Basic Remediation
COMPANY

Remedial Alternative Study
Slit Trench Area

July 2007

I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances. I hereby certify that all laboratory analytical data was generated by a laboratory certified by the NDEP for each constituent and media presented herein.

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REMEDIAL ALTERNATIVE STUDY

FOR THE SLIT TRENCH AREA

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1. Introduction

This Remedial Alternatives Study (RAS) presents an evaluation of options for remediation of contaminated waste soils in the area known as the Slit Trench Area (STA), located in the proposed Corrective Action Management Unit (CAMU) area of the BMI Common Areas (the Site). Also presented are a summary of several additional remedial actions planned for the CAMU area. Collectively, the selected STA remedy and the other remedial actions will constitute a package of actions that will meet applicable regulatory criteria and goals. Previously, the remedial actions associated with the Eastside Area of the BMI Common Areas were the subject of an NDEP Record of Decision (ROD) in November 2001. The remedial actions for the November 2001 ROD are presented in the *Corrective Action Plan for the Basic Remediation Company (BRC) Common Areas Remediation Project* (BRC, September 2006). One of the aspects of the November 2001 ROD is the placement of the CAMU on the STA. The CAMU has been designed to meet the regulatory requirements for a CAMU as referred to in 40 CFR 264.552. The CAMU elements are presented in the *Revised Remedial Action Plan (RAP) Permit Application for Corrective Action Management Unit (CAMU), Henderson, Nevada* (BRC, March 2006). The remedial actions constituting the baseline condition of work to be completed for the STA include

- Placement of the CAMU including a liner and leachate collection system over the entire CAMU area, including over the STA,
- Placement of waste onto the CAMU liner,
- Placement of a cover over the disposed waste in the CAMU,
- Institutional controls for the entire CAMU area including the STA,
- Upgradient and downgradient groundwater monitoring across the CAMU area (per a separate work plan to be provided to the NDEP) and potential treatment, as required, based on this monitoring, and

- Placement of RCRA Subtitle C equivalent covers over the North and South Landfill Lobes of the existing BMI landfills in the CAMU area.

In order to keep this document focused and to avoid repetition, references to available soil, soil gas, and groundwater chemical analytic data for the CAMU area including the STA wastes themselves are not discussed in this document. These data are described in the CAMU Conceptual Site Model (CAMU CSM) report submitted to the NDEP in February 2007; (conditionally approved by the NDEP on April 12, 2007 and supplemental information provided by BRC on June 11, 2007). This RAS will focus on the feasibility of potential remedial alternatives for waste materials that are known to have been located in the slit trenches themselves. Based on the comparative analysis provided, BRC will recommend one of the options for remediation of the slit trench wastes. Once this option (or any other option) is approved by the NDEP, along with the package of complimentary remedial actions, it will collectively constitute the selected remedial action for the STA.

1.1 Site Location and Description

The CAMU Area is located within the city limits of Henderson, Clark County, Nevada, as shown on Figure 1-1. It is located within the boundaries of property operated by BRC, in an area formerly designated as the Clark County Industrial Plant Area, and is bordered on all sides by former and present industrial facilities (Figure 1-2). A smaller-scale aerial photograph showing the Site is presented on Figure 1-3. The CAMU Area has been subdivided into the following subareas (Figure 1-4 from the BRC CAMU CSM report):

1. The northern lobe of the BRC Closed Landfill (the "North Landfill Lobe")
2. The southern lobe of the BRC Closed Landfill (the "South Landfill Lobe")
3. The STA
4. The northern lobe of the Borrow Area (the "North Borrow Pit Lobe")
5. The southern lobe of the Borrow Area (the "South Borrow Pit Lobe")
6. The western portion of the Western Ditch (the "Western W. Ditch Area")

7. The eastern portion of the Western Ditch, including the piece of land extending north of the Western Ditch to the southern toe of the South Landfill Lobe, and the land extending south to the Pioneer property boundary (the "Eastern W. Ditch Area")

The area of interest for this RAS is the STA. This 27.7-acre area is bounded by the North Landfill Lobe and South Landfill Lobe at the north and south, respectively. The STA consists of a series of linear trenches approximately 20 feet in width and roughly 25-32 feet deep, into which a variety of wastes were deposited sometime between 1968 through 1980. Remedial actions are under evaluation for these wastes, to potentially be conducted prior to the placement of the CAMU on the STA. The trenches appear to have been dug on an ad-hoc basis since BRC has not been able to find any plans or engineering drawings related to their construction; an exhaustive review of documents was conducted at BRC as well as at the firms responsible for construction of the trenches.

Figure 1-4 shows the trenches and BRC's designation of the individual trenches. The trenches were backfilled after waste deposition with the soil excavated to create them. The STA has remained in its present form since 1980. Since 2000, BRC has evaluated the slit trenches themselves using non-intrusive geophysical techniques to delineate them, followed by several intrusive investigations in order to determine the nature of the wastes in the trenches. Based on the collected data, BRC has affirmed that the wastes in the trenches are heterogeneous. Additional discussion of trench wastes is provided in Section 3.

Although the two closed BRC landfill lobes are not the topic of this study, proximity to these adjacent areas needs to be considered as part of the evaluation process for potential remedial alternatives for wastes in the STA. One of the southern-most of the slit trenches (SLT-1E) is located in close proximity to the CAMU-area boundary. The trench to the west (SLT-1W) is located so close to the South Landfill Lobe that wastes from SLT-1W may have commingled with wastes from the BMI landfill. While there appears to be reasonable distance between the northern trenches and the North Landfill Lobe, similar commingling of the trench and landfill wastes, while unlikely, cannot be ruled out.

In addition, upgradient groundwater flowing onto the CAMU Area and below the STA has been impacted by historical off-site activities on neighboring properties. Because of the similar

wastes disposed upgradient of the Site and the STA, most chemicals dissolved in groundwater upgradient of the Site were also detected in soils in the STA.

A more detailed description of these areas is presented in the BRC CAMU CSM report.

1.2 Project History

This RAS is being provided as part of the overall Closure of the BMI Common Areas as defined in the *Nevada Division of Environmental Protection Settlement Agreement and Administrative Order on Consent: BMI Common Areas, Phase 3* (AOC3; NDEP, 2006).

1.3 RAS Process

The RAS characterizes the nature and extent of risks posed by chemical occurrence in site soils and evaluates potential remedial options to address these risks. The objective of the RAS is to gather sufficient information to support an informed risk management decision regarding which remedy appears to be most appropriate for the STA. Remedial alternatives will be developed and evaluated with regard to criteria intended to be consistent with the federal statutory evaluation criteria defined in the National Contingency Plan (NCP) for conducting feasibility studies under CERCLA (U.S. EPA, 1988). The development and screening of the various alternatives follows the general approach provided in Chapter 4 of the EPA guidance. As noted, this RAS also relies on data previously provided in the BRC CAMU CSM report.

This RAS includes the following components:

- Summary of geology and hydrogeology (provided in the BRC CAMU CSM report)
- Summary of previous investigations (provided in the BRC CAMU CSM report)
- Screening and evaluation of soil, soil gas and groundwater data (provided in the BRC CAMU CSM report)
- Identification of applicable, relevant, and appropriate requirements (ARARs)
- Development of a remedial action objectives (RAOs)

- Development of general response actions (GRAs)
- Identification of remedial technologies
- Development of remedial alternatives considered in the RAS
- Screening of performance of each of the remedial alternatives
- Identification of a recommended remedial alternative for the STA (to be completed upon receipt of NDEP and community input regarding the acceptability of the candidate alternatives)

1.4 Document Organization

This RAS report is organized into six sections. After this introductory section, the following sections are included:

- Section 2. Physical Characteristics
- Section 3. Chemical Occurrence in Site Soils and Groundwater – mainly referencing discussions in the BRC CAMU CSM report.
- Section 4. Development of Remedial Action Alternatives
- Section 5. Identification of Remedial Alternatives; and
- Section 6. Screening of Remedial Alternatives

2. Physical Characteristics

This section briefly summarizes physical characteristics of the Site and chemical occurrence trends in soil and groundwater based on the results of previous site-specific investigations and regional knowledge. A more detailed presentation of this information is included in Section 2 of the BRC CAMU CSM report.

2.1 Topography and Climate

Las Vegas Valley is a northwest-southeast trending, rectangular-shaped alluvial valley that extends 50 miles from Indian Springs to the Las Vegas Wash. Near the BRC CAMU area, the ground surface slopes gently to the northeast toward the Las Vegas Wash at a gradient of 0.020. At the upgradient (southern) property boundary, the ground surface elevation is approximately 1,875 feet above mean sea level (ft msl); at the northern property boundary, the ground surface elevation is approximately 1,680 ft msl.

The Las Vegas Valley is one of the driest and warmest areas in the nation. The climate consists of hot summers, cool winters, and wide fluctuations in annual rainfall. Evaporation is high in the Las Vegas Valley. Measurements of evaporation at Boulder City and Lake Mead indicate an annual loss of about 6.5 feet of water, three-fourths of which occurs during the six warmer months.

2.2 Geology

The CAMU Site is located in the southeastern portion of the northwest-southeast trending Las Vegas Valley, one of several basins within the Basin and Range Province. The Spring Mountains bound Las Vegas Valley to the southwest, and several smaller, north-trending ranges bound the valley to the northwest. Near the CAMU Site, the valley is bounded by the McCullough Range to the south, the Black Hills to the southeast, and the River Mountains to the east. The Sunrise and Frenchman Mountains are present north of the CAMU Site.

Valley fill in the vicinity of the CAMU Site consists of the Tertiary Muddy Creek Formation (TMCf) and the overlying Quaternary alluvium (Qal). TMCf refers to the older basin fill deposits

in southern Nevada that accumulated during the formation of the Basin and Range Province in alluvial, fluvial, and acustrine environments associated with internally drained valleys (Bohannon, 1984). The TMCf is reported to comprise over 2,000 feet of stratigraphy ranging from gravel- to clay-sized particles and evaporite deposits, depending on the depositional environment. Figure 2-1 shows the location of cross sections (Figures 2-2 and 2-3) that illustrate the stratigraphic relationships that exist at the CAMU Site. These cross sections, which were prepared using logs of wells and borings that have been advanced at the CAMU Site over two decades of environmental investigation, reveal the irregular nature of the contact between the Qal and the TMCf.

2.3 Hydrogeology

Groundwater at and near the BMI Complex is typically first encountered in the lower part of the Qal, and occurs under unconfined water table conditions. Based on measurements made in the spring of 2005, depth to first encountered water in the Qal in wells bordering the perimeter of the CAMU range from 32.5 ft bgs (monitoring well AA-BW-06) on the northern perimeter of the CAMU to 59.5 ft bgs (monitoring well AA-BW-12) on southern perimeter of the CAMU. The direction of the groundwater flow in this alluvial aquifer (Qa) is generally to the north, toward the Las Vegas Wash (Figure 2-4). The average horizontal hydraulic gradient, as measured in the spring 2005 (BRC and MWH, 2005), ranges from about 0.02 to 0.04 north, toward the Las Vegas Wash (Figure 2-4).

Beneath the Qal, water-producing zones in the Muddy Creek Formation occur as saturated silty sand, sand, and/or gravel stringers that range in thickness from inches to only a few feet (MWH and DBS&A, 2004). Boring data indicate that these layers are not laterally contiguous, and are surrounded by low-permeability silts and clays. Groundwater in these layers is partially confined by the silt and clay units of the TMCf. An upward vertical hydraulic gradient exists from the deeper water-bearing zones of the Muddy Creek Formation to the Quaternary Alluvium. The upward vertical hydraulic gradient is expected since the study area is located within a regional groundwater discharge area.

Natural discharge of the alluvial aquifer groundwater in the Site vicinity is via evapotranspiration, seepage to the Las Vegas Wash, and spring flow to surface streams. One of the major

proximal elements of groundwater discharge near the Site is a line of remediation extraction wells located north and downgradient of the STA. The groundwater remediation system is referred to as the Groundwater Treatment System (GWTS), and consists of 13 extraction wells installed along a 1,800-foot-long line perpendicular to groundwater flow (Figure 2-4). The GWTS is operated by the upgradient companies – Pioneer Americas LLC (Pioneer) Stauffer Management Company, LLC (Stauffer), Syngenta Crop Protection, Inc. (Syngenta), and Montrose Chemical Corporation of California, Inc. (Montrose). The term PSSM will be used to collectively refer to these four companies or their facilities hereafter.

2.4 Summary of Conceptual Site Model

The BRC CAMU CSM report summarizes the physical setting, use history, release mechanisms, and fate and transport for the CAMU area, which incorporates the STA. The BRC CAMU CSM report provides a much more detailed discussion of these site characteristics. Information on the use history, release mechanisms, and fate and transport of chemicals in the CAMU area is provided in a series of four illustrations (Figures 2-5 through 2-8) that summarize conditions from 1943 through the future. Each of these figures is described below.

Figure 2-5 presents conditions that existed circa 1943. During this time period, the area defined as the proposed CAMU Site was minimally developed. Unlined wastewater treatment ponds that received effluent from BMI's World War II era operations to the south were located along both the northern and later the southern boundaries of the CAMU Site. After World War II era operations, these ponds received wastewater from Stauffer's operations. Aerial photographs and historical data reveal that process effluents were routed from caustic-chlorine operations through the Western Drainage Ditch, a natural unlined surface channel that runs along the southern boundary of the North Borrow Pit Lobe and South Landfill Lobe. This practice lasted from 1946 to 1970 and explains the elevated contaminant concentrations both in the surface and subsurface soils. Effluent disposed of in the Western Drainage Ditch eventually flowed north to the Lower Ponds. Impacts to the CAMU Site soils and groundwater were primarily a result of infiltration of contaminants from the Trade Effluent Ponds and Western Drainage Ditch and resultant chemical migration in the saturated sediments of the Qal water-bearing zone beneath the CAMU Site. Dissolved-phase contamination from other upgradient sources may have been migrating in the saturated Qal, though the timing of all of these releases is uncertain.

Figure 2-6 presents conditions that existed circa 1976. The slit trenches were in operation from approximately 1970 through 1980. Little was recorded about the wastes placed in these trenches other than the observations of materials encountered during the Slit Trench Investigation of 2005 and 2006 (BRC and MWH, 2005). Contaminant migration from these trenches to the underlying groundwater occurred in both the vapor phase and the aqueous phase as a result of the infiltration of precipitation. The dissolved-phase plume then migrated to the north within the Qal. During this time, landfill operations to the north of the slit trenches were ongoing, with subsurface chemical migration in both the vapor and dissolved phases occurring in a similar manner as in the STA. Impacts to the Qal upgradient of the CAMU Site continued as a result of infiltration from the off-site impoundments and other activities within the industrial area to the south of the CAMU Site. Surficial runoff during storm events also had the potential to impact surface soils. Dissolved-phase contamination from other upgradient sources was also migrating in the saturated Qal, though the timing of these releases is uncertain.

Figure 2-7 presents conditions that existed in 2005. The use of the slit trenches has long since ceased, the STA is covered with backfill, and BMI landfills to the north and south of the STA have been closed and capped. Contaminant migration from the slit trenches potentially continues in both the vapor, aqueous, and non-aqueous phases. Dissolved-phase contamination from other upgradient sources discussed in Section 3.2 is also migrating in the Qal groundwater. Subsurface data and historical information for the CAMU Site and from upgradient properties indicate that significant releases of chemicals to the subsurface occurred at various upgradient locations.

Figure 2-8 is a schematic of the CSM that depicts site conditions once the CAMU is in place. Design specifications of the landfill are discussed separately in the Remedial Action Plan (RAP), the permit application for the CAMU. BRC recently presented a revised RAP to the NDEP. The CAMU will be constructed with an impermeable cap and liner system. Subsequent to completion of the CAMU, infiltration of water through locally impacted materials (i.e., beneath the CAMU) will be minimized, and the generation of leachate will be negligible due to the nature of the “dry” soils and sediments to be interred in the CAMU. Any generated leachate will be captured within the engineered leachate collection layer beneath the CAMU and will not impact the Aa or the Qal.

3. Chemical Occurrence in Site Soils and Groundwater

The primary focus of this section is on conditions in the STA, where wastes were historically disposed. A broader discussion on the STA, as well as the entire CAMU area and upgradient and downgradient conditions is provided in the BRC CAMU CSM report.

3.1 STA Investigations

Several investigations have been performed in the STA. The first of these investigations was performed in 2000, and consisted of the collection of geophysical data followed by soil, soil gas, and groundwater sample collection for laboratory analysis. The second investigation was performed in 2005, when additional soil and soil gas samples were collected for laboratory analysis. Groundwater wells were also installed along the Site perimeter and sampled during the 2005 investigation. Subsequently, in August 2006 focused investigations were conducted to address localized impacts of selected chemicals noted in the 2005 investigation. These data were collected as part of a “step-out” sampling program based on elevated sample concentrations detected in the 2005 investigation. In February 2007 several additional samples were collected and analyzed specifically for PCB congeners. These last February 2007 data were not available at the time the BRC CAMU CSM report was prepared. However, they have since been reviewed by BRC and the findings of the CSM do not change as a result of these new focused data. Groundwater analytical data are discussed in Section 3.2.

Results of field investigations are based on the review of the following documents:

- Geophysical Investigation Report, BRC Landfill (Spectrum, 2000)
- Implementation of Sampling Plan for the Slit Trench Site Located in Henderson, Nevada (GES, 2000a)
- Implementation of Supplemental Sampling Plan for the Western Ditch and Slit Trench Site, Located in Henderson, Nevada (GES, 2000b)

- BRC CAMU Area - 2005 Soil, Soil Vapor, Groundwater, and Slit Trench Investigation Report (BRC and MWH, 2005)

As noted earlier, the BRC CAMU CSM report contains an in-depth discussion of the data collected in these prior investigations as well as that collected in the 2006 step-out sampling investigation.

Both a geophysical and a soil/soil gas/groundwater investigation were performed in 2000. Spectrum Geophysical (Spectrum) conducted the first investigation to delineate the lateral and vertical extent of buried waste trenches and to identify buried objects that might potentially interfere with the planned sample collection phase of the investigation. Five independent pieces of field instrumentation were used to characterize the following:

1. The alignment and lateral boundaries of the waste trenches by inducing an electromagnetic field (EM-31)

2. The depths of trenches as well as lateral changes with depth within each trench by passing an electrical current through the soil (testing resistivity)

3. The delineation of buried metallic objects by generating short-pulse electromagnetic energy to induce a magnetic field (EM-61)

4. The occurrence of deeply (greater than 6 meters) buried drum-sized metallic objects or clusters of buried metallic debris by inducing an electromagnetic field focused at a maximum depth of 15 meters (EM-34)

5. The occurrence of surface to near-surface metallic material at proposed drilling locations by inducing a magnetic field in the metallic material with a radio-frequency source signal (Fischer M-Scope)

Based on the aerial photograph review, and supported by the geophysical investigation conducted in 2000, there appear to be eight or nine slit trenches that were excavated along east-west trends, with the trenches ranging in length from approximately 300 to 1,100 feet

(Figure 1-4). The geophysical investigation conducted in 2000 determined the width of the trenches to be around 20 feet (Spectrum, 2000). However, this geophysical survey could not conclusively delineate trench boundaries where the excavations were very closely spaced; thus some trenches could be narrower. Field observations during drilling operations conducted in 2005 indicate that the trenches vary in depth from approximately 25 to 32 feet (BRC and MWH, 2005).

Two successive phases of sampling were performed by GES in 2000 in accordance with NDEP-approved work plans. The first of these was during May 2000, when six boreholes (B-1 through B-6) were advanced in the vicinity of the slit trenches using a hollow-stem auger rig (Figure 1-4). Boreholes were advanced to depths of 25 ft bgs, and soil samples were collected from each boring at depths of approximately 0 (surface), 10, 15, 20, and 25 ft bgs. In addition, soil gas samples were collected from seven other locations (SG-1 through SG-7). Soil gas samples were collected using direct push technology at depths of 5, 15, and 25 ft bgs, and were stored in stainless steel Summa canisters pending laboratory analysis.

The soil samples collected in May 2000 were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), organochlorine pesticides, polychlorinated biphenyls (PCBs), metals, gross alpha, gross beta, and asbestos (U.S. EPA method 600/R-93/116). The soil gas samples were analyzed for VOCs (EPA method TO-14). In addition, a toxicity characteristic leaching procedure (TCLP) analysis was run on two samples that contained elevated metal concentrations.

Building on the results of the May 2000 sampling event, a second round of sampling was conducted by GES in July/August 2000. Six additional soil borings were installed. Two sets of three borings were located near former boring locations B-1 and B-5 (Figure 1-4). Each of these sets has a single boring installed within the trench that is identified by a “C” designation (e.g., B-1C or B-5C), another boring installed outside the southern limit of the trench identified with an “S” designation, and one to the north of the trench limit that was identified with an “N” designation. Soil samples at two of the borings were collected at roughly 5-foot intervals until groundwater was encountered (B-1C and B-5C). Soil samples at the other four borings were collected at either 20 or 25 ft bgs. A grab groundwater sample was also collected from the open borehole at each of the six locations, although the procedure used to collect these samples is

not known. Soil and groundwater were analyzed for a variety of analytes, including VOCs, SVOCs, pesticides, and metals. In addition, per the NDEP's request, one groundwater sample was also analyzed for PCBs.

In 2005, MWH performed a thorough investigation of the STA and proposed CAMU perimeter boundary (BRC and MWH, 2005). The STA investigation included the advancement of soil borings at slit trench locations to collect soil and soil gas samples. A total of 20 soil borings (BRC-BS-01 through BRC-BS-20) were advanced within the slit trenches at the Site using hollow-stem auger drilling method (Figure 1-4). At each location, three soil samples were collected from depths of approximately 10, 20, and 30 feet bgs. A total of 59 primary samples were submitted for analyses of total metals, SVOCs, VOCs, pesticides and herbicides, PCBs, and radionuclides using approved U.S. EPA methods.

Debris encountered and characterized during the drilling and sampling of slit trench borings included:

- rubber cord
- belt pieces
- paper (including empty DDT bags)
- wood
- fabric
- plastic
- paper bags
- chalky white powder
- concrete
- plastic sheeting
- cardboard
- traces of greenish-white powder
- metal scraps
- newspaper
- dark brown to black oily residue/sludge
- cement
- glass
- black fine material (fine sand size)
- plastic bottles
- rope
- charred wood
- red brick
- clay with hydrocarbon odor
- rusted metal pipe fragments with insulation material coating

MWH also performed a soil gas survey at the STA in 2005. Soil gas samples were collected from 22 locations (SV-01 through SV-08) (Figure 1-4). Soil gas samples were collected along three east-west transects, with the northern transect (SV-01 through SV-08) butting against the north landfill, and the southern transect (SV-17 through SV-22) close to the north end of the plant site. Samples were collected using drive points installed in near proximity to the slit trenches at depths ranging from 10 to 50 feet, were stored in Summa canisters, and were analyzed using EPA method TO-14 for selected VOCs.

A total of 14 soil borings were also advanced in 2005 along the perimeter of the Site using the rotary sonic drill method at locations BW-1 through BW-12 (multiple borings were installed at locations BW-08 and BW-09) (Figure 2-1). The soil borings were completed to depths ranging from 60 to 200 ft bgs. A total of 40 primary soil samples were collected and submitted for total metals, SVOCs, VOCs, pesticides and herbicides, PCBs, and radionuclides analyses using approved U.S. EPA methods.

These 15 borings were subsequently completed as groundwater monitor wells with screens that intersect the Qal or deeper water-bearing zones of the TMCf. Four of these alluvial wells are located upgradient (and south) of the STA (Figure 2-1). Wells AA-BW-08A, AA-BW-08B, and AA-BW-09 are located immediately adjacent to the southern STA boundary, and well AA-BW-12 is located upgradient of the STA, the South Landfill Lobe and the Western Ditch area. Three other alluvial wells are located along the downgradient (northern) property line (wells AA-BW-04 through AA-BW-06).

Groundwater samples from these 15 wells were collected in April 2005 and analyzed for a number of constituents, including total metals, SVOCs, VOCs, pesticides and herbicides, PCBs, radionuclides, and general chemistry parameters. A second round of groundwater samples was collected from wells BW-12 and BW-05 in July 2005 for VOC analysis.

Based on the results of the 2005 investigations, a focused “step-out” sampling was conducted in STA soils in late August 2006. These data were collected as part of a “step-out” sampling program based on elevated sample concentrations detected in the soil sampling event conducted by MWH (BRC and MWH, 2005). For presentation purposes, analytical results for soils have been presented for the four step-out clusters around the original boring (base

locations BS-08, BS-11, BS-17, and BS-20) and a group of three additional supplemental borings. All of the supplemental sampling occurred at three discrete depths, 10 feet bgs, 20 feet bgs, and 30 feet bgs, with the exception of sampling at 15 feet bgs at location BS-08-W10. The supplemental samples were taken from six locations around each original boring. Relative to the original boring the locations are 10 feet and 20 feet both east (-E10 and -E20) and west (-W10 and -W20) along the trench, and 10 feet north (-N10) and 10 feet south (-S10) outside of the trench.

Finally, in order to confirm the data on PCBs obtained in the August 2006 sampling, a limited step-out sampling event was conducted in 2007 near location BS-11. Six samples were collected and analyzed specifically for PCB congeners to obtain PCB congener data at these locations. These data will be used to support waste disposal decisions.

3.2 Distribution of Chemicals in Soil, Soil Gas, and Groundwater

Figures in the BRC CAMU CSM report and the supplemental response to NDEP show the distribution of 40 chemicals in soil with depth. Figures in the BRC CAMU CSM report also show the distribution of 42 chemicals in Aa groundwater.

Figures in the BRC CAMU CSM report show the distribution of the VOCs 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform in soil gas with depth. The highest VOC concentrations in soil gas samples collected in 2005 were noted along the southern transect, with the highest concentrations of most constituents detected at locations SV-18 through SV-22.

The distribution of chemicals in soil gas is not completely coincident with contamination in either shallow soils or subsurface (5 to 10 feet bgs) soils, even accounting for degradation effects (such as from carbon tetrachloride to chloroform as discussed in Section 5.1.5). This indicates that their distribution may not be solely the result of disposal to the slit trenches. Other likely sources include off-gassing from contamination within the Aa, as well as potential leakage from upgradient ponds. The trend of elevated soil gas concentrations in samples collected from the southern transect is consistent with an upgradient source.

No non-aqueous phase liquid (NAPL) has been observed in the southern CAMU Site boundary monitoring wells. However, the data presented in the CSM and the pure phase solubility of some chemicals are suggestive of the presence of NAPL. It is also possible that the NAPL materials that appear to be present in the CAMU area may have affected deeper water bearing zones.

4. Development of Remedial Action Objectives

Remedial action objectives (RAOs) provide a general description of the remediation performance objective. To develop these objectives, the potential risks posed by the compounds detected in STA soil were compared to the proposed SSLs and selected applicable requirements. Applicable requirements for the CAMU itself were considered in the RAP (BRC, March 2007). RAOs were then developed that would address the potential land-use-specific risks, and to serve as the performance objective for remediation of the site.

4.1 Identification and Selection of ARARs

Although the site is not regulated under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), consideration of ARARs is a useful means to ensure that contaminant levels at a site are compared with appropriate standards. "Applicable requirements" means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site.

"Relevant and appropriate requirements" means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not specifically "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a (CERCLA) site, address problems sufficiently similar to those encountered at the (CERCLA) site that their use is well suited to the particular site.

An additional category of information that may be useful in developing CERCLA remedies, the "to be considered" (TBC) category, refers to non-promulgated criteria, advisories, guidance, and proposed standards that have also been issued by a state and/or the federal government.

Some of the major and controlling ARARs applicable for the STA remediation include:

- Dust control as required by the Air Pollution Control Division of the Clark County Health District,

- Vapor emissions control and permits as required by the Air Pollution Control Division of the Clark County Health District,

- “Zero Discharge” permits if deemed appropriate by the Bureau of Water Control of the NDEP

- Stormwater Pollution Prevention Plans (SWPPP) and approval of such Plans by the NDEP,

- TSCA requirements for PCB disposal (i.e., lack of ability to dispose of PCBs greater than 50 ppm in the CAMU)

- EPA Region 9 preliminary remediation goals (PRGs) and EPA generic soil screening levels (SSLs) for migration to groundwater, and

- RCRA Land Disposal Restrictions (including adjusted disposal standards) and Universal Treatment Standards (UTS) (40 CFR Part 268)

4.2 Land Use Summary

The current zoning for the STA is M-2, or Heavy Industrial, reflecting its historical use. The area is vacant, with no structures. The future land use zoning is also M-2, or Heavy Industrial. The STA is proposed to be used as a portion of the BRC CAMU.

4.3 Remedial Action Objectives

The following four RAOs are proposed for the Site:

1. Prevent future migration of COPCs, including prevention of any further degradation of groundwater quality and prevention of future dust migration.

2. Avoid unacceptable risk to human health under the current or future potential land uses (including construction workers).

3. Avoid other significant collateral environmental impacts such as fugitive dust.

4. Prevent further migration of COPCs already present in groundwater from CAMU area sources

Figure 4-1 shows the soils and groundwater regions where each of these RAOs are applicable. Cleanup goals or standards that are applicable to these RAOs include:

- for RAO 1, EPA SSLs as well as dust control requirements by Clark County;
- for RAO 2, EPA Region 9 PRGs;
- for RAO 3, dust control requirements by Clark County; and
- for RAO 4, the difference between upgradient and downgradient groundwater monitoring.

5. Identification of STA Remedial Alternatives

The initial step in the identification of remedial alternatives to address the RAOs is the development of general response actions (GRAs) (Section 5.1). The next step is the screening and evaluation of remedial technologies and process options (Section 5.2). The term “remedial technologies” refers to the general categories of technologies within each GRA. For example, physical treatment and thermal treatment are remedial technologies within the *in situ* treatment GRA. Process options are the specific processes within each technology type. For example, steam and electrical resistant heating are process options within the thermal treatment technology category. Subsequently, Section 5.3 describes remedial technologies that were retained and used to develop the various remedial alternatives that could potentially be used to remediate soils in the STA.

5.1 General Response Actions

GRAs are broadly defined as general types of actions that can reduce or eliminate the adverse impacts of chemicals on human health and the environment. GRAs are site-specific and medium-specific categories of actions that will satisfy the RAOs. Except for the no action GRA, the GRAs described below are intended to satisfy the three RAOs presented in Section 4.4. The GRAs considered for soil in the STA include:

1. No action
2. Institutional controls/limited action
3. Containment
4. Treatment
5. Removal/disposal

The following subsections further define the GRAs for the Site. The medium of concern to be addressed by these GRAs is vadose zone soil. Specific technologies applicable to each GRA are described in each subsection.

5.1.1 No Action

The EPA guidance for conducting a remedial investigation/feasibility study (RI/FS) (U.S. EPA, 1988) indicates that a “no action” GRA must be developed and examined as a potential remedial action for all sites. In this option, the slit trenches would be left as they exist today with no changes. No direct steps would be taken to protect human health and the environment from potential exposure to chemicals that have been detected in the STA soils. However, the baseline condition of the STA, that is, the “no action” condition, will comprise a set of baseline remedial actions. This alternative is retained for consideration as a baseline condition for comparison to the other alternatives.

5.1.2 Institutional Controls

Institutional controls, such as land-use restrictions and water-use restrictions, are a part of the baseline condition. Institutional controls can be used to prevent or reduce exposure to chemicals in soil and groundwater. Institutional controls are typically divided into governmental and proprietary controls:

- Governmental controls are usually implemented and enforced by state or local government and can include zoning restrictions, ordinances, statutes building permits, or other provisions that restrict land or resource use at a site.

- Proprietary controls, such as easements and covenants, include private land-use restrictions that typically result by agreement with the landowner and an enforcing party (such as a state environmental agency). These controls are often referred to as “deed restrictions” because the restriction typically becomes placed within the chain-of-title to the restricted property.

The institutional controls GRA consists of minimal-cost actions that could be rapidly implemented with only minor construction and Site disturbances. This type of response is used to limit exposure to impacted soil. These actions may include the installation of fences and warning signs. Other measures could include dust suppression and deed notification or deed restrictions.

5.1.3 Containment

Containment GRAs are intended to minimize or eliminate potential exposure to chemical in soils and to prevent the migration of chemical in soils to the environment by reducing or eliminating infiltration of surface water and reducing dust migration. The purpose of containment is not to reduce the actual toxicity or volume of impacted soils, but to reduce potential contaminant migration from soil to groundwater and prevent the potential for direct human contact with contaminants. Containment of impacted soils can be accomplished by placing a physical barrier around, beneath, and/or over the area of interest to prevent or minimize the horizontal and/or vertical mobility of chemical constituents in soils.

5.1.4 Treatment

Soil treatment GRAs actively remove or alter contaminants in soil to reduce their mobility or concentrations. Soil treatment GRAs are grouped into two categories:

- *In-situ* treatments are remedial technologies that are applied to the media in their natural setting. Typically, *in-situ* treatments result in reduced treatment costs and environmental impacts, particularly with land treatment. *In-situ* treatment may have complex designs and may be more difficult to manage than *ex situ* treatments. *In-situ* treatments are preferred in situations where the contaminant source is dispersed over a large volume, where the source is beyond the reach of conventional excavation at a reasonable cost, and when excavation is not possible on safety, engineering or environmental grounds.

- *Ex-situ* treatments refer to the actions a contaminated medium undergoes after being extracted from its natural setting. Once extracted, the medium undergoes *ex-situ* treatment to remove compounds or chemicals that have impacted the media.

5.1.5 Removal/Disposal

The removal/disposal GRA consists of the excavation of contaminated soils. Following excavation, the soils may either be transported off site for disposal to an appropriately licensed off-site waste management facility, or could be disposed on site.

5.2 Identification of Applicable Remedial Technologies

This section identifies and evaluates remedial technologies that could potentially be used to implement the STA soil GRAs listed in Section 5.1. The objective of the remedial action is to prevent potential human exposure to soil contaminants and to mitigate the potential for groundwater impacts. The selection of technologies includes the identification and initial screening of potential remedial technologies and process options.

5.2.1 No Action

There is no technology associated with the no action GRA. Inclusion of this GRA is used to establish a baseline for comparison against other technologies.

5.2.2 Institutional Controls/Limited Action

Various limited actions, including access restrictions, deed restrictions/notifications and monitoring, were evaluated. Each of these possible actions are part of the baseline condition..

5.2.3 Containment

The following containment technologies were evaluated: in-place stabilization/solidification (S/S), slurry cut-off wall (along the downgradient extent of the CAMU area), and placement of a RCRA Subtitle C equivalent cap.

S/S reduces the mobility of hazardous substances and contaminants in the environment through both physical and chemical means. Unlike other remedial technologies, S/S seeks to trap or immobilize contaminants within their "host" medium (i.e., the soil, sand, and/or other materials that contain them) instead of removing them through chemical or physical treatment. Leachability testing is typically performed to measure the immobilization of contaminants. S/S techniques can be used alone or combined with other treatment and disposal methods to yield a product or material suitable for land disposal or, in other cases, which can be applied to beneficial use. S/S is not suitable for sites that contain or potentially contain petroleum related

NAPL at it can interfere with the stabilization process. This technology was retained for further evaluation.

A slurry wall placed at the downgradient edge of the site boundary would hinder groundwater flow beneath the property toward offsite receptors and the currently operational wastewater treatment facility. The slurry wall would be placed to cutoff groundwater to a depth of approximately 70 feet bgs. This technology was retained for further evaluation.

A surface cap design that conforms with applicable regulations governing the use of caps for a CAMU would mitigate surface water infiltration and exposure by humans and other environmental receptors to the contaminants in STA soil. This technology was retained for further evaluation.

Groundwater monitoring would be a required element of all containment technologies, to verify that the remedy is effective. Results of the groundwater monitoring may indicate that additional groundwater treatment is required.

5.2.4 Treatment

Various *in situ* treatment technologies were evaluated, including biological, chemical, and physical process options. Due to the variability in the types of contaminants, and the large areal distribution of the impacted soils, only the *in situ* treatment of VOCs was retained.

Bioventing aims to stimulate natural *in situ* biodegradation of aerobically degradable compounds in soil by providing oxygen to existing soil microorganisms. Air/oxygen are supplied through direct air injection into residual contamination in soil. In addition to degradation of adsorbed fuel residuals, volatile compounds are biodegraded as vapors while moving slowly through biologically active soil. Bioventing is not effective for the majority of contaminants identified in STA soil, and is screened from further evaluation.

Enhanced In Situ Bioremediation (EISB) uses indigenous or inoculated microorganisms to degrade organic contaminants by converting them to innocuous end products. Nutrients, electron donors or acceptors, or other amendments may be used to enhance bioremediation and contaminant desorption from subsurface materials. Processes are aerobic or anaerobic.

Aerobic EISB would likely not be feasible for this site as most of the target COCs are chlorinated compounds that are not subject to aerobic biodegradation processes. Anaerobic EISB is technically possible but difficult to implement over a large treatment zone. Anaerobic EISB was retained for further evaluation

In situ chemical oxidation (ISCO) refers to a group of technologies that each use differing combinations of oxidants and delivery techniques. ISCO has been shown to destroy or degrade an extensive variety of chemical impacts in groundwater and soil, including fuel hydrocarbons, chlorinated solvents (e.g., PCE, TCE), fuel oxygenates (e.g., methyl-tert-butyl-ether [MTBE]), and polycyclic aromatic hydrocarbons (PAHs). Most of the oxidants (permanganate, Fenton's and persulfate) are applied in the liquid form and would be unsuitable for vadose zone application. Ozone is a gas and would be suitable for vadose zone application but would be difficult to implement with appropriate and sufficient controls over a large vadose zone. This technology using ozone was retained for further evaluation.

In situ soil flushing is accomplished by passing an extraction fluid through in-place soils using an injection or infiltration process. Extraction fluids must be recovered from the underlying aquifer. Cosolvent flushing involves injecting a solvent mixture (e.g., water plus a miscible organic solvent such as alcohol or surfactants) into either vadose zone, saturated zone, or both to extract organic contaminants. Cosolvent flushing can be applied to soils to dissolve either the source of contamination or the contaminant plume emanating from it. The cosolvent mixture is normally injected upgradient of the contaminated area, and the solvent with dissolved contaminants is extracted downgradient and treated above ground. The separation of surfactants from recovered flushing fluid, for reuse in the process, is a major factor in the cost of soil flushing. Treatment of the recovered fluids results in process sludges and residual solids, such as spent carbon and spent ion exchange resin, which must be appropriately treated before disposal. Air emissions of volatile contaminants from recovered flushing fluids should be collected and treated, as appropriate, to meet applicable regulatory standards. Injection into and extraction of groundwater at the site to achieve soil cleanup would be difficult to implement and may interfere with other groundwater cleanup activities currently underway. In addition, this technology would require on-site containment or off-site disposal which would be redundant and more expensive than off-site disposal or on-site containment alone. Finally, it may be difficult to

obtain an air permit to allow this activity. This technology was screened out for further evaluation.

Soil vapor extraction (SVE) is an in situ vadose zone soil remediation technology in which a vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants, depending on local and state air discharge regulations. Vertical extraction wells and horizontal extraction wells (installed in trenches or horizontal borings) can be used as warranted by contaminant zone geometry, drill rig access, or other site-specific factors. Other types of contaminants that are present in STA soils (i.e., SVOCs, pesticides, PCBs, furans, and dioxanes) have physical characteristics that impede their ability to potentially impact groundwater via the vapor pathway. This technology was retained for further evaluation.

5.2.5 Removal/Disposal

Excavation of contaminated soils using heavy equipment is retained as a possibility to remove soils from the STA. Soils excavated would either be transported off-site for disposal in an approved landfill, or could be disposed of on-site. This technology was retained for further evaluation.

5.3 Development and Detailed Descriptions of STA Remedial Alternatives

Eleven primary alternatives were developed to reduce or eliminate the potential adverse impacts of chemicals in the STA soils on human health and the environment. Alternatives 4 and 5 are further refined by options on the size and location of the proposed remedial action. The remedial alternatives presented in the following sections were all retained for further evaluation in Section 6. These alternatives are as follows:

- Alternative 1 – baseline condition/no action,
- Alternative 2 - institutional controls,
- Alternative 3 – STA cap,
- Alternative 4 - excavation and off-site disposal,

- Alternative 5 - excavation and on-site disposal,
- Alternative 6 - in-situ SVE treatment,
- Alternative 7 –EISB,
- Alternative 8 –ISCO by ozone,
- Alternative 9 – soil stabilization, and
- Alternative 10 – slurry cut-off wall.

5.3.1 Alternative 1 – Baseline Condition/No Action

Under Alternative 1, the slit trenches would be left as they exist today with no changes, except for removal of those wastes containing PCBs greater than 50 ppm, in order to meet TSCA requirements. No remediation of any kind would be implemented at the STA. The following additional remedial actions would be implemented, however:

- Placement of a liner and leachate collection system over the entire CAMU area, including over the STA,
- Placement of waste onto the CAMU liner,
- Placement of a cap or cover over the disposed waste in the CAMU,
- Institutional controls for the entire CAMU, including the STA,
- Upgradient and downgradient groundwater monitoring and potential treatment, as required, based on the results of such monitoring (specifically to address RAO 4). A separate work plan relating to groundwater monitoring will be submitted to the NDEP and implemented after NDEP approval. The upgradient and downgradient data from this groundwater monitoring will be evaluated for a period of time to be determined by the NDEP and BRC in order to determine the mass loading of any contaminants from the CAMU area sources. The evaluation period will commence after implementation of the selected RAS remedy and the CAMU itself. If the mass loading data indicate that unacceptable levels of contaminants

continue to migrate to groundwater from CAMU area sources, then BRC will initiate discussions with the PSSM companies in order to add/amend the PSSM GWTS treatment train in order to accommodate the addition mass loading from CAMU area sources; alternatively, if the PSSM GWTS treatment train is already treating the additional mass loading from the CAMU area sources, BRC will discuss with the PSSM companies, the need for compensation of such treatment, etc., and

- Placement of RCRA Subtitle C equivalent covers over the closed BMI Landfill North and South Lobes.

Few impacts to groundwater quality have been directly attributed to STA soils, and the groundwater that flows beneath the STA is currently being partially captured and partially remediated by the existing downgradient GWTS. BRC recognizes that the NDEP and the PSSM companies are currently addressing the potential need for upgrades to the GWTS to insure complete capture and treatment of contaminated groundwater by the GWTS.

5.3.2 Alternative 2 - Institutional Controls

This alternative is a part of the baseline condition. Institutional controls such as the installation of fences and warning signs and application of deed restrictions would be used to limit exposure to impacted soil in the STA (ERM, 1999).

5.3.3 Alternative 3 - STA Cap

This alternative is part of the baseline condition. The STA would be capped with the CAMU liner and leachate collection system as well as by the placement of the CAMU itself on the STA.

5.3.4 Alternative 4 - Excavation and Off-Site Disposal

Under Alternative 4, soils in the STA would be excavated and transported off site for disposal in an appropriate permitted facility. The four options (Alternatives 4a through 4d) of this alternative propose different excavation volumes, each geographically-based to pre-determined boundaries; soil sampling will not be used to establish a clean zone, nor the excavation

boundary. Three disposal costs are assumed: 1) soils exceed the RCRA land disposal restrictions, 2) soils are hazardous, and 3) soils are non-hazardous.

5.3.4.1 Alternative 4a - Entire Slit Trench Area

Under Alternative 4a the entire STA would be excavated, which comprises approximately 1,212,250 ft^2 (Figure 5-1). The depth of the excavation is assumed to be 35 feet bgs (slightly above the water table) to incorporate assumed COPC mass below the deepest sample interval of 29 ft bgs. Therefore, the in-situ soil volume for this alternative is approximately 42,428,750 ft^3 (or roughly 1,571,435 cubic yards [yd^3]). Acceptable backfill would be placed within the excavation to produce a consistent grade for proper drainage within the future CAMU liner system, and to maintain at least 5 feet of separation between the bottom of the CAMU and groundwater. The CAMU would be constructed from the backfill on up.

5.3.4.2 Alternative 4b - Partial Slit Trench Area

Under Alternative 4b, a smaller area of the STA would be excavated (Figure 5-1). This area is defined by the smallest contiguous area that includes all of the trenches identified by the historical aerial photograph analysis, including a 50-foot-wide buffer zone. The buffer zone is included to account for uncertainties in the actual trench locations, as well as to include some of the potentially contaminated soils that are immediately adjacent to the slit trenches and may have been impacted by wastes disposed in the trenches. This area is approximately 800,000 ft^2. As was assumed for Alternative 4a, the depth of the proposed excavation is 35 feet. Therefore, an in situ soil volume for this alternative is approximately 28,000,000 ft^3 (or roughly 1,037,000 yd^3). Backfill would be placed to produce consistent grade within the bounds of the excavation for proper drainage within the future CAMU liner system, and to maintain at least 5 feet separation between the bottom of the CAMU and groundwater. Sump pumps and vertical risers will be required to remove collected leachate from this lower-elevation portion of the CAMU.

5.3.4.3 Alternative 4c - Hot Spot Locations for non-VOCs

Under Alternative 4c, hot spots where non-VOC chemicals exceed the SSLs, will be excavated (Figure 5-2). The horizontal extent of the hot spots is assumed be one-half the distance to the nearest clean boring location or the property line. VOC-containing soil would be left in place. The soil volume for this alternative is approximately 324,000 ft^3 (or roughly 12,000 yd^3). Backfill

would be brought in from the local CAMU area itself and compacted to return the hot-spot excavations to previous grade elevation; hot-spot excavations would not be suitable for CAMU construction; the CAMU would be constructed on top of the back-filled hot spot areas.

5.3.4.4 Alternative 4d - Slit Trench Waste Excavation

Under Alternative 4d, the defined limit of the slit trenches would be excavated (Figure 5-2) to remove the disposed waste as observed during excavation. As described above in Section 3.1.3, trench widths vary, but for costing purposes are assumed to be approximately 20 feet which results in an area of approximately 135,000 ft^2. For costing purposes, the depth of the proposed excavation for this alternative was assumed to be 35 feet, or the approximate maximum depth of the trenches in this area. Therefore, an in-situ soil volume for this alternative is roughly 4,725,000 ft^3 (or about 175,000 yd^3). The excavated cover soil would be replaced into the trench excavations, and backfill would be brought in from the local STA to return the discrete trench excavations to previous grade elevation; trench excavations would not be suitable for CAMU construction; the CAMU would be constructed on top of the back-filled areas.

5.3.5 Alternative 5 – Excavation with On-Site Disposal

Alternative 5 consists of excavation and on-site disposal in the CAMU itself (in the South Mesa or Borrow Pit area). As was the case for Alternative 4, four soil volume options were considered. The excavation boundaries are geographically based to pre-determined boundaries; additional soil sampling will not be used to establish a clean zone, nor the excavation boundary.

Soil in the STA would be excavated and transported to the CAMU for disposal. However, approximately 69 cubic yards of soil in the vicinity of boring BS-11 (Figure 5-3) would not be disposed in the CAMU due to PCB concentrations that exceed 50 ppm. This area, as shown in Figure 5-2 is delineated using the completed step-out sampling, and the PCB-containing wastes will be sent offsite to a suitable disposal facility. It is currently believed that this material would be accepted by U.S. Ecology in Beatty, Nevada based upon conversations with the facility. However, the final disposal location for the PCB containing soils could be other facilities, pending waste disposal discussions.

To ensure that the closed BMI landfills and offsite ponds to the south of the STA are not disturbed, temporary shoring will be placed for the southern most excavations; sidewalls will not be sloped. Excavations will not extend beyond temporary shoring as shown on Figure 5-2.

Excavations would be backfilled using native soil scraped from the surface of STA. The excavations would be backfilled as described above for Alternative 4a through 4d, to either produce consistent proper grade for drainage, and to maintain at least 5 feet separation between the bottom of the CAMU and groundwater (Alternatives 5a and 5b), or to return the excavations to previous grade elevation (Alternatives 5c and 5d).

This technology would remove contaminants from the site in varying degrees, based on the volume of the proposed excavation. This alternative and its options provide high protectiveness to the environment.

5.3.5.1 Alternative 5a - Entire Slit Trench Area

For this alternative, the area identified in Alternative 4a (Section 5.3.4.1) and shown on Figure 5-1, would be excavated and managed on-site as described above (Section 5.3.5).

Alternative 5b - Partial Slit Trench Area

For this alternative, the area identified in Alternative 4b (Section 5.3.4.2) and shown on Figure 5-1, would be excavated and managed on-site as described above (Section 5.3.5).

5.3.5.2 Alternative 5c - Hot Spot Locations

For this alternative, the area identified in Alternative 4c (Section 5.3.4.3) and shown on Figure 5-2, would be excavated and managed on-site as described above (Section 5.3.5).

5.3.5.3 Alternative 5d – Slit Trench Waste Removal

For this alternative, the area identified in Alternative 4d (Section 5.3.4.4) and shown on Figure 5-2, would be excavated and managed on-site as described above (Section 5.3.5).

5.3.6 Alternative 6 - In-Situ SVE Treatment

Under Alternative 6, subsurface soils in the entire STA would be treated using *in-situ* SVE. This subsurface treatment would remove the VOCs that are known to be present in soil and soil gas. As discussed above, the intent of this remedial action would be to eliminate the potential for VOCs in soil to impact groundwater via the vapor pathway, or by migration. Other, non-VOC contaminants present in soil would not be treated using this technology. A proposed layout for this alternative is shown on Figure 5-4.

This technology would reduce the volume of VOC contaminants potentially able to migrate to groundwater. Other non-VOCs would not be treated under this alternative. The time to achieve protectiveness from VOC contaminants would be on the order of decades. During this time, it is possible that surface water infiltration would potentially increase contaminant mobility, both VOC and non-VOC contaminants.

5.3.7 Alternative 7 -– Enhanced In Situ Bioremediation

Under this alternative, electron donor and biological culture would be injected into groundwater underneath the STA. The injections would cover approximately 25 percent of the STA area; it is assumed that bio growth and dispersion over the next several years would generate the remainder of coverage required to remediate primarily chlorinated VOCs that are susceptible to anaerobic dechlorination. It is assumed that three rounds of donor injection would be required. A proposed injection layout is shown on Figure 5-4.

This alternative would not address contaminants present in STA vadose zone soil. In addition, upgradient groundwater contains significant concentrations of contaminants; on-site flow would continue to mobilize groundwater contaminants from upgradient sources.

Due to the continued presence from upgradient sources, and potential mobility of soil contaminants, there is high potential for required ongoing groundwater treatment into the future.

5.3.8 Alternative 8 –In Situ Chemical Oxidation

Under this alternative, ozone gas would be generated on site and injected into the vadose zone. Ozone would oxidize VOC contaminants, as wells as other oxidizable material such as naturally occurring organics in the soil. Direct contact must be made between the ozone and the contaminant for destruction to occur. Injections would cover approximately 90% of the STA area. VOCs and naturally occurring organic material would be permanently destroyed by contact with ozone. A proposed injection layout is shown on Figure 5-4.

This alternative would not address other non-VOC contaminants in the vadose zone such as PCBs and pesticides.

5.3.9 Alternative 9 –Soil Stabilization

Under this alternative, stabilization agents would be mixed into STA soil using an auger mixing technique. The stabilizing agent would require direct contact with all STA soils in order to reduce the mobility of STA contaminants. The potential presence of non-aqueous phase liquids within the STA could interfere with the effectiveness and longevity of the stabilization agent. It is expected that all contaminants would be stabilized under this alternative. A proposed stabilization approach is shown on Figure 5-4.

The mobility of the STA contaminants would be significantly reduced, making the potential for migration into groundwater low.

5.3.10 Alternative 10 –Slurry Cut-off Wall

Under this alternative, a slurry cut-off wall would be installed into groundwater along the northern property boundary, downgradient of the site (Figure 5-4). BRC also considered a conceptual slurry wall along the entire CAMU area boundary – however, give the proximate locations of the closed BMI land fill (South Lobe) as well as the slit trenches to the southern boundary with Pioneer, implementing a slurry cut-off wall along the south would not be feasible. Thus, the slurry wall concept was envisioned as a cut-off wall along the northern boundary. The purpose of the slurry wall would be to impede groundwater flow from off the property.

Groundwater would mound behind the slurry wall, and eventually flow around the perimeter. Reduced and altered groundwater flow may impede the operation of the existing off site wastewater treatment system.

There would be no reduction in mobility, toxicity, or volume of STA contaminants under this alternative.

6. Detailed Analysis of the STA Remedial Alternatives

A detailed analysis of the retained remedial alternatives for the STA is presented below. The criteria used to assess the alternatives are intended to be consistent with the federal statutory evaluation criteria defined in the National Contingency Plan (NCP) for conducting feasibility studies under CERCLA (U.S. EPA, 1988). The nine criteria used to assess each of the alternatives are briefly described in Section 6.1. The evaluation of the remedial alternatives using these criteria and a discussion of the recommended alternative are discussed in Sections 6.2 and 6.3, respectively.

6.1 Evaluation Criteria

The nine evaluation criteria used to assess the remedial alternatives are:

1. Overall protection of human health and the environment
2. Compliance with Applicable, Relevant, and Appropriate Requirements (ARARs)
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, or volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost
8. Community acceptance
9. State acceptance

Criteria 1 and 2 are “threshold criteria” that each alternative must meet in order to be eligible for selection. Criteria 3 through 7 are “primary balancing criteria” that are used to evaluate and identify the major tradeoffs among the remedial alternatives. Criteria 8 and 9 are “modifying criteria” that are considered in remedy selection. A brief description of the nine criteria is presented in Sections 6.1.1 through 6.1.8.

6.1.1 Overall Protection of Human Health and the Environment

Alternatives are assessed to determine whether they can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances present at the site (U.S. EPA, 1988). Each alternative is evaluated on its potential to limit exposure risk to humans and the environment during and after implementation of the remedial action. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially compliance with ARARs, long-term effectiveness and permanence, and short-term effectiveness.

6.1.2 Compliance with ARARs

Alternatives are assessed to determine whether they meet the selected ARARs and the four RAOs developed for the STA, as presented in Section 4.3.

6.1.3 Long-Term Effectiveness and Permanence

Alternatives are assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. This criterion evaluates the ability of an alternative to prevent or minimize risk to public health and the environment after RAOs have been met. Factors that are considered, as appropriate, include the following (U.S. EPA, 1988):

- The magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- The adequacy and reliability of controls such as containment systems and institutional controls that is necessary to manage treatment residuals and untreated waste.

6.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume is assessed, including how treatment is used to address the principal threats posed by the site. EPA has a statutory preference for selecting remedies that use treatment technologies to permanently and significantly reduce toxicity, mobility, or volume of hazardous substances. Factors that are considered include: (1) the treatment process(es), (2) the amount of hazardous substances that will be destroyed, treated, or recycled, (3) the degree of expected reduction in toxicity, mobility, or volume of the waste, (4) the degree to which the treatment is irreversible, (5) the type and quantity of residuals that will remain following treatment, and (6) the degree to which treatment reduces the inherent hazards posed by principal threats at the site (U.S. EPA, 1988).

6.1.5 Short-Term Effectiveness

The short-term impact of an alternative refers to its effect on human health and the environment during implementation of the alternative, and until the RAOs for the site are met. This criterion is assessed by considering the short-term risks that might be posed to the community during implementation of an alternative. In addition, potential impacts on workers during remedial action and the effectiveness and reliability of protective measures are assessed. The effectiveness and reliability of remedial measures during implementation and the time until protection is achieved are also considered.

6.1.6 Implementability

Implementability is used as a measure of both the technical and administrative feasibility for constructing, operating, and maintaining a remedial action alternative (U.S. EPA, 1988). Technical feasibility refers to the following factors:

- The ability to reliably construct, operate, and maintain the components of the alternative during remediation and after completion, as well as the ability to meet applicable technical regulatory requirements

- The reliability of the technology, including the likelihood that technical problems associated with the implementation may lead to schedule delays
- The ease of undertaking additional remedial actions, if necessary
- The ability to monitor the effectiveness of the remedy

Administrative feasibility includes the following criteria:

- The ability to get approvals from appropriate agencies to implement the alternative
- The availability of services and materials for the treatment, storage, and disposal of generated wastes
- The availability of specialized equipment or technical specialists to support the remedial actions

6.1.7 Cost

The cost criterion assesses the financial burden associated with implementing the alternative. Both capital and operation and maintenance (O&M) costs are evaluated for each alternative. Capital costs include design costs, equipment costs, construction costs, and other relevant short-term expenditures associated with the installation of the remedial action components. O&M costs include the expenses associated with equipment maintenance and repair, site and equipment monitoring, power, chemicals, and disposal of residues. Cost is primarily used to eliminate alternatives that are significantly more expensive than others without proportional benefits, or to choose among several alternatives offering similar protection to human health and the environment.

6.1.8 Community Acceptance

The evaluation of community acceptance considers the community's apparent preferences among alternatives or concerns about specific alternatives.

6.1.9 State Acceptance

The evaluation of NDEP acceptance considers the technical and administrative issues and concerns that the NDEP may have regarding each of the alternatives.

6.2 Evaluation of Remedial Alternatives

The remedial alternatives identified in Section 5.3 are evaluated using the criteria described above. Table 6-1 presents a summary of the evaluation of each remedial alternative with respect to the nine criteria and a summary of the comparative evaluation of each alternative, with respect to each other.

Alternative 1, Baseline Condition/No Action, is only evaluated with respect to “no action” taken directly on the STA, and not with respect to the effects of the other baseline remedial actions. This is so that a comparative analysis may be made amongst the 10 alternatives. The Baseline Condition, that is, the baseline remedial actions, will occur regardless of which alternative is selected. Therefore, the protectiveness provided by the baseline remedial actions is equal across the alternatives, and can be neglected for purposes of comparing the alternatives to the nine criteria and to each other.

Likewise, Alternative 2 (Institutional Controls) and Alternative 3 (STA Cap) are a part of the Baseline Condition, and will not be considered in the evaluation of the remedial alternatives. These alternatives were described and presented separately from the Baseline Condition only in order to highlight the effect of the action on the STA. However, being a component of the baseline remedial actions, these alternatives are not separately evaluated.

Other important factors that need to be considered during the evaluation of the potential remedial alternatives include the following:

- Groundwater that flows onto the Site from the PSSM site located to the south of the STA contains elevated concentrations of dissolved chemicals. Chemicals such as VOCS are present at concentrations that are more than 1,000 times their respective MCL. In

addition to VOCs, elevated concentrations of other types of chemicals have also impacted the quality of the groundwater flowing onto the Site.

- The contaminated groundwater that flows onto the Site flows beneath the STA prior to flowing off site to the north.

- The suite of chemicals detected in soils of the STA is inclusive of the suite of chemicals that was used on the off-site upgradient property.

- The analysis of available groundwater laboratory data indicates that no discernable impact that can be attributed to STA soils is observed for most of the chemicals detected in groundwater. The data indicate that the mass flux of chemicals migrating in groundwater from upgradient sources is significantly greater than the mass flux of chemicals emanating from the CAMU area that can be specifically attributed to impacts caused by chemicals in the STA soils.

- Groundwater that flows beneath the STA moves to the north and flows off-site, where it is partially captured by the existing PSSM GWTS.

6.2.1 Overall Protection of Human Health and the Environment

This criterion is a threshold that proposed alternatives must meet to be eligible for selection

Alternative 1 (Baseline Condition/No Action) does not meet the RAOs for the STA. No action is taken to prevent potential degradation of groundwater quality from STA soil, avoid unacceptable risk to human health, or to avoid other environmental impacts such as fugitive dust.

Alternatives 4 (Excavation and Off site Disposal) and 5 (Excavation and On Site Disposal) achieve RAO 1, because the soils are either transported off-site for disposal at a licensed facility or disposed on-site in the CAMU. Both of the alternatives achieve RAO 2. Alternatives 4c and 5c comply partially with RAOs 1 and 2 since only PCBs, not VOCs, are removed. Both

Alternatives 4 and 5 avoid unacceptable risk to human health under current and future potential land uses because impacted soils would be excavated and replaced with clean fill. Either alternative involves the excavation and handling of soils containing chemicals at concentrations exceeding screening levels, which would increase the short-term risk to human health during the remedial process. The action might therefore increase risks of exposure to chemicals in the soil that pose a potential threat to construction workers, the community, and the environment. Under Alternative 4 the off-site transportation activities could increase the possibility of community exposure. For example, Alternative 4a would require approximately 150,000 truck trips through the community to transport soils to a licensed disposal facility. This increased level of traffic in the area could represent a significant nuisance to the community, as well as human health risks due to the increased potential for traffic accidents. RAO 3 is potentially achievable by both alternatives. Neither alternative achieves RAO 4 by itself; however, the baseline action of groundwater monitoring, followed by remediation as necessary, achieves RAO 4.

Alternative 6 (In Situ SVE) does meet the objective of RAO 1 for VOCs. However, since the groundwater flowing beneath the site is currently contaminated with dissolved VOCs, the immediate benefit of such an action appears to be negligible. In fact, it is likely that the SVE system would collect VOCs that are derived from PSSM sources in addition to those from the STA wastes themselves. Alternative 6 does not meet the objective of RAO 1 for the other chemicals that have been detected in soils at concentrations above the SSLs. RAO 2, 3, and 4 are not achieved.

Alternative 7 (EISB) does not comply with the chemical specific requirements, and does not achieve RAO 1 or 2. Vadose zone contaminants would remain in place, and be subject to surface water infiltration which could increase their mobility and provide potential transport into groundwater. Alternative 7 provides no protection from site soils to human or other environmental receptors. Dust control is not provided by this alternative; however, the action will not generate dust. Therefore, RAO 3 is potentially achieved. VOCs in groundwater underlying the site would be addressed by this alternative, so RAO 4 would be partially achieved.

Alternative 8 (ISCO) does not comply with chemical specific requirements for non-VOCs, and does not fully achieve RAOs 1 or 2. Ozone will treat the readily oxidizable compounds with

which it comes into direct contact. Compounds that exceed the oxidizing potential of ozone will not be destroyed. In addition, the ozone is non-specific in that it will oxidize any oxidizable material it contacts; this will require ozone injection in significant stoichiometric excess. Alternative 8 provides no protection from remaining site contaminants to potential human exposure or to groundwater by potential transport by surface water infiltration. The action will not generate dust. Therefore, RAO 3 is achieved. RAO 4 is not achieved.

Alternative 9 (Soil Stabilization) can comply with chemical specific requirements, and can potentially achieve RAOs 1, 2, and 3. However, given the heterogeneous nature of the wastes, it is not clear that adequate or uniform stabilization can be achieved considering all of the chemicals present. Thus, in reality, RAOs 1 and 2 may be difficult to achieve. RAO 4 is not achieved by this alternative itself.

Alternative 10 (Slurry Cut Off Wall) does not comply with chemical specific requirements and does not achieve RAO 1, 2, or 3. The slurry wall does not reduce the volume, toxicity, or mobility of any site contaminants. Nor will it prevent groundwater impacts from contaminants present in soil, or exposure to humans or other environmental receptors. Dust will likely be generated during implementation of the remedy, but this is controllable by standard engineering methods. This Alternative does nothing to impede dust formation from site soils subsequent to implementation. RAO 4 is partially achieved due to restrictions to groundwater flow offsite. However, the groundwater is not permanently eliminated from the aquifer, and therefore the positive impact is low.

6.2.2 Compliance with ARARs

Compliance with the applicable requirements and RAOs is a threshold criterion that proposed alternatives must achieve. The evaluation of the various alternatives determined that:

- Alternative 1 does not comply with the preliminary remediation goals (PRGs) nor does it achieve the four RAOs.
- Alternatives 4(a), (b), and (d) comply with the PRGs, achieve RAOs 1 and 2, but could potentially not achieve RAO 3, and do not achieve RAO 4. Alternative 4c does not comply with the PRGs for VOCs. Other ARARs are achievable.

- Alternative 5(d) complies with the PRGs, achieves RAOs 1 and 2, but could potentially not achieve RAO 3, and does not achieve RAO 4. Other ARARs are achievable. Alternative 5c does not comply with the PRGs for VOCs, and partially achieves RAOs 1, 2, and 3. RAO 4 is not achieved. Other ARARs are achievable.
- Alternative 6 does not comply with the PRGs for non-VOCs, and does not achieve RAOs 2, 3, or 4. ARARs for emissions control and permitting could be difficult to achieve.
- Alternative 7 does not comply with the PRGs for non-VOCs, and does not achieve RAO 1, 2, or 3, but does achieve RAO 4.
- Alternative 8 does not comply with the PRGs for non-VOCs, and does not achieve RAO 4, potentially achieves RAO 1 and RAO 2, and does achieve RAO 3.
- Alternative 9 does comply with the PRGs and does achieve RAO 1, RAO 2, and RAO 3, but does not achieve RAO 4.
- Alternative 10 does not comply with the PRGs, and does not achieve RAO 1, RAO 2, or RAO 3, but potentially does achieve RAO 4.

6.2.3 Long-Term Effectiveness and Permanence

Alternatives were assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative will prove successful. This criterion evaluates the ability of an alternative to prevent or minimize risk to public health and the environment after RAOs have been met.

Alternative 1 does not provide any long-term effectiveness or permanence.

Alternatives 4 and 5 provide high effectiveness and permanence for larger volumes and fair effectiveness for the hot spots. Alternative 4 removes the wastes from the STA and the property and therefore results in less residual risk at the conclusion of the remedial activities than does Alternative 5 where residual risk remaining from untreated waste is addressed by containment and institutional controls.

Under Alternative 6 only VOCs would be treated using SVE. The magnitude of residual risk from the other chemicals known to be present in soils is not addressed. No adequate or reliable containment or institutional controls will reduce or prevent human exposure. In addition, the infiltration of water into the vadose zone could potentially mobilize non-VOC chemicals and transport them to the water table.

Alternative 7 provides low effectiveness and permanence. Alternative 7 does not treat any compounds in the site soil; groundwater contaminants would be reductively dechlorinated by microorganisms. As long as the dechlorination process is complete to ethene, the toxicity and volume of contaminants would be permanently reduced. It is possible that some VOCs would be dechlorinated to vinyl chloride, which is a more toxic compound that TCE or PCE, so the effectiveness of the technology is potentially low with respect to groundwater. This alternative has no effectiveness or permanence on site soil. In addition, upgradient groundwater along with site soil provides an ongoing source of contamination to site groundwater. It is likely that groundwater goals will not be achieved under this alternative in any reasonable time frame.

Alternative 8 provides moderate effectiveness and high permanence. The VOCs that are destroyed by contact with ozone will not reoccur. Although there is no mitigation for surface water infiltration, the treatment that occurs is permanent. However, ozone will not oxidize all site contaminants, and therefore does not mitigate all impacts to groundwater, human, or other environmental receptors.

Alternative 9 provides high effectiveness and moderate permanence. The site contaminants bound to soil will not be a source of adverse exposure to groundwater, human, or other receptors. However, the permanence of the stabilization is uncertain. Soil conditions, and certain chemical elements, such as NAPLs, can interfere with the longevity of the stabilization agents.

Alternative 10 provides low effectiveness and low permanence. Exposure to site contaminants are not mitigated for groundwater, human, or other environmental receptors.

6.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume of wastes in the STA is assessed below. Alternatives 1, 4, and 5 do not use any technology to destroy or treat any of the chemicals in the STA soils to permanently and significantly reduce the toxicity, mobility, or volume of hazardous substances. Although Alternatives 4 and 5 do address the principal threats posed by chemicals in the soil, they do not employ any technologies that destroy or reduce the volume or toxicity of the contaminants.

Alternative 6 uses SVE technology to treat the VOCs that have been detected in soils, and permanently reduce the volume of these compounds in the subsurface. Other contaminants known to be present in the soils are not addressed by these two alternatives.

Alternative 7 does not treat any compounds in site soil. It is possible that some VOCs in groundwater would be dechlorinated to daughter products which could be more toxic or more mobile, and not totally reduced to ethene. Therefore the reduction in volume, toxicity, and mobility is potentially low with respect to groundwater. This alternative has no effectiveness or permanence on site soil.

Alternative 8 treats by oxidation organic compounds in the site soil. Not all site contaminants will be amenable to oxidation by ozone. In addition, oxidation will only occur with direct contact, so it is possible that some contaminant mass will not be destroyed. Therefore reduction in volume is dependent on delivery of the oxidant to the contaminant.

Alternative 9 treats contaminant mobility by binding the contaminant with soil, into a stabilized, non-leachable mass. The volume and toxicity of the contaminant is not changed; the mobility of the contaminant is essentially contained by this treatment.

Alternative 10 does not treat site soil or groundwater. Contaminant toxicity, volume, mobility are not affected.

6.2.5 Short-Term Effectiveness

The short-term impact of an alternative refers to its effect on human health and the environment during implementation of the alternative, and the time needed to achieve the RAOs for the STA. Alternative 1 was not evaluated using this criterion because it calls for no remedial actions.

Alternatives 6, 7, 8, and 10 are less intrusive than the alternatives 4, 5, and 9 that use proposed soil excavations or auguring techniques to remediate the STA soils. Because alternatives 6,7, 8 and 10 minimize disturbance to soils, the risk of exposure to chemicals in the soil that pose a potential threat to construction workers, the community, and the environment is minimized.

Alternatives 6 and 8 will take on the order of years to achieve RAOs. Alternatives 4, 5, and 9 will achieve RAOs more quickly.

Alternatives 7 and 10 will not achieve RAOs at all.

6.2.6 Implementability

Implementability is used as a measure of both the technical and administrative feasibility for constructing, operating, and maintaining a remedial action alternative. The required products and services necessary to implement the seven proposed alternatives are readily available.

Alternative 1 is the most easily implementable because it requires no action. The remaining alternatives are all implementable, but vary in their complexity.

Alternatives 4a and 4b are the least favored alternatives relative to the implementability criterion. For these two alternatives, the large volumes of soils that would need to be handled, the concerns regarding the increased community exposure to soils, and the extensive handling and transportation plans that would be required for these actions all combine to make these alternatives harder to implement. Alternatives 4c and 4d would be implementable as the proposed soil volume is significantly less than under 4a and 4b. Alternatives 5c and 5d are implementable. The soil volumes under 5c and 5d are able to be placed into the South Mesa CAMU without compromising the needed capacity.

Alternative 6 is implementable. SVE would require standard industry construction techniques.

Alternatives 7 and 8 are difficult to implement due to the large size of the area to be treated, but can be accomplished.

Alternative 9 is moderately implementable. Soil stabilization can be applied to large areas, however, the proximity of the BMI landfills will limit the applicability of this Alternative.

Alternative 10 is moderately implementable. The depth of the slurry wall would be approximately 70 feet bgs which can be accomplished using standard construction equipment.

6.2.7 Cost

The relative cost of each alternative is presented in Table 6-1. The highest cost is for Alternative 4a. The lowest cost is for Alternative 1.

6.2.8 State and Community Acceptance

The evaluation of NDEP and community acceptance will be based on input received during the NDEP review process and from the public. The various alternatives were discussed in a public meeting on July 12, 2007. Transcripts of the meeting are available and part of the administrative record. Other than a few clarifying questions, there were no significant public comments. The public agreed with the recommended alterative discussed below. BRC's discussions with the NDEP during the development of the RAS also indicate general agreement by NDEP that the recommended alternative below is acceptable to the NDEP.

6.3 Recommended STA Remedial Alternative

Based on the evaluation presented in Section 6.2, Alternative 5d is the recommended remedial approach for the STA. Under this alternative, trench wastes will be excavated to the greatest extent practically possible, and placed in the CAMU (Borrow Pit Area). It is noted that approximately 100 cubic yards of soil in the vicinity of boring BS-11 (Figure 5-2) will not be placed in the CAMU due to PCB concentrations that exceed 50 mg/kg. This area will be

delineated using the existing data from the step-out sampling. These PCB-containing wastes will be excavated and sent offsite to a suitable disposal facility.

To ensure that the closed BMI landfills and ponds on offsite locations to the south of the STA are not disturbed, the southern most trenches will be shored; sidewalls will not be sloped. Excavations will not extend beyond temporary shoring as shown on Figure 5-2.

Trench excavations will be backfilled using native soil scraped from the surface of STA area (outside the areas where wastes were interred); the STA area grade elevation will be dropped prior to placement of the CAMU liner on which the Eastside area wastes will be disposed.

As noted earlier, implementation of this recommended remedial alterative will also include the other baseline remedial activities below:

- Placement of the CAMU itself (including its liner, leachate collection layer, waste material, and the cap) on the STA;

- Institutional controls for the entire CAMU, including the STA,

- Upgradient and downgradient groundwater monitoring and potential treatment, if needed, based on the results of such monitoring (see section 5.3.1 for details).

- Placement of RCRA Subtitle C equivalent covers over the closed BMI Landfill North and South Lobes.

7. References

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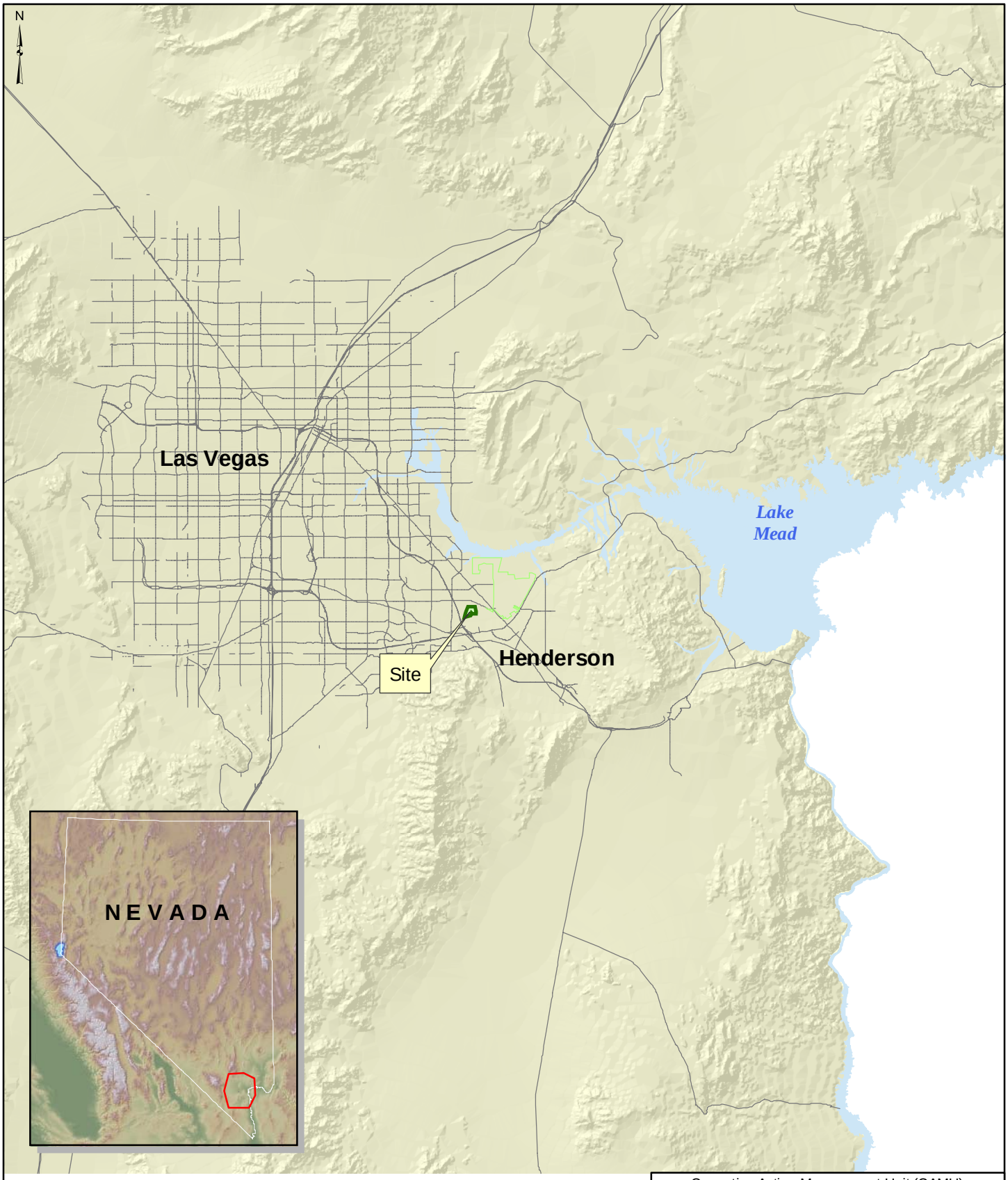


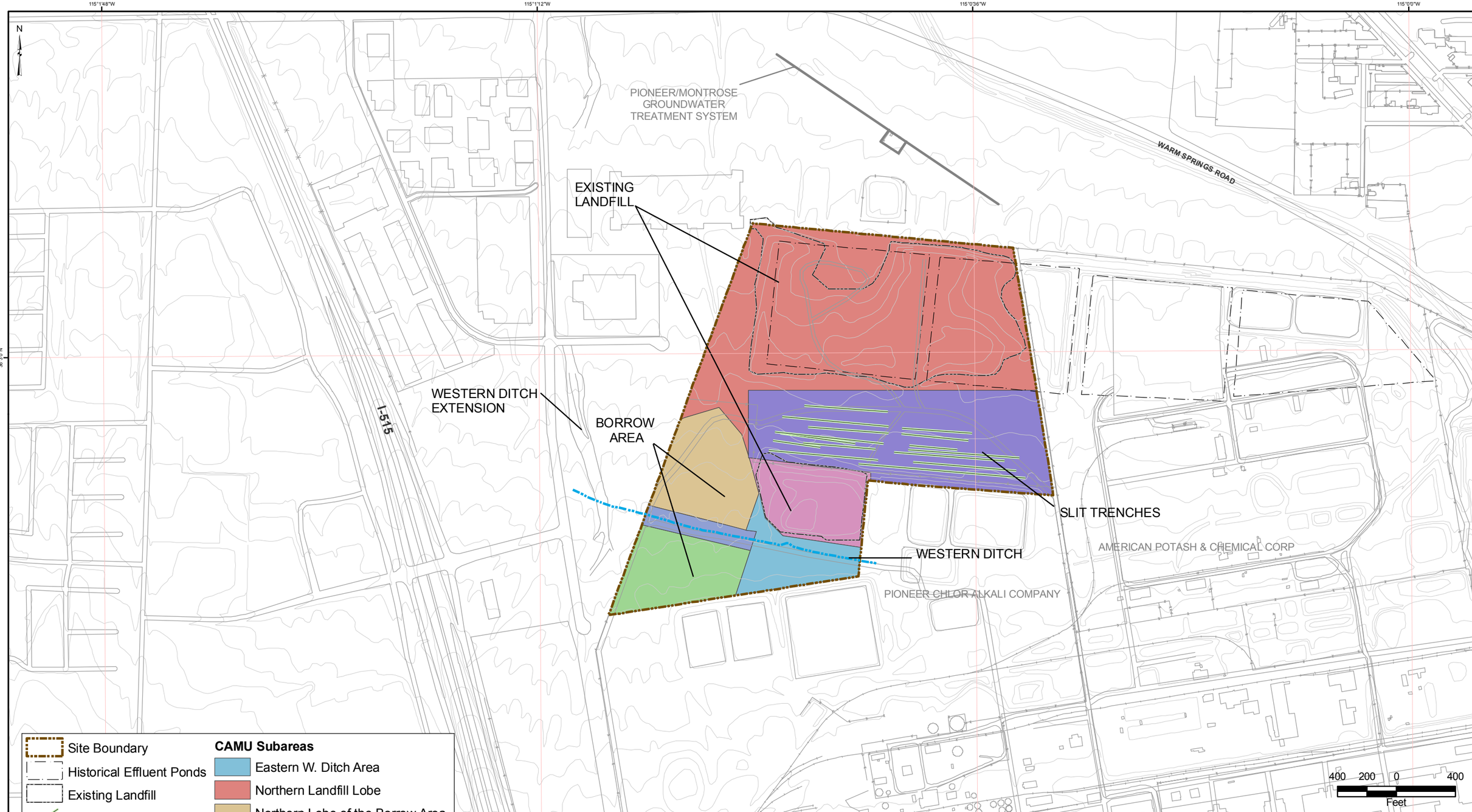
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

FIGURE 1-1

SITE LOCATION

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	06/05/07	FILE: GIS/BRC/CAMU/FIGURE_1-1.MXD



Site Boundary
Historical Effluent Ponds
Existing Landfill
Slit Trenches
Western Ditch

CAMU Subareas

- Eastern W. Ditch Area
- Northern Landfill Lobe
- Northern Lobe of the Borrow Area
- Slit Trench Area (STA)
- Southern Landfill Lobe
- Southern Lobe of the Borrow Area
- Western W. Ditch Area

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

FIGURE 1-2

SITE PLAN

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	06/05/07	FILE: GIS/BRC/CAMU/FIGURE_1-2.MXD

Current (Fall 2006) Aerial Photograph (from Clark County)

Site Boundary

Existing Landfill

Proposed Landfill

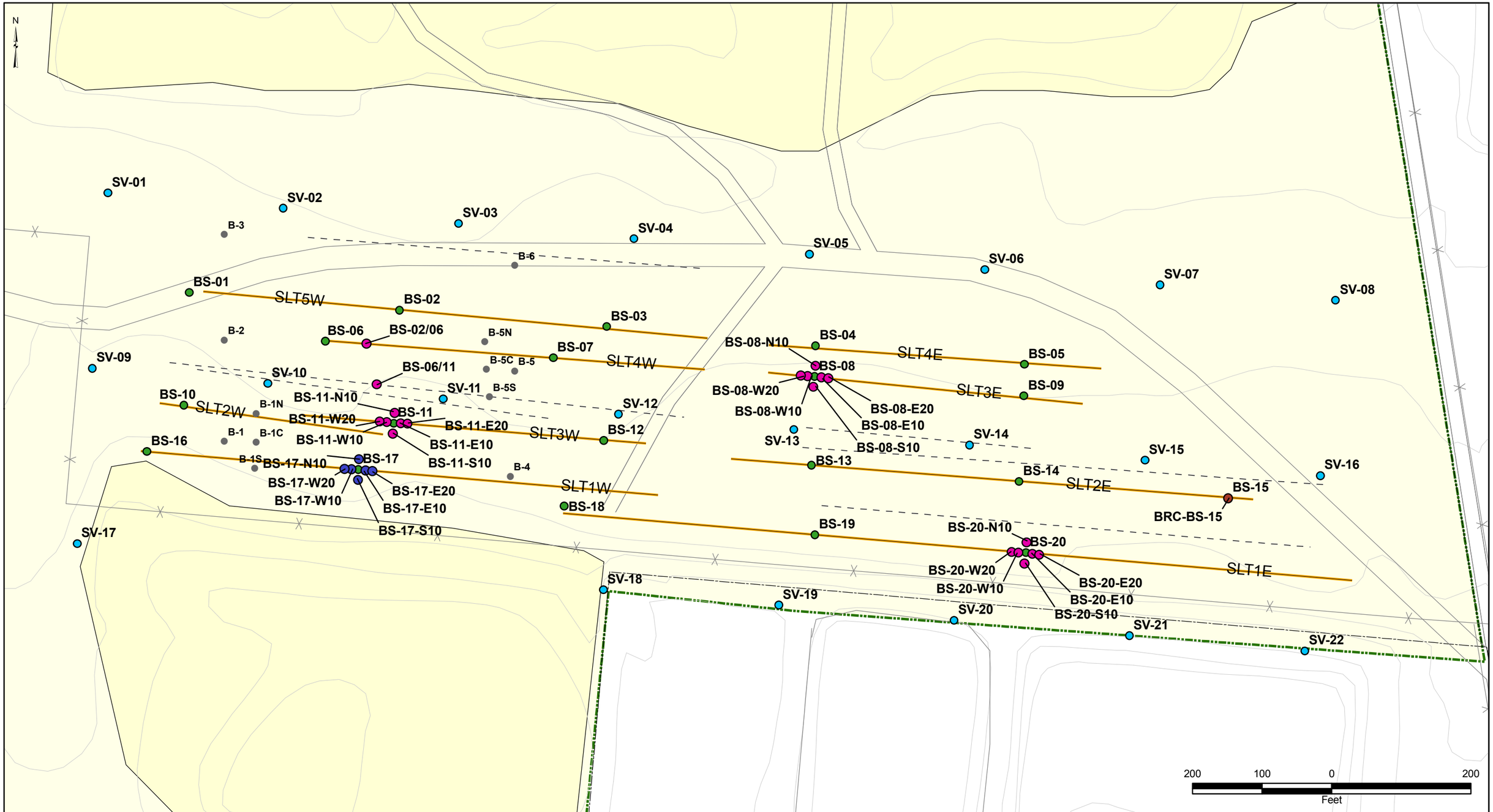
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

FIGURE 1-3

SITE BOUNDARY

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
ERM MKJ	06/05/07	FILE: GIS/BRC/CAMU/FIGURE_1-3.MXD



Site Boundary

Existing Landfill

Previous Slit Trench Boring Locations

- 2005 Soil Boring Location
- 2005 Soil Vapor Location
- Historical Boring Locations

2006 Supplemental Sampling Locations

- 10 feet bgs
- 10 and 20 feet bgs
- 10, 20, and 30 feet bgs

Slit Trench Identified from Historical Aerials and Verified with Geophysics

Line Features Identified in Historical Aerials but Not Verified with Geophysics

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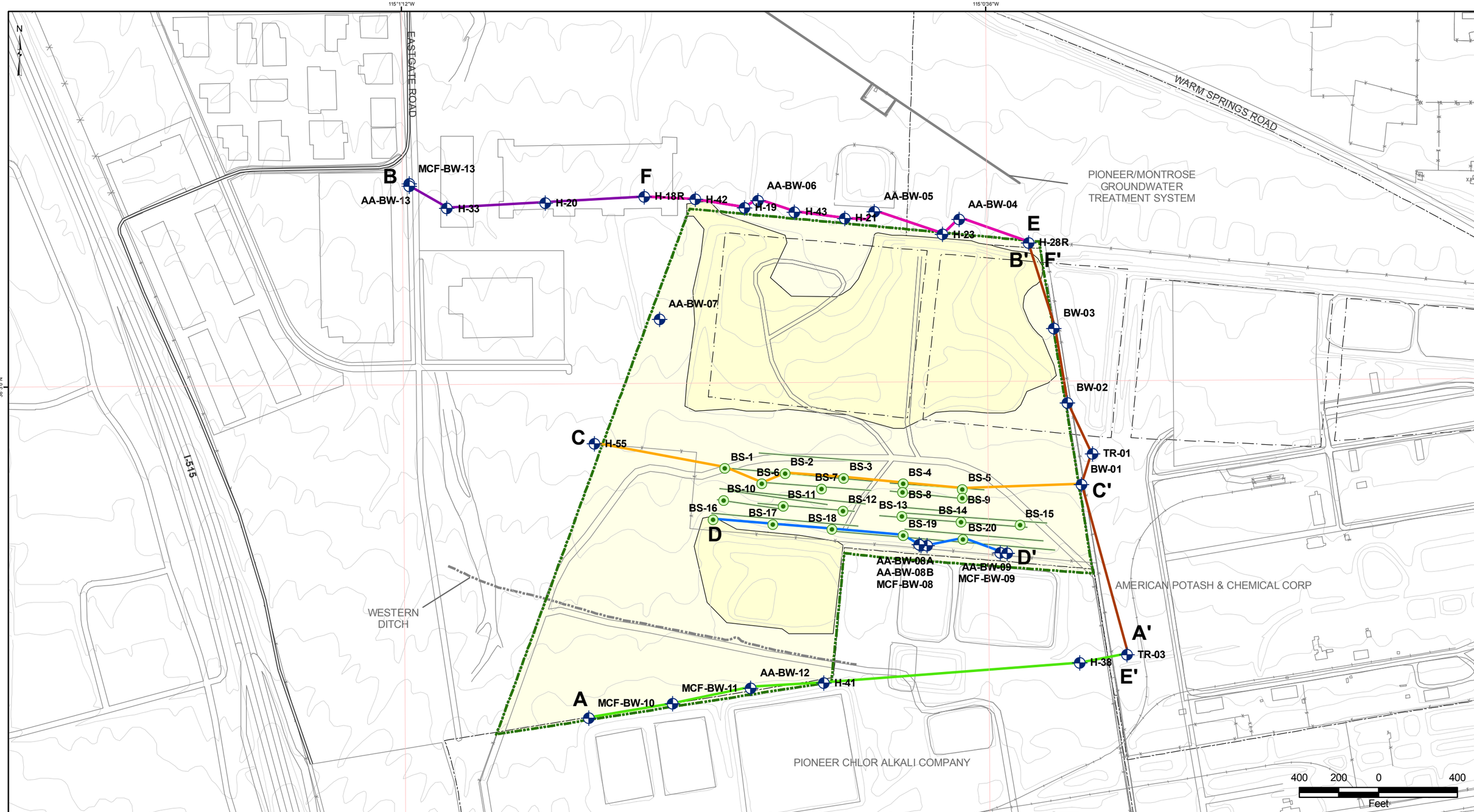
FIGURE 1-4

SLIT TRENCH AREA SAMPLE LOCATIONS

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	06/05/07	FILE: GIS/BRC/CAMU/SUPPL_SLIT-TRENCH.MXD



Site Boundary
Former Effluent Ponds
Existing Landfill
Slit Trenches
Monitoring Well
STA Soil Boring

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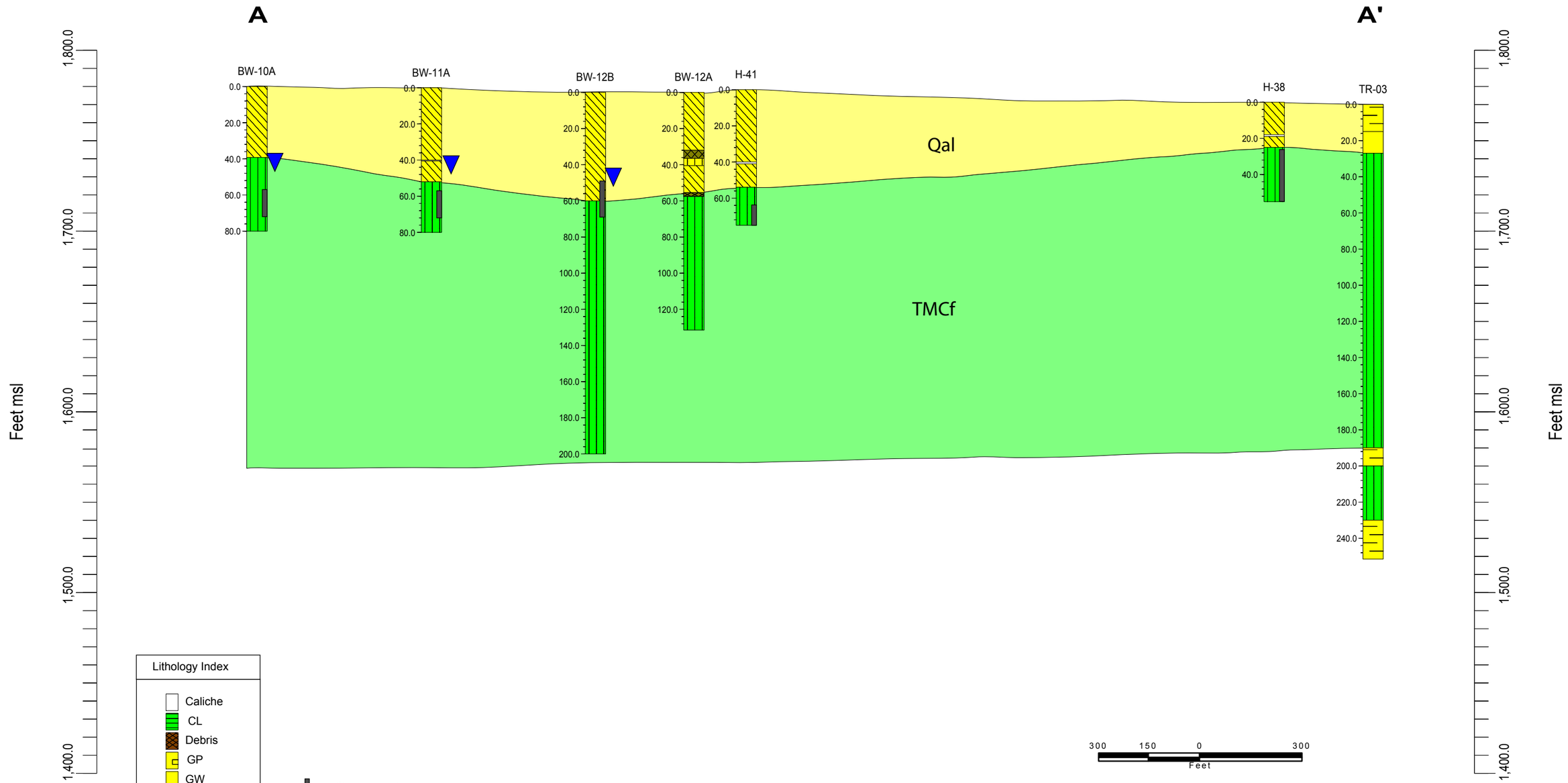
FIGURE 2-1

CROSS-SECTION LOCATIONS

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	06/05/07	FILE: GIS/BRC/CAMU/FIGURE_2-1.MXD



Lithology Index

- Caliche
- CL
- Debris
- GP
- GW
- ML
- SC
- SM
- SM-ML
- SP
- SP-SM
- SW

= Screen Interval

= Qal Water Level*

= UMCf Water Level*

Vertical Scale = 4x Horizonal Scale

Qa = Quaternary alluvium

TMCf = Tertiary Muddy Creek formation

Note: Screen intervals are shown for wells with available data.
Water levels are shown only for those wells measured by BRC in 2005.
For soil lithology details, please see the individual boring logs.
Boring BW-12A was an initial exploratory boring, and no well was installed.

*Water levels are based on measurements from each well installed in the respective soil boring location.

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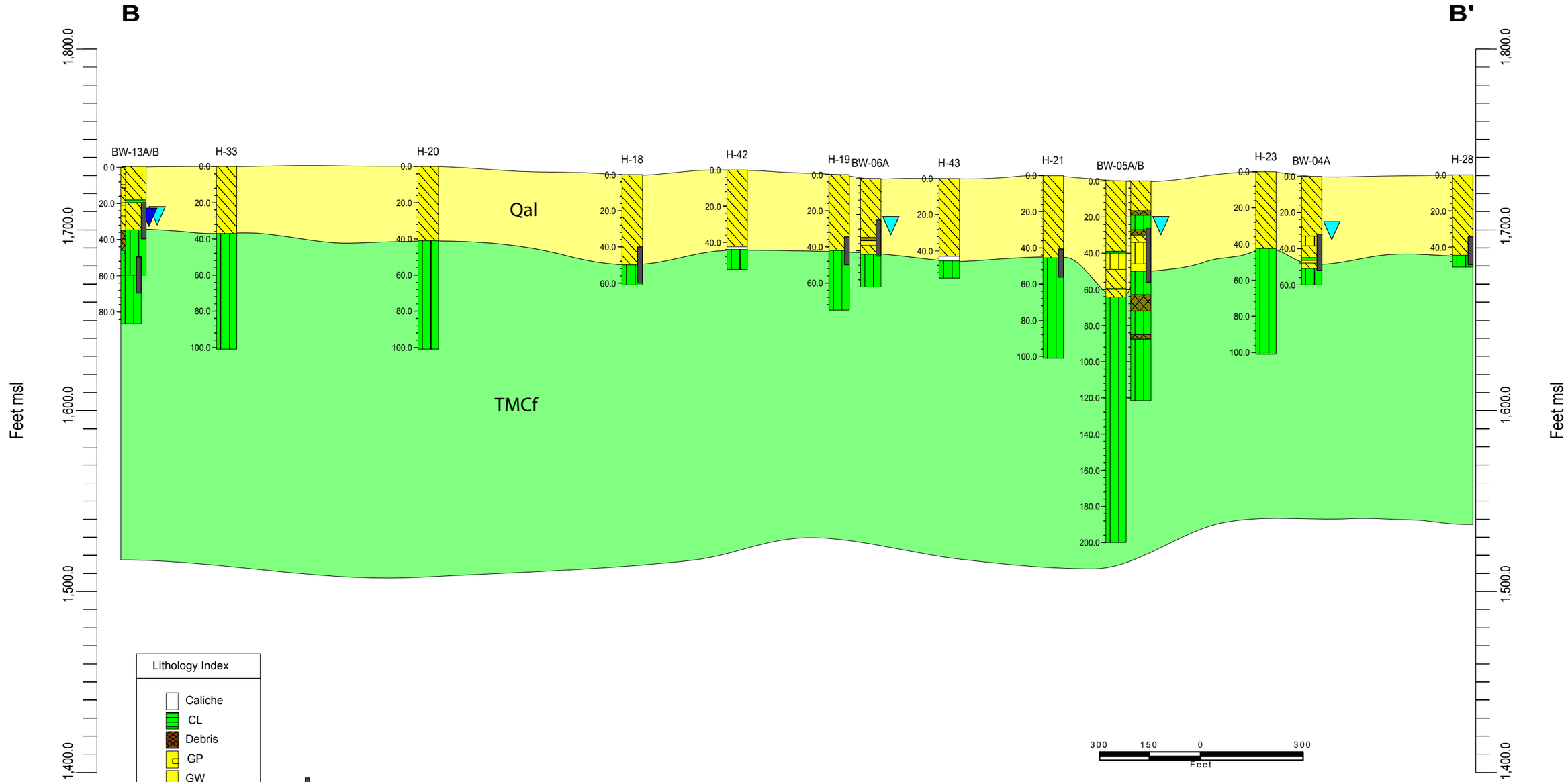
FIGURE 2-2

BRC CAMU AREA
CROSS-SECTION A-A'

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	06/05/07	FILE: GIS/BRC/2005_CAMU/CROSS-SECTIONS.AI



Lithology Index

- Caliche
- CL
- Debris
- GP
- GW
- ML
- SC
- SM
- SM-ML
- SP
- SP-SM
- SW

= Screen Interval

= Qal Water Level*

= UMCf Water Level*

Vertical Scale = 4x Horizonal Scale

Qa = Quaternary alluvium

TMCf = Tertiary Muddy Creek formation

Note: Screen intervals are shown for wells with available data.
Water levels are shown only for those wells measured by BRC in 2005.
For soil lithology details, please see the individual boring logs.
Boring BW-05A was an initial exploratory boring, and no well was installed.

*Water levels are based on measurements from each well installed in the respective soil boring location.

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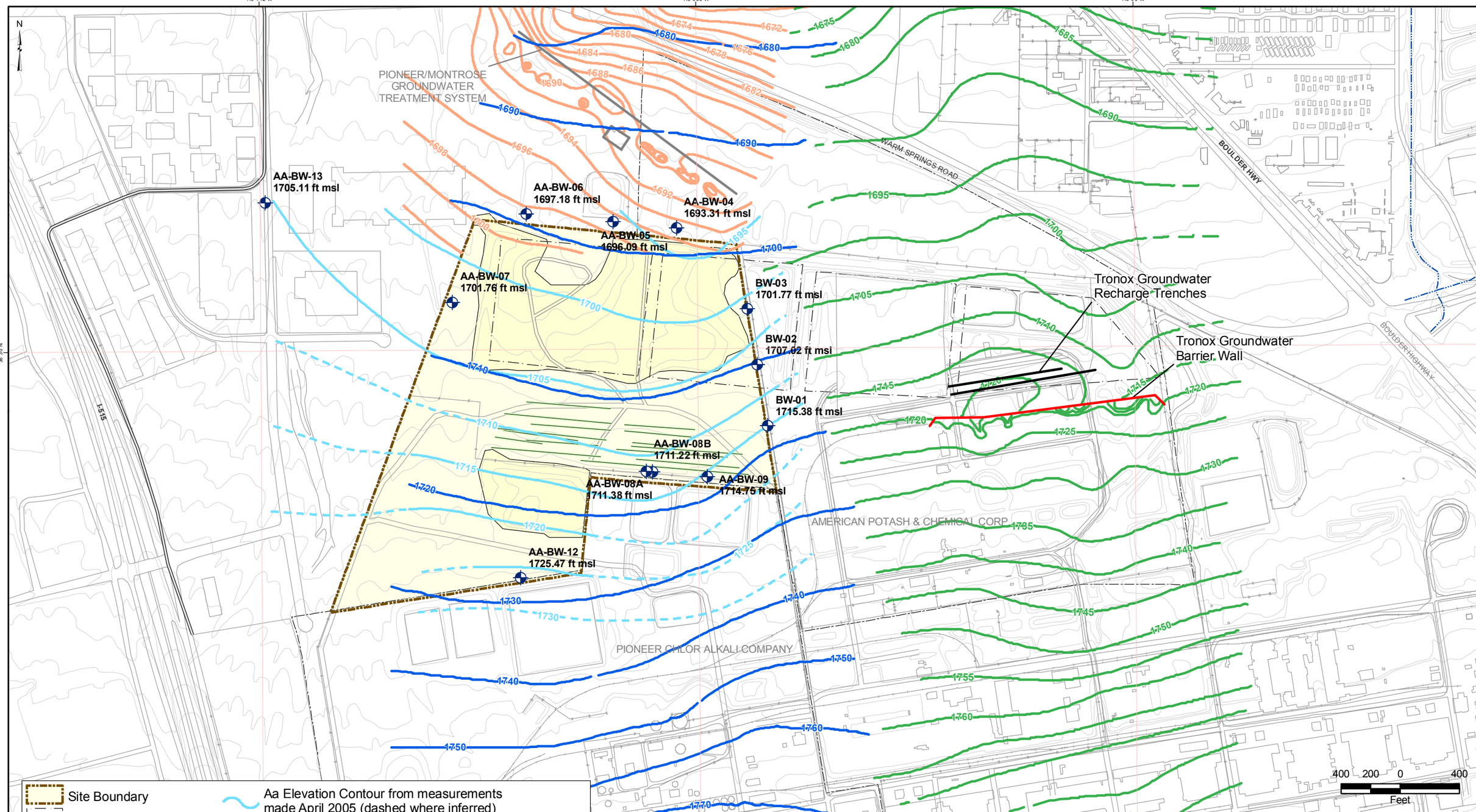
FIGURE 2-3

BRC CAMU AREA
CROSS-SECTION B-B'

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	06/05/07	FILE: GIS/BRC/2005_CAMU/CROSS-SECTIONS.AI



Site Boundary
Historical Effluent Ponds
Existing Landfill
Slit Trenches
Monitoring Wells
Aa Elevation Contour from measurements made April 2005 (dashed where inferred)
Aa Contours from Pioneer/Stauffer/Montrose 1st Quarter 2007 Groundwater Monitoring Report
Aa Contours from Tronox December 2006 Semi-Annual Performance Report
Aa Contours from Pioneer/Stauffer/Montrose 1st Quarter 2007 Groundwater Treatment System

Notes:
All data are elevations in feet above mean sea level (msl).
Elevations shown are from measurements made April 2005 (MWH, July 2005).

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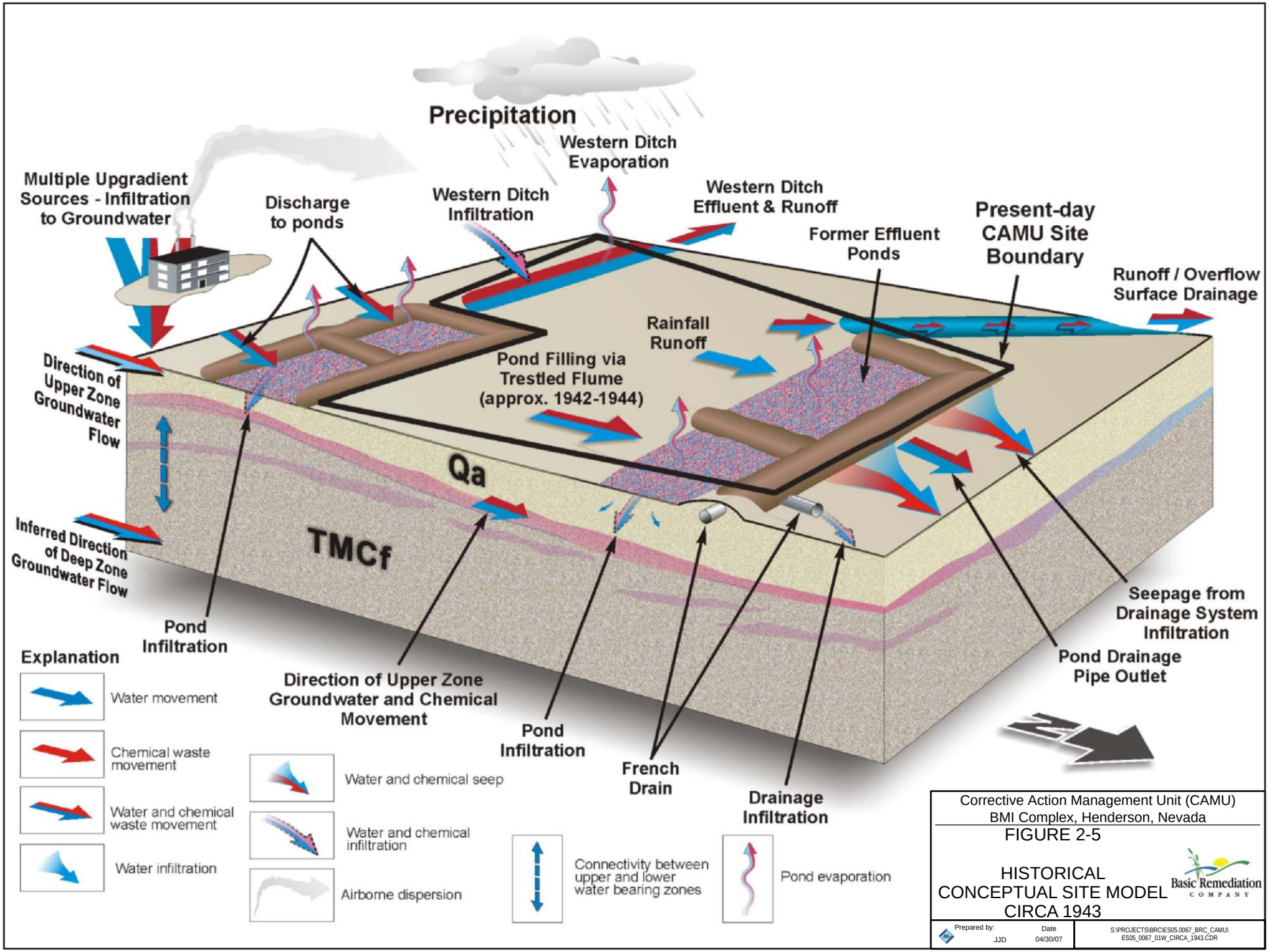
BMI Complex, Henderson, Nevada

FIGURE 2-4

POTENTIOMETRIC SURFACE MAP, ALLUVIAL AQUIFER

Basic Remediation COMPANY

Prepared by: MKJ
Date 06/05/07
JOB No. 0064276
FILE: GIS/BRC/CAMU/WATER_ELEV.MXD



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BMI Complex, Henderson, Nevada

FIGURE 2-5

HISTORICAL CONCEPTUAL SITE MODEL CIRCA 1943

Basic Remediation COMPANY

Prepared by:	Date	
JJD	04/30/07	S:\PROJECTS\BRC\ES05.0067_BRC_CAMU\ ES05_0067_01W_CIRCA_1943.CDR

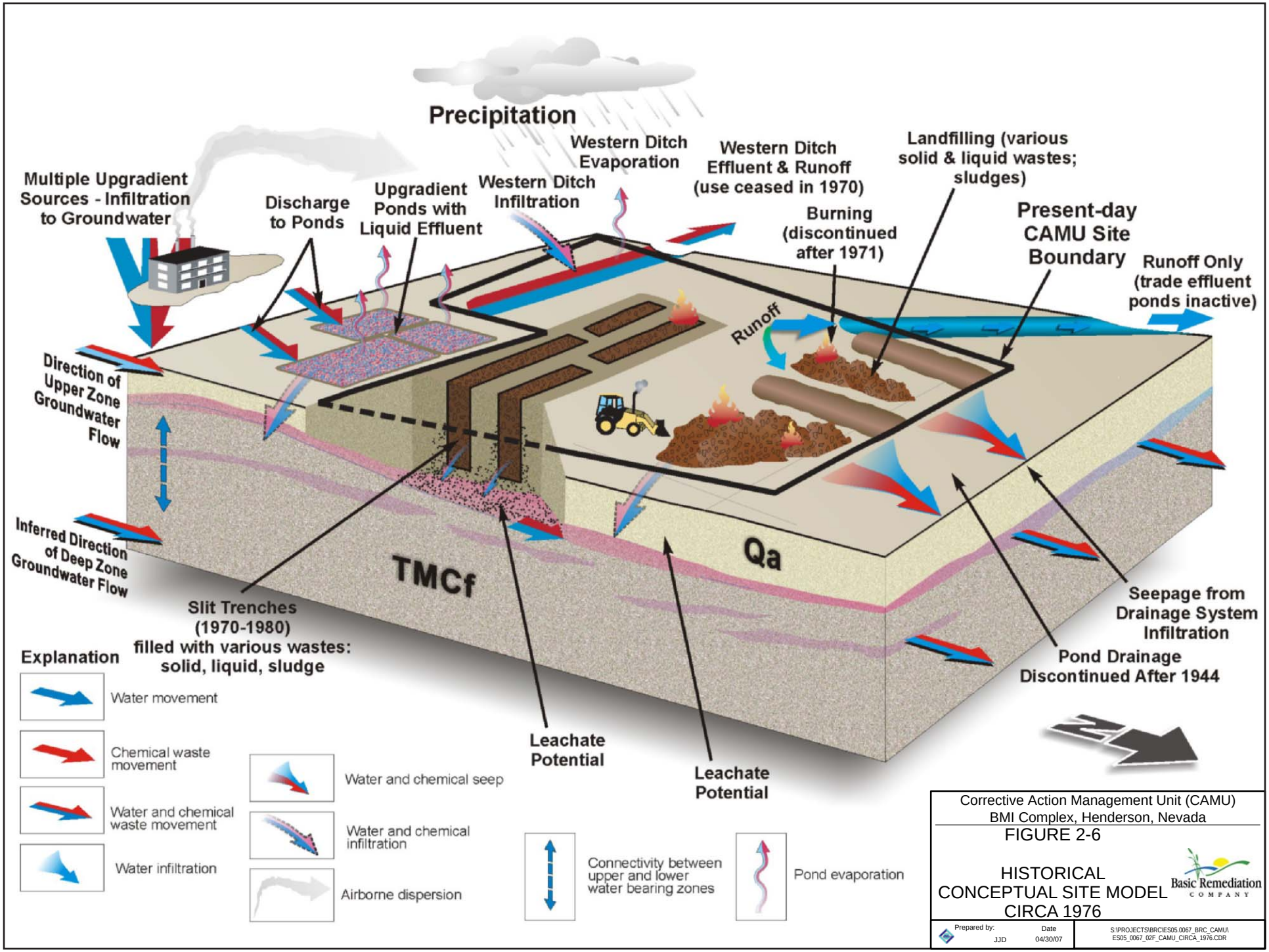

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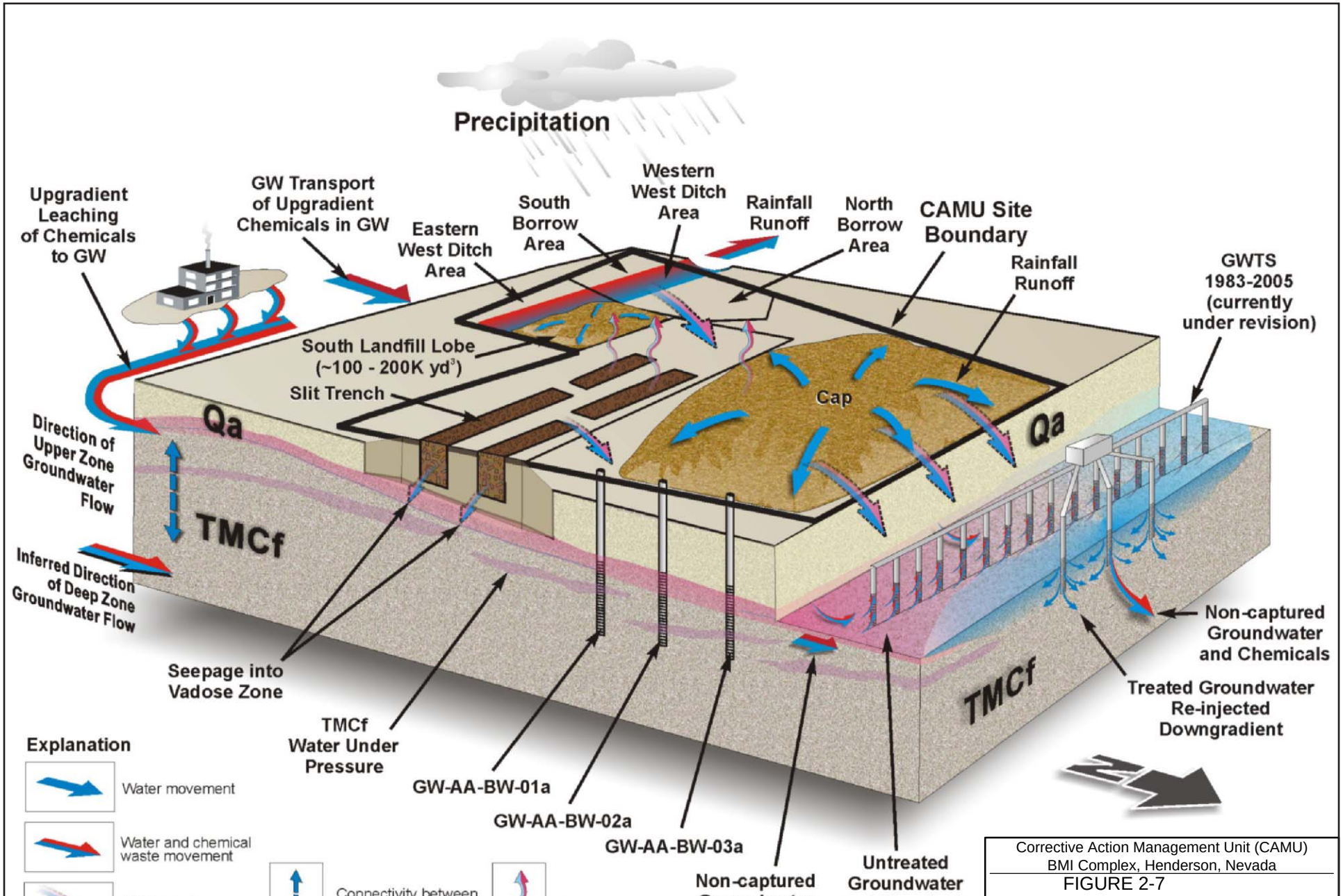
FIGURE 2-6

HISTORICAL CONCEPTUAL SITE MODEL CIRCA 1976

Basic Remediation COMPANY

Prepared by:	Date	
JJD	04/30/07	S:\PROJECTS\BRC\ES05.0067_BRC_CAMU\ ES05_0067_02F_CAMU_CIRCA_1976.CDR



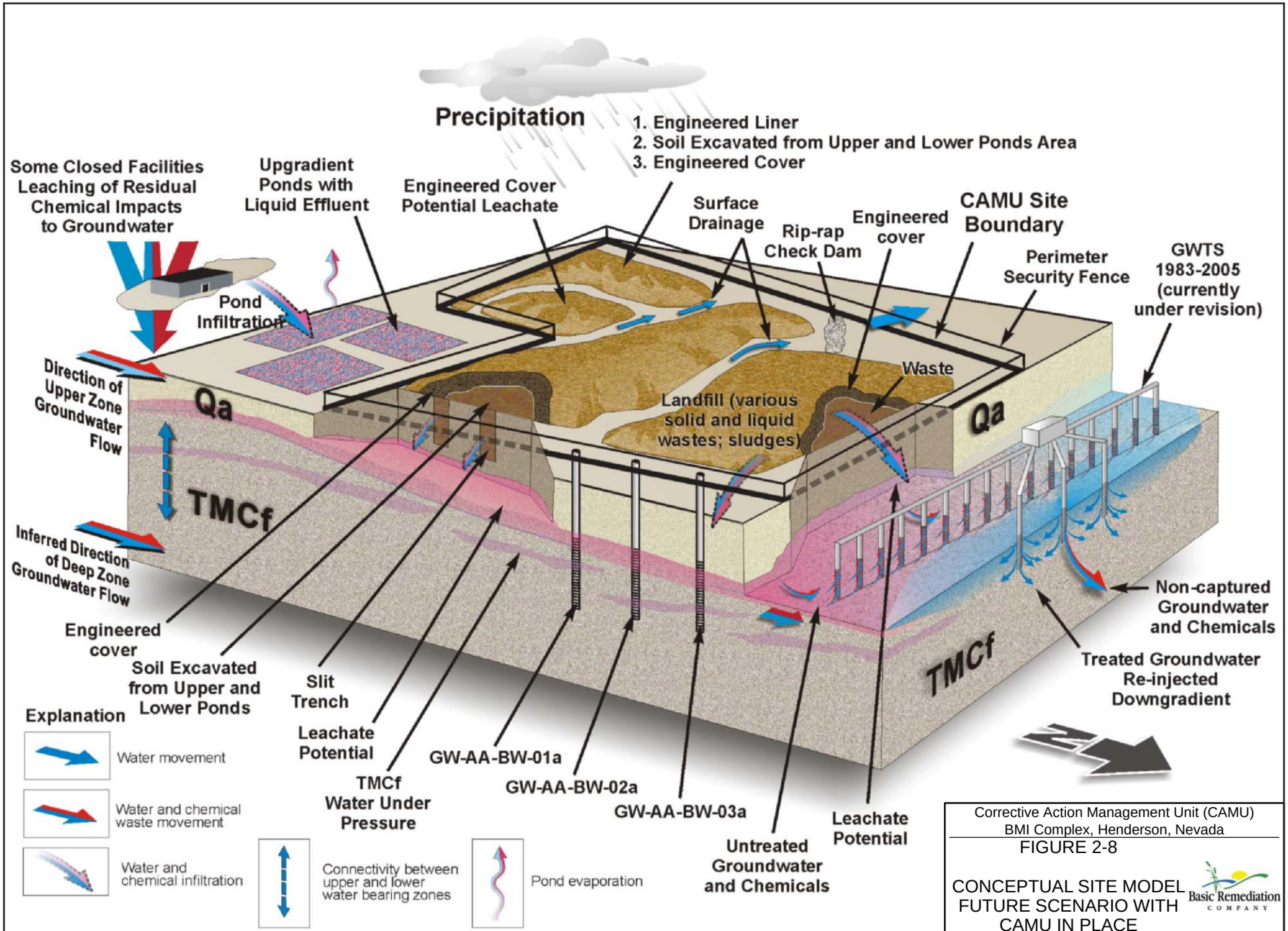
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

FIGURE 2-7

HISTORICAL CONCEPTUAL SITE MODEL CIRCA 2005

Basic Remediation COMPANY

Prepared by:	Date	
JJD	04/30/07	S:\PROJECTS\BRC\ES05.0067_BRC_CAMU\VR\ES05_0067_03W_CAMU_CIRCA_2005.CDR



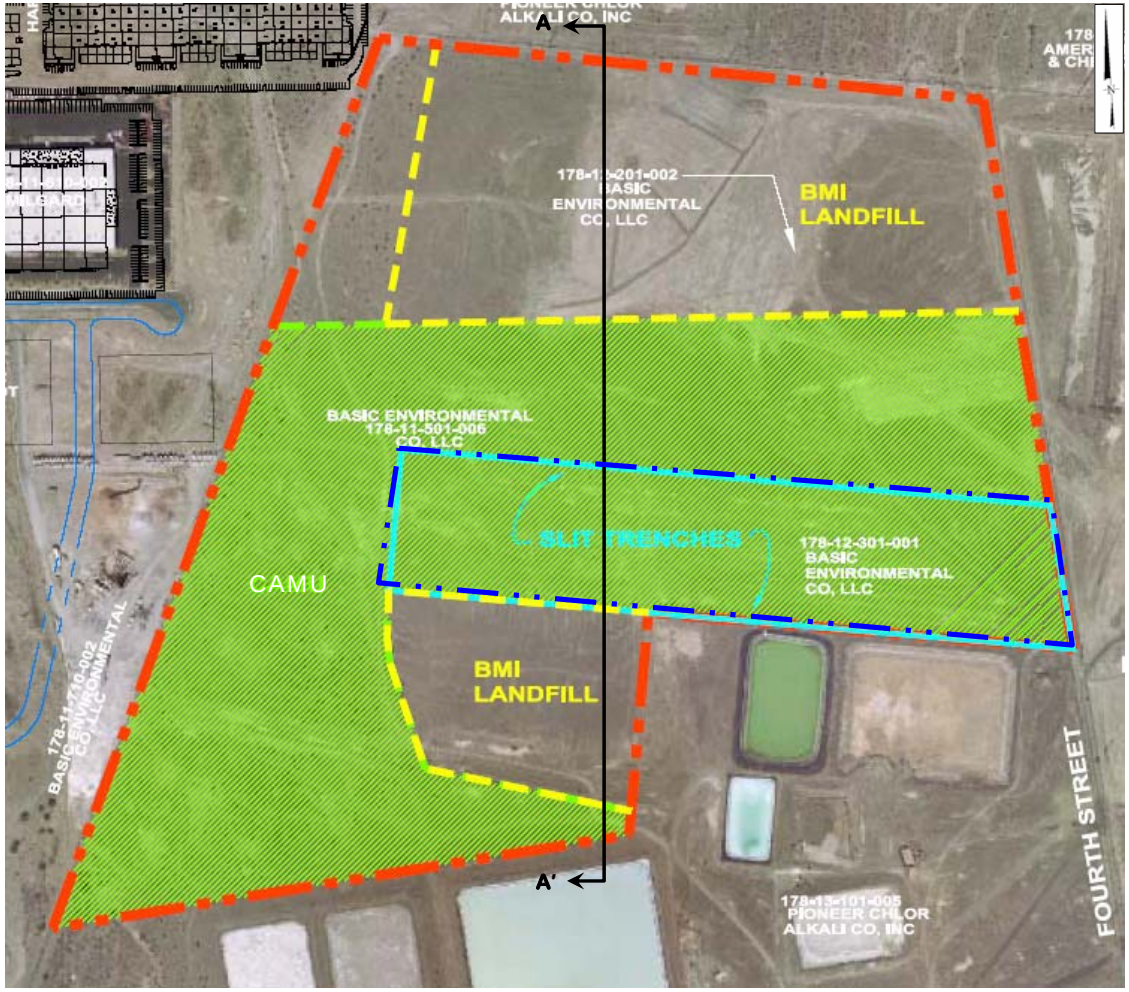
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

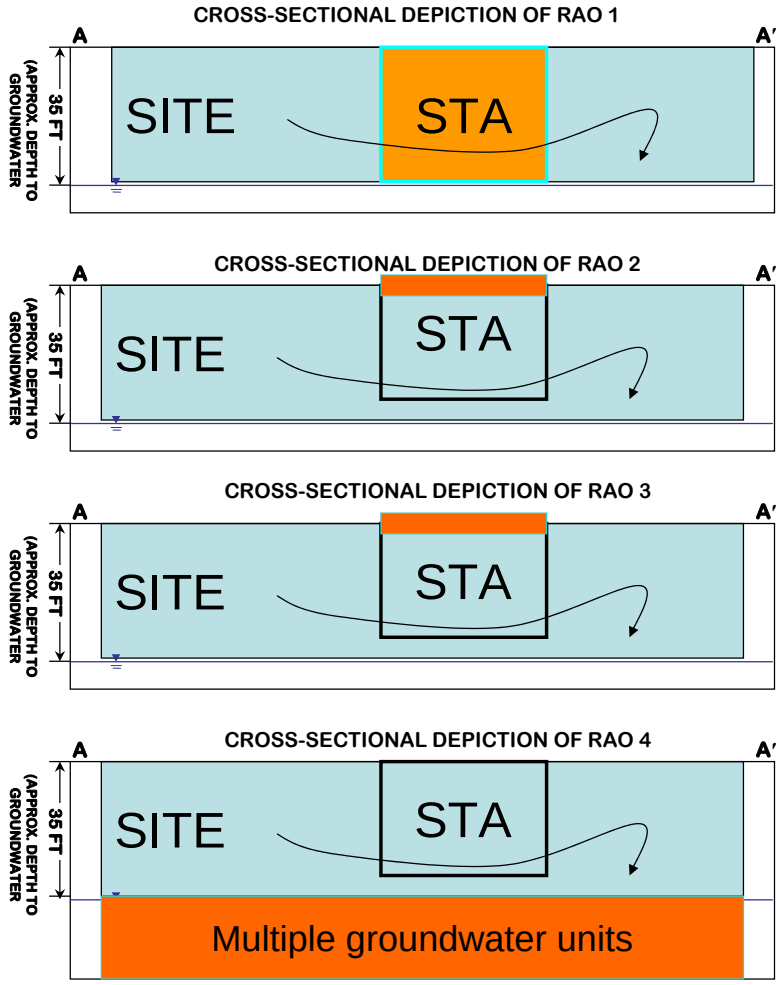
FIGURE 2-8

CONCEPTUAL SITE MODEL FUTURE SCENARIO WITH CAMU IN PLACE

Basic Remediation COMPANY

Prepared by:	Date	
JJD	04/30/07	S:\PROJECTS\BRC\ES05.0067_BRC_CAMU\ ES05_0067_04F_FUTURE_SCENARIO.CDR





LEGEND

- EXTENT OF CAMU
- EXTENT OF AREA TO WHICH RAO 4 APPLIES
- EXTENT OF AREA TO WHICH RAOS 1, 2, AND 3 APPLY
- EXTENT OF CROSS SECTION TO WHICH THE RAOs APPLY
- EXTENT OF BMI LANDFILLS

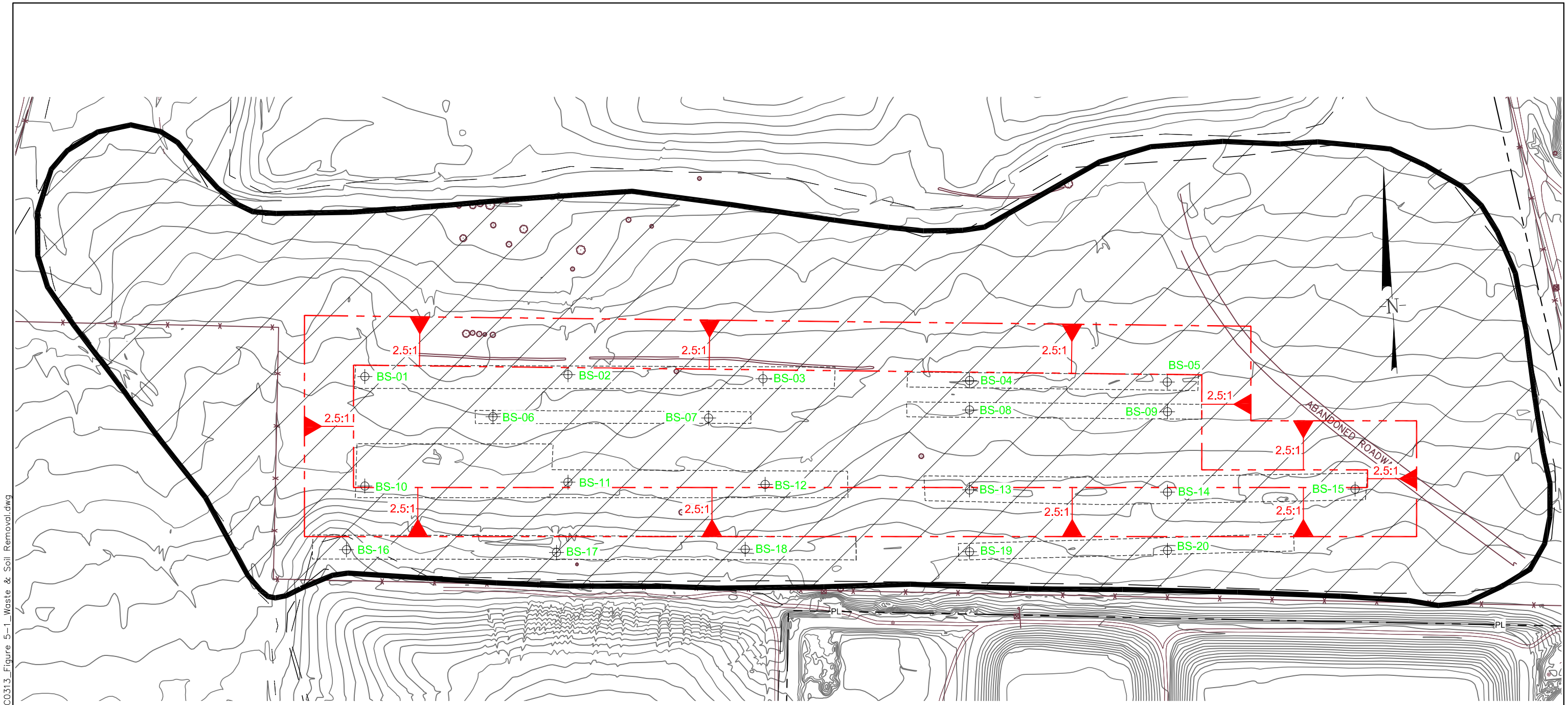
NOT TO SCALE

REMEDIAL ACTION OBJECTIVE LOCATION

Geosyntec consultants

DATE:	JULY 2007	FIGURE
PROJECT NO.:	SC0313	4-1

P:\PRJ\Current Projects\SC0313\RAS\2007 Revised RAS\Figures\Figure 4-1.ppt



LEGEND

EXTENT OF STA AND APPROXIMATE LIMITS OF EXCAVATION (ALTERNATIVE 4a & 5a)

APPROXIMATE LIMITS OF SLIT TRENCH EXCAVATION (ALTERNATIVE 4b & 5b)

APPROXIMATE SLIT TRENCH LIMITS

BS-04 BORING LOCATION - MWH

150 75 0 150

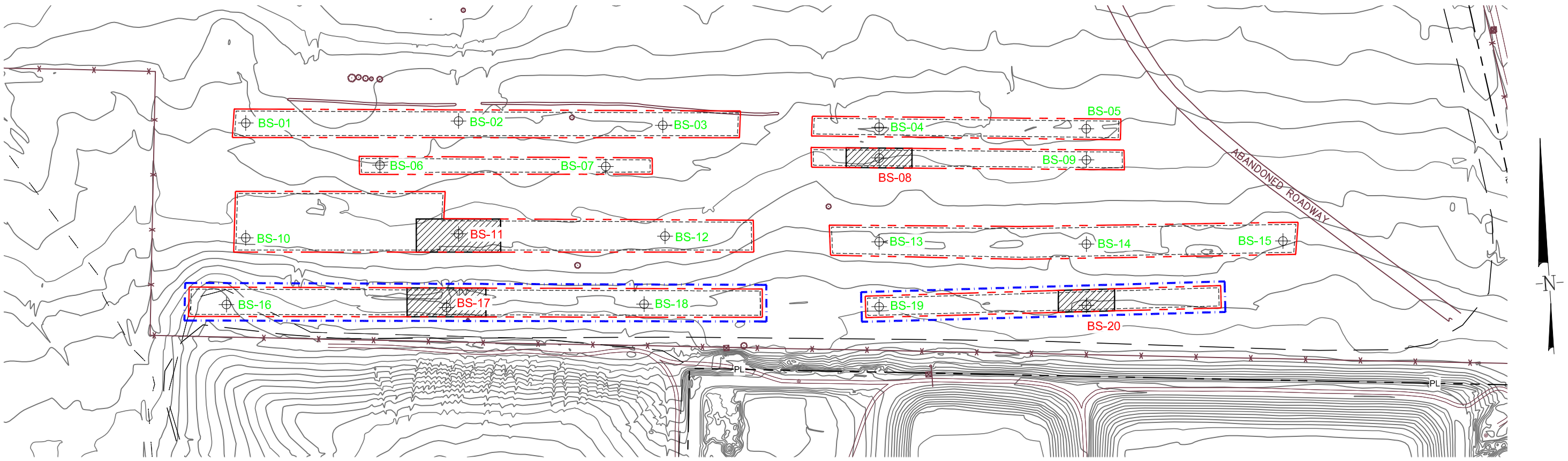
SCALE IN FEET

BRC SLIT TRENCH AREA RAS
PROPOSED EXCAVATION AREAS FOR
ALTERNATIVE 4a, 4b, 5a, & 5b

Geosyntec consultants

DATE:	JULY 2007	FIGURE
PROJECT NO.	SC0313	5-1

P:\PRJ\SDCadd\CADD\SC0313\BRC\figures\Slit Trench Areas\SC0313_Figure 5-1_Waste & Soil Removal.dwg



LEGEND

	APPROXIMATE LIMITS OF HOT SPOT EXCAVATIONS (ALTERNATIVE 4c & 5c)
	APPROXIMATE LIMITS OF SILT TRENCH EXCAVATION (ALTERNATIVES 4d & 5d)
	TEMPORARY SHORING
	APPROXIMATE SLIT TRENCH LIMITS
BS-04	BORING LOCATION - MWH
BS-08	HOT SPOT BORING LOCATIONS

150 75 0 150

SCALE IN FEET

BRC SLIT TRENCH AREA RAS
PROPOSED EXCAVATION AREAS FOR
ALTERNATIVES 4c, 4d, 5c, & 5d

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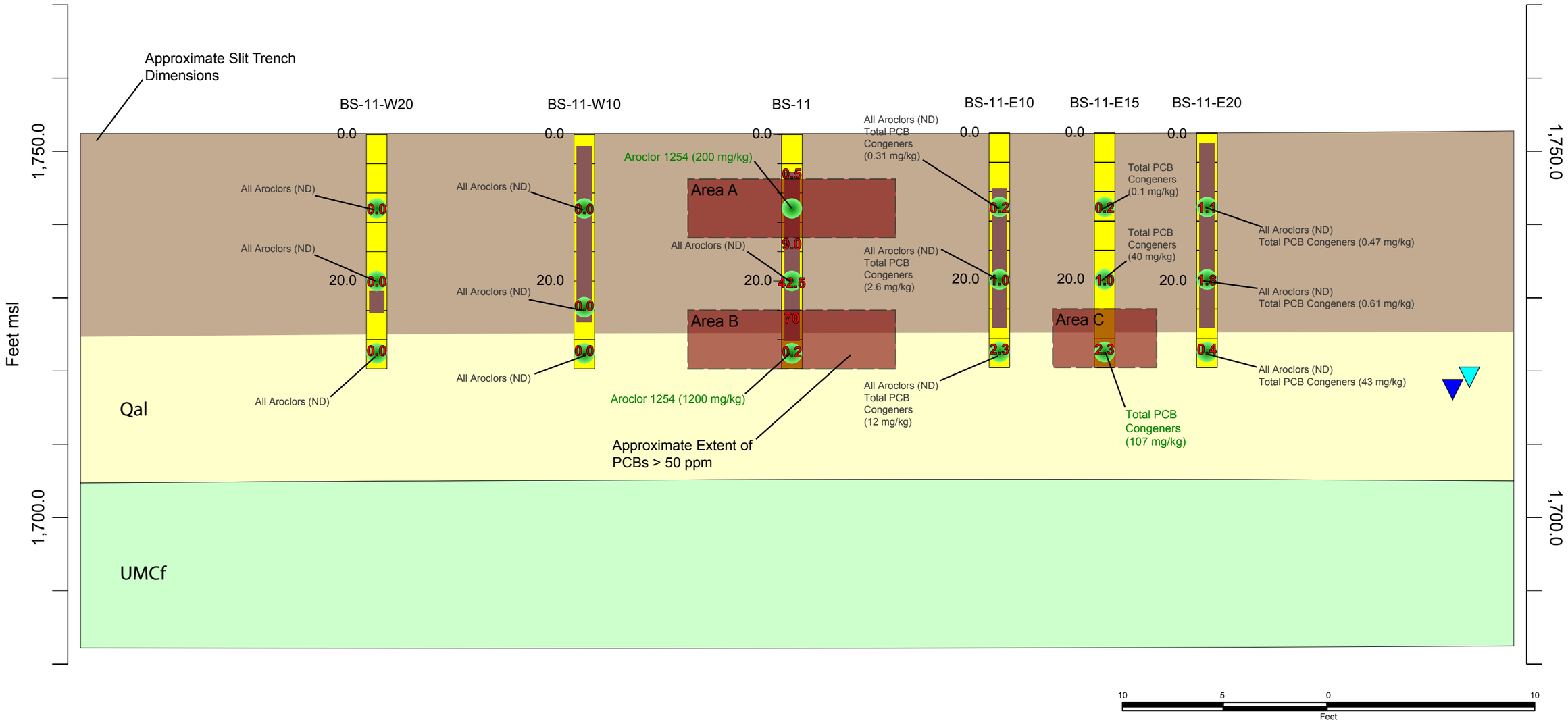
DATE:	JULY 2007	FIGURE
PROJECT NO.	SC0313	5-2

NOTE: CONCEPTUAL DRAWING; EXCAVATION BOUNDARIES ARE APPROXIMATE.

P:\PRJ\SDCadd\CADD\SC0313\BRC\figures\Slit Trench Areas\SC0313_Figure 5-2_Discreet Waste Removal.dwg



2.5 = PID Reading

= Soil Sample Location

= Debris

= Soil Boring

= Qal Water Level (AA-BW-08 3/15/05)

= UMCf Water Level (MCF-BW-09 3/12/05)

Vertical Scale = 1/3x Horizontal Scale

Qal = Quaternary alluvium

UMCf = Upper Muddy Creek formation

Notes:

= Exceeds TSCA 50 ppm Level

Volume Estimates:
Area A: 10 ft. (length) x 10 ft. (width) x 7.5 ft. (depth) = 750 cubic ft. (27.8 cu. yds.)
Area B: 10 ft. (length) x 10 ft. (width) x 7.5 ft. (depth) = 750 cubic ft. (27.8 cu. yds.)
Area C: 5 ft. (length) x 10 ft. (width) x 7.5 ft. (depth) = 375 cubic ft. (13.9 cu. yds.)

Total Volume = 1,875 cubic ft. (69.5 cu. yds.)

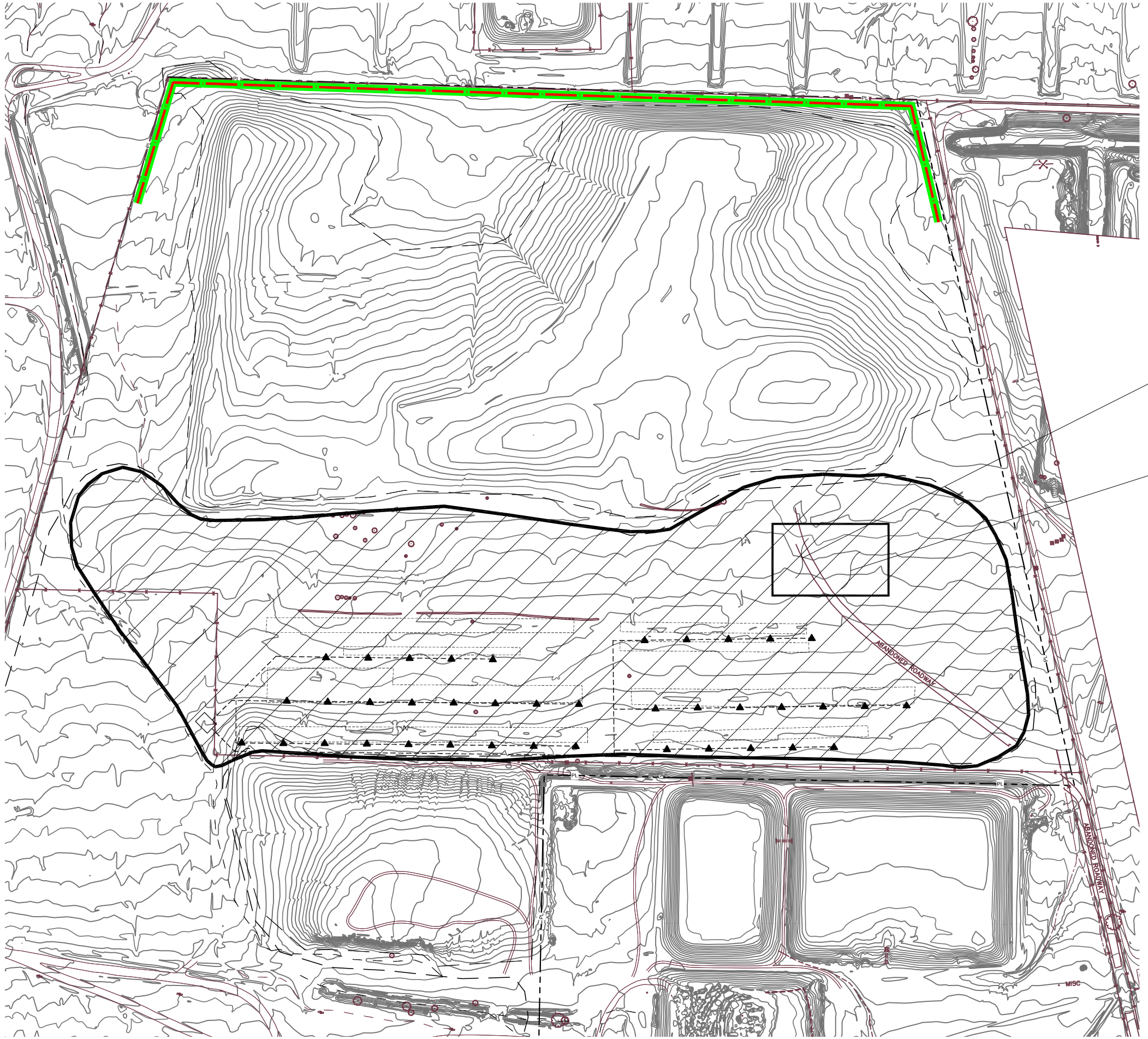
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

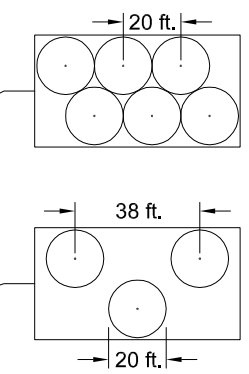
FIGURE 5-3

APPROXIMATE EXTENT OF PCB TSCA EXCEEDANCES AROUND LOCATION BS-11

Basic Remediation COMPANY

Prepared by:	Date	JOB No. 0064276
MKJ	07/18/07	FILE: GIS/BRC/CAMU/SLIT_TRENCHES/BS-11_PCBs.AI





ALTERNATIVE 9: IN SITU CHEMICAL OXIDATION BY OZONE (90% COVERAGE)

ALTERNATIVE 8: ENHANCED IN SITU BIOLOGICAL REDUCTION (25% COVERAGE)

LEGEND

- AREA FOR ALTERNATIVES 6 - 9
- SLURRY WALL (ALTERNATIVE 10)
- PROPOSED SVE LINES (ALTERNATIVE 6)
- PROPOSED SVE WELL (ALTERNATIVES 6)
- APPROXIMATE SLIT TRENCH LIMITS

250 175 0 250

SCALE IN FEET

BRC RAS
PROPOSED LAYOUT FOR
ALTERNATIVES 6 - 11

Geosyntec consultants

DATE:	JULY 2007	FIGURE
PROJECT NO.	SC0313	5-4

P:\PRJ\SDCadd\CADD\SC0313\BRC\figures\Slit Trench Areas\SC0313_Figure 5-3_BRC RAS.dwg

Table 6-1
Summary of Detailed Analysis of Remedial Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short-Term Effectiveness	Implementability	Cost	Community Acceptance	State Acceptance	Sum
1 Baseline Condition/No Action	• Does not improve protectiveness	• Does not comply with RAOs	• Not effective	• No reduction	• Not applicable	• Easily implemented	• No cost	•	•	8
	Unacceptable (0)	Unacceptable (0)	Unacceptable (0)	Unacceptable (0)	Unacceptable (0)	Most favorable alternative (4)	None (4)			
4a Excavation and Off-Site Disposal -entire STA excavation	• Good protection to human health • Good protect to environment • Shipping large volumes off-site potential hazard to community	• Complies with RAOs 1 and 2 • Complies partially with RAO 3 • Does not comply with RAO 4 • Complies with chemical specific requirements	• High effectiveness and permanence	• High volume reduction by removal	• Excellent and quick effectiveness for environment • Controllable exposure to workers • Quick to mitigate human health exposure • High potential for dust	• Difficult	• $387,829,000	•	•	18
	Good, generally favorable (3)	Good, generally favorable (3)	Most favorable alternative (4)	Most favorable alternative (4)	Good, generally favorable (3)	Poor, potentially unfavorable (1)	Very high (0)			
4b Excavation and Off-Site Disposal -partial STA excavation	• Good protection to human health • Good protection to environment • Shipping large volumes off-site potential hazard to community	• Complies with RAOs 1 and 2 • Complies partially with RAO 3 • Does not comply with RAO 4 • Complies with chemical specific requirements	• Good effectiveness • High permanence	• Moderate volume reduction by removal	• Excellent and quick effectiveness for environment • Controllable exposure to workers • Quick to mitigate human health exposure • High potential for dust	• Difficult	• $256,876,000	•	•	17
	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Fair, potentially unfavorable (2)	Very high (0)			
4c Excavation and Off-Site Disposal -hot-spot STA excavation for non-VOCs	• Moderate protection to human health • Moderate protection to environment	• Complies partially with RAOs 1, 2, and 3 • Does not comply with RAO 4 • Does not achieve chemical specific requirements for VOCs	• Fair effectiveness • High permanence	• Low volume reduction by removal	• Quick, moderate effectiveness for environment • Controllable exposure to workers • Quick, moderate mitigation to human health exposure • Moderate potential for dust	• Implementable	• $4,584,000	•	•	16
	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Good, generally favorable (3)	Low (3)			

AO = Remedial action objective
STA = Slit trench area
VOCs = Volatile organic compounds
SVE = Soil vapor extraction
ARARs = Applicable, Relevant, and Appropriate Requirements
Cost rating: 0 = None (4); <10M = Low (3); 10M to 50M = Medium (2); 50M to 100M = High (1); >100M = Very High (0)

Table 6-1
Summary of Detailed Analysis of Remedial Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short-Term Effectiveness	Implementability	Cost	Community Acceptance	State Acceptance	Sum
4d Excavation and Off-Site Disposal - STA waste-only excavation	• Good protection to human health • Good protection to environment	• Complies with RAOs 1 and 2 • Complies partially with RAO 3 • Does not comply with RAO 4 • Complies with chemical specific requirements within the slit trench boundaries	• Good effectiveness • High permanence	• Moderate volume reduction by removal	• Quick, good effectiveness for environment • Controllable exposure to workers • Quick, good mitigation to human health exposure • Moderate potential for dust	• Implementable	• $46,858,000	•	•	19
	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	High (1)			
5a Excavation and On-Site Disposal -4a volume	• Good protection to human health • Good protect to environment	• Complies with RAOs 1 and 2 • Complies partially with RAO 3 • Does not comply with RAO 4 • Complies with chemical specific requirements	• High effectiveness and permanence	• High volume reduction by removal	• Excellent and quick effectiveness for environment • Controllable exposure to workers • Quick to mitigate human health exposure • High potential for dust	• Difficult	• $12,215,000	•	•	20
	Good, generally favorable (3)	Good, generally favorable (3)	Most favorable alternative (4)	Most favorable alternative (4)	Good, generally favorable (3)	Poor, potentially unfavorable (1)	Medium (2)			
5b Excavation and On-Site Disposal -4b volume	• Good protection to human health • Good protection to environment	• Complies with RAOs 1 and 2 • Complies partially with RAO 3 • Does not comply with RAO 4 • Complies with chemical specific requirements	• Good effectiveness • High permanence	• Moderate volume reduction by removal	• Excellent and quick effectiveness for environment • Controllable exposure to workers • Quick to mitigate human health exposure • High potential for dust	• Difficult	• $8,086,000	•	•	20
	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Fair, potentially unfavorable (2)	Low (3)			
5c Excavation and On-Site Disposal -4c volume	• Moderate protection to human health • Moderate protection to environment	• Complies partially with RAO 1, 2, and 3 • Does not comply with RAO 4 • Does not achieve chemical specific requirements for VOCs	• Fair effectiveness • High permanence	• Low volume reduction by removal	• Quick, moderate effectiveness for environment • Controllable exposure to workers • Quick, good mitigation to human health exposure • Moderate potential for dust	• Implementable	• $249,000	•	•	19
	Fair, potentially unfavorable (2)	Good, generally favorable (3)	Good, generally favorable (3)	Fair, potentially unfavorable (2)	Good, generally favorable (3)	Good, generally favorable (3)	Low (3)			
5d Excavation and On-Site Disposal -4d volume	• Good protection to human health • Good protection to	• Complies with RAOs 1 and 2 • Complies partially with	• Good effectiveness • High permanence	• Moderate volume reduction by removal	• Quick, good effectiveness for environment • Controllable exposure to	• Implementable	• $2,646,000	•	•	22

AO = Remedial action objective
STA = Slit trench area
VOCs = Volatile organic compounds
SVE = Soil vapor extraction
ARARs = Applicable, Relevant, and Appropriate Requirements
Cost rating: 0 = None (4); <10M = Low (3); 10M to 50M = Medium (2); 50M to 100M = High (1); >100M = Very High (0)

Table 6-1
Summary of Detailed Analysis of Remedial Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short-Term Effectiveness	Implementability	Cost	Community Acceptance	State Acceptance	Sum
	environment	RAO 3 • Does not comply with RAO 4 • Complies with chemical specific requirements			workers • Quick, good mitigation to human health exposure • Moderate potential for dust					
	Good, generally favorable (3)	Most favorable alternative (4)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Good, generally favorable (3)	Low (3)			
6 In Situ SVE	• Moderate protection to human health • Low protection to environment	• Complies partially with RAO 1 • Does not comply with RAO 2, 3, or 4 • Does not comply with chemical specific requirements for non-VOCs	• Fair effectiveness • High permanence	• Moderate volume reduction by removal	• Slow to achieve protectiveness • Controllable exposure to workers	• Implementable	• $6,504,000	•	•	16
	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Good, generally favorable (3)	Poor, potentially unfavorable (1)	Good, generally favorable (3)	Low (3)			
7 Enhanced In Situ Biological Reduction	• Low protection to human health and environment	• Does not comply with RAOs 1 and 2 • Complies partially with RAO 3 • Complies with RAO 4 • Does not comply with chemical specific requirements for non-VOCs	• Low effectiveness and permanence	• Poor volume reduction by treatment	• Low to no effectiveness	• Difficult	• $16,104,000	•	•	8
	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Medium (2)			
8 In Situ Chemical Oxidation by Ozone	• Moderate protection to human health • Low protection to environment	• Complies partially with RAOs 1 and 2 • Complies with RAO 3 • Does not comply with RAO 4 • Does not comply with chemical specific requirements for non-VOCs	• Moderate effectiveness • High permanence	• Moderate volume reduction by treatment	• Moderate effectiveness • Controllable exposure to workers	• Difficult	• $4,700,000	•	•	13
	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Low (3)			
9 In situ soil stabilization	• Good protection to human health and the environment	• Complies with RAOs 1, 2, and 3 • Does not comply with RAO 4 • Complies with chemical specific requirements	• High effectiveness • Moderate permanence	• Good mobility reduction by stabilization	• Excellent quick control of exposure to environment and human health • Controllable exposure to workers • High potential for dust	• Moderately implementable	• $9,000,000	•	•	19
	Good, generally favorable	Most favorable alternative	Fair, potentially	Good, generally	Good, generally favorable	Fair, potentially	Medium (2)			

AO = Remedial action objective
STA = Slit trench area
VOCs = Volatile organic compounds
SVE = Soil vapor extraction
ARARs = Applicable, Relevant, and Appropriate Requirements
Cost rating: 0 = None (4); <10M = Low (3); 10M to 50M = Medium (2); 50M to 100M = High (1); >100M = Very High (0)

Table 6-1
Summary of Detailed Analysis of Remedial Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume	Short-Term Effectiveness	Implementability	Cost	Community Acceptance	State Acceptance	Sum
	(3)	(4)	unfavorable (2)	favorable (3)	(3)	unfavorable (2)				
10 Slurry Wall	• Low protection to human health • Low protection to environment	• Does not comply with RAOs 1, 2, or 3 • May comply partially with RAO 4 • Does not comply with chemical specific requirements	• Low effectiveness • Low permanence; relies on wall integrity	• Low mobility reduction	• No effectiveness	• Moderately implementable	• $1,500,000	•	•	12
	Fair, potentially unfavorable (2)	Fair, potentially unfavorable (2)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Poor, potentially unfavorable (1)	Fair, potentially unfavorable (2)	Low (3)			

AO = Remedial action objective
STA = Slit trench area
VOCs = Volatile organic compounds
SVE = Soil vapor extraction
ARARs = Applicable, Relevant, and Appropriate Requirements
Cost rating: 0 = None (4); <10M = Low (3); 10M to 50M = Medium (2); 50M to 100M = High (1); >100M = Very High (0)