08 15 77	2.0000	0.0000	2	09		2 LECTURE SIZE TANKS	NA	NA	S	Y
252	08 17 77	18.5000	0.0000	0	06		CHEMICALS, BERYLLIUM OXIDE, LITHIUM	I/M	R	S	Y
253	08 29 77	26.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
254	09 07 77	3.0000	0.0000	0			SULFURIC ACID	I	C	L	N
255	09 07 77	3.0000	0.0000	0	10		TRANSFORMER OIL	O	TBD	L	Y
256	09 07 77	3.0000	0.0000	0	02		WHITE PHOSPHOROUS	I	TBD	S	Y
257	09 14 77	11.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
258	09 15 77	48.0000	0.0000	0			DRUMS W/SOLVENTS, PCB RAGS	O	TBD	S/L	N
259	09 21 77	12.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
260	09 29 77	0.1000	0.0000	0	06		SMALL PKG MAGNESIUM CHIPS	N	R	S	Y
261	09 30 77	18.0000	0.0000	0	10		OLD PHOTO CHEMICALS	NA	NA	L	Y
262	10 04 77	72.0000	0.0000	0	10		DRUMS	NA	NA	NA	Y
263	10 14 77	6.0000	0.0000	0	06		CHEMICALS, LITHIUM HYDRIDE	I/O	R	NA	Y
264	10 14 77	25.0000	0.0000	0			ORGANIC & INORGANIC CHEMICALS	O/I	NA	NA	N
265	10 19 77	1.0000	0.0000	0			ORGANICS	O	NA	L	N
266	07 13 77	16.0000	0.0000	0	10		BORIC ACID	I	TBD	S	Y

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 8
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
267	07	14	77	7.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
268	07	14	77	2.0000	0.0000	0			MILD ACID PLATING SOLUTION	I*	TBD	L	N
269	07	18	77	32.0000	0.0000	4			SOLVENTS	O*	I*	L	N
270	07	20	77	7.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
271	07	21	77	2.0000	0.0000	0	02		CALCIUM CARBIDE	I	R	S	Y
272	07	25	77	1.0000	0.0000	0	06		2 SODIUM-POTASSIUM ALLOY VALVES	I	TBD	S	Y
273	07	25	77	1.0000	0.0000	0	06		SODIUM-POTASSIUM ALLOY VALVE	I	TBD	S	Y
274	07	27	77	0.5000	0.0000	0	06		SODIUM-POTASSIUM ALLOY VALVE	I	TBD	S	Y
275	07	28	77	0.0000	0.0000	0			(1) BOTTLE LEAKING THIOPHOSGENE	I	T	S	N
276	07	28	77	31.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
277	07	28	77	4.0200	0.0000	0	06		1 30 GALLON DRUM LITHIUM CHIPS	I	R	S	Y
278	07	28	77	21.4400	0.0000	0	02		ACID	I/O	C	L	Y
279	07	29	77	1.5000	0.0000	0	06		3 SODIUM-POTASSIUM ALLOY VALVES	I	TBD	S	Y
280	08	03	77	1.0000	0.0000	0	06		2 SODIUM-POTASSIUM ALLOY VALVES	I	TBD	S	Y
281	08	05	77	4.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
282	08	08	77	27.5000	0.0000	0	03		MAGNESIUM OXIDE	I	TBD	S	Y
283	08	08	77	27.5000	0.0000	0			SOLVENTS	O	I*	L	N
284	08	09	77	1.0000	0.0000	0	06		1 SODIUM-POTASSIUM ALLOY VALVE	I	TBD	S	Y
285	05	19	77	3.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
286	05	23	77	48.0000	0.0000	0			DRUMS	NA	NA	NA	N
287	05	25	77	12.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
288	05	25	77	0.0000	1.0000	0	06		LITHIUM	N	R	S	Y
289	06	02	77	10.0000	0.0000	0			CHEMICALS (SOLVENTS)	O	I	L	N
290	06	06	77	3.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
291	06	06	77	0.0000	0.0000	1	06		SMALL CYLINDER TRIETHYL ALUMINUM	O	I	L	Y
292	06	07	77	36.0000	0.0000	0	10		CHELATING AGENT	O	TBD	S	Y
293	06	07	77	0.0000	0.0000	0			DRUMS	NA	NA	NA	N
294	06	07	77	0.0000	0.0000	0		A	DRUMS	NA	NA	NA	Y
295	06	09	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
296	06	17	77	2.0000	0.0000	0			2 EMPTY DRUMS SODIUM HYDROXIDE; 2 CANS OF OIL	O/I	TBD	S/L	N
297	06	21	77	4.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
298	06	22	77	10.0000	0.0000	0			CALGON (SODIUM PHOSPHATE)	I	TBD	S	N
299	06	23	77	0.0000	0.0000	2	09		HYDROGEN CYANIDE TANKS	O	T	V	Y
300	06	23	77	3.0000	0.0000	0			SOLVENT	O	I*	L	N
301	06	24	77	8.0000	0.0000	0	02		PERCHLORIC ACID	I	R	L	Y
302	06	27	77	1.0000	0.0000	0	06		SODIUM-POTASSIUM ALLOY VLV ASSEMBLY	I	TBD	S	Y
303	07	12	77	8.0000	0000	0	02		SODIUM CHLORIDE	I	TBD	S	Y
304	04	11	77	48.0000	000	0			USED OIL	O	TBD	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 9
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
305	04	12	77	24.0000	0.0000	0			METHYLETHYL KETONE SOLVENT	O	I	L	N
306	04	13	77	72.0000	0.0000	0			UNKNOWN	NA	NA	NA	N
307	04	13	77	48.0000	0.0000	0			UNKNOWN	NA	NA	NA	N
308	04	13	77	24.0000	0.0000	0			DRUMS	NA	NA	NA	N
309	04	13	77	3.0000	0.0000	0	05		DRUMS	NA	NA	NA	Y
310	04	13	77	2.0000	0.0000	0	05		DIISOBUTYL ALUMINUM HYDRIDE	O	I/R	L	Y
311	04	13	77	1.0000	0.0000	0	05		PHOSPHORIC ACID,TOLUENE & MISC CHEMICALS	I/O	I	L	Y
312	04	13	77	1.0000	0.0000	0	06		SODIUM-POTASSIUM ALLOY	I	TBD	S	Y
313	04	18	77	32.0000	0.0000	0			DRUMS	NA	NA	NA	N
314	04	19	77	67.0000	0.0000	0			NEUTRALIZED SALTS SOLUTION	I	TBD	L	N
315	04	19	77	25.0000	0.0000	0	02		DIL. ACETIC ACID & STRONG ALK. SOLU	O	C	L	Y
316	04	20	77	38.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
317	04	20	77	1.0000	0.0000	0	06		1 CAN CALCIUM CARBIDE	I	R*	S	Y
318	04	28	77	7.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
319	05	04	77	15.0000	0.0000	0	06		CHEMICALS, SODIUM-POTASSIUM VALVE	I/O	NA	NA	Y
320	05	06	77	10.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
321	05	09	77	8.0000	0.0000	0			SOLVENTS	O*	I*	L	N
322	05	12	77	3.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
323	05	17	77	5.5000	0.0000	0			SODIUM, CALCIUM, ORGANIC CHEMICALS	I/O	NA	NA	N
324	02	04	77	61.0000	0.0000	0			USED REFRIG. OIL AND FREON	O	TBD	L	N
325	02	07	77	0.0000	0.0000	0	05		DRUMS	NA	NA	NA	Y
326	02	09	77	36.0000	0.0000	0			CHEMICAL WASTE	NA	NA	NA	N
327	02	10	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
328	02	22	77	56.0000	0.0000	0				NA	TBD		N
329	02	24	77	5.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
330	02	24	77	0.0000	0.0000	2	09		SMALL CYLINDERS W/NICKEL CARBONYL	NA	TBD	NA	Y
331	03	02	77	5.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
332	03	02	77	0.0000	0.0000	0	06		CANS LITHIUM & SODIUM	N	R	S	Y
333	03	02	77	23.0000	0.0000	0	06		LITHIUM HYDRIDE	I	R	S	Y
334	03	02	77	23.0000	0.0000	0	05		OIL	O	TBD	L	Y
335	03	16	77	12.0000	0.0000	0	05		ACETONE	O	I	L	Y
336	03	16	77	16.0000	0.0000	0	09		OXYGEN & NITROGEN DIOXIDE CYLINDERS	I	TBD	V	Y
337	03	16	77	20.1000	0.0000	0	02		HYDROCHLORIC ACID W/PALLADIUM CHLORIDE	I	C	L	Y
338	03	22	77	40.0000	0.0000	0	02		ALKALINE SOLUTION	I*	C*	L	Y
339	03	23	77	1.0000	0.0000	0	04		SMALL CAPACITOR	O	TBD	L/S	Y
340	03	25	77	72.0000	0.0000	0			MINERAL OIL	O	TBD	L	N
341	03	31	77	8.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
342	04	06	77	18.0000	0.0000	0			CHEMICALS	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

'age No. 10
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
343	04	07	77	13.0000	0.0000	0	02		NITRIC ACID	I	C	L	Y
344	11	23	76	36.0000	0.0000	0			GLASS CARBOYS (SOLV. & EXCESS)	O*	I*	L	N
345	12	02	76	5.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
346	12	02	76	3.0000	0.0000	0	07		SODIUM, POTASSIUM	M	R	S	Y
347	12	17	76	30.0000	0.0000	0			SOLVENT (110 GAL), ETCHING SOLN (150)	O	I*	L	N
348	12	17	76	64.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
349	12	27	76	24.0000	0.0000	0			SOLVENTS	O*	I*	L	N
350	12	29	76	12.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
351	01	13	77	5.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
352	01	19	77	0.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
353	01	24	77	51.5900	0.0000	0	05			NA	TBD		Y
354	01	26	77	5.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
355	01	26	77	5.0000	0.0000	0	06		2 SMALL BOTTLES SODIUM	I	R	S	Y
356	01	26	77	5.0000	0.0000	0	09		3 SMALL BOTTLES OF ???	M	R	S	Y
357	01	27	77	0.5000	0.0000	0	06		SODIUM	M	R	S	Y
358	02	01	77	216.0000	0.0000	0			OIL & SOLVENTS	O	I*	L	N
359	02	02	77	160.0000	0.0000	0			OIL	O	TBD	L	N
360	02	03	77	34.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
361	01	06	76	3.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
362	01	07	76	2.0000	0.0000	0			HYDROGEN FLUORIDE CONTAMINATED CYLINDERS	I	TBD	V	N
363	02	03	76	150.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
364	02	10	76	2.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
365	02	12	76	48.0000	0.0000	0		A	SOLVENT (SOLVENT PIT)	O	I*	L	Y
366	02	12	76	12.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
367	02	24	76	36.0000	0.0000	0	06		LITHIUM METAL	M	R	S	Y
368	03	05	76	2.0000	0.0000	0			HYDROFLUORIC ACID	I	C	L	N
369	03	09	76	64.0000	0.0000	0			MISC CHEM	NA	NA	NA	N
370	03	09	76	0.0000	0.0044	0	06		SODIUM	M	R	S	Y
371	03	12	76	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
372	03	12	76	0.5000	0.0000	0	06		LITHIUM	M	R	S	Y
373	03	16	76	80.0000	0.0000	0		A	OLD CHEMICALS (SOLVENT PIT)	NA	NA	NA	Y
374	03	23	76	1.0000	0.0000	0	06		LITHIUM	M	R	S	Y
375	03	23	76	7.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
376	03	23	76	7.5000	0.0000	0	06		CYANIDE CRYSTAL	I	R	S	Y
377	03	25	76	6.0000	0.0000	0			MISC CHEMICALS	NA	NA	NA	N
378	04	07	76	58.9600	0.0000	0	06		OIL	O	TBD	L	Y
379	04	07	76	88.4400	0.0000	0		A	OLD CHEMICALS (SOLVENT PIT)	NA	NA	NA	Y
380	04	07	76	10.0000	0.0000	0	02		BARIUM NITRATE	I	T	S	Y

BENCHMARK ENVIRONMENTAL CORPORATION

ᵖage No. 11
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
381	04	12	76	75.0000	0.0000	0			MISC CHEMICALS & OIL	O	NA	L	N
382	04	12	76	1.0000	0.0000	0	09		GAS SAMPLES, XENON TRIFLUORIDE	I	NA	V/S	Y
383	04	13	76	40.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
384	04	13	76	0.0000	1.0000	0	06		SODIUM	M	R	S	Y
385	04	15	76	1.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
386	04	15	76	1.0000	0.0000	0	07		SODIUM-POTASSIUM CHIPS	M	R	S	Y
387	04	27	76	12.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
388	04	27	76	40.0000	0.0000	0	07		LITHIUM HYDRIDE FILTERS	I	R	S	Y
389	05	12	76	12.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
390	05	27	76	19.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
391	05	27	76	8.1700	0.0000	0	07		MAGNESIUM CHIPS IN DRUMS	M	R	S	Y
392	06	01	76	22.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
393	06	08	76	36.0000	0.0000	0			MISC CHEMICALS	NA	NA	NA	N
394	06	08	76	14.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
395	06	15	76	16.0000	0.0000	0			KETONE SOLVENTS	O	I*	L	N
396	06	15	76	10.0000	0.0000	0			3 CAPACITORS, OIL (30 GALLONS), MISC. CHEMICALS	NA	NA	NA	N
397	06	16	76	4.0000	0.0000	0			ACETIC ACID	O	C	L	N
398	06	23	76	30.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
399	06	25	76	56.0000	0.0000	0	05		WASTE OIL	O	TBD	L	Y
400	06	28	76	1.0000	0.0000	1	09		LEAKY HYDROGEN FLUORIDE CYLINDER	I	TBD	V	Y
401	07	06	76	16.0000	0.0000	0			SOLVENT	O	I*	L	N
402	07	12	76	64.0000	0.0000	0	05		HYDRAULIC OIL	O	TBD	L	Y
403	07	16	76	9.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
404	07	16	76	1.0000	0.0000	0	06		SMALL TUBE OF CESIUM	I	R	S	Y
405	07	30	76	6.5000	0.0000	0			CHEMICALS	NA	NA	NA	N
406	08	11	76	40.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
407	08	11	76	10.0000	0.0000	0	09		2 SMALL BOTTLES (NO LABELS)	M	TBD	S	Y
408	08	17	76	24.0000	0.0000	0			SOLVENT	O	I*	L	N
409	08	19	76	0.5000	0.0000	2	09		2 BORON TRIFLUORIDE CYLINDERS	I	TBD	V	Y
410	08	19	76	36.8500	0.0000	0			OIL	O	TBD	L	N
411	08	25	76	15.0000	0.0000	0			WASTE CHEMICALS	NA	NA	NA	N
412	09	01	76	8.0000	0.0000	0	05		OIL	O	TBD	L	Y
413	09	08	76	132.6600	0.0000	0	05			NA	TBD		Y
414	09	08	76	8.0400	0.0000	0	06			NA	TBD		Y
415	09	09	76	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
416	09	10	76	1.0000	0.0000	1	09		OLD CORRODED NICKEL CARBONYL CYLINDER	O	R/I	L/S	Y
417	09	10	76	8.0000	0.0000	0	05		EMPTY PLASTIC DRUM	NA	NA	S	Y
418	09	15	76	8.0000	0.0000	0			CHEMICAL WASTE	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 12
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
419	09 22 76	102.0000	0.0000	0			SOLVENT & OIL	O	I	L	N
420	09 22 76	70.0000	0.0000	0			WASTE CHEMICALS,	NA	NA	NA	N
421	10 15 76	40.0000	0.0000	0			1-55 GAL. DRUMS FROM OMEGA, TA-55 OMEGA	NA	NA	NA	N
422	10 21 76	4.0000	0.0000	0		A	SALT SOLUTION	I	TBD	L	Y
423	10 22 76	8.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
424	10 28 76	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
425	11 08 76	200.0000	0.0000	0	05			NA	TBD		Y
426	11 11 76	1.0000	0.0000	0	02		XENON TANKS	I	TBD	V	Y
427	11 19 76	4.0000	0.0000	0	06		2 BADLY CORRODED CHLORINE CYLINDERS	I	TBD	V	Y
428	11 22 76	16.0000	0.0000	0	05		SOLVENT	O	I*	L	Y
429	12 11 80	2.6800	0.0000	0	17		CHROMIC ACID	I	C	L	Y
430	12 11 80	2.6800	0.0000	0	17		ARSENIC TRIOXIDE	I	T	S	Y
431	12 11 80	2.6800	0.0000	0	17		PHOSPHOROUS TRICHLORIDE	I	TBD	L	Y
432	12 11 80	0.2700	0.0000	0	17		BENZENE	O	T/I	L	Y
433	12 11 80	0.2700	0.0000	0	17		CARBON TETRACHLORIDE	O	T	L	Y
434	12 11 80	0.2700	0.0000	0	17		HEPTANE	O	I	L	Y
435	12 11 80	0.1340	0.0000	0	17		MERCURY	M	T	S*	Y
436	12 11 80	0.2700	0.0000	0	17		PHOSPOROUS OXYCHLORIDE	I	TBD	L	Y
437	12 11 80	0.1340	0.0000	0	17		CARBON TETRACHLORIDE	O	T	L	Y
438	12 11 80	12.0600	0.0000	0	17		ORGANIC WASTE	O	NA	L	Y
439	12 03 80	0.1400	0.0000	0	17		NINHYDRIN	O	TBD		Y
440	12 23 80	0.6700	0.0000	0	17		HEXANE/ACETONE MIXTURE	O	I	L	Y
441	12 12 80	0.1400	0.0000	0		B	PERCHLORIC ACID	I	R	L	Y
442	12 04 80	0.0170	0.0000	0	17		P-CHLOROPHENOL	O	C	S	Y
443	12 04 80	0.0170	0.0000	0	17		BROMINE & CARBON TETRACHLORIDE	O	T	L	Y
444	11 21 80	0.0500	0.0000	0	17		BENZENE	O	T/I	L	Y
445	12 11 80	4.0200	0.0000	0	17		1,1,1 - TRICHLOROETHANE	O	TBD	L	Y
446	12 03 80	0.1500	0.0000	0	17		PYRIDINE	O	T/I	L	Y
447	12 03 80	0.1000	0.0000	0	17		POLYOXYETHYLENE LAURAL ALCOHOL	O	TBD	L	Y
448	11 04 80	0.1000	0.0000	0			MERCAPTANS	O	I*	L	N
449	11 04 80	3.0000	0.0000	0	13		NITRIC ACID	I	C	L	Y
450	11 05 80	0.6700	0.0000	0	13		WATCH SOLUTION	NA	NA	L	Y
451	11 05 80	77.0000	0.0000	0	19		UNKNOWN OIL	O	TBD	L	Y
452	11 03 80	2.0000	0.0000	0			RENZENETHIOL, P-DIOXANE, TETRAHYDROFURAN	O	I	L	N
453	11 07 80	0.0000	0.0000	2			BORON TRIFLUORIDE, NITROGEN DIOXIDE	I	TBD	V	N
454	11 18 80	0.0000	0.0000	0			AMMONIUM HYDROXIDE	I	C	L	N
455	11 18 80	2.0000	0.0000	0			ORGANIC & INORGANIC	O/I	NA	L	N
456	11 18 80	0.0900	0.0000	0			AMMONIUM HYDROXIDE	I	C	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 13
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
457	11 18 80	0.0350	0.0000	0			MERCURIC CHLORIDE	I	T	S	N
458	11 18 80	0.0350	0.0000	0			1% ACETIC ACID SOLN	O	TBD	L	N
459	11 18 80	0.0350	0.0000	0			HYDROCHLORIC ACID	I	C	L	N
460	11 18 80	0.0350	0.0000	0			MAYERS HEMAXYLIN (HEMATOYLIN)	O	TBD	S	N
461	11 18 80	0.0350	0.0000	0			GLACIAL ACETIC ACID	O	C/I	L	N
462	11 18 80	0.0350	0.0000	0			PICRIC ACID	O	R	S*	N
463	11 18 80	0.0350	0.0000	0			ZENBER SOLN	NA	TBD	L	N
464	11 18 80	0.0350	0.0000	0			POTASSIUM HYDROXIDE	I	TBD	S	N
465	11 18 80	0.0350	0.0000	0			IODINE SOLN	I	TBD	L	N
466	11 18 80	0.0700	0.0000	0	17		POTASSIUM DICHROMATE & PHOSPHATE BUFFER	I	T	L	Y
467	11 18 80	0.5400	0.0000	0	17		TRICHLOROETHYLENE	O	T	L	Y
468	11 19 80	0.0000	0.0000	0			MERCURY VAPORS	M/I	T	V	N
469	11 19 80	0.5000	0.0000	0			VACUUM TUBES OF MERCURY	M	T	S	N
470	11 21 80	0.0018	0.0000	1	16		FLUORINE GAS	I	TBD	V	Y
471	11 20 80	0.0012	0.0000	1	16		BROMINE	I	TBD	L	Y
472	11 20 80	0.0010	0.0000	1	16		BROMINE TRIFLUORIDE	I	R	L	Y
473	11 20 80	0.0700	0.0000	1	16		BROMINE PENTAFLUORIDE	I	R	L	Y
474	11 21 80	0.0035	0.0000	1	16		BORON TRICHLORIDE	I	TBD	L	Y
475	11 21 80	0.0180	0.0000	1	16		PHOSPHOROUS PENTOXIDE	I	R	S	Y
476	11 21 80	0.0035	0.0000	1	16		SILANE	I	I	V	Y
477	11 21 80	0.0018	0.0000	0	13		HYDROGEN FLUORIDE	I	TBD	V	Y
478	10 01 80	1.0000	0.0000	0	17		ORGANIC	O	NA	L*	Y
479	10 08 80	1.0000	0.0000	0	13		INORGANIC	I	NA	NA	Y
480	10 01 80	0.4700	0.0000	0	17		LASER DYE	O*	TBD	L	Y
481	10 03 80	0.4600	0.0000	0	13		AMMONIUM HYDROXIDE	I	C	L	Y
482	10 03 80	0.0000	5.2800	0	13		ABSORBER	NA	TBD	S	Y
483	10 03 80	14.7400	0.0000	0	19		CHEMICALS	NA	NA	NA	Y
484	10 03 80	3.0000	0.0000	0	17		CHEMICALS/STRONG ACIDS	I/O	C	L	Y
485	10 08 80	50.0000	0.0000	0	19		OIL	O	TBD	L	Y
486	10 08 80	7.0000	0.0000	0			STRONG ACIDS	I/O	C	L	N
487	00 00 00	0.0000	0.0000	0			FLUORINE GAS CYLINDERS	I	TBD	V	N
488	09 25 80	1.0000	0.0000	0			MISC. ORGANIC LIQUIDS	O	NA	L	N
489	10 09 80	14.0000	0.0000	0			MAGNESIUM CHIPPING METAL	M	R	S	N
490	10 14 80	8.0000	0.0000	0	13		CHROMIC ACID	I	C	L	Y
491	10 16 80	3.0000	0.0000	0			ORGANIC & SULFURIC ACID	O	C	L	N
492	10 03 80	13.4000	0.0000	0	13		CYANIDE COPPER STRIKE BATH	I*	TBD	L	Y
493	10 20 80	0.0170	0.0000	0			DIPHENYLSULFIDE	O	TBD	L	N
494	10 30 80	2.0000	0.0000	0			ACIDS & BASES	I/O	C*	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 14
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
495	00	00	00	1.0000	0.0000	0	13		MERCURIC CYANIDE (10/80)	I	T/R	L	Y
496	09	15	80	1.0000	0.0000	0			PROPANEDIOL, W/CHROMIUM (V)	O	T	L	N
497	09	27	80	1.0000	0.0000	0			ETHER	O	I	L	N
498	09	26	80	1.0000	0.0000	0	13		NITRIC ACID	I	C	L	Y
499	09	26	80	7.3700	0.0000	0	13		ACIDS	I/O	C	L	Y
500	09	19	80	2.8100	0.0000	0			ORGANIC	O	NA	L*	N
501	09	19	80	0.6700	0.0000	0	13		SULFURIC ACID	I	C	L	Y
502	09	19	80	2.0000	0.0000	0			CHEM WASTE CLEANUP	NA	NA	NA	N
503	09	16	80	5.0000	0.0000	0			TRICHLOROETHENE, HARDENER, ORGANIC SOLVENT (UNKNOWN)	O	TBD	L	N
504	09	15	80	0.0700	0.0000	0			NITRIC ACID	I	C	L	N
505	09	15	80	0.0700	0.0000	0			ACETIC ACID	O	C	L	N
506	09	15	80	0.0700	0.0000	0			BUTYL ACETATE	O	TBD		N
507	09	15	80	0.0000	0.0700	0			AMMONIUM HYDROXIDE	I	C	L	N
508	09	15	80	0.0000	2.0000	0			SODIUM HYDROXIDE	I	C	L	N
509	09	15	80	0.0100	0.0000	0			ACETONE	O	I	L	N
510	09	10	80	73.3000	0.0000	0	19		WASTE OIL	O	TBD	L	Y
511	09	08	80	0.0000	0.0000	0			SODIUM VALVES	I	TBD		N
512	09	05	80	1.3400	0.0000	0	13		WATER W/ASBESTOS	I	TBD	L	Y
513	08	19	80	0.0350	0.0000	0			COBALT CHLORIDE	I	TBD	S	N
514	08	19	80	0.0350	0.0000	0			ORTHO CRESOLSULFONPHTHALEIN	O	TBD	S	N
515	08	19	80	0.0350	0.0000	0			DINITROPHENOL-A	O	R	S	N
516	08	19	80	0.0350	0.0000	0			1,5-DIPHENYLCARBAZIDE	O	TBD	S	N
517	08	19	80	22.1100	0.0000	0			SODIUM CHLOROPENTAPHENATE, SODIUM-2,4,5-TRICHLOROPHENATE, SODIUM SALTS,	O	TBD		N
518	08	19	80	0.0700	0.0000	0			HYDROXYL AMMONIUM CHLORIDE	I	TBD	L	N
519	08	19	80	0.0350	0.0000	0			IODINE CRYSTALS	I	TBD	S	N
520	08	19	80	0.0350	0.0000	0			MOLYBDATE REAGANT	I	TBD	L*	N
521	08	19	80	0.0350	0.0000	0			MERCURIC IODIDE IN POTASSIUM IODIDE	I	T	L*	N
522	08	19	80	0.0350	0.0000	0			4-METHYL-2-NITROPHENOL	O	TBD	S	N
523	08	19	80	0.0350	0.0000	0			ORANGE SHELLAC	O	TBD		N
524	08	19	80	0.1100	0.0000	0			PHENOLPHTHALEIN	O	TBD	S	N
525	08	19	80	0.0700	0.0000	0			POTASSIUM CHROMATE	I	T	S	N
526	08	19	80	0.1100	0.0000	0			POTASSIUM CHROMATE	I	T	S	N
527	08	19	80	0.0350	0.0000	0			POTASSIUM HYDROXIDE OIL	O	TBD	L	N
528	08	19	80	0.0350	0.0000	0			POTASSIUM IODIDE	I	TBD		N
529	08	19	80	0.0350	0.0000	0			POTASSIUM PERMANGANATE	I	TBD		N
530	08	19	80	0.0350	0.0000	0			POTASSIUM RHODANIDE	I	TBD		N
531	08	19	80	0.0350	0.0000	0			POTASSIUM SULFOCYANIDE	I	TBD		N
532	08	19	80	0.0350	0.0000	0			SILVER NITRATE	I	TBD		N

BENCHMARK ENVIRONMENTAL CORPORATION

age No. 15
0/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
533	08	19	80	0.1100	0.0000	0			SODIUM CARBONATE	I	TBD		N
534	08	19	80	0.1100	0.0000	0			SODIUM HYDROXIDE	I	TBD		N
535	08	19	80	0.1100	0.0000	0			SODIUM HYPOSULFATE	I	TBD		N
536	08	19	80	0.0350	0.0000	0			TRANS -1,2-DIAMINOCYCLOHEXANE TETRAACETIC ACID	O	TBD		N
537	08	19	80	0.0350	0.0000	0			ETHYLENEDIAMINE-TETRAACETIC ACID	O	TBD		N
538	08	19	80	0.0350	0.0000	0			TIN DICHLORIDE	I	TBD		N
539	08	19	80	0.0350	0.0000	0			SULFAMIC ACID	I	TBD		N
540	08	19	80	0.0700	0.0000	0			HYDROGEN SULFATE	I	TBD		N
541	08	19	80	0.0350	0.0000	0			ISOPROPYL-META-CRESOL	O	TBD		N
542	08	19	80	0.1100	0.0000	0			3-3' DYMETHYLBENZIDINE	O	TBD		N
543	08	19	80	0.0700	0.0000	0			PARA-(PARA-DIMETHYLAMINO PHENYL-AZOBENZENE SULFONATE)	O	TBD		N
544	08	19	80	0.0350	0.0000	0			UNKNOWN	NA	NA	NA	N
545	08	19	80	0.0350	0.0000	0			CARBAMIDE (UREA)	O	TBD	S	N
546	08	19	80	0.0350	0.0000	0			VERSENE IRON (III)	O	TBD	S	N
547	08	19	80	0.0350	0.0000	0			ALIZARIN REDS	O	TBD	S	N
548	08	19	80	0.0700	0.0000	0			1,2 HYDROXYANTHROQUINONE	O	TBD	NA	N
549	08	19	80	0.0350	0.0000	0			XYLENE CYANOLE DIFLUORIDE	O	TBD	NA	N
550	08	19	80	0.0350	0.0000	0			XYLENE CYANOLE	O	TBD	NA	N
551	08	19	80	0.0350	0.0000	0			UNKNOWN	NA	NA	NA	N
552	08	19	80	0.0350	0.0000	0			TOTAL CHROMINE BUFFER	NA	T	L*	N
553	08	19	80	0.0700	0.0000	0			TELLURIUM VERSENE IN POWDER PILLOWS	O	TBD	S	N
554	08	19	80	0.0350	0.0000	0			SODIUM DICHROMATE	I	T	S	N
555	08	19	80	0.0350	0.0000	0			SODIUM CHLORIDE SOLUTION	I	TBD	L	N
556	08	19	80	0.0000	1.0000	0			POTATO POWDER	O*	TBD	S	N
557	08	19	80	0.0350	0.0000	0			STABLE STARCH SOLUTION	O	TBD	L	N
558	08	19	80	0.0350	0.0000	0			SODIUM NITRATE	I	I	S	N
559	08	19	80	0.0700	0.0000	0			SODIUM AZIDETE	I	TBD	S	N
560	08	19	80	0.0350	0.0000	0			SILVER NITRATE	I	I	S	N
561	08	19	80	0.1400	0.0000	0			CHLOROHYDROXYBENZENE	O	TBD	S*	N
562	08	19	80	0.0350	0.0000	0			TRI CHLOROMETHANE (CHLOROFORM)	O	T	L	N
563	08	19	80	0.0350	0.0000	0			BROMINE	I	I*	L	N
564	08	19	80	0.0700	0.0000	0			3,3',5,5'-TETRABROMO-META-CRESOLSULFON-PHTHALEIN	O	TBD	S	N
565	08	19	80	0.0350	0.0000	0			BENZIDINE DIHYDROCHLORIDE	O	TBD	NA	N
566	08	19	80	0.0350	0.0000	0			POTASSIUM CHLORIDE & SILVER CHLORIDE	I	T	S	N
567	08	19	80	0.0700	0.0000	0			AMMONIUM OXALATE	I	TBD	S	N
568	08	19	80	0.0700	0.0000	0			NITRIC REAGENT	I	NA	L	N
569	08	19	80	0.0700	0.0000	0			NITRIC REAGENT	I	NA	L	N
570	08	19	80	0.1100	0.0000	0			CADMIUM (IV) NITRATE	I	T	S	N

BENCHMARK ENVIRONMENTAL CORPORATION

ge No. 16
/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
571	08 19 80	0.0700	0.0000	0			MERCURY NITRATE	I	T/I	S	N
572	08 19 80	0.0350	0.0000	0			MANGANESE SULFATE	I	TBD	S	N
573	08 19 80	0.0350	0.0000	0			HYDROXYLAMINE REAGENT	I	TBD	L	N
574	08 19 80	0.0350	0.0000	0			3,4,5-TRIHYDROZYBENZOIC ACID (GALLIC ACID)	O	TBD	S	N
575	08 19 80	0.0350	0.0000	0			FREE CHLORINE BUFFER	I	TBD	L	N
576	08 19 80	0.0350	0.0000	0			FLUORESCEIN	O	TBD	S	N
577	08 19 80	0.0700	0.0000	0			FERROUS IRON TEST POWDER PILLOWS	I*	TBD	S	N
578	08 19 80	0.0350	0.0000	0			DIPHENYLCARBAZIDE & TETRABROMOPHENOSULFONPHTHALAIN	O	TBD	S	N
579	08 19 80	0.0350	0.0000	0			DIPHENYL CARBAZIDE	O	TBD	S	N
580	08 19 80	0.0350	0.0000	0			P-DIMETHYLAMINOBENZALDEHYDE	O	TBD	S	N
581	08 19 80	0.0000	1.0000	0			CADMIUM	M	T	S	N
582	08 19 80	0.0700	0.0000	0			DIMETHOXYSTRYCHNINE (BRUCINE)	O	TBD	S	N
583	08 19 80	0.0350	0.0000	0			TETRABROMOPHENOLSULFONPHTHALEIN	O	TBD	S	N
584	08 19 80	0.0350	0.0000	0			1-AMINO-2-NAPHTHOL-4-SULFONIC ACID	O	TBD	S	N
585	08 19 80	0.0000	1.2500	0			MOLYBDIC ACID & AMMONIUM MOLYBDATE	I	TBD	S	N
586	08 19 80	0.0000	1.0000	0			AMMONIUM OXALATE	I	TBD	S	N
587	08 19 80	0.0350	0.0000	0			PHENAZINE	O	TBD	S	N
588	08 19 80	0.0350	0.0000	0			POTASSIUM PERMANGANATE	I	I	S	N
589	08 19 80	0.0350	0.0000	0			POTASSIUM HYDRATE	I	TBD	S	N
590	08 19 80	0.0350	0.0000	0			POTASSIUM DICHROMATE	I	T/I	S	N
591	08 19 80	0.0700	0.0000	0			POTASSIUM DICHROMATE	I	T/I	S	N
592	08 19 80	0.0700	0.0000	0			POTASSIUM CHROMATE INDICATOR	I	T	S	N
593	08 19 80	0.0350	0.0000	0			POTASSIUM CHLORIDE	I	TBD	S	N
594	08 19 80	0.0000	0.1250	0			4,5-PHENANTHROLINE	O	TBD	S	N
595	08 19 80	0.0350	0.0000	0			PH-7 BUFFER	I*	TBD	L	N
596	08 19 80	0.1400	0.0000	0			NITRIVER POWDER PILLOWS	NA	TBD	S	N
597	08 19 80	7.3700	0.0000	0			DIMETHYL ARSINIC ACID,SODIUM CACODYLATE & CACODYLIC ACID	O	T	S	N
598	08 19 80	14.7400	0.0000	0			2,4-DICHLOROPHENOXYBUTHRIC ACID	O	TBD	S	N
599	08 19 80	1.0000	0.0000	0			ECCO PRIME PP (ORGANIC ACID)	O	TBD	L	N
600	09 04 80	12.0600	0.0000	0			METHYL CHLOROFORM,UNKNOWN ACID	O	T	L	N
601	07 30 80	0.0000	6.0000	0			COPPER CHLORIDE	I	TBD	S	N
602	07 30 80	0.0000	22.0000	0			ALUMINUM CHLORIDE,ANHYDROUS	I	R	S	N
603	07 30 80	0.0000	5.0000	0			FUROXYL CHLORIDE	O	TBD		N
604	07 30 80	0.0000	1.0000	0			PHOSPHORIC ANHYDRIDE	I	R	S	N
605	07 30 80	0.0000	1.0000	0			SODIUM METAL	M	R	S	N
606	07 30 80	0.0000	0.0700	0			ALKYL HALIDES	I	TBD	NA	N
607	07 30 80	0.0700	0.0000	0			BROMINATED HYDROCARBONS	O	TBD	NA	N
608	07 30 80	0.0700	0.0000	0			UNKNOWN	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 17
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
609	08	05	80	22.1100	0.0000	0	13		SULFURIC ACID	I	C	L	Y
610	08	05	80	22.1100	0.0000	0			NITRIC ACID	I	C	L	N
611	08	05	80	0.8000	0.0000	0		B	COPPER STICK SOLUTION	I	NA	L	Y
612	08	05	80	1.0700	0.0000	0		B	NITRIC ACID OF LEAD	I	T/C	L	Y
613	08	05	80	29.4800	0.0000	0		B	SODIUM HYDROGEN SULFATE & CHROMIL ACID	I	I	S	Y
614	08	05	80	6.7000	0.0000	0		B	NICKEL CHLORIDE SOLUTION	I	TBD	L	Y
615	08	05	80	0.6700	0.0000	0			SULFURIC ACID	I	C	L	N
616	08	05	80	0.0170	0.0000	0			FORMIC ACID	I	TBD	L	N
617	08	05	80	0.0000	2.2000	0			DICHLOROMETHANE	O	TBD		N
618	08	05	80	2.6800	0.0000	0			PAINT	O	I		N
619	08	04	80	14.7400	0.0000	0	19		OIL	O	TBD		Y
620	08	12	80	0.2500	0.0000	0			EPOXIDES & HARDENERS	O	I*		N
621	08	12	80	0.3400	0.0000	0	13		COPPER SULFATE SOLVENT	I	TBD		Y
622	08	15	80	0.0600	0.0000	0			LIQUID CHEMICALS	NA	NA		N
623	08	15	80	0.0100	0.0000	0			ORGANIC	O	NA		N
624	08	15	80	0.0100	0.0000	0			INORGANIC	I	NA		N
625	08	15	80	7.3000	0.0000	0	19		OIL	O	TBD		Y
626	08	15	80	0.2700	0.0000	0	19		OIL	O	TBD		Y
627	08	14	80	1.0700	0.0000	0			ACID SOLUTION OF BERYLLIUM	NA	C*		N
628	08	14	80	6.9700	0.0000	0			POTASSIUM CYANIDE GOLD RECOVERY SOLUTION	I	R		N
629	08	22	80	1.5000	0.0000	0			3-PENTANONE,CHLOROFORM,OCTYL ALCOHOL,4-HYDROXY-4-METHYL-2-PENTANONE,BRO	O	T/I*		N
630	08	22	80	0.0000	0.0000	2	16		2 BROMIDE CYLINDERS	I	I*		Y
631	07	01	80	4.0000	0.0000	0	19		OIL	O	TBD		Y
632	07	07	80	0.6800	0.0000	0		B	POWDER (TALCUM)	I	TBD		Y
633	07	07	80	0.0200	0.0000	0		B	NITRIC ACID	I	C		Y
634	07	07	80	0.7000	0.0000	0		B	PHOTOCHEMICALS	NA	NA		Y
635	07	07	80	0.0200	0.0000	0		B	HYDROCHLORIC ACID	I	C		Y
636	07	07	80	0.1340	0.0000	0		B	CITRIC ACID	O	TBD		Y
637	07	10	80	20.0000	0.0000	0		B	CHROMIC SULFURIC AICD,METHYL CHLOROFORM,TIN-LEAD SOLUTION	O	T/C		Y
638	07	10	80	7.3700	0.0000	0			NITRIC ACID	I	C		N
639	07	14	80	0.1340	0.0000	0			TOLUENE	O	I		N
640	07	14	80	0.6800	0.0000	0	13		INORGANIC	I	NA		Y
641	07	14	80	0.6800	0.0000	0			ORGANIC	O	NA	L*	N
642	07	14	80	0.3400	0.0000	0	13		INORGANIC	I	NA	NA	Y
643	07	14	80	0.5100	0.0000	0			ORGANIC	O	NA	L*	N
644	07	15	80	0.1000	0.0000	0			ORGANIC	O	NA	L*	N
645	07	15	80	0.1000	0.0000	0			LITHIUM & BERYLLIUM	M	R	S	N
646	07	15	80	0.5400	0.0000	0			SULFURIC ACID	I	TBD		N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 18
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
647	07 16 80	2.0000	0.0000	0			COAL TAR CONTAINING BENZ-A-PYRENE & CYCLOHEXANE	O	TBD	L	N
648	07 18 80	1.3400	0.0000	0			WEAK ACID	NA	NA	L*	N
649	07 21 80	3.0000	0.0000	0			1,1,1-TRICHLOROETHANE	O	TBD		N
650	07 21 80	2.0000	0.0000	0	13		FILTERS	NA	NA	S	Y
651	07 23 80	0.1700	0.0000	0			EPOXY & RESIN	O	I	L	N
652	07 31 80	0.3300	0.0000	0			STRONG ACIDS	NA	C	L	N
653	07 25 80	2.0000	0.0000	0			ORGANIC SOLVENTS	O	I*	L	N
654	07 28 80	58.9600	0.0000	0			OIL	O	TBD	L	N
655	06 20 80	2.0000	0.0000	0			GALLIUM ARSINIDE,HYDROCHLORIC ACID	I	T/C	L	N
656	06 24 80	7.3700	0.0000	0	19		OIL	O	TBD	L	Y
657	06 27 80	30.0000	0.0000	0	13		POTASSIUM SUPER OXIDE	I	TBD	S	Y
658	06 26 80	1.0000	0.0000	0	13		ASBESTOS	I	TBD	S	Y
659	06 12 80	0.2700	0.0000	0			WASTE ORGANIC	O	NA	NA	N
660	06 12 80	2.0000	0.0000	0			POLYLITE RESIN	O	TBD	NA	N
661	00 00 00	2.0100	0.0000	0			ORGANIC (6/80)	O	NA	L*	N
662	00 00 00	0.1340	0.0000	0			OTHER (6/80)	NA	NA	NA	N
663	06 13 80	0.0000	0.0000	0			ASBESTOS	I	TBD	S	N
664	06 18 80	0.0000	0.0000	0			ASBESTOS	I	TBD	S	N
665	06 19 80	0.0100	0.0000	0			SULFURIC ACID SOLUTION	I	C	L	N
666	00 00 00	0.0000	0.0000	0			MERCURY CONTAMINATED OIL (6/80)	M	T	S	N
667	06 24 80	14.7400	0.0000	0			PLATING ACID	NA	NA	L	N
668	06 24 80	0.0500	0.0000	0			MERCURY	M	T	S*	N
669	06 24 80	0.1000	0.0000	0			ORGANIC	O	NA	L*	N
670	00 00 00	0.0700	0.0000	0			ORGANIC (6/80)	O	NA	L*	N
671	06 05 80	0.2700	0.0000	0			CHEMICALS	NA	NA	NA	N
672	06 05 80	0.0000	0.0000	0			PHOTOCHEMICALS	NA	NA	NA	N
673	06 04 80	7.3700	0.0000	0			ORGANIC	O	NA	L*	N
674	06 04 80	0.0000	10.0000	0			INORGANIC	I	NA	NA	N
675	06 04 80	3.0000	0.0000	0			ASBESTOS	I	TBD		N
676	06 04 80	29.4800	0.0000	0			OIL	O	TBD		N
677	06 04 80	6.7000	0.0000	0			INORGANIC	I	TBD		N
678	06 64 80	0.5400	0.0000	0			ORGANIC	O	NA	L*	N
679	06 04 80	2.6800	0.0000	0			OIL W/ SAND & RESIN	O	TBD	L	N
680	06 10 80	0.5400	0.0000	0			AMMONIUM HYDROXIDE	I	TBD	L	N
681	06 10 80	7.3700	0.0000	0			BERYLLIUM WASTE	M	TBD	S	N
682	06 09 80	0.9400	0.0000	0			HYDROCHLORIC ACID	I	C	L	N
683	06 09 80	32.1600	0.0000	0			OIL	O	TBD	L	N
684	06 09 80	36.8500	0.0000	0			OIL	O	TBD	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 19
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
685	05 08 80	0.0350	0.0000	0			BUTYRIC (?) ACID	O	C	L	N
686	05 07 80	34.8400	0.0000	0			OIL	O	TBD	L	N
687	05 07 80	51.5900	0.0000	0			OIL W/WATER	O	TBD	L	N
688	05 07 80	0.0000	20.0000	0			CALCIUM CHLORIDE	I	TBD	S	N
689	05 06 80	1.3400	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
690	05 06 80	3.0000	0.0000	0			WASTE GLASSWARE & OTHERS	NA	NA	S	N
691	00 00 00	0.0000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
692	05 02 80	3.0800	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
693	05 02 80	0.1700	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
694	05 01 80	2.0100	0.0000	0			SOLVENT	O*	NA	NA	N
695	05 01 80	3.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
696	05 01 80	0.0350	0.0000	0			OIL	O	TBD	L	N
697	05 01 80	1.3400	0.0000	0			ACID	NA	C*	L	N
698	05 01 80	0.0000	0.0000	5			EMPTY GAS CYLINDERS	NA	NA	V	N
699	00 00 00	0.1500	0.0000	0			SULFURIC ACID (5/80)	I	C	L	N
700	00 00 00	0.4100	0.0000	0			PERCHLORIC ACID (5/80)	I	I/C	L	N
701	00 00 00	0.1200	0.0000	0			NITRIC ACID (5/80)	I	C	L	N
702	00 00 00	0.0500	0.0000	0			METHANOL (5/80)	O	I	L	N
703	00 00 00	0.0500	0.0000	0			ACETONE (5/80)	O	I	L	N
704	00 00 00	0.1000	0.0000	0			ACETONE (5/80)	O	I	L	N
705	00 00 00	0.1000	0.0000	0			METHANOL (5/80)	O	I	L	N
706	00 00 00	0.6800	0.0000	0			PERCHLORIC ACID (5/80)	I	I/C	L	N
707	00 00 00	1.1900	0.0000	0			NITRIC ACID (5/80)	I	C	L	N
708	00 00 00	0.3100	0.0000	0			SULFURIC ACID (5/80)	I	C	L	N
709	00 00 00	0.0500	0.0000	0			HYDROFLUORIC ACID (5/80)	I	C	L	N
710	00 00 00	0.1000	0.0000	0			FERROSULFATE (5/80)	I	TBD	L*	N
711	00 00 00	0.0700	0.0000	0			AMMONIUM MOLYBDATE (5/80)	I	TBD	S	N
712	05 21 80	0.2700	0.0000	0			CHEMICALS	NA	NA	NA	N
713	05 19 80	0.5400	0.0000	0			CHEMICALS	NA	NA	NA	N
714	05 20 80	0.2700	0.0000	0			CHEMICALS	NA	NA	NA	N
715	05 20 80	0.0000	0.0000	0			MERCURY	M	T	S*	N
716	05 20 80	0.1100	0.0000	0			CHEMICALS	NA	NA	NA	N
717	05 20 80	0.6700	0.0000	0			SOLUTION	NA	NA	L	N
718	05 19 80	1.0700	0.0000	0			CHEMICALS	NA	NA	NA	N
719	05 14 80	0.4000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
720	05 13 80	22.1100	0.0000	0			BERYLLIUM CONTAMINATED TRASH & OIL	M/O	TBD	S/L	N
721	05 13 80	24.1200	0.0000	0			ACID	NA	C*	L	N
722	05 12 80	0.6700	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 20
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
723	05	12	80	0.0000	0.0000	2			2 GAS CYLINDERS	NA	NA	V	N
724	05	12	80	0.6700	0.0000	0			ORGANIC	O	NA	L*	N
725	05	12	80	0.6700	0.0000	0			OIL	O	TBD	L	N
726	00	00	00	10.7200	0.0000	0			SULFURIC/NITRIC ACIDS (5/80)	I	TBD	L	N
727	05	30	80	2.0100	0.0000	0			NITROBENZENE W/ VERMICULITE	O	T	S	N
728	05	30	80	0.0000	0.0000	0		B	SODIUM HYDROXIDE	I	TBD	S	Y
729	05	30	80	0.2700	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
730	05	29	80	2.4100	0.0000	0			OIL MIX	O	NA	L	N
731	05	23	80	0.0000	0.0000	0			MERCURY BATTERIES	M	T	S	N
732	05	22	80	0.0900	0.0000	0			FORMALDEHYDE	O	I*	L	N
733	05	21	80	0.1700	0.0000	0			TOLUENE/STYRENE MIXTURE W/CYANIDE & VERMICULITE	O	I/R	L	N
734	04	03	80	0.0000	0.0000	1			CERIUM METAL HYDROGEN GAS CYLINDER	M	TBD	S	N
735	04	08	80	53.6000	0.0000	0		B	PHOTOCHEMICALS	NA	NA	NA	Y
736	04	09	80	0.0000	0.0000	0			CESIUM METAL SAMPLE	M	R	S	N
737	04	07	80	147.4000	0.0000	0			OIL	O	TBD	L	N
738	04	18	80	0.0000	7000.0000	0			THERMITE	I	R	S	N
739	04	18	80	56.2800	0.0000	0			LITHIUM HYDRIDE	I	R	S	N
740	04	21	80	0.0000	0.0000	0			TRICHLOROETHYLENE	O	T	L	N
741	04	20	80	2.0000	0.0000	0			ORGANIC	O	NA	L*	N
742	04	20	80	0.1340	0.0000	0			ACID	NA	C*	L	N
743	04	23	80	26.8000	0.0000	0			OIL	O	TBD	L	N
744	04	30	80	0.0000	0.0000	0			SODIUM METAL	M	R	S	N
745	03	24	80	10.8500	0.0000	0			PHOTOCHEMICAL DEVELOPER SOLUTION	O	TBD	L	N
746	03	24	80	12.7300	0.0000	0			PHOTOCHEMICAL STOP BATH	I*	TBD	L	N
747	03	24	80	9.9200	0.0000	0			PHOTOCHEMICAL FIXER	I*	TBD	L	N
748	03	12	80	0.6700	0.0000	0			COAL TAR EPOXY	O	NA	L	N
749	03	21	80	16.0000	0.0000	0			DOWFROST	O	TBD	L	N
750	03	20	80	0.4000	0.0000	0	17		TETRAHYDROFURAN	O	I	L	Y
751	03	04	80	29.4800	0.0000	0			NITRIC ACID	I	C	L	N
752	03	03	80	3.0000	0.0000	0			ORGANIC	O	NA	L*	N
753	03	03	80	4.0000	0.0000	0			INORGANIC	I	NA	NA	N
754	03	03	80	0.1400	0.0000	0			ACID	NA	C*	L	N
755	03	03	80	0.0000	0.0000	0			MERCURY BATTERIES & TRASH	M	T	S	N
756	03	05	80	0.0000	0.0000	0			TRANSIT	O	TBD	L	N
757	03	05	80	0.6700	0.0000	0			CHEMICAL SOLVENTS	O*	I*	L	N
758	03	06	80	0.1700	0.0000	0			TRICHLOROETHYLENE	O	T	L	N
759	03	06	80	0.1700	0.0000	0			TOLUENE	O	I	L	N
760	03	06	80	0.1700	0.0000	0			CHLOROFORM	O	TBD	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 21
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
761	03 06 80	1.3400	0.0000	0			OIL	O	TBD	L	N
762	03 07 80	0.0000	0.0000	0			MERCURY IN OIL	M/O	T	L	N
763	03 07 80	1.0000	0.0000	0			SOLIDS	NA	NA	S	N
764	03 10 80	33.5000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
765	03 10 80	0.0000	0.0000	0			SULFURIC ACID	I	C	L	N
766	03 10 80	0.0000	300.0000	0			BARIUM NITRATE	I	I/T	S	N
767	03 11 80	3.0000	0.0000	0			INORGANIC	I	NA	NA	N
768	03 11 80	1.0000	0.0000	0			ORGANIC	O	NA	L*	N
769	03 11 80	4.0000	0.0000	0			ORGANIC	O	NA	L*	N
770	03 11 80	4.0000	0.0000	0			INORGANIC	I	NA	NA	N
771	03 11 80	1.3400	0.0000	0			OIL	O	TBD	L	N
772	03 11 80	0.1700	0.0000	0			SODIUM,MAGNESIUM,COPPER	M	R	S	N
773	03 11 80	0.4000	0.0000	0			ORGANIC	O	NA	L*	N
774	03 11 80	1.3400	0.0000	0			OIL	O	TBD	L	N
775	03 11 80	0.0000	0.0000	0			IGNITOR METAL	M	NA	S	N
776	03 11 80	2.0000	0.0000	0			WATER	I	TBD	L	N
777	03 11 80	0.0170	0.0000	0			SODIUM HYDRIDE	I	R	S	N
778	03 11 80	0.0170	0.0000	0			ACETONE	O	I	L	N
779	03 12 80	4.0200	0.0000	0			SOLVENT	O*	I*	L	N
780	03 13 80	0.0000	40.0000	0			SODIUM	M	R	S	N
781	03 12 80	12.0600	0.0000	0			OIL	O	TBD	L	N
782	00 00 00	0.0000	0.0000	80			BORON TRIFLUORIDE CYLINDERS(3/80)	I	TBD	V	N
783	03 17 80	134.0000	0.0000	0			AMMONIUM BIFLUORIDE	I	TBD	S	N
784	03 14 80	3.0000	0.0000	0			INORGANIC	I	NA	NA	N
785	03 14 80	1.0000	0.0000	0			ORGANIC	O	NA	L*	N
786	03 17 80	0.0000	0.0000	0			ASBESTOS	I	TBD	S	N
787	03 17 80	1.0700	0.0000	0			PAINT SOLVENTS	O	I	L	N
788	03 18 80	2.6800	0.0000	0			CHEMICALS	NA	NA	NA	N
789	03 19 80	0.5400	0.0000	0		B	ARSENIC	I	T	S	Y
790	03 19 80	0.0000	0.0000	0			EMPTY CYLINDERS	NA	NA	V	N
791	03 20 80	0.6700	0.0000	0			ORGANICS	O	NA	L*	N
792	03 20 80	1.0000	0.0000	0			INORGANICS	I	NA	NA	N
793	03 20 80	0.0350	0.0000	0			ACID	NA	C*	L*	N
794	03 20 80	0.0000	0.0000	0			CONTAMINATED CYLINDER VALVES	NA	NA	NA	N
795	03 20 80	0.4000	0.0000	0			PHOTOCHEMICAL	NA	NA	NA	N
796	03 20 80	0.2700	0.0000	0			ORGANIC	O	NA	L*	N
797	03 25 80	0.5400	0.0000	0			LIQUID	NA	NA	L	N
798	03 25 80	2.0000	0.0000	0			INORGANIC	I	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 22
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
799	03 25 80	14.7400	0.0000	0			ACID	NA	C*	L*	N
800	00 00 00	0.0000	0.0000	0		B	LITHIUM AND SILVER (3/80)	M	T/R	S	Y
801	03 26 80	0.0000	0.0000	100	16		CYLINDERS BORON TRIFLUORIDE	I	TBD	V	Y
802	03 26 80	3.0000	0.0000	0			ORGANIC	O	NA	L*	N
803	03 26 80	14.7400	0.0000	0			OIL	O	TBD	L	N
804	03 26 80	6.7000	0.0000	0			VAC. PUMP OIL	O	TBD	L	N
805	03 28 80	0.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
806	03 31 80	6.0000	0.0000	0			ORGANICS	O	NA	L*	N
807	03 31 80	0.8000	0.0000	0			ACIDS	NA	C*	L*	N
808	03 31 80	3.0000	0.0000	0			ORGANICS	O	NA	L*	N
809	03 31 80	0.8000	0.0000	0			OIL	O	TBD	L	N
810	03 31 80	0.0000	3.0000	0			CADMIUM	M	T	S	N
811	02 01 80	1.3400	0.0000	0			SOLVENT	O*	NA	L	N
812	02 01 80	0.0700	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
813	02 01 80	0.0340	0.0000	0			RESIN	O	NA	L	N
814	02 01 80	0.2000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
815	02 01 80	0.0340	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
816	02 01 80	0.0340	0.0000	0			ACID	NA	C*	L*	N
817	02 04 80	1.3400	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
818	02 04 80	0.4000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
819	02 12 80	0.0000	300.0000	0			BARIUM NITRATE	I	T/I	S	N
820	02 06 80	14.7400	0.0000	0			OIL	O	TBD	L	N
821	02 06 80	3.0000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
822	02 06 80	1.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
823	02 06 80	0.2000	0.0000	0			MERCURY	M	T	S*	N
824	02 13 80	0.4000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
825	02 12 80	0.1700	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
826	02 06 80	0.0000	0.0000	0			OIL, CHEMICALS & METALS	O/M	NA	L/S	N
827	02 13 80	0.5400	0.0000	0			ORGANICS	O	NA	L*	N
828	02 13 80	4.0000	0.0000	0			ORGANICS	O	NA	L*	N
829	02 13 80	3.0000	0.0000	0			INORGANICS	I	NA	NA	N
830	02 13 80	1.0000	0.0000	0			REACTIVE METAL	M	R	S	N
831	02 13 80	0.0000	0.0000	1			CYLINDER W/BAD VALVE	NA	NA	V	N
832	02 12 80	0.4000	0.0000	1			SOLVENT	O	NA	L	N
833	02 12 80	0.4000	0.0000	1			ORGANIC CHEMICALS	O	NA	L*	N
834	02 12 80	2.0000	0.0000	1			INORGANIC CHEMICALS	I	NA	NA	N
835	02 14 80	0.0000	0.0000	0			BERYLLIUM	M	TBD	S	N
836	02 21 80	1.0000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 23
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
837	02	21	80	2.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
838	02	21	80	7.3700	0.0000	0			DILUTE NITRIC ACID	I	TBD	L	N
839	02	21	80	4.0000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
840	02	21	80	4.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	NA	N
841	02	21	80	2.0000	0.0000	0			METAL	M	NA	S	N
842	02	21	80	0.0900	0.0000	0			MERCURY	M	T	S*	N
843	02	22	80	2.6800	0.0000	0			TOLUENE	O	I	L	N
844	02	22	80	0.0000	0.0000	0	16		CYLINDERS	NA	NA	V	Y
845	02	25	80	0.9400	0.0000	0			OIL, CHEMICALS	O	TBD	L	N
846	02	25	80	10.7200	0.0000	0			SULFURIC ACID	I	C	L	N
847	02	25	80	6.7000	0.0000	0			ORGANICS	O	NA	L*	N
848	02	26	80	14.7400	0.0000	0			TOLUENE	O	I	L	N
849	02	26	80	10.7200	0.0000	0			PHOTOCHEMICALS	NA	NA	NA	N
850	02	28	80	7.3700	0.0000	0			NITRIC ACID	I	C	L	N
851	02	28	80	1.0000	0.0000	0			INORGANIC	I	NA	NA	N
852	02	28	80	0.2700	0.0000	0			ACID	NA	C*	L*	N
853	02	28	80	0.4000	0.0000	0			ORGANIC	O	NA	L*	N
854	01	29	80	0.4000	0.0000	0			ORGANIC	O	NA	L*	N
855	01	29	80	0.1340	0.0000	0			NITRIC ACID	I	C	L	N
856	01	29	80	0.0000	0.0000	1			CYLINDER	NA	NA	V	N
857	01	31	80	4.0000	0.0000	0			DRY CHEMICALS	NA	NA	S*	N
858	01	31	80	0.9400	0.0000	0			INORGANIC LIQUID	I	NA	L	N
859	01	31	80	0.2700	0.0000	0			INORGANIC SOLIDS	I	NA	S	N
860	01	14	80	48.2400	0.0000	0			DILUTE ACID	NA	TBD	L	N
861	01	14	80	8.0400	0.0000	0			CAUSTIC	I*	TBD	NA	N
862	01	14	80	8.0400	0.0000	0			METAL	M	NA	S	N
863	01	14	80	0.6700	0.0000	0			SULFURIC ACID	I	C	L	N
864	01	14	80	0.2700	0.0000	0			ORGANIC	O	NA	L*	N
865	01	14	80	0.5400	0.0000	0			INORGANIC	I	NA	NA	N
866	01	10	80	0.6700	0.0000	0			ORGANIC	O	NA	L*	N
867	01	10	80	0.0340	0.0000	0			CAUSTIC	I	TBD	NA	N
868	01	10	80	0.0170	0.0000	0			INORGANIC	I	NA	NA	N
869	01	10	80	0.3400	0.0000	0			METAL POWDER	M	R	S	N
870	01	11	80	14.7400	0.0000	0			COPPER SULFATE	I	TBD	S	N
871	01	11	80	4.2900	0.0000	0			SULFURIC ACID	I	C	L	N
872	01	11	80	3.3500	0.0000	0			ORGANIC	O	NA	L*	N
873	01	11	80	1.3400	0.0000	0			ORGANIC	O	NA	L*	N
874	01	09	80	2.6800	0.0000	0			ORGANIC	O	NA	L*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 24
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
875	01 09 80	0.2600	0.0000	0			INORGANIC	I	NA	NA	N
876	01 09 80	0.0700	0.0000	0			NITRIC ACID	I	C	L	N
877	01 09 80	7.3700	0.0000	0			NICKEL-CONTAMINATED ACID	I*	NA	L	N
878	01 07 80	0.6700	0.0000	0			ALUMINUM SOLVENTS	I*	NA	L	N
879	01 07 80	3.0000	0.0000	0			ORGANICS	O	NA	L*	N
880	01 07 80	0.4000	0.0000	0			ACID	NA	C*	L*	N
881	01 07 80	0.0900	0.0000	0			INORGANICS	I	NA	NA	N
882	01 07 80	0.0170	0.0000	0			ORGANICS	O	NA	L*	N
883	01 03 80	0.0000	0.0000	0			CATHODE RAY TUBE	I	TBD	S	N
884	01 17 80	0.9400	0.0000	0			ETHANOL	O	I	L	N
885	01 17 80	0.0000	0.0000	5			SMALL CYLINDERS	NA	NA	V	N
886	01 23 80	0.0000	0.0000	1			CYLINDER OF SILANE	I	I*	V	N
887	01 23 80	0.2700	0.0000	0			ALCOHOL	O	I*	L	N
888	01 23 80	0.1700	0.0000	0			ORGANICS	O	NA	L*	N
889	01 23 80	0.1400	0.0000	0			INORGANICS	I	NA	NA	N
890	01 23 80	0.0340	0.0000	0			METHYLENE CHLORIDE	O	TBD	L	N
891	01 29 80	2.0100	0.0000	0			OIL W/MAGNESIUM CHIPS	O/M	TBD	L/S	N
892	01 14 80	2.0000	0.0000	0			ASBESTOS	I	TBD	S	N
893	01 14 80	0.1700	0.0000	0			ORGANICS	O	NA	L*	N
894	01 14 80	0.0170	0.0000	0			ETHER	O	I	L	N
895	00 00 00	2.1400	0.0000	0			ACID (1/80)	NA	C*	L*	N
896	01 02 80	0.6700	0.0000	0			ORGANICS	O	NA	L*	N
897	01 02 80	0.4000	0.0000	0			INORGANICS	I	NA	NA	N
898	01 02 80	0.1340	0.0000	0			NITRIC ACID	I	C	L	N
899	01 10 80	0.0340	0.0000	0			LITHIUM METAL IN BTS OIL	O/M	TBD	L/S	N
900	01 10 80	0.0170	0.0000	0			SODIUM METAL IN OIL	O/M	TBD	L/S	N
901	01 24 80	0.0170	0.0000	0			PICRIC ACID	O	R	S	N
902	01 24 80	0.2700	0.0000	0			RESIN CONTAMINATED W/PICRIC ACID	O	R	L	N
903	01 24 80	0.4000	0.0000	0			ORGANIC	O	NA	L*	N
904	01 14 80	0.0000	5.0000	0			COPPER SULFATE	I	TBD	S	N
905	01 09 80	0.6700	0.0000	0			ACID	NA	C*	L*	N
906	01 19 80	0.0000	25.0000	0			INORGANIC SALTS	I	TBD	S	N
907	01 19 80	0.0700	0.0000	0			INORGANIC SALTS	I	TBD	S	N
908	01 09 80	58.9600	0.0000	0			BERYLLIUM CONTAMINATED H20	I	TBD	L	N
909	01 17 80	4.6900	0.0000	0			OIL	O	TBD	L	N
910	01 17 80	1.3400	0.0000	0			ORGANIC	O	NA	L*	N
911	01 17 80	0.2700	0.0000	0			INORGANIC	I	NA	NA	N
912	01 02 80	3.3500	0.0000	0			ACIDS	NA	C*	L*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 25
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
913	01	08	80	2.6800	0.0000	0			ETHER	O	I	L	N
914	01	03	80	0.6700	0.0000	0			SOLVENTS	O*	NA	L	N
915	01	07	80	0.4000	0.0000	0			VACUUM OIL W/DIRT & H2O	O	TBD	L	N
916	01	09	80	0.4000	0.0000	0			SULFURIC ACID	I	C	L	N
917	01	09	80	0.1800	0.0000	0			RESIN	O	I	L	N
918	01	23	80	0.1400	0.0000	0			BENZENE	O	T/I	L	N
919	01	23	80	0.3400	0.0000	0			ETHANOL DYE	O	I	L	N
920	01	28	80	0.4000	0.0000	0			ORGANICS	O	NA	L*	N
921	01	28	80	0.1340	0.0000	0			INORGANICS	I	NA	NA	N
922	03	25	83	4.0100	0.0000	0	23		TRANSFORMER OIL ON ZORBAL & VERMICULITE	O	TBD	S*	Y
923	02	23	83	2.0000	0.0000	0	20		CHROMIC ACID BURIED IN 15 GAL DRUM	I	ITC	L*	Y
924	02	23	83	4.0100	0.0000	0	20		ALUMINUM CHLORIDE IN DRUM #17 PLUS BE	I	R	S	Y
925	02	23	83	4.0100	0.0000	0	20		INORGANICS IN DRUM #18	I	NA	NA	Y
926	02	23	83	4.0100	0.0000	0	20		INORGANICS IN DRUM #17	I	NA	NA	Y
927	02	23	83	0.1300	0.0000	0	20		PERCHLORIC ACID	I	I/C*	L	Y
928	03	24	83	16.0400	0.0000	0	20		INORGANICS DISPOSED OF IN OWN DRUM	I	NA	NA	Y
929	03	24	83	1.3400	0.0000	0	20		10 GAL OF FUME LITHARGE (PRO) (LEAD OXIDE)	I	T	S*	Y
930	09	29	83	14.8300	0.0000	0	20		OIL ON VERMICULITE	O	TBD	S	Y
931	09	29	83	15.8900	0.0000	0	20		CUTTING OIL ON VERMICULITE	O	TBD	S	Y
932	09	29	83	21.8900	0.0000	0	20		OIL ABSORBED ON VERMICULITE	O	TBD	S	Y
933	05	23	83	2.6800	0.0000	0	21		CORRODED CHLORINE AND HYDROGEN FLUORIDE CYLINDERS	I	TBD	V	Y
934	09	29	83	0.4900	0.0000	0	21		FLUORINE CYLINDER VENTED PUT IN SHAFT	I	TBD	V	Y
935	12	15	83	7.0600	0.0000	8	21		CYLINDERS FROM C AREA TO CYL. SHAFT	NA	NA	V	Y
936	04	24	84	0.4900	0.0000	0	21		EMPTY CYLINDERS TO SHAFT	NA	NA	V	Y
937	07	03	84	0.3500	0.0000	0	21		EMPTY GAS MIXING CYLINDER	NA	NA	V	Y
938	08	06	84	2.0100	0.0000	0	21		EMPTY GAS CYLINDERS	NA	NA	V	Y
939	09	24	84	4.9400	0.0000	0	21		EMPTY CYLINDERS	NA	NA	V	Y
940	07	26	84	1.6900	0.0000	0	21		EMPTY CYLINDERS	NA	NA	V	Y
941	11	20	84	3.0000	0.0000	0	21		EMPTY GAS CYLINDERS	NA	NA	V	Y
942	11	20	84	25.0700	0.0000	0	21		EMPTY GAS CYLINDERS	NA	NA	V	Y
943	03	19	85	3.8800	0.0000	0	21		GAS CYLINDERS THAT HAVE BEEN VENTED	NA	NA	V	Y
944	07	15	85	0.1800	0.0000	0	21		EMPTY HELIUM CYLINDERS	I	TBD	V	Y
945	07	25	85	0.7100	0.0000	0	21		EMPTY KRYPTON CYLINDERS	I	TBD	V	Y
946	08	13	85	3.0000	0.0000	0	21		EMPTY FLUORINE CYLINDERS	I	TBD	V	Y
947	08	05	85	14.8300	0.0000	0	21		BATTERIES	I	NA	S	Y
948	02	23	83	3.8800	0.0000	0	22		ORGANICS IN DRUM #40	O	NA	L*	Y
949	02	23	83	3.8800	0.0000	0	22		ORGANIC SOLVENT WITH KEROSENE BASE	O	I*	L	Y
950	02	23	83	3.8800	0.0000	0	22		ORGANIC CHEMICALS	O	NA	L*	Y

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 26
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALSTS.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	LTH	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
951	02	23	83	3.8800	0.0000	0	22		ORGANICS	O	NA	L*	
952	02	23	83	3.8800	0.0000	0	22		ORGANICS DRUM #44	O	NA	L*	
953	02	23	83	3.8800	0.0000	0	22		ORGANICS IN DRUM #45	O	NA	L*	
954	02	23	83	3.8800	0.0000	0	22		ORGANICS IN DRUM #46	O	NA	L*	
955	02	23	83	3.8800	0.0000	0	22		ORGANICS IN DRUM #47	O	NA	L*	
956	02	23	83	3.8800	0.0000	0	22		ORGANICS IN DRUM #39	O	NA	L*	
957	02	23	83	10.9500	0.0000	0	22		CUTTING OIL ON VERMICULITE	O	TBD	S	
958	03	23	83	21.8900	0.0000	0	22		PAINT THINNER IN VERMICULITE	O	TBD	S	
959	03	25	83	7.4200	0.0000	0	22		ORGANICS DRUM #48	O	NA	L*	
960	03	25	83	7.4200	0.0000	0	22		ORGANICS DRUM #49	O	NA	L*	
961	03	15	83	8.1200	0.0000	0	22		CHEMICALS DISPOSED OF IN OWN CONTAINER	NA	NA	NA	
962	03	24	83	109.4600	0.0000	0	22		UNREACT ORGANICS BURIED IN OWN CONTAINER	O	NA	NA	
963	05	25	83	29.3000	0.0000	0	23		OIL ON VERMICULITE	O	TBD	S	
964	05	25	83	29.3000	0.0000	0	23		OIL ON VERMICULITE	O	TBD	S	
965	05	25	83	7.4200	0.0000	0	23		VACUUM PUMP OIL ON VERMICULITE	O	TBD	S	
966	05	25	83	3.8800	0.0000	0	23		OIL ABSORBED ON VERMICULITE	O	TBD	S	
967	05	25	83	1.3400	0.0000	0	23		25 GAL OIL CHROMIUM AND OXYGEN	O	T	L	
968	05	26	83	15.8900	0.0000	0	23		CUTTING OIL ON VERMICULITE	O	TBD	S	
969	12	16	83	78.0400	0.0000	0	23		LOW PCB OIL FOR AREA L	O	TBD	L	
970	12	16	83	15.8900	0.0000	0	23		CUTTING OIL ON VERMICULITE	O	TBD	S	
971	12	16	83	66.0100	0.0000	0	23		LOW PCB OIL ON VERMICULITE	O	TBD	S	
972	12	16	83	21.0900	0.0000	0	23		OIL AND WATER ABSORBED ON VERMICULITE	O	TBD	S	
973	12	16	83	0.6400	0.0000	0	23		DIRTY OIL TO OIL SHAFT	O	TBD	L	
974	12	16	83	197.7400	0.0000	0	23		DIESEL FUEL OIL ON VERMICULITE	O	TBD	S	
975	12	16	83	0.0400	0.0000	0	23		LIGHT WEIGHT OIL TO OIL SHAFT	O	TBD	L	
976	02	23	84	7.4200	0.0000	0	23		OIL ON VERMICULITE	O	TBD	S	
977	02	23	84	29.3100	0.0000	0	23		PCB FREE OIL ON VERMICULITE	O	TBD	S	
978	02	23	84	15.8800	0.0000	0	23		USED CUTTING OIL ON VERMICULITE	O	TBD	S	
979	12	16	83	7.3400	0.0000	0	24		ORGANICS IN DRUM 21	O	TBD	L*	
980	12	16	83	29.4100	0.0000	0	24		OIL AND KEROSENE ON VERMICULITE	O	TBD	S	
981	12	16	83	7.3400	0.0000	0	24		TRICHLOROETHANE ON VERMICULITE	O	TBD	S	
982	12	16	83	22.0700	0.0000	0	24		RESIN	O	TBD	S	
983	12	16	83	7.3400	0.0000	0	24		ETHYLENE GLYCOL ON VERMICULITE	O	TBD	L	
984	12	16	83	29.4100	0.0000	0	24		STODDARD SOLVENT ON VERMICULITE	O	TBD	S	
985	12	16	83	7.3400	0.0000	0	24		ORGANICS IN DRUM 88	O	TBD	S	
986	12	16	83	7.0600	0.0000	0	24		ORGANICS IN DRUM 89	O	NA	L*	
987	12	16	83	7.3400	0.0000	0	24		ORGANICS IN DRUM 99	O	NA	L*	
988	02	29	83	10.6900	0.0000	0	24		2-ETHYL-1HEXANOL	O	NA	L*	
										O	TBD	L	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 27
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
989	02 23 84	14.6900	0.0000	0	24		PAINT THINNER ABSORBED ON VERMICULITE	O	TBD	S	
990	02 23 84	14.6900	0.0000	0	24		2-PROPANOL ABSORBED ON VERMICULITE	O	TBD	S	
991	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 92	O	NA	L*	
992	02 23 84	11.3700	0.0000	0	24		SURFACTANT OVERPACKED IN VERMICULITE	O	TBD	S	
993	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 93	O	NA	L*	
994	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 94	O	NA	L*	
995	02 23 84	14.6900	0.0000	0	24		PAINT THINNER ON VERMICULITE	O	TBD	S	
996	02 23 84	4.6600	0.0000	0	24		GLYCOL ETHER ON VERMICULITE	O	TBD	S	
997	02 23 84	80.8600	0.0000	0	24		OILS WITH SOLVENT ON VERMICULITE	O	TBD	S	
998	02 23 84	36.7600	0.0000	0	24		1,1,1-TRICHLOROETHANE ON VERMICULITE	O	TBD	S	
999	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 95	O	NA	L*	
1000	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 96	O	NA	L*	
1001	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 97	O	NA	L*	
1002	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 98	O	NA	L*	
1003	02 23 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 99	O	NA	L*	
1004	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 111	O	NA	L*	
1005	04 05 84	4.0100	0.0000	0	24		ORGANICS IN DRUM 110	O	NA	L*	
1006	04 05 84	4.0100	0.0000	0	24		ORGANICS IN DRUM 109 (BENZENE)	O	NA	L*	
1007	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 108	O	NA	L*	
1008	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 107	O	NA	L*	
1009	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 106	O	NA	L*	
1010	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 105	O	NA	L*	
1011	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 104	O	NA	L*	
1012	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 103	O	NA	L*	
1013	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 102	O	NA	L*	
1014	04 05 84	7.3400	0.0000	0	24		ORGANICS IN DRUM 101	O	NA	L*	
1015	04 05 84	4.0100	0.0000	0	24		ORGANICS IN DRUM 100	O	NA	L*	
1016	04 05 84	102.9300	0.0000	0	24		LOW LEVEL PCB OIL ON VERMICULITE	O	TBD	S	
1017	04 05 84	12.0300	0.0000	0	24		VACUUM PUMP OIL ON VERMICULITETE	O	TBD	S	
1018	04 05 84	36.7600	0.0000	0	24		TEXACO REGAL OIL ON VERMICULITE	O	TBD	S	
1019	04 05 84	129.6200	0.0000	0	24		ORGANIC AND OIL ON VERMICULITE	O	TBD	S	
1020	03 25 83	7.3400	0.0000	0	25		INORGANIC IN DRUM #20	I	NA	NA	
1021	03 25 83	4.0100	0.0000	0	25		INORGANIC IN DRUM #21	I	NA	NA	
1022	03 25 83	4.0100	0.0000	0	25		INORGANIC IN DRUM #22	I	NA	NA	
1023	03 25 83	4.0100	0.0000	0	25		GALLIUM ARSENIDE ON PAPER TOWELS DRUM #23	I	T/I/C*	S	
1024	04 05 83	0.6700	0.0000	0	25		PERCHLORIC ACID	I	T/I/C*	L	
1025	05 25 83	7.3400	0.0000	0	25		PHOTOCHEMICAL WASTES IN DRUM 23	NA	NA	L*	
1026	05 25 83	7.3400	0.0000	0	25		INORGANICS IN DRUM #24	I	NA	NA	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 28
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1027	05	25	83	4.0300	0.0000	0	25		PHOTOCHEMICALS INORGANIC DRUM # 25	I*	NA	L*	
1028	05	25	83	4.0300	0.0000	0	25		PHOTOCHEMICALS IN DRUM INORGANIC # 26	I*	NA	L*	
1029	05	25	83	7.3400	0.0000	0	25		UNKNOWN WHITE POWDER IN INORGANIC DRUM #27		NA	S	
1030	07	25	83	7.3400	0.0000	0	25		INORGANICS IN DRUM #22		NA	NA	
1031	07	25	83	7.3400	0.0000	0	25		INORGANICS IN DRUM #28		NA	NA	
1032	07	25	83	4.0300	0.0000	0	25		INORGANICS IN DRUM #29		NA	NA	
1033	07	25	83	7.3400	0.0000	0	25		INORGANICS IN DRUM #30		NA	NA	
1034	07	25	83	7.3400	0.0000	0	25		INORGANICS IN DRUM #31		NA	NA	
1035	08	29	83	48.0900	0.0000	0	25		INORGANICS IN OWN CARTONS		NA	NA	
1036	12	16	83	7.3400	0.0000	0	25		INORGANICS IN DRUM #34		NA	NA	
1037	12	16	83	4.0300	0.0000	0	25		SODA LIME IN OWN DRUM		TBD	S	
1038	12	16	83	7.3400	0.0000	0	25		INORGANICS IN DRUM #33		NA	NA	
1039	01	27	84	8.0200	0.0000	0	25		INORGANICS BURIED IN OWN CONTAINERS		NA	NA	
1040	02	23	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #35		NA	NA	
1041	02	23	84	2.0100	0.0000	0	25		OAKITE STRONG DETERGENT (SODIUM PHOSPHATE TRIBASIC)		TBD	S	
1042	02	23	84	4.0300	0.0000	0	25		CHEESECLOTH WITH DIL. ACIDS ON PLASTIC		TBD	S	
1043	04	05	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 41		NA	NA	
1044	04	05	84	4.0300	0.0000	0	25		INORGANICS IN DRUM 40		NA	NA	
1045	04	05	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 39		NA	NA	
1046	04	05	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 38		NA	NA	
1047	04	05	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 37 (NC)		NA	NA	
1048	04	05	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 36		NA	NA	
1049	04	05	84	0.2340	0.0000	0	25		GLASSWARE - MERCURY CONTAM. WITH ARSENIC		T	S	
1050	04	05	84	4.0300	0.0000	0	25		VARIOUS ARTICLES CONTAM. WITH ARSENIC	I	T	S	
1051	04	26	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #46	I	NA	NA	
1052	04	26	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #45	I	NA	NA	
1053	04	26	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #44	I	NA	NA	
1054	04	26	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #42	I	NA	NA	
1055	06	18	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #51	I	NA	NA	
1056	06	18	84	4.0300	0.0000	0	25		GALLIUM ARSENIDE IN DRUM #54	I	T	S	
1057	06	18	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #49	I	NA	NA	
1058	06	18	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #48	I	NA	NA	
1059	06	18	84	7.3400	0.0000	0	25		SIGMA CHEMICALS DISPOSED OF IN OWN DRUMS	NA	NA	NA	
1060	06	18	84	7.3400	0.0000	0	25		BROKEN BATTERY PLUS CLEANUP ON VERMICULITE	I*	NA	S	
1061	06	18	84	7.3400	0.0000	0	25		ENBOND	I*	NA	L	
1062	07	23	84	4.0300	0.0000	0	25		LEAD CHIPS	M	T	S	
1063	07	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 57 COPIER FLUID	I	NA	L	
1064	07	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 56 COPIER FLUID	I	NA	L	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 29
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1065	07	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 55 COPIER FLUID	I	NA	L	
1066	07	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 54	I	NA	L	
1067	07	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 53	I	NA	L	
1068	10	29	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 60	I	NA	L	
1069	09	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 59	I	NA	L	
1070	09	24	84	7.3400	0.0000	0	25		INORGANICS IN DRUM 58	I	NA	L	
1071	09	24	84	7.3400	0.0000	0	25		SODIUM SILICATE	I	TBD	S	
1072	10	29	84	4.0300	0.0000	0	25		BERYLLIUM WASTES PACKED IN VERMICULITE	M	TBD	S	
1073	12	19	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #64 (SALTS)	I	NA	NA	
1074	12	19	84	10.7000	0.0000	0	25		EBONAL-C	NA	TBD	NA	
1075	12	19	84	14.6900	0.0000	0	25		PHOTO RESIST STRIPPER	I*	TBD	L	
1076	12	19	84	22.0500	0.0000	0	25		AMMONIA ETCHANT	I	C*	L	
1077	12	19	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #62	I	NA	NA	
1078	12	19	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #61	I	NA	NA	
1079	12	19	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #63	I	NA	NA	
1080	12	19	84	7.3400	0.0000	0	25		INORGANICS IN DRUM #65	I	NA	NA	
1081	12	19	84	4.0300	0.0000	0	25		HYDROGEN CHLORIDE ON SODIUM CARBONATE	I	TBD	S	
1082	02	21	85	7.3400	0.0000	0	25		INORGANICS IN DRUM #66	I	NA	NA	
1083	02	21	85	7.3400	0.0000	0	25		INORGANICS IN DRUM #67	I	NA	NA	
1084	02	21	85	7.3400	0.0000	0	25		INORGANICS IN DRUM #68	I	NA	NA	
1085	04	26	85	7.3400	0.0000	0	25		INORGANICS IN DRUM #69	I	NA	NA	
1086	03	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #50	O	NA	L*	
1087	03	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #51	O	NA	L*	
1088	03	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #52	O	NA	L*	
1089	03	25	83	7.3400	0.0000	0	26		ORGANICS DRUM #56	O	NA	L*	
1090	03	25	83	7.3400	0.0000	0	26		ORGANICS DRUM #57	O	NA	L*	
1091	03	25	83	7.3400	0.0000	0	26		FLAMMABLE ORGANICS IN DRUM #58	O	I*	L*	
1092	03	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #59	O	NA	L*	
1093	03	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #60	O	NA	L*	
1094	03	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #60	O	NA	L*	
1095	03	25	83	14.7000	0.0000	0	26		BIPHENYL PHTHALATE CONTAMINATED EQUIPMENT	O	TBD	S	
1096	03	25	83	4.0300	0.0000	0	26		1 PT. TRIFLUOROMETHANE & SULFAMIC ACID	O	TBD	L*	
1097	05	25	83	7.3400	0.0000	0	26		ETHANOL & FREON ON VERMICULITE	O	TBD	S	
1098	05	25	83	22.0500	0.0000	0	26		SOLVENT PACKED ON VERMICULITE	O	TBD	S	
1099	05	25	83	14.7000	0.0000	0	26		CHLOROPHENE ON VERMICULITE	O	TBD	S	
1100	05	25	83	7.3400	0.0000	0	26		PHOTOCHEMICAL WASTES IN DRUM #61	I*	NA	L*	
1101	05	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #62	O	NA	L*	
1102	05	25	83	7.3400	0.0000	0	26		ORGANICS IN DRUM #63	O	NA	L*	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 30
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1103	05 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #64	O	NA	L*	
1104	05 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #65	O	NA	L*	
1105	05 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #66	O	NA	L*	
1106	05 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #67	O	NA	L*	
1107	05 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #68	O	NA	L*	
1108	05 25 83	4.0300	0.0000	0	26		ORGANICS IN DRUM #69	O	NA	L*	
1109	05 25 83	4.0300	0.0000	0	26		COPPER SULFATE AND OIL ON VERMICULITE	O	TBD	S	
1110	05 25 83	4.0300	0.0000	0	26		ORGANICS IN DRUM #71	O	NA	L*	
1111	05 25 83	4.0300	0.0000	0	26		ETHYLENE DIAMINE LEAKING DRUM #72	O	I	L	
1112	06 20 83	2.6700	0.0000	0	26		4 5GAL. CANS OF OIL	O	TBD	L	
1113	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #72	O	NA	L*	
1114	07 25 83	29.4100	0.0000	0	26		CLEANING SOL. CONTAIN. BERYLLIUM ON VERMICULITE	I*	NA	S	
1115	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #73	O	NA	L*	
1116	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #74	O	NA	L*	
1117	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #75	O	NA	L*	
1118	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #76	O	NA	L*	
1119	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #77	O	NA	L*	
1120	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #78	O	NA	L*	
1121	07 25 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #79	O	NA	L*	
1122	09 29 83	94.2400	0.0000	0	26		ORGANIC CHEMICALS FROM S-SITE CLEANUP	O	NA	L*	
1123	09 29 83	22.0700	0.0000	0	26		SOLVENT WATSE ON VERMICULITE	O*	TBD	S	
1124	09 29 83	14.6900	0.0000	0	26		ORGANICS ABSORBED ON VERMICULITE	O	TBD	S	
1125	09 29 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #80	O	NA	L*	
1126	09 29 83	4.0300	0.0000	0	26		ORGANICS IN DRUM #81	O	NA	L*	
1127	09 29 83	7.3400	0.0000	0	26		DYE ON VERMICULITE DRUM #82	O	NA	S	
1128	09 29 83	7.3400	0.0000	0	26		ORGANICS IN DRUM #83	O	NA	L*	
1129	09 29 83	4.0300	0.0000	0	26		ORGANICS IN DRUM #84 ON VERMICULITE	O	NA	S	
1130	09 29 83	4.0300	0.0000	0	26		DRUM 85 DYE ON VERMICULITE	O	NA	S	
1131	09 29 83	7.3400	0.0000	0	26		ORGANICS IN DRUM 86	O	NA	L*	
1132	09 29 83	7.3400	0.0000	0	26		ORGANICS IN DRUM 87	O	NA	L*	
1133	03 07 85	16.0300	0.0000	0	26		BERYLLIUM WASTE	M	TBD	S	
1134	04 05 83	2.0000	0.0000	0	27		SULFAMIC ACID ABSORBED ON VERMICULITE	I	TBD	S	
1135	05 12 83	0.0300	0.0000	0	27		MERCURY WITH HIGH EXPLOSIVE TO SHAFT #27	M/O	T/R	S	
1136	05 25 83	11.3700	0.0000	0	27		? OR MISC. ARTICLES 1-55 GAL.,1-30 GAL.	NA	NA	NA	
1137	07 27 83	7.3400	0.0000	0	27		? CONTAMINATED OPTICLES	NA	NA	NA	
1138	07 25 83	4.0300	0.0000	0	27		SODIUM-POTASSIUM CONTAMINATED MATERIAL IN DRUM #32	I	I	S	
1139	07 28 83	0.0200	0.0000	0	27		MERCURY VAPOR LIGHT IN SHAFT 27	M	T	S	
1140	09 09 83	2.6700	0.0000	0	27		BERYLLIUM WASTE IN SPECIAL SHAFT	M	TBD	S	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 31
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1141	02 27 84	0.1100	0.0000	0	27		BERYLLIUM OXIDE	I	TBD	S	
1142	02 23 84	37.7600	0.0000	0	27		CLEANUP FROM HYDROXYLAMINE NITRATE SPILL	I	I*	S*	
1143	02 23 84	29.4100	0.0000	0	27		MAGNESIUM TURNINGS	M	R	S	
1144	02 01 84	0.1000	0.0000	0	27		LASER CELL WITH OSMIUM TETRAOXIDE	I	TBD	S	
1145	02 23 84	4.0300	0.0000	0	27		CLOTHING,GLOVES,ETC. CONTAMINTED WITH ARSENIC	I	T	S	
1146	03 09 84	0.9900	0.0000	0	27		ROLL OF ASBESTOS	I	TBD	S	
1147	03 23 84	1.3400	0.0000	0	27		MATERIALS CONTAMINATED WITH SODIUM & POTASSIUM	I	I	S	
1148	04 05 84	4.0300	0.0000	0	27		LOW LEVEL PCB CONTAM. ARTICLES IN VERM.	O	TBD	S	
1149	04 26 84	0.6700	0.0000	0	27		BERYLLIUM SCRAPS	M	TBD	S	
1150	05 14 84	2.0000	0.0000	0	27		CELLULOSE NITRATE FILM	O	I	S*	
1151	05 10 84	0.1000	0.0000	0	27		MERCURY VAPOR TUBE FROM OZALID MACHINE	I	T	V	
1152	10 29 84	32.0800	0.0000	0	27		BARIUM NITRATE	I	T	S	
1153	11 14 84	2.0000	0.0000	4	27		EMPTY KRYPTON CYLINDERS	I	TBD	V	
1154	11 28 84	0.0200	0.0000	0	27		PICRIC ACID	O	I	S	
1155	12 18 84	5.0000	0.0000	0	27		HEPA FILTERS WITH CARCINOGENS	O	NA	S	
1156	02 21 85	24.0500	0.0000	0	27		BERYLLIUM WASTE	M	TBD	S	
1157	08 06 84	0.5000	0.0000	0	28		BERYLLIUM OXIDE FROM MACHINING	I	TBD	S	
1158	04 26 85	7.3400	0.0000	0	28		ORGANICS IN DRUM #154	O	NA	L*	
1159	04 26 85	7.3400	0.0000	0	28		PHOTOCHEMICALS IN DRUM #155	NA	NA	NA	
1160	04 26 85	8.0200	0.0000	0	28		EPOXY IN DRUMS #156 & 157	O	NA	NA	
1161	04 26 85	7.3400	0.0000	0	28		ORGANICS IN DRUM #158	O	NA	L*	
1162	04 26 85	22.0700	0.0000	0	28		ORGANICS IN DRUMS 162,163,164	O	NA	L*	
1163	04 26 85	66.1700	0.0000	0	28		PAINT ON VERMICULITE	O	TBD	S	
1164	04 26 85	7.3400	0.0000	0	28		EPON RESIN	O	NA	NA	
1165	04 26 85	22.0700	0.0000	0	28		OIL ON VERMICULITE	O	TBD	S	
1166	04 26 85	14.6900	0.0000	0	28		WEED KILLER & COMPOUND SPRAY ON VERMICULITE	NA	NA	S	
1167	04 26 85	7.3400	0.0000	0	28		DIESEL FUEL ON VERMICULITE	O	TBD	S	
1168	04 26 85	8.0200	0.0000	0	28		USED CUTTING OIL ON VERMICULITE	O	TBD	S	
1169	04 26 85	14.6900	0.0000	0	28		TRANSFORMER OIL ON VERMICULITE	O	TBD	S	
1170	04 05 84	7.3400	0.0000	0	29		ORGANICS IN DRUM 113 OIL	O	NA	L*	
1171	04 05 84	7.3400	0.0000	0	29		ORGANICS IN DRUM 112	O	NA	L*	
1172	04 05 84	124.9700	0.0000	0	29		OIL ON VERMICULITE	O	TBD	S	
1173	04 05 84	7.3400	0.0000	0	29		HYDRAULIC OIL (REGAL 0) ON VERMICULITE	O	TBD	S	
1174	04 26 84	7.3400	0.0000	0	29		ORGANICS IN DRUM #116	O	NA	L*	
1175	04 26 84	7.3400	0.0000	0	29		ORGANICS IN DRUM #115 METHANOL	O	NA	L*	
1176	04 26 84	16.0400	0.0000	0	29		VACUUM PUMP OIL ON VERMICULITE	O	TBD	S	
1177	04 26 84	141.2400	0.0000	0	29		OIL ON VERMICULITE	O	TBD	S	
1178	04 26 84	7.3400	0.0000	0	29		INORGANICS IN DRUM 43 (CD)	I	NA	NA	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 32
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1179	04	26	84	7.3400	0.0000	0	29		ORGANICS IN DRUM 114	O	NA	L*	
1180	04	26	84	7.3400	0.0000	0	29		MECHANICAL PUMP OIL	O	TBD	L	
1181	04	26	84	7.3400	0.0000	0	29		CHLOROETHANE,ETHANOL, AND ACETONE	O	I	L	
1182	04	26	84	7.3400	0.0000	0	29		DYE, METHANOL, AND ETHANOL ON VERMICULITE	O	TBD	S	
1183	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #127	O	NA	L*	
1184	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #126	O	NA	L*	
1185	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #125	O	NA	L*	
1186	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #123	O	NA	L*	
1187	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #122	O	NA	L*	
1188	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #121	O	NA	L*	
1189	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #120	O	NA	L*	
1190	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #119	O	NA	L*	
1191	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #118	O	NA	L*	
1192	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM #117	O	NA	L*	
1193	06	18	84	7.3400	0.0000	0	29		INORGANICS IN DRUM 47	I	NA	NA	
1194	06	18	84	29.7700	0.0000	0	29		SLUDGE WITH PCB (10PPM)	O	TBD	S	
1195	06	18	84	7.3400	0.0000	0	29		DIELECTRIC FLUID WITH TRACE OF ARSENIC	O*	T	L	
1196	06	18	84	14.6900	0.0000	0	29		MISC. ORGANIC FLUIDS ON VERMICULITE	O	NA	S	
1197	06	18	84	7.3400	0.0000	0	29		OIL WITH ACETONE ON VERMICULITE	O	TBD	S	
1198	06	18	84	7.3400	0.0000	0	29		METHYL ETHYL KETONE ON VERMICULITE	O	T	S	
1199	06	18	84	7.3400	0.0000	0	29		OIL ON VERMICULITE	O	TBD	S	
1200	06	18	84	58.8300	0.0000	0	29		? FUNGICIDE F16	NA	NA	L*	
1201	06	18	84	7.3400	0.0000	0	29		ORGANICS IN DRUM # 126	O	NA	L*	
1202	06	18	84	7.3400	0.0000	0	29		OIL ABSORBED ON VERMICULITE	O	TBD	S	
1203	06	18	84	7.3400	0.0000	0	29		DIMETHYL SULFOXIDE ON VERMICULITE	O	TBD	S	
1204	06	18	84	218.9200	0.0000	0	30		OIL ON VERMICULITE	O	TBD	S	
1205	07	23	84	22.0700	0.0000	0	30		MIXED ORGANIC WASTES ON VERMICULITE	O	NA	S	
1206	07	23	84	22.0700	0.0000	0	30		SOLVENTS AND OILS ON VERMICULITE	O*	NA	S	
1207	07	23	84	13.3700	0.0000	0	30		SOLIDIFIED PAINT	O	TBD	S	
1208	07	23	84	14.6900	0.0000	0	30		DIBUTYL PHTHALATE ON VERMICULATE	O	TBD	S	
1209	07	23	84	121.4500	0.0000	0	30		OIL ON VERMICULITE	O	TBD	S	
1210	07	23	84	7.3400	0.0000	0	30		CHLOROETHANE,ETHANOL,ACETONE,OIL ON VERMICULITE	O	TBD	S	
1211	07	23	84	14.6900	0.0000	0	30		DIBUTYL CARBITOL ON VERMICULATE	O	TBD	S	
1212	07	23	84	14.6900	0.0000	0	30		STODDARD SOLVENT ON VERMICULATE	O	TBD	S	
1213	07	23	84	14.6900	0.0000	0	30		TRICHLOROETHYLENE ON VERMICULATE	O	T	S	
1214	07	23	84	14.6900	0.0000	0	30		ISOBUTYL ACETATE ON VERMICULITE	O	TBD	S	
1215	07	23	84	14.6900	0.0000	0	30		METHYL ISOBUTYLKETONE ON VERMICULITE	O	TBD	S	
1216	07	23	84	14.6900	0.0000	0	30		DOWCLENE ON VERMICULITE	O	TBD	L	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 33
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1217	07	23	84	14.6900	0.0000	0	30		?? CONCENTRATE ON VERMICULITE	NA	NA	S	
1218	07	23	84	14.6900	0.0000	0	30		TRIBUTYL PHOSPHATE ON VERMICULITE	O	TBD	S	
1219	07	23	84	7.3400	0.0000	0	30		DIESEL OIL ON VERMICULITE	O	TBD	S	
1220	07	23	84	14.6900	0.0000	0	30		ACETONE ON VERMICULITE	O	TBD	S	
1221	07	23	84	14.6900	0.0000	0	30		METHYLENE CHLORIDE ON VERMICULITE	O	TBD	S	
1222	07	23	84	22.0700	0.0000	0	30		FREON ON VERMICULITE	O	TBD	S	
1223	07	23	84	14.6900	0.0000	0	30		WASTE OIL ON VERMICULITE	O	TBD	S	
1224	07	23	84	14.6900	0.0000	0	30		ORGANICS IN DRUM 132	O	NA	L*	
1225	07	23	84	14.6900	0.0000	0	30		ORGANICS IN DRUM 131	O	NA	L*	
1226	07	23	84	14.6900	0.0000	0	30		ORGANICS IN DRUM 130	O	NA	L*	
1227	07	23	84	14.6900	0.0000	0	30		ORGANICS IN DRUM 129	O	NA	L	
1228	07	24	84	7.3400	0.0000	0	31		ORGANIC DYE ON VERMICULITE	O	TBD	S	
1229	07	24	84	22.0700	0.0000	0	31		PAINT THINNER ON VERMICULITE	O	TBD	S	
1230	07	24	84	7.3400	0.0000	0	31		VACUUM PUMP OIL ON VERMICULITE	O	TBD	S	
1231	07	24	84	29.4100	0.0000	0	31		DIRT WITH ORGANICS	O	NA	S	
1232	09	24	84	7.3400	0.0000	0	31		ORGAINCS IN DRUM 139	O	NA	L*	
1233	09	24	84	7.3400	0.0000	0	31		ORGANICS IN DRUM 137	O	NA	L*	
1234	09	24	84	7.3400	0.0000	0	31		ORGANICS IN DRUM 136	O	NA	L*	
1235	09	24	84	7.3400	0.0000	0	31		ORGANICS IN DRUM 135	O	NA	L*	
1236	09	24	84	12.0400	0.0000	0	31		OIL ON VERMICULITE	O	TBD	S	
1237	09	24	84	14.6900	0.0000	0	31		TRICHLOROETHYLENE ON VERMICULITE	O	T	S	
1238	10	29	84	7.3400	0.0000	0	31		ORGANICS IN DRUM 143	O	NA	L*	
1239	10	29	84	7.3400	0.0000	0	31		ORGANICS IN DRUM 144	O	NA	L*	
1240	09	24	84	132.3400	0.0000	0	31		OIL ON VERMICULITE	O	TBD	S	
1241	09	24	84	22.0700	0.0000	0	32		OIL ON VERMICULITE	O	TBD	S	
1242	09	24	84	36.7600	0.0000	0	32		SHEATH (STODDARD SOLVENT) ON VERMICULITE	O	TBD	S	
1243	10	29	84	7.3400	0.0000	0	33		ORGANICS IN DRUM 142	O	NA	L*	
1244	10	29	84	7.3400	0.0000	0	33		ORGANICS IN DRUM 141	O	NA	L*	
1245	10	29	84	7.3400	0.0000	0	33		ORGANICS IN DRUM 140	O	NA	L*	
1246	10	29	84	7.3400	0.0000	0	33		ORGANICS IN DRUM 138	O	NA	L*	
1247	10	29	84	7.3400	0.0000	0	33		ORGANICS IN DRUM 134	O	NA	L*	
1248	10	29	84	7.3400	0.0000	0	33		ORGANICS IN DRUM 133	O	NA	L*	
1249	10	29	84	7.3400	0.0000	0	33		ORGANICS SOLVENTS ON VERMICULITE	O	NA	S	
1250	10	29	84	95.5700	0.0000	0	33		LOW LEVEL PCB OIL ON VERMICULITE	O	TBD	S	
1251	10	29	84	7.3400	0.0000	0	33		NON-PCB TRANS. OIL AND WATER ON VERMICULITE	O	TBD	S	
1252	12	19	84	7.3400	0.0000	0	33		ORGANICS IN DRUM #148	O	NA	L*	
1253	12	19	84	7.3400	0.0000	0	33		ORGANICS IN DRUM #149	O	NA	L*	
1254	12	19	84	58.8100	0.0000	0	33		OIL ON VERMICULITE	O	TBD	S	

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 34
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1255	12	19	84	7.3400	0.0000	0	33		ORGANICS IN DRUM #146	O	NA	L*	Y
1256	12	19	84	7.3400	0.0000	0	33		ORGANICS IN DRUM #145	O	NA	L*	Y
1257	12	19	84	7.3400	0.0000	0	33		ORGANICS IN DRUM #147	O	NA	L*	Y
1258	12	19	84	7.3400	0.0000	0	33		MACHINE OIL ON VERMICULITE	O	TBD	S	Y
1259	12	19	84	58.8100	0.0000	0	33		TRICHLOROETHANE,1-1-1 ON VERMICULITE	O	TBD	S	Y
1260	12	19	84	7.3400	0.0000	0	33		ORGANICS ON VERMICULITE	O	NA	S	Y
1261	12	19	84	2.2700	0.0000	0	33		USED PUMP OIL ON VERMICULITE	O	TBD	S	Y
1262	12	19	84	8.0200	0.0000	0	33		USED VACUUM PUMP OIL ON VERMICULITE	O	TBD	S	Y
1263	02	21	85	7.3400	0.0000	0	33		CHLOROETHANE ON VERMICULITE	O	TBD	S	Y
1264	02	21	85	12.0400	0.0000	0	33		ORGANICS	O	NA	L*	Y
1265	02	21	85	7.3400	0.0000	0	33		ORGANICS IN DRUM #152	O	NA	L*	Y
1266	02	21	85	4.0300	0.0000	0	33		METHANOL & LASER DYE ON VERMICULITE	O	TBD	S	Y
1267	02	21	85	4.0300	0.0000	0	33		MOTOR OIL ABSORBED ON VERMICULITE	O	TBD	S	Y
1268	02	21	85	7.3400	0.0000	0	33		ORGANICS IN DRUM #150	O	NA	L*	Y
1269	02	21	85	7.3400	0.0000	0	33		ORGANICS IN DRUM #151	O	NA	L*	Y
1270	02	21	85	7.3400	0.0000	0	33		ORGANICS IN DRUM #153	O	NA	L*	Y
1271	02	21	85	36.7600	0.0000	0	33		USED TRASH FLUIDS IN VERMICULITE	NA	NA	S*	Y
1272	02	21	85	0.0000	0.0000	0	33		CHLORETHANE,ETHANOL,WATER,ACETONE,OIL	O	I	L	Y
1273	02	21	85	29.4100	0.0000	0	33		ACETONE ON VERMICULITE	O	TBD	S*	Y
1274	02	21	85	4.0300	0.0000	0	33		VACUUM PUMP OIL ON VERMICULITE	O	TBD	S	Y
1275	02	21	85	14.6900	0.0000	0	33		VACUUM PUMP OIL ON VERMICULITE	O	TBD	S	Y
1276	04	26	85	7.3400	0.0000	0	34		ORGANICS IN DRUM #159	O	NA	L*	Y
1277	04	26	85	14.6900	0.0000	0	34		ORGANICS IN DRUM #160	O	NA	L*	Y
1278	04	26	85	66.1700	0.0000	0	34		PSEUDO (TRI-METHYL-BENZENE)	O	I	L	Y
1279	04	26	85	0.0000	0.0000	0	34		LOW PCB OIL ON VERMICULITE	O	TBD	S	Y
1280	04	26	85	11.3700	0.0000	0	34		NEUTRALIZED ACIDS,HYDRIDES & SULFATES	I	C*/R*	S/L	Y
1281	05	07	85	7.3400	0.0000	0	34		ORGANICS IN DRUM #161	O	NA	L*	Y
1282	05	07	85	7.3400	0.0000	0	34		ORGANICS IN DRUM #165	O	NA	L*	Y
1283	05	07	85	0.0000	0.0000	0	34		TRICHLOROETHANE ON VERMICULITE	O	TBD	S*	Y
1284	05	07	85	26.0600	0.0000	0	34		PHOTO STRIPPING ON VERMICULITE	I	TBD	S*	Y
1285	05	07	85	22.0300	0.0000	0	34		WASTE FLUID MIXED WITH VERMICULITE	NA	NA	S*	Y
1286	05	07	85	7.3400	0.0000	0	34		ORGANICS OF VARIOUS TYPES	O	NA	L*	Y
1287	05	25	83	0.5330	0.0000	0		B	DEVELOPER TO ORGANIC PIT	O	TBD	L	Y
1288	10	24	83	0.1300	0.0000	0		B	CORROSIVE LIQUID TO PIT B	I*	C*	L	Y
1289	11	01	83	0.3530	0.0000	0		B	AQUEOUS SOLUTION TO INORGANIC PIT	NA	NA	L	Y
1290	01	26	84	22.0700	0.0000	0		B	BORIC ACID SOL. TO PIT	I	NA	L	Y
1291	07	13	84	80.1900	0.0000	0			AMMONIUM BIFLUORIDE	I	TBD	S	N
1292	07	16	84	1.0030	0.0000	0			P.T. ACTIVATOR DEVELOPER	O*	NA	L*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 35
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1293	07 25 84	66.8400	0.0000	0			AMMONIUM BIFLUORIDE	I	TBD	S	N
1294	08 01 84	80.1900	0.0000	0			AMMONIUM BIFLUORIDE	I	TBD	S	N
1295	08 07 84	0.0000	0.3600	0			ZINC, NICKEL, ARSENIC	I	T	S	N
1296	09 02 83	0.2680	0.0000	0		B	AMMONIA FROM OZALID MACHINE TO PIT	I	C	L	Y
1297	11 14 83	0.1340	0.0000	0		B	AMMONIA FROM OZALID MACHINE TO PIT	I	C	L	Y
1298	11 29 83	0.0670	0.0000	0		B	AMMONIA FROM OZALID MACHINE TO PIT	I	C	L	Y
1299	12 20 83	0.1590	0.0000	0		B	PHOTOCHEMICALS TO PIT	O*	NA	L*	Y
1300	01 19 84	24.0500	0.0000	0		B	BASIC PHOTOCHEMICALS IN INORGANIC PIT	NA	NA	L*	Y
1301	11 17 83	0.0700	0.0000	0		B	LITHIUM HYDRIDE REACTED IN PIT	I	R	S	Y
1302	08 05 77	4.0000	0.0000	0			SOLVENTS	O	NA	L	N
1303	07 28 77	4.0000	0.0000	0			LITHIUM CHIPS	M	R	S	N
1304	07 28 77	21.4000	0.0000	0			SULFURIC & CHROMIC ACID	I	C	L	N
1305	06 20 77	4.0000	0.0000	0			ACIDS, BASES, ORGANICS	O/I	NA	L	N
1306	07 14 77	0.1000	0.0000	0			EPOXY MATERIAL	O	NA	L*	N
1307	07 22 77	1.0000	0.0000	0			OLD OZALID SOLUTION	NA	NA	NA	N
1308	07 27 77	0.5000	0.0000	0			ETHER	O	I	L	N
1309	07 28 77	1.5000	0.0000	0			SODIUM-POTASSIUM ALLOY	M	I	S*	N
1310	07 12 77	8.0000	0.0000	0	02		SODIUM CHLORIDE ALLOY	I	TBD	S	Y
1311	07 13 77	16.0000	0.0000	0			BORIC ACID	I	TBD	S	N
1312	06 21 77	3.0000	0.0000	0			MISC CHEMICALS	NA	NA	NA	N
1313	07 12 77	1.0000	0.0000	0			NITRIC ACID	I	C	L	N
1314	07 13 77	2.0000	0.0000	0			PHOSPHORIC ACID	I	C	L	N
1315	07 14 77	2.0000	0.0000	0			PLATING SOLUTION	NA	NA	L	N
1316	07 18 77	32.0000	0.0000	0			SOLVENTS	O	NA	L	N
1317	07 20 77	6.0000	0.0000	0			MISC. ORGANICS	O	NA	L*	N
1318	07 20 77	2.0000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1319	07 20 77	1.0000	0.0000	0			BENZENE, EPOXY MATERIAL	O	T	L	N
1320	07 20 77	0.5000	0.0000	0			BENZENE	O	T	L	N
1321	07 20 77	4.0000	0.0000	0			SOLVENTS	O	NA	L	N
1322	07 21 77	2.0000	0.0000	0			CALCIUM CARBIDE	O	R	S	N
1323	07 25 77	2.0000	0.0000	0			SODIUM-POTASSIUM ALLOY VALVES	M	I	S	N
1324	07 25 77	1.0000	0.0000	0			SODIUM-POTASSIUM ALLOY VALVES	M	I	S	N
1325	07 27 77	0.5000	0.0000	0			SODIUM-POTASSIUM ALLOY VALVES	M	I	S	N
1326	00 00 00	1.0000	0.0000	0			MISC CHEMICALS (7/77)	NA	NA	NA	N
1327	00 00 00	16.5000	0.0000	0			FERRIC CHLORIDE (7/77)	I	TBD	S	N
1328	00 00 00	1.0000	0.0000	0			LITHIUM & BERYLLIUM OXIDE (7/77)	M/I	R	S	N
1329	08 12 77	8.0000	0.0000	0			USED OIL	O	TBD	L	N
1330	08 12 77	16.0000	0.0000	0			SOLVENT-TRICHLORETHYLENE	O	T	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 36
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1331	06 06 77	0.0000	0.0000	0			MAGNESIUM METAL	M	I	S	N
1332	06 06 77	54.0000	0.0000	0			SOLVENTS & OIL	O	NA	L	N
1333	08 03 77	16.0000	0.0000	0			SOLVENTS	O	NA	L	N
1334	08 15 77	1.0000	0.0000	0			SODIUM-POTASSIUM ALLOY VALVES	M	I	S	N
1335	07 22 77	2.0000	0.0000	0			ETHYLENE OXIDE, HYDROCHLORIC ACID	O/I	I*/C	L	N
1336	08 10 77	2.0000	0.0000	0			SOLVENTS, ALCOHOL, DYE	O	I*	L	N
1337	07 14 77	16.0000	0.0000	0	10		TISSUE EQUIVALENT FLUID	NA	NA	L	Y
1338	08 10 77	8.0000	0.0000	0	10		SOLVENTS	O	NA	L	Y
1339	08 10 77	80.4000	0.0000	0		A	AMMONIUM BIFLUORIDE SOLUTION	I	TBD	S	Y
1340	00 00 00	1.0000	0.0000	0			SODIUM-POTASSIUM ALLOY (8/77)	M	I	S	N
1341	08 03 77	1.0000	0.0000	0			SODIUM-POTASSIUM ALLOY	M	I	S	N
1342	07 20 77	0.5000	0.0000	0			ARSENIC	I	T	S	N
1343	04 19 77	0.5000	0.0000	0			CALCIUM CARBIDE	O	R	S	N
1344	03 02 77	0.5000	0.0000	0			RUST INHIBITOR	NA	NA	NA	N
1345	04 06 77	4.0000	0.0000	0			SOLVENTS	O	NA	L	N
1346	03 23 77	1.0000	0.0000	0			EPOXY WASTE	O	TBD	L*	N
1347	04 20 77	18.7600	0.0000	0			ACETIC ACID	O	C*	L	N
1348	03 15 77	20.0000	0.0000	0			DIMETHYLSULFOXIDE, DIETHYL ETHER	O	TBD	L	N
1349	00 00 00	1.0000	0.0000	0			PCB (3/77)	O	TBD	L	N
1350	04 04 77	16.0000	0.0000	0			NITRITES	I	NA	S	N
1351	03 16 77	8.0000	0.0000	0			ACETONE	O	I	L	N
1352	03 16 77	20.0000	0.0000	0			OXYGEN (NITROGEN DIOXIDE) GAS CYLINDERS	I	TBD	V	N
1353	00 00 00	20.0000	0.0000	0			PALLADIUM CHLORIDE (3/77)	I	TBD	S	N
1354	02 24 77	46.0000	0.0000	0			LITHIUM HYDRIDE RESIDUES	I	I	S	N
1355	02 17 77	56.0000	0.0000	0			DIRTY OIL	O	TBD	L	N
1356	03 23 77	1.0000	0.0000	0			CAPACITOR	O	TBD	L	N
1357	03 31 77	9.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1358	03 31 77	1.0000	0.0000	0			TRIFLUOROMETHANE SULFONIC ANHYDRIDE	O	TBD	L*	N
1359	04 05 77	3.0000	0.0000	0			MAGNESIUM TURNINGS	M	I	S	N
1360	03 17 77	5.0000	0.0000	0			DARK ROOM CHEMICALS (PHOTOCHEMICALS)	I*	NA	L*	N
1361	00 00 00	13.0000	0.0000	0	02		NITRIC ACID (3/77)	I	C	L	Y
1362	03 09 77	18.0000	0.0000	0			CAPACITOR OIL & MISC. CHEMICALS	O	NA	L	N
1363	04 11 77	48.0000	0.0000	0			USED OIL	O	TBD	L	N
1364	04 12 77	24.0000	0.0000	0			USED SOLVENTS	O	NA	L	N
1365	02 28 77	0.2680	0.0000	0			TOLUENE	O	I	L	N
1366	00 00 00	0.6700	0.0000	0			CUTTING OIL CONTAINING NITRATES (2/77)	O	NA	L	N
1367	00 00 00	2.0000	0.0000	0			BARIUM PEROXIDE & NITROBASE (2/77)	NA	I/T	S*	N
1368	02 10 77	2.0000	0.0000	0			AMMONIUM PERSULFATE & MISC. PHOTOCHEMICALS	I*	N/I*	L*	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 37
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1369	00	00	00	5.0000	0.0000	0			NICKEL CARBONYL & OIL (2/77)	O	I*	L	N
1370	01	31	77	2.0000	0.0000	0			MISC. OLD CHEMICALS	NA	NA	NA	N
1371	00	00	00	1.0000	0.0000	0			MISC. ORGANIC SOLVENTS (2/77)	O	NA	L	N
1372	02	09	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1373	02	03	77	3.5000	0.0000	0			FERRIC CHLORIDE ETCHANT	I	TBD	L*	N
1374	02	03	77	11.2000	0.0000	0			NICKEL STRIKE (NICKEL CHLORIDE & HYDROCHLORIC ACID)	I	C*	L	N
1375	02	04	77	60.0000	0.0000	0			USED OIL & PHOSPHORIC ACID	O	C*	L	N
1376	01	26	77	1.3000	0.0000	0			PHOTOCHEMICALS	I	NA	L	N
1377	02	02	77	32.1600	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1378	02	04	77	2.0100	0.0000	0			SOLVENT & DYE	O	NA	L	N
1379	02	04	77	1.0000	0.0000	0			DEUTERIUM & THALLIUM METAL	N	R	S	N
1380	02	07	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1381	02	02	77	376.0000	0.0000	0			USED OIL, MISC. CHEMICALS, SOLVENTS	O	NA	L	N
1382	02	02	77	5.0000	0.0000	0			TOLUENE	O	I	L	N
1383	01	27	77	6.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1384	01	11	77	24.0000	0.0000	0			NICKEL ELECTROPLATING BATH	I*	TBD	L	N
1385	01	26	77	10.0000	0.0000	0			MISC. OLD CHEMICALS	NA	NA	NA	N
1386	01	19	77	0.5400	0.0000	0			ALCOHOL & DYE	O	I*	L	N
1387	01	14	77	0.1300	0.0000	0			METHYLENE CHLORIDE	O	TBD	L	N
1388	01	13	77	1.0000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1389	01	13	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1390	01	13	77	0.6700	0.0000	0			WASTE SOLVENT (ALCOHOL)	O	I	L	N
1391	01	27	77	0.0000	3.0000	0	06		SODIUM	N	R	S	Y
1392	12	28	77	1.0000	0.0000	0			OSMIUM TETROXIDE	I	TBD	S	N
1393	12	21	77	0.0000	0.0000	0			MISC. OLD CHEMICALS	NA	NA	NA	N
1394	12	21	77	3.0000	0.0000	0			AMMONIUM NITRATE	I	I	S	N
1395	12	15	77	6.0000	0.0000	0			ACID, DOWANOL & MINERAL OIL	O	I*	L	N
1396	12	15	77	6.0000	0.0000	0			PHOSPHORIC ACID & MISC. CHEMICALS	NA	C*	L	N
1397	12	15	77	4.0000	0.0000	0			TRANSFORMER OIL, FORMALDEHYDE	O	TBD	L	N
1398	12	13	77	32.0000	0.0000	0			CHROMIC SULFURIC ACID ETCHING SOL'N	I	C	L	N
1399	12	08	77	2.0000	0.0000	0	09		LEAKING FLUORINE GAS CYLINDER	I	TBD	V	Y
1400	12	02	77	1.0000	0.0000	0			SOLVENTS	O	NA	L	N
1401	12	01	77	0.5000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1402	12	01	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1403	12	01	77	5.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1404	12	01	77	10.0000	0.0000	0			ASBESTOS CONTAMINATED CEMENT, OIL, ORGANIC CHEMICALS	O	NA	S/L	N
1405	12	15	77	30.0000	0.0000	0			MISC. OLD CHEMICALS	NA	NA	NA	N
1406	11	23	77	1.0000	0.0000	0			SOLVENTS	O	NA	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 38
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALSTS.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1407	11	23	77	10.0000	0.0000	-0			MISC. CHEMICALS	NA	NA	NA	N
1408	11	21	77	18.7600	0.0000	0			INDENE	O	TBD	L	N
1409	11	21	77	20.6400	0.0000	0			CHEMICALS	NA	NA	NA	N
1410	11	21	77	27.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1411	00	00	00	0.5000	0.0000	0			LITHIUM METAL IN HEAT PIPE (11/77)	M	I	S	N
1412	11	18	77	22.0000	0.0000	0	07		UNKNOWN	NA	NA	NA	Y
1413	11	18	77	20.1000	0.0000	0			LITHIUM HYDRIDE	I	I	S	N
1414	11	15	77	1.0000	0.0000	0			ACETONE, XYLENE, ALCOHOL	O	I	L	N
1415	01	14	77	5.0000	0.0000	0			MISC. OLD CHEMICALS	NA	NA	NA	N
1416	11	14	77	5.0000	0.0000	0			MISC. OLD CHEMICALS	NA	NA	NA	N
1417	11	02	77	2.0000	0.0000	0			USED OIL	O	TBD	L	N
1418	11	03	77	14.0000	0.0000	0			KEROSENE & SOLVENTS	O	I	L	N
1419	11	03	77	40.0000	0.0000	0			USED OIL	O	TBD	L	N
1420	11	03	77	1.0000	0.0000	0			INORGANIC CHEMICALS	I	NA	S	N
1421	11	03	77	0.0000	0.0000	6			RESPIRATOR CARTRIDGES	I	NA	S	N
1422	11	09	77	2.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1423	11	10	77	15.0000	0.0000	0			SODIUM FLUORIDE, MISC. CHEMICALS & SOLVENTS	O	NA	L	N
1424	11	11	77	1.0000	0.0000	0			FREON 13	O	TBD	L	N
1425	11	14	77	32.0000	0.0000	0			SOLVENTS	O	NA	L	N
1426	11	17	77	12.0000	0.0000	0			OLD GAS CYLINDERS	NA	NA	V	N
1427	11	17	77	2.0000	0.0000	0			SOLVENTS	O	NA	L	N
1428	00	00	00	0.1000	0.0000	0			HELIUM CONTAMINATED MERCURY	M	T	S	N
1429	11	09	77	1.3400	0.0000	0			USED OIL & SOLVENTS	O	TBD		N
1430	11	08	77	0.2700	0.0000	0			OIL	O	TBD	L	N
1431	11	09	77	2.6800	0.0000	0			MISC. CHEMICALS & WASTE OIL	O	NA	L	N
1432	11	09	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1433	11	02	77	4.1000	0.0000	0			SULFURIC ACID	I	C	L	N
1434	11	02	77	2.0000	0.0000	0			LEAKY CAPACITORS	O	TBD	L	N
1435	10	14	77	48.0000	0.0000	0			EPOXY RESIN, CURING AGENTS	O	I*	L	N
1436	10	14	77	200.0000	0.0000	0			OIL	O	TBD	L	N
1437	10	14	77	1.0000	0.0000	0			LITHIUM HYDRIDE	I	I	S	N
1438	10	04	77	72.0000	0.0000	0	10		OIL	O	TBD	L	Y
1439	10	03	77	4.0000	0.0000	0			ORGANIC CHEMICALS	O	NA	L*	N
1440	09	26	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1441	09	21	77	4.0200	0.0000	0			TRANSFORMER OIL	O	TBD	L	N
1442	09	20	77	2.0000	0.0000	0			SOLVENTS, ETC.	O	NA	L	N
1443	09	16	77	17.4200	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1444	09	15	77	16.0000	0.0000	0	10		PCB CONTAMINATED RAGS	O	TBD	S	Y

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 39
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1445	09	15	77	32.0000	0.0000	0	10		SOLVENTS	O	NA	L	Y
1446	09	08	77	0.1000	0.0000	0			MAGNESIUM	M	I	S	N
1447	09	07	77	9.0000	0.0000	0			BATTERY ACID	I	C	L	N
1448	09	06	77	10.0000	0.0000	0			OLD CHEMICALS	NA	NA	NA	N
1449	08	31	77	64.0000	0.0000	0	02		WHITE PHOSPHOROUS PACKAGED UNDER WATER	I	I	L	Y
1450	00	00	00	0.5000	0.0000	0			IRON PENTACARBONYL	O	I	L	N
1451	08	31	77	1.0000	0.0000	0			BROMINE	I	TBD	L	N
1452	08	30	77	8.0000	0.0000	0			SOLVENTS	O	NA	L	N
1453	08	30	77	1.3400	0.0000	0			OIL	O	TBD	L	N
1454	08	30	77	6.0000	0.0000	0			BERYLLIUM WIRE	M	TBD	S	N
1455	08	29	77	2.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1456	08	29	77	10.0000	0.0000	0			WHITE PHOSPHOROUS, FIRE EXTINGUISHER POWDER, MISC. CHEMICALS	NA	I	S*	N
1457	08	29	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1458	08	29	77	5.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1459	08	29	77	8.0000	0.0000	0			MISC. INORGANIC & ORGANIC CHEMICALS	I/O	NA	NA	N
1460	08	26	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1461	07	13	77	9.0000	0.0000	0			SULFURIC ACID	I	C	L	N
1462	00	00	00	0.0000	400.0000	0			POLYETHYLENE POWDER (8/77)	O	TBD	S	N
1463	00	00	00	0.0000	150.0000	0			NEOPRENE (8/77)	O	TBD	S	N
1464	07	01	77	3.3500	0.0000	0			TRICHLOROETHANE	O	TBD	L	N
1465	08	23	77	25.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1466	03	15	77	1.0000	0.0000	0			PHOSPHOROUS PENTOXIDE	I	R	S	N
1467	03	15	77	2.0000	0.0000	0			URANIUM HYDRIDE CAPSULES	I	I	S	N
1468	03	08	77	8.0000	0.0000	0			METHANE GAS CYLINDERS	O	I	V	N
1469	03	08	77	6.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1470	03	08	77	6.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1471	00	00	00	20.0000	0.0000	0			SOLVENT, USED OIL (3/77)	O	NA	L	N
1472	01	19	77	1.0000	0.0000	0			MISC. CHEMICALS	NA	NA	NA	N
1473	00	00	00	1.0000	0.0000	0			MISC. CHEMICALS (1/77)	NA	NA	NA	N
1474	01	04	77	1.0000	0.0000	0			MISC. INORGANIC CHEMICALS	I	NA	NA	N
1475	00	00	00	6.0000	0.0000	0			CHEMICALS (1/77)	NA	NA	NA	N
1476	00	00	00	0.0000	0.0000	0			CHEMICALS (1/77)	NA	NA	NA	N
1477	11	06	80	0.0170	0.0000	0			CARBON TETRACHLORIDE	O	T	L	N
1478	11	06	80	0.0340	0.0000	0			CHLOROFORM	O	T	L	N
1479	11	06	80	0.0510	0.0000	0			BROMOTRICHLOROMETHANE	O	TBD	L	N
1480	11	06	80	0.0340	0.0000	0			ACETIC ANHYDRIDE	O	I	L	N
1481	11	06	80	0.0000	44.0000	0			1,2,DICHLOROETHANE	O	T/I	L	N
1482	11	06	80	0.0340	0.0000	0			CHLOROBENZENE	O	T/I	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 40
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1483	11 06 80	0.0170	0.0000	0			N,N,DIMETHYLFORMIDE	O	I	L	N
1484	11 06 80	0.0000	2.2000	0			FLUOROBENZENE	O	I*	L	N
1485	11 06 80	0.0000	33.0000	0			BUTYROLACTONE	O	TBD	L	N
1486	11 06 80	0.0170	0.0000	0			MONOCHLORONAPHTHALENE	O	TBD	L	N
1487	11 06 80	0.0000	2.2000	0			DICHLOROBENZENE	O	T*	S*	N
1488	11 06 80	0.2000	0.0000	0			KODAK RESIST THINNER TYPE 3	O	TBD	L	N
1489	11 06 80	0.0000	28.0000	0			PHOTO RESIST CHEMICALS	I*	NA	L	N
1490	11 06 80	0.1340	0.0000	0			TRITON W30	NA	TBD	NA	N
1491	11 06 80	0.1340	0.0000	0			TRITON X15	NA	TBD	NA	N
1492	11 06 80	0.1340	0.0000	0			STAFOAM BASE & CATALYST	NA	NA	NA	N
1493	11 06 80	0.0000	1.0000	0			LEAD DIOXIDE	I	T/I	S	N
1494	11 06 80	0.0000	1.0000	0			SODIUM AZIDE	I	TBD	S	N
1495	11 06 80	0.0000	1.0000	0			POTASSIUM HYDROXIDE	I	TBD	S	N
1496	11 06 80	0.1340	0.0000	0			LEAD PERCHLORATE	I	T/I	S	N
1497	11 06 80	0.0000	220.0000	0			ZINC CHLORIDE	I	TBD	S	N
1498	11 06 80	0.1340	0.0000	0			EPON RESIN 828	O	I	L	N
1499	11 06 80	0.0170	0.0000	0			VERSAMIDE 125	O	TBD	S*	N
1500	11 06 80	0.0000	1.0000	0			SODIUM BORATE	I	TBD	S	N
1501	11 06 80	0.0000	1.0000	0			AMMONIUM CHLORIDE	I	TBD	S	N
1502	11 06 80	0.0000	1.0000	0			CALCIUM OXIDE	I	R	S	N
1503	11 06 80	0.0000	1.0000	0			POTASSIUM CHLORATE	I	I	S	N
1504	11 06 80	0.0000	1.0000	0			POTASSIUM NITRATE	I	I/R	S	N
1505	11 06 80	0.0000	1.0000	0			SULFUR	I	R	S	N
1506	11 06 80	0.0000	8.0000	0			PERCHLORIC ACID	I	I/R	L	N
1507	11 06 80	0.0000	0.5000	0			COPPER SULFATE	I	I	S	N
1508	11 06 80	0.0000	1.2500	0			POTASSIUM PERMANGANATE	I	I	S	N
1509	11 06 80	0.0000	0.2500	0			CUPRIC NITRATE	I	I	S	N
1510	11 06 80	0.0000	1.0000	0			AMMONIUM SULFIDE	I	TBD	S	N
1511	11 06 80	0.0700	0.0000	0			PHOTO RESIST STRIPPER	NA	NA	L	N
1512	11 06 80	0.0170	0.0000	0			DISPERSION COATING 92-009	NA	NA	L	N
1513	11 06 80	0.2200	0.0000	0			KEL-F OIL	O	TBD	L	N
1514	11 06 80	0.0000	25.0000	0			POTASSIUM CARBONATE	I	TBD	S	N
1515	11 06 80	0.0700	0.0000	0			OAKITE #33 (SODIUM PHOSPHATE, TRIBASIC)	I	TBD	S	N
1516	11 06 80	0.0170	0.0000	0			SILICONE PUMP OIL 704	O	TBD	L	N
1517	11 06 80	0.0170	0.0000	0			FLUOROSILICONE FLUIDS	I	TBD	L	N
1518	11 06 80	0.0000	1.0000	0			IODINE	I	TBD	S	N
1519	11 06 80	0.0000	1.0000	0			SODIUM HYDROXIDE	I	TBD	S	N
1520	11 06 80	0.0000	1.0000	0			NICKEL SULFATE	I	TBD	S	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 41
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1521	11 06 80	0.0040	0.0000	0			POTASSIUM PERMANGANATE SOL.	I	I	S	N
1522	12 04 79	0.2010	0.0000	0			CHEMICALS ORGANICS	O	NA	L*	N
1523	12 03 79	2.6800	0.0000	0			OIL	O	TBD	L	N
1524	12 14 79	0.0000	0.0000	0			CHEMICALS, 2 BOTTLES HYDROCHLORIC ACID	I	C	L	N
1525	12 04 79	0.5100	0.0000	0			ORGANIC SOLVENT, DRY INORGANIC	I/O	C	L/S	N
1526	12 07 79	0.8040	0.0000	0			SULFURIC ACID	I	C	L	N
1527	12 06 79	0.5360	0.0000	0			CHEMICALS ORGANIC	O	NA	L*	N
1528	00 00 00	0.0000	0.0000	0			BERYLLIUM WASTE, 6 BOXES & 1 VACUUM CLEANER	M	TBD	S	N
1529	12 10 79	0.4020	0.0000	0			CHEMICALS ORGANIC & BASE	O/I	NA	L*	N
1530	12 13 79	2.0000	0.0000	0			1 IGNITRON, ORGANICS, ASBESTOS	O/I	T/NA	NA/S	N
1531	12 13 79	2.2780	0.0000	0			10 GALLON ORGANIC, 2 GALLON INORGANIC, 5 GALLON NITRIC ACID	M/O/I	C/NA	L/NA	N
1532	12 13 79	22.1100	0.0000	0			OIL NON PCB	O	TBD	L	N
1533	12 13 79	0.0000	0.0000	0			ZIRCONIUM CHIPS,1 GALLON VAC. OIL,3 QT. INORGANIC	M/O/I	I/NA	S/L	N
1534	12 14 79	2.0000	0.0000	0			1 IGNITRON,ORGANICS	O/M	T/NA	S/NA	N
1535	12 14 79	5.0000	0.0000	0			2 CU.FT. INORGANIC,3 CU.FT. ORGANIC	O/I	NA	NA	N
1536	12 13 79	1.6080	0.0000	0			10 GAL. ORGANIC,2 GALLON INORGANIC	O/I	NA	NA	N
1537	12 18 79	2.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1538	12 18 79	3.4690	0.0000	0			2 1/2 GALLONS ORGANIC, 1 GALLON ACID, 3 CU.FT. INORGANICS	I/O	NA	L/S	N
1539	12 18 79	4.4220	0.0000	0			VACUUM PUMP OIL	O	TBD	L	N
1540	12 18 79	29.4800	0.0000	0			3-55 GAL. DRUMS MAGNESIUM METAL, 1-55 GAL. DRUM HAFNIUM, 1 CAN BERYLLIU	M	I*	S	N
1541	12 19 79	0.0000	25.0000	0			BORIC ACID	I	TBD	S	N
1542	11 01 79	7.3700	0.0000	0			ORGANIC	O	NA	L*	N
1543	11 02 79	0.1340	0.0000	0			1 GAL CHLOROFORM	O	T	L	N
1544	11 02 79	0.1675	0.0000	0			COMBUSTIBLE TOXIC METAL	NA	I*	NA	N
1545	11 05 79	0.6750	0.0000	0			NICKEL METAL;ARSENIC	I	T	S	N
1546	11 06 79	0.1340	0.0000	0			ORGANIC CHEM.	O	NA	L*	N
1547	11 06 79	0.0000	0.0000	0			OIL	O	TBD	L	N
1548	11 05 79	0.9380	0.0000	0			5 GAL VACUUM PUMP OIL, 2 GAL. ORGANIC WASTE, 1 PINT INORGANIC WASTE	I/O	NA	L*	N
1549	11 09 79	0.0000	0.0000	0			ASBESTOS GLOVE,PIECE OF ASBESTOS	I	TBD	S	N
1550	11 09 79	0.0000	0.0000	0			SOLVENT & OIL	O	NA	L	N
1551	11 14 79	3.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1552	11 14 79	2.0000	0.0000	0			3 QTS. ORGANIC,3 QTS. INORGANIC,1 CU.FT. UNKNOWN	I/O	NA	NA	N
1553	11 14 79	5.6280	0.0000	0			27 GAL. CHROMIC SULFATE,15 GAL. ORGANIC	I	T	S	N
1554	11 15 79	0.2680	0.0000	0			ORGANIC & INORGANIC CHEMICALS	I/O	NA	NA	N
1555	11 15 79	0.8040	0.0000	0			ORGANIC & INORGANIC CHEMICALS	I/O	NA	NA	N
1556	11 28 79	0.5360	0.0000	0			MINERAL OIL	O	TBD	L	N
1557	10 01 79	0.0670	0.0000	0			1,2-DICHLOROETHANE	O	I/T	L	N
1558	10 02 79	0.0000	0.0000	0			IGNITRONS	M	T	S	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 42
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1559	10 02 79	0.0350	0.0000	0			AMMONIA	I	C	L	N
1560	00 00 00	0.0510	0.0000	0			BENZENE (10/79)	O	I/T	L	N
1561	10 05 79	4.5500	0.0000	0			SULFURIC ACID	I	C	L	N
1562	10 17 79	0.0000	50.0000	0			ASBESTOS	I	TBD	S	N
1563	10 11 79	7.3700	0.0000	0			PLATING SOLUTION	I*	NA	L	N
1564	10 12 79	5.3600	0.0000	0			CHROMATE SOLUTION	I	T	S*	N
1565	10 12 79	1.3400	0.0000	0			ACID	NA	C*	L*	N
1566	10 12 79	0.0000	0.0000	0			IGNITRON	M	T	S	N
1567	10 12 79	0.0000	50.0000	0			HOSES, CYC. SOLVENT (3 GAL), 50 LB. FLUORINE	I/O	NA	S/L/V	N
1568	10 15 79	0.0000	500.0000	0			BARIUM NITRATE	I	I/T	S	N
~~1569~~	~~10 16 79~~	~~8.0400~~	~~0.0000~~	0			~~CHROMIC ACID,~~ STRIPPING SOLUTION, ORGANIC & INORGANIC CHEMICALS	~~I/O~~	~~C/T~~	~~L~~	~~N~~
1570	10 17 79	0.3400	0.0000	0			LASER DYE	O*	NA	L	N
1571	00 00 00	0.0000	0.0000	0			SOLUTION ARSENIC & CHLOROFORM (10/79)	O	T	L	N
1572	10 23 79	4.0200	0.0000	0			ACID	NA	C*	L*	N
1573	00 00 00	0.6700	0.0000	0			AMMONIA (10/79)	I	C*	L	N
1574	10 25 79	0.2010	0.0000	0			CHLOROFORM	O	T	L	N
1575	10 26 79	7.3700	0.0000	0			ETHANOL	O	I	L	N
1576	10 30 79	0.5360	0.0000	0			ACID	NA	C*	L*	N
1577	10 30 79	0.0000	0.0000	0			LYE	I	TBD	S	N
1578	09 06 79	0.0000	100.0000	0			ACID,SODIUM,TITANIUM,INORGANIC,ORGANIC	I/O/M	I/R/C	S/L	N
1579	00 00 00	14.3380	0.0000	0			ACID, SOLVENTS (9/79)	NA	NA	L	N
1580	09 10 79	4.0200	0.0000	0			SOLVENT	O	NA	L	N
1581	08 07 79	3.0000	0.0000	0			BERYLLIUM CONTAMINATED PLASTIC	M	TBD	S	N
1582	09 08 79	2.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1583	09 18 79	147.4000	0.0000	0			OIL	O	TBD	L	N
1584	09 17 79	29.4800	0.0000	0			OIL	O	TBD	L	N
1585	09 18 79	0.1340	0.0000	0			TOLUENE	O	I	L	N
1586	09 18 79	36.8500	0.0000	0			OIL	O	TBD	L	N
1587	09 17 79	0.0000	3.0000	0			CHROMIC ACID	I	C/T	L	N
1588	09 21 79	2.1440	0.0000	0			PHOTOCHEMICALS	I*	NA	L	N
1589	09 25 79	2.0000	0.0000	0			ASBESTOS COATS	I	TBD	S	N
1590	09 25 79	0.0000	0.2500	0			LITHIUM 4" X 8" X 1/16" SHEET	M	I	S	N
1591	08 01 79	1.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1592	08 01 79	1.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1593	08 01 79	10.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1594	08 07 79	14.7400	0.0000	0			MINERAL OIL	O	TBD	L	N
1595	08 07 79	44.2200	0.0000	0			OIL	O	TBD	L	N
1596	00 00 00	0.0000	0.0000	0			ACID (8/79)	NA	C*	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 43
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1597	00	00	00	6.0000	0.0000	0			INORGANIC CHEMICAL (8/79)	I	NA	NA	N
1598	08	14	79	6.0000	0.0000	0			ORGANIC & INORGANIC CHEMICALS	I/O	TBD	NA	N
1599	08	20	79	21.0000	0.0000	0			LIQUID CHEMICAL	NA	NA	L	N
1600	08	21	79	2.5000	0.0000	0			ORGANIC & INORGANIC CHEMICALS	O/I	NA	NA	N
1601	08	21	79	0.0000	0.0000	0			ASBESTOS GLOVES	I	TBD	S	N
1602	08	20	79	7.3700	0.0000	0			NITRIC ACID	I	C	L	N
1603	08	20	79	6.0000	0.0000	0			ORGANIC & INORGANIC CHEMICALS,OIL	O/I	NA	L	N
1604	08	21	79	0.5360	0.0000	0			CHEMICALS	NA	NA	NA	N
1605	08	23	79	0.0000	0.0000	0			MERCURY CONTAINERS	M	T	S	N
1606	08	23	79	4.0200	0.0000	0			TRICHLOROETHANE	O	TBD	L	N
1607	08	23	79	4.0000	0.0000	0			INORGANIC & ORGANIC CHEMICALS	I/O	NA	NA	N
1608	08	24	79	1.0000	0.0000	0			DYES	NA	NA	L*	N
1609	07	02	79	6.0000	0.0000	0			INORGANIC & ORGANIC CHEMICALS	I/O	NA	NA	N
1610	07	05	79	2.0000	0.0000	0			ASBESTOS GLOVES	I	TBD	S	N
1611	07	05	79	3.0000	0.0000	0			CHEMICALS INORGANIC & ORGANIC	I/O	NA	NA	N
1612	07	05	79	2.0000	0.0000	0			CHEMICALS ORGANIC	O	NA	L*	N
1613	07	09	79	5.0000	0.0000	0			CHEMICALS INORGANIC	I	NA	NA	N
1614	00	00	00	0.0000	0.0000	0			ACID (7/79)	NA	C*	L*	N
1615	07	10	79	21.0000	0.0000	0			BARIUM NITRATE	I	I/T	S	N
1616	00	00	00	0.0000	0.0000	0			GLASS WITH MERCURY	M	T	S	N
1617	07	13	79	0.0000	0.0000	0			TUBES (?)	NA	NA	NA	N
1618	07	13	79	11.3900	0.0000	0			GAS & OIL	O	NA	L	N
1619	07	16	79	3.0000	0.0000	0			ORGANIC & INORGANIC CHEMICALS	I/O	NA	NA	N
1620	07	17	79	0.6700	0.0000	0			LEAD NITRATE SOLUTION	I	T/I	L	N
1621	07	18	79	1.0000	0.0000	0			CHEMICALS ORGANIC	O	NA	L*	N
1622	07	18	79	3.0000	0.0000	0			TOXIC CHEMICALS (ORGANIC & INORGANIC)	I/O	NA	NA	N
1623	07	19	79	10.0000	0.0000	0			CHEMICALS INORGANIC & ORGANIC	I/O	NA	NA	N
1624	07	23	79	0.0000	0.0000	0			SULFURIC ACID,HYDROCHLORIC ACID	I	C	L	N
1625	07	23	79	1.3400	0.0000	0			ACID	NA	C*	L*	N
1626	07	25	79	23.0000	0.0000	0			ORGANIC & INORGANIC CHEMICALS	O/I	NA	NA	N
1627	07	19	79	2.0000	0.0000	0			LASER DYE	NA	NA	L*	N
1628	07	30	79	0.0000	0.0000	0			ASBESTOS GLOVES	I	TBD	S	N
1629	07	30	79	2.0000	0.0000	0			AMMONIUM HYDROXIDE	I	C*	L	N
1630	07	30	79	0.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1631	06	04	79	8.0000	0.0000	0			OIL	O	TBD	L	N
1632	06	04	79	15.0000	0.0000	0			OIL	O	TBD	L	N
1633	06	05	79	28.0000	0.0000	0			OIL	O	TBD	L	N
1634	06	05	79	0.0000	0.0000	0			CHEMICALS	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 44
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1635	06 11 79	8.0000	0.0000	0			INORGANIC & ORGANIC ACIDS & BASES	I/O	C*	L*	N
1636	06 11 79	16.7500	0.0000	0			SOLVENTS	O	NA	L	N
1637	06 15 79	70.0000	0.0000	0			NITRIC ACID; SOLVENTS	I/O	C/NA	L	N
1638	06 12 79	22.1100	0.0000	0			ACID & BASE	NA	C*	L*	N
1639	06 12 79	0.6700	0.0000	0			OIL	O	TBD	L	N
1640	06 13 79	0.0000	0.0000	0			BERYLLIUM OXIDE IN A TUBE	I	TBD	S	N
1641	06 19 79	0.0000	0.0000	0			OIL	O	TBD	L	N
1642	00 00 00	0.0000	0.0000	0			BERYLLIUM CONTAMINATED BAG	M	TBD	S	N
1643	06 12 79	0.0700	0.0000	0			ACID	NA	C*	L*	N
1644	06 19 79	0.0000	0.0000	0			LAB CHEMICALS	NA	NA	NA	N
1645	06 19 79	0.0000	0.0000	0			POTASSIUM NITRITE	I	I/R	S	N
1646	06 20 79	176.8800	0.0000	0			OIL,KEROSENE,METHANOL	O	I*	L	N
1647	06 20 79	9.3800	0.0000	0			CHEMICAL	NA	NA	NA	N
1648	06 20 79	0.0000	0.0000	0			BERYLLIUM CONTAMINATED OIL	O	TBD	L	N
1649	06 21 79	0.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1650	06 25 79	0.0000	0.0000	0			ASBESTOS GLOVES	I	TBD	S	N
1651	06 26 79	3.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1652	06 26 79	4.0000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1653	06 27 79	198.9900	0.0000	0			CALCIUM NITRATE	I	I	S	N
1654	06 28 79	1.0000	0.0000	0			ASBESTOS GLOVES	I	TBD	S	N
1655	06 28 79	2.0000	0.0000	0			ASBESTOS GLOVES	I	TBD	S	N
1656	06 04 79	7.3700	0.0000	0			OIL	O	TBD	L	N
1657	06 04 79	14.7400	0.0000	0			OIL	O	TBD	L	N
1658	05 31 79	20.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1659	05 31 79	33.5000	0.0000	0			NITRIC ACID CONTAMINATED WITH NICKEL	I/M	C*	L	N
1660	05 30 79	3.0000	0.0000	0			CHEMICAL	NA	NA	NA	N
1661	05 30 79	3.0000	0.0000	0			CHEMICAL	NA	NA	NA	N
1662	05 30 79	51.5900	0.0000	0			OIL NO PCB	O	TBD	L	N
1663	05 30 79	7.3700	0.0000	0			OIL	O	TBD	L	N
1664	05 30 79	29.4800	0.0000	0			OIL NO PCB	O	TBD	L	N
1665	05 29 79	8.7100	0.0000	0			40 GAL SOLVENT, 25 GAL SULFURIC ACID	O/I	C/NA	L	N
1666	05 25 79	4.0000	0.0000	0			BERYLLIUM CONTAMINATED WOOD, 2 GAL SOLVENT	M	NA	S	N
1667	05 25 79	0.2680	0.0000	0			2 GAL. SOLVENT	O	NA	L	N
1668	05 24 79	0.0000	0.0000	0			SCRAP METAL	N	NA	S	N
1669	05 24 79	0.1340	0.0000	0			CESIUM 2 GRAMS IN VERMICULITE	M	I	S	N
1670	05 23 79	0.0000	0.0000	0			NITRIC ACID,MERCURY,INORGANIC	I/M	C/T	L/S	N
1671	05 23 79	0.0000	0.0000	0			CYLINDER WITH NITROGEN AND WATER	I	TBD	V/L	N
1672	00 00 00	3.0000	0.0000	0			CHEMICALS (5/79)	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 45
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO DY YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1673	05 14 79	2.0000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1674	05 14 79	8.0000	0.0000	0			ORGANICS & INORGANICS,BASES & ACIDS	I/O	NA	L*	N
1675	05 14 79	33.5000	0.0000	0			NITRIC ACID	I	C	L	N
1676	05 09 79	2.0000	0.0000	0			CHEMICALS ORGANIC & INORGANIC	O/I	NA	NA	N
1677	05 08 79	1.0000	0.0000	0			PICRIC ACID	O	I	S	N
1678	05 03 79	2.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1679	05 04 79	6.0000	0.0000	0			ORGANIC & INORGANIC CHEMICALS, ACIDS, BASES & METALS	I/O/M	NA	NA	N
1680	05 01 79	2.0000	0.0000	0			NITRIC ACID	I	C	S	N
1681	05 01 79	1.0000	0.0000	0			CHEMICAL	NA	NA	NA	N
1682	04 30 79	20.0000	0.0000	0			BERYLLIUM TRASH	M	TBD	S	N
~~1683~~	~~04 30 79~~	~~53.6000~~	~~0.0000~~	~~0~~			~~OIL CONTAMINATED WITH SOLVENT~~	~~O~~	~~NA~~	~~L~~	~~N~~
1684	04 26 79	4.0000	0.0000	0			METAL OIL SALT	M/O/I	NA	S/L	N
1685	04 26 79	2.0000	0.0000	0			ORGANIC CHEMICAL	O	TBD	L	N
1686	04 27 79	0.0000	0.0000	0			LITHIUM METAL	M	I	S	N
1687	04 24 79	2.0000	0.0000	0			CHEMICALS ORGANIC & INORGANIC	I/O	NA	NA	N
1688	04 24 79	1.0000	0.0000	0			INORGANICS & ORGANICS	I/O	NA	NA	N
1689	04 24 79	13.0000	0.0000	0			12 CU. FT. INORGANIC,1 CU. FT. ACID	I	NA	NA	N
1690	04 23 79	0.0000	0.0000	0			CHEMICALS INORGANIC & ORGANIC	I/O	NA	NA	N
1691	04 20 79	4.0000	0.0000	0			OIL (NITRATE SOLUTION)	O	TBD	L	N
1692	04 20 79	1.0000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1693	04 19 79	0.0000	0.0000	0			SODIUM-POTASSIUM ALLOY	M	I	S	N
1694	04 19 79	0.0000	0.0000	1			CHLORINE TRIFLUORIDE	I	I/R	V	N
1695	04 18 79	2.0000	0.0000	0			MAGNESIUM CHIPS	M	I	S	N
1696	04 18 79	0.2680	0.0000	0			NITRIC ACID	I	C*	L	N
1697	04 17 79	1.0000	0.0000	0			CHEMICALS ORGANIC	O	NA	L*	N
1698	04 17 79	3.0000	0.0000	0			PHOTOCHEMICALS	I*	NA	L*	N
1699	04 17 79	3.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1700	03 30 81	0.0000	0.0000	0			USED VACUUM PUMP OIL-1 PLASTIC JAR	O	NA	L	N
1701	03 30 81	2.0000	0.0000	0		B	1-15 GAL. CONTAINER-NITRIC ACID	I	C	L	Y
1702	03 30 81	0.1200	0.0000	0		B	5 PT.-GLACIAL ACETIC ACID,2 PTS.-HYDROCHLORIC ACID	O/I	C	L	Y
1703	03 30 81	0.3400	0.0000	0		B	2-20 FL. OZ. AMMONIA,2-9 1/2" X 9 1/2" AMMONIA ABSORBER CANISTER	I	C*	L	Y
1704	04 28 81	52.0000	0.0000	0	17		1-15 GAL. DRUM PHYTAR 560,60 GAL 2-4D BUTYL ESTER IN 1 GAL PLASTIC BOTT	O	TBD	NA	Y
1705	04 23 81	14.7400	0.0000	0		B	HYDROCHLORIC ACID AND WATER	I	C*	L	Y
1706	04 20 80	1.0000	0.0000	0	13		16 GLASS JARS, INORGANICS	I	NA	NA	Y
1707	04 21 81	3.0000	0.0000	0		B	2-15 GAL. LITHIUM HYDROXIDE WITH DEPLETED URANIUM,10 GM PER DRUM	I	I	S	Y
1708	04 20 81	1.0000	0.0000	0	17		4 GLASS BOTTLES WITH ORGANICS, 1 PLASTCIC BOTTLE WITH LITHIUM ACETYLIDE	O	NA	L*	Y
1709	04 16 81	1.0000	0.0000	0	17		SOLVENT	O	NA	L	Y
1710	04 16 81	1.0000	0.0000	0		B	AMMONIA 5 BOTTLES	I	C	L	Y

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 46
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1711	00	00	00	6.0000	0.0000	0			BERYLLIUM WASTE (4/81)	M	TBD	S	N
1712	04	23	81	0.6700	0.0000	0		B	2-3.25 L AMMONIUM HYDROXIDE,12.5 L OF KODAK RAPID FILTER	I	C*	L	Y
1713	04	08	81	0.0000	0.0000	0			MOSTLY ORGANIC SOLVENTS AND SOLID ORGANICS, SOME INORGANICS	I/O	NA	L/S	N
1714	04	08	81	2.0000	0.0000	0		B	7 BOTTLES (SAVIN) ?, 7 BOTTLES OF LIQUID (COPY MACHINE) ?, QT BOTTLES	NA	NA	NA	Y
1715	03	09	81	1.0700	0.0000	0			4-2 GALLON CANS-MACHINE OIL, CUTTING OIL, ETC.	O	TBD	L	N
1716	03	10	81	0.0000	0.0000	0	15		LITHIUM METAL, 2 1/2 FT. LENGTH DRUMS,UNOPENED	M	I	S	Y
1717	03	09	81	0.0000	0.0000	0	17		1.0 ML LIQUID (DICHLOROETHYLENE W/ BORON)	O	NA	L	Y
1718	03	09	81	0.0000	0.0000	0	17		ORGANICS W/ CANCER SUSPECT AGENTS	O	NA	NA	Y
1719	03	00	81	0.0000	0.0000	0			KEMWIPES & GLOVES CONTAMINATED WITH PYRENE AND OTHER SUSPECT CANCER AGE	O	NA	S	N
1720	03	09	81	0.0070	0.0000	0	17		METHANOL, TRICHLOROETHYLENE & UNIDENTIFIED CANCER SUSPECT AGENTS	O	I/T	L	Y
~~1721~~	~~03~~	~~05~~	~~81~~	~~0.0000~~	~~0.0000~~	0			~~WASTE MATERIAL CONTAMINATED WITH CANCER SUSPECT AGENTS~~	~~NA~~	~~NA~~	~~NA~~	~~N~~
1722	03	03	81	0.0510	0.0000	0	17		SOLVENT	O	NA	L	Y
1723	03	02	81	3.0000	0.0000	0		B	75# ACID CARBOY FULL, 75#ACID CARBOY PARTIAL FULL-NITRIC ACID	I	C	L	Y
1724	03	17	81	0.0340	0.0000	0	17		LIQUID "A" QUINIENE 13 SOLVENT BASE	O*	TBD	L*	Y
1725	03	17	81	8.0000	0.0000	0		B	NITRIC ACID	I	C	L	Y
1726	03	17	81	1.0500	0.0000	0		B	BRIGHT DIP ACID BATH:MIXTURE 14.7L WATER,2.2L NITRIC ACID,13.1L SULFURI	I	C	L	Y
1727	03	16	81	0.0000	0.0000	0	17		LIQUID ORGANICS/INORGANICS	O/I	NA	NA	Y
1728	03	16	81	2.0000	0.0000	0		B	INORGANICS,SOME SOLVENTS 19 CONTAINERS	O/I	NA	NA	Y
1729	03	09	81	1.0000	0.0000	0			CARBON TETRACHLORIDE	O	T	L	N
1730	03	09	81	8.0400	0.0000	0			DIRTY TRICHLORETHYLENE	O	T	L	N
1731	03	09	81	0.1250	0.0000	0			ALUMINUM PHOSPHIDE,ALUMINUM NITRIDE,TITANIUM	I/M	TBD	S	N
1732	03	31	81	7.3700	0.0000	0			OIL,ONE BATTERY;APPEARS TO HAVE NOT BEEN DISPOSED OF	O	TBD	L	N
1733	04	01	81	6.0000	0.0000	0			30-1 GAL CONTAINERS CHROMIC ACID,3 QT. OF SOLVENT:BENZENE,CARBON TETRAC	O	I/R	L	N
1734	03	31	81	0.0000	0.0000	0			ACIDS & BASES:PHOSPHORIC,NITRIC,ACETIC,HYDROCHLORIC ACIDS;AMMONIUM HYDR	I/O	C	L	Y
1735	03	31	81	14.7400	0.0000	0			1 BBL TRANSMISSION OIL,1BBL GEAR OIL	O	TBD	L	N
1736	03	30	81	0.0000	0.0000	0		B	2 BARRELS-COPPER AMMONIUM HYDROXIDE	I	TBD	NA	Y
1737	00	00	00	0.0000	0.0000	0			CERIUM METAL (3/81)	M	TBD	S	N
1738	00	00	00	0.0090	0.0000	0		B	UNKNOWN (ACID) (3/26/81)	NA	NA	NA	Y
1739	03	20	81	1.0000	0.0000	0	17		3 CANS & 2 BOTTLES EPOXY	O	I*	L*	Y
1740	03	16	81	16.0000	0.0000	0	17		12 GAL. CANS,9 GAL BTLS,2 QT. BTTLS,2-5 GAL CANS,1-1 GAL PLASTIOC,1 BOX	O	I	L	Y
1741	03	23	81	0.0000	0.0000	0			80 SMALL GLASS CONTAINERS (LIST MISSING)	NA	NA	NA	N
1742	02	19	81	3.5000	0.0000	0	17		30 GALLON DRUM-METHYLETHYL KETONE MIX ON VERMICULITE	O	T/I	L/S	Y
1743	02	12	81	5.0000	0.0000	0			30-9LB. CONTAINERS (SULFURIC ACID),7 GAL. CONTAINERS,25-QT CONTAINERS	O/I	C	L	N
1744	02	11	81	0.0000	0.0000	0	17		1 PT. PAINT THINNER,1 PT. CITRIC AICD,5 GAL. OIL	O	I	L	Y
1745	02	11	81	0.2500	0.0000	0	16		CADMIUM ANALGUM,CADMIUM-MERCURY	M	T	S	Y
1746	02	11	81	0.2500	0.0000	0	16		TRIMETHYLALUMINUM	O	I	S	Y
1747	02	11	81	1.0000	0.0000	0	16		TANTALUM PENTACHLORIDE	I	TBD	S	Y
1748	02	09	81	0.0000	0.0000	1			90 WT. GEAR BOX OIL	O	TBD	L	N

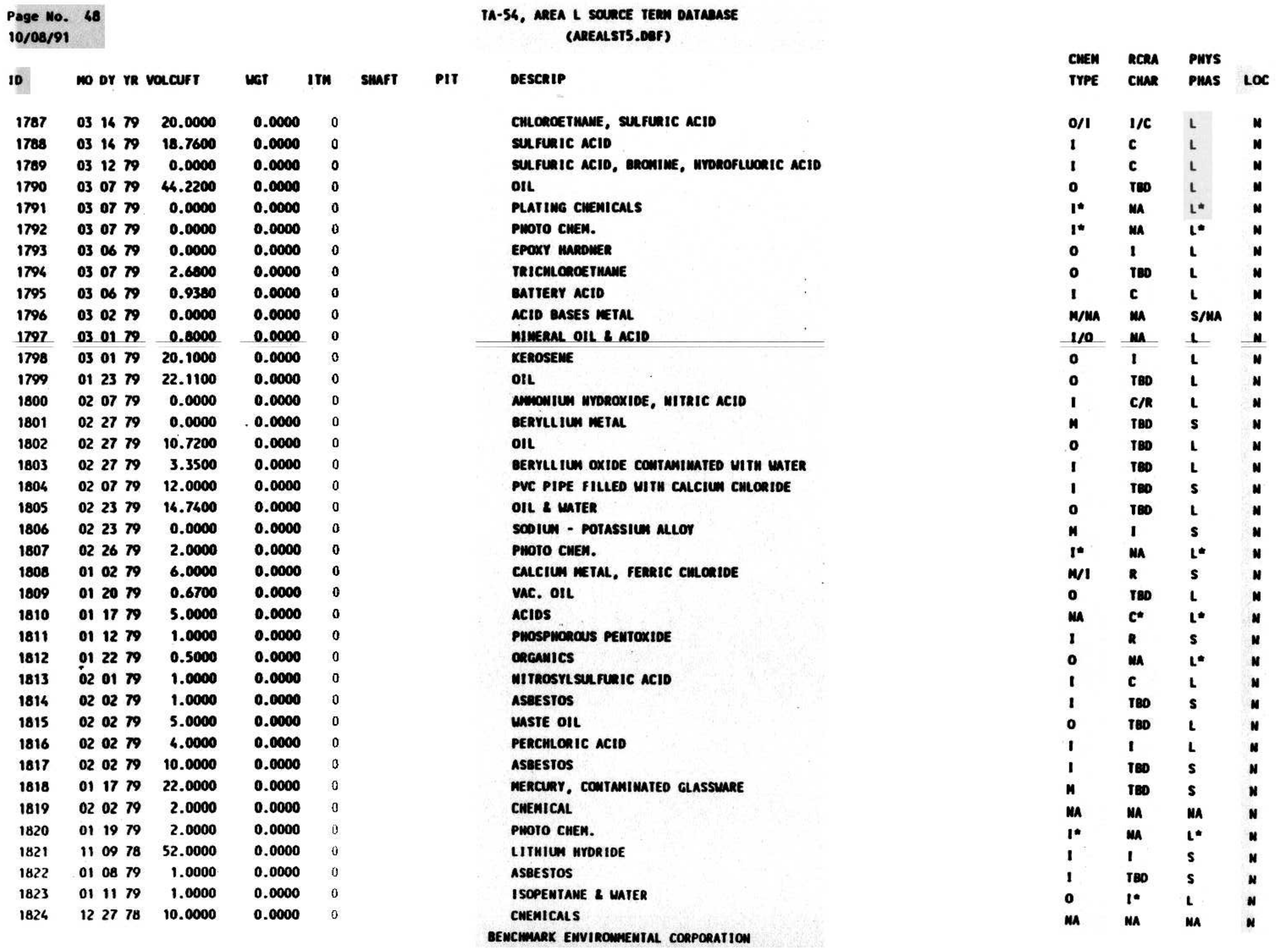
BENCHMARK ENVIRONMENTAL CORPORATION

age No. 47
0/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1749	02	09	81	16.0000	0.0000	0			2-55 GAL. DRUMS-VACUUM OIL	O	TBD	L	N
1750	02	05	81	0.3500	0.0000	0		B	ARSENIC/NICKEL-LIQUID	I	T	L	Y
1751	02	05	81	0.0000	0.0000	0	17		3-PINTS,2 QUARTS,2 1/2 PINTS - ORGANICS	O	NA	NA	Y
1752	01	08	81	0.5000	0.0000	0		B	FERRIC CHLORIDE-3 GAL.	I	TBD	S	Y
1753	01	11	81	0.5360	0.0000	0		B	3 GAL. OF AZ303 DEVELOPER,1 GAL. OF THINNER	O	I	L	Y
1754	01	27	81	2.0000	0.0000	0	17		VERSATEC TONER & DISPERSANT (KEROSENE BASE)	O	I	L	Y
1755	01	27	81	7.3700	0.0000	0	17		1,1,1 TRICHLOROETHANE W/ OIL FORM PART CLEANING	O	TBD	L	Y
1756	01	21	81	0.2500	0.0000	0	17		3 BOTTLES ORGANIC WASTE-TRICHLOROETHANE,BENZENE	O	I	L	Y
1757	01	19	81	22.1100	0.0000	0		B	TREATED COPPER CYANIDE SOLUTION FROM TA-50	I	TBD	L	Y
1758	01	19	81	0.2680	0.0000	0		B	AMMONIUM HYDROXIDE;ABSORBER	I	TBD	S	Y
~~1759~~	~~01~~	~~19~~	~~81~~	~~20.1000~~	~~0.0000~~	0		~~B~~	~~RAPID CIRCUIT ETCHANT,FERRIC CHLORID~~	~~I~~	~~TBD~~	~~S~~	Y
1760	01	19	81	1.0000	0.0000	0	17		12 CONTAINERS,ASBESTOS,MERCURY VAPORLITE,2 PTS. THINNER,5 PTS. SOLVENTS	I/O/M	I/T	S/L	Y
1761	01	16	81	12.0600	0.0000	0			3-5 GAL. PHOTO RESISTOR,11-5 GAL. METHYLCHLOROFORM,4-5 GAL. ISOPROPANOL	O	I	L	N
1762	01	10	81	2.0000	0.0000	0	13		1 PLASTIC BAG WASTE CONTAMINATED W/ ARSENIC,HYDROCHLORIC ACID	I	T/C	S/L	Y
1763	01	10	81	0.8710	0.0000	0	17		4-1 GAL. & 1-10L CAN; N-METHYLPYRROLIDONE AND CYCLOHEXANE	O	I	L	Y
1764	01	11	81	0.2000	0.0000	0	17		MERCURY SWITCH	M	T	S	Y
1765	01	07	81	0.1340	0.0000	0	17		TRICHLOROETHANE	O	TBD	L	Y
1766	01	07	81	1.5000	0.0000	0	17		VARIOUS ORGANICS,ASBESTOS(40) MERCURY (2CC)	O/I/M	T	S/L	Y
1767	01	07	81	29.4800	0.0000	0		B	4-55 GAL. DRUMS-ETHANOL CONTAMINATED W/ BERYLLIUM	O	I	L	Y
1768	04	10	79	0.0000	0.0000	0			LITHIUM METAL	M	I	S	N
1769	04	06	79	0.0000	0.0000	0			ORGANIC	O	NA	L*	N
1770	04	06	79	0.0000	0.0000	0			SOLVENTS	O	NA	L	N
1771	04	05	79	0.0000	0.0000	0			SULFURIC ACID	I	C	L	N
1772	04	04	79	0.0000	0.0000	0			SULFURIC ACID	I	C	L	N
1773	04	04	79	0.0000	0.0000	0			OIL	O	TBD	L	N
1774	04	02	79	7.0000	0.0000	0			ORGANIC & INORGANIC CHEM.	O/I	NA	NA	N
1775	04	02	79	1.0000	0.0000	0			MERCURY	M	T	S	N
1776	02	07	79	51.5900	0.0000	0			TRANSFORMER OIL	O	TBD	L	N
1777	02	07	79	4.6900	0.0000	0			OIL	O	TBD	L	N
1778	03	27	79	81.0700	0.0000	0			MINERAL OIL	O	TBD	L	N
1779	03	26	79	0.0670	0.0000	0			SULFURIC ACID	I	C	L	N
1780	03	26	79	0.6700	0.0000	0			VAC. OIL	O	NA	L	N
1781	03	23	79	0.3500	0.0000	0			CHROMIC ACID	I	T/C	L	N
1782	03	23	79	24.0000	0.0000	0			OIL & SOLVENTS	O	NA	L	N
1783	03	21	79	0.0000	0.0000	0			SODIUM - POTASSIUM ALLOY	M	I	S	N
1784	03	21	79	0.0000	0.0000	0			BROMOBENZENE	O	I	L	N
1785	03	14	79	2.0000	0.0000	0			PAINT CANS, OIL	O	NA	L	N
1786	03	19	79	29.4800	0.0000	0			MAGNESIUM CHIPS	M	I	S	N

BENCHMARK ENVIRONMENTAL CORPORATION



Page No. 48
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1787	03	14	79	20.0000	0.0000	0			CHLOROETHANE, SULFURIC ACID	O/I	I/C	L	N
1788	03	14	79	18.7600	0.0000	0			SULFURIC ACID	I	C	L	N
1789	03	12	79	0.0000	0.0000	0			SULFURIC ACID, BROMINE, HYDROFLUORIC ACID	I	C	L	N
1790	03	07	79	44.2200	0.0000	0			OIL	O	TBD	L	N
1791	03	07	79	0.0000	0.0000	0			PLATING CHEMICALS	I*	NA	L*	N
1792	03	07	79	0.0000	0.0000	0			PHOTO CHEM.	I*	NA	L*	N
1793	03	06	79	0.0000	0.0000	0			EPOXY HARDNER	O	I	L	N
1794	03	07	79	2.6800	0.0000	0			TRICHLOROETHANE	O	TBD	L	N
1795	03	06	79	0.9380	0.0000	0			BATTERY ACID	I	C	L	N
1796	03	02	79	0.0000	0.0000	0			ACID BASES METAL	M/NA	NA	S/NA	N
1797	03	01	79	0.8000	0.0000	0			MINERAL OIL & ACID	I/O	NA	L	N
1798	03	01	79	20.1000	0.0000	0			KEROSENE	O	I	L	N
1799	01	23	79	22.1100	0.0000	0			OIL	O	TBD	L	N
1800	02	07	79	0.0000	0.0000	0			AMMONIUM HYDROXIDE, NITRIC ACID	I	C/R	L	N
1801	02	27	79	0.0000	0.0000	0			BERYLLIUM METAL	M	TBD	S	N
1802	02	27	79	10.7200	0.0000	0			OIL	O	TBD	L	N
1803	02	27	79	3.3500	0.0000	0			BERYLLIUM OXIDE CONTAMINATED WITH WATER	I	TBD	L	N
1804	02	07	79	12.0000	0.0000	0			PVC PIPE FILLED WITH CALCIUM CHLORIDE	I	TBD	S	N
1805	02	23	79	14.7400	0.0000	0			OIL & WATER	O	TBD	L	N
1806	02	23	79	0.0000	0.0000	0			SODIUM - POTASSIUM ALLOY	M	I	S	N
1807	02	26	79	2.0000	0.0000	0			PHOTO CHEM.	I*	NA	L*	N
1808	01	02	79	6.0000	0.0000	0			CALCIUM METAL, FERRIC CHLORIDE	M/I	R	S	N
1809	01	20	79	0.6700	0.0000	0			VAC. OIL	O	TBD	L	N
1810	01	17	79	5.0000	0.0000	0			ACIDS	NA	C*	L*	N
1811	01	12	79	1.0000	0.0000	0			PHOSPHOROUS PENTOXIDE	I	R	S	N
1812	01	22	79	0.5000	0.0000	0			ORGANICS	O	NA	L*	N
1813	02	01	79	1.0000	0.0000	0			NITROSYLSULFURIC ACID	I	C	L	N
1814	02	02	79	1.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1815	02	02	79	5.0000	0.0000	0			WASTE OIL	O	TBD	L	N
1816	02	02	79	4.0000	0.0000	0			PERCHLORIC ACID	I	I	L	N
1817	02	02	79	10.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1818	01	17	79	22.0000	0.0000	0			MERCURY, CONTAMINATED GLASSWARE	M	TBD	S	N
1819	02	02	79	2.0000	0.0000	0			CHEMICAL	NA	NA	NA	N
1820	01	19	79	2.0000	0.0000	0			PHOTO CHEM.	I*	NA	L*	N
1821	11	09	78	52.0000	0.0000	0			LITHIUM HYDRIDE	I	I	S	N
1822	01	08	79	1.0000	0.0000	0			ASBESTOS	I	TBD	S	N
1823	01	11	79	1.0000	0.0000	0			ISOPENTANE & WATER	O	I*	L	N
1824	12	27	78	10.0000	0.0000	0			CHEMICALS	NA	NA	NA	N

BENCHMARK ENVIRONMENTAL CORPORATION

age No. 49
0/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1825	01	05	79	2.0000	0.0000	0			HYDROGEN FLUORIDE	I	TBD	L	N
1826	01	05	79	2.0000	0.0000	0			CHEM. ACID & BASE	NA	C*	L*	N
1827	01	04	79	2.0000	0.0000	0			SODIUM HYDROXIDE, CARBON DISULFIDE	O	C/I	L	N
1828	01	03	79	3.0000	0.0000	0			CHEM., ACETIC ACID, NITRO METHANE	O	C/I	L	N
1829	01	04	79	4.0000	0.0000	0			CHEMICAL	NA	NA	NA	N
1830	12	22	78	1.0000	0.0000	0			DICHLOROETHYLENE	O	I/T	L	N
1831	10	04	78	6.0000	0.0000	0			CHEMICALS	NA	NA	NA	N
1832	12	27	78	3.0000	0.0000	0			CHEM.	NA	NA	NA	N
1833	12	27	78	23.0000	0.0000	0			SHELL DIALA AX	NA	TBD	NA	N
1834	12	03	75	51.5900	0.0000	0			TOLUENE, ACETIC ACID, ALCOHOL	O	I/C	L	N
~~1835~~	~~12~~	~~03~~	~~75~~	~~1.0000~~	~~0.0000~~	0			~~SODIUM & OTHER CHEMICAL~~	~~N/NA~~	~~R/NA~~	~~S/NA~~	~~N~~
1836	00	00	00	1.0000	0.0000	0			ALCOHOL (12/75)	O	I	L	N
1837	00	00	00	13.0000	0.0000	0			BARIUM CHIPS IN OIL (12/75)	M/O	I/T	S/L	N
1838	00	00	00	3.0000	0.0000	0			AMMONIUM HYDROXIDE & ABSORBER (12/75)	I	C*	L*	N
1839	00	00	00	13.0000	0.0000	0			HYDROCARBON TRANSFORMER OIL (12/75)	O	TBD	L	N
1840	11	21	75	0.5000	0.0000	0			ETHER OIL, POSSIBLE PEROXIDE MAT'L.	O	I*	L	N
1841	11	18	75	3.0000	0.0000	0			MISC. CHEM.	NA	NA	NA	N
1842	10	24	75	1.0000	0.0000	0			METAL (?) UNDER KEROSENE (?) POSSIBLE SODIUM	M/O*	R/I*	S/L	N
1843	10	20	75	3.0000	0.0000	0			WASTE CHEM. FROM PHOTO LAB	NA	NA	NA	N
1844	10	17	75	2.0000	0.0000	0			PLATING ACIDS	NA	C*	L*	N
1845	10	17	75	1.0000	0.0000	0			SEVERAL SMALL BOXES OF NON-SALVAGE CHEMICALS	NA	NA	NA	N
1846	10	04	75	0.0000	0.0000	0			LITHIUM - HYDROXIDE	I	I	S	N
1847	10	03	75	2.0000	0.0000	0			MISC. INORGANIC CHEMICAL	I	NA	NA	N
1848	10	08	75	0.0000	500.0000	0			USED STOCK OF ORGANICS NO REUSE	O	NA	NA	N
1849	10	02	75	8.0000	0.0000	0			NITRATED WET BAGS	I	TBD	S*	N
1850	09	30	75	28.0000	0.0000	0			TRICHLOROETHANE	O	TBD	L	N
1851	09	20	75	6.0000	0.0000	0			MISC. ACIDS - CAUSTICS & ELECTROPLATE CHEM.	NA	C*	L*	N
1852	09	18	75	0.0000	0.0000	0			MISC. CHEM. & ETHER	O	I	L	N
1853	09	18	75	0.0000	0.0000	0			NITROBENZENE & OTHER DERIVITIVES	O	TBD	L*	N
1854	09	17	75	3.0000	0.0000	0			BORON IN CANS, SMALL AMT.	I	I	S	N
1855	09	16	75	0.0000	500.0000	0			LITHIUM - HYDRIDE	I	I	S	N
1856	09	11	75	10.0000	0.0000	0			10GAL.DIMETHYLSULFOXIDE,5GAL.METHYL CELLOSOLVE,1GAL.BROMOBENZEN,1GAL.EP	O	I	L	N
1857	09	11	75	0.0000	65.0000	0			SMALL GAS CYLINDER HAZARDOUS MATERIAL	NA	NA	V	N
1858	09	11	75	0.0000	0.0000	0			MISC. WASTE CHEMICALS	NA	NA	NA	N
1859	09	11	75	12.0000	0.0000	0			1-1-1 TRICHLOROETHANE	O	TBD	L	N
1860	09	03	75	4.0200	0.0000	0			2 GAL. CARBON TETRACHLORIDE,1 GAL. CHLOROFORM	O	I/T	L	N
1861	08	25	75	14.0700	0.0000	0			USED OIL 2-55 GAL. DRUMS	O	TBD	L	N
1862	08	25	75	1.0000	0.0000	0			TRIFLUORO ACETIC ACID	O	TBD	L	N

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 50
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1863	08	21	75	1.0000	0.0000	0			LEAKING BOTTLE OF TRIFLUOROACETIC ACID	O	C*	L	N
1864	08	15	75	5.0000	0.0000	0			BOXED CHEMICALS CLEANED OUT OLD LAB.	NA	NA	NA	N
1865	08	14	75	2.0000	0.0000	0			3-30LBS BOXES CARBON DIOXIDE CARTRIDGES	O	TBD	V	N
1866	08	12	75	4.6900	0.0000	0			35 GAL. SOLVENTS	O	NA	L	N
1867	08	12	75	1.0000	0.0000	0			BOX MISC. ORGANICS	O	NA	L*	N
1868	08	12	75	2.0000	0.0000	0			PHOSPHOROUS TRICHLORIDE, PHOSPHOROUS PENTOXIDE	I	R	L/S	N
1869	08	11	75	0.0000	0.0000	0			SODIUM HYDROXIDE, POTASSIUM DICHROMATE	I	I/C	S*	N
1870	08	05	75	7.3700	0.0000	0			55 GAL. FLAMMABLE LIQ.	O*	I*	L	N
1871	08	04	75	4.0000	0.0000	0			ORGANIC SOLVENTS, ALCOHOL DIMETHYL FORMAMIDE	O	I*	L	N
1872	07	29	75	10.0000	0.0000	0			OLD CHEMICALS	NA	NA	NA	N
~~1873~~	~~07~~	~~28~~	~~75~~	~~10.0000~~	~~0.0000~~	~~0~~			~~MISC. CHEM. ACID, BASES, ORGANICS, INORGANICS~~	~~I/O~~	~~NA~~	~~L*~~	~~N~~
1874	07	28	75	0.0000	0.0000	0			MISC. CHEM.	NA	NA	NA	N
1875	07	25	75	1.0000	0.0000	0			FLAM. LIQ. & PUMP OIL	O	I*	L	N
1876	07	23	75	1.0000	0.0000	0			MIXED CHEM. INORGANIC	I	NA	NA	N
1877	07	23	75	5.0000	0.0000	0			100 LBS. MIXED CHEM.	NA	NA	NA	N
1878	07	21	75	2.0000	0.0000	0			MISC. WASTE CHEM.	NA	NA	NA	N
1879	07	20	75	1.0000	0.0000	0			MISC. WASTE CHEM.	NA	NA	NA	N
1880	07	17	75	3.0000	0.0000	0			2 - BOXES MIXED CHEM., MOSTLY INORGANIC	NA	NA	NA	N
1881	07	10	75	0.0000	0.0000	1			HYDROGEN FLUORIDE CYL. LEAKING HYDROGEN FLUORIDE	I	TBD	V	N
1882	06	20	75	0.0000	0.0000	0			ALCOHOL	O	I*	L	N
1883	06	05	75	1.0000	0.0000	0			MISC. CHEM.	NA	NA	NA	N
1884	06	05	75	6.0000	0.0000	0			TRIETHYL BENZENE	O	TBD	L	N
1885	06	03	75	1.0000	0.0000	0			MISC. CHEM.	NA	NA	NA	N
1886	06	03	75	20.0000	0.0000	0			500 LBS. DRY CHEM. USED IN PLATING SOLUTION DAMAGED BY WATER	NA	NA	NA	N
1887	06	02	75	40.0000	0.0000	0			2-55 GAL. DRUMS TRICHLOROETHYLENE	O	I	L	N
1888	05	31	75	0.0000	0.0000	0			SODIUM CONTAMINATED PIPING	N	R	S	N
1889	05	30	75	0.0000	0.0000	41			41 GAS CYL. FAILED HYDROSTETIC TESTS	NA	NA	V	N
1890	11	18	81	0.2300	0.0000	0			AMMONIUM HYDROXIDE (W/AMMONIUM ARRESTORS)	I	C	L	N
1891	11	30	81	12.3300	0.0000	0			ETHYLENE GLYCOL, 2 AMYLE ACETATE, ACETIC ACID,SULFURIC ACID,NITRIC ACID	I/O	C/I	L	N
1892	11	23	81	176.8800	0.0000	0	17		METRAN 425 P(10 DRUMS) CO-REZYN (13 DRUMS), CORGIL A-527 (1 DRUM)(CONTA	O	I	L	Y
1893	11	18	81	0.2700	0.0000	0			SILGARD SEALANT COMPOUND TYPE 102 IN WATER	NA	NA	L	N
1894	11	20	81	0.9400	0.0000	0	19		N-METHYLPYROLIDONE	O	TBD	L	Y
1895	11	18	81	0.0000	27.5000	0		B	AMONONIUM HYDROXIDE	I	C	L	Y
1896	11	16	81	0.2500	0.0000	0	19		48 BOTTLES OF POTENTIALLY HAZARDOUS CHEMICALS	NA	NA	NA	Y
1897	11	16	81	0.2500	0.0000	0	19		2 BOXES CONTAINING LESS THAN 35 BOTTLES OR CANS EACH	NA	NA	NA	Y
1898	11	12	81	2.0000	0.0000	0	19		1 BOX, SOLVENTS, PHOTO CHEMICALS	O*	NA	L*	Y
1899	11	13	81	1.5000	0.0000	0	15		2 EA; (ONE-1FT3) (ONE-1FT2X1") ASBESTOS	I	TBD	S	Y
1900	11	03	81	0.2000	0.0000	0	19		2-1 GAL. SAFETY CANS; 1-1QT. SAFETY CANS CHLOROTHENE (METHYL CHLOROFORM	O	TBD	L	Y

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 51
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1901	11	02	81	1.0000	0.0000	0	15		ASBESTOS	I	TBD		Y
1902	10	30	81	0.0000	0.0000	0			2 BARRELS TRANSFORMER OIL COLD	O	TBD		N
1903	11	03	81	0.6120	0.0000	0	15		DISPERSANT	I*	C*		Y
1904	11	03	81	0.1140	0.0000	0	15		AMMONIUM HYDROXIDE	I*	C*		Y
1905	11	03	81	0.1340	0.0000	0	15		PHOSPHORIC ACID	I*	C*		Y
1906	11	03	81	0.0000	0.0000	0	15		RADIO MIXTURE #3	I*	C*		Y
1907	11	02	81	4.0200	0.0000	0			30 GAL. CUTTING OIL FROM MACHINE SHOP	O	TBD		N
1908	11	02	81	2.0100	0.0000	0			15 GAL. CHLORONATED HYDROCARBINS (TRICHLOROETHYLENE, ETC.)	O	T*		N
1909	11	02	81	8.0000	0.0000	0			ACID AND WATER	NA	NA		N
1910	10	23	81	0.0000	0.0000	0		B	1# SODIUM SULFIDE, 1 QT. VARNISH, 2 PINTS SODIUM HYDROXIDE, 24 PINTS SO	I/O	R*/C*		Y
~~1911~~	~~10~~	~~27~~	~~81~~	~~0.3500~~	~~0.0000~~	0		~~B~~	~~ARSENIC-NICKEL (ACIDS/LIQUIDS)~~	~~M/NA~~	~~T/NA~~		~~Y~~
1912	10	20	81	2.9500	0.0000	0			BELIEVED TO BE ETHEYLENE GLYCOL IN 55 GAL. DRUM	O	TBD		N
1913	08	25	81	0.1340	0.0000	0			ACRYLIC ADHESIVE RESIN RP560 (NEW) DAMAGED DURING SHIPPING	O	I*		N
1914	10	15	81	0.1700	0.0000	0	19		KEROSENE, TRI-N-BUTYL PHOSPHITE, DI-BUTYL, BUTYLPHOSPHENATE, 1M NITRIC	O	I/C		Y
1915	10	13	81	9.3800	0.0000	0			TRICHLOROETHENE, PHOTO RESIST STRIPPER (MILD ACID)	O	TBD		N
1916	09	23	81	51.5900	0.0000	0			7-DRUMS OIL & VERMICULITE/OIL	O	TBD		N
1917	09	23	81	0.3400	0.0000	0			20-1PT. BOTTLES CHLOROFORM & 1,1,2 TRICHLOROETHENE, ASBESTOS GLOVE,1 CA	O/I/M/	I/T/NA		N
1918	09	23	81	0.0000	4.4000	0	19		HYDRAZINE	I	I		Y
1919	09	23	81	5.3600	0.0000	0	19		CAPELLA OIL	NA	TBD		Y
1920	10	09	81	7.3700	0.0000	0	19		55 GAL. OF KEROSENE	O	I		Y
1921	10	05	81	3.3000	0.0000	0	16		RAGS FROM MERCURY HG SPILL CLEAN UP	M	T		Y
1922	10	05	81	20.0000	0.0000	0	19		SAND MIXED WITH OIL	O	TBD		Y
1923	10	09	81	1.0000	0.0000	0	19		METHYLETHYLKETONE, MERCURY-CONTAMINATED OXYLENE, N,N,DIMETHYLY FORMAMID	O/M	T/I		Y
1924	10	05	81	2.0100	0.0000	0	19		DOW CORNING FLUID (SILICON OIL)	O	TBD		Y
1925	10	05	81	0.2700	0.0000	0		B	HYDROCHLORIC ACID	I	C		Y
1926	10	05	81	4.0000	0.0000	0	17		TRANSENE	NA	NA		Y
1927	10	05	81	14.7400	0.0000	0	15		BARIUM NITRATE & INERT	I	I/T		Y
1928	09	14	81	0.0007	0.0000	0			CESIUM - 2 CONTAINERS	M	I		N
1929	09	14	81	3.0000	0.0000	0	17		PICHROMIC ACID,BENZENE,HEPTONE,LEXANE,ETHYL ETHER,TETRAHYDROFURAN,14-1G	I/O	I/T/C		Y
1930	09	14	81	2.0000	0.0000	0	17		6LBS. POTASSIUM HYDROXIDE, 1QT. SYLARD 134 DIELECTRIC GEL, 6PT. CAN EPO	I/O	C/I		Y
1931	07	29	81	7.3700	0.0000	0			VACUUM PUMP OIL	O	TBD		N
1932	09	09	81	10.0000	0.0000	0	17		5 CARTONS CONTAINING 165 BOTTLES (LONG LIST SAME FAMILY DANGERS)	NA	NA		Y
1933	09	09	81	7.0000	0.0000	0			2-18X18X13, 1-13X13X24, 1-12X12X12 OLD REAGENT GRIDE ORGANIC CHEMICALS	O	NA		N
1934	09	09	81	8.0000	0.0000	0		B	PLATING SOLUTION - ACID	I*	C*		Y
1935	09	01	81	29.4800	0.0000	0	19		MOTOR OIL - STODDARS SOLVENT	O	I*		Y
1936	09	03	81	30.0000	0.0000	0	17		35-1 GAL, 5-5 GAL, 1-55 GAL, MISC PAINT THINERS & DRUM OF RAGS, BRUSHES	NA	NA		Y
1937	09	03	81	4.0000	0.0000	0		B	HYDROCLORIC ACID, CLEAN UP WASTE	I	C*		Y
1938	09	03	81	8.0400	0.0000	0	17		60-1 GAL, TRINSENE 100-22GAL, XYLENE-26GAL, SESQUANOX-12GAL	O	I		Y

BENCHMARK ENVIRONMENTAL CORPORATION

Page No. 52
10/08/91

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO	DY	YR	VOLCUFT	WGT	ITN	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1939	09	03	81	1.0000	0.0000	0	17		ALKOLE, PAINT CANS, GLUE	O	I	L	Y
1940	09	02	81	1.0000	0.0000	0	17		XYLENE, NITRIC ACID	O/I	I/C	L	Y
1941	08	21	81	0.0000	0.0095	0			LEAD FLOURIDE	I	T	S	N
1942	08	13	81	0.0000	0.0000	0			1 BOX CONTAINING POTASSIUM HYDROXIDE OR BORON NITRIDE, 1 PIECE PIPE COV	I	TBD	S	N
1943	08	13	81	2.0100	0.0000	0			3-5GAL CAN CONTAINING VACUUM PUMP OIL, DIALEX,AND/OR TURBO-OIL (MNRL BA	O	TBD	L	N
1944	08	06	81	36.8500	0.0000	0	19		SMALL CAPACITORS CONTAINING PCBS	O	TBD	L	Y
1945	08	07	81	14.7400	0.0000	0	19		SMALL CAPACITORS CONTAINING PCBS	O	TBD	L	Y
1946	08	13	81	13.3500	0.0000	0	17		PHOTO RESIST STRIPPING SOLUTION CONTAINING METHYLENE CHLORIDE SOLVENT	O	I	L	Y
1947	08	13	81	6.0300	0.0000	0	17		TRICHLOROETHYLENE PHOTO DEVELOPER (METHYL CHLOROFORM)	O	T	L	Y
1948	08	13	81	36.8500	0.0000	0	19		SMALL CAPACITORS CONTAINING PCBS	O	TBD	L	Y
1949	08	11	81	4.0000	0.0000	0	17		ORGANICS & INORGANICS (OIL & OTHER CHEMICALS)	O/I	NA	NA	Y
1950	08	10	81	0.0340	0.0000	0	13	B	1 PT NITRIC ACID, 1 PT COPPER SULFATE	I	C	L/S	N
1951	08	10	81	1.0000	0.0000	0	17		2-1 GAL PLASTIC WASTE DCE, ONE-1/2 GALLON GLASS UNKNOWN	NA	NA	NA	Y
1952	08	05	81	7.3700	0.0000	0			1-55 GAL. DRUM TRI CHLOROTHENE	O	TBD	L	N
1953	08	05	81	0.6700	0.0000	0	17		5 GAL CANS - TETRAHYROFURAN, ETHYLENE DICHLORIDE, METHENOL	O	I/T	L	Y
1954	08	05	81	0.0000	0.0000	0	19		PYRIMIDINE, PYRIDAZINE, TRIAZINE, & TWO UNKNOWN LIQUIDS	O/NA	NA	L	Y
1955	08	06	81	6.0000	0.0000	0	17		2-30 GAL DRUMS OF CUTTING OILS FROM MACHING SHOP OPS. (SOME TRICHLOROET	O	TBD	L	Y
1956	08	07	81	1.0000	0.0000	0	17		4-500 ML - THALLIUM MALONATE/FORMATE (CLERS' SOLN)	O	TBD	S	Y
1957	08	30	81	0.0000	1.0000	0	13		2 JARS - 1 POTASSIUM CHLORIDE CRYSTALS, 1 UNIDENTIFIED DRY CHEMICAL	I	TBD	S	Y
1958	07	29	81	7.3700	0.0000	0			TRANSFORMER OIL - TO BE SAMPLED FOR PCBS 8/12/81	O	TBD	L	N
1959	00	00	00	10.0500	0.0000	0		B	ALUMINUM DE-SMUTTING SOLUTION ACID (CHROMIC ACID 30E/GAL PLT 2)(7/81)	I	C	L	Y
1960	00	00	00	6.7000	0.0000	0			PHOSPHORIC ACID CONCENTRATED,NITRIC ACID 3 GAL,ALUMINUM METAL 1OZ/GAL 7	I/M	C	S	N
1961	00	00	00	6.7000	0.0000	0			COPPER STRIPPING SOLUTION PH10 8OZ. COPPER/GAL (8/81)	I	TBD	L	N
1962	07	20	81	29.4800	0.0000	0		B	15% SULFURIC ACID ANODIZING BATH, 5 GM/L ALUMINIUM SULFATE	I	C	L	Y
1963	07	17	81	0.0000	0.0000	0		B	HYDROCHLORIC ACID	I	C	L	Y
1964	07	19	81	0.0170	0.0000	0		B	SULFURIC ACID - CONCENTRATED	I	C	L	Y
1965	07	09	81	2.5000	0.0000	0			25 BOTTLES CANS - ACIDS, BASES & SALTS ONE IS RADIOACTIVE (UR???? NITRA	NA	NA	NA	N
1966	07	07	81	0.8040	0.0000	0	17		HEXANE	O	I	L	Y
1967	07	10	81	0.2500	0.0000	0	17		1-ETHYL ETHER 2-ETHYL OXALATE,24OZ PHOSPHOROUS TRICHLORIDE,1-TRICHLORO	O/I	I/R	L	Y
1968	07	08	81	3.0000	0.0000	0		B	3-ACETIC ACID, 1-SULPHURIC ACID, 2-UNKNOWNS, 2-AMMONIUM HYDROXIDE	O/I	C	L	Y
1969	07	29	81	0.0000	0.0000	0		B	1 PLASTIC BOTTLE - FIXER	I	TBD	L	Y
1970	07	29	81	0.0000	0.0000	0	13		MOSTLY 1 LB BOTTLES OF ANALYTICAL REAGENTS (LIST GONE)	NA	NA	NA	Y
1971	07	24	81	0.2680	0.0000	0		B	4-1/2 GAL NALGEN BOTTLE W/NITRIC ACID (50% SOLUTION)	I	C	L	Y
1972	07	21	81	14.5600	0.0000	0		B	COPPER PLATING BATH - 200 GAL	I*	TBD	L	Y
1973	07	21	81	36.8500	0.0000	0		B	COPPER SULFATE, 80GM/L SULFURIC ACID	I	C	L	Y
1974	07	21	81	5.3600	0.0000	0		B	ZINCATE FOR ZINC COATING ALUMINUM. 7000/GAL SODIUM HYDROXIDE, 13OZ/GAL	I	C*	L	Y
1975	07	21	81	22.1100	0.0000	0		B	ALODINE FOR CHROMATE COATING ALUMINUM 2.0 OX/GAL CHROMIC ACID, 0.4OZ/GA	I*	C*	L	Y
1976	07	21	81	5.9500	0.0000	0		B	NICKEL PLATING BATH, 80GM/L NICKEL, 46GM/L BORIC ACID	I	TBD	L	Y

BENCHMARK ENVIRONMENTAL CORPORATION

TA-54, AREA L SOURCE TERM DATABASE
(AREALST5.DBF)

ID	MO DY YR	VOLCUFT	WGT	ITM	SHAFT	PIT	DESCRIP	CHEM TYPE	RCRA CHAR	PHYS PHAS	LOC
1977	07 17 81	1.0000	0.0000	0			5-1LB PERCHLORIC ACID 70%, 4-1LB HYDROFLORIC ACID 48%, 2-3.25L AMMONIUM	I	C/I	L	N
1978	07 17 81	0.0000	0.0000	0			1 BOX - HYDROCHLORIC ACID - 4LB JARS	I	C	L	N
1979	00 00 00	162.1400	0.0000	0			TRANSFORMER OIL (HAS RSWDS) (7/81)	O	TBD	L	N
1980	06 01 81	4.0000	0.0000	0	17		1-1LB GLASS BOTTLE LITHIUM FLUORIDE, 7-1GAL PLASTIC BOTTLES & 2QT CAN E	I/O	I*	L	Y
1981	06 02 81	37.5200	0.0000	0			2-55 GAL & 2-30GAL DRUMS OF ?????, 2-55 GAL DRUMS OF ABSORBED OIL	O	NA	L	N
1982	06 03 81	64.0000	0.0000	0		B	INORGANIC CHEMICALS	I	NA	NA	Y
1983	06 04 81	0.1500	0.0000	0			CHROMIC ACID	I	T	NA	N
1984	06 09 81	8.0000	0.0000	0	13		1 BBL OF UNKNOWN FROM BIOMED EQUIP. ROOM, 1PT PLASTIC, 1QT HG, 1 SHEET	M/NA	T	S	Y
1985	06 11 81	5.0000	0.0000	0		B	13-1GAL & 1 LOT ASSORTED SIGN - PHOTO GRAPHIC CHEMICALS	I	TBD	L	Y
1986	06 12 81	0.0000	0.0000	0	15		MERCURY	M	T	S	Y
1987	06 19 81	5.0000	0.0000	0		B	29-GLASS GAL, 9-GLASS QTS 4-1/2GAL DICHROMIC ACID, AQUA ????, PHOSPHORU	O/I	T/I	L	Y
1988	05 26 81	0.0000	0.0000	0	17		5 PT ETHERS, 2 BOXES & 5 UNKNOWN ORGANICS	O	I	L	Y
1989	05 26 81	3.0000	0.0000	0			4-1 GAL BOTTLES CASTOR OIL, 1-5 GAL SAFETY CAN ETHANOL	O	I	L	N
1990	05 25 81	0.0000	0.0000	0			12 CONTAINERS - LONG LIST - INORGANIC & ORGANICS	I/O	NA	NA	N
1991	05 18 81	4.0000	0.0000	0		B	PHOTOGRAPHIC CHEMICALS, I.E., FIXER, DEVELOPER, REPLENISHER, 20 CC MERC	M/I	T	S/L	Y
1992	04 28 81	0.0000	0.0000	0	17		2 CANS EPOXY, 2 CANS HARDNER	O	I*	L	Y
1993	08 23 81	1.3400	0.0000	0		B	NITRIC ACID/WATER 70% HNO2) & UNLABELED ACID BOTTLE 600ML	I	C	L	Y
1994	04 07 81	9.0000	0.0000	0			1-30 GAL DRUM BROMACIL (HYVAR-X6)	O	TBD	L	N
1995	05 04 81	2.0000	0.0000	0			1 PLASTIC BAG; HYDROCHLORIC ACID SATURATED WITH SOME /SS TUBING	I	C/T	L/S	N

BATCH WASTE SOURCE TERM DATA BASE

ge No. 1
/02/91

BATCH WASTE TREATMENT PLANT AREA L SOURCE TERM

MO	DY	YR	VOLUME (cu. ft)	CONTENT	TREATMENT (batch analysis)	LOCATION KNOWN?	PIT	SHAFT	WASTE TYPE	SOURCE	HAZ CHAR	RADIAT. IN WASTE	PHYSICAL PHASE
12	20	74	14.7000	Aniline Dye	NONE	Y	A		O	CMB-6			
12	20	74	5.3500	HNO3-20%	NaOH	Y	A		M	CMB-6			
01	08	75	13.3700	NiCl2-NH4Cl+	NaOH	Y	A			CMB-6			
01	03	75	0.0000	NaC6H5O7		Y	A			CMB-6			
01	03	75	0.0000	NaH2PO2		Y	A			CMB-6			
01	08	75	20.0500	Ni Sulfamate	NaOH	Y	A		M	CMB-6			
01	03	75	0.0000	Boric Acid		Y	A			CMB-6			
01	03	75	0.0000	Ni Bromide		Y	A			CMB-6			
01	10	75	3.3400	Cl3CrO3	SO2 + NaOH	Y	A		M	CMB-6			
01	03	75	0.0000	H2SO4		Y	A			CMB-6			
~~01~~	~~10~~	~~75~~	~~8.0200~~	~~H2SO4 20%~~	~~NaOH~~	~~Y~~	~~A~~			~~CMB-6~~			
01	10	75	8.0200	H2SO4 + Cr(+6)	SO2 + NaOH	Y	A		M	E-2			
01	10	75	6.6900	Ferric Cl3		Y	A		M	CMB-6			
01	16	75	13.3700	Ni Chloride	H2SO4+NaOH	Y	A		M	CMB-6			
01	16	75	8.0200	ABF	CaOH	Y	A			ENG-4			
02	10	75	0.5300	H3PO4 + HF + CrO3		Y	A		M	CMB-6			
02	10	75	33.4200	CuCN + NaCN + Na2CO3		Y	A		O,M	CMB-6			
02	12	75	6.6900	HNO3 + H3PO4		Y	A			ETL			
02	12	75	33.4200	H2SO4 + HNO3 + HCl		Y	A			CMB-6			
02	12	75	2.0000	H3PO4		Y	A			CMB-6			
01	31	75	80.2000	NH4F	400 # lime	Y	A			TA-48 ENG-4			
01	31	75	60.1000	NH4F	300 # lime	Y	A			TA-48 ENG-4			
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.7061	3H	Asphalt lined drums	N			AreaG	CNC-11		yes	
02	07	75	0.2825	3H	Asphalt lined drums	N			AreaG	CNC-11		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.0706	3H	Asphalt lined drums	N			AreaG	CMB-1		yes	
02	07	75	0.4944	3H	Asphalt lined drums	N			AreaG	CNC-11		yes	
03	25	75	6.6900	HNO3 + H3PO4	NaOH	Y	A			ETL			
03	25	75	0.7239	3H	Asphalt drum	N			AreaG	CNC-11			
03	26	75	33.4200	50% HNO3, Co, Al, Fe	NaOH	Y	A		M	CMB-6			

BENCHMARK ENVIRONMENTAL CORPORATION

ge No. 2
/02/91

BATCH WASTE TREATMENT PLANT AREA L SOURCE TERM

MO	DY	YR	VOLUME (cu. ft)	CONTENT	TREATMENT (batch analysis)	LOCATION KNOWN?	PIT	SHAFT	WASTE TYPE	SOURCE	HAZ CHAR	RADIAT. IN WASTE	PHYSICAL PHASE
03	26	75	0.0706	3H-0.17 ug/l	Asphalt drum	N			AreaG	CMB-1			
03	26	75	0.0706	3H < 0.01 mg/l	Asphalt drum	N			AreaG	CMB-1			
09	29	75	13.3700	HNO3 - 33%	NaOH	Y	A			SH-105			
09	30	75	13.3700	NiCl + NaAc	NaOH	Y	A		M	CMB-6			
00	00	00	0.0000	NH4Cl		Y	A			CMB-6			
09	30	75	33.4200	NiCl2 + HCl	NaOH	Y	A		M	CMB-6			
09	30	75	3.3400	HNO3 + Cu	NaOH	Y	A		M	CMB-6			
09	30	75	0.4000	KCN + NaOH	Cl + NaOH	Y	A			CMB-6			
10	15	75	0.2119	3H @ 21.6 mg/l	Grit Chamber	N			TA-50	CMB-1		yes	
12	12	00	8.0200	NaOH + 2NiO		Y	A		M	CMB-6			
12	12	00	6.6900	30% HNO3 - 5% H3PO4		Y	A			ETL			
01	13	76	10.7000	Trichloroethylene		Y	A		O	CMB-6			
03	22	76	80.2000	ABF	600 lbs Ca(OH)2	Y	A			ENG-4-TA-48			
02	16	76	12.0300	90% H3PO4		Y	A			CMB-6			
02	16	76	5.3500	NaOH Zinc Bright		Y	A		M	CMB-6			
02	12	76	6.6900	20% HNO3 + H3PO4		Y	A			ETL			
02	20	76	16.0400	H2SO4 + Cr(+6)		Y	A		M	E-2			
07	02	76	33.4200	NiSO4 + NiCl3 + H3BO3		Y	A		M	CMB-6			
12	12	75	8.0200	NaOH + 2NiO		Y	A		I,M	CMB-6			
12	12	75	6.6900	30% HNO3 + 5% H3PO4		Y	A		I	MP			
12	20	75	16.0400	H2SO4 + Cr(+6)		Y	A		I,M	E-2			
01	13	76	10.7000	TriClor (TCE)		Y	A		O	CMB-6			
03	22	76	100.2800	ABF	Ca(OH)2 - 600 lb.	Y	A		I	ENG-4			
02	10	76	12.0300	90% H3PO4		Y	A		I	CMB-6			
02	10	76	5.3500	NaOH + Zinc Bright		Y	A		I,M	CMB-6			
02	-12	76	6.6900	30% HNO3 + 5% H3PO4		Y	A		I	MP			
05	27	00	4.6800	NaCN + CuCN		N			O,M	CMB-6			
05	04	76	66.8400	ABF	Ca(OH)2 - 300 lb.	Y	A		I	ENG-4			
05	27	00	0.4700	NiCO3+HF+C6H8O7+NH4F,NaHPO3		Y	A		I,O,M	CMB-6			
05	27	00	1.4700	NiSO4+Ni+(NH4)2SO4,ZnSO4,NaSCN		Y	A		I,O,M	CMB-6			
05	27	00	1.6000	H3PO4		Y	A		I	CMB-6			
05	27	00	4.0100	NH4F+Na2Cr2O7+H3PO4		Y	A		I,M	CMB-6			
05	27	00	0.4700	CoCO3+EDTA+NH4OH		Y	A		I,O	CMB-6			
07	02	76	2.0100	KCN		N			O	CMB-6	R		
07	02	76	33.4200	NiSO4+NiCl2+H3BO3		Y	A		I,M	CMB-6	C		
08	04	76	6.6900	NiClSO4, Na3PO4		Y	A		I,M	CMB-6	C		
08	10	76	66.8400	ABF	Ca(OH)2+CaCl2	Y	A		I	ENG-4			
08	10	76	66.8400	ABF	Ca(OH)2+CaCl2	Y	A		I	ENG-4			

BENCHMARK ENVIRONMENTAL CORPORATION

age No. 3
0/02/91

BATCH WASTE TREATMENT PLANT AREA L SOURCE TERM

	MO	DY	YR	VOLUME (cu. ft)	CONTENT	TREATMENT (batch analysis)	LOCATION KNOWN?	PIT	SHAFT	WASTE TYPE	SOURCE	HAZ CHAR	RADIAT. IN WASTE	PHYSICAL PHASE
77	04	22	77	0.0000	KCN-Granular (1/4 lb.)	Cl2 (2 lbs)	Y	A		O	N-7			L,S
78	11	10	76	16.0400	Chromic Acid	SO2 (100 lbs)	Y	A		I	E-2			L,S
79	11	15	76	7.3500	HNO3 - 20%	NaOH (5 gal)	Y	A		I	NP-11			L
80	09	20	76	66.8400	ABF	CaOH (500 lbs)	Y	A		I	ENG-4			L,S
81	04	24	77	23.4000	NH4 + CN(*)	Cl2 (25 lbs)	Y	A		I,O	CMB-6			L
82	04	19	77	7.3500	CN-Ni, CU(*)	Cl2 (150 lbs)	Y	A		I,O	CMB-6			L,S
83	03	22	77	6.6900	Chrome +6(*)	SO2 + NaOH	Y	A		I	E-2			L,S
84	10	21	00	267.4000	ABF	NaOH	Y	A		I	ENG-4			L,S
85	10	22	00	28.0800	3H	Dumped in Grit Chamb	Y	A			CNC-11		Yes	L
86	04	22	77	0.0530	NaCN	Cl2 (5 lbs)	Y	A		O	P-4			L
87	11	15	76	20.0600	HNO3	NaOH (30 gal)	Y	A		I	CMB-6			L
88	04	19	77	0.1300	NaCN	Cl2	Y	A		O	WX-2			L
89	04	19	77	0.0100	NaCN	Cl2	Y	A		O	CMB-1			L
90	11	15	76	2.0100	HNO3 - 50%	NaOH (5 gal)	Y	A		I	R			L
91	01	04	77	40.1200	ABF	NaOH	Y	A		I	ENG-4			L,S
92	03	10	77	40.1200	ABF	NaOH	Y	A		I	ENG-4			L,S
93	03	22	77	14.0400	H2SO4 + Cr(+6)	SO2 + NaOH	Y	A		I	E-2			L,S
94	03	22	77	4.0100	HNO3+HCL+CO	NaOH	Y	A		I	Q-13			L
95	03	26	77	80.2000	ABF	NaOH	Y	A		I	ENG-4			L,S
96	04	02	77	66.8400	ABF	NaOH	Y	A		I	ENG-4			L,S
97	04	17	77	160.4400	ABF	NaOH	Y	A		I	ENG-4			L,S
98	04	20	77	13.3700	KCN+CU+K2O3	Cl2 + NaOH	Y	A		O,N	CMB-6			L,S
99	04	20	77	14.7000	DTPA+KCN+CU	Cl2 + NaOH	Y	A		O,N	CMB-6			L
100	04	20	77	4.0100	Na+Cr(+6)+H2SO4	SO2 + NaOH	Y	A		I,N	CMB-6			L,S
101	08	09	77	33.0191	70% H2SO4+Cr(+6)+U238	SO2 + NaOH (NOT DUMP)	N				CMB-6		yesU	
102	08	08	77	14.7000	Nickel/Acetate		Y	A		I,O,N	CMB-6	T		L
103	08	08	77	29.4000	H2SO4 Anodizer	NaOH	Y	A		I	CMB-6			L
104	08	09	00	80.2000	ABF	Ca(OH)2+CaCl2	Y	A		I	ENG-4			L,S
105	08	10	77	0.5300	Udylite	NaOH	Y	A			CMB-6			L
106	08	10	77	14.7000	KCN+NH3	Cl2+NaOH	Y	A		O	CMB-6			L
107	08	10	77	2.0100	H2SO4+Na2Cr(+6)2O7	SO2+NaOH	Y	A		I,N	CMB-6			L,S
108	09	22	77	5.3500	Cr(+6)+H2SO4	SO2+NaOH	Y	A		I,N	E-2			L,S
109	09	27	77	133.7000	ABF	450#Ca(OH)2+160#CaCl2	Y	A		I	ENG-4			L,S
110	09	30	77	133.7000	ABF	200#Ca(OH)2+160#CaCl2	Y	A		I	ENG-4			L,S
111	10	03	77	133.7000	ABF	300#Ca(OH)2+80#CaCl2	Y	A		I	EN-4			L,S
112	10	05	77	133.7000	ABF	300# Ca(OH)2	Y	A		I	ENG-4			L,S
113	10	20	77	29.4100	50% HNO3 + AgCl-AgClAl		Y	A		I,N	CMB-6	C		L
114	10	13	77	4.0100	Fluoroboric Acid, Pb		Y	A		I,N	CMB-6	C		L

BENCHMARK ENVIRONMENTAL CORPORATION

ge No. 4
/02/91

BATCH WASTE TREATMENT PLANT AREA L SOURCE TERM

	NO	DY	YR	VOLUME (cu. ft)	CONTENT	TREATMENT (batch analysis)	LOCATION KNOWN?	PIT	SHAFT	WASTE TYPE	SOURCE	HAZ CHAR	RADIAT. IN WASTE	PHYSICAL PHASE
15	11	22	77	4.0100	(Fe,Ni,CO,Hg) HNO3	NaOH	Y	A		I,M	Q-13			L,S
16	11	24	77	6.0200	NH4 Citrate+NaOH+CN	Cl2 + NaOH	Y	A		O	CMB-6			L
17	04	19	78	7.3500	NH4 Citrate+NaOH+CN	Cl2 + NaOH	Y	A		O	CMB-6			L
18	11	22	77	4.0100	H3PO4	NaOH	Y	A		I	CMB-6			L
19	04	21	78	5.3500	KCN	Cl2 + NaOH	Y	A		O	CMB-6			L
20	04	25	78	2.0100	KCN+KNi(CN)2	Cl2 + NaOH	Y	A		O,M	CMB-6			L
21	04	25	78	5.3500	KCN+NaOH	Cl2 + NaOH	Y	A		O,M	CMB-6			L
22	04	27	78	14.7000	NaCN+Na2CO3	Cl2 + NaOH	Y	A		O	CMB-6			L
23	02	07	78	6.0200	FeCl3		Y	A		I	WX-7	C		L
24	02	07	78	4.0100	Stripper		Y	A			WX-7			L
25	~~02~~	~~17~~	~~78~~	~~133.7000~~	~~ABF~~	~~Ca(OH)2 + CaCl2~~	~~Y~~	~~A~~		~~I~~	~~ENG-4~~			~~L,S~~
26	02	23	78	66.9000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
27	04	01	78	133.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
28	04	06	78	133.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
29	04	08	78	240.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
30	04	12	78	2.0100	Cr(+6) Acid	SO2 + NaOH	Y	A		I,M	N-7			L,S
31	04	12	78	0.4000	Cr(+6) Acid	SO2 + NaOH	Y	A		I,M	AP1			L,S
32	04	12	78	240.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
33	04	19	00	133.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
	04	19	78	200.0000	ABF	Ca(OH)2	Y	A		I	ENG-4			L
35	04	21	78	240.6600	ABF	CaCl2	Y	A		I	ENG-4			L
36	04	25	78	267.4000	ABF	CaCl2	Y	A		I	ENG-4			L
37	04	27	78	22.0600	Ni Acetate	NaOH	Y	A		O,M	CMB-6			L,S
38	04	27	78	7.3500	Ni Salt	NaOH	Y	A		I,M	CMB-6			L,S
39	04	27	78	7.3500	Cr(+6) + H2SO4	SO2 + NaOH	Y	A		I,M	CMB-6			L,S
40	04	27	78	267.4000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
41	05	15	78	36.7700	30% HCl, Fe, Cu	NaOH	Y	A		I,M	CMB-6			L,S
42	05	12	78	22.0600	50% HNO3, Fe, Cu	NaOH	Y	A		I,M	CMB-6			L,S
43	05	15	78	0.6700	Lead Fluorobate		Y	A		I,M	CMB-6			L,S
44	05	15	78	7.3500	Ni Strip		Y	A		u	CMB-6			L
45	05	19	78	0.6700	Ag+CN+KCN	Cl2+NaOH	Y	A			CMB-6		yes	L
46	10	19	78	13.3700	Cr(+6)+H2SO4	SO2 + NaOH	Y	A		I,M	E-2			L,S
47	07	26	78	66.9000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
48	07	27	78	0.2700	3H		Y	A			H-4		yes	L
49	10	19	78	6.6900	HNO3	NaOH	Y	A		I	HP			L
50	10	19	78	2.7600	HNO3	NaOH	Y	A		I	0-13			L
51	10	19	00	9.3600	HNO3	NaOH	Y	A		I	CTR-11			L
52	09	21	00	14.7000	1,1,1 Methyl Chloroform		Y	A		O	E-2			L

BENCHMARK ENVIRONMENTAL CORPORATION

age No. 3
0/02/91

BATCH WASTE TREATMENT PLANT AREA L SOURCE TERM

NO	DY	YR	VOLUME (cu. ft)	CONTENT	TREATMENT (batch analysis)	LOCATION KNOWN?	PIT	SHAFT	WASTE TYPE	SOURCE	HAZ CHAR	RADIAT. IN WASTE	PHYSICAL PHASE
	28	78	20.0500	Cr(+6)+H2SO4	SO2 + NaOH	Y	A		I,M	E-2			L,S
	17	00	133.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
	19	00	133.7000	ABF	Ca(OH)2 + CaCl2	Y	A		I	ENG-4			L,S
	06	78	36.1000	HCl+Cu+Ni	NaOH	Y	A		I,M	CMB-6			L,S
	06	78	29.4000	Ni-Acetate	NaOH	Y	A		O,M	CMB-6			L,S
	06	78	7.3500	Gold Solute W/NaOH+SO3		Y	A		I,M	CMB-6			L
	08	79	7.3500	20% HNO3		Y	B		I	NP			L
	22	79	7.3500	SO3+H2SO4	NaOH	Y	B		I	CMB-6			L
	13	79	14.7000	DTPA+CN+NaOH+Au+Cu	Cl2+NaOH	Y	B		O,M	CMB-6			L
	13	79	4.0100	CN+NaOH	Cl2+NaOH	Y	B		O	CMB-6			L
	20	79	133.7000	ABF	Ca(OH)2+CaCl2	Y	B		I	ENG-4			L,S
	25	79	66.9000	ABF	Ca(OH)2+CaCl2	Y	B		I	ENG-4			L,S
	27	79	66.9000	ABF	Ca(OH)2+CaCl2	Y	B		I	ENG-4			L,S
	05	79	36.7621	HNO3+Cu+Ni+Te	NaOH H-1 PAD)	N				CMB-6		yes	
	18	79	7.3500	Cr(+6) Dye	SO2 + NaOH	Y	B		I,M	E-1			L,S
	24	00	401.0000	ABF	Ca(OH)2 + CaCl2	Y	B		I	ENG-4			L,S
	04	00	6.0156	HNO3+3802	(H-1 PAD)	N				CMB-6		yes	
	04	00	6.0156	CuCl2+HF+3802	(H-1 PAD)	N				CMB-6		yes	
	12	00	7.3500	CN+H2O2+C	Cl2+NaOH	Y	B		O	CMB-6			L
	12	00	11.3600	NaOH+CN+Au	Cl2+NaOH	Y	B		O,M	CMB-6			L
	09	79	133.9000	ABF	Ca(OH)2 CaCl2	N				ENG-4			L,S
	15	79	36.7700	HCl+Fe+Cu		Y		2,13	I,M	CMB-6	C		L,S
	18	00	7.3500	50% HNO3	NaOH	Y	B		I	CMB-6			L
	25	00	80.2083	ABF	Ca(OH)2+CaCl2(PLANT	N				ENG-4 OMEGA		YES	
	30	00	36.7700	Nickel Bright		Y	B		?,M	CMB-6			L
	05	79	66.8403	ABF	Ca(OH)2+CaCl2(H-1 PAD	N				ENG-4		YES	
	04	79	66.9000	ABF	Ca(OH)2+CaCl2	Y	B		I	ENG-4			L,S
	11	00	14.7000	50% HNO3		Y	B		I	CMB-6	C		L
	11	00	7.3500	NaOH+DTPA+S		Y	B		I	CMB-6			L
	11	00	7.3500	Dow Therm		Y	B		u	H-7			L
	16	00	0.8000	H2SO4+Cr(+6)	SO2 + NaOH	Y	B		I,M	H-7			L,S
	14	00	0.4000	H2SO4+Cr(+6)	SO2 + NaOH	Y	B		I,M	H-7			L,S
	03	00	133.7000	ABF	Ca(OH)2+CaCl2	Y	B		I	ENG-4			L,S
	07	00	5.3500	HNO3	NaOH	Y		13	I	CTR			L
	05	79	133.7000	ABF	Ca(OH)2+CaCl2	Y	B		I	ENG-4			L,S
	11	79	7.3500	Ni Bright		Y	B		u	CMB-6			L
	00	00	1.3400	Ni Bright		Y	B		u				L
	12	79	5.3500	Ca + Ni		Y	B		I,M	E-2			L,S

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Page No. 6
10/02/91

BATCH WASTE TREATMENT PLANT AREA L SOURCE TERM

	MO	DY	YR	VOLUME (cu. ft)	CONTENT	TREATMENT (batch analysis)	LOCATION KNOWN?	PIT	SHAFT	WASTE TYPE	SOURCE	HAZ CHAR	RADIAT. IN WASTE	PHYSICAL PHASE
191	11	02	79	133.7000	ABF	Ca(OH)2 + CaCl2	Y	B		I	ENG-4			L,S
192	01	09	80	7.3500	Ni Plating	Ni	Y	B		I,M	CMB-6			L
193	02	20	80	133.7000	ABF	Ca(OH)2 + CaCl2	Y	B		I	ENG-4			L,S
194	03	04	80	56.1500	HNO3	Ni	Y	B		I,M	CMB-6			L
195	03	11	80	133.7000	ABF	CaCO3+CaCl2	Y	B		I	ENG-4			L
196	08	12	80	56.1500	Ni Plating	Ca(OH)2 + CaCl2	Y	B		I,M	CMB-6			L
197	08	20	80	6.6900	CN + Ag	Cl2 + NaOH	Y	B		O,M	CMB-6			L
198	08	25	80	6.6900	CN+Ag+Cu	Cl2 + H2O	Y	B		O,M	CMB-6			L
199	10	00	80	6.6900	CN+Cu	Cl2 + H2O	Y	B		O,M	CMB-6			L
200	01	00	81	6.6900	CuCN	Cl2 + H2O	Y	B		O,M	CMB-6			L
201	06	16	81	133.7000	ABF	Ca(OH)2 + CaCl2	Y	B		I	ENG-4			L,S
202	07	14	82	29.4100	CN	Cl2	Y	B		O	CN6			L
203	04	19	83	1.3400	CN	Ca(OCl)2+NaOH	Y	B		O	MST6			L
204	06	09	83	6.0200	CN	Ca(OCl)2+NaOH	Y	B		O	MST6			L
205	07	21	83	3.6100	CN	Ca(OCl)2+NaOH	Y	B		O	MST6			L
206	07	13	84	80.2200	ABF	CaO+CaCl2	Y	B		I	ENG-4			L,S
207	07	25	84	66.9000	ABF	CaO+CaCl2	Y	B		I	ENG-4			L,S

Appendix D

Final Cover Design Specifications

D-1.0 INTRODUCTION

This appendix describes modeling to develop specifications for an evapotranspiration (ET) cover at Material Disposal Area (MDA) L within Technical Area (TA) 54. The specifications are based on modeling applicable to both MDA L and the nearby MDA G site. Both MDA G and MDA L are located on the eastern end of Mesita del Buey and are impacted by the same weather. The effectiveness of an ET cover depends on precipitation, potential ET, and unsaturated soil hydraulic properties. These factors determine how much moisture is input into the cover system, how much moisture is removed by evaporation and plant transpiration, and how quickly the remaining moisture migrates downward to the waste layer. As amended, TA-61 borrow soil will be used to construct both ET covers, these three major factors are identical for both sites. Attachment D-1 provides supporting documentation for the modeling and specifications presented.

The UNSAT-H infiltration modeling used to calculate cover thickness was based on the wettest decade on record, which is a common data set used for Resource Conservation and Recovery Act (RCRA) hazardous waste landfill cover design (Benson 2007, 097054, p. 3). The 3.5 ft (1 m) cover depth with 1.5 ft (0.45 m) of soil-gravel admixture was designed to reduce flux through the cover to less than 0.04 in./yr (1 mm/yr), the RCRA Subtitle C–equivalent infiltration. Alternative 1B, which relies on this unamended soil, requires nearly 6.6 ft (200 cm) of depth to reach the desired 0.04 in./yr (1 mm/yr) flux. Because there is only 3 ft (1 m) of existing cover at MDA L, Alternative 1B would not achieve an infiltration rate less than the RCRA Subtitle C cover. Alternative 2B requires only 5 ft (1.5 m) of amended soil to have less than the RCRA Subtitle C–equivalent infiltration.

Nearly 1.5 ft (0.4 m) of soil-gravel admixture was designed to protect the cover surface layer from wind and water erosion. The cover top slopes of the MDA L cover are less steep and shorter than the slopes of MDA G, so the admixture calculations for MDA G are conservative for the MDA L cover. The same size gravel ranging in diameter from 1.5 in. (4.4 cm) to 3 in. (7.6 cm), will be used in a 33 percent-by-weight admixture. Because the admixture was designed for 1000-yr recurrence interval storm, it will remain effective after the 60-yr monitoring and maintenance period. A mix of native warm and cool weather grasses will be used to seed the cover surface.

Burrowing animals and plant roots on Mesita del Buey will be deterred by the biobarrier consisting of a thin filter layer and a cobble layer. This biobarrier is described below. All these cover layers will be placed on the existing subgrade of interim cover, which will be scarified to promote adhesion to the final cover and highly compacted to reduce possible subsidence.

This appendix also describes the rationale for selecting an ET cover, the purpose for each layer of the cover, the design methodology used, and the calculations and modeling results that validate the design (Attachment D-1). Most of the input parameters are identical for MDA L and MDA G sites, with only differences in the cover slopes and slope lengths.

D-2.0 BACKGROUND

MDA L is located within TA-54 at Los Alamos National Laboratory (LANL or the Laboratory) in Los Alamos, New Mexico. TA-54 is located on Mesita del Buey and spans the boundary of the Cañada del Buey and Pajarito Canyon watersheds. TA-54 ranges in elevation from 6700 ft to 6800 ft with a depth to groundwater ranging between 900 ft and 980 ft. The major industrial activity at TA-54 has been waste storage and disposal. MDA L is a 2.5-acre site that has served as the Laboratory’s nonradioactive liquid chemical waste subsurface disposal site from the early 1960s to 1986. The majority of stormwater runoff from MDA L enters the Pajarito Canyon watershed with a much smaller portion draining into Cañada del Buey, which is located within the Mortandad Canyon watershed.

This appendix provides a summary of the basis for the conceptual cover design for MDA L as part of the corrective measures evaluation (CME) for remediation of the site. Many of the calculations and specifications for the MDA L site are similar to those developed by Dwyer in the report "Conceptual Cover Design Report for the Corrective Evaluation Measure for Closure of MDA G" (Dwyer 2007, 098276). At MDA L, an ET cover with an erosion-resistant surface treatment and a biobarrier will be constructed to provide adequate protection and risk reduction. The ET cover will consist of a single, vegetated soil layer constructed to represent an optimum mix of soil texture, soil thickness, and vegetation cover (Figure D-2.0-1).

The ET cover concept relies on the soil to act as a sponge (Dwyer 2003, 097902, p. 162). Infiltrated water is held in this "sponge" until it can be removed via ET. Generally, ET is defined as the combination of water removal because of both evaporation from the surface and transpiration through vegetation. Previous research has shown that a simple soil cover can be very effective at minimizing percolation and erosion, particularly in dry environments.

The MDA L site is an ideal site for an ET cover. Prescriptive RCRA covers that depend on geosynthetics cannot effectively be used for these sites because the geosynthetics will not last as long as the waste poses a significant risk, nor will they meet the 60-yr monitoring and maintenance period. Additionally, the climate's demand for water or potential evapotranspiration (PET) far exceeds the actual supply of water (precipitation) as shown in Figure D-2.0-2. The ET cover offers another important advantage in that it provides for a deeper rooting medium that will provide an opportunity for native vegetation to survive lengthy drought periods because the water storage of the ET cover is greater than that of a prescriptive cover.

D-3.0 CONCEPTUAL DESIGN

The cover system proposed for final closure as part of the CME for MDA L is shown in Figure D-3.0-1. A brief description of each layer in the cover profile is presented in Table D-3.0-1, with more complete descriptions presented in sections D-3.1 to D-3.5.

D-3.1 VEGETATION

Seed and/or live plants used to revegetate disturbed areas at the Laboratory shall be native to the Los Alamos vicinity. Table D-3.1-1 lists the seed mix to be used for the cover system at MDA L.

Seed Application

Seeding of native vegetation on the cover systems shall be performed in the spring, after the last frost of the season and before the arrival of the summer rains that typically occur in July and August. Seeding will not be done from August 1 to September 30 to avoid germination too close to the first frost, which can kill the new seedlings.

Revegetation shall be done by first preparing the soil by tilling and applying fertilizer. Care must be taken to ensure the rock/soil surface treatment maintains the desired ratio during this activity. Care must also be taken to ensure the rock/soil surface treatment layer is not mixed deeper into the cover profile. Slow-release organic fertilizers shall be applied as necessary to eliminate any deficiencies of the topsoil. Table D-3.1-1 lists the recommended levels of available plant nutrients. Bio-Sol or a similar fertilizer shall be applied at rates up to 1500 lb/acre. Analyses of cover soils used will dictate the actual fertilizer rate required. Granular humate can be applied at 400 lb/acre to 500 lb/acre if it is in a hydroseeding slurry and up to 1800 lb/acre if it is incorporated into the top 4 in. of the soil. Application rates of composted manure vary depending on the source (chicken, horse, etc.) and the type of materials (wood chips, paper, soil, etc.) used to compost. If composted manure is to be applied, the nutrient content shall be tested and interpreted before it is used.

Drill seeding shall be the method used to apply the seed mix. Drilling introduces seed directly into the prepared seedbed by machine. Seeding shall be performed by drilling at a minimum rate of 25 pure live seed (PLS) lb/acre. In areas that limit equipment access, broadcast seeding may be used at a rate of 40 PLS lb/acre.

D-3.2 Surface Treatment

To address the potential erosion of the cover system, a surface treatment is to be used composed of a mixture of gravel and cover soil. This admixture was designed following the procedure described in Dwyer et al. (1999, 099309, p. 34; 2007, 096232, pp. 5-19-5-25).

The gravel-to-soil ratio and gravel size was determined based on the most critical drainage section (north-south). With the addition of the gravel-soil admixture to the surface, annual soil loss because of both wind and runoff was estimated to be minimal. The gravel-soil admixture shall include a mixture of 33% gravel by weight. The cover soil shall exhibit the storage capacity and soil nutrients described in section D-3.3. Salts in this soil shall also be limited in the cover soil as described in section D-3.3. The critical gravel size was determined to be 1.5 in. (3.8 cm) (gravel size between 1.5 in. [3.8 cm] and 3 in. [7.6 cm] in diameter to be used), and the total gravel-soil admixture thickness is to be no less than 18 in. (0.5 m). The design methodology and procedure with input and output specifics are included in Attachment D-1. Many of the input parameters required to calculate the specifics of this gravel admixture, surface treatment such as bulk density and percentage of silt/clay in the soil were estimated based on soil amendment requirements. Slopes and slope lengths were estimated based on preliminary contours provided by Pro2Serve (Attachment D-1). These estimates will be replaced with measured values during the final design phase.

Because the gravel is used to control erosion and is subject to weathering, it shall meet the durability requirements described in NUREG (NRC 2002, 097900, Appendix D) (see Table D-3.2-1).

Soil Placement

The gravel-soil admixture used as a surface treatment shall be placed in one uncompacted lift, if practical. Two lifts are also acceptable provided the bottom lift is not overcompacted because of placement of the top lift. This surface treatment layer shall be placed as dry as possible but no wetter than the optimum moisture content as determined by American Society for Testing and Materials (ASTM) D698. Any excessive compaction this layer receives during placement shall be scarified. The loose state of placement is to provide the best means for vegetation establishment. Overcompaction is one of the primary causes of unsuccessful revegetation efforts.

D-3.3 Cover Soil

The cover soil layer beneath the gravel/soil admixture shall be a minimum of 3.5 ft (1 m) of amended soil meeting the water storage capacity properties of a typical sandy loam soil, based on the ROSETTA Software, Version 1.2, developed in 2000 by Marcel G. Schaap of the U.S. Salinity Laboratory, Riverside, California. The cover soil, including the soil in the surface treatment (gravel admixture), must have adequate storage capacity to retain infiltrated water until that water can be removed via ET. This soil must provide a quality rooting medium to maintain native vegetation; therefore, the soil must have acceptable levels of available plant nutrients, and its salt content must be below acceptable levels.

The depth of the cover soil was determined based on water storage requirements to meet RCRA-equivalency less than 1 mm/yr. Modeling using UNSAT-H (Fayer 2000, 072734) was performed to determine the minimum thickness required to provide adequate storage capacity for an upper boundary condition consisting of the wettest decade in recorded history in Los Alamos (1985 to 1994).

Average hydraulic properties (Shaw Environmental Inc. 2006, 091368, Appendix D) from the TA-61 soil borrow site were used as input parameters. The modeling output determined that a depth greater than 6.6 ft (2 m) would be required to minimize flux largely because of the lack of water storage capacity in the TA-61 soils (Figure D-3.3-1). The TA-61 soils consist of crushed tuff and were classified as a sandy loam but are on the coarser side of sandy loam soils. The ROSETTA software, Version 1.2, was used to perform another modeling exercise using typical sandy loam hydraulic properties to ascertain if this soil type would decrease the soil depth requirement. This output (Figure D-3.3-2) determined that approximately 5 ft (1.5 m) of typical sandy loam soil would minimize flux to a point of diminishing returns (Dwyer et al. 2007, 096232, pp. 3-10-3-11).

The depth of the surface treatment was determined to be a minimum of 1.5 ft (0.5 m). Therefore, the additional cover soil depth required to minimize flux is 3.5 ft (1 m). This depth provides for a minimum cover soil depth of 5 ft (1.5 m). A third modeling exercise was performed to capture the entire conceptual design that includes all layers above the existing subgrade. This modeling output determined that flux through the cover will be negligible with the conditions modeled. It is important to note that the inclusion of a filter medium above the biobarrier and the inclusion of a biobarrier create a capillary barrier. Details of the modeling performed, including specific input and output parameters, are included in Attachment D-1.

The amendments shall ensure the cover soil is capable of maintaining a desired stand of native vegetation. The plant nutrients should allow for the final amended soil to meet the requirements listed in Table D-3.3-1.

Because it is not known where the amendments to the TA-61 borrow soil will come from, it is also important to verify that the cover soils have tolerable quantities of salts. That is, the salt content in the soils shall be below levels that would hinder the establishment and growth of native vegetation. The final amended soils shall comply with the requirements outlined in Table D-3.3-2.

Soil Placement

An important aspect involved with the construction of a soil cover system is that the soils are placed in a uniform manner to help limit preferential flow through the cover. Dwyer (2003, 097902, p. 32) describes the impact of preferential flow in landfill covers. Preferential flow cannot be avoided, but necessary precautions shall be employed to ensure it is minimized. An important feature of the design specifications will involve determining an acceptable density range for installation of the cover soils. To increase the initial storage capacity of the cover system and mitigate the potential for desiccation cracking, the soils will be placed as dry as possible but no greater than the optimum moisture content as determined by ASTM D698. The acceptable density and moisture content placement range is described as the acceptable compaction zone (ACZ).

The ACZ (Figure D-3.3-2) is unknown as of the date of this report because the desired soil will require amendment to meet the performance objectives of the cover system. Therefore, the process involved in determining this ACZ is briefly described here. Further details may be found in Dwyer et al. (2007, 096232, pp. 3-7-3-8).

The determination of the ACZ for placement of cover soil follows.

1. Cover soil shall be placed at the goal density. The goal density is best determined from the borrow soil's in situ density. That is, over an extended period of time, a given soil will move toward its "natural" density state. Therefore, it is the goal of the soil installation to place the soil at a density that is as close to that "goal" density as possible from the onset. In this case, because the soil will be amended, the goal density shall be assumed to be between 85% to 90% of the maximum dry density (MDD), as determined by ASTM D698.

2. Determine a standard proctor curve for the amended soil used per ASTM D698, "Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort," to obtain the respective MDD and optimum moisture content.

3. The allowable dry unit weight or soil density during construction shall be the goal density, plus or minus 5 lb/ft^3 (80.1 g/L).

4. The cover soils shall be placed as dry as possible not to exceed the optimum moisture content per ASTM D698 derived for each borrow soil used. Installing soil dry will provide for a maximum initial water storage capacity in the cover and minimize the potential for desiccation cracking, particularly when clays are used (Dwyer 2003, 097902). This moisture content is applicable for all soils in the cover system, including the upper 1 ft (31 cm) of the interim cover or subgrade.

D-3.4 Filter Medium

A filter medium composed of sand and/or gravel shall be placed above the biobarrier, between the biobarrier and the overlying cover soil layer. This layer is designed to prevent the mixing of soil layers and meet specified filter criteria. The depth of this layer is to be determined in the field and will be the minimum depth required to completely cover the biobarrier layer and provide a smooth and continuous surface layer for placement of the cover soil. For estimating purposes, this layer shall be assumed to be 6 in. (15 cm) thick.

Two primary mechanisms of concern for transport of contaminants from the MDA L site are biointrusion and erosion. Both burrowing animals and roots are of concern because they can bring contaminants to the surface. A biobarrier is included in the conceptual design to minimize the potential for burrowing animals and roots from accessing the buried source materials. The biobarrier is composed of large cobble. To prevent the mixing of finer cover soil into the cobble layer, a filter layer is included. A geotextile or other geosynthetics were not used as a filter fabric because they have limited performance lives that are significantly less than the 30- to100-yr performance criteria applied to the MDA L site.

The filter medium will be composed of coarse material (sand and/or gravel) that meet specific filter criteria to prevent the mixing of materials. These criteria are as follows:

$D_{15}/ d_{85} \leq 5$ **Equation D-1**

where

D_{15} = particle size of the coarse soil for which 15% of the particles are finer,

d_{85} = particle size of the fine soil for which 85% of the particles are finer.

The filter design criteria, summarized in a DOE technical report (1989, 099296, Table 4.2-3), and the following requirements shall also be used. The filter material shall pass the 3-in. sieve for minimizing particle segregation and bridging during placement. Smaller maximum particle sizes may be specified if practical. Also, filters must not have more than 5% passing the No. 200 mesh sieve to prevent excessive movement of fines in the filter. Filter material shall be reasonably well graded throughout the in-place layer thickness.

A capillary barrier will be formed with the inclusion of the filter medium beneath the fine cover soils. A second capillary barrier may also be formed between the filter medium and the cobble biobarrier. Consequently, all requirements for a capillary barrier must be followed, as outlined in Dwyer et al. (2007, 096232). Of particular concern are long slope lengths and consequently the diversion capacity of the capillary barrier. The interface between the materials forming the capillary barrier(s) shall maintain a smooth and continuous interface. Discontinuities in this interface may result in significant preferential flow and must be prevented.

D-3.5 Biobarrier

As stated in section D-3.4, a biobarrier is included in the cover profile to minimize the intrusion of flora and fauna into the buried source materials. A minimum 1-ft- (0.3-m-) thick layer of cobble with a minimum diameter of 6 in. (15 cm) will be included in the cover profile. This layer will minimize the potential burrowing of the animal of most concern at the site (gophers) as well as the intrusion of woody roots from plants such as shrubs, piñon, and juniper.

Biointrusion in a landfill cover system refers to the flora and fauna (including insects) interactions or intrusion into the cover system. Biointrusion is important in that it can represent a mechanism leading to vertical transport of contaminants to the ground surface via plant root uptake or soil excavation by burrowing animals and insects. Biointrusion can lead to increased infiltration and preferential flow of surface water through the cover system and contribute to the change in the soil layer’s hydraulic properties. However, the increased soil moisture resulting from burrowing effects on infiltration can actually stimulate increased plant growth, leading to an increase in plant transpiration (Gonzales et al. 1995, 073708; Hakonson 2002, 099469) and a net decrease in flux.

Vertical transport by biota may be small over a short time scale; however, over many decades these processes may become dominant in mobilizing buried waste or contaminated soil (Dwyer et al. 2007, 096232, p. 4-7). Burrowing by animals and insects has the potential to access buried waste several meters below ground surface, which may lead to chemical and radiation exposures to organisms and physical transport of waste upward in the soil profile to ground surface, to biota, and across the landfill surface to offsite areas. These processes are enhanced by erosion (wind/water), transport of animals moving on/off the landfill, deposition of soil particles on biological surfaces from rain splash and wind resuspension, and wind transport of senescent vegetation to off-site areas.

Numerous studies, many of which are summarized in Dwyer et al. (2007, 096232) discuss the effects of biointrusion on cover systems and waste sites. Several specifically applicable to MDA L are summarized in Attachment D-1.

D-3.6 Subgrade/Interim Cover Preparation

MDA L currently has an interim soil cover over it. This site will require clearing, grubbing, and some regrading (including cut/fill operations to bring the site to grade) before placement of the final cover system. The elevations and grades shall comply with those shown on the project drawings provided by others. At a minimum depth, the upper 1 ft (31 cm) of the interim cover or subgrade shall be scarified and recompacted before placement of the biobarrier. This recompaction shall produce a density not less than 95% of the maximum dry density as determined by ASTM D698. The moisture content shall be placed dry of the optimum moisture content as determined by ASTM D698.

D-4.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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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Shaw Environmental Inc., February 2006. “Geotechnical and Hydraulic Characterization at the Technical Area 61 Borrow Area,” report prepared for Los Alamos National Laboratory, Albuquerque, New Mexico. (Shaw Environmental, Inc. 2006, 091368)

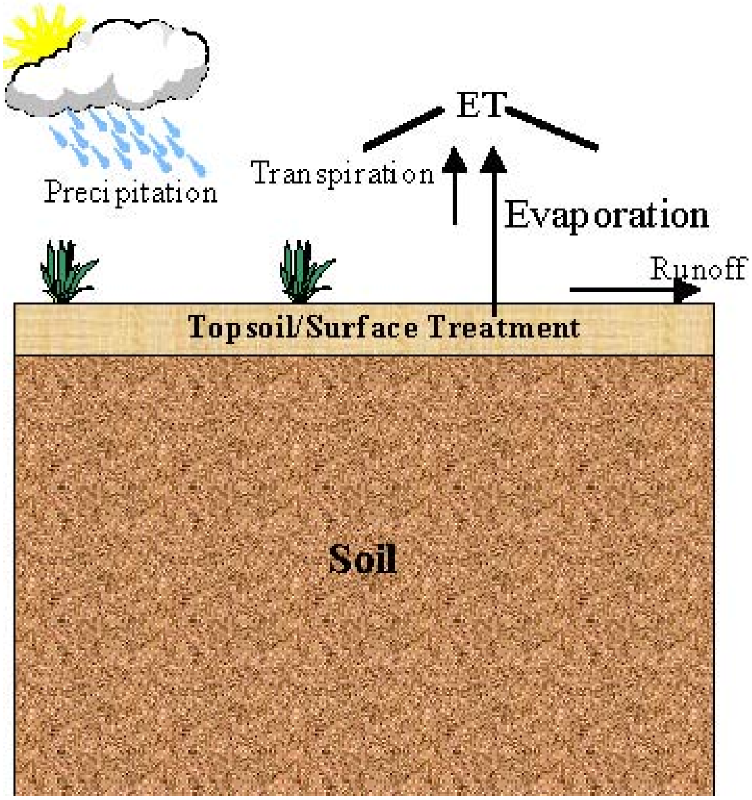


Figure D-2.0-1 Typical ET cover profile

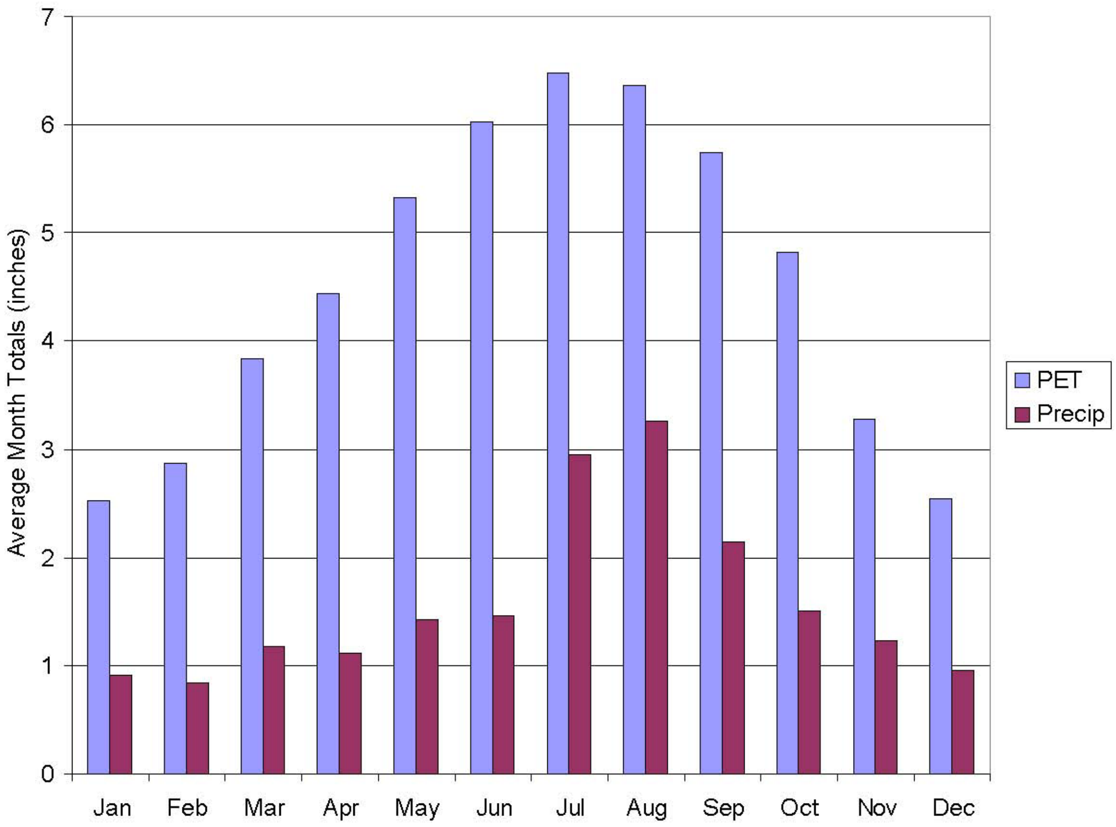


Figure D-2.0-2 **Climate's demand for water (PET) versus supply of water (precipitation) for Los Alamos, New Mexico**

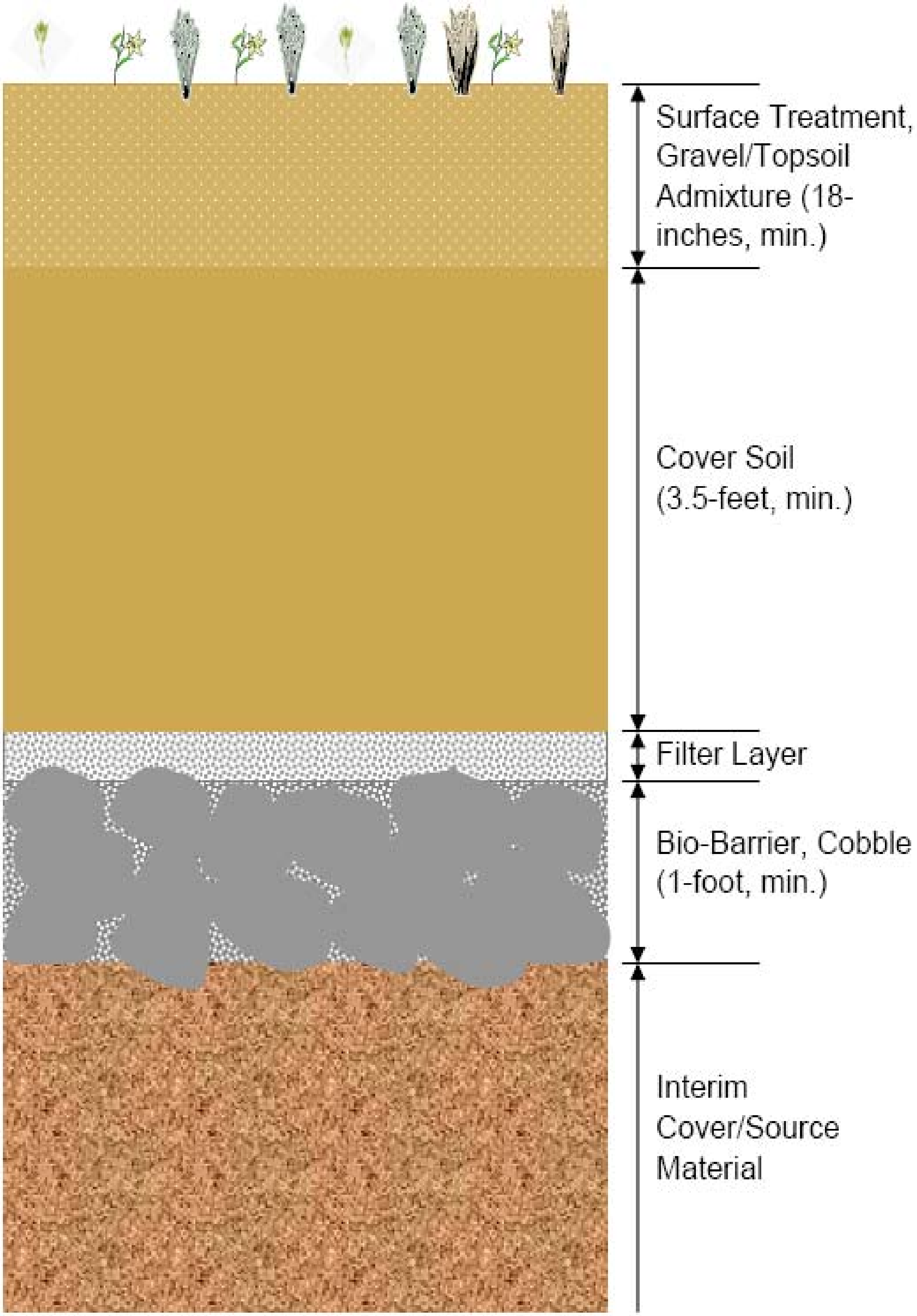


Figure D-3.0-1 MDA L CME conceptual cover profile

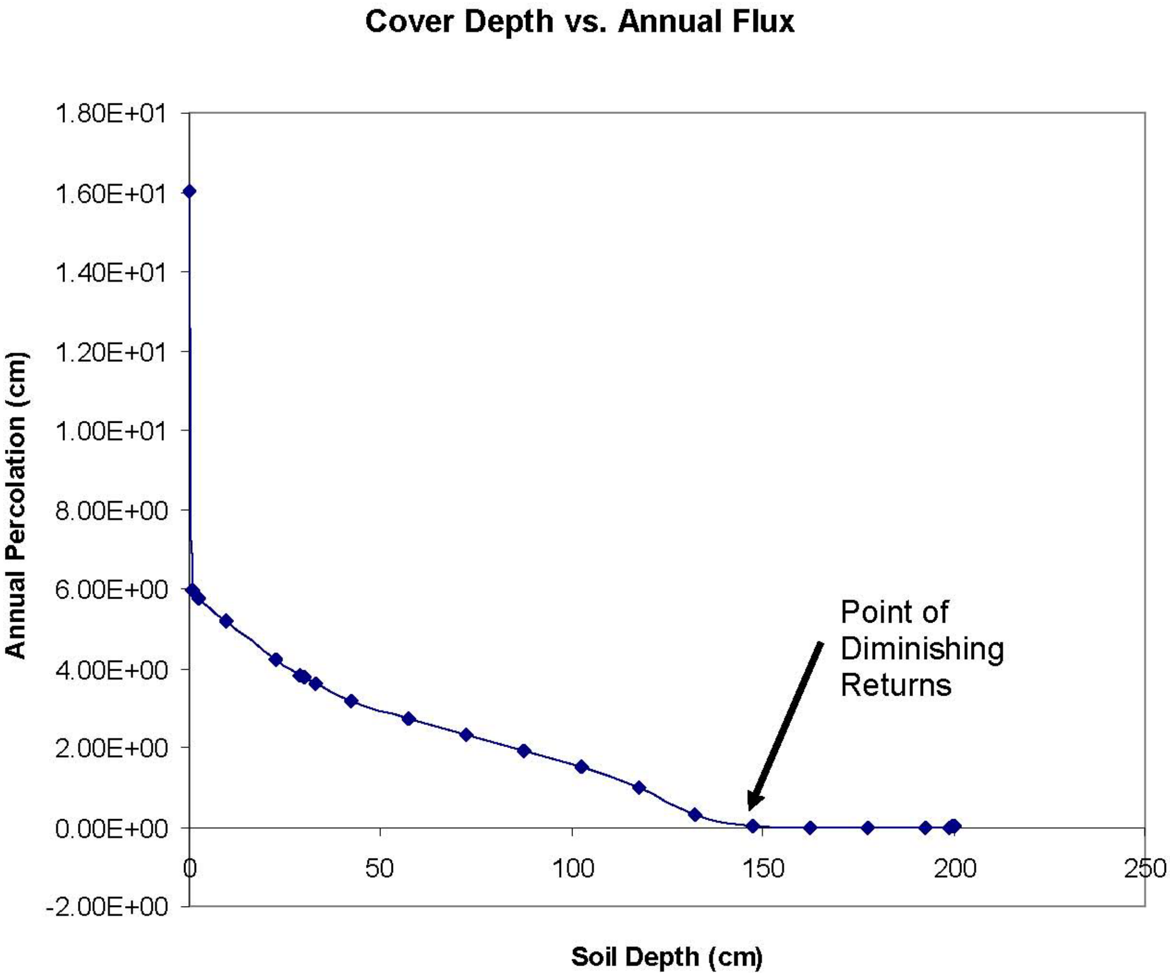


Figure D-3.3-1 Typical sandy loam soil: point of diminishing returns (1.5 m)

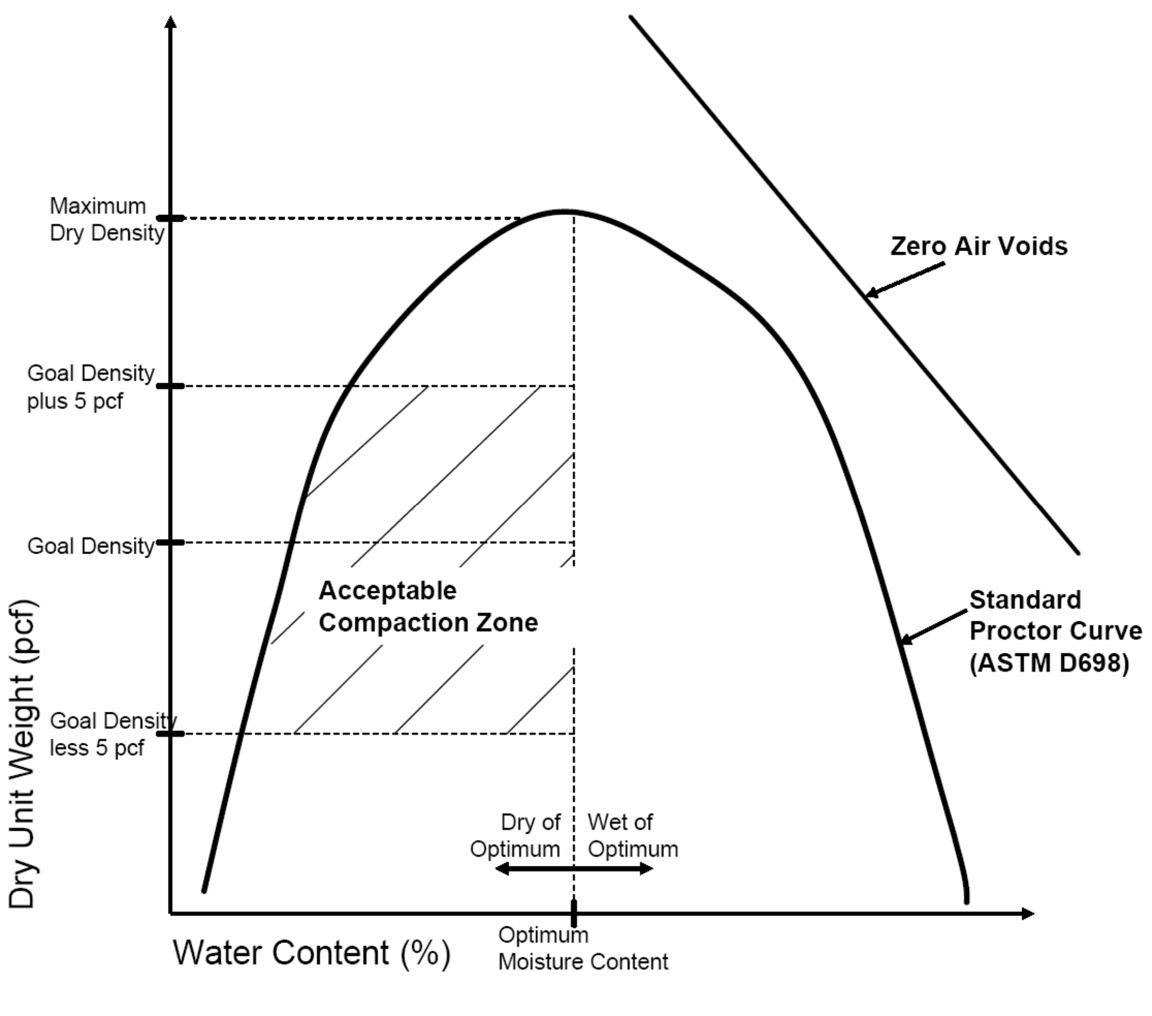


Figure D-3.3-2 ACZ for soil placement shown in hatch marks

Table D-3.0-1
MDA L CME Conceptual Cover Profile Layer Specifics and Justification

Cover System Layer	Design Specifics	Design Justification
Vegetation	The site is to be seeded with native vegetation composed of both cool and warm weather species (grasses). Table D-3.1-1 lists the recommended seed mix.	The vegetation will help stabilize the cover surface, minimize erosion, and remove infiltrated water via transpiration.
Surface Treatment	Mixture of cover soil and gravel. The gravel is to be mixed into the cover soil at a rate of 33% by weight. The gravel will be 1.75 in. (4.4 cm) to 3 in. (7.6 cm) in diameter. The cover soil will be capable of maintaining native vegetation with adequate storage capacity and nutrient availability. This layer will be a minimum of 18 in. (0.5 m) thick.	The gravel-soil admixture is designed to minimize erosion because of both wind and surface runoff.
Cover Soil	The cover soil depth will be a minimum of 3.5 ft (1 m). The layer will consist of soil from TA-61 with a determined mix of soil amendments. The cover soil will be capable of maintaining native vegetation with adequate storage capacity and nutrient availability.	Hydraulic characteristics of a typical sandy loam were used to determine the required soil depth because it is recommended that the TA-61 borrow soils be amended to possess the storage capacity of this soil type. The soil depth was determined using modeling where a depth of soil was determined to minimize flux. The modeling used the wettest decade on record as the upper boundary condition. However, because the site requires a 30- to 100-yr performance period, it was estimated that the added storage capacity offered by the inclusion of a biobarrier that creates a capillary barrier was more than adequate to store any infiltration events that would occur over a 100-yr return period.
Filter Layer	This layer is composed of sand and gravel that meet determined filter criteria to prevent the overlying finer cover soils from migrating into the underlying biobarrier.	A thin layer placed directly on the biobarrier to serve as a filter medium to prevent the overlying finer soils from migrating into the underlying biobarrier.
Biobarrier	A layer of minimum 6-in.- (15-cm-) diameter cobble composed of rock or concrete. The layer is to be a minimum of 1 ft (0.3 m) thick.	The layer prevents biointrusion (burrowing animals and plant roots) from entering the underlying source material.
Subgrade	The upper foot of existing interim cover soil shall be scarified and recompacted to a minimum of 95% of the maximum dry density and dry of the optimum moisture content as determined per ASTM D698.	The subgrade provides a firm foundation for the construction of the cover profile and the final grades and slopes for installation of a uniform cover profile.

Table D-3.1-1
Seed Mix

Common Name	Scientific Name	% of Mix	PLS (lb/acre)
Sideoats grama	Bouteloua curtipendula	15%	3.75
Blue grama	Bouteloua gracilis	15%	3.75
Indian ricegrass	Oryzopsis hymenoides	10%	2.5
Western wheatgrass	Agropyron smithii	15%	3.75
Sand dropseed	Sporobolus cryptandrus	10%	2.5
Sheep fescue	Festuca ovina	20%	5
Firewheel	Gaillardia pulchella	3%	.75
Western yarrow	Achillea millefoium	2%	.5
Prairie coneflower	Ratibida columnifera	4%	1
Blue flax	Linum perenne lewisii	6%	1.5
Total			**25**

Source: Dwyer et al. 2007, 096232.

Table D-3.2-1
Scoring Criteria for Determining Rock Quality

	Weighting Factor			Score										
	Limestone	Sandstone	Igneous	10	9	8	7	6	5	4	3	2	1	0
Specific Gravity (SSD)	12	6	9	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.40	2.35	2.40	2.25
Absorption (%)	13	5	2	0.1	0.3	0.5	0.67	0.83	1.0	1.5	2.0	2.5	3.0	3.5
Sodium Sulfate (%)	4	3	11	1	3	5	6.7	8.3	10	12.5	15	20	25	30
Abrasion (%)	1	8	1	1	3	5	6.7	8.3	10	12.5	15	20	25	30
Schmidt Hammer	11	13	1	70	65	60	54	47	40	32	24	16	8	0
Tensile Strength (psi)	5	4	10	1400	1200	1000	833	666	500	400	300	200	100	<100

Source: Modified from NUREG (NRC 2002, 097900).

Table D-3.3-1
Recommended Available Plant Nutrients for Cover Soil

Test	Limits
CEC	Greater than 15
Percent organic matter	Greater than 2% (g/g)
N	Greater than 6 parts per million (ppm)
P	4 to 7 ppm
K	61 to 120 ppm

Table D-3.3-2
Recommended Limitations of Salt in Cover Soil

Test	Limits
EC	Less than 8 μS/cm
SAR	Less than 6
ESP	Less than 15% (g/g)
$CaCO_3$	Less than 15% (g/g) – to 3-ft (91-cm) depth of cover; No limit below 3 ft (91 cm)

Attachment D-1

Appendixes A–C of the "Conceptual Design Report for the Corrective Evaluations Measure for the Closure of MDA G"

Attachment A

GRAVEL ADMIXTURE DESIGN

DESIGN RAINFALL EVENT

The rainfall intensity value used to calculate the runoff volume was determined using data supplied by the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Hydrometerological Design Studies Center and is available on the internet on NOAA's Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/sa/nm_pfds.html). The data from NOAA Atlas 14 for Los Alamos, NM was used whereby the 30 minute precipitation frequency estimate for a 1000 return period is 2.46 inches (6.25 cm). The 30 minute time of concentration is conservative for any contributory area less than 50 acres (20 hectares) (Lindeburg 1989).

RUNOFF PREDICTION

The "rational method" was used to estimate runoff volumes. This method is commonly used in civil engineering applications and is a method approved by DOE (1989) for design of cover systems for sites regulated by the Uranium Mill Tailings Radiation Control Act of 1978 (i.e., UMTRA sites). Refer to "LANL Engineering Standards Manual," Section G20 (http://engstandards.lanl.gov/engrman/3civ/pdfs/Ch3_G20-R1.pdf). The rational method is based on the assumption that rainfall occurs uniformly over the watershed at a constant intensity for a duration equal to the time of concentration.

Using the rational method, the peak rate of runoff, (Q), in cubic feet per second (cfs) (runoff is actually in acre-inches/hour but is rounded to cfs is given by the following expression:

$$Q = C\ I\ A \qquad \textbf{Equation A.1}$$

where:

C = Runoff coefficient (dimensionless)

I = Rainfall intensity (in/hr)

A = Surface area that contributes to runoff (acres)

The value for "I" in this case was 2.46 inches/hour (6.25 cm/hr). For storms with return periods longer than 100 years, DOE recommends the use of C = 1.0 (DOE 1989). The surface area was calculated based on the assumed configuration shown in figure A.1 where L is the critical slope length. Slopes and slope lengths were estimated from proposed contoured plans of the MDA G conceptual cover. Because most of the drainage areas from the cover were irregularly shaped, the slopes and slope lengths were estimated to match the area configuration described here.

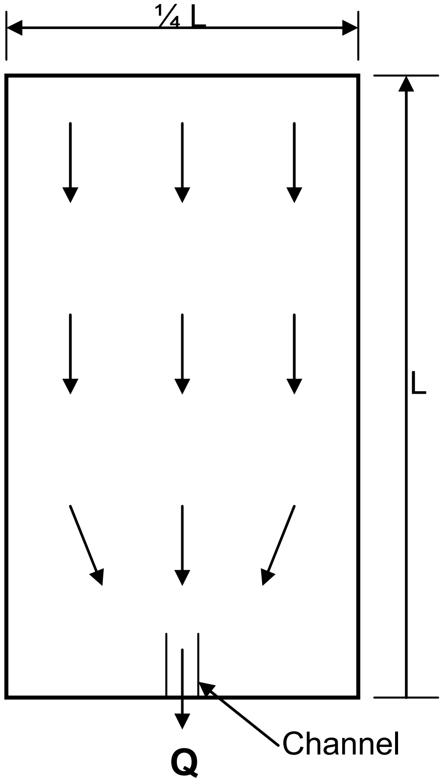


Figure A.1
Contributory area for gully formation

Channel Geometry

The channel geometry shown in Figure A.2 is that assumed for the gully formation.

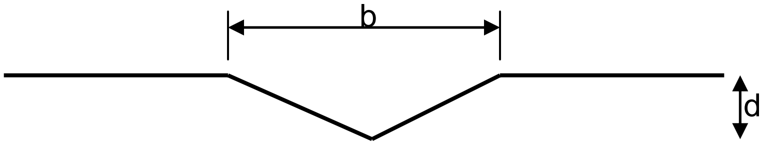


Figure A.2
Channel geometry

The geometry of the channel that forms is based on regression equations developed from analysis of a large number of channels (Simon, Li & Assoc. 1982). The channel width is given by:

$$b = 37\ (Q_m^{0.38} / M^{0.39})$$ **Equation A.2**

where:

b = width of flow (ft);

Q_m = mean annual flow (cfs);

M = percentage of silts and clays in soils.

The mean annual flow (Q_m) is assumed to be between 10% and 20% of the peak rate of runoff (Q) (Dwyer et al. 1999). In this case 20% was conservatively used.

For the given discharge point of geometry, the hydraulic depth (d_h), defined as the flow cross-sectional area divided by the width of water surface, is half of the gully depth (d).

For flows at the critical slope:

$$b = 0.5\ F^{0.6}\ F_r^{-0.4} Q^{0.4} \qquad \textbf{Equation A.3}$$

where:

F = width to depth ratio = b/dh;

F_r = Froude Number ≈ 1.0.

These equations were solved simultaneously to yield the channel width and depth for the given peak flow rate and percentage of silt and clay. Refer to Table A.1 for the summary of calculations performed.

Incipient Particle Size

The incipient particle size is the particle that is on the brink of movement at the assumed conditions. Any increase in the erosional forces acting on the particle, due to an increase in velocity or slope, for example, will cause its movement. This incipient particle size (D_c) was calculated using the Shield's Equation:

$$D_c = \tau/F_s(\gamma_s - \gamma) \qquad \textbf{Equation A.4}$$

where:

τ = total average shear stress (pcf);

F_s = Shield's dimensionless shear stress = 0.047;

γ_s = specific weight of soil (pcf);

γ = water density = 62.4 pcf.

The total average shear stress is given by:

$$\tau = \gamma\ d_h\ S \qquad \textbf{Equation A.5}$$

where:

S = slope (ft/ft).

d_h = hydraulic depth (ft)

Depth of Scour and Armoring Required

The incipient particle size defines the maximum size of particle that will be eroded for a given set of conditions. The material larger than the incipient particle size will not be displaced or eroded, and can form an armoring that will protect the channel from further erosion from similar or lesser storm events.

The depth of scour (Ys) (Figure A.3) to establish an armor layer is given by (Pemberton and Lara 1984):

$$Y_s = Y_a\ [(1/P_{c)}-1] \qquad \textbf{Equation A.6}$$

where:

Y_s = scour depth;

Y_a = armor layer thickness;

P_c = decimal fraction of material coarser than the incipient particle size.

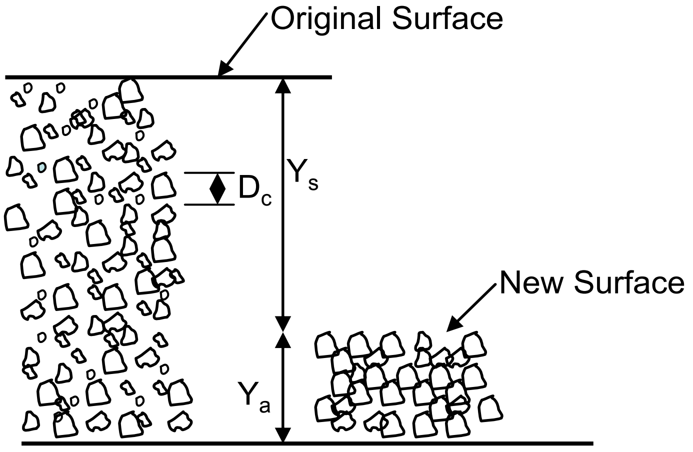


Figure A.3
"Desert Pavement" development

Table A.1 summarizes the gravel admixture calculations performed including critical input and output parameters. The slopes and slope lengths were estimated based on approximate drainage paths and contributory areas as they relate to that assumed in this set of calculations. The first column describes the section that is related to the project drawings produced by PRO2SERVE (not part of this report).

TABLE A.1
GRAVEL ADMIXTURE CALCULATIONS SUMMARY

Section	C Value	I (in/hr)	S (%)	Slope Length (ft)	Q (cfs)	Q_m (cfs)	% silt/clay[1]	Bulk Density[1] (pcf)	Critical Gravel Size [2] (in)	Ratio	Total depth req'd (inches)
DA1	1.0	2.46	2.7	350	1.73	0.17	20	115	0.75	33%	9
DA2	1.0	2.46	3	500	3.53	0.35	20	115	1.25	33%	15
DA3	1.0	2.46	4	375	1.99	0.20	20	115	1.25	33%	15
DA4	1.0	2.46	2.8	800	9.04	0.90	20	115	1.50	33%	18
DA5	1.0	2.46	3.5	500	3.53	0.35	20	115	1.25	33%	15
DA6	1.0	2.46	2	750	7.94	0.79	20	115	1.00	33%	12
DA7	1.0	2.46	2	750	7.94	0.79	20	115	1.00	33%	12

[1] assumed values based on amendments and gravel mixture

[2] value rounded up to nearest quarter inch

Attachment B
BIOINTRUSION STUDIES

Plutonium is the best example of a radionuclide whose transport to animals in arid ecosystems is dominated by physical processes. Data from many field sites and source conditions show that gut availability of plutonium and other contaminants bound to soil in a variety of animals including rodents, deer and cattle is very low (gut to blood transfer $<10^{-5}$) leading to very low concentrations of contaminant in internal tissues and organs (Smith, 1977; Moore et al., 1977; Hakonson and Nyhan, 1980; Arthur et al., 1987). Highest concentrations of most soil contaminants in dry, dusty environments are usually found in tissues exposed to the external environment. Those tissues include the pelt, gastro-intestinal tract, and lungs. At Los Alamos, about 96% of the plutonium body burden in rodents from the canyon liquid waste disposal areas was in the pelt and gastro-intestinal tract (Hakonson and Nyhan, 1980).

Because soil passes through the gastro-intestinal tract of free-ranging animals on a daily basis, there is a potential to redistribute soil radionuclides across the landscape. Studies at Nevada Test Site with cattle (Moore et al., 1977), at Rocky Flats Plant with mule deer and small mammals (Little, 1980; Arthur, 1979), and at Idaho National Engineering Laboratory with small mammals and coyotes (Arthur and Markham, 1983; Arthur et al., 1980) demonstrate that horizontal (and vertical in the case of burrowing animals) redistribution of soil plutonium does occur as animals move within and outside contaminated areas. However, the magnitude of this transport was shown to be very small over the short-term (Arthur, 1979; Arthur and Markham, 1983; Arthur et al., 1980).

There are circumstances where animal transport of soil contaminants can assume more importance. For example, fission product sludge containing 90Sr and 137Cs in a salt form was released to unlined cribs at Hanford and the cribs were backfilled with clean soil. A large animal, probably a coyote or badger then burrowed down to the sludge and created direct access for other animals seeking the salts including jackrabbits (O'Farrell and Gilbert, 1975). Jackrabbits ingested the radioactive salts, became contaminated and then excreted 90Sr on the ground surface. Levels of 90Sr in excreta were found over a 15 km^2 surface area (O'Farrell and Gilbert, 1975). This incident with 90Sr and jackrabbits was a special case that involved liquid waste sludge disposal trenches that were not adequately covered.

Potentially more soluble strontium and cesium transport to animals in arid ecosystems involves a combination of physical and physiological processes. The more tightly bound these radionuclides are to soil (related to clay content of soil and local climate); the more their transport will be governed by soil particle transport. Data on Sr90 and Cs137 in small mammals from the Nevada Test Site (Romney et al., 1983) and at a burial ground at Idaho National Engineering Laboratory (Arthur et al., 1987) show relatively high concentrations of these radionuclides in lung, pelt and gastro-intestinal tract similar to plutonium. This suggests that physical transport of these more "soluble" radionuclides is also important as with plutonium. The bioavailability of radionuclides such as cesium and strontium will depend on chemical form, local environmental conditions, and the structure and function of the relevant food webs.

Tritium would be one of the few exceptions to the general observation that physical transport mechanisms dominate in the transport of soil surface contaminants to biota. Uptake by roots or sorption through the leaf surface would dominate in tritium transport to vegetation. Levels of tritium in animals would reflect levels in the source (i.e., concentration ratios are 1 or less) since tritium is not concentrated as it moves through abiotic and biotic pathways. Furthermore, tritium in vegetation is available to nectivorous organisms such as honeybees as well as herbivores. While tritium is readily transported through ecosystems, it is rapidly turned over in biological systems at rates corresponding to water turnover in these systems. In humans, body water turnover is about 3 days (RHH, 1970).

Although vegetation is very important in controlling erosion and percolation in landfill covers (Nyhan et al., 1984), deeply penetrating plant roots have the potential to access buried waste and bring plant available constituents including landfill contaminants to the surface of the site (Klepper et al., 1979; Foxx et al., 1984; Tierney and Foxx, 1987). Contaminants such as tritium can be incorporated within plant tissue and enter the food web of herbivorous or nectivorous organisms. For example, at Los Alamos National Laboratory tritium transport away from a controlled low-level waste site occurred via the soil moisture/plant nectar/honey bee/ honey pathway (Hakonson and Bostick, 1976). As another example, deep-rooted Russian Thistle (Salsola kali) growing over the waste burial cribs at Hanford penetrated into the waste, mobilized 90Sr, and then transferred it to the ground surface. The contaminated surface foliage was transferred away from the cribs when the matured Thistle (tumbleweeds) blew away from the site (Klepper et al., 1979). Two mechanisms for soil contaminant transport to terrestrial plants are absorption by roots and deposition of contaminated soil particles on foliage surfaces. Field studies suggest that deposition of soil particles on foliage surfaces is a major transport mechanism for soil associated contaminants under many arid site and contaminant source conditions (Romney and Wallace, 1976; Romney et al., 1987; White et al., 1981; Arthur and Alldredge, 1982).

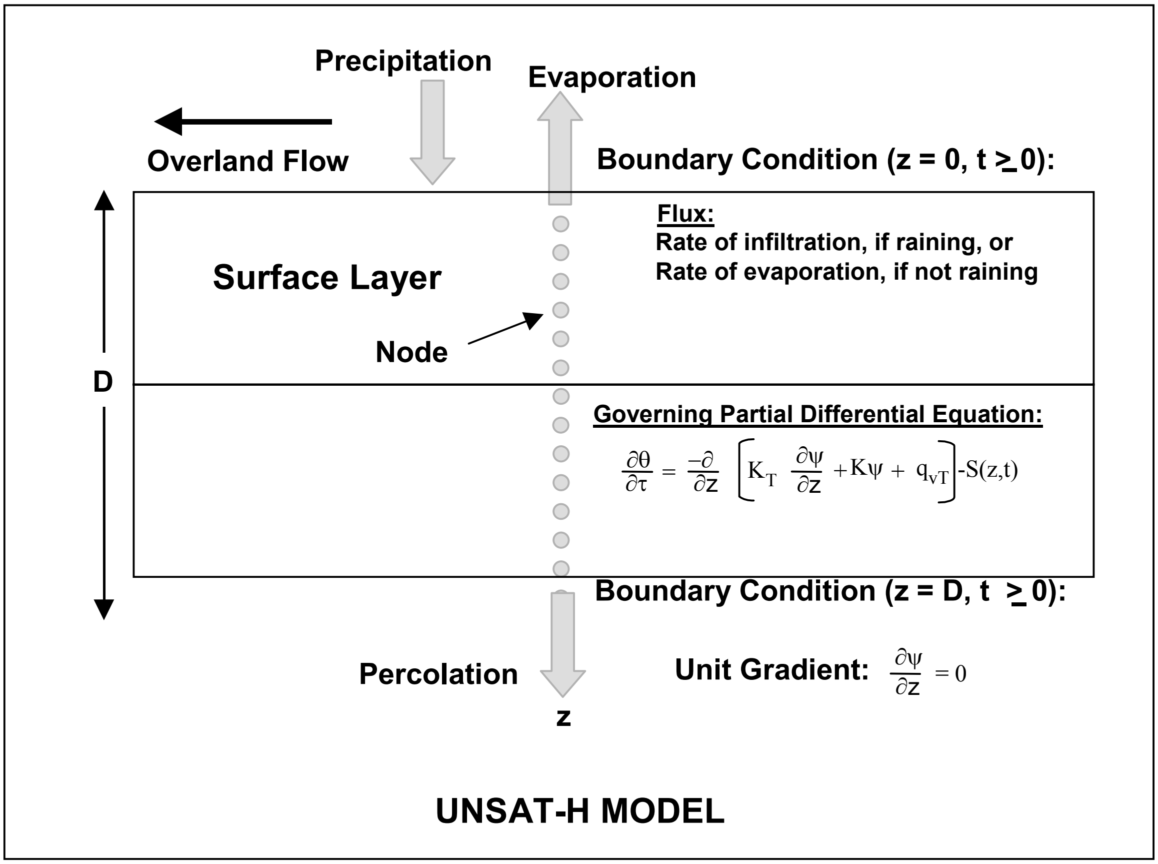
Attachment C
MODELING

Overview of UNSAT-H

UNSAT-H has been used to design many recent alternative earthen cover designs (Dwyer 2003). Unlike most unsaturated flow programs, UNSAT-H was specifically developed for the evaluation of earthen covers. UNSAT-H is a one-dimensional, finite-difference computer program developed at the Pacific Northwest National Laboratory by Fayer and Jones (1990). UNSAT-H can be used to simulate the water balance of earthen covers as well as soil heat flow (Fayer 2000). UNSAT-H simulates water flow through soils by solving Richards' equation and simulates heat flow by solving Fourier's heat conduction equation.

A schematic illustration showing how UNSAT-H computes the water balance is shown in Figure C.1. UNSAT-H separates precipitation falling on an earthen cover into infiltration and overland flow. The quantity of water that infiltrates depends on the infiltration capacity of the soil profile immediately prior to rainfall (e.g., total available porosity). Thus, the fraction of precipitation shed as overland flow depends on the saturated and unsaturated hydraulic conductivities of the soils characteristic of the final cover. If the rate of precipitation exceeds the soil’s infiltration capacity, the extra water is shed as surface runoff. UNSAT-H does not consider absorption and interception of water by the plant canopy, or the effect of slope and slope-length when computing surface runoff.

Figure C.1
SCHEMATIC REPRESENTATION OF WATER BALANCE COMPUTATION BY UNSAT-H (modified from Khire 1995)



Water that has infiltrated a soil profile during an UNSAT-H simulation moves upward or downward as a consequence of gravity and matric potential. Evaporation from the cover surface is computed using Fick's law. Water removal by transpiration of plants is treated as a sink term in Richards' equation. Potential evapotranspiration (PET) is computed from the daily wind speed, relative humidity, net solar radiation, and daily minimum and maximum air temperatures using a modified form of Penman's equation given by Doorenbos and Pruitt (1977). Soil water storage is computed by integrating the water content profile. Flux from the lower boundary is via percolation. UNSAT-H, being a one-dimensional program, does not compute lateral drainage.

UNSAT-H Input Parameters

A set of input parameters were developed for simulations using UNSAT-H for the given cover profiles. These parameters were developed based on field and laboratory measurements, values from the literature, and expert opinion.

Model Geometry

The model geometry was based on the depth of the cover profile modeled.

Boundary Conditions

The MDA G site in Los Alamos, NM is located in a dry environment where the climate's demand for water referred to as PET far exceeds the actual supply of water or precipitation (Figure 2.2). These are ideal conditions for deployment of an earthen soil cover such as an ET Cover.

The flow of water across the surface and lower boundary of the cover profile is determined by boundary condition specifications. The UNSAT-H program partitions PET into potential evaporation (E_p) and potential transpiration (T_p). Potential evaporation is estimated or derived from daily weather parameters (Fayer 2000). Potential transpiration is calculated using a function (Equation C.1) that is based on the value of the assigned leaf area index (LAI) and an equation developed by Ritchie and Burnett (1971) as follows:

$$T_p = PET\,[a + b(LAI)^c] \quad \text{where } d \le LAI \le e$$ **Equation C.1**

Where:

a,b,c,d, and e are fitting parameters;

a = 0.0, b = 0.52, and c = 0.5, d = 0.1, and e = 2.7 (Fayer 2000)

The UNSAT-H program partitioned PET into E_p and T_p. PET was derived from daily weather parameters obtained from this weather data. T_p was calculated using a function developed by Equation 1 above.

The lower boundary condition was a unit gradient. With the unit gradient, the calculated drainage flux depended upon the hydraulic conductivity of the lower boundary node. The unit gradient corresponded to gravity-induced drainage and was most appropriate when drainage was not impeded.

Upper Boundary Condition - Climate Data

The surface boundary condition during evaporation was modeled as a flux that required daily weather data. The wettest decade on record was used (1985 to 1994) from Los Alamos National Laboratory (weather.lanl.gov). The annual precipitation totals for this decade are summarized in Tables C.2 to C.4. Because the RCRA requirements to minimize flux was the regulatory driver for determining the storage capacity requirements of the cover profile, it was determined that the wettest decade on record would provide a conservative measure to evaluate the RCRA-equivalency of the cover profile.

VEGETATION DATA

Vegetation will generally increase ET from the cover because a plant's matric potential or suction is orders of magnitude higher than that of the soil (Figure C.2). The input parameters representing vegetation include the LAI, rooting depth and density, root growth rate, the suction head values that corresponds to the soil's field capacity, wilting point, and water content above which plants do not transpire because of anaerobic conditions. The onset and termination of the growing season for the site are defined in terms of Julian days. The root length density (RLD) is assumed to follow an exponential function such as that defined in Equation C.2:

$$\text{RLD} = a \exp(-bz) + c \qquad \textbf{Equation C.2}$$

where:
a,b, and c are fitting parameters
z = depth below surface

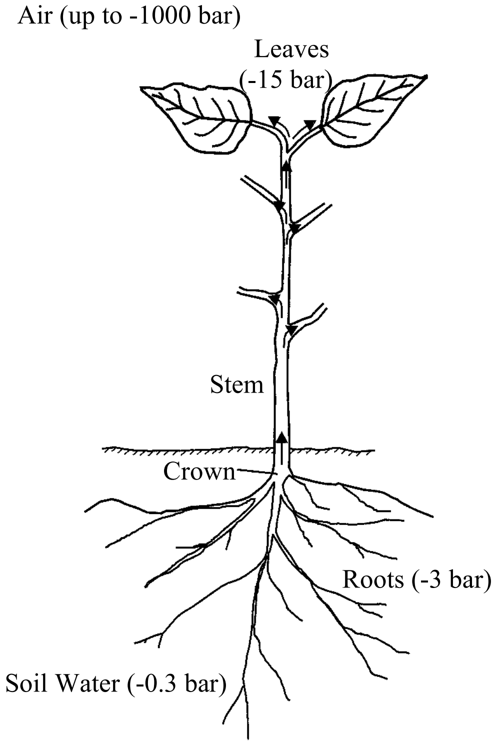
The parameters used for the RLD functions in Equation C.2 were: a = 0.315, b=0.0073, and c = 0.076 (Fayer 2000). The time required for maximum rooting depth establishment was set at full depth beginning on day 1. The rooting depth was set at 6.6-feet (200 cm) (Foxx et al 1984). An average LAI of 0.65 was used (McDowell et al 2005). This value represents an average of values reported for the site of 0.3 and 1.0. The onset and termination of the growing season for the site were Julian days 74 and 288, respectively (EIS, Appendix E). The LAI was transitioned from 0 to 0.65 starting with Julian day 74 to 90. Day 91 through 270, the full LAI equal to 0.65 was utilized. The LAI was then transitioned down from 0.65 to 0 from Julian day 271 to 288. This was conservative since it is realistic that plants can transpire longer than indicated at this site. An average percent bare area of 84.4% was used. This value represents an average of reported values for the area of 91.5% and 77.3 % (Tierney and Foxx 1982). The relative humidity for the site was set at 51% based on the average conditions for Los Alamos (Los Alamos Climatology internet site).

SOIL PROPERTIES RELATED TO VEGETATION

Suction head values corresponding to the wilting point, field capacity, and a head value corresponding to the water content above which plants do not transpire because of anaerobic conditions were defined. Matric potential or suction heads are generally written as positive numbers, but in reality are negative values. Consequently, the higher the value, the greater the soil suction. The maximum water content a soil can hold after all downward drainage resulting from gravitational forces is referred to as its field capacity. Field capacity is often arbitrarily reported as the water content at about 330 cm of matric potential head (Jury et al, 1991). Below field capacity, the hydraulic conductivity is assumed to be so low that gravity drainage becomes negligible and the soil moisture is held in place by suction or matric potential.

Not all of the water stored in the soil can be removed via transpiration. Vegetation is generally assumed to reduce the soil moisture content to the permanent wilting point. The wilting point was conservatively assumed to be 20,000 cm (typical for native grasses) used although the shrubs present at the site could remove water from the soil to a suction of 100,000 cm (Figure C.2). Evaporation from the soil surface can further reduce the soil moisture below the wilting point toward the residual saturation, which is the water content at an infinite matric potential.

Figure C.2
TYPICAL SOIL-PLANT-ATMOSPHERE WATER POTENTIAL VARIATION
(Hillel 1998)



Soil Properties

Soil hydraulic properties were obtained from laboratory testing of soil samples collected from the TA61 borrow site (Shaw 2006). The saturated hydraulic conductivity of the soils were obtained using flexible wall permeameters in accordance with ASTM D 5084. Unsaturated soil properties were obtained from data using pressure plates and water columns (depending on the suction values) to develop values of water content as a function of pressure head (ASTM D 6836). These data were then used as input into the RETC code (van Genuchten et al 1991) to compute curve fitting parameters used to estimate the moisture characteristic curve (van Genuchten 1980). The Mualem conductivity function was used to describe the unsaturated hydraulic conductivity of the soils. The van Genuchten ‘m’ parameter for this function is assumed to be‘1-1/n’; ‘n’ being one of the established van Genuchten parameters. The initial soil conditions are expressed in terms of suction head values that correspond to the average moisture content between each soil layer's field capacity and permanent wilting point determined from each respective soil layer's moisture characteristic curve. The soil properties used as input parameters are summarized in Table C.1.

Table C.1
COVER SOIL PROPERTIES

Cover Profile	Soil Layer Type	Soil Layer Depth	van Genuchten Parameters				Sat. Hydr. Cond. (cm/hr)
			θ_s	θ_r	α	n	
TA61 BORROW SOILS USED (BH1 @ 15 TO 25-FT DEPTH)							
Cover Soil Only	Cover Soil	6.6 ft (200 cm)	0.2454	0	0.0027	1.6175	17.64
TYPICAL SANDY LOAM (ROSETTA 2000)							
Cover Soil Only	Cover Soil	6.6 ft (200 cm)	0.387	0.039	0.0267	1.4488	1.5951
CONCEPTUAL COVER DESIGN WITH TYPICAL SANDY LOAM							
Conceptual Cover Profile	Gravel/ Soil Admixture	1.5 ft (46 cm)	0.383	0.039	0.0267	1.4488	1.5951
	Cover Soil	3.5 ft (108 cm)	0.383	0.039	0.0267	1.4488	1.5951
	Filter Layer	6 in (15 cm)	0.34	0.026	0.0597	2.81	65.52
	Bio-barrier	1 ft (31 cm)	0.374	0.017	2.5075	2.47	15912.0

Modeled Percolation

Percolation results from the redistribution of water through a soil profile in response to gradients formed by differences in the energy state of the water. Flux is defined as the volume flow rate per unit area (Jury et al 1991) through a given soil profile. Other mechanisms that might induce water redistribution, such as geothermal gradients and barometric pressure fluctuations, have been shown to be minor contributors to water flow in most instances (Jones 1978, Gee and Simmons 1979). Tables C.2 TO C.4 present predicted annual flux values for the modeled cover profiles under the typical or average annual precipitation volumes.

Table C.2 summarizes a monolithic soil profile modeled with hydraulic soil properties from the TA61 borrow site. The soil sample that possessed a saturated hydraulic conductivity closest to the overall average of all soil samples tested form the site was used. The overall average was calculated to be 6.6E-03 cm/sec. This soil sample was BH1 taken from a depth of 15 to 25-ft. The saturated hydraulic conductivity for sample BH1 was 4.9E-03 cm/sec. As seen in figure 3.2, the Point of Diminishing Returns (Dwyer et al 2006) was greater than 6.6 ft (200 cm). Consequently, it was determined that the soil would require amendment to improve its water storage capacity and thus decrease the soil depth required. The soil amendment will also provide for adequate plant available nutrients.

The TA61 soils were characterized as sandy loams. However, they were relatively coarse sandy loams. Table C.3 summarizes a monolithic soil profile that used a typical sandy loam with somewhat better storage capacity than the TA61 soils. This value was obtained from ROSETTA (2000). These soils are commonly found throughout New Mexico. These soils significantly improved the cover performance by producing a Point of Diminishing Returns at about 5 ft (1.5 m).

Table C.4 summarizes the output from the actual conceptual cover profile that includes all layers. The addition of the bio-barrier created a capillary barrier. The final predicted flux through the cover profile utilizing a sandy loam soil overlying a coarse material was zero.

Table C.2.
WETTEST DECADE CLIMATE DATA WITH TA61 SOILS

Cover Depth (cm)	**Annual Flux (cm/year)**										
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**Average**
50	5.53	4.11	3.14	4.68	3.17	3.92	6.01	0.98	2.05	4.43	3.80
100	2.84	1.70	1.42	2.37	1.31	1.51	3.06	0.47	1.22	2.04	1.79
150	1.12	0.56	0.71	0.95	0.40	0.06	1.19	0.30	0.49	0.72	0.65
200	.05	0.03	0.03	0.03	0.29	0.26	0.03	0.04	0.02	0.02	0.08
Precipitation (cm)	49.76	47.48	40.34	42.55	35.74	43.31	47.78	32.11	32.54	43.05	41.47

Table C.3.
WETTEST DECADE CLIMATE DATA WITH TYPICAL SOILS FOR SANDY LOAM (ROSETTA 2000)

Cover Depth (cm)	**Annual Flux (cm/year)**										
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**Average**
50	4.31	3.37	2.94	4.28	1.69	3.03	5.39	1.19	2.07	3.64	3.20
100	7.16E-2	1.13	1.59	1.94	8.43E-1	8.17E-1	2.31	1.37	6.15E-1	7.31E-1	1.14
150	0	0	5.41E-4	9.12E-2	5.33E-1	1.69E-1	1.96E-1	7.70E-1	2.29E-1	9.21E-2	2.08E-1
200	0	0	0	0	0	6.93E-6	6.72E-6	7.25E-6	9.14E-6	1.71E-5	4.71E-6
Precipitation (cm)	49.76	47.48	40.34	42.55	35.74	43.31	47.78	32.11	32.54	43.05	41.47

Table C.4.
WETTEST DECADE CLIMATE DATA WITH CONCEPTUAL COVER PROFILE THAT UTILIZED TYPICAL SOILS FOR SANDY LOAM (ROSETTA 2000)

Cover Depth (cm)	**Annual Flux (cm/year)[1]**										
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**Average**
Base of Cover	0	0	0	0	0	0	0	0	0	0	0
Precipitation (cm)	49.76	47.48	40.34	42.55	35.74	43.31	47.78	32.11	32.54	43.05	41.47

[1] values less than 1E-10 cm/year were approximated to be zero

Appendix E

Erosion Evaluation of Surface Cover

E-1.0 INTRODUCTION

The surface cover placed over Material Disposal Area (MDA) L will be protective of human health and the environment over a 60-yr period. Maintenance, monitoring, and institutional control will be conducted for 60 yr, based on the time that it will take to remediate solvents in the unsaturated zone using soil vapor extraction (SVE) (see section 8.1.1 of the report for a discussion of the 60-yr period).

Erosion modeling was used to determine the ability of the design to maintain a required cover thickness for the 60 yr period that would minimize human and other biological intrusion into the waste and maintain the thickness needed for precipitation storage and evaporation. Erosion modeling was restricted to that resulting from precipitation runoff, not wind. Modeling of wind erosion in the performance assessment (PA) (Wilson et al. 2005, 092034) has shown wind erosion to be negligible for material disposal areas on Mesita del Buey. The erosion modeling was also used to provide an estimate of the time interval for cover maintenance. Erosion modeling was performed for two cover alternatives:

- Alternative 1B: Monitoring and Maintenance of Existing Cover, SVE for 60 yr, and Monitoring for 60 yr
- Alternative 2B: Engineered ET Cover, Maintenance for 30 yr, SVE for 60 yr, and Monitoring for 60 yr

The Rational Method and Hillslope Erosion Model (HEM) were used to simulate erosion modeling of the cover. The Rational Method was used to predict runoff for 10-yr, 25-yr, 50-yr, and 100-yr design storms, and HEM was used to estimate erosion from those storms, because these high-intensity storms were more likely to have a severe erosion effect than average annual storms would indicate. A modified Revised Universal Soil Loss Equation (RUSLE) was used to estimate annual erosion amounts. Descriptions of these models and references for them are provided in sections E-2.2.1, E-2.2.4, and E-2.2-4

E-2.0 COVER EROSION MODELING

Erosion modeling is necessary to determine whether the MDA L cover has adequate thickness to minimize infiltration over the 60-yr period and to support surface vegetation growth. Erosion can also cause surface contamination to be transported off-site. Wind erosion on Mesita del Buey was studied for the MDA G cover during the PA and was estimated to cause minor suspended soil loss from the cover compared to water erosion (Wilson et al. 2005, 092034). The results are summarized below. Therefore, no further wind erosion modeling was performed as part of this corrective measures evaluation (CME) report.

To minimize wind and water erosion for Alternative 2B, 18 in. (0.5 m) of soil-gravel admixture containing 33% gravel by weight with diameters ranging from 1.5 in. (3.8 cm) to 3 in. (7.6 cm) was added to the top of the cover (Appendix D, p. D-3).

E-2.1 Wind Erosion

Wind erosion of an MDA L cover is considered a long-term performance issue, as semiarid ecosystems have been shown to have higher wind erosion rates than water erosion rates (Whicker and Breshears 2005, 098643, p. 1). To estimate soil loss and the potential for wind-driven contaminant transport from an MDA G cover, a mass transport study was performed in 2004 at two analogous sites on Mesita del Buey, west of MDA G. MDA J, a closed landfill site, was chosen for the study because in June 2002 it was covered with native grasses. Grasslands at MDA J are representative of the surface soil and vegetation conditions at MDA G in the early years following closure of the facility (French 2007, 099306). A piñon-juniper woodland at Technical Area (TA) 51 was chosen as a site that would represent the MDA G cover after successional changes in vegetation over a 1000-yr period.

Horizontal mass flux transports larger soil particles close to the surface and redeposits them locally (Whicker and Breshears 2005, 098643, p. 1). This horizontal flux was higher at the grassland site because of higher ground-level wind velocities (Whicker and Breshears 2005, 098643, p. 12). Higher rates of wind erosion occurred in the piñon-juniper woodland surrounding the MDA J site following tree-thinning operations (Whicker and Breshears 2005, 098643, p. 24). Rain splash significantly increased the horizontal mass flux near the ground at both sites during precipitation periods. A small net soil loss accumulated over the 10 months of the study (Whicker and Breshears 2005, 098643, p. 12). Vertical mass flux transports smaller soil particles at heights more than 3.3 ft (1 m) for longer distances into and out of an area (Whicker and Breshears 2005, 098643, p. 1). The average vertical flux 6.6 ft (2 m) above the surface at MDA J was 0.013 ± 0.054 t/acre/yr (0.03 ± 0.12 T/ha/yr) (Whicker and Breshears 2005, 098643, p.19). This small amount suggests little net loss from an area of suspended soils.

E-2.2 Water Erosion

This CME study simulated only long-term erosion resulting from stormwater flows, as short-term erosion protection during cover construction is covered in stormwater pollution prevention plans (SWPPPs) required for all land-disturbing projects at Los Alamos National Laboratory (LANL or the Laboratory). These SWPPPs require erosion controls that will be left in place until vegetation is established on the cover surface. Therefore, all long-term erosion modeling assumed that vegetation is present, covering a similar percentage of soil as undisturbed native vegetation. Cover erosion rates depend on many factors, including slope angle and length, surface soil characteristics, rainfall intensity and duration, and vegetation. All covers of Laboratory MDAs are being designed to reduce sheet flow erosion to less than 2 t/acre/yr (4.5 T/ha/yr) (LANL 2002, 095739, pp. 88-97).

MDA L is near the eastern downslope end of a long fingerlike mesa that extends from the Jemez Mountains east of the Laboratory to TA-54, so stormwater flows generally eastward and off the sides of the mesa. To minimize the amount of stormwater that runs on to the MDA L cover, a drainage swale south of MDA L will divert stormwater from the west so there will be no run-on to the MDA L cover. This swale will divert stormwater flowing from the west towards Cañada del Buey north of the mesa. Stormwater on the cover is assumed to be limited to precipitation that falls on the cover surface area.

E-2.2.1 HEM Description

The HEM was used to estimate the overland flow erosion created by precipitation impacting the surface of the cover and flowing in sheets into the adjacent canyons. For the purposes of this modeling, a conservative assumption was made that all precipitation would run off as stormwater, and none would infiltrate the cover. The HEM simulates overland flow with kinematic wave equations and regression equations that conserve the total runoff volume for a variety of slopes, slope lengths, surface roughnesses, soil classes, and rainfall distributions (LANL 2002, 095739, pp. 91–93).

Erosion is greatly affected by rainfall intensity, because higher intensities increase stormwater runoff velocities. The erosive force of the stormwater flow increases as the square of the velocity, so high-intensity storms create the most erosion (LANL 2002, 095739, pp. 101–102). Therefore, erosion modeling was performed using the high-intensity events characterized as the 10-yr, 25-yr, 50-yr, and 100-yr return period storms for Mesita del Buey near Los Alamos, New Mexico, for all alternatives. Alternative 5B removes the waste term that requires protection from infiltration and erosion, so no erosion modeling was necessary for that option. However, residual contamination in environmental media in Alternative 5B would be susceptible to erosion, similar to that modeled for Alternative 1B.

E-2.2.2 Input Parameters

Surface runoff depth, slope angles, and slope lengths were input into the HEM to calculate erosion estimates for hillslope overland flow. The slope angles and lengths were generated from the cover profiles developed after infiltration modeling was completed. Alternatives 1B and 2B cover profiles were derived from site cover profiles.

Surface runoff was calculated using the Rational Method, which is typically used for areas less than 200 acres (80 ha) (DOE 1989, 099296, p. 56) The Rational Method assumes that rainfall occurs uniformly over an entire surface at a constant intensity for a period equal to the drainage area's time of concentration. The U.S. Department of Energy (DOE) approved the use of this method for covers at Uranium Mill Tailings Radiation Control Act (UMTRA) of 1978 sites. The following is the Rational Method formula:

$Q = C*i*A = q*W$

where Q - peak discharge rate (ft^3/s)

C - runoff coefficient (dimensionless)

i - rainfall intensity for time of concentration (in./hr)

A – surface area (acre)

q – peak discharge per unit width ($ft^3/s/ft$)

W – width of drainage area (ft)

DOE recommends that C = 1 be used for the runoff coefficient for storm return periods greater than 100 yr, so this coefficient was used for the 100-yr storm. Although the 100-yr storm is the recommended return period for Resource Conservation and Recovery Act–equivalent covers, this study also evaluated 10-yr, 25-yr, 50-yr, and 100-yr storm intensities as approximations for the 10-yr, 20-yr, 30-yr, and 100-yr return periods required in the scope of work (LANL 2002, 095739, pp. 101-102). The runoff coefficient for the shorter return periods was calculated using rural factors supplied in the Laboratory Engineering Standards, Chapter 3, Civil, Section G20, Site Improvements (available at http://engstandards.lanl.gov/):

C = 1 – topography factor – soil factor – cover factor

$C = 1 – 0.2 – 0.4 – 0.0 = 0.4$

For MDA G, the factors of rolling topography, open sandy loam soil, and a relatively barren cover were used. Therefore, the runoff coefficient used for 10-yr, 25-yr, and 50-yr return period storms was 0.4. Design storm intensities to input into the Rational Method equation were taken from the National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server (http://hdsc.nws.noaa.gov/hdsc/pfds/), which provides updated data from the NOAA Atlas 14 for latitude and longitude. The time of concentration was calculated using the following formula (Kent 1972, 097066, p. 15-3):

$tc = L/(60*V)$

where tc = time of concentration (min)

L = hydraulic length (ft)

V = velocity of precipitation particle (ft/s)

The hydraulic length used was 1360 ft (415 m), the length of the swale draining the south side of MDA L to Canada del Buey. The 1.4 ft/s (0.43 m/s) velocity was found from a graph for nearly bare hillsides with slopes of 2%, which is the slope on the Alternative 2D cover (Kent 1972, 097066, p. 15-8). Using the nearly bare velocity instead of that for short grass pasture makes this time of concentration calculation conservative. A 15-min time of concentration was calculated for the MDA L drainage area as an approximation of the time that precipitation impacting the remotest portion of the area would take to run off the surface of that drainage. Table E-2.2-1 shows the 15-min design storm intensities used for erosion modeling from the NOAA Atlas 14 storm intensities data (http://hdsc.nws.noaa.gov/hdsc/pfds/).

The 10-yr return period does not indicate that a storm of that intensity will occur every 10 yr. It indicates that if a storm of that intensity occurs, another storm of that intensity is not statistically expected to recur for another 10 yr.

Surface runoff flow was converted to a runoff depth using Manning's equation and the average width of the drainage areas shown in Figure 8.1-1 for Alternative 1B and Figure 8.2-1 for Alternative 2B. Figure 8.2-1 shows the contours for the top of the cap for Alternative 2B. These drawings also show cap features, including the rip-rap apron, drainage swale, rock buttresses, and section cuts.

$$D = [(q*n)/(S^{0.5})]^{0.6}$$

where D = depth of runoff (ft)

q = peak discharge per unit width ($ft^3/s/ft$)

n = Manning's runoff coefficient (dimensionless)

S = slope (ft/ft)

The Manning's runoff coefficient for overland flow used for the soil-gravel admixture surface in Alternatives 2B was 0.012 for a graveled surface and for the tuff/soil mixture currently in place at MDA L for Alternative 1B was 0.13 for natural rangeland (USDA 1986, 099402, p. 3-3). These runoff depths, cover slopes, and slope lengths for the five sections were input into the HEM to predict erosion results.

E-2.2.3 Water Erosion Modeling Results

Table E-2.2-2 presents the HEM results for the four 15-min design storms impacting the covers in Figures 8.1-1 and 8.2-1. The assumptions used were similar to those used for the MDA G PA model; high erosion estimates used loam as the soil (with a relative soil erodibility default in HEM of 1.84) with 30% canopy cover and 30% ground cover, and moderate erosion estimates used sandy loam as the soil (with a relative erodibility default of 2.34), with 30% canopy cover and 70% ground cover (Wilson et al. 2005, 092034, p. 16). Sandy loam is considered to approximate the properties of the TA-61 borrow soils that will be used to construct the cover (LANL 2002, 095739, p. 22).

All three alternatives met the design goal of less than 2 t/acre/yr (4.5 T/ha/yr) for each storm, so the covers should perform well even in high intensity storms. Alternative 2B had lower erosion predictions than Alternative 1B. The high erosion scenario with 40% less ground cover and a less erodible soil has predicted sediment yields at least 2 times higher than the moderate erosion scenario for all covers. This finding shows the importance of vegetation in addition to the soil-gravel admixture in retarding the erosion of the cover. Alternative 1B has higher predicted sediment yields than Alternative 2B for all design storms, because no soil-gravel admixture roughens the surface and reduces the runoff depths.

E-2.2.4 RUSLE for Average Annual Soil Loss

Because these design storms have much higher rainfall intensities than expected in a normal year, an average annual soil loss was calculated for all alternatives' covers based on the RUSLE calculator, available online at http://landfilldesign.com/cgi-bin/erosion.pl. The RUSLE uses a regional rainfall and erosivity index, soil erodibility factors based on average particle diameter, slope length and steepness factors, cover management factors, and support practice factors to calculate an average soil loss per year. The rainfall and erosivity index for Los Alamos County was 25, cover management factors were set to 0.01 for poor grass, and the support practice factor used was 1. The steepest slope and the approximate drainage slope length for each cover section were used to compute the average annual soil loss. An average particle diameter of 2.36 in. (60 mm) was used to represent the soil/gravel admixture in Alternative 2B, which will be similar to desert pavement as soil fines are lost over time. An average particle diameter of 0.0005 in. (0.012 mm) was used to represent the sandy loam soil used as cover for Alternative 1B. The results for the alternatives are presented in Table E-2.2-3.

Both covers have acceptable annual erosion rates if the covers remain well vegetated, but the rates for Alternatives 2B and 1B are satisfactory under both vegetated and bare soil conditions. Alternative 1B would exceed the 2 t/acre/yr (4.5 T/ha/yr) design goal if the soil became bare, which may occur in extended drought conditions. The estimated annual erosion rates for Alternative 2B are much lower than that goal. These estimates show that a minimal amount of soil would be lost in an average year if the cover becomes well vegetated, although poor grass was used as the cover factor for these calculations. This result occurs because of the erosion protection the top cover layer receives from the soil-gravel admixture. The estimates also show that cover maintenance could be minimal and infrequent if no high-intensity storms occur.

E-3.0 COMPARISON OF COVER SOIL REPLACEMENT REQUIREMENTS

The following comparison is based on HEM and RUSLE modeling results for the alternatives, which can only estimate what erosion may occur as a result of uniformly intense storms. The actual erosion of various covers depends upon the actual storm intensities that will occur in the 60-yr period and the recovery time between major storms, the formation of rills and the deposition of sediment in those rills during milder storms, and the effects of vegetation changes on the cover surface.

The soil replacement requirements presented in Table E-3.0-1 are based on the previous annual and individual storm erosion estimates. This table compares the maintenance requirements for the two alternatives under several climate scenarios after 100 yr, including the average annual precipitation, a high-intensity 100-yr storm, and four high-intensity 25-yr storms. The estimates for Alternative 2B are based on their top cover layer of soil/gravel admixture, which minimizes the amount of soil lost under any climate. The total mass of soil required to restore the cover depth is calculated, along with the average soil depth required, assuming erosion occurs uniformly across the entire cover.

These results show the stabilizing influence of the soil/gravel top layer. After the fines in the top layer are removed and the top layer becomes desert pavement, very little soil is removed in high-intensity storms.

E-4.0 SUMMARY

Erosion modeling was performed to optimize the cover design in Alternative 2B and determine the size and amount of soil-gravel admixture for the surface layer. Alternative 2B has a soil-gravel admixture on the surface to minimize wind and water erosion. HEM erosion modeling predicted that the Alternative 2B will erode less than the required goal of 2 t/acre/yr (4.5 T/ha/yr), even if impacted by high-intensity storms. Cover maintenance to repair erosion damage should be infrequent, based on the average annual soil losses predicted by RUSLE.

All covers have acceptable annual erosion rates if the covers remain well vegetated, but the rates for Alternative 2B are acceptable under both vegetated and bare soil conditions. Table E-2.2-3, which shows the RUSLE annual erosion estimates for Alternative 1B versus Alternative 2B, indicates that Alternative 1B has significantly higher sediment erosion yields. Alternative 1B has higher runoff velocities because the surface is not roughened by the soil-gravel admixture used in Alternative 2B so it exceeds the 2 t/acre/yr design standard for bare soil. None of the Alternative 2B cover erosion estimates reached half the annual limit for any of the high-intensity design storms.

The sediment yield estimates in Table E-2.2-2 show that the Alternative 2B cover should perform better than the Alternative 1B cover. The high erosion scenario with 40% less ground cover had erosion estimates at least 2 times higher than the moderate erosion scenario for all design storms, showing the importance of vegetation in minimizing cover erosion. Maintenance frequency for Alternative 2B can be calculated based on a conservative average erosion rate for bare soil of 0.54 t/yr (0.48 T/yr). If the cover soil is constructed to have a bulk density of 107 lb/ft^3 (1.71 g/cm^3), the depth of soil removed is 0.0014 in./yr (0.0034 cm/yr). For Alternative 2B, eroded soil under bare soil conditions would not need to be replaced during the 60-yr maintenance period because the total eroded depth would be 0.08 in. (0.2 cm) of soil. Inspection and maintenance should follow every 100-yr, 15-min storm. Inspections should occur after every 25-yr, 15-min storm. A maintenance frequency for Alternative 1B was not proposed because of the excessively high erosion rates for the bare soil condition, which could occur during drought periods.

E-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 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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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TableE-2.2-1
Design Storm Intensities

Storm Return Period	NOAA Atlas Intensity* in./hr (mm/hr)
10-yr, 15-min	3.19 (81)
25-yr, 15-min	3.9 (99)
50-yr, 15-min	4.44 (109)
100-yr, 15-min	5.02 (128)

* Data from NOAA atlas for latitude 35.83N, longitude -106.24W.

Table E-2.2-2
HEM Design Storm Erosion Estimates

Cover	High-Erosion Sediment Yield tons (Tonnes)				Moderate-Erosion Sediment Yield tons (Tonnes)			
	10-yr 15-min	25-yr 15-min	50-yr 15-min	100-yr 15-min	10-yr 15-min	25-yr 15-min	50-yr 15-min	100-yr 15-min
Alt. 1B	1.74 (1.58)	1.95 (1.77)	2.10 (1.91)	3.96 (3.59)	0.67 (0.61)	0.75 (0.68)	0.81 (0.73)	1.52 (1.38)
Alt. 2B	0.18 (0.16)	0.20 (0.18)	0.22 (0.20)	0.41 (0.37)	0.05 (0.05)	0.07 (0.06)	0.07 (0.07)	0.12 (0.11)
Cover	t/acre (T/ha)				t/acre (T/ha)			
Alt. 1B	0.32 (0.71)	0.35 (0.79)	0.38 (0.85)	0.72 (1.61)	0.12 (0.27)	0.14 (0.31)	0.15 (0.33)	0.28 (0.62)
Alt. 2B	0.09 (0.20)	0.10 (0.22)	0.11 (0.24)	0.20 (0.45)	0.03 (0.06)	0.03 (0.07)	0.04 (0.08)	0.06 (0.13)

Table E-2.2-3
RUSLE Average Annual Soil Loss

Cover	Average Annual Soil Loss	
	Bare Soil t/acre/yr (T/ha/yr)	Bare Soil t/acre/yr (T/ha/yr)
Alternative 1B	28 (62)	0.27 (0.61)
Alternative 2B	0.26 (0.59)	0.002 (0.004)

Table E-3.0-1
Comparison of Soil Replacement Requirements Every 100 Yr

Climate Scenario	Sediment Replacement Mass After 100 Yr tons (Tonnes)		Average Sediment Replacement Depth After 100 Yr in. (cm)	
	Alternative 1B	Alternative 2B	Alternative 1B	Alternative 2B
Average Annual, Bare Soil	15,200 (13,800)	54 (48)	14 (36)	0.14 (0.36)
Average Annual, Vegetated	150 (136)	0.34 (0.31)	0.14 (0.36)	0.0009 (0.002)
One 100-yr, 15-min High Erosion Storm	3.96 (3.59)	0.41 (0.37)	0.004 (0.009)	0.001 (0.003)
One 100-yr, 15-min Medium Erosion Storm	1.52 (1.38)	0.12 (0.11)	0.001 (0.004)	0.0003 (0.0008)
Four 25-yr, 15-min High Erosion Storms	7.80 (7.08)	0.81 (0.73)	0.007 (0.019)	0.002 (0.005)
Four 25-yr, 15-min Medium Erosion Storms	3.00 (2.72)	0.26 (0.24)	0.003 (0.007)	0.0007 (0.0017)

Appendix F

Soil Vapor Extraction Pilot Text at
Technical Area 54, Material Disposal Area L:
Numerical Modeling in Support of Decision Analysis

SOIL VAPOR EXTRACTION PILOT TEST AT TECHNICAL AREA 54, MATERIAL DISPOSAL AREA L:
NUMERICAL MODELING IN SUPPORT OF DECISION ANALYSIS

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I. ABSTRACT

This report presents a numerical model of an SVE pilot test on a volatile organic compound (VOC) plume in the subsurface at Material Disposal Area L, Los Alamos National Laboratory. A site-scale numerical model was previously developed to evaluate the impact of subsurface processes on subsurface contaminants associated with waste disposed at the site. One of the main goals of the SVE modeling is to support the corrective measures evaluation. The model has been extensively tested and used to confirm our conceptual model for transport within the very dry mesa-top setting. In this study we present results of simulations of the SVE test. The SVE simulations are performed on a new high resolution, 3-D, site scale model. The model is calibrated to the extraction borehole concentration data using a state-of-the-art single objective optimization algorithm. Simulations show how the site may behave in the event of a sudden release of VOC from subsurface drums. Results show that the current monitoring network should be able to detect sudden VOC release of 800-1400 kg within one year. Subsequent simulations of SVE show that the current two SVE boreholes at the site would likely be sufficient to remove a substantial portion of the total sudden release within a one year period. The simulations show that some modification to the current system may be required to extract VOC from deeper in the mesa, such as installation of two new SVE holes with casing to greater depth. Plume rebound calculations suggest that in the absence of a catastrophic leak, the SVE system would only need to be operated for two to three months in each one to three year period. Finally, the simulated radius of influence is greatest in the higher permeability units, and for practical purposes extends to approximately 40 m.

II. INTRODUCTION

The SVE Pilot test at the Los Alamos National Laboratories former liquid waste disposal area, MDA L was designed to collect data to better understand how vapor extraction technology could used in the corrective measures analysis and possible future remediation. MDA L is located just north of Pajarito Rd., about 3 km west of the town of White Rock. The site is on top of Mesita del Buey, a finger mesa that is bounded to the north by Canada del Buey and to the south by Pajarito Canyon. Figure 1 shows an aerial photograph of MDA L (outlined by an orange line), surrounding boreholes, and the locations of the shafts and pits in which liquid waste was disposed of during the time period that this site was an active subsurface disposal unit. This figure also shows the locations of the two pilot SVE wells (red circles) that were used to extract subsurface vapor during the tests. The red circle on the left of the figure marks the location of SVE West and the one on the right marks the location of SVE East. The site is currently being used as an above ground packaging and storage facility for chemical waste as can be seen by the buildings and pavement that cover the site.

This paper is a continuation of a previous numerical modeling work on a VOC plume located beneath the former Los Alamos National Laboratories liquid waste disposal area, MDA L. The first of the previous papers, Stauffer et al. [35] presented a numerical model of plume growth from the years 1975 – 2000 that was used to constrain processes in the conceptual model of diffusive transport within the mesa on which MDA L is located. This model was calibrated using a set of 132 borehole vapor measurements of 1,1,1 trichlorethane (TCA), the primary volatile organic compound (VOC) at MDA L. The simulations were performed using a finite volume heat and mass transport code (FEHM) that solves the diffusion equation and includes Henry’s Law partitioning between the liquid and vapor phases [21]. The calculations were performed on a numerical grid that incorporates local topography and honors existing knowledge of subsurface geology in three dimensions. Results from this modeling exercise allowed us to refine our conceptual model for plume growth at this site. We believe that the source release is most likely characterized by slow leaking of TCA vapor leading to relatively constant source region TCA concentrations in the range of 3000 ppmv, well below the saturated vapor pressure of 160,000 ppmv that would be seen when TCA vapor is in equilibrium with a liquid source. Transport away from the source region is primarily by diffusion, with model diffusion coefficients falling very close to values measured on core samples from the site. This implies that barometric pumping and wind effects are not effective in increasing the in situ diffusion of TCA. Furthermore, the inclusion of Henry’s Law partitioning between the liquid and vapor phases was required to achieve the best fit. Finally, the asphalt at the site appears to be acting as a diffusive barrier, leading to a broader plume within the subsurface and higher concentrations in the shallow subsurface near the source region.

The second paper that we build on, Stauffer et al. [35], presents preliminary analysis of the SVE tests using both two and three dimensional numerical models. This work suggested that the subsurface most likely behaves as a dual continuum during the SVE test, with higher permeability conduits and lower permeability regions contributing to the total air flow that is captured by the extraction wells. The effective porosity of the higher permeability pathways is on the order of 10 – 15%. Because traditional fractures have a porosity of only 0.1% or less, this implies that fractures are most likely not well connected over large distance yet provided increased local permeability. However, the long term extraction tail can be fit with a single continuum, and Section 2.3.4 in the current paper presents logic that reduces the probable role of dual continuum behavior and helps to explain some of the inconsistencies found in the data. Another result presented in Stauffer et al. [35] was to show that our new, high resolution numerical grid is able to recreate the results of the original coarse grid for plume growth through the year 2000. The new grid is vital to the SVE study because it allows much finer resolution of concentrations and pressures in the upper 90 m where the effects of the SVE vacuum are most pronounced.

We take the results from the two previous modeling papers and use these as the foundation for the current study that is broken into three main sections. In Section 1 we review model details including both the conceptual and numerical models of flow and transport. Next, we discuss automated 3-D model calibration, done since the release of Stauffer et al. [35], that uses thousands of simulations to better match concentrations in the extraction wellbores. This section includes a discussion of possible problems with the FLUTE system that may require us to reexamine short term data from boreholes surrounding the SVE extraction holes. Finally, in Section 3 we present results of hypothetical sudden releases at both the East and West source areas. We show how quickly the releases are expected to be seen in the nearby monitoring wells, and then show how the released TCA responds to the SVE system. Additional topics discussed include the rebound of the plume due to continued slow leakage from the source region and the consequences of not remediating both the sudden release scenario and the continued slow leak.

1. MODEL DISCUSSION

1.1. Vadose zone transport properties

This section describes the physical properties that are relevant for the SVE modeling. Table I lists physical properties relevant for TCA transport. Table II lists the mean measured porosity, saturation, and effective diffusion coefficient determined from the best-fit model. Table III lists measured air permeability ranges for the geologic units beneath the site (Figure 2) for both straddle packer measurements and core measurements. The straddle packer permeability measurements were made on seven boreholes found approximately 100 m to the east of the MDA L boudnary. The packer interval was 0.6 m (2ft) and the data provide a high resolution view of variability that is typical of the Bandelier Tuff. Straddle packer measurements were not made in the SVE boreholes used for the MDA L Pilot Test, thus the measured values provide the best initial guess as to the likely range of values expected around the SVE holes. The mean core permeability measurements are generally at least an order of magnitude lower than the mean straddle packer measurements, showing the role that fractures play in the rocks at MDA L. The permeability data show that increased permeability due to fractures at this site is not limited to the more welded Units Qbt-2 and Qbt-1vc, but is apparently ubiquitous throughout the Tshirege member of the Bandelier Tuff.

1.2. Concentration units used in the Calibration

Historically at MDA L, vapor concentrations have been reported in units of ppmv, meaning parts per million by volume. This is equivalent to one million times the ratio of the number of moles of a contaminant to the total number of moles in a given volume. The units of ppmv are quite useful in that the measured value in a given packet of air will not change in response to changes in pressure or temperature. Therefore as air expands or contracts, the ppmv concentration will remain constant. Recently, the NMED has requested that VOC concentrations be reported in units of ug/m3. This is somewhat problematic because when one converts samples measured in ug/m3 to true concentration units, samples of different densities, caused by changes in pressure and temperature, will yield different values of concentration. Because concentration gradients are what drive diffusive transport, it is important to have measured values that are in the appropriate units. This is especially problematic because generally the pressure and temperature of the sample are not reported. For example, if soil gas is pulled to the surface for measurement where the temperature is significantly less than in the subsurface, the measured values will be higher by the ratio of density between the cold gas and the warmer gas in the subsurface. The density difference for air between 0 C and 30 C leads to a difference in calculated ug/m3 of about 10%.

To convert between the two units, one must know the molecular weight of the contaminant and that of air. Air is a mixture of many gasses, but can be approximated as having a molecular weight of 29 g/mol. The primary VOC at MDA L, TCA, has a molecular weigh of 133 g/m (Table I). Assuming that the density of air on the mesa top (6800 ft and 50 F) is approximately 1 kg/m3, a concentration of 1000 ppmv TCA can be converted to ug/m3 as:

1000 ppmv = 1000 moles TCA/1e6 moles Air

1000 moles TCA * 133 g/mol * 1e6 ug/g = 133.e9 ug TCA
1e6 moles Air * 29 g/mol * 1 m3/kg = 29000 m3
Yielding
133.e9 ug/29000 m3 = 4.6e6 ug/m3

1.3. Conceptual model

1.3.1. Processes included in the conceptual model

The conceptual model for plume growth at MDA L is described in Stauffer et al. [7], and we summarize the assumptions and findings of that study in this paragraph. These findings form the basis for the conceptual model used in the current paper. The primary VOC in the plume, comprising approximately 70% by mass of the total plume, TCA, is taken as representative of the plume. The VOC plume MDA L is controlled by vapor diffusion through variably saturated rocks with partitioning into the liquid phase. A zero concentration atmospheric boundary following the topography of the mesa and canyon is necessary to simulate the current plume. The rock saturation and porosity limit the ability of vapor to diffuse and the numerical representation of an effective diffusion coefficient are described below in the Model Formulation section. Henry’s Law partitioning between the vapor and liquid phases (also described in the Model Formulation section) and greatly reduced diffusion across the asphalt at the site are both very important at MDA L. The best-fit land/air interface diffusion coefficient is slightly lower than the value used for the surface rocks, to represent the effects of a soil horizon that may contain more water than is found in the deeper mesa. Finally, the plume appears to be in a pseudo-steady state, growing only slowly, because most of the source release is following steep concentration gradients toward the atmosphere.

In this paper, we make the further assumption that during SVE, TCA transport can be described by the advection-dispersion equation [see Section 1.3]. The role of fractures appears to be quite important for simulating the concentration rebounds in the SVE tests [35]. Rocks containing fractures and porous rock matrix form a dual continuum that can behave differently than rocks containing only a single continuum of porous rock [6]. At this site, the rocks in Qbt2 and Qbt1-vc contain numerous vertical fractures that can lead to significant increases in permeability (Table III). Robinson et al. [19] found that water injection in the Bandelier Tuff showed behavior that was best fit with a single continuum representative of the matrix; however, air flow is substantially different from water flow due to capillary suction that pulls water into pores. Additionally, as described in the vadose zone transport section (1.1), the straddle packer data show much higher air permeability than the core data for all units tested.

Pipe flow can lead to frictional losses, however calculations done on a pipe flow calculator (web based: www.efunda.com/formulas) for an 8 inch diameter pipe with values of density, viscosity, and flow rate appropriate for the SVE tests show that such losses should be quite small, less than 10 Pa in 65 ft (19.8 m). Because the SVE tests generated suction of greater than 10 kPa, we ignore the effects of frictional losses in the boreholes, and set the borehole permeability high enough (1.0×10^{-4} m^2) to ensure a pressure drop of less than 30 Pa.

Currently, the 3-D site scale model cannot incorporate dual continuum behavior; however the results of calibrated simulations presented should be fairly robust in capturing the general behavior of the system. This is because the full porosity can be assigned an equivalent permeability that will recreate the pressure-flow rate response at the wellhead. Although this approximation will not reproduce the steep drop-off in concentrations seen in the data or the rebound spikes seen after SVE shut-in, the long term evolution of the plume should be of the correct magnitude and spatial extent. We stress that this would not be the case if the matrix permeability was several orders of magnitude lower; however with the high matrix permeabilities measured in the Bandelier Tuff (Table III), equilibration times between matrix and fractures should be significantly shorter than those found in dual continua such as clay/sand systems where contaminant tails can last for decades due to diffusion limited mass removal from extremely low permeability clays (Fetter, 1999). Additionally, Section 2.3.4 points out some possible inconsistencies in the rebound and manometer data that seem to imply that a single continuum may be sufficient to simulate the SVE Pilot test.

1.3.2. Processes not included in the conceptual model

Movement of liquid water at this site is assumed to be negligible (<1 mm/yr) and arguments for this assumption can be found in the conceptual model for flow and transport of liquid water beneath the Pajarito Plateau [20]. Temperatures vary only by a few degrees C within the region of interest in the mesa and we assume isothermal conditions for all simulations presented. Because measured effective diffusion coefficients of TCE on crushed tuff columns were very similar to those required to best fit the plume growth [15], we assume that barometric pumping within the mesa is not leading to increased apparent diffusion. Although the land/air interface in the previous model used a slightly lower effective diffusion coefficient, in the current model we do not reduce the permeability at this interface. Such a minor reduction in properties should have very little impact on the SVE simulations because the SVE system is much more sensitive to the properties of the rocks within the mesa that are in contact with the open interval of the extraction boreholes.

1.4. Model formulation

We are using the Los Alamos porous flow simulator, FEHM, for all calculations presented in this paper [21,37]. FEHM is a finite-volume heat and mass transfer code that has been used extensively for simulation of multiphase transport [22, 23, 24, 25, 7, 26]. Equations governing the conservation of phase mass, contaminant moles, and energy are solved numerically using a fully implicit Newton-Raphson scheme. As stated in the conceptual model section, we simplify the analysis by assuming constant temperature and no movement of the liquid phase. Justification for these assumptions in the context of the Pajarito Plateau is given in Stauffer et al. [7]. Further, we assume that the atmospheric pressure on the top of the mesa at an elevation of 2072 masl (6798 feet above sea level) is constant at 80 kPa.

The primary assumptions governing vapor-phase flow and transport are as follows. First, we assume that the vapor phase is composed solely of air that obeys the Ideal Gas Law and calculate vapor-phase density (kg/m^3) as a function of vapor pressure, P_v (MPa), and temperature, T (C) as:

$$\rho_v = 1.292864\left(\frac{273.15}{T+273.15}\right)\left(\frac{P_v}{0.101325}\right) \qquad \text{Eq. 1}$$

We use Darcy's law to calculate the advective volume flux [27] of the vapor phase as:

$$v_v = -\frac{kR_v}{\mu_v}(\nabla P_v - \rho_v \bar{g}) \qquad \text{Eq. 2}$$

where k is the intrinsic permeability of the rock (m^2), R_v is the relative permeability function for the vapor phase (calculated as a function of saturation via a Brooks-Corey relationship for this study [28]), $\bar{g}$ is the gravitational vector (9.81 m^2/s), and vapor viscosity is assumed constant as:

$$\mu_v = 1.82x10^{-5}\, Pa \cdot s \qquad \text{Eq. 3}$$

Vapor-phase contaminant conservation is governed by the advection-dispersion equation (Fetter, 1999) where the contaminant flux (moles/(m^2 s))is given by:

$$q_v = v_v C_v + \phi S_v D^i{}_{cv} \cdot \nabla C_v \qquad \text{Eq. 4}$$

where ϕ is porosity, S_v is vapor saturation defined as air filled porosity divided by total porosity, C_v is the molar concentration (moles/m$^3{}_{\text{phase}}$) and the dispersion coefficient, D_{cv}, includes contributions from both dispersivity (and molecular diffusion as:

$$D_{cv} = \alpha^i (v^i{}_v / \phi) + D^*{}_v \qquad \text{Eq. 5}$$

where the molecular diffusion coefficient in FEHM is a function of the free air diffusion coefficient (D_{free}) and the tortuosity (τ) as:

$$D^*{}_v = \tau D_{free} \qquad \text{Eq. 6}$$

The dispersivity tensor (α^i) is directional; however in FEHM we keep only the diagonal terms of this tensor. The superscript i implies that the equation is solved for the principle directions. For example, in 3-D, the volume flux at any point can be decomposed into three principle components, ν_x, ν_y, and ν_z, while in 2-D radial the components are ν_r and ν_z. An additional constraint is imposed by Henry's Law equilibrium partitioning which requires a constant ratio between concentrations in the liquid and vapor phase as:

$$C_v = HC_l \qquad \text{Eq. 7}$$

where the Henry's Law value for TCA (H_{TCA}) is listed in Table I. As described, the model is a molar based solution to the advection-dispersion equation using Fickian transport theory. We do not account for the effects of non-Fickian diffusion; however corrections for non-equimolar behavior are relatively small (<3%) [29].

FEHM also has a new capability that allows us to embed radial boreholes within an existing 3-D site scale mesh [32]. This capability is used to reduce the total number of nodes required to capture the radial flow near the simulated SVE extraction holes while also capturing the topography and stratigraphy at the site scale. Without this capability, we would need to embed two 3-D extraction borehole meshes and all the necessary extra nodes to allow the borehole meshes to correctly connect to the existing 3-D grid while maintaining the Voronoi volume constraints that are required for computational accuracy. Furthermore, the flexibility allowed by the new capability is such that one can add or remove boreholes at any time, permitting us to study the effects of SVE borehole placement location without having to spend large amounts of time embedding 3-D borehole meshes into site scale grids. Another useful feature of the wellbore capability includes the ability to add onion shells around the open hole, allowing us to include a very low permeability casing that correctly simulates the in situ casing used for the SVE Pilot Tests. Currently, use of the wellbore module precludes the use of the dual continuum portion of the code; however, we are working to allow simultaneous use of both options. As stated previously in Section 1.2.1, we believe that omission of the dual continuum behavior of the system results in some mismatch between model and data during rebound spikes; however we should be able to capture the long term behavior of the plume by using an equivalent continuum approximation.

1.5. 3-D Model domain and computational grid

1.5.1. Numerical grid

The 3-D simulation domain is approximately centered on MDA L, and includes the surrounding mesa/canyon environment from the land surface to the water table. Figure 4 shows an aerial photo of MDA L with the computational domain outlined in red. This figure also shows contours of the initial plume on a horizontal plane sliced 80 ft below the surface of the mesa. MDA L is approximately 180 m E-W by 120 m N-S (600 x 400 ft), and the simulated domain extends beyond the site on all sides by a minimum of 100 m to minimize boundary effects. The computational grid is made up of over 140,000 nodes and nearly 800,000 volume elements. The lateral extent is 410. m E-W by 370 m N-S. The grid extends vertically from an elevation of 1737 meters above sea level (masl) at the water table to 2074 masl on the northwestern corner of Mesita del Buey. The grid has a vertical resolution of 1 m in the top 90 m and stretches to a resolution of 25 m at the water table. The horizontal resolution of the primary grid is everywhere 10 m. The grid captures the topography of the site and extends to the water table, over 300 m below the surface of the mesa on which MDA L is situated. The deeper part of the grid, 270 ft (90 m) below the mesa top, has little impact on the simulations, and is included to address questions concerning plume impacts on the regional water table. The 3-D grid used in this paper is an extension and refinement of the grid used in Stauffer et al. [7]. Figure 5 and Figure 6 show two additional views of the 3-D domain. Figure 5 is an angled view of the entire simulation block showing the gross stratigraphy. Figure 6 shows two slice planes of the pre-SVE plume concentrations, one on the same plane 80 ft below the surface shown in Figure 4, and another vertical slice along the axis of the mesa. The high resolution embedded wellbores used in the simulations each have an inner radius of 0.08 m and an outer shell radius of 2 m with 4 nodes spanning this distance. Therefore each well has one vertical line of nodes representing the open hole and four onion skins surrounding this. Both SVE holes have a total depth of 66 m (216 ft) with 67 nodes along the vertical. The nodes representing the open borehole are assigned a permeability of 1 x 10^{-4} m^2, providing little resistance to flow in the open hole. The first onion skin in the upper 20 m of each hole are assigned a permeability of 5 x 10^{-19} m^2 and a diffusion coefficient (D*) of 5 x 10^{-19} m^2/s to simulate the effects of the steel casing. Nodes in the remaining onion skins are assigned the rock and tracer transport properties specified in a given simulation for the geologic unit in which they reside.

1.6. 3-D Simulations: Boundary and initial conditions

The domain was initialized with concentrations in the source region fixed to values representing the maximum observations and the two source regions were activated at the appropriate time from 1975 until 2006 (see Stauffer et al. [7] for a more thorough explanation of the plume generation algorithm). The initial concentration of TCA on a plane at a depth of 80 ft below the surface is shown on Figure 4. From this figure one can see the intersection of the plume with the atmosphere at the canyon slopes, where the plume delineates the narrow finger mesa on which MDA L is situated. The total width of the mesa at this location is only approximately 500 ft (152 m). The initial plume for the SVE simulations is slightly modified from Stauffer (2005) to account for more recent data in the vicinity of the extraction boreholes. Specifically, the concentrations in the East source region were lowered during the years 2004-2006 to better match data from boreholes BH-24243 and 54-2002. Additionally, the source locations in this higher resolution grid are modified slightly from Stauffer et al. [7], and the new simulation results for 2006 were compared to the data from the previous modeling combined with new data collected during 2004-2006. The model-data regression remained quite good with an r^2 correlation coefficient of greater than 0.89. Therefore we are confident that the initial condition for the 3-D SVE simulations is a very good representation of the actual plume beneath MDA L.

2. 3-D Model Calibration

2.1. Calibration goals

The goal of the calibration is not to find exact fits to all of the test data, but to find the set of parameters that will approximate the overall data trends. This is a vital point of the modeling study. Given the inherent uncertainty in the subsurface we will never be able to exactly match all of the data from the Pilot Test. We do, however, strive to recreate as many aspects of the test as possible given constrains on the number of simulations, the number of adjustable parameters (horizontal and vertical permeability), the spatial variability of parameters, and uncertainty in the applicability of representing the rock units in the mesa as single continua with average fracture/matrix properties. The two most robust data sets that we have for each test are the concentration versus time in the extraction stream and the pressure at the top of the wellbore. The primary calibration target is the extraction concentration, while the pressure at the top of the hole is fixed to the average value for both the East and West tests. A final calibration target is to have the simulation maintain the approximate flow rate calculated from the data during the test period. Issues with pressure and concentration measurements in surrounding wellbores, discussed in Section 2.3.4, have led us to not use these data in the parameter estimation section of the calibration. However, we do discuss the relationship of these data to the results of the calibrated parameters.

2.2. Calibration details

Calibration of the 3-D model is performed using the AMALGAM parallel optimization algorithm of Vrugt et al. [37]. AMALGAM uses thousands of realizations to search the mulit-dimensional parameter space. AMALGAM is extremely adept at finding global minimum solutions. Observed VOC concentrations in the vapor phase at the tops of the East and West extraction holes during the initial 22-d pilot experiment were used for SVE model calibration. The basic idea is that we can determine the subsurface permeability distribution by matching the concentration versus time curve that is measured at the top of the extraction boreholes while simultaneously maintaining close agreement with measured borehole flow rates and pressure at the top of the borehole. For this scheme to work correctly, the initial state of the simulated plume must be fairly close to the in situ plume. The pre-SVE simulated plume versus data, as presented by a model-data correlation in Figure 7, shows that our initial state is fairly close to the data.

To ensure that the calibrated permeability distribution matches the data from the tests, we must impose several conditions on the simulations. The most restrictive calibration condition we use fixes the simulated pressure at the top of the extraction borehole to the average pressure measured during the test. The second calibration condition that we use is that the simulated flow rate at the top of the borehole must remain within 10% of the values calculated for each test shown in Table IV at all times after the first day. Simulations that fail either of these criteria are removed from the model calibration by giving the parameter value combination a large weighting term. The flow rate during the test was calculated from an equation provided by the manufacturer of the orifice plate used to measure the pressure drop across a slight decrease in the diameter of the extraction line. Table IV shows values for the average pressure drop across the orifice plate, wellhead pressure, wellhead suction, and calculated extraction rates for the Pilot Test. There are three distinct rates because the extraction vacuum was increased during the later part of the SVE West test. For the SVE West calibration, only the first 21.9 days were simulated so that we remained within the lower flow rate time period shown in Table IV.

Because the permeability data from the packer tests show wide variability within the subsurface at MDA L, the East and West SVE Pilot tests were calibrated separately. Figure 8 shows the relative locations of the SVE cased interval, the open borehole interval, and the rock units found at both the East and West SVE site. There are small differences in the rock thicknesses between the two sites, however these differences were not sufficient to allow one set of permeability values to calibrate both the East and the West tests. As calibration parameters, we selected the permeability of the rocks of the upper four geological units depicted in Figure 8. An initial sensitivity analysis demonstrated that deeper geological units had marginal impact on the simulation results. To simulate the effects of vertical cracks, separate values of the horizontal and vertical permeability were optimized for each rock type. We also optimized the permeability of asphalt because this material acts as an important diffusive barrier over almost the entire grid surface. Permeability in the calibration was allowed to range from 1e-13 m2 to 1e-11 m2 to cover the ranges seen in the straddle packer data and core permeability measurements shown in Table III,

A distributed computing implementation of AMALGAM was used to optimize the SVE model parameters for the East and West pilot tests using a simple F_{SLS} objective function [38]. We used a population size of 10 points, and hence 10 different slave computers, in combination with 120 computing hours on the LISA cluster at the SARA parallel computing center (U of A, The Netherlands). Each of these nodes is equipped with a dual-core Intel® Xeon™ 3.4 GHz processor with 4 GB of memory. The optimization performed over 2000 realizations for both the SVE East and SVE West experiments. To reduce the complexity of the SVE West test, the data were compressed in time to remove the period during which the SVE system had failed (2.88-6.66 days). Additionally, some of the clearly spurious data outlier points were removed from the calibration target, providing a smoother version of the data curve than that which is presented in Figure 10.

Figures 10 and 11 present a time series plot of observed (solid circles) and simulated (solid line) VOC vapor phase outlet concentration at the western (Fig. 10) and eastern (Fig. 11) SVE extraction well. The corresponding optimized permeability values for the individual rock types are listed in Table V. In general, the fit to the observed data is quite good for both pilot tests after about 2 days, successfully capturing and simulating the process of matrix flow. However, during the first 2 days the SVE model significantly underestimates observed VOC concentrations. This initial misfit is probably caused by flow through joints and fractures, a process widely observed throughout the Pajarito Plateau and the experimental site, but not explicitly included in our model. We represent fracture flow by allowing AMALGAM to optimize the horizontal and vertical permeability in ranges above measured matrix values. This implementation combines the effect of matrix and fracture flow, and does not allow us to explicitly simulate flow through fractures, which would be required to match the early time data. Hence, much better predictions at the initial time steps are possible if we explicitly incorporate fracture flow in the model. One approach of doing this would be to augment the current SVE model with the generalized dual porosity model (GDPM) presented in Zyvoloski [37]. This method assumes one-dimensional transport into and out of the matrix using multiple closely-spaced nodes connected to the primary fracture nodes. This setup can capture preferential flow and transport processes and therefore will likely simulate the high initial extraction of VOC observed in the experimental data. We are currently in the process of including this in our SVE model as well. The results of this will be reported in a forthcoming paper.

The optimized permeabilities for the East and West pilot tests are in good agreement, generally within an order of magnitude difference. Such a spatial variability is observed in the field (Neeper [11]; Stauffer et al. [35]). Table V lists the values of permeability that were found to provide the optimal fits to the test data for both the East and West tests. SVE West required higher permeability in unit Qbt1-vu while SVE East required higher permeability in Qbt1-vc. Deeper units in both tests appeared to be better fit with values from the lower bounds of the packer data. Moreover, their optimized values are typically within the middle of the prior uncertainty ranges, only approaching the outer bounds for a few parameters. This finding increases confidence in our SVE model calibration, with parameter values that appear reasonable and demonstrate the appropriate variability between locations. Despite this, given the presence of systematic errors in our model predictions, apparent during the first 2 days in both Fig. 10 and 11, over-conditioning to a single “best” parameter combination seems unjustified, and the assumptions underlying the classical approach to parameter estimation need to be revisited.

For all calibrations, the vertical and horizontal permeability of each rock unit shown in Table V was varied to find the best overall fit to the data as described above. Several simplifications have been made for the current calibration. Stauffer et al. (2007) gives a more detailed description of attempting to fit the rebound spike seen after the pump failure on the SVE West test; however for simplicity we have removed the restart interval from the current calibration exercise. We also run both the East and West tests out to only 21.9 days because this time interval contains the most useful data.

2.3. Calibration results

2.3.1. Top-hole pressure versus flow rate

The calibrated SVE West test has a top-hole pressure fixed at 66.8 kPa while the pressure at the top of the SVE East borehole is fixed at 63.4 kPa. Both East and West calibration runs were required to remain within 10% of the calculated extraction mass flow rates for all times after 1 day of simulation time. We only examine flow rate after one day of extraction, because the extraction rate in the simulations varies through time as the pressure wave moves through the rocks. The final flow rates in the calibration runs were both within the prescribed tolerance of 10% of the measured values. Figure 9 shows the simulated top-hole flow rate response for both the East and West tests compared to the average flow rate calculated from the Dwyer pressure plate equation for each of these tests. This plot shows that the flow rate reaches equilibrium during the extraction test within approximately one day.

2.3.2. Extraction concentration and total mass removal

Figure 10 compares the SVE West test data to the simulated concentration at the wellhead for the calibrated fit of the SVE West test. The single continuum is able to recreate the general trend of the extraction data. The early time simulation results do not show the initial rise in concentration that was observed, however the longer time trend of the simulation shows the same trailing behavior at about the same concentration that was seen in the test. The calibrated SVE East simulation versus data, shown in Figure 11, also does not capture the initial spike in concentrations seen in the data, but does capture the longer time tailing behavior at nearly the same concentration as seen in the data. Figure 12 shows that simulated total TCA mass removal versus time is a good fit to the data from both the SVE East test, however the flowrate for the West test was slightly higher than the flow rate calculated from the pressure plate data leading to a systematic over prediction of the total mass removed.

2.3.3. Concentrations in surrounding boreholes

Results from simulated concentrations in surrounding boreholes show that the model is capturing the magnitude and trend of the data (Figures 13, 14, and 15). Points in the model that were closest to the data were chosen for comparison; however because the grid spacing is 10 m in the x and y directions, the comparison points are somewhat offset. For example, BH-24240 is 3.5 m from the nearest model node, while 54-2002 is 6 m from the nearest grid node. Thus, we are not trying to determine exact fits between data and model. We are attempting to see if there is agreement with the trend and magnitude of the data for the simulations at a point approximating the data location. Figure 13 shows simulated results versus data at a well (BH-24240) lying only 25 ft. laterally from the extraction borehole. This simulation uses the calibrated SVE W parameters run with more detailed logic including a well shut-in period to represent the broken pump interval. The simulation does not rebound, since we do not have dual continuum behavior, however the overall decline in concentration at the 50 ft. depth in borehole BH-24240 is a good match to the data. Figure 14 shows the decline in simulated concentration at a depth of 100 ft. in BH-24243, lying approximately 54 ft. from the SVE East extraction borehole. The simulated concentration change does not produce the sharp drop in concentration seen in the data, nor does the simulation lead to a large rebound after the SVE system is shut off. Because the data fall to near zero concentration so rapidly, the system is either extremely fracture dominated or there may be a problem with surface air being pulled down the sampling ports by the applied suction. The possibility of a problem with the sampling is discussed in more detail in Section 2.3.4. One of these two mechanisms must also be affecting the data from BH-2002 (Figure 15), located 130 ft. from the extraction hole. This borehole also shows a sharp drop in concentration to near zero in just a few days, with an equally rapid rise in concentration after the SVE system is shut off. It is very interesting to note that the simulated concentrations for the SVE East test track the data very well at both early and late times.

2.3.4. Pressure changes in surrounding boreholes

As with the surrounding concentration data, we pick a point that is most appropriate on the existing 3-D grid for the comparisons. For the manometer, because flow to the wellbore is fairly radial and there is no preexisting lateral pressure gradient in the mesa, we pick the node in the grid that is the closest in radial distance from the well. For this reason some of the manometer comparison points are not at the same node as the concentration comparisons for the same data points. For example, the closest node from the extraction borehole in the direction of the source region for BH-24240 is 16 ft., which was the node chosen for concentration comparison; however the node chosen for manometer comparison lies 27 ft. from the simulated extraction hole in a more westerly direction.

Figure 16 shows values for the calibrated simulation compared to manometer readings in ports located in boreholes 54-24240, 54-2002, and 54-24243. Interestingly, the data versus model correlation in borehole 54-24240 has one point where the data and model are in agreement; however in boreholes 54-24243 and 54-2002 the data show much lower pressure drops than the calibrated simulation. The simple, hand-held manometer readings are meant to be a qualitative tool; however the data collected may point to an underlying problem with the FLUTe^{TM} system (www.geoprobe.com/products/flute/flutedesc.htm, accessed on 7/2/2007) that otherwise would not have been noticed.

We now speculate on the possible causes for the differences between the manometer readings and the simulated subsurface pressure field. First, the hand-held manometers are hooked to tubes in the FLUTe^{TM} socks that line the sampling boreholes (Anderson et al., 2007). These socks may not be providing a complete seal, leading to manometer readings that are lower than that in situ pressure. One line of evidence that supports this conclusion is that the difference between the downhole pressure and the surface pressure while the extraction pump was shut down is very small, for most manometer readings the differences were less than 0.1 kPa even at depths of greater than 100 ft. below the surface. Figure 17 shows that the magnitude of the barometric signal change during the time of the two tests can be as high as 1.6 kPa in only 2.5 days. Even in the absence of the SVE testing, barometric swings of this magnitude should lead to differences between the surface and the subsurface. Neeper [11] presents data collected from a borehole located 100 m to the East of the site that shows almost no pressure difference between the atmosphere and a port at 11 m depth. However at depths of 77 m and 103 m the amplitude of the pressure wave is depressed and phase shifted such that differences between atmospheric pressure and downhole pressure should vary between +0.6 and -0.6 kPa. Because differences between the downhole pressure and atmospheric pressure measured before and after the SVE tests were much smaller than this, and in many cases were virtually zero, we believe that there is a strong possibility that there is a pressure connection between the ports on the monitoring wells.

The possibility of ports leaking during the high suction of an SVE test raises the concerns that an incomplete seal on the sampling ports could lead to the high suction pulling fresh air down the sampling boreholes. Fresh air flowing down the sampling holes would lead to dramatic drops in concentration at all leaky depths, such as seen in the data for BH-24243 and BH-2002. Once the vacuum is removed, the ports would show rapid rebound. This may be a valid explanation for the extreme dual continuum behavior seen in the surrounding borehole concentration data. If this is indeed the case, the current model assumption of a single continuum may be more valid than we first thought.

2.3.5. Conclusions from the calibration

The general conclusions from the calibration are 1) that the upper unit near the SVE West test are more permeable than the upper units near the SVE East test and 2) that the bulk permeability on the West side is higher than on the East side. Furthermore, the fact that measured pressure changes at depth are not in agreement with previous pressure data point to possible problems associated with leaks in the sampling tubes. Such leaks would bring fresh air to depth, leading to sharp drops in apparent concentration that would quickly rebound after the suction is removed. The concentration data from boreholes surrounding the SVE East test particularly support this hypothesis over the dual continuum hypothesis because the extraction borehole concentrations do not show a corresponding drop in concentration to near zero, which one would expect to see if the concentrations in the incoming gas from nearby boreholes was truly at such low levels.

3. 3-D MODEL USED FOR DECISION ANALYSIS

One of the primary recommendations of the MDA L RFI report [34] was that a corrective measures study should be performed at this site. In this section we discuss how the results from the modeling can be used to guide decisions about possible remediation alternatives. Results from a hypothetical sudden release of VOC are presented to show how modeling can be used to explore scenarios that are relevant to demonstrating that SVE can be a successful corrective measure at MDA L.

The simulations presented in Section 3.1 are modified to explore how an SVE system can be used at MDA L to respond to catastrophic failure of drums containing VOC. We first estimate the time required to detect a catastrophic failure using the in-situ monitoring network and, by knowing how long it will take to detect such a failure suggest a sampling plan to maximize the ‘early warning’ capability of the monitoring network by showing which of the existing ports are most useful for early detection. We envision that the early warning design can provide data for a decision point that can trigger activation of the SVE system if action levels are exceeded. Under this plan, the SVE system will not need to be run constantly, but will used as an auxiliary intervention device when needed. We next use the model to show the effectiveness of the SVE system to remediate any VOC released during such a hypothetical catastrophic event. The modeling shows that, even in extreme release scenarios for this site, SVE technology can be used successfully to extract the increased VOC load and stop any migration toward the regional water table. We must stress that 1) modeling is the only tool available to explore sudden failure, and 2) that the model results can be used in demonstrating to Stakeholders that the proposed closure plan is comprehensive and safe.

In Section 3.2, we discuss the results of a plume rebound analysis that is used to estimate the amount of time required for the plume to regenerate at the estimated pre-SVE leakage rate. Regeneration time is an important parameter in determining how often the SVE system may need to be utilized to ensure that the plume does not grow significantly.

3.1. Hypothetical sudden release scenario

In this section we present results from simulations of a sudden release of 3 and 5 drums of pure TCA in both the East and West source regions. We consider this amount to be at the upper end of a reasonable release because many of the drums at this site were filled with adsorbent material, and early releases were not containerized in drums.

The sudden release scenario simulations use the calibrated SVE parameters. These simulations are initiated with the pre-SVE plume in the year 2006; use the same fixed slow release in the source region from the best-fit calibration, and inject a pulse of TCA beneath the shafts to represent the drum failures. Using the TA-21 diesel leak as a guide, we assume that the release as liquid reaches depths between 60 ft to 120 ft. As seen on Figure 8, the hypothetical sudden release reaches from the middle of unit Qbt 1v-u into the top of unit Qbt 1v-c. The vapor phase concentration of the release is fixed at the vapor pressure limit of TCA (160,000 ppmv) for varying amounts of time to generate 3 drums (843 kg TCA) and 5 drums (1405 kg TCA) in both the East and West source regions. For example, simulation of a three drum failure using this conceptual model requires that the region below the shafts be fixed for 8.12 days while the 5 drum case requires 86.25 days of fixed concentrations to generate the required mass in the release area. The location of the sudden releases on the east and west sides of MDA L are shown on Figure 18. One primary assumption in this release scenario is that once the liquid flows to the prescribed depth, it quickly volatilizes and the resulting vapor plume grows only through diffusion away from high concentrations in the release area.

This simplified release scenario does not take into consideration the density change caused by 160,000 ppmv TCA in the pore gas. Gas containing this concentration of TCA would be about 1.6 times denser than the rest of the pore gas in the mesa, and could lead to advective transport to greater depths. This underscores the importance of quickly identifying such a release and having a rapid response plan that can be quickly implemented.

3.1.1. Plume growth due to sudden release detected in surrounding boreholes

After the mass representing the release of drums is input to the model, the simulation is continued for 5 years to provide insight into how fast such a plume may be detected in surrounding sentry wells. Figure 19 shows the 5 year response in several surrounding boreholes at a depth of 150 ft. to a sudden release of 5 drums beneath both the East and West source regions. This figure shows that the concentrations rise dramatically after only one year in the boreholes closest to the sudden release. Borehole C (54-24240) and BH-I (not yet constructed) are both located 46 ft. from the hypothetical release and show very similar behavior. Concentrations rise from less than 500 ppmv to greater than 2000 ppmv in the first year, with continued increases until the plume begins to diffuse away after 2 years. For borehole H (54-24243), located 73' from the hypothetical release, the response is muted; however concentrations rise from 270 ppmv to over 700 ppmv in the first year and continue to rise. The response for the 3 drum scenario is shown in Figure 20 and has the same character as the 5 drum scenario but lower total increases for each of the sentry wells. Boreholes E (54-24238) and F (54-24243), located 93 ft. and 98 ft. respectively from the release area show similar behavior (Figure 21) and suggest that wells located within 100 ft. of any significant release (3-5 drums) should provide timely evidence of such a release. Wells that could be used for sentry wells include boreholes 54-24243, 24240, 24238, and the soon to be completed boreholes H, I, and J. Because the nearby simulations showed a robust response to the sudden release at all depths between 25 ft. and 150 ft., only one or two ports from each of these wells should be sampled quarterly. If sudden increases in concentration at the sentry ports are detected, we recommend sampling all ports at that location to see if the increase is affecting the entire depth interval. Once it is determined that an increased release is occurring, there should be metrics in place to determine when to initiate the SVE system. One possibility would be to have a target concentration, such as 1000 ppmv at which time the release is considered significant enough to turn on the SVE system. Another approach would be to compare several quarters of data before the sentry ports began increasing in concentration and make the action level be a function of the pre-increased leak. For example, action could be triggered if ports at given sentry well increase in concentration by a factor of 2 or 3 times their long term near steady values, and the SVE system turned on to remediate the increased leak.

3.1.2. Effectiveness of remediation on the hypothetical 5 drum sudden release

We next present results from a hypothetical SVE operation on the 5 drum release described above. Because of the similarity of the results for the 3 and 5 drum scenarios, for the rest of the report we discuss only the 5 drum case. For this simulation we assume that the site operators have determined that a release has occurred and implemented a corrective measure one year after a sudden release of 5 drums. Simulations were done simultaneously for both the East and West release areas. Figure 22 shows the plume just prior to the beginning of the SVE operation, after one year of plume growth from the 5 drum scenario, on a slice plane approximately 80 ft. below the mesa top. Concentrations in the center of the source release areas remain quite high, and the 1000 ppmv contour has moved outward significantly from the source region as can be seen by comparing this figure to the plume shown in Figure 4. After one year of SVE pulling 0.049 kg/s from the SVE West borehole and 0.052 kg/s from the SVE East borehole, the extraction was stopped and the plume was allowed to rebound for one year.

Figure 23 shows the concentration versus depth profile beneath the western release area for the series of events beginning with the pre-sudden release 2006 plume, followed by one year of plume growth from the 5 drum failure scenario, followed by one year of SVE, and an additional year of plume rebound. During the entire simulation the original pre-sudden release source region continues to release TCA at the same rate as before the release. Concentrations after 1 year of plume growth are quite high in the upper 200 ft. while at greater depths concentrations are close to the 2006 pre-sudden release plume. After one year of SVE extraction, concentrations in the upper 130 ft. have been reduced to below the pre-sudden release plume values; however below this depth the concentrations remain higher than the pre-sudden release plume. Higher concentrations at depth after one year of SVE are due to the lower permeabilities used in the simulations for the Qbt 1g unit. Because our assumed sudden release scenario may underestimate the vertical migration of TCA, it may be necessary to modify the current SVE system to more efficiently remove VOC from unit Qbt 1g and below. One possible technique would be to retool the current SVE boreholes to include packers that could isolate suction on the lower portions of the borehole. This approach could be costly due to the complex technology needed. Other drawbacks include the necessity to use a smaller diameter inner casing to allow sections to be isolated, and also the fact that the current holes only goes to 215 ft. deep. The second approach would be to drill two new SVE boreholes, located directly next to the current SVE boreholes. These holes could be drilled to 300 ft. and cased to the 150 ft. level, allowing more efficient removal of VOC from this depth range. The co-location of the pairs of SVE holes would allow the SVE system to quick switch between depth intervals by simply moving the hose from the top of one hole to the top of the other hole.

The final part of the 5 drum SVE extraction simulation shown on Figure 23 involves one year of plume rebound from the slowly leaking source region the upper 60 ft., after which time the concentrations in the upper 60 ft. are back to the original pre-SVE values. Concentrations in the Qbt 1g unit are beginning to decrease as diffusion spreads the plume both laterally and vertically.

Figure 24 shows concentrations beneath the eastern sudden release area for the same series of events. Concentrations at the release area do not drop as significantly in the upper 130 ft. because the SVE East borehole is located further from the source. Concentrations in the upper 60 ft. rebound to values higher than the 2006 plume because the leak rate applied was based on the year 2000 plume generation which has slightly higher concentrations in the source region than the year 2006 pre-SVE plume; this slight difference does not affect the conclusions.

3.1.3. No further action

Figure 25 shows concentration beneath the western sudden release area at various times over the span of 100 years starting from the 5 drum sudden release scenario. The final curve shown on Figure 24 has no sudden release and only includes the effects of continued slow release for 100 years. Note that the sudden release includes continued slow release after the initial release, so that the difference in total mass input for the final two curves on Figure 24 is only 5 drums (1405 kg) of TCA. These two cases are the ‘No Further Action’ cases and show that although early time concentrations from a 5 drum release lead to significant increases in concentrations in the upper 200 ft. of the mesa, the long term diffusive nature of the plume will tend to smear the sudden release such that after 100 years there is little difference between continued slow release and the sudden release. After one year the 100 ppmv contour has reached the bottom of unit Qbt

1g. By 20 years, this contour has dropped to the middle of the Otowi member of the Bandelier Tuff. Within 50 years the 100 ppmv contour is at the top of the Tb4 Basalt.

Figure 26 expands the depth of Figure 25 and includes the regional aquifer depth. At no time in the 100 year simulations, either with or without the sudden release of 5 drums, does the 10 ppmv contour drop below 650 ft. below the top of the mesa. At 800 ft. below the mesa to, concentrations are below 3 ppmv, suggesting that releases from this site, including both sudden releases and slow leaks, will not impact the regional aquifer located at approximately 950 ft. below the mesa top.

3.2. Plume rebound after one year of SVE

Finally, we present a simulation showing how the total mass of the plume may rebound after one year of SVE. Figure 27A shows the total mass in the plume as a function of time. During the first year of the simulation, both the East and West SVE boreholes have pressures fixed at 64.3 and 66.8 kPa respectively. During the entire simulation, VOC is allowed to leak at the pre-SVE leakage rate from both source regions. During the extraction (Figure 26B), the plume loses more than 40% of its mass during the first three months of SVE. After 3 months of extraction, the rate of withdraw decreases significantly, showing that the most efficient timeframe to run the SVE system is on the order of 2-3 months.

After the SVE system is shut down, the plume begins to grow slowly at the pre-SVE leakage rate. As seen on Figure 27A, the plume does not rebound to its original size after 9 years of growth from the imposed slow leaks. This implies that in the absence of a catastrophic drum failure, activation of the SVE system every few years should be sufficient to control the continued growth of the plume. A best management practice solution to plume control at MDA L could be developed to maximize withdraw while minimizing the time required to run the SVE pumps and other equipment. Figure 27 suggests that such an analysis would likely result in a recommendation to run the SVE system for only 2 to 3 months every 1 to 3 years.

3.3. Radius of influence

The radius of influence for the simulated SVE West test is shown in Figures 28 A and B. The images are (A) a N-S slice and (B) an E-W slice through the SVE West site. The purple colored region in both images is below the cut-off flux of 4.e-6 m/s. This cut-off flux translates to a true velocity of about 0.7 m/day or 41 m in 60 days. The region of active extraction is limited to the higher permeability rocks. The radius of influence is not symmetric with respect to the mesa and is influenced by the geometry and permeability structure of the mesa.

4. CONCLUSIONS

Data collected during a one month SVE test are sufficient to calibrate a site-scale 3-D model of VOC transport at MDA L. Some questions developed during the calibration of the manometer data suggest that the FLUTe^{TM} system in surrounding boreholes may be leaking, especially during the high suction of the SVE test. This may in turn explain the extremely rapid drops in concentration at all depths in several of the monitoring wells. It would also explain the manometer readings taken before and after the SVE test that show almost no differential pressure between the surface and ports at a range of depths to 200 ft.

Simulations of a sudden release of VOC show that the current and planned monitoring holes within 100 ft. of the source regions at MDA L will be useful sentry wells. We recommend that one or two ports from these wells be sampled every quarter and examined for sudden increases in concentrations. If such increases are seen, the rest of the ports in the affected well should be sampled and trend analysis performed over the span of a few quarters. Additionally, action criterion should be developed to determine at what level of increased concentrations a significant leak has occurred. The action levels should trigger the activation of the SVE system to promptly remediate a sudden release. Prompt action will limit the time that any sudden release will have to migrate to depth. The SVE system should be run until extracted concentrations drop below some target level, such as 100 ppmv (4.6e5 ug/m3).

Simulation of SVE extraction after a release of 5 drums of VOC shows that the current system can remove a significant portion of the release. Concentrations in the upper 130 ft. of the mesa were reduced through time by SVE pumping to levels well below the pre-sudden release; however concentrations below this depth were not as efficiently removed from the mesa. The presence of higher permeability rocks in the more shallow sections of the mesa means that the SVE system preferentially pulls contaminants from the 0 – 130 ft depth interval. In the event that density driven transport of vapor phase VOC reaches depths greater than presented in our simplified release scenario, we recommend installation of two additional boreholes that would be drilled to 300 ft. and isolate the lower 150 ft. of the borehole. This system would allow removal of contaminants to the top of the Otowi unit and provide and extra level of safety in the event of a sudden release. Simulations of the ‘No Further Action’ option for both sudden releases and long term slow leaking at estimated current rates show that the plume is unlikely to reach the regional aquifer at concentrations greater than a few ppmv in the next 100 years. This result shows that the ability of the mesa to diffuse VOC is quite impressive.

Calculations of plume rebound show that in the absence of a catastrophic drum failure, activation of the SVE system every few years should be sufficient to control the continued growth of the plume. Finally, the radius of influence in the more permeable units is on the order of 40 m when for the SVE West test.

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Table I 1,1,1-TCA Physiochemical Parameters

1,1,1-TCA ($C_2H_3CL_3$)	
Molecular weight [12]	133 g/mol
Liquid density [12]	1325 kg/m3 (at 293 K)
Vapor pressure [12]	100 mmHg (at 293 K)
Water solubility (mg/l) [12]	950 mg/L (at 293 K)
Tuff sorption coefficient K_d [13]	< 0.08 mL/kg fully saturated
Henry's Law constant (H_{TCA}) [14]	62 MPa/(liquid mole fraction) equal to 0.458 $(g/L)_{vapor}/(g/L)_{liquid}$ (at 285 K)
Diffusion coefficient in crushed Bandelier tuff assumed to be nearly equal to TCE $J = -\theta_a D \text{ grad}C$ where J is flux, θ_a is volumetric air content, C is the concentration, and D is the diffusion coefficient. [15]	4.6 e-6 to 9.3 e-6 m^2/s at 2-7% relative saturation 4.4e-7 to 1.4e-6 m^2/s at 29-36% relative saturation

Table II Porosity, saturation, and effective diffusion coefficient values used in the simulations.

Unit	Effective porosity	In-situ saturation	D* (m^2/s)
Qbt 2	0.41[a]	0.06 [b]	$3x10^{-6}$
Qbt 1vu	0.49 [a]	0.15 [b]	$2x10^{-6}$
Qbt 1vc	0.49 [a]	0.15 [b]	$2x10^{-6}$
Qbt 1g	0.46 [a]	0.15 [b]	$2x10^{-6}$
Cerro Toledo (Qct or CT)	0.45 [a]	0.40 [b]	$5x10^{-7}$
Otowi Member (Qbo)	0.44 [a]	0.35 [b]	$5x10^{-7}$
Cerros del Rio basalt	0.1 [b]	0.02[c]	$3x10^{-6}$
Land surface	0.48 [c]	0.02 [c]	$3x10^{-6}$
Asphalt	0.5 [c]	0.02 [c]	$1x10^{-14}$
Shafts	0.5 [c]	0.02 [c]	$3x10^{-6}$
Wellbore	1.0	0.001	$3x10^{-6}$
Well Casing	0.5	0.001	$1x10^{-14}$

[a] fixed to mean measured value from Springer [16]
[b] fixed to measured values reported in Birdsell et al. [17]
[c] assigned fixed value for the simulations

Table III In situ and core permeabilty data for the MDA L area.

GeologicUnit	0.6 m Packer Permeability (m^2) Includes fractures [18]			Mean Core Permeability (m^2) Matrix only [16]
	MIN	MEAN	MAX	
Qbt 2	5.3e-13	1.7e-12	3.8e-12	2.0e-13
Qbt 1vu	4.7e-13	2.9e-12	1.6e-11	1.2e-13
Qbt 1vc	8.5e-14	1.5e-12	1.2e-11	1.2e-13
Qbt 1g	1.1e-13	2.5e-12	5.4e-11	1.3e-13
Qtt (TT)	9.3e-13	7.5e-12	1.7e-11	NA
Qct (CT)	1.2e-12	5.7e-12	1.1e-11	NA
Qbo	5.5e-13	6.1e-13	7.1e-13	2.3e-13[b]

[b] Canada del Buey data

Table IV Extraction pressure and flow calibration targets for the SVE Pilot Tests

Test period	Average pressure drop across orifice plate (inches of water)	Pressure at the top of the wellhead[a] (kPa)	Wellhead suction (inches of Hg)	Calculated mass flow rate (kg/s)	Calculated volumetric flow rate (standard ft^3/min^b)
SVE West 0 - 21.9 days	3.66	66.8	3.9	0.0487	85.61
SVE West 21.9 – 28.7 days	4.68	65.1	4.4	0.0543	95.45
SVE East	4.46	63.4	4.9	0.0523	91.97

[a] assumes constant atmospheric pressure of 80kPa at the wellhead

[b] standard cubic feet per minute assumes air at a density of 1.206 kg/m3

Table V Calibrated permeabilities in both the horizontal and vertical directions used for the SVE Pilot Test simulations (Results from AMALGAM Calibration).

Unit	SVE West permeability m^2		SVE East permeability m^2	
	x , y	z	x , y	z
Qbt 2	6.5e-13	4.6e-13	4.7e-13	7.5e-13
Qbt 1vu	6.0e-12	2.0e-12	7.6e-13	1.2e-13
Qbt 1vc	1.0e-13	5.7e-13	1.0e-11	1.5e-12
Qbt 1g	1.0e-13	5.1e-13	1.0e-13	1.0e-13
Qtt (TT)	5.0e-13	5.0e-13	5.0e-13	5.0e-13
Qct (CT)	5.0e-13	5.0e-13	5.0e-13	5.0e-13
Qbo	1.5e-13	1.5e-13	1.5e-13	1.5e-13
Asphalt	1.9e-13	1.9e-13	1.4e-12	1.4e-12
Wellbore	1.0e-4	1.0e-4	1.0e-4	1.0e-4
Well Casing	5.0e-19	5.0e-19	5.0e-19	5.0e-19

Table VI Surrounding Borehole Manometer Data compared to Simulated Pressure Response for Selected Monitoring Ports

Borehole	Monitoring port depth (ft)	Pressure change from initial condition (-ve kPa)	
		Data	Model
24240	25	0.2	0.67
	50	0.6	1.31
	75	1.8	1.88
	100	1.5	2.34
	125	1.0	2.97
	150	0.5	2.87
24243	25	0.1	1.22
	50	0.1	2.32
	75	0.2	2.53
	100	0.7	2.70
	117	0.8	2.79
2002	60	0.1	1.38
	100	0.25	1.45
	140	0.27	1.41
	200	0.4	1.15

Figure 1: MDA L Site Boundary, monitoring boreholes, and SVE locations.

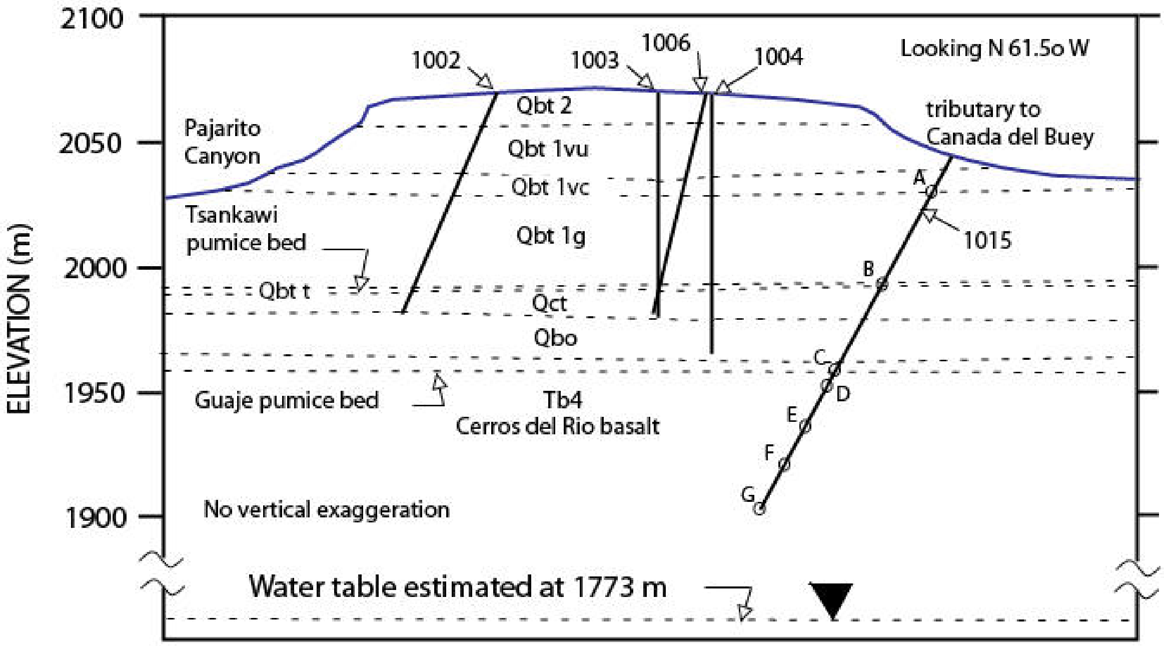

Figure 2 Site stratigraphy with wells lying immediately to the east of MDAL, After Neeper 2002.

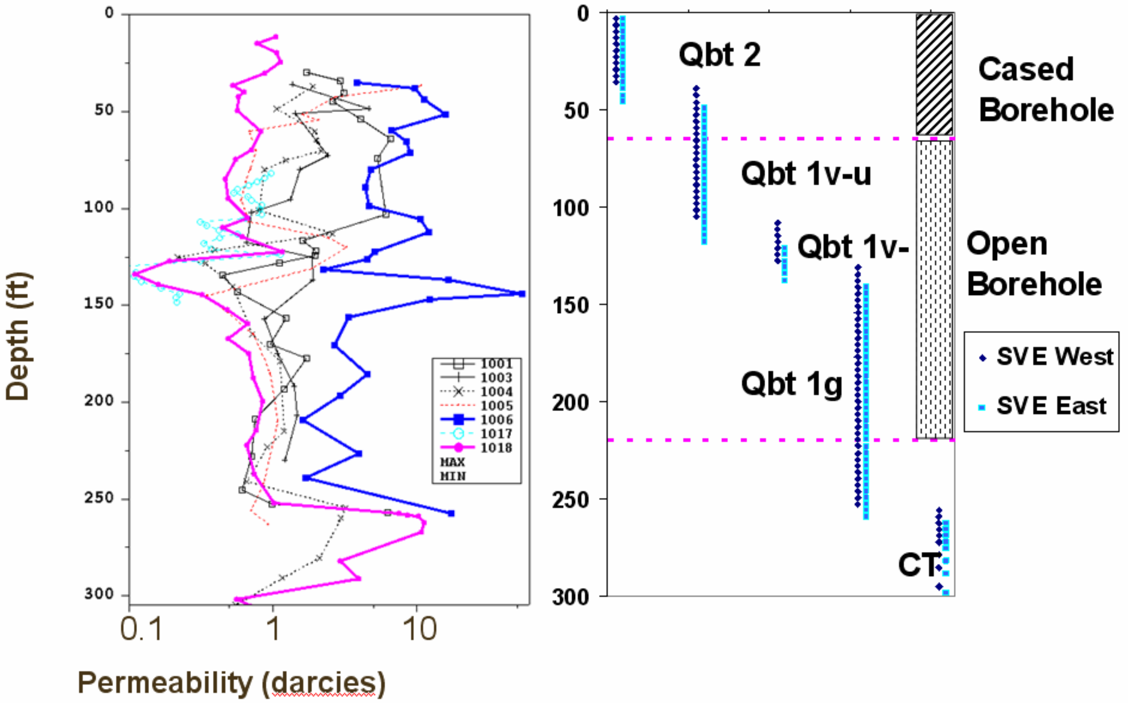

Figure 3 Straddle packer permeability data related to geologic units and the SVE borehole design.

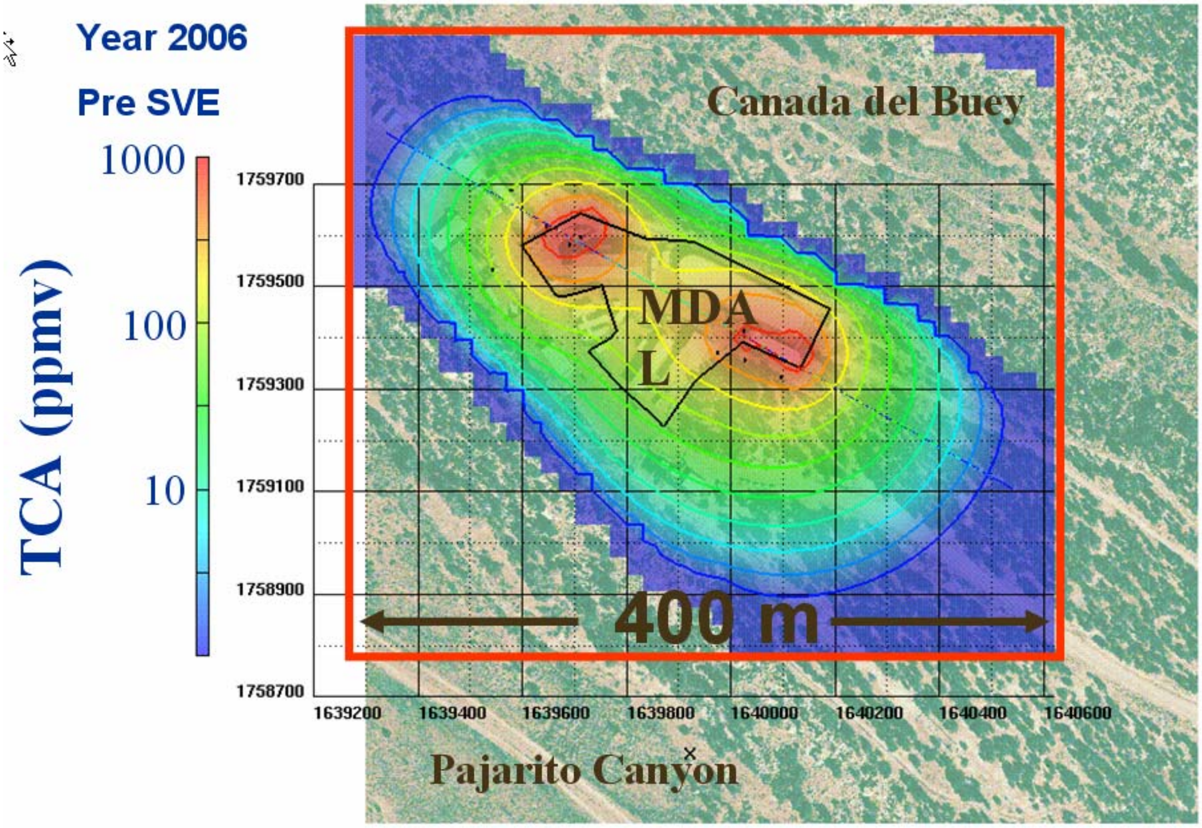

Figure 4 The lateral extent of the numerical grid is shown by the red line. Contours show a simulated concentration profile of the pre-SVE plume on a plane 80 ft. below the mesa top. The aerial photograph shows the relationship of the site boundary to Pajarito Canyon and Pajarito Rd. which runs through the text for Pajarito Canyon.

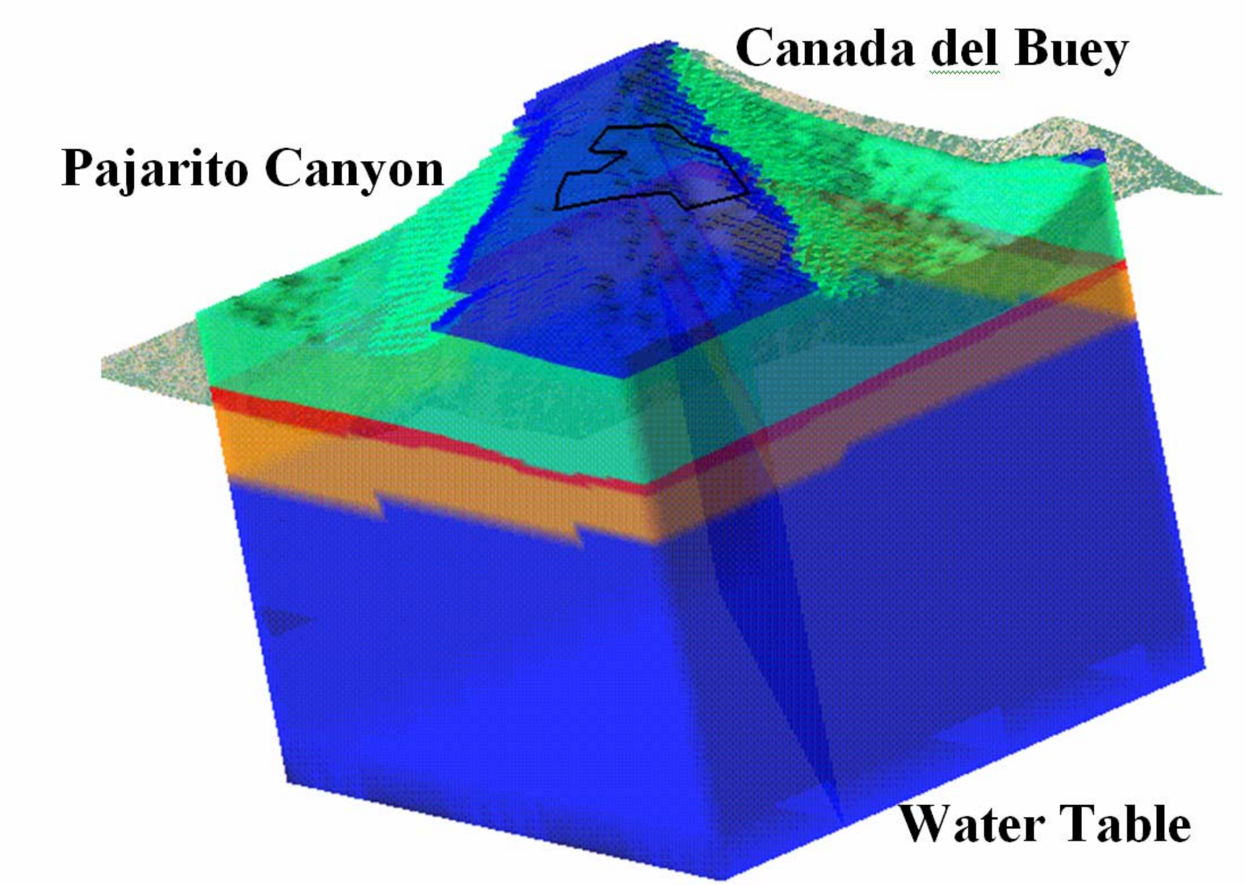

Figure 5 Angled view of the numerical grid with gross stratigraphy and MDA L outline. The topography of the grid is apparent from the way the model surface follows the aerial photograph that has been draped onto the digital elevation model of the site.

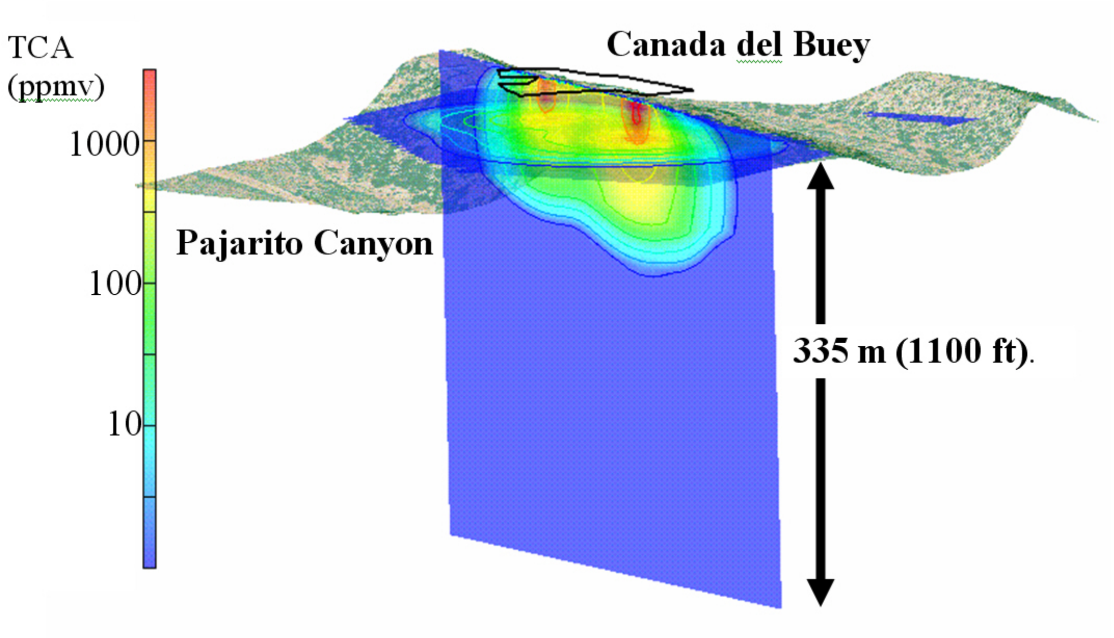

Figure 6 Slice planes of the numerical grid with concentration contours in ppmv showing the simulated pre-SVE Pilot test plume. The aerial photograph is draped onto the digital elevation model of the site and shows the canyons on either side of the mesa. The MDA L site boundary is the black polygon lying above the aerial photograph.

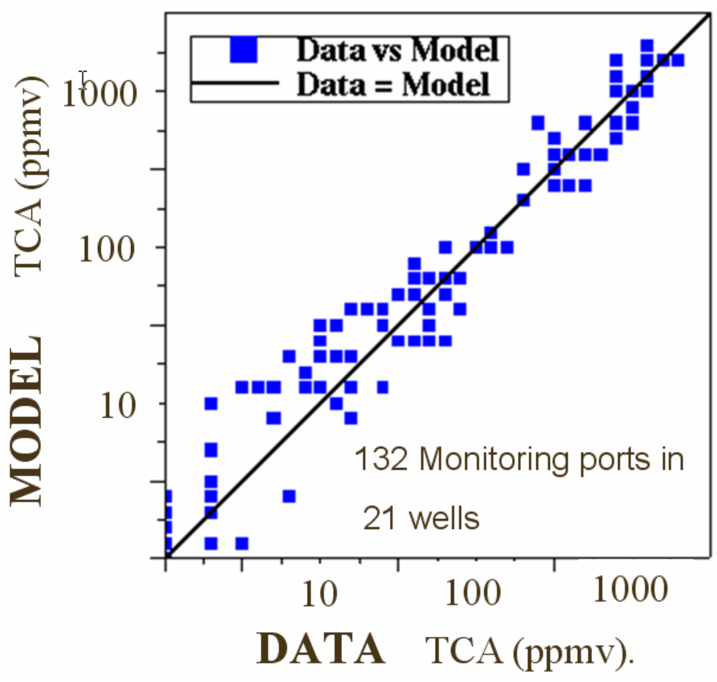

Figure 7 Model data regression for the pre-SVE Pilot Test simulated plume.

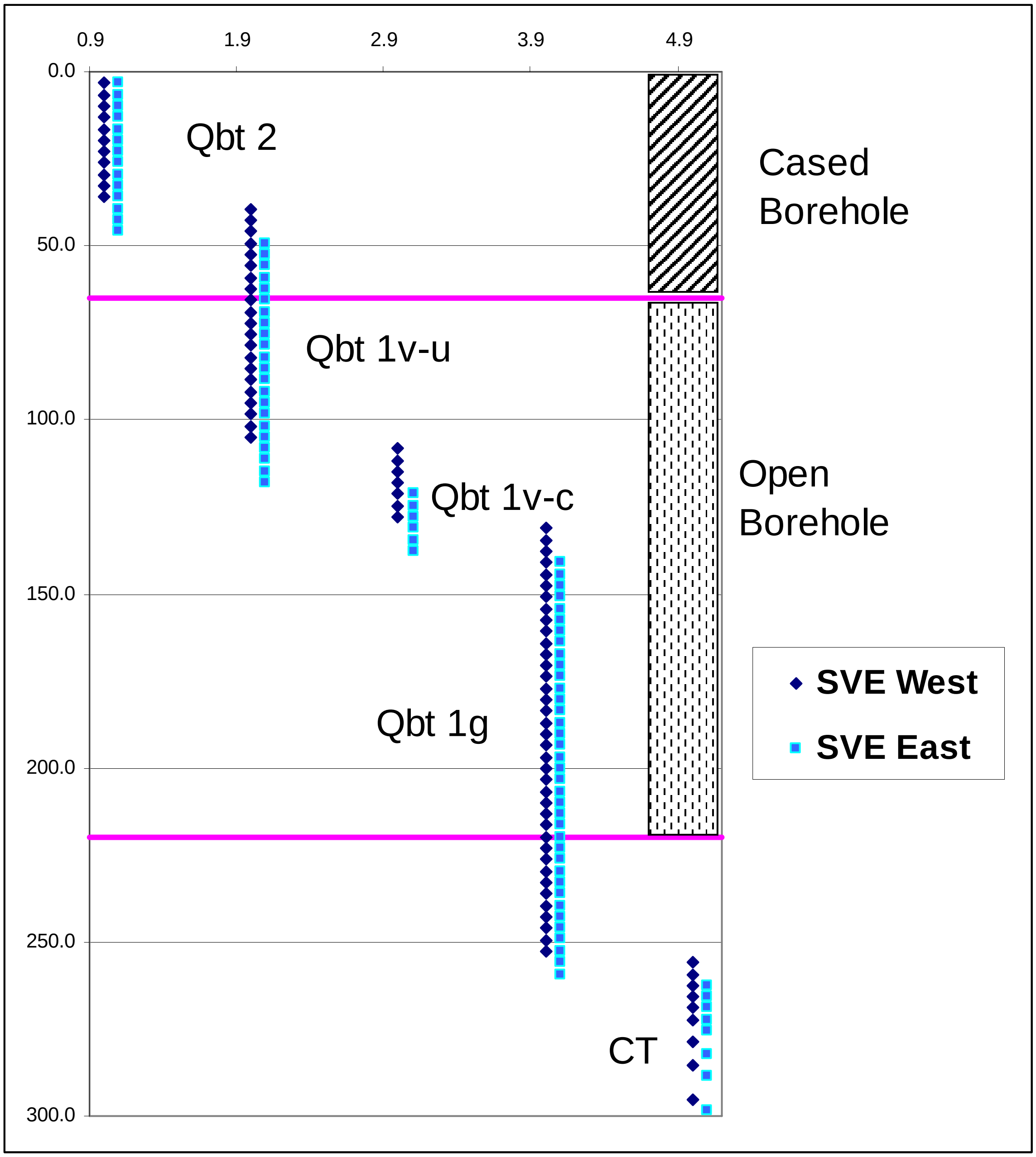

Figure 8 Site stratigraphy for the SVE boreholes in relationship to the well construction.

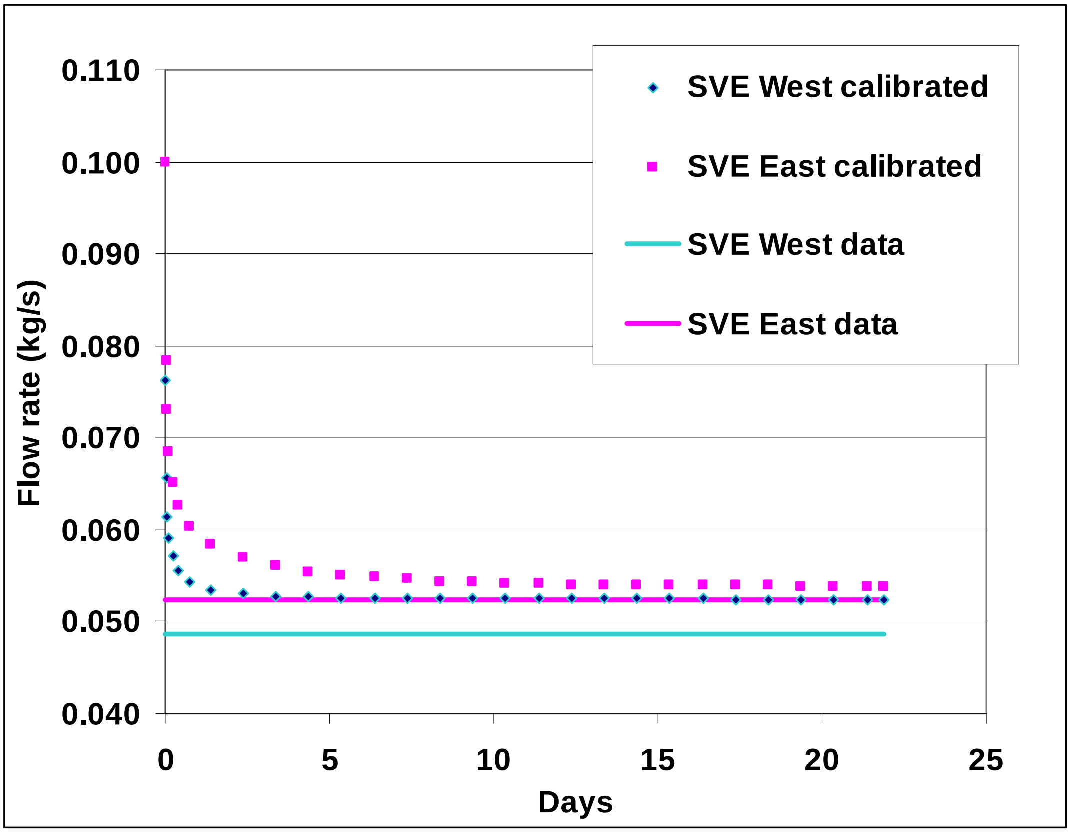

Figure 9 Simulated flow rates in the extraction boreholes compared to calculated flow rates for the East and West tests.

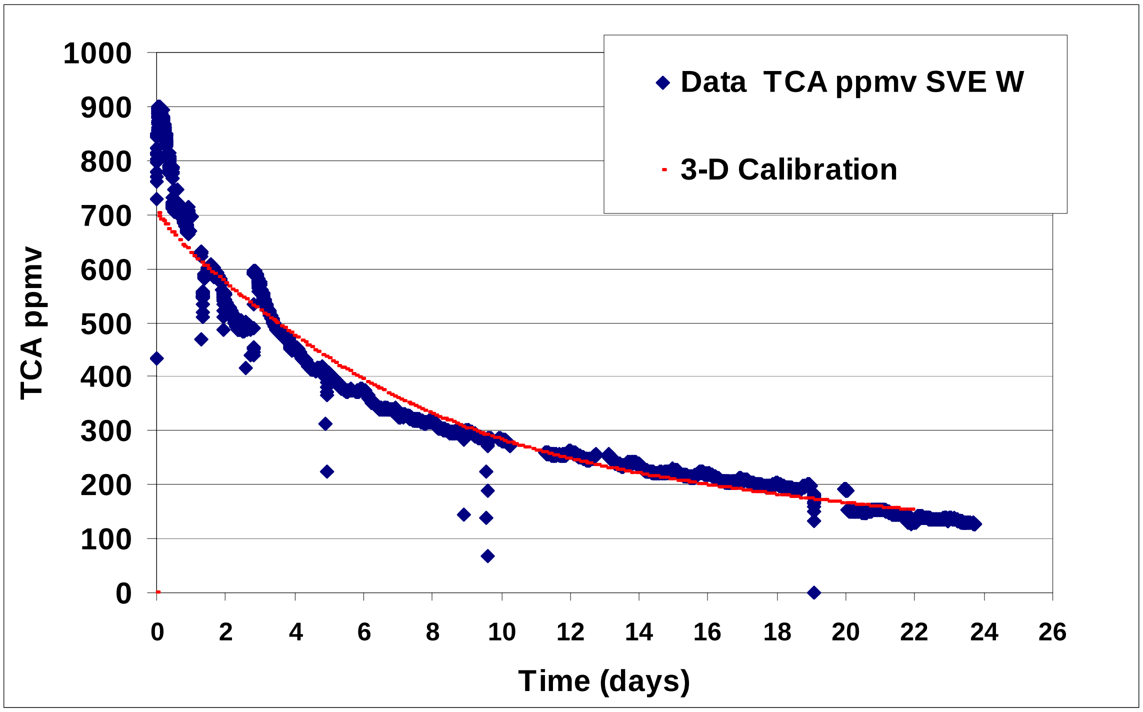

Figure 10 SVE West wellhead data versus calibrated simulation. The time period during which the SVE system was shut down for repair has been removed from the calibration.

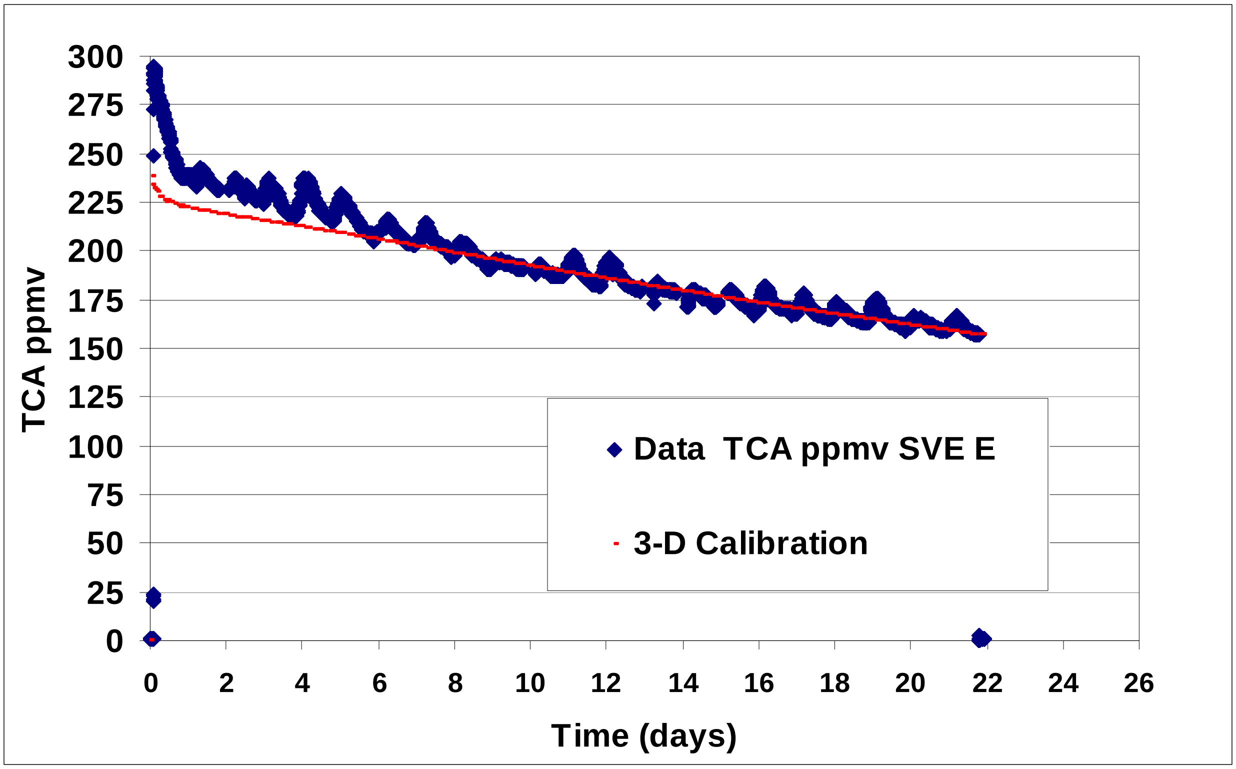

Figure 11 SVE East wellhead concentration versus time.

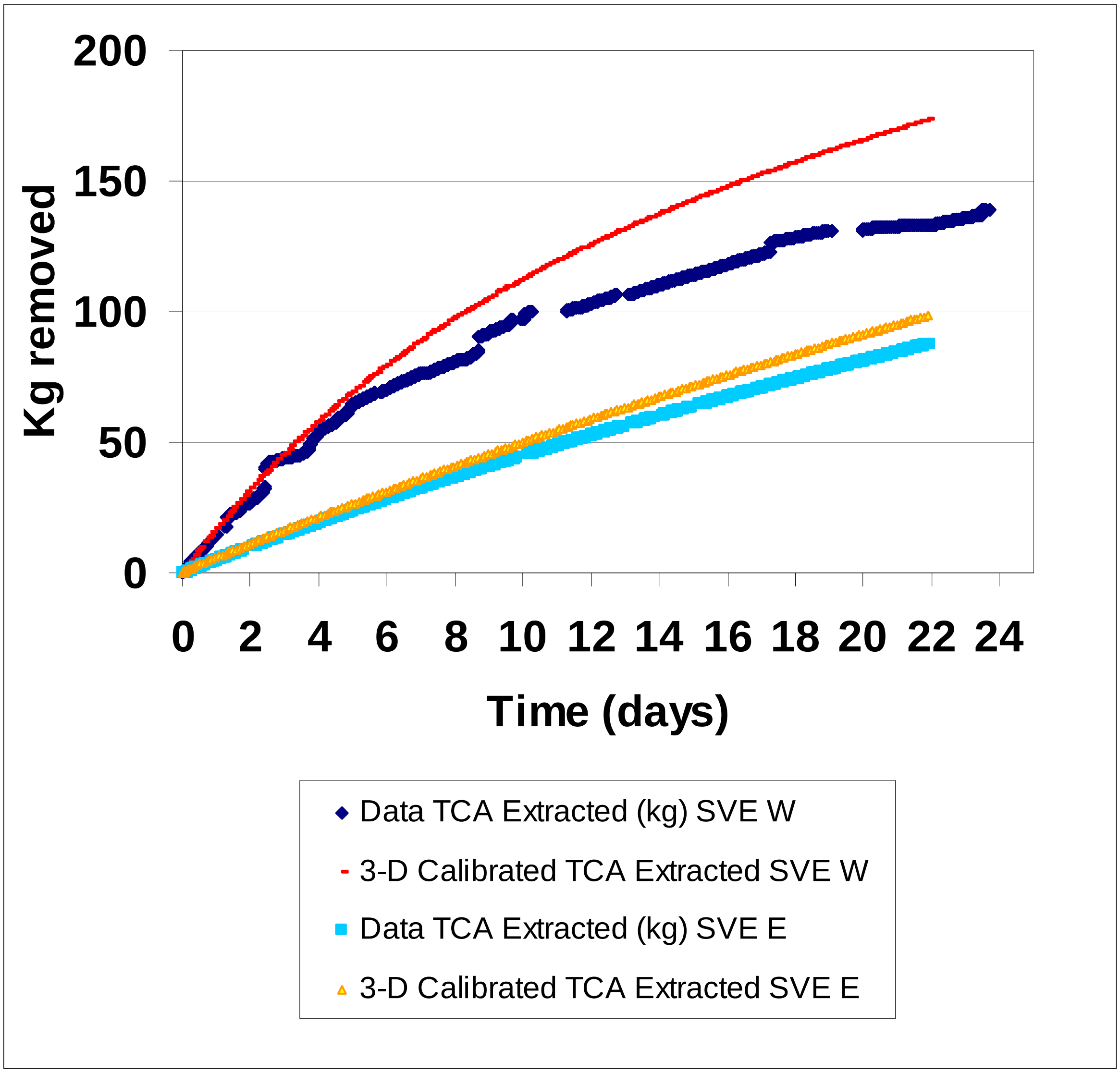

Figure 12 Mass removal for both SVE West and SVE east simulations compared to calculated mass removal rates during the Pilot Test.

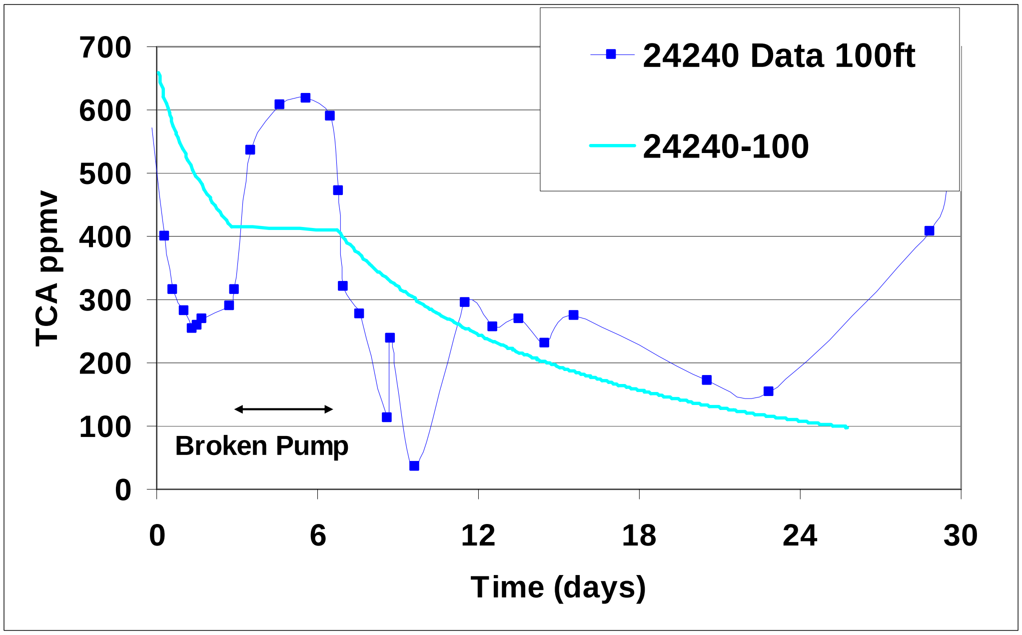

Figure 13 Concentration versus time for borehole 54-24240 at 100 ft below ground surface (bgs), model versus simulation.

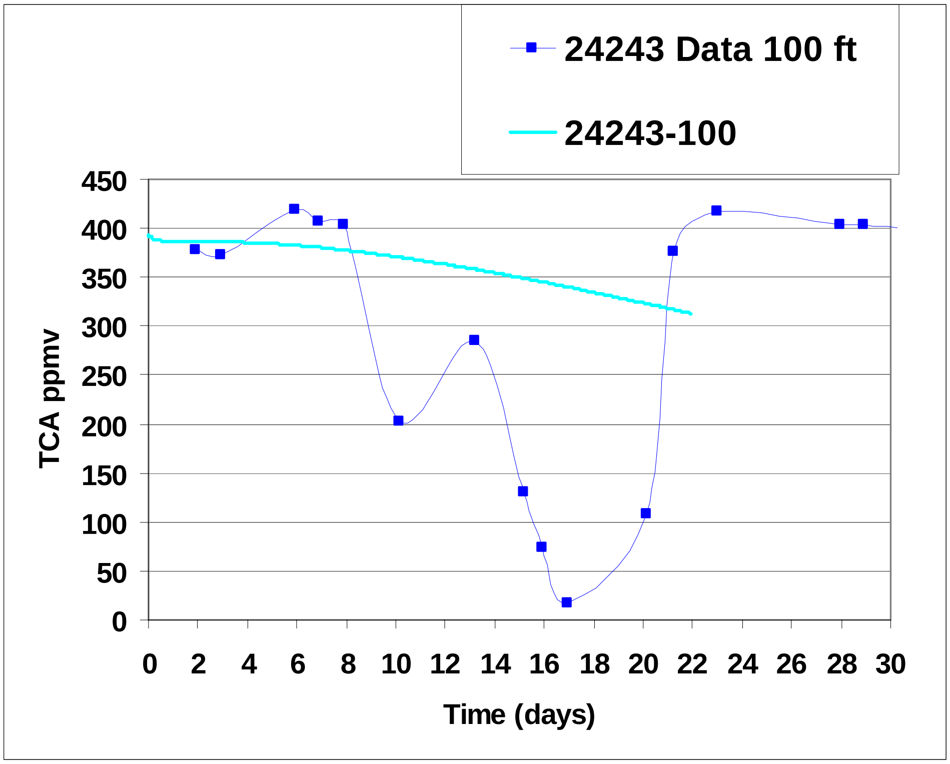

Figure 14 Concentration versus time for borehole 54-24243 at 100 ft bgs, model versus simulation.

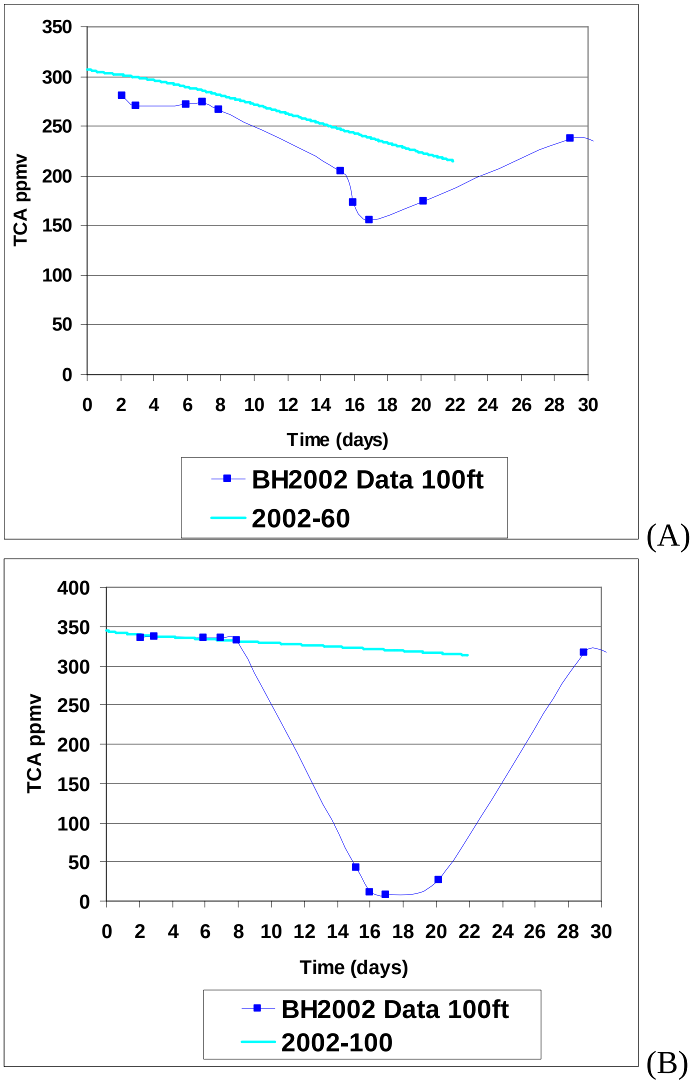

Figure 15 Concentration versus time for borehole 54-2002 at (A) 60 ft bgs and (B) 100 ft bgs, model versus simulation.

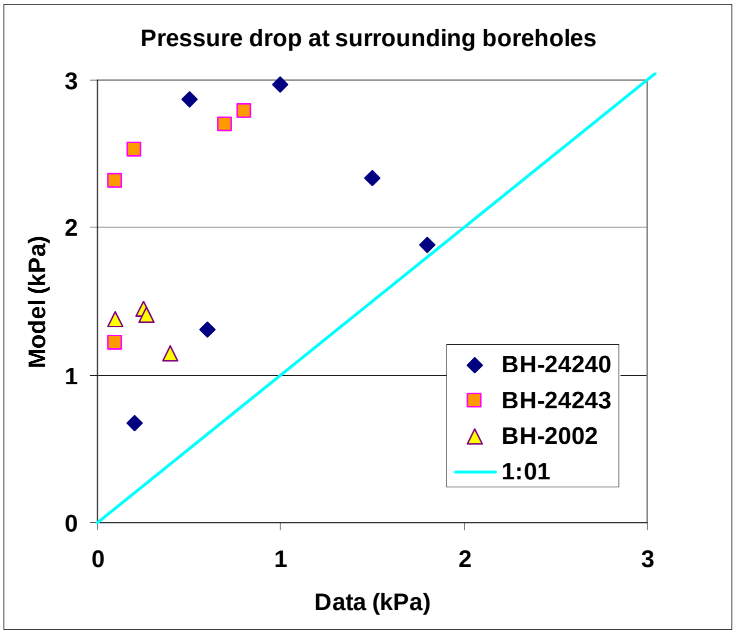

Figure 16 Manometer data versus simulation results for three boreholes. The 1:1 line is plotted to show that the simulated pressure drops are consistently higher than the measured data except for one point in BH-24240.

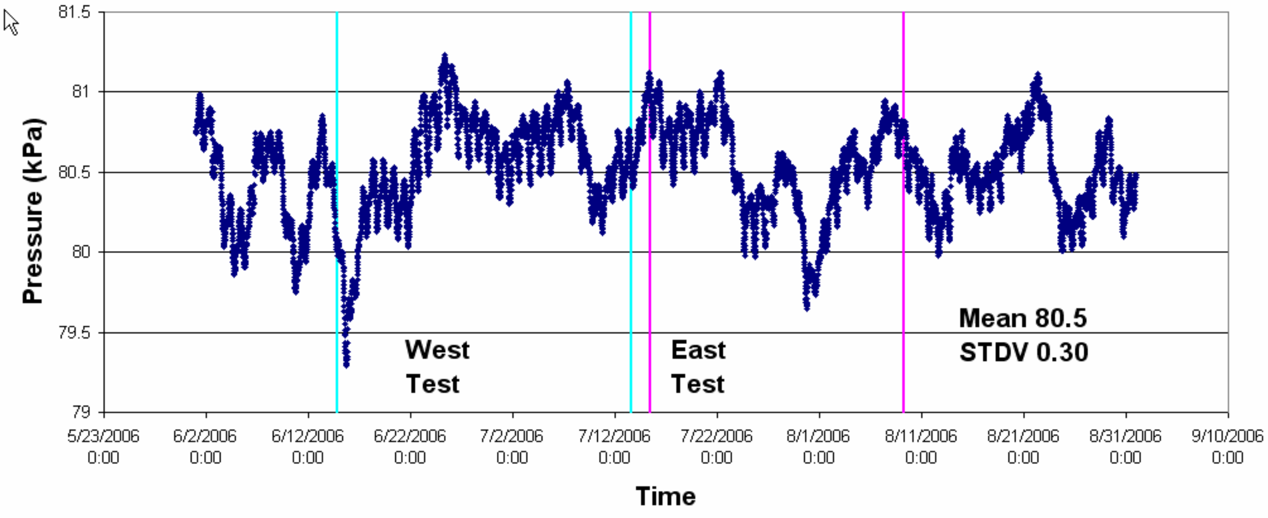

Figure 17 TA-54 barometric pressure data during the time of the SVE Pilot Test.

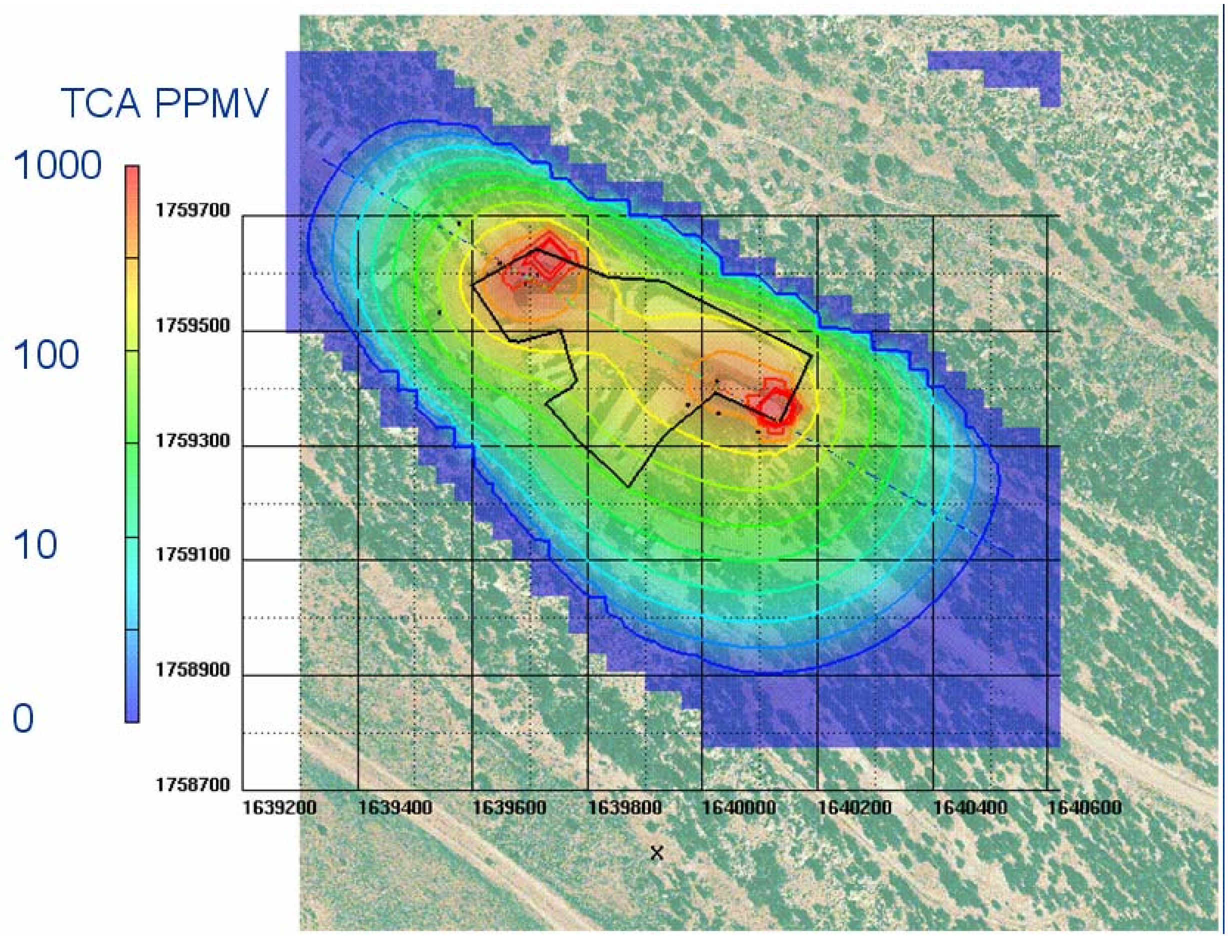

Figure 18 Source locations for the 5 drum sudden release scenario.

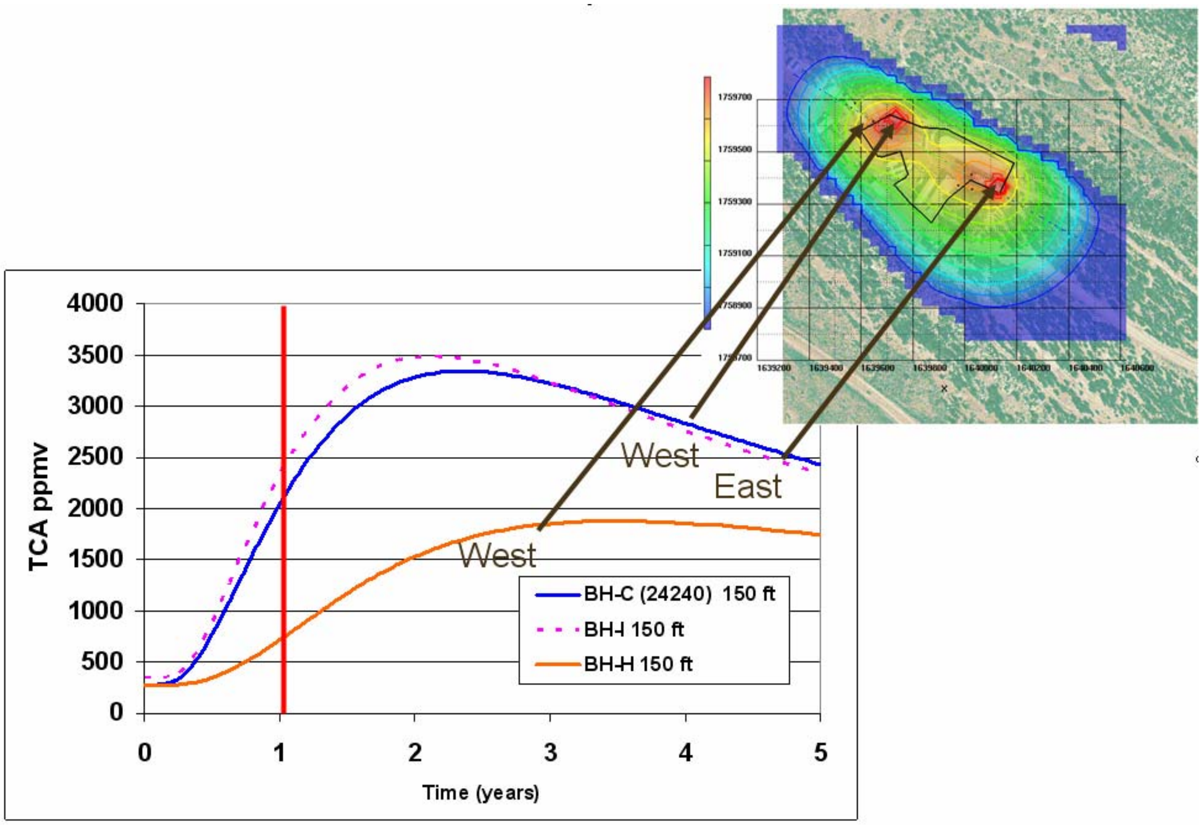

Figure 19 Response at the 150 ft. depth in several surrounding boreholes for the 5 drum release scenario.

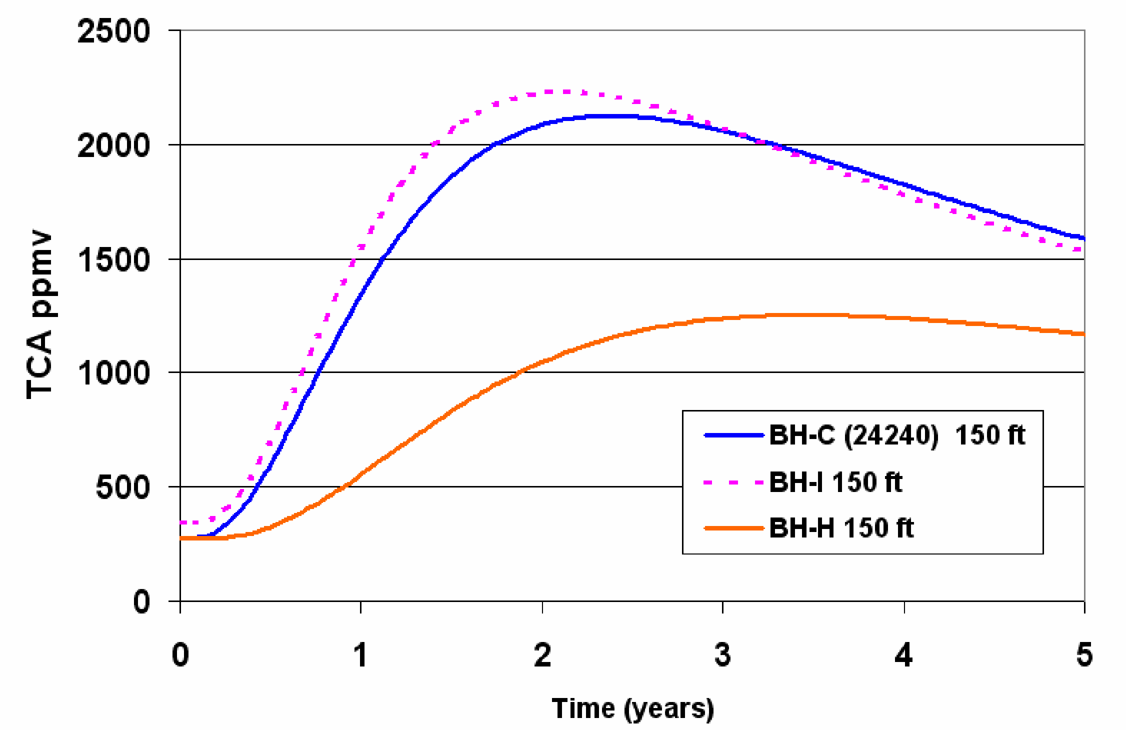

Figure 20 Response at the 150 ft. depth in several surrounding boreholes for the 3 drum release scenario.

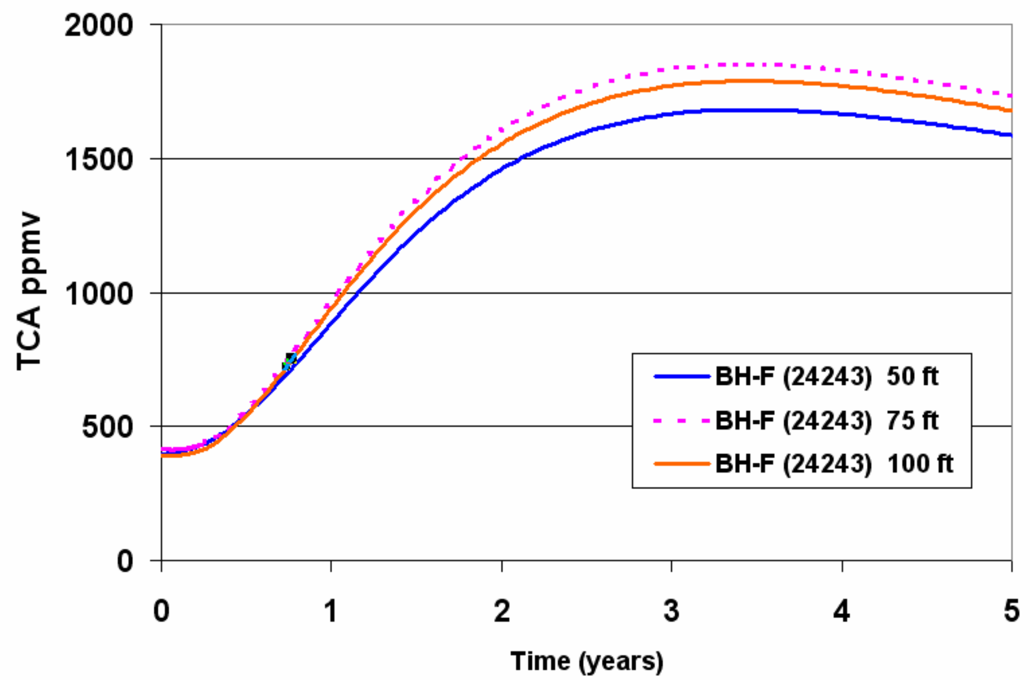

Figure 21 Concentration responses for the 5 drum scenario in boreholes E and F, located 93 ft. and 98 ft. respectively from the release area.

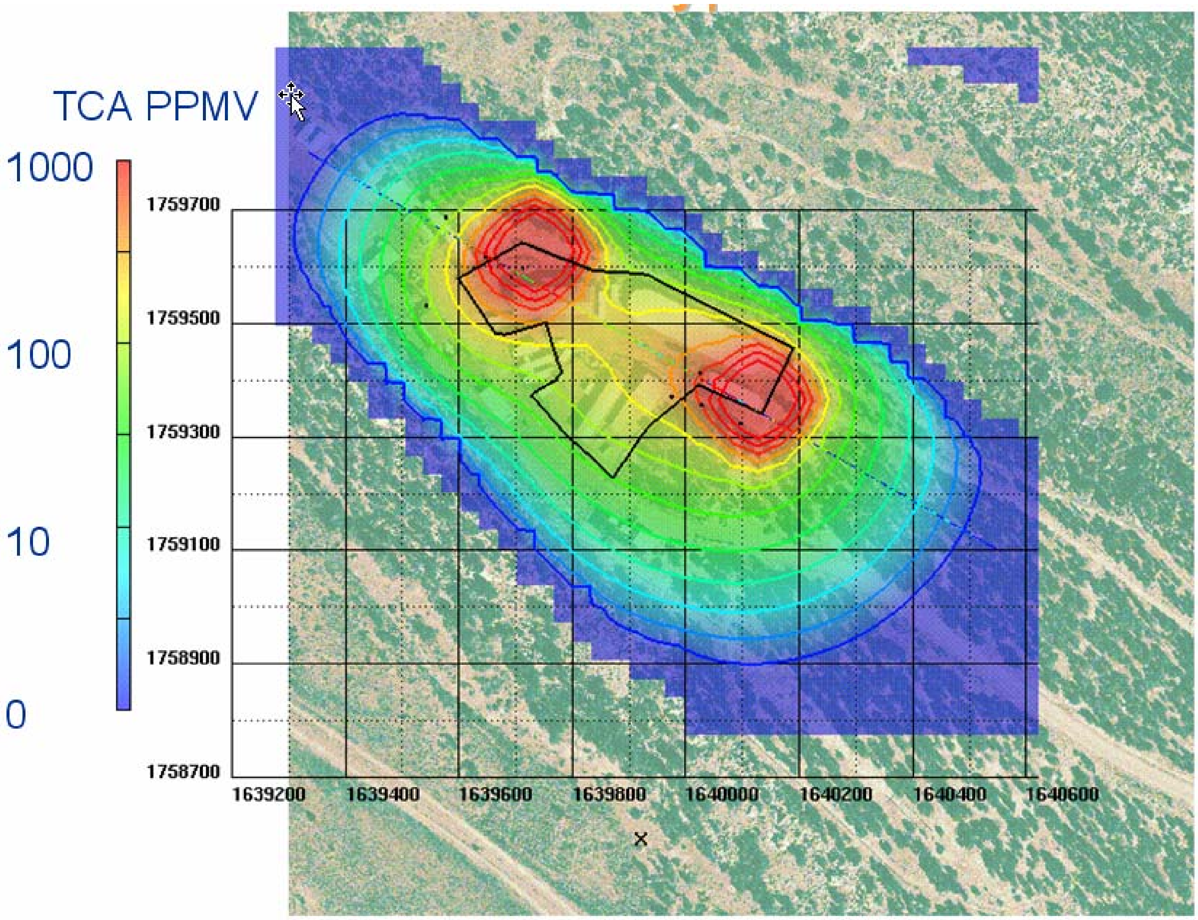

Figure 22 Concentration after one year of plume growth from the 5 drum sudden release scenario on a plane 80 ft. beneath the mesa top.

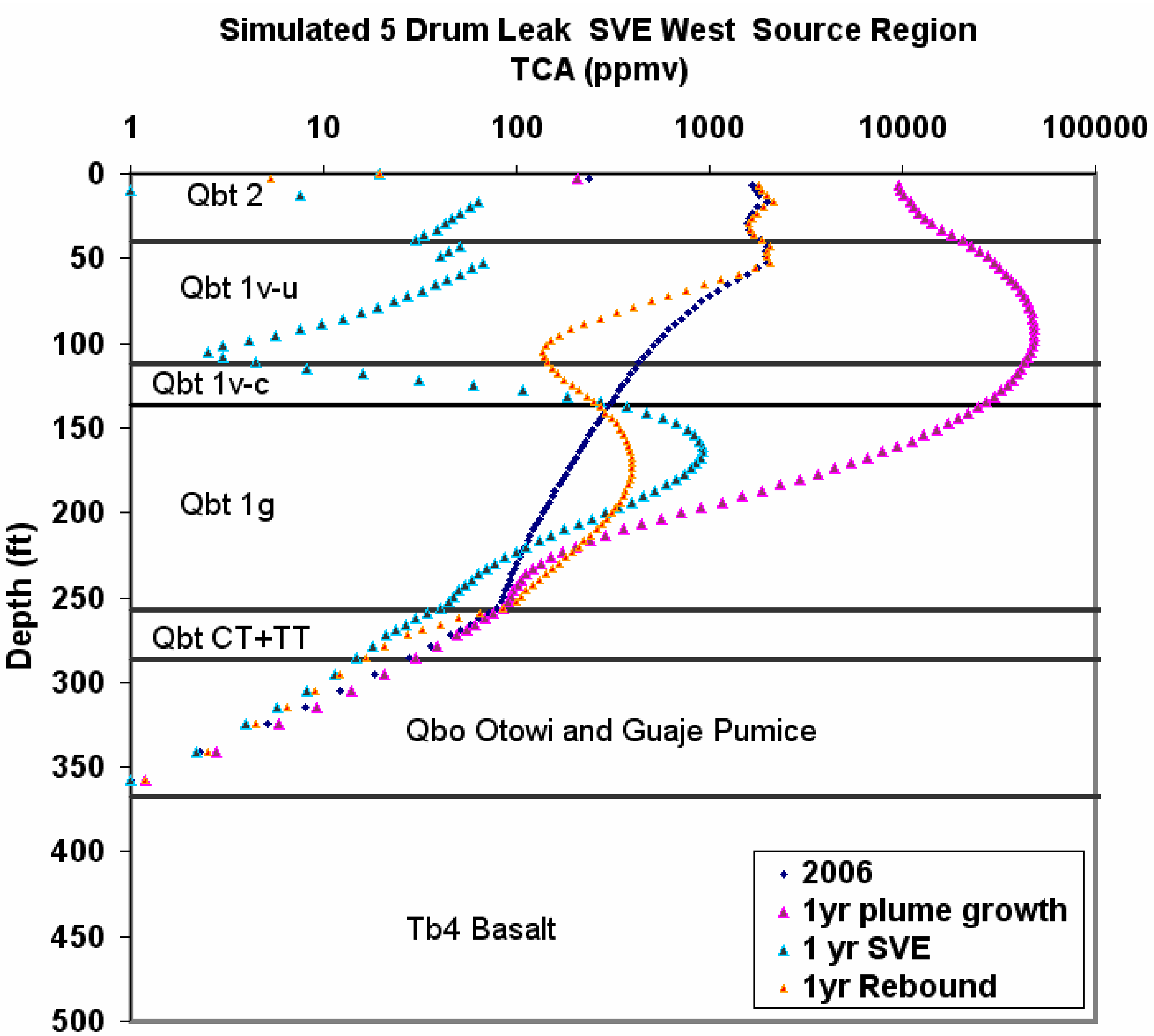

Figure 23 Concentration versus depth beneath the western sudden release area.

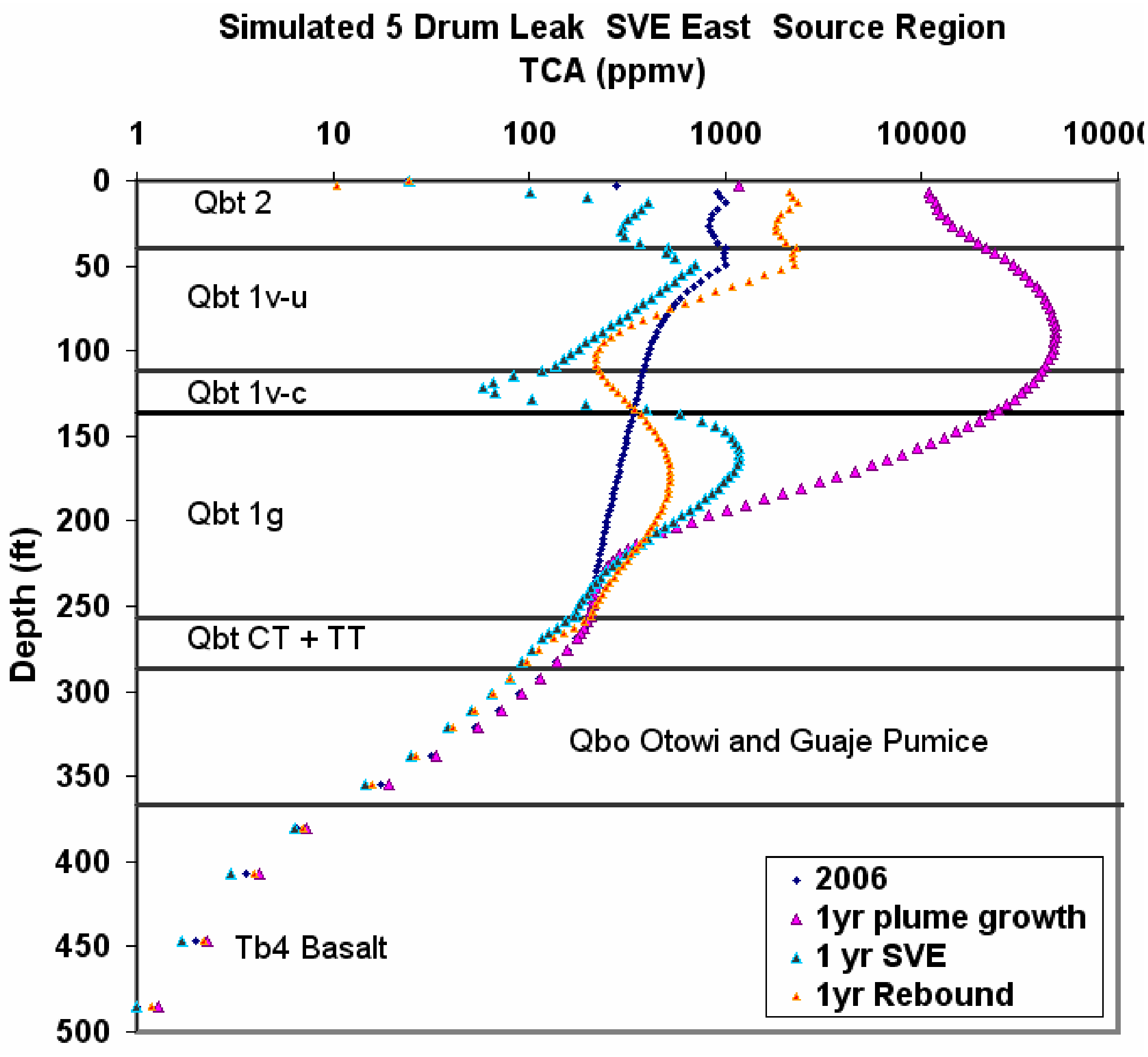

Figure 24 Concentration versus depth beneath the eastern sudden release area.

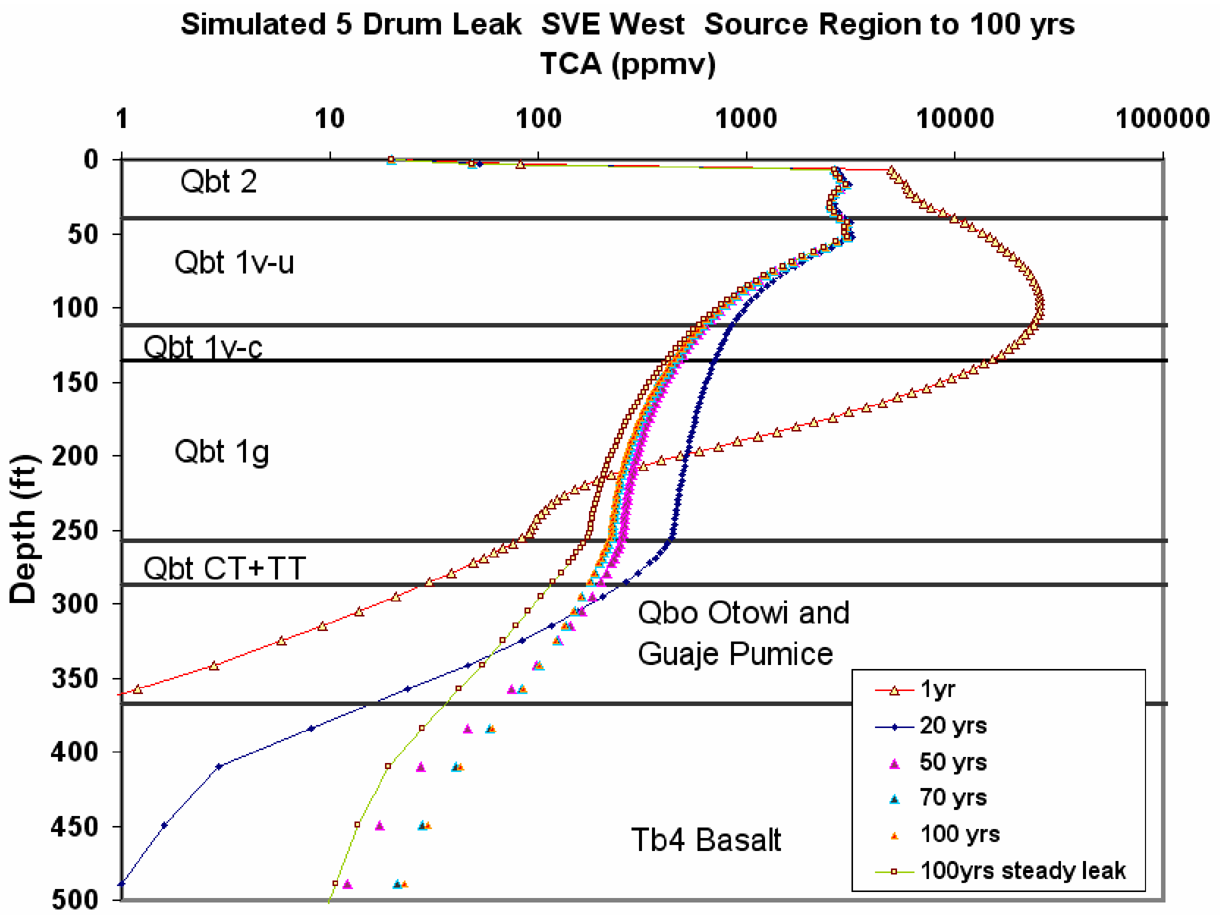

Figure 25 Concentration versus depth beneath the western sudden release area to 100 years.

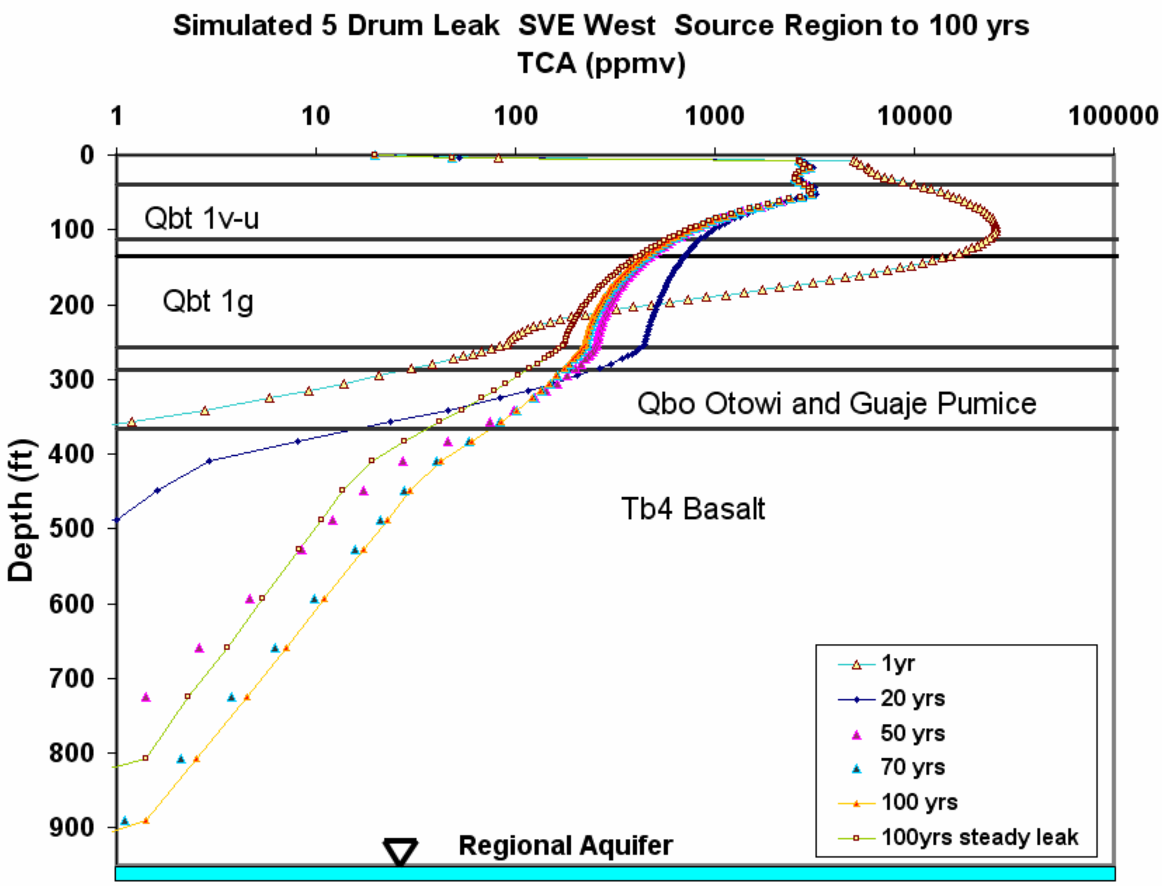

Figure 26 Concentration versus depth beneath the western sudden release area to 100 years. This figure shows the same data as in Figure 24 and also includes the depth range of the regional aquifer.

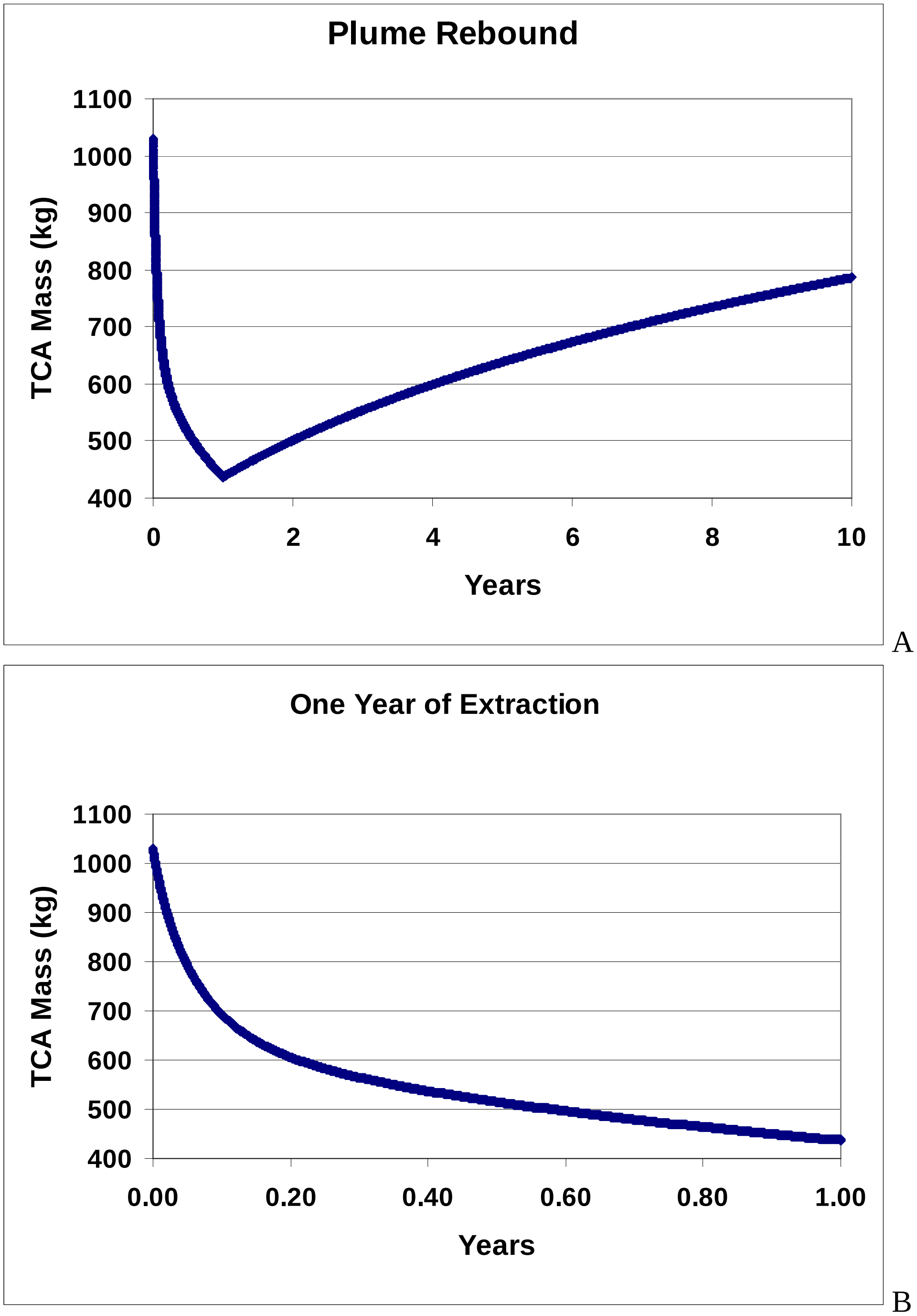

Figure 27 A) Plume rebound after one year of SVE. The simulation has both SVE West and East pumping for one year. After one year, both East and West source regions continue to leak at pre-SVE rates. B) Zoom in on the first year of extraction showing the change in plume mass as a function of time.

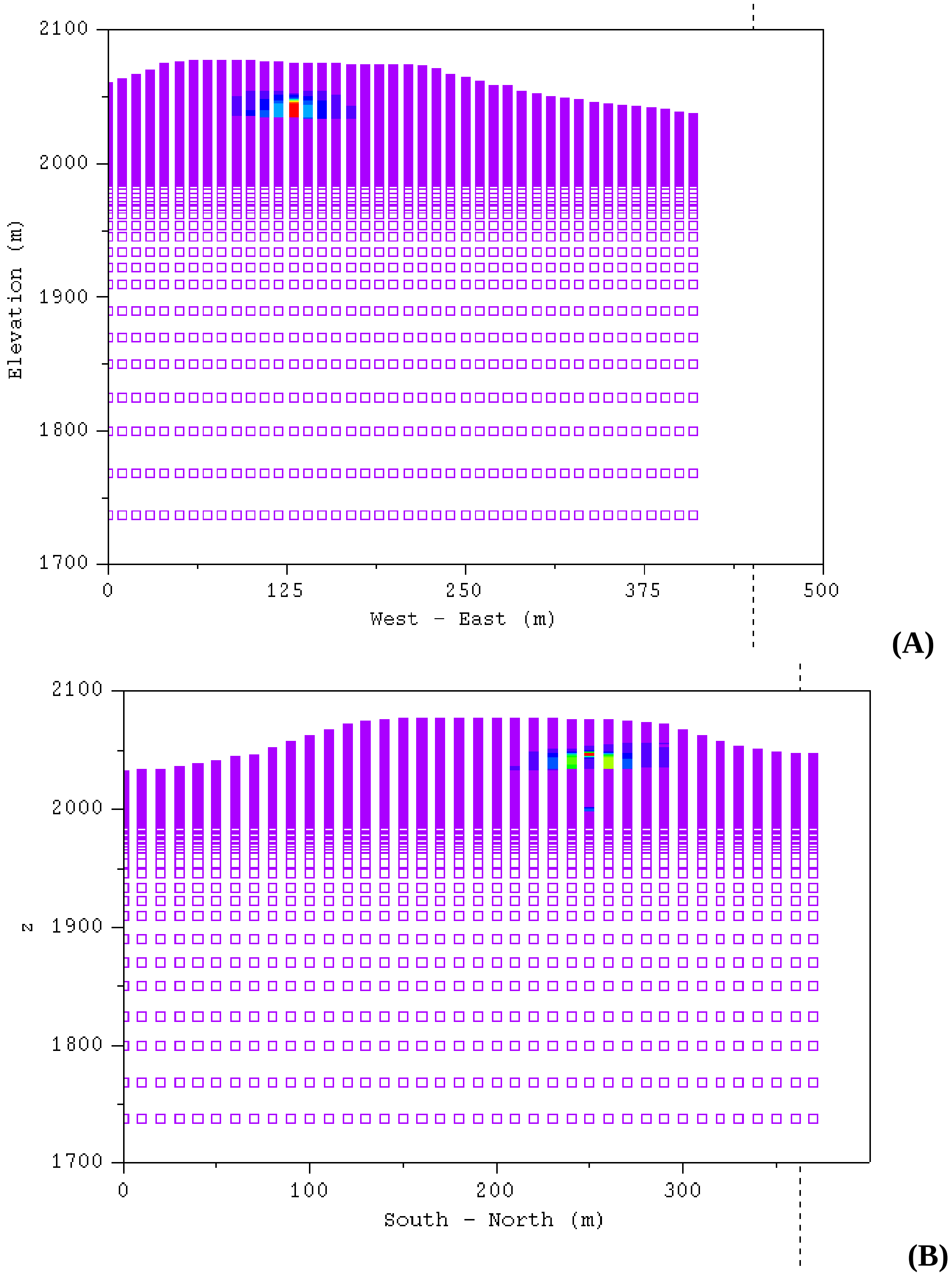

Figure 28 SVE West radius of influence on (A) a N-S slice and (B) an E-W slice, through the mesa at the SVE West location showing a region (blue to red) where the magnitude of the total volume flux is equal to or greater than 4.e-6 m/s. A particle with a volume flux of 4.e-6 m/s in a rock with porosity of 50% will move 40 m in 60 days.

Appendix G

Supporting Information for Cost Estimates

G-1.0 INTRODUCTION

This appendix provides the basis for the cost estimates, summary cost information, assumptions, estimate details, and material and labor pricing data used in developing the cost estimates for the Los Alamos National Laboratory (LANL or the Laboratory) Material Disposal Area (MDA) L corrective measures evaluation (CME). The estimates made are intended to be consistent with U.S. Environmental Protection Agency (EPA) guidance on developing and documenting costs estimated during feasibility studies.

The estimates were developed using the Remedial Action Cost Engineering and Requirements (RACER) System, a parametric cost modeling tool widely used by U.S. Department of Energy (DOE) projects. RACER 2007, Version 9.1.0, was used under license from Earth Tech. The estimates are considered feasibility estimates under DOE Guidance 430.1 with an expected accuracy range of -30% to +80%.

G-1.1 Method of Accomplishment

The estimates are developed by using an approach, wherein a management and operations prime contractor (Los Alamos National Security [LANS]) will invite and award bids for design, construction management, and remedial action (RA) by a yet-to-be-decided procurement strategy, such as fixed-price subcontract.

The same methodology will be used to award long-term operations & maintenance (O&M) contracts in multiyear increments for specific activities. The following outline represents an example work-breakdown structure (WBS) used in generating the cost estimates; XX stands for the alternative number:

WBS XX.1 Capital Project Costs

WBS XX.2 Recurring Operations, Maintenance, and Monitoring Costs

This approach is consistent with the March 1, 2005, Compliance Order on Consent (hereafter, the Consent Order), which requires costs be broken out as capital costs including construction, installation, pilot testing, evaluation, permitting, and reporting of the effectiveness of the alternatives and continuing costs associated with operation, maintaining, monitoring, testing, and reporting on the use and effectiveness of the technology.

As presented in guidance documents, confusion often exists with the terms “direct” and “indirect” costs. Therefore, in this document the term “capital” costs is meant to include planning, design, construction, management related activities, and both labor and professional services for installation of the corrective action. Recurring operations, maintenance, and monitoring costs, including regular annual costs and periodic costs are separated from capital costs. Periodic costs include 5-yr reviews, equipment replacement, and major cover repairs.

Capital project costs were estimated using the standard phase categories available in RACER including

- studies,
- remedial design (RD),
- site preparation, and

- RA.

Recurring project costs were estimated using the standard phase categories available in RACER including

- operations,
- maintenance, and
- monitoring.

G-1.2 Studies

The archaeological studies needed for MDA L have already been completed, and no other studies are anticipated (LANL 1992, 007669). As a result, no study phases were included in the RACER estimates.

G-1.3 RD

Before initiation of the RD, the Architect-Engineer (A/E) will prepare the RD work plan, which will state the objectives of RD, potential problems with the site, etc. The plan shall contain the site description, site history, summary of existing data, technical information on the tasks to be performed, schedule of completion, and project management plan. The RD work plan will be reviewed by a construction manager (CM) and submitted for regulatory approval.

The A/E will develop the RD report, which will include Title I and II design-related activities resulting in an approved Certified for Construction design package to be used as the basis for remedial activities. The RD report will contain a description of the evaluations conducted to select the treatment method, supporting calculations, and process flow diagrams.

The report will also discuss permit requirements, procurement methods and availability concerns, and need for any land acquisition/easement requirements for the site access. Finally, the report will include a preliminary description of O&M activities along with a cost estimate projected on an annual basis. The RD report will be reviewed by the CM and submitted for regulatory approval.

The CM will develop the RA work plan, which will include the constructability review based on the RD report. It will also include the work description of all RA activities assigned to a general contractor and subcontractors, detailed schedule of the activities, overall construction schedule and site requirements of various plans (e.g., general and site-specific safety plan, work plan, rigging plan, quality assurance (QA) plan) to be submitted by relevant contractors. The RA work plan will be reviewed by the A/E and submitted for regulatory approval.

The A/E will provide Title III engineering support services including bid evaluation and inspections during construction, both in the office and the field. The CM will participate in bid evaluation and oversee RA activities during the entire period of construction. The CM will ensure that the work is done to meet all applicable codes, the intent of the RD report, and plans submitted by the contractors. At the end of the RA, the CM will write a final report on the construction activities.

The Laboratory has the overall responsibility for all project management, including bid invitations, bid evaluations, contract award, project control, and contract management. The Laboratory will manage the RA and long-term O&M for the project.

The RD costs were calculated in RACER using the tool's percentage methodology. This method calculates design costs as a percent of the total marked-up costs from all RA phases.

G-1.4 Site Preparation

Site preparation includes mobilization and construction activities to facilitate the RA. Site preparation activities include demolition of asphalt and concrete pads, relocating electrical and fire water utilities, rerouting drainage, installing catch basins, and developing a site readiness health and safety plan. The demolished pavement is assumed to be removed from the site and disposed of as hazardous waste.

G-1.5 RA

Activities associated with the RA alternatives are estimated under the headings of evapotranspiration (ET) cover construction, soil vapor extraction (SVE) installation, excavation with off-site disposal, and monitoring system installation. The ET cover will encompass 1.72 acres. SVE is required for the extraction of the subsurface volatile organic compound (VOC) plume. Completion of this activity is necessary before the final cover can be constructed. Two of the alternatives include excavation activities. It is assumed that all excavated waste will be disposed of as hazardous waste at an off-site facility. Given the nature of the waste material, the full excavation alternative also includes a protective enclosure with granular activated carbon filtering for sorting and waste classification.

The RACER software provides a list of standard assemblies to accomplish many of the activities for the MDA L alternatives. In some cases, however, the RACER standard assemblies were inadequate or not available for anticipated activities. The estimator created custom, or user-defined, assemblies to estimate these tasks.

G-1.6 Operations, Maintenance, and Monitoring

The duration for operation of SVE, maintenance, and monitoring activities for MDA L CME alternatives varied among the alternatives and are summarized in Table G-1.6-1. All alternatives included operation of an SVE system. Because of the low concentration of VOCs present in the subsurface soils, a relatively simple system is anticipated that will be operated 2 months on and 22 months off for a period of 30 yr. At the end of 30 yr, it will be converted to a passive-venting system that does not incur cost.

Maintenance of the ET cover is required for all alternatives, except the full excavation alternative. Maintenance consists of periodic mowing, fertilizing, and reseeding and is assumed for a period of 100 yr.

Long-term monitoring and maintenance activities for each alternative are described.

G-2.0 MATERIAL AND LABOR PRICING

RACER technologies were used to develop the quantities and costs for each component within an alternative. Professional labor rates and appropriate analytical rates were customized to reflect approved costs from the Laboratory resource dictionary. The remainder of the unit costs for material, labor, and equipment are based on the RACER database. In a few cases, special equipment or special facilities costs were obtained either by contacting vendors or consulting data from similar projects.

The basic estimating units generally reflect a normal standard for construction costs. Many special work situations and job conditions can require additional material or labor work hours.

G-2.1 Wage Rates

Professional labor wage rates were customized from the approved Laboratory resource dictionary and mapped to appropriate RACER resources. Table G-2.1-1 lists the rates for each resource and represents fully burdened rates.

G-2.2 Prime and Subcontractor Markups, Overhead, and Profit

Costs presented in this estimate include markups, overhead, and profit. The professional labor rates are fully burdened, and no additional markups are applied to work performed by the prime contractor. Subcontracted work is marked up an additional 44.9% to account for subcontractor markups, overhead, and profit to estimate a contract price more accurately.

G-2.3 Contingency/Risk

No contingency or risk is included for this estimate.

G-3.0 PRESENT VALUE ANALYSIS

The present value analysis method is used to compare different remedial alternatives with different operating time periods on the basis of a single cost figure.

Net present value was calculated according to the following formula:

$$PV_{total} = \sum_{t=1}^{t=n} \frac{1}{(1+i)^t} \cdot C_t$$

Where PV_{total} = present single sum of money

t = specific year

n = final project year

i = the discounted interest rate

C_t = cost in year t in base year dollars

The discount factor, the $1/(1+i)^t$ term from the present value equation, has been calculated for interest rates of 3% and 7.0%.

G-4.0 ALTERNATIVE 1B: IMPROVED NATURAL COVER, SVE, AND MONITORING AND MAINTENANCE

This alternative includes monitoring and maintenance of the site and implementing institutional controls. The highlights of this alternative are as follows:

- RD activities estimated using the RACER percentage method
- Site preparation activities

- RA to install the SVE system
- Maintenance of the existing operational cover
- Operation of the SVE system for 30 yr then converting to passive venting
- Monitoring using time-domain reflectometry (TDR)
- O&M for the cover for 100 yr
- Long-term monitoring, including sediment sampling for 45 yr

Details of the cost estimate are provided in Attachment G-1.

G-4.1 Project (General and WBS-Specific) Assumptions and Basis of Estimate

The following assumptions were generated during the development of the alternatives for various overall site conditions and operating parameters.

G-4.2 Project General Assumptions

The estimate is based on an 8-h work day and 5-d work week. No overtime is included. On-site activities will be conducted under Hazardous Waste Operations and Emergency Response (HAZWOPER) requirements.

The RACER system uses safety levels based on Occupational Safety and Health Administration (OSHA) regulations to account for productivity in different work environments. Safety levels range from level A, the highest level of protection, to level E, which represents minimal hazard. The safety-level selection affects the costs for professional labor, construction labor, and other activities. With the exception of excavation phases, the estimate assumes the safety level = E because the professional labor costs and analytical costs have been customized to reflect the Laboratory resource dictionary fully burdened costs. Alternative 1B does not include any excavation phases.

G-4.3 Project-Specific Assumptions by WBS

WBS 1B.1.1 Study

No studies are necessary for Alternative 1B.

WBS 1B.1.2 RD

The RD activities are estimated using RACER's percentage method. It is assumed that the design costs are represented by 6.5% of the total marked up costs for each RA phase included in the alternative.

WBS 1B.1.3 Site Preparation

Site preparation activities for Alternative 1B include demolishing the asphalt and concrete pads, relocating electrical and fire water utilities, rerouting drainage, installing catch basins, removing the existing fencing, clearing and grubbing the site, and developing a site readiness health and safety plan. The demolished pavement is assumed to be removed from the site and disposed of as hazardous waste.

WBS 1B.1.4 RA Cover

Alternative 1B accounts for grading and reseeding the existing cover. No capping materials are required for this option.

WBS 1B.1.5 RA SVE Construction

The RACER technology for SVE construction was used to estimate this activity. The RACER estimate includes containerizing, loading, transporting, and disposing of secondary solid waste generated during construction (e.g., drill cuttings and personal protective equipment [PPE]). The solid waste is considered Resource Conservation and Recovery Act (RCRA) hazardous and will be disposed of at an off-site disposal facility. Characterization costs have been estimated for hazardous wastes.

WBS 1B.1.6 RA Excavation

No excavation construction activity is required for Alternative 1B.

WBS 1B.1.7 RA Monitoring Installation

Monitoring equipment will consist of a TDR system to monitor runoff, interflow, and seepage. There are 12 TDR locations per acre, with three probes per location (ground level, -3 ft, and -6 ft).

WBS 1B.2.1 SVE System O&M

The SVE system is estimated to operate 2 months on and 22 months off for a period of 30 yr. At the end of 30 yr, the system will be converted to a passive venting system that does not incur costs

WBS 1B.2.2 Cover Maintenance

Site maintenance includes visual inspection, removal of debris and large woody plants, and erosion control for the 1.72 acre site for a period of 100 yr. Periodic fertilization and seeding is assumed, and the site will be mowed every 5 yr.

WBS 1B.2.3 Monitoring

Long-term monitoring includes sediment sampling in two locations twice a year, plus a quality control (QC) sample. Monitoring costs include 5-yr reviews for the 30-yr period.

It is assumed that groundwater monitoring will be conducted by the Laboratory Water Stewardship Project (LWSP). No costs are included in this estimate.

G-4.4 Project Schedule

The project schedules were based on logical sequencing of activities to achieve Consent Order requirements. The duration of each component was determined by the level of effort required for that component and its effect on preceding and succeeding activities. The schedule and appropriate application of discount form the basis for obtaining discount rates and fiscal year summary cost information.

G-5.0 ALTERNATIVE 2B: ENGINEERED ET COVER, SVE, AND MONITORING AND MAINTENANCE

This alternative includes constructing an ET cover, constructing an SVE system, installing a monitoring system, operation and maintenance of the SVE system and ET cover, and monitoring the site. Alternative 2B represents the current baseline, with the exception that the asphalt and concrete pads are assumed to be removed and disposed of at an off-site facility. The highlights of this alternative are as follows:

- RD activities, estimated using the RACER percentage method
- Site preparation activities
- RA to install an ET cover
- RA to install the SVE system
- RA to install a TDR monitoring system
- Maintenance of the 1.72 acre ET cover
- Operation of the SVE system for 30 yr then converting to passive venting
- Monitoring using TDR
- Long-term monitoring, including sediment sampling for 45 yr
- Monitoring and maintenance for the cover for 100 yr
- Site access and administrative controls for 100 yr

Details of the cost estimate are provided as Attachment G-2.

G-5.1 Project (General and WBS-Specific) Assumptions and Basis of Estimate

The following assumptions were generated during the development of the alternatives for various overall site conditions and operating parameters.

G-5.2 Project General Assumptions

The estimate is based on an 8-h work day and 5-d work week. No overtime is included. On-site activities will be conducted under HAZWOPER requirements.

The RACER system uses safety levels based on OSHA regulations to account for productivity in different work environments. Safety levels range from level A, the highest level of protection, to level E, which represents minimal hazard. The safety level selection affects the costs for professional labor, construction labor, and other activities. With the exception of excavation phases, the estimate assumes safety level = E because the professional labor costs and analytical costs have been customized to reflect the Laboratory resource dictionary fully burdened costs. Excavation phases have been set to safety level C. Alternative 2B does not include any excavation phases.

All appropriate site-related plans (e.g., general safety plan, QA plan, waste management plan, work plan, hoisting and rigging plan, and site- specific health and safety plan) will be prepared and submitted by the contractor. All plans will be reviewed and approved as necessary so as not to adversely impact the project schedule.

G-5.3 Project-Specific Assumptions by WBS

WBS 2B.1.1 Study

No studies are necessary for Alternative 2B.

WBS 2B.1.2 RD

The RD activities are estimated using RACER's percentage method. It is assumed that the design costs are represented by 6.5% of the total marked up costs for each RA phase included in the alternative.

WBS 2B.1.3 Site Preparation

Site preparation activities for Alternative 2B include demolishing the asphalt and concrete pads, relocating electrical and fire water utilities, rerouting drainage, installing catch basins, removing the existing fencing, clearing and grubbing the site, and developing a site readiness health and safety plan. The demolished pavement is assumed to be removed from the site and disposed of as hazardous waste.

WBS 2B.1.4 RA Cover

Table G-5.3-1 presents estimated material quantities for Alternative 2B. The ET cover design is a crushed tuff biointrusion landfill cover for the 1.72-acre site. The material quantities for the cover components are documented in the RACER estimate.

WBS 2B.1.5 RA SVE Construction

The RACER technology for SVE construction was used to estimate this activity. The Alternative 2B estimate includes containerizing, loading, transporting, and disposing of secondary solid waste generated during construction (e.g., drill cuttings and PPE). The solid waste is considered RCRA hazardous and will be disposed of at an off-site disposal facility. The RACER system includes characterization costs for RCRA hazardous wastes.

WBS 2B.1.6 RA Excavation

No excavation construction activity is required for Alternative 2B.

WBS 2B.1.7 RA Monitoring Installation

Monitoring equipment will consist of a TDR system to monitor runoff, interflow, and seepage. There are 12 TDR locations per acre, with three probes per location (ground level, -3 ft, and -6 ft).

WBS 2B.2.1 SVE System O&M

The SVE system is estimated to operate 2 months on and 22 months off for a period of 30 yr. At the end of 30 yr, the system will be converted to a passive venting system that does not incur costs.

WBS 2B.2.2 Cover Maintenance

Site maintenance includes visual inspection, removal of debris and large woody plants, and erosion control for the 1.72 acre site for a period of 100 yr. Periodic fertilization and seeding is assumed and the site will be mowed every 5 yr.

WBS 2B.2.3 Monitoring

Long-term monitoring includes sediment sampling in two locations twice a year plus a QC sample. Monitoring costs include 5-yr reviews for the 30-yr period.

It is assumed that groundwater monitoring will be conducted by LWSP. Not costs are included in this estimate.

G-5.4 Project Schedule

The project schedules were based on logical sequencing of activities to achieve Consent Order requirements. The duration of each component was determined by the level of effort required for that component and its effect on preceding and succeeding activities. The schedule and appropriate application of discount form the basis for obtaining discount rates and fiscal year summary cost information.

G-6.0 ALTERNATIVE 5A: ENGINEERED ET COVER, PARTIAL EXCAVATION, SVE, AND MONITORING AND MAINTENANCE

This alternative includes partial excavation of waste, construction of an SVE system, construction of an ET cover, installation of a monitoring system, operations and maintenance of the SVE system, maintenance of the ET cover, and monitoring the site. The highlights of this alternative are as follows:

- RD activities, estimated using the RACER percentage method
- Site preparation activities
- RA to remove approximately 740 yd^3 of waste, transport off-site, disposal, and backfill
- RA to construct an ET cover
- RA to install the SVE system
- RA to install the TDR monitoring system
- Operation of the SVE system for a period of 30 yr then converting to passive venting
- Long-term monitoring, including sediment sampling for 45 yr
- Maintenance of the ET cover for 100 yr
- Site access and administrative controls for 100 yr

Details of the cost estimate are provided as Attachment G-3.

G-6.1 Project (General and WBS-Specific) Assumptions and Basis of Estimate

The following assumptions were generated during the development of the alternatives for various overall site conditions and operating parameters.

G-6.2 Project General Assumptions

The estimate was based on an 8-h work day and 5-d work week. No overtime was included. On-site activities will be conducted under HAZWOPER requirements.

The RACER system uses safety levels that are based on OSHA regulations to account for productivity in different work environments. Safety levels range from level A, the highest level of protection, to level E, which represents minimal hazard. The safety level selection affects the costs for professional labor, construction labor and other activities. With the exception of excavation phases, the estimate assumes safety level = E because the professional labor costs and analytical costs have been customized to reflect the Laboratory resource dictionary fully burdened costs. Excavation phases have been set to safety level C.

All appropriate site-related plans (e.g., general safety plan, QA plan, waste management plan, work plan, hoisting and rigging plan, and site-specific health and safety plan) will be prepared and submitted by the contractor. All plans will be reviewed and approved as necessary so as not to adversely impact the project schedule.

G-6.3 Project-Specific Assumptions by WBS

WBS 5A.1.1 Study

No studies are anticipated.

WBS 5A.1.2 RD

The RD activities are estimated using RACER's percentage method. It is assumed that the design costs are represented by 6.5% of the total marked up costs for each RA phase included in the alternative.

WBS 5A.1.3 Site Preparation

Site preparation activities for Alternative 5A include demolishing the asphalt and concrete pads, relocating electrical and fire water utilities, rerouting drainage, installing catch basins, removing the existing fencing, clearing and grubbing the site, and developing a site readiness health and safety plan. The demolished pavement is assumed to be removed from the site and disposed of as hazardous waste.

WBS 5A.1.4 RA Cover Construction

The ET cover design is a crushed tuff biointrusion landfill cover for the 1.72-acre site. The material quantities for the cover components are documented in the RACER estimate.

WBS 5A.1.5 RA SVE Construction

The RACER technology for SVE construction was used to estimate this activity. The Alternative 5A estimate includes containerizing, loading, transporting, and disposing of secondary solid waste generated during construction (e.g., drill cuttings and PPE). The solid waste is considered RCRA hazardous and will be disposed of at an off-site disposal facility. The RACER system includes characterization costs for hazardous wastes.

WBS 5A.1.6 RA Excavation

Alternative 5A includes the excavation of Impoundments B, C, and D. Excavation of these areas would be accomplished using standard excavation methods. Table G-5.3-1 shows the dimensions, dates of operation, and capacities of the impoundments. The total volume of waste is approximately 740 yd^3.

Waste shipped off-site must meet U.S. Department of Transportation shipping requirements and treatment, storage, and disposal (TSD) specific waste acceptance criteria and permit conditions before shipment and disposal occurs. The hazardous wastes can be disposed of at a number of permitted hazardous waste disposal facilities.

The crushed tuff backfill from Technical Area (TA) 61 will be used for fill trenches. It is assumed that the source of backfill material (vendor-supplied) is within 5 mi of the site.

WBS 5A.1.7 RA Monitoring Installation

Monitoring equipment will consist of a TDR system to monitor runoff, interflow, and seepage. There are 12 TDR locations per acre, with three probes per location (ground level, -3 ft, and -6 ft).

WBS 5A.2.1 SVE System O&M

The SVE system is estimated to operate 2 months out of every 24 for a period of 30 yr. At the end of 30 yr, the system will be converted to a passive venting system that does not incur costs.

WBS 5A.2.2 Cover Maintenance

Site maintenance includes visual inspection, removal of debris and large woody plants, and erosion control for the 1.72 acre site for a period of 100 yr. Periodic fertilization and seeding is assumed, and the site will be mowed every 5 yr.

WBS 5A.2.3 Monitoring

Long-term monitoring includes sediment sampling in two locations twice a year plus a QC sample. Monitoring costs include 5-yr reviews for the 30-yr period.

It is assumed that groundwater monitoring will be conducted by LWSP. Not costs are included in this estimate.

G-6.4 Project Schedule

The project schedules were based on logical sequencing of activities to achieve Consent Order requirements. The duration of each component was determined by the level of effort required for that component and its effect on preceding and succeeding activities. The schedule and appropriate application of discount form the basis for obtaining discount rates and fiscal year summary cost information.

G-7.0 ALTERNATIVE 5B: COMPLETE WASTE-SOURCE EXCAVATION AND BACKFILLING, OFF-SITE DISPOSAL, SVE, AND MONITORING AND MAINTENANCE

This alternative includes full excavation and complete waste removal, construction of an SVE system, installation of a monitoring system, operations and maintenance of the SVE system for a period of 30 yr, and monitoring the site. The highlights of this alternative are as follows:

- RD activities, estimated using the RACER percentage method
- Site preparation activities
- RA to remove waste, transport off-site, disposal, and backfill
- RA to install the SVE system
- RA to install the TDR monitoring system
- Operation of the SVE system for a period of 30 yr then converting to passive venting
- Long-term monitoring including sediment sampling for 45 yr
- Site access and administrative controls for 100 yr

Details of the cost estimate are provided as Attachment G-4.

G-7.1 Project (General and WBS-Specific) Assumptions and Basis of Estimate

The following assumptions were generated during the development of the alternatives for various overall site conditions and operating parameters.

G-7.2 Project General Assumptions

The estimate was based on an 8-h work day and 5-d work week. No overtime was included. On-site activities will be conducted under HAZWOPER requirements.

The RACER system uses safety levels that are based on OSHA regulations to account for productivity in different work environments. Safety levels range from level A, the highest level of protection, to level E, which represents minimal hazard. The safety level selection affects the costs for professional labor, construction labor, and other activities. With the exception of excavation phases, the estimate assumes safety level = E because the professional labor costs and analytical costs have been customized to reflect the Laboratory resource dictionary fully burdened costs. Excavation phases have been set to safety level C.

All appropriate site-related plans (e.g., general safety plan, QA plan, waste management plan, work plan, hoisting and rigging plan, and health and safety plan) will be prepared and submitted by the contractor. All plans will be reviewed and approved as necessary so as not to adversely impact the project schedule.

G-7.3 Project-Specific Assumptions by WBS

WBS 5B.1.1 Study

No studies are anticipated.

WBS 5B.1.2 RD

The RD activities are estimated using RACER's percentage method. It is assumed that the design costs are represented by 6.5% of the total marked up costs for each RA phase included in the alternative.

WBS 5B.1.3 Site Preparation

Site preparation activities for Alternative 5B include demolishing the asphalt and concrete pads, relocating electrical and fire water utilities, rerouting drainage, installing catch basins, removing the existing fencing, clearing and grubbing the site, and developing a site readiness health and safety plan. The demolished pavement is assumed to be removed from the site and disposed of as hazardous waste.

WBS 5B.1.4 RA Site Restoration

No cover construction activity is required for Alternative 5B, but the estimate includes activities to completely restore the site, including additional fill material, grading, and seeding.

WBS 5B.1.5 RA SVE Construction

The RACER technology for SVE construction was used to estimate this activity. The Alternative 5B estimate includes containerizing, loading, transporting, and disposing of secondary solid waste generated during construction (e.g., drill cuttings and PPE). The solid waste is considered RCRA hazardous and will be disposed of at an off-site disposal facility. The RACER system includes characterization costs for hazardous wastes.

WBS 5B.1.6 RA Excavation

For this alternative, excavation of Pit A and Impoundments B, C, and D would be performed using a tiered approach based on hazard level and assessment of specific inventory. Excavation of these areas would be accomplished using standard excavation methods unless potential or real hazards dictated remote handling. The need for remote handling is not expected. A protective enclosure with granular activated carbon filtration is included to sort and classify excavated waste.

Excavation of shafts would be performed using a parallel trench approach. In general, trenching would be conducted parallel to the line of the shafts and would take place in 6-ft increments to expose the line of shafts. Waste will be removed from the shafts at each 6-ft interval and a minimum 1.5:1 side slope would be maintained on the outside edge during excavation operations.

For the area with Shafts 29 through 34, the tuff (overburden) adjacent to the shafts would be excavated to a depth of 65 ft below ground surface (bgs) at the minimum slope of 1.5:1 starting along the north and east edges of the shaft area. Shafts 33 and 34 would be accessed from the northeast to avoid disturbing existing structures that must remain in use. Some shoring of cut slopes may be necessary where the minimum 1.5:1 cannot be met. The complete footprint of the excavation would measure approximately 165 ft × 190 ft at the ground surface. From this footprint, 342 yd^3 of waste would be removed from the shafts. This volume includes the 3-ft-deep concrete plug at the top of each shaft. The remaining volume of the excavation would be approximately 38,560 yd^3 of overburden. Assuming that 10% of this overburden is contaminated and combining that number with the volume of waste, approximately 4210 yd^3 of material would need to be removed from this area. These volumes assume that only the structures located between the shafts on the west and the impoundments on the east may be disturbed.

For the area with Pit A, Impoundments B through D, and Shafts 1 through 28, the excavation depth of the adjacent tuff would vary. All shafts in this area are 60 ft deep; therefore, this depth would be the minimum excavation depth immediately around the shafts. All the impoundments are 10 ft deep and Pit A is 12 ft deep. In excavating the shafts and keeping the minimum 1.5:1 side slope, the majority of the impoundments and pit would also be excavated. Again, shoring may be necessary to avoid the existing structures along the south of the buried waste in this area. The following volumes assume that these facilities cannot be disturbed. The footprint of the excavation would consist of two rectangular areas to avoid the southern facilities. The first would run along the top of the buried waste and measure approximately 400 ft × 140 ft at the ground surface. The second would begin at about Shaft 19 and measure approximately 230 ft × 80 ft. From this footprint, 2530 yd^3 of waste would be removed. This volume includes the 3-ft-deep concrete plug at the top of each shaft. The remaining volume of the excavation would be approximately 88,660 yd^3 of overburden. Assuming that 10% of this overburden is contaminated and combining that number with the volume of waste, approximately 11,400 yd^3 of material would need to be removed from this area.

Waste shipped off-site must meet U.S. Department of Transportation shipping requirements and TSD-specific waste acceptance criteria and permit conditions before shipment and disposal occurs. The hazardous wastes can be disposed of at a number of permitted hazardous waste disposal facilities.

The most likely facility for disposal of nonradiologically contaminated RCRA waste is assumed to be Envirocare. All waste requiring off-site disposal would be transported on Pajarito Road. An estimated maximum 15,610 yd^3 of material would be transported on public roads. Approximately 127,220 yd^3 of overburden material would be removed from the excavation area. The estimated result is approximately 12,722 10-yd^3 truckloads of overburden material. Any of the removed overburden materials characterized as solid, hazardous, mixed waste or low-level waste would be managed according to applicable waste management and disposal requirements. Removed overburden materials determined to be contaminated would be replaced by clean fill. For the purpose of evaluating corrective measure alternatives, it is assumed that 10% of the removed overburden materials will be replaced with clean fill.

The facilities required for the excavation alternatives include a facility for waste sorting, a tent over the excavation for security purposes and protection from the elements, a waste declassification facility, a storage vault, and a storage area for removed materials. Appropriate level B PPE would be used in areas of material sorting, declassifying, characterization, and packaging. The facility would be a tent under positive pressure, and off-gas would be treated because of VOCs in the soil.

The horizontal extent of contamination was assumed to not extend beyond the edges of the shafts and pits. The vertical extent of contaminants was assumed to be bottom of the shafts and pits. The estimated volume of contaminated soil is presented in Table G-7.3-1.

Operations would be conducted within a large metal-framed fabric retrieval enclosure equipped with granular activated carbon filtration.

All excavated waste materials will be characterized and sorted to differentiate waste categories using a facility constructed for that purpose. It is assumed that waste characterization and waste profiling are required. The weight of the containerized soil is 100 lb/ft^3. A swell factor of 25% is applied to the excavated soil to determine the loose volume being containerized.

The crushed tuff backfill from TA-61 will be used for fill trenches. It is assumed that the source of backfill material (vendor-supplied) is within 5 mi of the site.

WBS 5B.1.7 RA Monitoring Installation

Monitoring equipment will consist of a TDR system to monitor runoff, interflow, and seepage. There are 12 TDR locations per acre, with three probes per location (ground level, -3 ft, and -6 ft).

WBS 5B.2.1 SVE System Operations and Maintenance

The SVE system is estimated to operate 2 months on and 22 months off for a period of 30 yr. At the end of 30 yr, the system will be converted to a passive venting system that does not incur costs.

WBS 5B.2.2 Cover Maintenance

No maintenance activities are required under the full excavation alternative.

WBS 5D.2.3 Monitoring

Long-term monitoring includes sediment sampling in two locations twice a year plus a QC sample. Monitoring costs include 5-yr reviews for the 30-yr period.

It is assumed that groundwater monitoring will be conducted by the LWSP. Not costs are included in this estimate.

G-7.4 Project Schedule

The project schedules were based on logical sequencing of activities to achieve Consent Order requirements. The duration of each component was determined by the level of effort required for that component and its effect on preceding and succeeding activities. The schedule and appropriate application of discount form the basis for obtaining discount rates and fiscal year summary cost information.

G-8.0 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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), May 1992. "RFI Work Plan for Operable Unit 1148," Los Alamos National Laboratory document LA-UR-92-855, Los Alamos, New Mexico. (LANL 1992, 007669)

Stauffer, P.H., and J.K. Hopkins, April 2004. "Vapor-Phase Transport Beneath MDA-L: Drum Failure Simulations with Implications for Site Remediation," Los Alamos National Laboratory, Los Alamos, New Mexico. (Stauffer and Hopkins 2004, 098533)

Table G-1.6-1
Duration for Operation of SVE, Maintenance, and Monitoring for MDA L CME Alternatives

Alternative	Description	SVE Duration[a,b] (yr)	Monitoring and Maintenance Period[c] (yr)	DOE Active Institutional Control Period (yr)
1B	Improved Natural Cover, SVE, Monitoring and Maintenance,	45	Active and passive SVE: 45 ET Cover: 100	100
2B	Engineered Alternative ET Cover, SVE, Monitoring and Maintenance	45	Active and passive SVE: 45 ET Cover: 100	100
5A	Partial Waste Source Excavation, Off-site Disposal, ET Cover Construction, SVE, Monitoring and Maintenance	45	Active and passive SVE: 45 ET Cover: 100	100
5B	Complete Waste Source Excavation, Waste Treatment, Off-site Disposal, SVE, Monitoring and Maintenance	30[d]	SVE, Monitoring: 30	100

[a] Based on Stauffer and Hopkins (2004, 098533) waste drum rupture rate. Duration is 30 yr of active SVE operation and 15 yr of passive SVE operation.

[b] After four consecutive SVE cycles where no rebound of contaminants is observed, the Laboratory will engage in negotiations with NMED to discontinue SVE operations.

[c] Although RCRA postclosure-care period is 30 yr, these periods include SVE duration and ET cover monitoring.

[d] Based on the RCRA postclosure-care period because for this alternative the source waste is completely removed.

Table G-2.1-1
Professional Wage Rates

Assembly	Description	Labor Rate $/hr
33220101	Senior Project Manager	188.10
33220102	Project Manager	159.06
33220103	Office Manager	188.10
33220104	Senior Staff Engineer	173.14
33220105	Project Engineer	159.06
33220106	Staff Engineer	144.55
33220107	Senior Scientist	173.14
33220108	Project Scientist	159.06
33220109	Staff Scientist	144.55
33220110	QA/QC Officer	144.55
33220111	Certified Industrial Hygienist	126.50
33220112	Field Technician	117.84
33220113	Secretarial/Administrative	67.48
33220114	Word Processing/Clerical	63.15
33220115	Draftsman/CADD	32.88
33220119	Health and Safety Officer	131.57

Table G-5.3-1
Dimensions, Dates of Operation, and Capacities of Surface Impoundments at MDA L

Impoundment	Dimensions (ft) (Width × Length × Depth)	Period of Use	Months Used	Total Capacity (ft^3)
B	60 × 18 × 10	01/1979–06/1985	78	7560
C	35 × 12 × 10	Believed to be before 1980; exact dates not known.	18	2940
D	75 × 18 × 10	1972–1984	156	9450

Table G-7.3-1
Estimate Volume of Source Waste in MDA L

	Alt 5B Excavation Plan Grouping	Alt 5B Estimated Excavation Plan Group Material Overburden Volume (yd^3)	Alt 5B Estimated Excavation Plan Group Waste Volume (yd^3)*
Shafts 1–28, Pit A, and Impoundments B, C, and D	Group 1	88,660	11,400
Shafts 29–34	Group 2	38,560	4210

*Waste volume includes 10% of contaminated overburden.

Attachment G-1

Detailed Cost Estimate for Alternative 1B
LA-CP-08-0037
(on CD included with this document)

Attachment G-2

Detailed Cost Estimate for Alternative 2B
LA-CP-08-0037
(on CD included with this document)

Attachment G-3

Detailed Cost Estimate for Alternative 5A
LA-CP-08-0037
(on CD included with this document)

Attachment G-4

Detailed Cost Estimate for Alternative 5B
LA-CP-08-0037
(on CD included with this document)

Appendix H

Proposed Long-Term Subsurface Vapor Monitoring Plan for Material Disposal Area L at Technical Area 54

H-1.0 INTRODUCTION

The following plan describes proposed subsurface monitoring activities and the frequency at which they will be conducted within the vadose zone in and around Material Disposal Area (MDA) L at Los Alamos National Laboratory (the Laboratory). The objective of the monitoring is to evaluate trends over time in volatile organic compound (VOC) concentrations.

H-2.0 HISTORIC DATA REVIEW

Vadose-zone monitoring has been ongoing at MDA L since the mid-1980s. The pore-gas monitoring data reported in Appendix E of the approved investigation report (LANL 2006, 091888; NMED 2007, 098409) indicate that 1,1,1 trichloroethane (TCA) is the primary VOC detected, followed consistently in quantity by trichloroethene (TCE).

As reported in the MDA L periodic monitoring report (LANL 2006, 093910), the VOC plume (as represented by TCA screening data) has been in a near steady state since the first quarter of fiscal year (FY) 1999. Spatial analysis of the pore-gas monitoring data indicates two unique sources, identified as Shaft Field 1 (Shafts 1 through 28) and Shaft Field 2 (Shafts 29 through 34) and referred to as the northwest and the southeast source areas, respectively. Both source areas are dominated by the presence of TCA, but the relative compositions and the concentrations of lesser compounds differ. Based on the screening results from quarterly sampling, concentrations remained relatively constant at depth.

Modeling results for the MDA L vapor plume have been presented in the technical report “Subsurface Vapor-Phase Transport of TCA at MDA L: Model Predictions” (Stauffer et al. 2005, 090537). Based on the observed site data and numerical modeling results, Stauffer et al. concluded the vapor plume at MDA L is currently at a near steady state, both in concentration and size, and the vapor plume is not expected to migrate significantly closer to White Rock or to the regional aquifer. In addition, because no evidence of liquid transport was found, it is not anticipated that VOCs will migrate as liquids to the regional aquifer. The plume size is predicted to decrease when the contaminant source is depleted (probably before 2060), based on estimates of a conservative TCA source. Stauffer et al. (2000, 069794) concluded the numerical model would provide a useful tool to explore the effects of potential corrective measures (e.g., passive venting or soil vapor extraction).

The existing pore-gas monitoring program has been successful in defining the nature and extent of the vapor-phase VOC plume at MDA L as indicated by the agreement between data collected from the 2005 borehole sampling and that of past quarterly monitoring. The numerical model of the plume results indicates that annual pore-gas monitoring will be sufficient to identify significant changes in the plume. (Stauffer et al. 2000, 069794). Quarterly pore-gas monitoring is proposed in four existing boreholes to detect possible increasing concentrations resulting from contemporaneous drum failure.

H-3.0 MONITORING METHODS

The method for monitoring pore gas at MDA L includes field screening with a Brüel and Kjær (B&K) multigas analyzer from all available ports, followed by collection of SUMMA canisters (Environmental Programs [EP] Directorate Standard Operating Procedure [SOP] 6.31, Sampling Sub-Atmospheric Air) from prescribed locations for off-site laboratory analysis. The frequency and locations to be sampled are found in section H-4.0, Monitoring Distribution and Frequency. Field screening of pore gas at MDA L includes measuring carbon dioxide and oxygen percentages, static subsurface pressure, and organic vapors.

Monitoring of pore gas at MDA L will be conducted in accordance with the current version of SOP-6.31, Sampling Sub-Atmospheric Air*.* In accordance with this procedure, field screening will be performed before analytical samples are collected. Each port will be purged and monitored with a Landtec GEM2000 monitor or equivalent until carbon dioxide and oxygen levels have stabilized at concentrations representative of subsurface pore-gas conditions and are consistent with previously recorded measurements. The vapor will then be screened for VOCs using a B&K multigas monitor, Type 1302, which measures four VOCs: TCA, TCE, tetrarchloroethene, and Freon 11. The B&K also measures carbon dioxide concentration down to a detection limit of 0.01%. Upon completion of purge and field screening, vapor samples will be collected using SUMMA canisters to be analyzed for VOCs by U.S. Environmental Protection Agency (EPA) Method TO-15. Field screening is done at all available ports while SUMMA canisters were collected only at assigned boreholes and ports. SUMMA canister samples will be collected from recently installed deep ports completed in the Otowi Member. The New Mexico Environment Department (NMED) required the installation of deep ports in the Otowi Member to monitor potential movement to groundwater. Pressure measurements will be performed in selected ports and boreholes to determine the change from static pressure.

During each sampling event, three types of field quality assurance (QA) samples will be collected and analyzed: a duplicate sample, an equipment blank of zero-grade air (a common term for air certified to be free from VOC contamination) or nitrogen drawn through the sampling apparatus in the working area, and a performance evaluation sample/calibration gas sample taken from a tank of a certified gas mixture. Analytical laboratory QA for EPA Method TO-15 includes internal standards, surrogates, replicates, blanks, laboratory control samples, and reference standards.

H-4.0 MONITORING DISTRIBUTION AND FREQUENCY

Since 1997, quarterly monitoring data and numerical modeling indicate vapor concentrations to be steady. However, it is unlikely the entire source of VOCs at MDA L is fully released in the plume outside the disposal units; for example, the shafts of MDA L may contain intact buried 55-gal. drums of liquid organic compounds. Therefore, a monitoring plan has been developed to identify new releases from the source regions and, to a lesser degree, confirm the characteristics of the plume that were defined by previous sampling in the lower-concentration fringes of the plume.

All pore-gas monitoring locations will be monitored annually by field measurement of percent carbon dioxide, percent oxygen, and organic vapors using the methods described in section H-3.0. These data will be compared to the historic record to confirm whether the plume remains in a steady state.

Synoptic static pressure measurements will be conducted before each start-up, quarterly during operation, and the day after shutdown. These measurements will be performed in selected boreholes and ports and will be used to evaluated the radius of influence and provide calibration data for numerical modeling of the SVE system.

To identify any new release of VOCs from the disposal units, vapor samples will be collected quarterly using a B&K multigas monitor from the four boreholes installed during the Phase I Resource Conservation and Recovery Act facility investigation. The field screening will be used to test VOC concentrations for four primary contaminants that are present at 10 different depths using a FLUTe, or equivalent, multilevel sampling locations in the borehole. Four SUMMA canisters will be used to verify concentrations at the four highest sampling locations. Samples will be collected daily during operation of the SVE system during the 2-months-on and 22-months-off intermittent operation.

Annual pore-gas monitoring data will be reported in a periodic monitoring report according to the requirements of Section XI.D of the March 1, 2005, Compliance Order on Consent. This report will include recommendations for future monitoring and remedial actions based on data results and trends.

H-5.0 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; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; 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 2006. "Investigation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54, Revision 1," Los Alamos National Laboratory document LA-UR-06-1564, Los Alamos, New Mexico. (LANL 2006, 091888)

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NMED (New Mexico Environment Department), July 18, 2007. "Approval with Direction for the 'Investigation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54' and 'Addendum to the Investigation Report for Material Disposal Area L, Solid Waste Management Unit 54-006, at Technical Area 54'," 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 2007, 098409)

Stauffer, P.H., K.H. Birdsell, M. Witkowski, T. Cherry, and J. Hopkins, March 2000. "Subsurface Vapor-Phase Transport of TCA and MDA L: Model Predictions," Los Alamos National Laboratory document LA-UR-00-2080, Los Alamos, New Mexico. (Stauffer et al. 2000, 069794)

Stauffer, P.H., K.H. Birdsell, M.S. Witkowski, and J.K. Hopkins, 2005. "Vadose Zone Transport of 1,1,1-Trichloroethane: Conceptual Model Validation through Numerical Simulation," *Vadose Zone Journal,* Vol. 4, pp. 760-773. (Stauffer et al. 2005, 090537)