

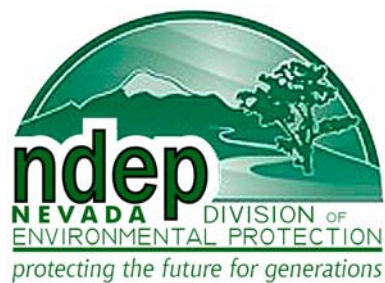
Conceptual Site Model

Proposed CAMU Site

Henderson, Nevada

February 16, 2007

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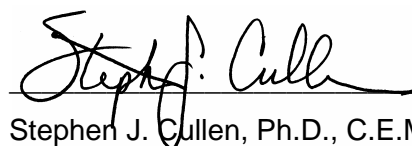


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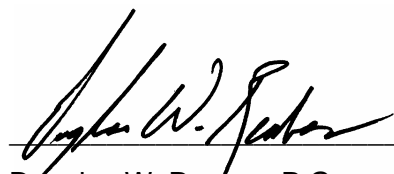
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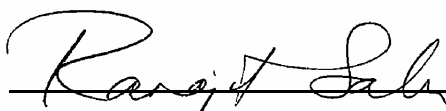
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List of Acronyms and Abbreviations

1,2-DCA	1,2-dichloroethane
1,2-DCB	1,2-dichlorobenzene
1,3-DCB	1,3-dichlorobenzene
1,4-DCB	1,4-dichlorobenzene
1,2,3-TCB	1,2,3-trichlorobenzene
1,2,4-TCB	1,2,4-trichlorobenzene
Aa	alluvial aquifer
ACD	Agricultural Chemical Division
atm-m ³ /mol	atmospheres-cubic meters per mole
ATSDR	Agency for Toxic Substances and Disease Registry
BCME	bischloromethylether
BHC	benzenehexachloride
bgs	below ground surface
BMI	Basic Management, Inc.
BRC	Basic Remediation Company
BTEX	benzene, toluene, ethylbenzene and xylenes
CAH	chlorinated aliphatic hydrocarbon
CAMU	Corrective Action Management Unit
CAPD	Chlor-Alkali Products Division
CCl ₄	carbon tetrachloride
CRC	Colorado River Commission
CSM	conceptual site model
DAF	dilution attenuation factor
DBS&A	Daniel B. Stephens & Associates, Inc.
DCE	dichloroethene
DEPT	diethylphosphorodithioic acid
DMPT	dimethylphosphorodithioic acid
DNAPL	dense nonaqueous-phase liquid
DTW	depth to water
DVSR	Data Validation Summary Report
ECA	environmental conditions assessment
ERM	Environmental Resources Management
f _{oc}	fraction organic carbon
ft/d	feet per day
ft ²	square feet
ft ³	cubic feet
G&M	Geraghty & Miller
GES	Geotechnical Environmental Services, Inc.
GM	silty gravel

List of Acronyms and Abbreviations (Continued)

GP	poorly graded gravel
gpm	gallons per minute
GRA	general response action
GWTS	groundwater treatment system
H	Henry's Law constant
HCB	hexachlorobenzene
HCl	hydrochloric acid
HDPE	high-density polyethylene
HISSC	Henderson Industrial Site Steering Committee
HSA	hollow-stem auger
KMCC	Kerr-McGee Chemical LLC
K _{HS}	Henry's Law constants
K _{OC}	Organic carbon-water partitioning coefficient
log K _{ow}	Octanol-water partitioning coefficient
LVVWD	Las Vegas Valley Water District
MCB	monochlorobenzene
MCBS	monochlorobenzene sulfonic acid
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
Montrose	Montrose Chemical Corporation of California, Inc.
mm Hg	millimeter(s) mercury
µg/kg	microgram(s) per kilogram
µg/m ³	microgram(s) per cubic meter
mph	miles per hour
msl	elevation above mean sea level
MWH	MWH Americas, Inc.
NDEP	Nevada Division of Environmental Protection
NPDES	National Pollution Discharge Elimination System
OSHA	Occupational Safety & Health Administration
PAH	polycyclic aromatic hydrocarbon
pCi/g	picoCuries per gram
pg/g	picograms per gram
PCB	polychlorinated biphenyl
PCE	tetrachloroethene or perchloroethene
PESI	Parsons Engineering Sciences, Inc.
Pioneer	Pioneer Chlor-Alkali Company, Inc.
PID	photoionization detector
ppb	part(s) per billion
ppm	part(s) per million

List of Acronyms and Abbreviations (Continued)

ppt	part(s) per trillion
PRG	preliminary remediation goals
PSL	preliminary screening level
PVC	polyvinyl chloride
Qal	Quaternary alluvium
RAO	remedial action objective
RBSL	risk-based screening level
RCRA	Resource Conservation and Recovery Act
RIB	rapid infiltration basin
SBR	Still Bottom Residue
SM	silty sand
SMC	Stauffer Management Company, Inc.
SNWA	Southern Nevada Water Authority (
SP	poorly graded sand
Spectrum	Spectrum Geophysics
STA	Slit Trench Area
SSL	site screening level
Stauffer	Stauffer Chemical Company
SVOC	semivolatile organic compound
SW	well-graded sand
TCA	trichloroethane
TCB	tetrachlorobenzene
TCDD	tetrachloro-dibenzo dioxins
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TEQ	toxicity equivalents
TIMET	Titanium Metals Corporation
TMCf	Tertiary Muddy Creek Formation
TOSCA	Toxic Substances Control Act
Tronox	Tronox Chemical Company LLC
USCS	Unified Soil Classification System
U.S. EPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WECCO	Western Electrochemical Company

Executive Summary

This report presents a conceptual site model (CSM) that details the subsurface conditions and contaminant distribution within the footprint of the property located east of Eastgate Road and south of West Warm Springs Road at the BMI industrial complex in Henderson, Nevada (referred to in this report as the "CAMU Site"). The CAMU Site encompasses Basic Remediation Company's (BRC) proposed Corrective Action Management Unit (CAMU), which will occupy a portion of the CAMU Site. This report presents the physical setting, potential sources, data evaluation techniques utilized, source characterization, chemical fate and transport, migration pathway analysis, receptor analysis, and data gaps at the CAMU Site.

To date more than 25 investigations have been performed at the CAMU Site and surrounding properties. Information and data derived from these investigation activities provide the basis for the development of this CSM.

Chemical manufacturing, storage, handling, distribution, and waste disposal facilities have historically operated south (upgradient) of the CAMU Site. These operations have been documented to have resulted in soil and groundwater impacts with VOCs, SVOCs, pesticides, and metals. Additional upgradient soil impacts may exist. Upon entering the groundwater, the chemicals from these off-site locations have migrated beneath the CAMU Site. A complete interpretation of impacts resulting from off-site sources comparable to the one given the CAMU Site is not possible because of the limited analyte list used for analyzing samples collected from the upgradient locations.

To facilitate complete accounting of all potential source and non-source areas on the CAMU Site, BRC subdivided the CAMU Site into seven subareas: (1) the BMI North Landfill Lobe, (2) the BMI South Landfill Lobe, (3) the North Borrow Pit Lobe, (4) the South Borrow Pit Lobe, (5) the Western W. Ditch Area, (6) the Eastern W. Ditch Area, and (7) the Slit Trench Area. Soil Impacts on the CAMU Site have been documented to exist in the North Landfill Lobe, beneath the Western Drainage Ditch (beneath pieces of Western W. Ditch Area and the Eastern W. Ditch Area), within the Slit Trench Area, and inferred in the South Landfill Lobe because of its similar history to the Northern Landfill Lobe. These impacts include VOCs, SVOCs, PCBs, pesticides, metals, and dioxins/furans. PCBs were detected in four samples in two borings in

the Slit Trench Area. Investigations and studies have indicated that limited soil impacts have occurred in the North Borrow Pit Lobe and the South Borrow Pit Lobe. Excluding the portion of land through which the Western Drainage Ditch traversed and based on the absence of historical waste disposal activities, no impacts to soil are known at the Eastern W. Ditch Area.

The two uppermost geologic units at the CAMU Site are the surficial Quaternary alluvium (Qal) and the underlying Muddy Creek Formation (TMCf). Groundwater occurs in both of these units beneath the CAMU Site. Groundwater in the alluvial aquifer (Aa) and in the TMCf both beneath and upgradient of the CAMU Site has been impacted with chemicals including VOCs, SVOCs, pesticides, metals, PCBs, dioxins/furans, and radionuclides. Chemicals found in the CAMU Site downgradient and cross-gradient wells were also found in the upgradient wells. Although significant impacts have been detected in the Aa and the TMCf, upward hydraulic gradients generally inhibit current significant downward migration of contaminants.

For chemicals found at the highest concentrations in groundwater, such as benzene, chlorobenzene, polychlorinated benzenes, and chloroform, CAMU Site upgradient wells typically had high concentrations as well. Historical groundwater isoconcentration plots indicate that significant groundwater sources exist for these chemicals at off-site upgradient locations. Isoconcentration plots of the 2005 contemporaneously collected data from the CAMU Site boundary wells show a repeated pattern that likewise indicates that significant upgradient sources exist for these chemicals.

The data also indicate that CAMU Site sources have likely contributed to groundwater impacts. Covering and capping of the buried waste in the North and South Landfill Lobes, and historical removal of surface liquids from ditch sections at the CAMU Site, was conducted in order to reduce the potential for chemicals to migrate to and impact groundwater. Because detected chemical concentrations are elevated in both upgradient and downgradient CAMU Site monitoring wells, with concentrations being typically higher in the upgradient wells, it is difficult to discern with certainty whether groundwater has been impacted, and to what degree, by releases from the CAMU Site. The likelihood of contribution of chemicals from the CAMU Site to groundwater is implied by observed impacts to deep soils (greater than 10 feet below ground surface), by historically collected groundwater samples with elevated concentrations from the interior of the CAMU Site, and by evaluation of the soil-to-groundwater pathway assuming little attenuation of concentration (the DAF-1 method).

Arsenic occurs in CAMU Site groundwater at concentrations above the U.S. Environmental Protection Agency maximum contaminant limit (MCL). Metals and radiochemicals often occur at concentrations in deep soil samples from the CAMU Site above the soil to groundwater (DAF-1) screening value, implying that the CAMU Site may be a source of these constituents to groundwater. Many of these soil sample concentrations are below the respective provisional shallow soil background concentration for these chemicals. It would be more appropriate to compare these soil sample concentrations to background levels evaluated for the appropriate deeper depth intervals in the Qal and TMCf. A program to develop CAMU Site-specific soil background concentrations for the deeper portions of the Qal and the TMCf is currently planned.

The Slit Trench Area has the potential to act as a source of groundwater contamination. Soil samples from the deep (greater than 10 feet below ground surface) interval exceeded the soil to groundwater screening criteria (DAF-1) for metals, organochlorine pesticides, radiochemicals, SVOCs, and VOCs. Samples collected from step-out borings advanced to the north, south, east, and west of selected borings advanced in the Slit Trench Area in 2005 indicate that elevated concentrations of chemicals (dioxins and furans, organochlorine pesticides, SVOCs, and VOCs) occur sporadically within the trenches in the Slit Trench Area at sample depths as great as 30 feet below ground surface. The generally rapid decline of chemical sample concentrations in step-out borings to the north and south of the individual slit trenches is consistent with impacts that are mostly confined to the slit trenches themselves, and the data indicate that chemical migration into soil outside of the trenches has been limited and that preferential migration occurs within the trench fill. Twenty-three of 66 soil samples collected and analyzed for dioxins and furans from depths greater than 10 feet below ground surface exceeded the ATSDR Interim Action Level of 50 parts per trillion. Of these samples, 20 samples exceeded 1 part per billion. Perchlorate was detected in 32 of 45 soil samples. The above-mentioned deep soil background study will also be used to evaluate the source of elevated Slit Trench Area soil sample concentrations for metals and radiochemicals.

Identified data gaps are largely focused on conducting future regular periodic groundwater monitoring, refining the parameters monitored, and improving monitored parameter detection limits.

1. Introduction

This report presents a conceptual site model (CSM) that details the subsurface conditions and contaminant distribution within the footprint of the property located east of Eastgate Road and south of West Warm Springs Road at the BMI industrial complex in Henderson, Nevada (referred to in this report as the “CAMU Site”). Figure 1-1 shows the CAMU Site location. Figure 1-2 presents the CAMU Site and vicinity topography. Figure 1-3 illustrates the subareas into which the CAMU Site has been divided, based on historical and anticipated future uses, for the purpose of organizing discussion in this report. Basic Remediation Company’s (BRC’s) proposed Corrective Action Management Unit (CAMU) will occupy a portion of the CAMU Site. Figure 1-4 is aerial photographic base map (Fall 2005) that depicts the approximate boundary of the historical North and South Landfill Lobes and the approximate location and boundary of the proposed CAMU landfill.

This CSM has been prepared by Daniel B. Stephens & Associates, Inc. (DBS&A) and BRC pursuant to the *Nevada Division of Environmental Protection Settlement Agreement and Administrative Order on Consent: BMI Common Areas, Phase 3* (NDEP, 2006). It is based on the interpretation of recently collected data, as well as reports that have been prepared by a number of consultants over the past 15 years. Historical aerial photographs of the CAMU Site are presented in Appendix A. As discussed below, all validated analytical results generated in these previous investigations have been incorporated into this CSM. A summary of the interpretations made during each of these investigations may be found in Appendix B of this report.

1.1 Background

A history of the BMI Industrial Complex is found in Section 2 of the draft Closure Plan (BRC, 2006). Briefly, the BMI Industrial Complex was originally owned by and constructed under the direction of the U.S. Government in early 1941 to 1942 for the production of magnesium to support the war effort. The plant, initially built and operated by Basic Magnesium, Inc. (Basic), operated from 1942 to 1944 and was the United State's largest producing magnesium plant during World War II. From 1945 to 1952, after Basic operations were ended, a number of private chemical producing companies leased and operated at the Basic plant site under U.S.

Government and then State of Nevada ownership (G&M, 1993; BRC et al., 2004). Later, the five principal operating companies at the Basic site—Stauffer, Western Electrochemical Company (WECCO, a predecessor to Kerr-McGee Chemical LLC [KMCC], now Tronox), United States Lime Corporation (U.S. Lime), National Lead (the predecessor of TIMET), and Combined Metals Reduction Co.—formed BMI for the purpose of owning and operating certain utilities in common to the Basic plant site, including electrical and water transmission assets and common disposal areas (i.e., the BMI Landfill and ponds, plant effluent, and storm drainage systems).

The BMI Landfill received wastes from 1942 until 1980, at which time it was closed and capped (Weston, 1993). As detailed in Appendix B, historical manufacturing operations in the production areas upgradient of the BMI Landfill have significantly impacted groundwater quality in the vicinity of the CAMU Site, as well as further downgradient.

From approximately 1958 to 1970 wastewater effluent from the upgradient Pioneer/Stauffer/Montrose site (Section 3.2) was reported to have traversed the western portion of the Northern BMI Landfill Lobe area via the Stauffer Effluent Ditch (Weston, 1993). This effluent was wastewater originating from tank and cell cleanout operations, brine releases, and cooling water flows (Weston, 1993). However, careful examination of historical aerial photographs indicates that this 1993 description of the Stauffer Effluent Ditch's traverse path was incorrect, and that the Stauffer Effluent Ditch never traversed the westernmost portion of the Northern BMI Landfill Lobe.

Rather, aerial and site photographs (Appendix A) and historical data reveal that process effluents from caustic-chlorine operations were actually routed through the Western Drainage Ditch, an unlined surface channel that drained west to the Western Ditch Extension. This practice lasted from 1946 to 1970. The Western Ditch, which is now closed, eventually flowed north to the Lower Ponds.

Periodically, between 1970 and 1980, undocumented process and office waste was also disposed of in the Slit Trenches, located immediately south of the BMI Landfill. There are no records to precisely document the nature of these wastes. Based on the aerial photograph review, there appear to be 10 slit trenches that were excavated along east-west trends, with the trenches ranging in length from approximately 450 to 900 feet. 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). A geophysical investigation conducted in 2000 determined the width of the trenches to be around 20 feet (Spectrum, 2000).

1.2 Purpose

The purpose of this report is to present a CSM of the BRC CAMU Site in Henderson, Nevada. This CSM is based on an evaluation of the activities and findings of historical and recent investigations, and it incorporates data and information derived from the hydrogeologic field investigation conducted at the CAMU Site from January through April 2005 (BRC and MWH, 2005), as well as the Borrow Pit investigation that was recently completed (BRC and MWH, 2006). This CSM also includes the results of the recently completed step-out sampling conducted at selected Slit Trench locations. This investigation was performed with the goal of identifying the extent of soil impacts at the selected locations prior to installation of the proposed CAMU.

BRC originally presented a CSM for this area in 2002 (PESI, 2002). Subsequently, a work plan designed to collect data for use in characterizing the CAMU Site (MWH, 2004) was implemented. Information and data collected during implementation of the work plan included (1) borelogs that characterize the stratigraphy and lithology beneath the CAMU Site, (2) borelogs and sample observations that directly characterize the waste disposed in the Slit Trenches, and (3) subsurface samples and chemical analyses of the CAMU Site soil matrix, soil vapor, and groundwater. In addition, several work plans to characterize the Borrow Area soils have also been implemented since 2002.

The following objectives were followed to develop this CSM:

1. Refine the stratigraphic model of the CAMU Site geology.
2. Evaluate the nature and extent of CAMU Site groundwater impacts by chemical constituents.
3. Evaluate the nature and extent of groundwater impacts relative to previously known potential source areas.

4. Evaluate and present detailed soil matrix, soil vapor, and groundwater sampling analytical data collected in the field investigation conducted January through April 2005 (BRC and MWH, 2005) and summarize salient observations from the field investigation. Chemical groups targeted in the analyte list were broad and included volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, metals, polychlorinated biphenyls (PCBs), perchlorate, radionuclides, dioxins, and general water quality parameters. These are the same chemical analytes that were previously targeted in the hydrogeologic investigation conducted in the BMI Common Areas (BRC et al., 2004, Appendix 3F) and presented to the Nevada Division of Environmental Protection (NDEP) by BRC in the BRC Closure Plan, BMI Common Areas (BRC et al., 2006a).
5. Evaluate CAMU Site lithology and stratigraphy and their influence on the flow of groundwater and the migration of chemicals in the subsurface.
6. Characterize upgradient and downgradient groundwater quality and present a comparative analysis between CAMU Site groundwater quality and off-site groundwater quality.
7. Review and analyze previous studies conducted on and adjacent to the CAMU Site.

2. Physical Setting

2.1 Site Description

The CAMU Site is located in Clark County, Nevada (Figure 1-1). As shown on Figure 1-2, the CAMU Site is located in portions of the southeast quarter of Section 11 and the southwest quarter of Section 12, Township 22 South, Range 62 East, Mount Diablo Base and Meridian.

The CAMU Site is located within the boundaries of property owned and operated by BRC, in an area formerly designated as the Clark County Industrial Plant Area, and is bordered by former and present industrial facilities of the BMI Industrial Complex (Figure 1-3). More specifically, the CAMU Site is bounded on the south by the border between property owned by Pioneer Chlor-Alkali Company, Inc. (Pioneer) and property owned by BRC. The eastern CAMU Site boundary is the border between property owned by Tronox (successor to Kerr-McGee Chemical LLC [KMCC]) and property owned by BRC. The northern CAMU Site boundary is defined by the northern limit of the toe of the closed BMI Landfill. The western CAMU Site boundary is defined by a northwest-trending line that runs along the western margin of the proposed aggregate Borrow Pit Area. Figure 1-4 illustrates the boundaries of the CAMU Site.

In order to account for all of the various investigation activities conducted at the CAMU Site, and to facilitate an accurate description of site features, the CAMU Site has been divided into seven subareas (Figure 1-3):

1. The northern lobe of the closed BMI Landfill (the North Landfill Lobe)
2. The southern lobe of the closed BMI Landfill (the South Landfill Lobe)
3. The northern lobe of the Borrow Area (the North Borrow Pit Lobe)
4. The southern lobe of the Borrow Area (the South Borrow Pit Lobe)
5. The western portion of the Western Ditch (the Western W. Ditch Area)

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

2.2 Climate

The Las Vegas Valley is one of the driest and warmest areas in the U.S. The climate consists of hot summers, mild winters, and wide fluctuations in the approximately 4.5-inch annual rainfall. Summer temperatures above 105°F are normal and winter temperatures below freezing are not uncommon. The average daily minimum and maximum temperatures during winter months are about 35°F and 60°F, respectively. During the summer, minimum temperatures average 70°F to 75°F. The frost-free period averages about 241 days per year (G&M, 1993).

Evaporation is high in the Las Vegas Valley, partly due to the high annual average temperature, but also due to wind and the prevalent low humidity. The average relative humidity is about 20 percent, and summer readings of less than 10 percent are common. 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. Winds frequently blow from the southwest or northwest and are strongly influenced by the mountain topography. The mean annual wind velocity is 9 miles per hour (mph); velocities in excess of 50 mph are known to occur.

2.3 Topography and Hydrology

Las Vegas Valley is a northwest-southeast trending, rectangular-shaped alluvial valley that extends 50 miles from Indian Springs to the Las Vegas Wash, the main catchment basin in the Las Vegas Valley. Highest elevations in mountains surrounding the Las Vegas Valley reach 12,000 feet above mean sea level (msl), while alluvial surfaces range from elevations as high as 9,000 feet msl near the heads of alluvial fans sourced in the Spring Mountains to as low as the point of entry of Las Vegas Wash into Lake Mead, approximately 1,300 feet msl.

Near the CAMU Site, the ground surface slopes gently to the northeast toward the Las Vegas Wash at a gradient of 0.020 foot per foot (ft/ft). The ground surface elevation is approximately 1,875 feet msl at the upgradient (southern) boundary and approximately 1,680 feet msl at the northern boundary.

2.3.1 Natural Watercourses and Drainage

The natural watercourses in the Las Vegas Valley direct all surface water toward the Las Vegas Wash, which exits the valley to the southeast and flows to Lake Mead, a manmade reservoir on the Colorado River.

2.3.1.1 Current

Current natural watercourses in the vicinity of the CAMU Site are limited to a network of shallow washes. The washes are dry except during short periods of time after rainfall events. The CAMU Site overlies an alluvial fan. As with most alluvial fans, sheet flow over the majority of the fan area could occur as part of the natural watercourse, but only under rare (greater than 500-year recurrence interval) flooding events. The CAMU Site is located outside of the 500-year flood zone.

2.3.1.2 Historical

Historical surface watercourses may have intermittently flowed through the area of the CAMU Site. Early topographic maps indicate the presence of intermittent streams on upgradient and downgradient sides of the CAMU Site, with diversions causing streams to flow around the industrial area. Of note, a shallow wash located west of the CAMU Site, known as the Western Ditch Extension, flowed northward toward the Las Vegas Wash. An on-site effluent disposal ditch, known as the Western Ditch, emptied into this feature during periods of sufficient flow.

2.3.2 Historical and Anthropogenic Watercourses and Drainage

Historical land use patterns within the BMI Industrial Complex are varied and have changed over the years. Unlined ponds were constructed over part of the Complex in 1941 and 1942, when the BMI Industrial Complex was originally built. The ponds were used to dispose of industrial wastewater until 1976, when they were permanently taken out of service. TIMET constructed lined evaporation ponds on the site of some of these older ponds, and these lined

ponds remained in service until 2005, when they were permanently taken out of service. Four unlined ditches were excavated to convey industrial wastewater to and between ponds and the Las Vegas Wash. Part of the BMI Industrial Complex site has also been used for the disposal of municipal effluent.

The effluent conveyance channel of particular significance to the CAMU Site is referred to as the Western Ditch; this channel was also known as the “Stauffer Ditch” and is discussed further in this report.

For a detailed history of the BMI Industrial Complex, see Section 2 of the BRC Closure Plan, BMI Common Areas (BRC et al., 2006a).

2.4 Geology

2.4.1 Regional

Southern Nevada regional geology is typical of the Basin and Range Province morphology of the Western Cordillera of North America. In this region, Cenozoic tectonic extension has resulted in one of the world’s most extensive systems of fault-bounded mountains separated by sediment-filled valleys, extending across Idaho, Oregon, Nevada, Utah, Arizona, New Mexico, California, and northern Mexico.

The Basin and Range Province is typified by elongated north-south-trending arid valleys bounded by mountain ranges that also bound adjacent valleys. Basins consist of down-dropped blocks of crust, and the ranges are upthrust slabs with a regional tilt to the east. The normal arrangement in the Basin and Range system is that each valley is bounded on each side by a normal fault that runs parallel to the range. Upthrown sides of Basin and Range normal faults form mountains that rise abruptly and steeply, and the down-dropped sides create low valleys. The fault plane, along which the two sides of the fault move, extends deep in the crust, usually at a nominal angle of 60 degrees. In places, the relief or vertical difference between the two sides is as much as 10,000 feet.

The mountain range rock types in this region consist primarily of consolidated sedimentary and volcanic rocks of Proterozoic and Mesozoic age, with some Precambrian Era rocks. A lesser percentage of the mountain rock types are metamorphic and intrusive igneous rocks. Following uplift, sediments originating from the mountain sources began filling the valleys, with sedimentary rocks of the Cenozoic Era forming the basin stratigraphy. Cenozoic volcanic rocks also comprise portions of selected mountain ranges in the Basin and Range Province.

2.4.2 Local 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.

South of the CAMU Site, the McCullough Mountains are formed almost entirely of andesite and basalt volcanic flows that date from 6 to 17 million years ago. Black basalt flows are exposed on the ridges, peaks, and western slopes. The east escarpment consists of reddish-brown andesite breccia.

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 lacustrine 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.

The source of the TMCf sediments (and thus the age) has not been completely resolved. Some of the sediments have a local origin, but a portion may have been deposited in pre-Grand Canyon time by the proto-Colorado River. The TMCf occurs in more than a dozen closed basins at the eastern edge of the Basin and Range Province in northwestern Arizona, southwestern Utah, and southern Nevada. To the east, closer to a suspected sediment source,

the TMCf is mostly sand. In the westernmost basins (including Las Vegas Valley), silt and clay predominate in thick, tabular beds (Schmidt, 2000).

Though the TMCf in the vicinity of the CAMU Site extends to significant depths, the precise total thickness is unknown. According to Environmental Resource Management (ERM) (2003), 2,158 feet of TMCf sediments were drilled at a salt exploration well about 2 miles north of the Pioneer/Stauffer/Montrose plant site. Another exploration well (petroleum, east of Whitney, Nevada and 5 miles north of the CAMU Site) penetrated a thickness of 3,050 feet of the TMCf (Malmberg, 1965).

2.4.3 Site Geology

The general geologic model of the CAMU Site consists of two geologic formations: Qal associated with alluvial fan deposits shed from McCullough Range Mountains, which unconformably overlies the TMCf. The TMCf consists of regionally extensive basin-fill sediments of lacustrine and subaerial origin (Bell and Smith, 1980).

2.4.3.1 Quaternary Alluvium

The CAMU Site is located near the southeastern margin of the Las Vegas Valley on Quaternary-age alluvial fan deposits deposited northeast of the McCullough Range (Figure 2-1). The Qal, which is the present-day land surface at most of the BMI Industrial Complex and throughout much of the Henderson area, slopes north toward the Las Vegas Wash. On the CAMU Site, the slope gradient is approximately 0.020 ft/ft. Figure 2-2 shows the location of cross sections (Figures 2-3 through 2-8) 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.

During the 2004 hydrogeologic characterization of the Upper and Lower Ponds Area (BRC et al., 2004), the Qal was generally encountered from the surface to approximately 50 feet below ground surface (bgs). The unit is locally thickest where it was deposited in paleochannels eroded into the surface of underlying finer-grained sediments. In wells and borings advanced at the CAMU Site, the average thickness of the Qal is about 50 to 60 feet.

The Qal is predominantly sands and gravels that consist mainly of volcanic detritus (Carlsen et al., 1991). More than 500 borings and monitoring wells have been drilled into the Qal at the BMI Industrial Complex and Common Areas, and lithologic descriptions show that the unit is typically logged as silty or sandy gravel, sand, or silty sand. Unified Soil Classification System (USCS) soil groups commonly used to describe the materials unearthed during this drilling are poorly graded gravels (GP), silty gravels (GM), well graded sands (SW), poorly graded sands (SP), and silty sands (SM).

2.4.3.2 Paleochannels and Unconformity

The lithologic record at the CAMU Site suggests that a fluvial to alluvial fan type of environment predominated during the deposition of the Qal. Between the Qal and the underlying TMCf is an unconformity that represents a gap in the stratigraphic record, during which the TMCf strata were likely exposed to weathering and erosion. Erosion by streams originating in the McCullough Range that cut into the TMCf resulted in paleochannels that were later filled by Qal. Concurrently, the surface of the TMCf was likely weathered and bioturbated, which would impact its composition near the paleosurface.

ERM (1999) presented a structural map of the top of the TMCf and inferred two paleochannels in the vicinity of the CAMU Site: one trending north-northwest from the south-central area to the northwest corner of the CAMU Site and the second trending almost due north from the northeast corner of the CAMU Site (reproduced in Figure 2-9). ERM (1999) reported that, "Based on previous investigations, the presence of paleochannels in the surface of the underlying Muddy Creek formation appears to be a key factor influencing ground water flow rates and patterns." ERM (1999) also presented groundwater contour maps from measured groundwater elevations. The relative "flatness" of the presented groundwater flow contour lines suggests that the paleochannels may currently only weakly influence the groundwater flow regime in the Qal.

2.4.3.3 Tertiary Muddy Creek Formation

Lithologic logs of most monitoring wells and borings drilled into the TMCf at the BMI Industrial Complex indicate that the upper portion of the unit is typically fine-grained (sandy silt and clayey silt), although layers with increased sand content are encountered. At Montrose and KMCC, the upper portion of the TMCf (top 50 feet) is predominantly fine-grained; however, interbedded

sand layers with thicknesses of 1 to 13 feet are present in the fine-grained strata (SECOR, 2002b; KMCC, 1999). At the TIMET facility, where only the upper 5 to 10 feet of the TMCf was penetrated at most borings, the TMCf was usually logged as a silty clay or clayey silt (Tetra Tech, 1998, 1999).

The proportion of coarse-grained sediments in the upper portion of the TMCf appears to decrease to the east and north; this trend is expected, given the increasing distance from the McCullough Range. At most wells and borings recently drilled by BRC in the Upper and Lower Ponds area (MWH and DBS&A, 2004), sand lenses are rare in the upper portion of the TMCf. For example, at BRC-SB-1, which was continuously cored, only one 4-inch-thick sand lens was reported in the TMCf between 50 and 309 feet bgs. The rest of the interval was logged as silt, clayey silt, and sandy silt. At BRC-SB-9, close to BRC-SB-1, and in the Pabco Road Ponds, conditions are similar.

Fine-grained sediments are also predominant in the upper portion of the TMCf at wells and borings that were drilled at Montrose, Tronox, the Upper and Lower Ponds, and the TIMET facility. However, a coarse-grained facies of the TMCf occurs closer to the mountain front. In monitoring wells MW-A and MW-AL at the former Pepcon plant, about 2 miles west of the TIMET facility, and about 1 mile from the McCullough Range, sediments interpreted as the upper part of the TMCf were mainly sand and gravel. Kleinfelder (1999) interpreted that the former Pepcon plant overlies the transition zone between the coarse-grained and fine-grained facies of the TMCf.

2.5 Hydrogeology

2.5.1 Regional Hydrogeology

The CAMU Site is located in the southern portion of what Malmberg (1965) refers to as the Las Vegas Groundwater Basin. This regional basin comprises about 3,000 square miles and includes the Las Vegas Valley (1,600 square miles), the southern part of Indian Springs Valley, Three Lakes Valley, and the northern part of Ivanpah Valley.

Aquifer storage projects have been undertaken in the Las Vegas Valley for nearly two decades. From 1987 to January 2005, approximately 284,000 acre-feet of Lake Mead water was injected into the Las Vegas Groundwater Basin from as many as 60 injection wells as part of the Southern Nevada Water Authority (SNWA) groundwater banking system (LVVWD, 2005). The primary water-bearing units used for water supply are located within the deeper portions of the TMCf.

The nearest aquifer storage injection wells are located more than 10 miles west of the CAMU Site. From fall 1990 to fall 2004, the Las Vegas Valley Water District (LVVWD) (2005) indicates a positive net change in potentiometric surface elevation of the principal aquifer of approximately 10 feet in the vicinity of the CAMU Site. Water level measurements in monitoring wells in the vicinity of the CAMU Site have indicated that groundwater in the deep TMCf is under pressure; this general trend of a rising potentiometric surface serves to maintain the upward groundwater gradient (thus likely inhibiting the downward flow from the Qal of water with dissolved chemicals) in the vicinity of the CAMU Site.

Water supply wells for municipal, domestic, agricultural, and industrial uses in the Las Vegas Groundwater Basin extract groundwater primarily from three major aquifer zones comprised of the coarser-grained units of the TMCf between 300 and 1,500 feet bgs. According to the LVVWD, there are approximately 6,700 water supply wells within the Las Vegas Valley that supply 12 percent of Las Vegas Valley's water annually. The balance of the Las Vegas Valley's water is supplied from the Colorado River via Lake Mead. Outside of the areas with municipal service connections, the entire water supply needs are met with groundwater supplies.

The State of Nevada Well Log Database (State of Nevada, 2006) provides information on the locations of wells within the State of Nevada. The Division of Water Resources is currently in the process of entering all the well logs in the database, but not all logs have been entered at this time. As of 2006, the State database reports the following information regarding groundwater wells in the vicinity of the CAMU Site.

The closest wells to the CAMU Site are:

- In the downgradient direction, the domestic well log number 51902, owned by T A Wells, is located approximately $\frac{2}{3}$ mile to the north of the CAMU Site and is screened from 550 to 600 feet bgs).
- The municipal public supply well log number 27676, owned by Sierra Vista Ranchos Inc., is located approximately $\frac{3}{4}$ mile to the northeast of the CAMU Site and is screened from 50 to 425 feet bgs.
- The nearest cross-gradient wells to the CAMU Site include two domestic wells and a municipal public supply well to the west and one domestic well and the location of one former (now abandoned) municipal public supply well to the east and southeast:
 - Domestic well log number 56903 (owned by WD Phelps) is located approximately $\frac{2}{3}$ mile to the west of the CAMU Site and has a depth of 334 feet with perforations starting at 50 feet bgs.
 - Domestic well log number 70312 (owned by Lewis Homes) is located approximately a mile west of the site and has a depth of 37 feet (no perforation interval was given).
 - The public supply well is the City of Henderson Well No. 1 (well log numbers 8106 and 56752) and is located 1.25 miles to the west-northwest. It was completed in 1957 and drilled deeper in 1964. The current depth is 1,000 feet with perforations from 430 to 783 feet bgs.
 - To the east approximately 1 mile is domestic well log number 35785 owned by Smith's Food & Drug Center. This well is 70 feet deep, and while no perforation interval is given, the gravel pack was set from 33 to 70 feet bgs.
 - Approximately 2 miles to the southeast is the location of the former municipal public supply well log number 5146 owned by the City of Henderson. It was initially installed to 580 feet bgs with casing to 460 feet bgs, but was deepened in 1960 (to 580 feet bgs with no explanation, log number 56788). The well was abandoned in 1992.

No domestic or public supply wells are located upgradient of the CAMU Site.

Springs in the Las Vegas Basin are also important features of the regional hydrogeology. For example, the seep area near the northeast corner of the Lower Ponds area (U.S. EPA, 2004), commonly known as the “Kerr-McGee” Seep (Kerr-McGee is now renamed Tronox), is located approximately 4.8 miles north-northeast of the CAMU Site.

2.5.2 Local Hydrogeology

The City of Henderson does not rely on groundwater (City of Henderson, 2006); it relies exclusively on Lake Mead to supply water to its citizens. Elsewhere in the Las Vegas Groundwater Basin, the principal aquifers targeted for groundwater production appear to be laterally continuous and extend to the southeasterly limits of the basin, with depths at and below approximately 400 feet bgs. Water levels in the regional groundwater level monitoring well LG230, which is located about 3 miles east of the CAMU Site and is screened between 390 and 400 feet bgs, have ranged from 202 to 220 feet bgs since continuous monitoring began in spring 2001 (SNWA, 2005). This well was constructed in 1980 and is a monitoring well in the SNWA’s regional water level monitoring network. Water quality data for this monitoring well is unavailable.

In the local vicinity of the CAMU Site, groundwater in the shallow alluvium is generally of poor quality and is not potable. BRC et al. (2004) reported that a groundwater sample collected from KMCC (now Tronox) monitoring well M-10, installed upgradient of the BMI Industrial Complex, contained elevated concentrations of total dissolved solids (TDS) (2,680 milligrams per liter [mg/L]), chloride (732 mg/L), and sulfate (857 mg/L).

Four potential jurisdictional wetlands that in the past have contained water during portions of the year are present to the northeast of the CAMU, in the vicinity of the BMI Lower Ponds. These four potential wetlands are near larger wetlands associated with the Las Vegas Wash and occupy approximately 13 acres. In recent years, groundwater seeps that have been observed at various locations in the northern portions of the BMI Commons Area close to the Las Vegas Wash and at nearby off-site locations, have been restricted to these wetland areas. An evaluation of historical aerial photographs indicates that the seeps appeared in association with past effluent conveyance into the ponds in the BMI Common Area and with infiltration of municipal wastewater at municipal rapid infiltration basins (RIBs), also located within and

adjacent to the BMI Common Area. No water has been observed in these four potential wetlands for at least two years.

2.5.3 Site Hydrogeology

2.5.3.1 Occurrence of Groundwater

In the vicinity of the CAMU Site, groundwater is typically encountered first in the Qal under unconfined conditions. Figure 2-10 presents the potentiometric surface of the water table within the Qal beneath the CAMU Site. Work performed by MWH Americas, Inc. (MWH) (BRC and MWH, 2005) indicated that the Qal is unsaturated toward the east, with saturation first noted in the uppermost TMCf, very near to the contact between the Qal and the TMCf. Cross Section E-E' depicts the hydrogeologic relationships along the east side of the CAMU Site (Figure 2-8). The three monitoring wells located along this transect were completed in the TMCf because the Qal was found to be unsaturated. Groundwater beneath the Montrose facility immediately to the south of the CAMU Site is also encountered first in the upper sediments of the TMCf (SECOR, 2002b). It is thought that the Qal has been dewatered in this area as a result of operation of the Tronox remediation system, located on the property east and adjacent to the CAMU Site.

Depth to water was measured in CAMU Site groundwater wells between April 18 and 21, 2005 (BRC and MWH, 2005). Depth to static water level in the monitoring wells ranged from 25.56 feet bgs in monitoring well BW-13B, located approximately 1,400 feet west of the northwest corner of the proposed CAMU, to 53.07 feet bgs in monitoring well BW-12B, located on the southern boundary of the CAMU Site. Depth to the contact between the Qal and the underlying TMCf at BW-13B was 35 feet bgs; depth to the contact at the location of monitoring well BW-12B was 60 feet bgs. The respective boring logs contain observations that report a change from saturated conditions in the Qal above the contact to unsaturated conditions in the TMCf below the contact, indicating a permeability contrast between the respective formation materials great enough to perch groundwater to a significant degree in the Qal.

Based on the data, groundwater thickness at BW-12B is 6.93 feet and groundwater thickness at BW-13B is 9.44 feet. BW-12B is located approximately at the site of a paleochannel mapped and interpreted by MWH (2004) as shown in Figure 2-9.

A long-term groundwater monitoring record for the CAMU Site groundwater monitoring wells does not exist. However, examination of the monitoring record reported by Tronox (Tronox, 2006) for monitoring wells to the east of the CAMU Site provides some insight as to what one might expect in terms of seasonal groundwater fluctuations. Monitoring wells to the west of the Tronox groundwater extraction well field (monitoring wells M-14A and M-57A) are reported by Tronox, as represented in the May 2006 groundwater elevation contours (Figure 2-13; Tronox, 2006), to be beyond the area of influence of the extraction well field. Over the period of record presented in the report (February 2001 to May 2006), the depth to water in well M-14A fluctuated from a high of 31.14 feet bgs (elevation 1729.79 feet msl) to a low of 34.24 feet bgs (elevation 1724.59 feet msl), representing a water level fluctuation over the period of 5.20 feet. The depth to water in well M-57A fluctuated from a high of 28.47 feet bgs (elevation 1724.97 feet msl) to a low of 31.81 feet bgs (elevation 1720.48 ft msl), representing a water level fluctuation over the period of 4.49 feet. Based on these data, a similar nominal maximum groundwater fluctuation due to seasonal variation of about 5 feet is anticipated to occur beneath the CAMU Site.

No information or data for historical long-term trends in groundwater levels beneath the CAMU Site are available to evaluate the historical impact of upgradient urban development on groundwater levels beneath the CAMU Site. Similarly, no information is available that would conclusively predict future urban growth upgradient of the CAMU Site. However, since the late 1980s the relatively flat-lying land upgradient of the CAMU Site and south of Lake Mead Drive has been developed into some commercial, but mostly residential, properties; these developments extend densely up to Horizon Drive to the south of the CAMU Site and into the surrounding hills and mountains. Small isolated parcels remain, but it is not clear that development of these remaining parcels south of Lake Mead Drive would have significant additional impact upon groundwater levels beneath the CAMU Site. Other open, unoccupied parcels of land intervene between the CAMU Site and Lake Mead Drive, but these are occupied and controlled by the industries within the BMI Industrial Complex and thus are finite and within an area of current industrial activity and environmental characterization and mitigation activities. Future development plans for this area are unlikely to include residential development.

Groundwater extraction has been conducted immediately east of the CAMU Site, at the Tronox facility, since 1987. Based on the most recent reporting from Tronox (2006), the maximum

groundwater level fluctuation induced by groundwater pumping and downgradient injection of water has been approximately 10 feet. This observed fluctuation has resulted in a minimum depth to groundwater of approximately 25 feet bgs at monitoring well M-23, located approximately 1800 feet north of the Tronox groundwater extraction well field and northeast of the CAMU Site. Though the groundwater monitoring record upgradient of the CAMU Site is limited, it is not anticipated that future developments are likely to have more impact on groundwater fluctuations than that induced by the Tronox groundwater extraction and water injection program.

A line of remediation extraction wells, known as the Pioneer/Stauffer/Montrose Groundwater Treatment System (GWTS), are installed north and downgradient of the CAMU Site. The GWTS was originally designed to remove only VOCs from groundwater. The line of extraction wells is oriented orthogonal to the northerly flow of groundwater and extends over a distance of approximately 1,800 feet. The 13 extraction wells currently operate at a reported combined influent flow rate of approximately 250 gallons per minute (gpm); flow rates for individual wells range from 3 to 70 gpm. In Attachment A (dated January 2005) entitled "Comparison of 1983 Consent Order with Current Methodologies and Knowledge" to its letter dated March 9, 2005, the NDEP provided a detailed critique questioning the efficacy of the GWTS. Although NDEP noted that the GWTS is being modified to remove pesticides and SVOCs in addition to VOCs, NDEP stated that there might be chemicals not treated by the GWTS and that the GWTS might not be capturing all of the impacted groundwater moving through the area that originates from the Pioneer/Stauffer/Montrose facilities.

Groundwater within the TMCf generally exists under confined conditions within 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 from the investigation conducted in the BMI Ponds area (BRC et al., 2004, Appendix 3F) indicate that these units are sporadically encountered during drilling and typically contain water that is confined by the silt and clay units of the TMCf. MWH (BRC and MWH, 2005) found similar conditions in the TMCf beneath the CAMU Site. Water encountered within the upper portion of the TMCf, in the five wells completed in the TMCf during the 2004/2005 investigation, rose under the confining pressure, to elevations within the overlying Qal, indicating an upward flux gradient from the TMCf into the overlying alluvium. However, the hydraulic connection between these units beneath the CAMU Site is uncertain.

MWH measured well yields, reported as “sustainable purge rate,” from 11 wells installed in the Qal on the northern, western, and southern perimeters of the CAMU Site and found them to vary from less than 1 gpm to 8.5 gpm (BRC and MWH, 2005). Out of 12 wells completed in the Qal, the sustainable purge rate was less than or equal to 1 gpm in 6 wells, between 1 and 6 gpm in 3 wells, and between 6 and 9 gpm in 2 wells. Sustainable purging rates, ranging from 0.11 to 1.2 gpm, were also reported for 4 monitoring wells completed in the upper portion of the TMCf beneath the CAMU Site.

2.5.3.2 Groundwater Flow Direction and Horizontal Gradient

Under current hydrologic conditions, the direction of the unconfined groundwater flow in the Qal is approximately parallel to the slope of the land surface. Shallow groundwater in the Qal at and near the CAMU Site flows generally to the north-northeast, toward Las Vegas Wash (Figure 2-10).

Water levels measured by BRC and MWH (2005) in spring 2005 indicate that the average gradient of the water table ranges from about 0.02 to 0.04 ft/ft. As mentioned above, there also appears to be an upward gradient between groundwater observed in the TMCf and groundwater observed in the Qal. Several wells in laterally adjacent and downgradient locations (such as well AGX at the Pepcon facility, 0.25 mile west of the CAMU Site, completed in a zone between 230 to 250 feet bgs) are reported to have flowed at ground surface from deep completion zones within the TMCf and had relatively high shut-in pressures on the order of 10 pounds per square inch (Kleinfelder, 1999), with the piezometric surface located about 2.2 feet above ground surface.

2.5.3.3 Aquifer Properties

Tetra Tech reported the results of aquifer tests conducted in monitoring wells in the Henderson Industrial Area TIMET plant site and in the Pabco Ponds vicinity to measure the hydraulic conductivity of the Qal (Tetra Tech, 1999). Reported hydraulic conductivity results ranged from about 0.075 to 33 feet per day (ft/d) at the plant site and from 0.94 to 777 ft/d in the Pabco Ponds Area. At the TIMET plant site, the highest values were measured at well J2D2-R2 (located approximately 0.75 mile east of the CAMU Site east property line), which may be completed near the center of a shallow paleochannel. The highest value at the Pabco Ponds area was measured at well POD6-R. No conductivity tests were conducted in the TMCf at the

TIMET facility; however, Montrose tested one well (CP-1) to the west of TIMET that was screened across two TMCf sand lenses with a combined thickness of 1.5 feet. The measured hydraulic conductivity was 12.5 ft/d (SECOR, 2002b). DBS&A submitted a work plan to NDEP that proposes an aquifer test field program on the BMI Commons Area (DBS&A, 2006b). This will provide additional information regarding the hydraulic properties of the Qal and the underlying TMCf.

In a TMCf well at the Pioneer/Stauffer/Montrose plant site, the hydraulic conductivity of the TMCf was 0.00014 feet per second (about 12 ft/d). These results are probably not representative of the finer-grained sediments of the TMCf, which previous data (MWH and DBS&A, 2004) indicate do not typically produce water readily and have not been screened for monitoring wells because of a lack of saturation. Based on reported laboratory tests, the vertical hydraulic conductivity of finer-grained clayey sediments that were cored at Montrose varied from 5.8×10^{-8} to 2×10^{-6} centimeters per second (0.000164 to 0.005669 ft/d) (SECOR, 2002a; Kleinfelder, 1983).

Tetra Tech (1999) reported a preliminary estimate of Darcian flux at the TIMET facility, calculated using measured values of hydraulic conductivity in the Qal. Values ranged from 0.004 to 2.9 ft/d at the plant site and from 0.006 to 75 ft/d at the Pabco Ponds area. A proposal to conduct aquifer testing on the Eastside of the Common Areas has been recently submitted by BRC (DBS&A, 2006b) and is under review by the NDEP.

In summary, groundwater beneath the general area of the BMI industrial plant complex flows within the Qal toward the Las Vegas Wash at a rate that varies by location. The hydraulic conductivity of the Qal typically ranges from less than inches to up to 33 ft/d locally, although some areas of preferential flow have been observed where the hydraulic conductivity is greater. Vertical hydraulic conductivity of the TMCf is quite low and impedes vertical downward movement of water out of the Qal and into the TMCf. Water within the TMCf moves preferentially within coarser-grained lenses. Measured hydraulic conductivity values indicate that the finer-grained portions of the TMCf do not readily yield water.

2.5.3.4 *Groundwater Recharge*

2.5.3.4.1 *Historical Recharge.* Pre-development (pre-1940s) groundwater recharge was exclusively attributable to natural recharge. The Las Vegas Groundwater Basin is naturally recharged from precipitation on the mountain ranges surrounding the valley, mainly the Spring Mountains. Generally, the groundwater supply is recharged naturally with an estimated 40,000 to 60,000 acre-feet of water per year (10 to 18 billion gallons) (SNWA, 2005).

After the industrial development of the 1940s, natural recharge in the Henderson area was augmented by the leaching of waters stored in unlined ponds and drainage ditches that were used for disposal of wastewater and cooling waters associated with the BMI complex. Conversion of ponds to lined impoundments and the installation of pipelines to convey waters to points of discharge have significantly reduced the components of groundwater recharge resulting from the industrial sources.

The City of Henderson Water Reclamation Facility (WRF)/Birding Preserve ponds and the two City of Henderson Rapid Infiltration Basins (RIBs) also represent recharge sources in the Upper and Lower Ponds area of the BMI Common Areas. The Birding Preserve is located approximately 2.5 miles north-northeast (downgradient) of the CAMU Site. The southern RIBs are located approximately 2 miles east-northeast (cross-gradient) of the CAMU Site, and the northern RIBs are located approximately 3 miles northeast (downgradient and cross-gradient) of the CAMU Site. Wastewater ponds were constructed in the southern RIB area in 1942 (BRC et al., 2006). Construction and use of the northern RIBs and WRF/Birding Preserve occurred beginning in the early 1980s (BRC et al., 2004); the southern RIBs were constructed in 1991. BRC et al. (2004) reported that these features represented recharge to groundwater on the order of 3 million gallons per day.

2.5.3.4.2 *Current Recharge.* Recent urbanization in the Henderson area has resulted in an increased number of residential, commercial, and recreational facilities, and the portion of recharge attributable to landscape irrigation return water, potentially leaking municipal water and sewer lines, and other similar sources has likely increased. Quantification of this recharge component is currently being undertaken as part of the groundwater modeling work plan for the Eastside submitted to NDEP and now undergoing review (DBS&A, 2006a). The City of Henderson has initiated a conservation program (City of Henderson, 2005) to encourage

residents to limit losses of potable water to the shallow alluvial aquifer. The City of Henderson southern RIBs are not currently in service and are expected to be taken out of service permanently in July 2007, removing the southern RIBs as a recharge source. Other historical recharge sources within the BMI Common Areas to the east and northeast of the CAMU Site that have been taken permanently out of service include the Upper and Lower BMI Ponds, the Beta and Alpha Ditches, and the TIMET ponds.

2.5.3.5 Groundwater Discharge

Natural discharge of the alluvial aquifer groundwater in the vicinity of the CAMU Site is through evapotranspiration (likely more pronounced to the north and closer to the Las Vegas Wash, where vegetation is more abundant, than to the south and away from the Wash, which is generally more barren), seepage to the Las Vegas Wash, and spring flow to surface streams.

One of the major proximal elements of groundwater discharge near the CAMU Site is a line of remediation extraction wells north and downgradient of the site, known as the Pioneer/Stauffer/Montrose GWTS (Section 2.5.3.1), which extends over a distance of approximately 1,800 feet. The 13 extraction wells currently operate at a reported combined influent flow rate of approximately 250 gpm; flow rates for individual wells range from 3 to 70 gpm. The reported combined influent concentrations of total VOCs in the extraction wells averaged 4.47 mg/L during the first quarter of 2005. During the same period, approximately 1,160 pounds of VOCs were removed by the GWTS (Hargis, 2005). Treated water is injected, via a set of infiltration galleries, downgradient of the extraction well field.

Tronox operates a groundwater extraction system on the property east of and adjacent to the CAMU Site. As a part of this system, groundwater is extracted and treated for chromium, nitrate, chlorate, perchlorate, and other chemicals present in the influent water. The majority of this treatment occurs on the Tronox plant site at the BMI Complex, east of and adjacent to the CAMU Site. Ferrous sulfate is also added approximately 8,700 feet downgradient at the location known as the Athens Road Lift Station. Approximately 5,500 feet farther downgradient toward the Las Vegas Wash, a line of nine extraction wells, oriented orthogonal to flow of groundwater, captures groundwater that is subsequently treated to remove perchlorate. Remediated water from the perchlorate treatment system (Section 3.2.3) is treated to remove solids, disinfected with an ultraviolet (UV) system, and then discharged via pipeline to the Las

Vegas Wash (NDEP, 2006). Figure 2-10 presents an approximation (based on water well elevation data from two different years) of the effect of the Tronox groundwater extraction system on groundwater elevations east of and adjacent to the CAMU Site.

3. Potential Sources

The historical ownership and operations at the CAMU Site, while complex, are well known and documented. Section 2 of the draft Closure Plan (BRC et al., 2006) contains a comprehensive narrative of these ownership and operations. This information is discussed in Section 1.1 and briefly summarized below.

The BMI Industrial Complex was originally owned by and constructed under the direction of the U.S. government in 1941-42 and was operated by Basic from 1942 to 1944 as the U.S.'s largest producing magnesium plant during World War II. From 1945 to 1952, after Basic operations were ended, a number of private chemical companies leased and operated at the Basic plant site under U.S. government and then State of Nevada ownership (G&M, 1993; BRC, 2006). In December 1951, the five principal operating companies at the Basic site formed Basic Management Inc. for the purpose of owning and operating certain utilities in common to the Basic plant site, including electrical and water transmission assets and common disposal areas (including the BMI Landfill and ponds, plant effluent, and storm drainage systems).

The production processes that have operated at the BMI Industrial Complex since 1942 have resulted in the generation of a variety of waste byproducts. A majority of these wastes were disposed of in four Trade Effluent Ponds (the Northern BMI Landfill Lobe is located approximately in the former position of one pond and a portion of a second of the two westernmost historical Trade Effluent Ponds) and in unlined ponds constructed northeast of the BMI Industrial Complex (i.e., the Eastside of the BMI Common Areas).

The BMI Landfill received wastes from 1942 until 1980, at which time it was closed and capped (Weston, 1993). Historical manufacturing and disposal operations in the production areas upgradient of the BMI Landfill have significantly impacted groundwater quality in the vicinity of the landfill area, as well as farther downgradient.

Wastewater effluent from the Pioneer/Stauffer/Montrose site was reported to have traversed the western portion of the BMI Northern Landfill Lobe area from approximately 1958 to 1970 via the Stauffer Effluent Ditch (Weston, 1993). This effluent was wastewater originating from tank and cell cleanout operations, brine releases, and cooling water flows (Weston, 1993). However,

Careful examination of historical aerial photographs undertaken for this CSM indicates that this interpretation was incorrect and that the course of the Stauffer Effluent Ditch never traversed the BMI Northern Borrow Pit Area or the westernmost portion of the Northern Landfill Lobe.

Aerial photographs and historical data reveal that the routing of process effluents from caustic-chlorine operations occurred through the Western Drainage Ditch, an unlined surface channel that drained west to the Western Ditch Extension. This practice lasted from 1946 to 1970. The Western Ditch, which is now closed, eventually flowed north to the Lower Ponds.

Periodically, between 1970 and 1980, a variety of process and office wastes were also reportedly disposed of in the STA, located immediately south of the BMI Landfill. There are no records that describe the construction of the slit trenches or that document the nature of these wastes. Initially it was assumed by BRC, based on the representations of plant operators, that the wastes disposed therein would all be similar. There appear to be 10 slit trenches that were excavated along east-west trends. Aerial photographs show the slit trenches to range in length from approximately 450 to 900 feet. Based on direct field observations during drilling and sampling operations, the trenches vary in depth between approximately 25 and 32 feet. Spectrum Geophysics (Spectrum) (2000) concluded, based on the results of a geophysical investigation, that the widths of the trenches were approximately 20 feet. However, this geophysical survey could not conclusively delineate trench boundaries where the excavations were very closely spaced; thus individual trenches are likely narrower (i.e., roughly 8 to 10 feet, consistent with being constructed using an excavator or similar equipment).

Sections 3.1 and 3.2 discuss both on-site and off-site operations and events that had the potential to impact soils and groundwater at the CAMU Site. Figure 3-1 shows operations and potential release locations.

3.1 Current and Historical On-Site Operations

As discussed in Section 2.1, the CAMU Site has been subdivided by BRC into seven subareas to facilitate complete accounting of all potential source and non-source areas on the CAMU Site (Figure 1-3). The entire CAMU Site is covered by these seven subareas. Sections 3.1.1 through 3.1.7 describe these subareas in terms of their historical use (to the extent that it is

documented), the historical and current subarea morphology and configuration, and the potential of the subarea to be a source of chemical migration.

3.1.1 The North Landfill Lobe

The North Landfill Lobe occupies a 51.7-acre rectangular-shaped area of land from the northern boundary of the CAMU Site south to approximately the northern edge of the STA (Figure 1-3). The rectangle stretches from the easternmost boundary to the westernmost boundary of the CAMU Site. The elevation to which disposal materials were placed in the BMI North Landfill Lobe is unknown.

Production processes that operated at the BMI Industrial Complex beginning in 1942 resulted in the generation of a variety of solid and liquid waste byproducts. The majority of the solid wastes, and a significant quantity of the liquid wastes, were disposed of in Trade Effluent Ponds, portions of which later became the BMI North Landfill Lobe. Geraghty & Miller (G&M) (1993) summarized a complete list of materials that were disposed of within the BMI Landfill (Table 3-1).

The BMI Landfill received wastes from 1942 until 1980, at which time it was closed and capped. Prior to use as a landfill, the BMI North Landfill Lobe was the location of one and a portion of a second of four of the so-called "Trade Effluent" disposal ponds (G&M, 1993). Geraghty & Miller (1993) reported that each of the Trade Effluent Ponds occupied an area of approximately 79 acres, with an average liquid depth of 7.5 feet; however, the individual pond areas were reported incorrectly. Each of the four trade effluent ponds actually occupied an area of approximately 20 acres (not 79 acres), for a total area of approximately 79 acres.

The ponds were formed by construction of an approximately 20-foot-tall earthen dike on the northern side of the ponds. No dike was necessary on the southern side of the ponds, due to the natural slope of the land. A French drain was installed to prevent undermining of the northern dike. Drainage outlets located along the toe of the northern dike emptied pond liquid contents onto the north side of the dike, where they percolated into the soils. The soil used to construct the dike was derived from the pond site itself, though the depth of excavation below the ground surface was not reported.

Waste acid and caustic liquors were conveyed to the ponds through a distribution pipeline known as the trade effluent launders, originating from the acid neutralization plant. Waste liquids conveyed to the ponds from the magnesium process included both acid and caustic process liquors. Some time between 1942 and 1945, the caustic line disintegrated and waste from the acid drains discharged directly into the ponds. Based on aerial photographs, it has been interpreted that waste discharge to the Trade Effluent Ponds occurred between 1942 and 1944 (G&M, 1993).

Prior to 1970, solid wastes were reportedly periodically disposed of in the area of the BMI North Landfill Lobe and burned (G&M, 1993). From roughly 1970 to 1980, a variety of wastes were disposed of in the STA. During 1971, it was reported that several fires occurred in these STAs, attributed then to spontaneous combustion (G&M, 1993). It is unknown whether combustible wastes were deliberately burned.

The BMI Landfill is unlined and, inclusive of the period of disposal to the Trade Effluent Ponds, received wastes from 1942 until 1980. Using two separate methodologies, BRC has estimated that the North and South Landfill Lobes received between 500,000 and 1,000,000 cubic yards of materials. In 1980, the BMI Landfill was capped and closed using a method approved by the NDEP (G&M, 1993). Waste was first covered by lime residue to form relatively impermeable layers, and water was added during placement. The total depth of the lime varied from 2 feet to 15 feet or more. The lime was then covered with a minimum of 2 feet of soil taken from dikes and surrounding on-site areas. The cover was contoured such that rainwater would rapidly drain from the site. Grain size analysis shows that the cover material consists of gravelly sand comprised of approximately 80 percent sand and 20 percent gravel. G&M (1993) reported that tests conducted by BMI on the permeability of the soil cover indicated that the average penetration of moisture, given average rainfall, was 6 to 10 inches.

Weston Solutions, Inc. (Weston) (1993) reported that the Stauffer Effluent Ditch (more recently referred to as the Western Ditch Extension) flowed through the western portion of the North Landfill Lobe. As noted above, however, examination of historical aerial photographs indicates that this interpretation was incorrect and that the course of the Stauffer Effluent Ditch never traversed the westernmost portion of the North Landfill Lobe.

3.1.2 The South Landfill Lobe

The BMI South Landfill Lobe is located south of the STA and occupies an 8.2-acre polygonal-shaped area that abuts the eastern boundary of the CAMU Site in the southern portion of the property (Figure 1-3). The South Landfill Lobe is bordered by the North Borrow Pit Lobe on the west and by the Eastern W. Ditch Area on the south. The elevation to which disposal materials were placed in the BMI South Landfill Lobe is unknown.

Some of the data and information reviewed indicate that there were differences between the historical disposal activities conducted at the BMI North Landfill Lobe and those conducted at the BMI South Landfill Lobe. The information available confirms that there were no effluent ponds (such as the Trade Effluent Ponds) located in the footprint of the South Landfill Lobe. There is no documentation to indicate that any burning occurred in the South Landfill Lobe. Other than these exceptions, it is believed that the South Landfill Lobe received similar wastes during similar time frames, was filled and operated in similar fashion, and was closed with the same type of landfill cap as the North Landfill Lobe.

3.1.3 The North Borrow Pit Lobe

The BMI North Borrow Pit Lobe is located in the western portion of the CAMU Site, north of the Western Drainage Ditch, and encompasses an area of approximately 9.3 acres (Figure 1-3). The BMI North Borrow Pit Lobe is bordered on the west by the western CAMU Site boundary, on the north by the westernmost portion of the BMI North Landfill Lobe, and on the east by the BMI South Landfill Lobe and the STA. Plans have been developed to mine this area for borrow materials and to create a portion of the space for the proposed CAMU. BRC has submitted a Risk Assessment to the NDEP associated with proposed mining activities and will commence mining activities upon approval of the Risk Assessment report.

Weston (1993) reported that the Stauffer Effluent Ditch (more recently referred to as the Western Ditch Extension) flowed through the western portion of the North Borrow Pit Lobe. Examination of historical aerial photographs undertaken for this CSM indicates that this interpretation was incorrect and that the course of the Stauffer Effluent Ditch never traversed the North Borrow Pit Lobe or the westernmost portion of the North Landfill Lobe. Furthermore, recent acquisition and evaluation of historical photographs taken at the CAMU Site indicate the

true nature of historical effluent conveyance and distribution from the plant processing area south of the CAMU Site to some of the Trade Effluent Ponds formerly located in what is now referred to as the BMI North Landfill Lobe. These photographs indicate that the effluent was conveyed in constructed aboveground wooden flumes or launders to the Trade Effluent Ponds. It is estimated that effluent was transported away from the plant at the rate of 5,000 to 8,000 gpm (Sahu, 2005).

A number of studies have been conducted to determine the suitability of the North Borrow Pit Lobe as a borrow source for the planned mining activities. Those studies, described in Appendix B of this report, support the conclusion that there have been only limited environmental impacts to the North Borrow Pit Lobe and that the material is suitable for beneficial use, primarily in roadbeds and other similar uses, with certain restrictions. These studies will soon be supplemented by BRC's formal Risk Assessment of the Borrow Pit materials, which has been submitted to the NDEP.

BRC and DBS&A (2005) submitted work plans to the NDEP designed to complete the characterization of the North and South Borrow Pit Lobes and to determine the environmental suitability of the borrow materials for the above-described uses. Those work plans were implemented in February 2006. Ten additional borings were installed in the proposed borrow area: five in the North Borrow Pit Lobe and five in the South Borrow Pit Lobe. Soil samples were collected at multiple depths including at the surface, 10 feet bgs, 30 feet bgs, and nominally 10 feet above the depth to the water table. The maximum depth of sample collection was approximately 50 feet bgs. All samples were analyzed for chemicals on the site-related chemicals (SRC) list. Analytic results of the sampling were subjected to a data validation process and submitted to NDEP (BRC and MWH, 2006).

The results of that sampling event are also reported and incorporated in the analysis presented in this CSM (represented by the sample identification prefixes of BP01 through BP10). As noted above, a formal Risk Assessment has been prepared by BRC (and submitted to NDEP) to determine the suitability of the soil materials in the North Borrow Pit Lobe and South Borrow Pit Lobe for use in industrial and commercial applications, with restrictions.

3.1.4 The South Borrow Pit Lobe

The South Borrow Pit Lobe is located in the western portion of the CAMU Site, south of the Western Drainage Ditch and is approximately 8.5 acres in size (Figure 1-3). It is bounded on the west by the western CAMU Site boundary, on the south by the southern CAMU Site boundary, and on the east by the Eastern W. Ditch Area.

No known waste disposal activities have taken place in the South Borrow Pit Lobe, and plans have been developed to mine this area for borrow materials, identical to those discussed for the North Borrow Pit Lobe.

The same studies conducted to determine the suitability of the North Borrow Pit Lobe as a borrow source for the planned mining activities also characterized the South Borrow Pit Lobe. Those studies are described in Appendix B of this report. As with the North Borrow Pit Lobe, those studies support the conclusion that there have been only limited environmental impacts to South Borrow Pit Lobe and that the material is suitable for industrial commercial uses, with restrictions.

BRC and DBS&A (2005) have submitted work plans to NDEP to complete the characterization of the North and South Borrow Pit Lobes and to determine the environmental suitability of the borrow materials for the above-described uses. As described in Section 3.1.3, those work plans have been implemented and the data incorporated into the analysis and reporting of this CSM.

3.1.5 The Western W. Ditch Area

Based on logistical considerations for implementation of the proposed CAMU, the Western Drainage Ditch traversing the CAMU Site has been divided into two pieces: (1) the Western W. Ditch and (2) the Eastern W. Ditch. The Western W. Ditch Area is a surface channel that was initially used to handle process effluents from the caustic-chlorine operations. It is located between the North Borrow Pit Lobe and the South Borrow Pit Lobe and is approximately 2.3 acres in size (Figure 1-3). It is bounded on the west by the western CAMU Site boundary and on the east by the Eastern W. Ditch Area.

The Western Drainage Ditch reportedly was used for disposal by the U.S. Government, Stauffer, and Montrose for process effluents (G&M, 1993). Discharges of process effluents to the Western Drainage Ditch were unregulated throughout its operational history from 1942 to 1970. Wastes disposed of into the Western W. Ditch Area reportedly included acid effluents, waste caustic liquor, brine sludge, sodium hypochlorite, sodium chloride, hydrochloric acid, sulfuric acid, magnesium oxide, sodium hydroxide, asbestos, benzene compounds, pesticides, and other unidentified chemical compounds.

3.1.6 The Eastern W. Ditch Area

The Eastern W. Ditch Area is located at the south end of the CAMU Site and is approximately 6.1 acres in size (Figure 1-3). It is bounded on the west by the Western W. Ditch Area, the South Landfill Lobe, and the North Landfill Lobe. It is bounded on the north by the South Landfill Lobe and on the east by the CAMU Site boundary.

In addition to the area where the historical Western Drainage Ditch flowed through the CAMU Site, the Eastern W. Ditch Area includes pieces of land to the north and south of the Western Drainage Ditch. No data or information that has been reviewed indicates that any historical disposal activities occurred on these non-ditch portions of the Eastern W. Ditch. Other than undocumented potential overflow from historical effluent flowing in the Western Drainage Ditch, all information available suggests that these portions of the area have remained undisturbed and have not been subjected to development and/or disposal activities.

3.1.7 The Slit Trench Area

The STA is a rectangular-shaped piece of land bounded on the east by the CAMU Site boundary, on the north by the North Landfill Lobe, on the south by the South Landfill Lobe, and on the west by the boundary between the North Landfill Lobe and the North Borrow Pit Lobe (Figure 1-3). The entire STA is approximately 27.7 acres in size and includes both areas where waste was disposed and undisturbed areas between and around the actual trenches

A total of 11 aerial photographs taken between 1943 and 2003 (Appendix A) were interpreted to determine the locations and times that the trenches were created and used for waste disposal. In spite of exhaustive searches, no other documentation such as engineering plans and/or

construction drawings was discovered; therefore, Trench activity was determined based on the presence of linear features within each photograph. The time a trench was in operation is bracketed by the photograph dates from which the feature first appears to when it is no longer visible, although it is important to note that the time interval between photographs is not uniform. The aerial photographs interpreted in this analysis are dated 1943, 1950, 1967, 1969, 1972, 1973, 1974, 1975, 1976, 1987, and 2003. The first photographic record of trench activity is dated 1967, and the last photographic record of trench activity is dated 1976. A 10-year hiatus exists in the photograph record prior to and after the identified trench activity. Therefore, it is not possible to determine from the aerial photographs whether there was trench activity before 1967 and after 1976.

Based on close evaluation of the aerial photographs and field examination, 10 trenches have been identified. The area containing all the identified trenches is 580,000 square feet (ft²). This area occupies a trapezoidal-shaped area with a southern base length of 1,800 feet, acute base angles 400 feet high (north to south), and a northern length of 1,200 feet (east to west). All trenches were aligned subparallel to the trapezoid base and to one another, as well as to the northern levee of the Stauffer/Montrose/Pioneer ponds. This description differs from the shape and size described by Spectrum (2000).

Materials reportedly disposed of in the Slit Trenches are listed in Table 3-2 and discussed in further detail in Section 6.1.7. Boring logs obtained from recent field investigations by MWH identify the maximum depth of solid waste disposal within the trenches (BRC and MWH, 2005). These logs (BS-1 through BS-20) report the first occurrence of debris in the STA as shallow as 3 feet bgs and the deepest occurrence of debris at 32 feet bgs. Most of the logged intervals were found to contain backfilled soil, with much lesser amounts of actual trash and debris observed. The most commonly observed depth to trench bottom was nominally 30 feet bgs, with the next most common trench bottom depth being 25 feet bgs.

3.2 Current and Historical Off-Site Operations

Directly upgradient of the CAMU Site, four companies have operated industrial chemical production facilities since 1942: Basic, Stauffer, Montrose, and Pioneer. Basic operated a chlor-alkali plant incident to the manufacture of magnesium. Stauffer operated chlor-alkali facilities

and an agricultural chemical plant. Montrose operated a hydrochloric acid and an agricultural chemical plant. Pioneer operated (and still operates) chlor-alkali and hydrochloric acid facilities.

A number of reports have been submitted by companies that have operated at locations upgradient and cross-gradient of the CAMU Site. These reports indicate that, since the Basic plant was originally constructed in 1941/1942, various chemical production and handling processes occurred in these locations and that releases to the subsurface, related to these operations, occurred. Sections 3.2.1 through 3.2.4 briefly describe the operations of Stauffer, Montrose, Tronox, and AMPAC. Potential upgradient sources of contamination are depicted in Figure 3-1 and listed in Table 3-3. .

3.2.1 Stauffer Operations

Operations performed by Stauffer and Montrose were somewhat similar in nature and resulted in the production of similar waste streams. Stauffer initiated chemical manufacturing operations to the south of the CAMU Site in 1945 and occupied about 458 acres. Stauffer leased and then owned and operated the property from 1945 to 1988 to produce chloral (1945 to 1988), hydrochloric acid (1945 to 1988), Lindane (1946 to 1958), Trithion/Imidan (1958 to 1984), parachlorophenol/thiophenol, benzene hexachloride, several other agricultural chemical products, and chlorine and sodium hydroxide (caustic soda). Section 2 of the Closure Plan, BMI Common Areas (BRC et al., 2006a) provides details of historical chemical production. Stauffer was known to operate two impoundments, with waste materials also being conveyed to the area of what is known as the BMI North Landfill Lobe via a ditch system.

In 1984, Stauffer purchased a 7.4-acre property north of the CAMU Site that contained a silica precipitate pond from BMI. Stauffer was reported to use this parcel for groundwater treatment activities.

Stauffer's Lindane plant operated from 1946 through 1958 (HLA, 1999). Stauffer reportedly dismantled its Agricultural Chemical Division (ACD) plant in 1984.

3.2.2 Montrose Operations

In 1947, Montrose subleased approximately 10 acres of property from Stauffer and built an organic chemical manufacturing plant. Between 1947 and 1983, Montrose produced a variety of organic and inorganic chemicals at this manufacturing plant, including monochlorobenzene, polychlorinated benzene, chloral, muriatic acid (hydrochloric acid), ethyl chloride, and dichlorobenzil (BRC, 2006). Montrose also produced certain byproducts at its organic chemical manufacturing plant, including ethyl chloride (which it marketed from 1958 through 1961). In 1954, Montrose built a synthetic hydrochloric acid plant on the same property. Between 1954 and 1985, Montrose produced industrial grade muriatic acid (hydrochloric acid), both as a byproduct and at its synthetic hydrochloric acid plant (SECOR, 2002a). Industrial process descriptions (including multimedia waste management practices) include the use of parachlorothiophenol/thiophenol, Trithion/Imidan, Lindane, and hydrochloric acid production processes.

Montrose's facilities included chemical production occurring on 2 acres, rail car loading and benzene tank storage on 1 acre, and a tank farm encompassing 2 acres, with the remaining acreage being used for five wastewater impoundments and one still-bottom residue (SBR) impoundment. Four of these ponds (Nos. 1 through 4) were constructed between 1973 and 1975 and contained liners (SECOR, 2002a). Pond No. 5 was constructed in 1979 and was used for the storage of hydrochloric acid (SECOR, 2002a).

3.2.3 Tronox Operations

The northern border of a system of holding ponds operated by Tronox is located approximately 700 feet east of the northeastern corner of the CAMU Site Northern Landfill Lobe. The Henderson Tronox facility (formerly operated as Kerr-McGee Chemical LLC) currently manufactures manganese dioxide, elemental boron, and boron trichloride. Historically, Tronox's corporate predecessors also manufactured a number of chlorate and perchlorate-based compounds including ammonium perchlorate. Perchlorate production ceased at this facility in July 1998, and the perchlorate production equipment was dismantled in March 2002 (NDEP, 2006).

Tronox has five double-lined, zero-discharge holding ponds (ponds GW-11, WC-West, WC-East, MN-1, and AP-5) for which separate zero-discharge permits have tentatively been issued by the Nevada Bureau of Pollution Control for a period of 5 years. The permit does not allow for direct discharge of pond contents to any ground or surface waters of the State of Nevada. The ponds are double-lined and have leak detection sumps between the primary and secondary liners to detect any leakage in the primary (surface) HDPE liners. A monthly water balance (mass balance) for each holding pond is also required to account for all inflow (process inputs and incident precipitation), outflow (recycle to process), and evaporative losses (NDEP, 2006).

Tronox operates a perchlorate treatment system under a NDEP Bureau of Corrective Actions Consent Agreement. The current perchlorate treatment system is comprised of a two-stage fluidized bed reactor (FBR) biological treatment system. Prior to and as part of the FBR treatment system, extracted groundwater and other water is treated for chromium, nitrate, chlorate, perchlorate, and other chemicals present in the influent water. The remediation process uses several biological reactors arranged in series to allow for the reduction of nitrate, chlorate, and perchlorate. Chromium is reduced and/or removed from the influent water through several methods including reduction and precipitation by electrolytic methods and through the introduction of ferrous sulfate. The majority of this treatment occurs east of the CAMU Site on the Tronox site at the BMI Complex. Ferrous sulfate is also added approximately 8,700 feet downgradient at the location known as the Athens Road Lift Station. Approximately 5,500 feet farther downgradient toward the Las Vegas Wash, a line of nine extraction wells, oriented orthogonal to flow of groundwater, captures groundwater that is subsequently treated to remove perchlorate. Remediated water from the FBR is treated to remove solids, disinfected with a UV system, and then discharged via pipeline to the Las Vegas Wash (NDEP, 2006).

3.2.4 AMPAC Operations

The former AMPAC plant was operational and manufactured perchlorate from 1959 to 1988 at a site located approximately 6,000 feet southwest of the southwest corner of the CAMU Site. The plant catastrophically exploded in May 1988 and was destroyed. AMPAC released perchlorate, and there is a significant plume that emanates from its former plant site and migrates northward

toward the Las Vegas Wash, just west of the CAMU Site. NDEP has described the AMPAC perchlorate plume as smaller and much less concentrated than the Tronox plume.

The AMPAC plume is being investigated and remediated. AMPAC conducted an in-situ bioremediation pilot study from December 2002 to April 2003. The pilot was successful, reducing perchlorate concentrations from about 500,000 parts per billion (ppb) to less than 2 ppb. During 2003 and 2004, AMPAC conducted additional investigation of the nature and extent of its perchlorate plume. The NDEP required AMPAC to install a remediation system at the leading edge of its plume by February 2006. This has been installed and is operating. The next step would be to install a full-scale groundwater mitigation system at the source of the plume, which is reportedly expected to occur in 2007 (U.S. EPA, 2005c).

3.2.5 Off-Site Release History

Between 1945 and 1975, process waste effluent from both Stauffer and Montrose operations and stormwater runoff from the two facilities were reportedly discharged into Stauffer's industrial sewer system. This system included a series of evaporation ponds connected by process piping and surface drainage ditches (PES Environmental, Inc., 2006). Reports regarding the system provide no indication that the evaporation ponds were lined. By 1976, Montrose directed efforts to minimize the volume of water it drained into the storm sewer system. When the NPDES program was implemented in 1976, both Stauffer and Montrose reportedly constructed new lined evaporation ponds for the purpose of containing process waste effluent from each respective facility (PES Environmental, Inc., 2006). To the extent that stormwater runoff entered the storm sewers after 1976 and before 1986, Montrose apparently operated under Stauffer's National Pollution Discharge Elimination System (NPDES) permits.

Beginning in November 1973, as part of a water conservation program, Montrose began construction of a 7-acre lined wastewater pond evaporation system (Ponds Nos. 1 through 4) on an additional 21 acres of property leased from Stauffer. The system was put into service by May 1976. Montrose disposed of waste (primarily waste acid streams from the dichlorobenzil process washing and product drying steps and sulfide wastes from the polychlorinated benzene and chloral process) in Ponds Nos. 1, 3, and 4. Pond No. 2 was used as a hydrochloric acid wastewater evaporation pond. Converse (1993) stated that various constituents potentially

could have accidentally migrated to the soils or groundwater through pond lining damage or overflow.

In approximately 1976, Montrose constructed a waste tank in the southwest portion of the Montrose site to store sulfuric acid wash waters generated from the polychlorinated benzene and the dichlorobenzene processes prior to disposal in Ponds Nos. 1, 3, and 4. Montrose discovered evidence indicating that the waste acid tank experienced a number of accidental releases (reported to be minor) in 1981.

In August 1976, Montrose constructed a lined pond (Pond No. 6) to accept polychlorinated benzene SBR from the chlorinated benzene distillation process (prior to mid-1976, the material was disposed of at the BMI Landfill). Montrose disposed of between 730 and 800 tons of SBR in Pond No. 6 until March 1980, when further use was discontinued pursuant to an NDEP order. Montrose reportedly discovered no evidence that SBR escaped from Pond No. 6 (Converse, 1993).

In late 1978, Montrose put into service a redwood tank to collect hydrochloric acid wastes prior to discharge in Pond No. 2. The redwood tank also collected wastewater and spills from surface drains that serviced the acid loading docks, "benzolator" or polychlorinated benzene distillation dike areas, and the acid recovery area. The tank, which was installed partly below ground in the northwest portion of the Montrose site, has been taken out of service. The aboveground portion of the tank was removed, and the portion at or below grade remains on-site.

In early 1979, Montrose completed the construction of, and put into service, a fifth pond, Pond No. 5, to hold hydrochloric acid wastes. Pond No. 2, which was originally put into service in 1976 to hold sulfuric acid wastewater for evaporation, was converted some time between August and October 1979 to handle overflow hydrochloric acid wastes from Pond No. 5. Montrose disposed of its hydrochloric acid wastes in Ponds No. 2 and 5 until March 1985, when Montrose discontinued further use of these ponds (Converse, 1993).

Inactive on-site waste management areas described by Converse (1993) include Wastewater Ponds 1 and 2, Chlor Alkali Products Division (CAPD) Pond 8, Wastewater Conveyance System (inactive), Leach Bed, Phosphoric Acid Pond and Trenches, Alpha Beta Cake Pile Nos. 1, 2,

and 3, ACD Drum Burial, and ACD Vapor Incinerator. Active (1993) on-site waste management areas included ACD Ponds Nos. 1 and 2, CAPD Ponds Nos. 1 (Pittman/Surge), 2 (Hypo Pond), and 3 through 7, Stormwater System, and Drum Storage Area. Off-site waste management areas are also discussed. On June 1, 1980, Montrose completed construction of a concrete surface water settling basin to hold and clarify neutralized surface water runoff from the facilities area, plus the benzolator cooling water, for use as cooling tower makeup (Weston, 1993).

In addition to the above disposals, Montrose experienced the following known or suspected releases or spills: (1) a 2,300-gallon monochlorobenzene spill in March 1974, (2) minor air emissions from the facilities, and (3) possible process losses tentatively identified through production reports (Weston, 1993).

Montrose disposed of polychlorinated benzene SBR, empty DDT paper bags, and miscellaneous mechanical equipment and non-metallic scrap in the BMI Landfill until mid-1976 (Weston, 1993). Empty DDT bags were also discovered in the Slit Trenches, and other evidence of Montrose wastes have likewise been found in the STA (BRC 2005).

In September 1978, high-paraffin fuel oil was released, solidified on the ground, and likely taken to the BMI Landfill (Weston, 1993).

In 1979, Stauffer discovered that approximately 30,000 gallons of benzene had leaked from an underground tank in the production area. On April 4, 1983, the NDEP, Montrose, and Stauffer agreed to a consent order for a groundwater cleanup program. The agreement was prompted by the discovery of a groundwater plume containing benzene, chlorinated benzene, and chloroform. During 1983 to 1984, in response to the consent order, Stauffer and Montrose installed the GWTS about 1,000 feet downgradient (north) of the BMI Landfill area to provide capture and treatment of groundwater contaminated with VOCs from the BMI Industrial Complex before it could migrate off-site (HLA, 1999). Since its discovery, however, the plume has migrated northeast, passing under the BMI Landfill area and toward the Pittman community and the Las Vegas Wash.

In Attachment A (dated January, 2005) entitled "Comparison of 1983 Consent Order with Current Methodologies and Knowledge" to its letter dated March 9, 2005, NDEP has asked Stauffer/Pioneer/Montrose to re-evaluate the efficacy of the capture and treatment of

groundwater by the GWTS. NDEP stated that several of the decisions and statements in the Consent Order appear out of date and no longer valid and went on to summarize the current conditions as of the letter date. In summary, NDEP stated that the GWTS was originally designed to treat only VOCs but will be modified to remove SVOCs and pesticides from groundwater. Even after the upgrades, compounds that might not be treated include TDS and other chemicals not treatable by air stripping or activated carbon, chemicals more dense than water, chemicals migrating beneath the well screens, and chemicals migrating around the cones of depression. NDEP also noted that only 16 chemicals were selected for monitoring and that the analyte list needs to be expanded to include all chemicals present.

Transformer PCB spills are reported as having occurred on the Stauffer site from June 1981 to January 1989, when response measures included cleaning with trichloroethene (TCE) followed by a washdown of industrial soap (Weston, 1993).

A monochlorobenzene spill occurred on the Stauffer site in November 1983, when a pipe rupture released 173 gallons that was allowed to evaporate and seep into the soil within a diked area (Weston, 1993).

Magnesium chloride was intentionally released from trucks onto the Stauffer site in May 1985 and was cleaned up by a Stauffer contractor (Weston, 1993).

The Henderson hydrochloric acid spill occurred on the Stauffer site in August 1988 due to a leaking railcar that released 851 gallons. The spill was neutralized with lime chips.

Montrose began closing its on-site ponds in 1984 and completed closure in 1989. The closure process involved evaporating the ponds to dryness and then mixing the remaining sludge with crushed limestone to neutralize residual acid. The ponds then were covered with a 12-inch layer of compacted clay, followed by a 20-mil polyvinyl chloride (PVC) membrane. On top of the membrane, Montrose placed 9 inches of sand and then 12 inches of native soil. Pond No. 6 was permanently closed in October 1981. The NDEP-approved closure activities consisted of removing the SBR and storing it in an approved aboveground tank. The excavated area was then backfilled with clean soil, a clay layer, and another layer of clean soil.

Montrose dismantled its manufacturing plant in 1983 by removing all equipment and structures that had been associated with its operations (HLA, 1999).

In 1989, Ponds Nos. 2 and 5 were closed by Montrose pursuant to Resource Conservation and Recovery Act (RCRA) regulations (Converse, 1993). The closure process involved evaporating the ponds to dryness and then filling them to grade with dry soil. Next, a 20-mil PVC membrane was installed over the soil filling, followed by a 9-inch layer of sand and an 18-inch layer of native soil to prevent erosion. Pond No. 2 was graded and filled along with Ponds Nos. 1, 3, and 4. Pond No. 5 was filled and graded separately.

Montrose also had a tank farm on which it stored raw material used in manufacturing its organic chemicals. Montrose discovered evidence of a few reportedly minor accidental releases and spills associated with the tank farm (Weston, 1993). A 1991 visual inspection and a review of 1989 aerial photographs indicate that all of the tanks located in the tank farm had been removed.

A hydrochloric acid release occurred in December 1990 to January 1991 due to structural failure of ponds, resulting in the release of 65,000 gallons of dilute (0.5 percent) hydrochloric acid. This release was determined to be relatively innocuous due to the presence of alkali material in the soils surrounding the spill, effectively neutralizing the acids (Weston, 1993).

A release of hydrochloric acid/bischloromethylether was reported to have occurred in April 1984, with unknown quantities released to the air. Miscellaneous small-quantity releases have been described as having occurred from March 1983 to January 1990 (Weston, 1993).

4. Data Evaluation

The long operational history of the BMI site and large number of complex manufacturing processes and waste streams when combined suggest that the number of chemicals that have the potential to have been produced at the site is quite long. This section discusses how chemicals were selected for evaluation.

4.1 Site Related Chemicals

BRC has developed, and NDEP has approved, the Site Related Chemicals (SRC) list (BRC, 2006), which considers (1) all chemicals known to have been manufactured or used at the BMI Complex and later industrial operations, (2) potential degradation and recombination products from such chemicals, (3) broad-suite analysis for selected chemical families, and (4) chemicals detected at the CAMU Site. The SRC list contains 483 individual chemicals. Because this list has been revised, with new chemicals added to the analytical program over time, samples collected from the CAMU Site investigations prior to 2003 were not analyzed for every SRC now included on the SRC list.

The SRCs as evaluated are broken into the following chemical classes:

- Aldehydes
- Asbestos
- Dioxins/furans
- Glycols and alcohols
- Herbicides
- Metals (including cyanide)
- Organochlorine pesticides
- Organophosphate pesticides
- Organic acids
- Perchlorate
- Polycyclic aromatic hydrocarbons (PAHs)
- Polychlorinated biphenyls (PCBs)
- Radionuclides
- Semivolatile organic compounds (SVOCs)
- Volatile organic compounds (VOCs)

4.2 Development of ARARs

Although the site is not regulated under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), consideration of applicable or relevant and

appropriate requirements (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 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. According to the U.S. Environmental Protection Agency’s (EPA’s) ARAR guidance, *CERCLA, Compliance with Other Laws Manual* (U.S. EPA, 1988a), in order for a requirement to be applicable, (1) it must be substantive as opposed to administrative, (2) it must be promulgated through a federal rulemaking procedure or, for state standards, it must be of general applicability and legally enforceable, and (3) its jurisdictional prerequisites must be satisfied by the circumstances at the CERCLA site.

“Relevant and appropriate requirements” means those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal 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 example of relevant and appropriate requirements would be that waste materials be managed in accordance with RCRA requirements.

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. For the CAMU Site, examples of TBCs include EPA Region 9 preliminary remediation goals (PRGs) for industrial workers. Despite their name, PRGs should not be confused with cleanup levels. PRGs are screening-level values established within EPA Region 9 to provide a means to conduct a preliminary comparative evaluation of site data as it relates to the potential of risk to human health. To the extent practicable, the SRCs are compared to these criteria. Table 4-1 summarizes the ARAR-based screening levels for soils.

4.3 Background Determination of Naturally Occurring Compounds

Because many of the SRCs are also naturally occurring, in addition to comparisons with PRGs, the analytical results for naturally occurring constituents (including, for example, arsenic, radium-226, and radium-228) have been compared to the BMI Common Areas (including the CAMU Site) background concentrations (Basic Remediation Company and Titanium Metals Corporation, 2006; under review by the NDEP). These naturally occurring constituents are significant in that they are carcinogenic and tend to drive cancer risk estimates and, as a result, remediation efforts. Because these particular compounds are naturally occurring and are commonly elevated in geologic environments where plutonic rocks are present, it is important to differentiate between naturally occurring concentrations and those concentrations that are a result of CAMU Site (and/or upgradient) operations.

Subarea soil sample concentrations at the CAMU Site have therefore been compared to the range of available observed shallow soil background concentrations. Samples exceeding this range are deemed above background. BRC has provided the NDEP with the draft shallow-soil (surface to 10 feet below ground surface) background concentrations for all naturally occurring SRCs at the BMI Complex (BRC and TIMET, 2006), and BRC recognizes that the report of these data is currently under review by the NDEP. Until final review of this background data report is completed and the report is approved, it will be considered as provisional. The provisional background values are included on Table 4-1. It should be noted also that BRC has separately submitted a deep soil background work plan to the NDEP (DBS&A, 2007) to help establish background values in soils deeper than 10 feet bgs up to possibly 60 feet bgs for the BMI Common Areas, including the CAMU Site. Since this study is not yet complete, this CSM compares soil concentrations deeper than 10 feet bgs to the provisional shallow background concentrations as noted above.

4.4 Comparisons

In order to provide a manageable, useful, and accurate discussion of the chemical impacts to the CAMU Site, the chemicals have been grouped into classes of like chemicals as indicated in Section 4.1. BRC recognizes that asbestos and perchlorate do not constitute individual chemical classes; however, because of the specific interest in these distinct constituents, they

are discussed individually at the level of a chemical class. Because asbestos only occurs as a solid and there is no mechanism to transport this compound to greater depths, only surface soils were analyzed for its presence.

A number of different comparisons were made:

- All soil chemical concentrations were compared to the soil to groundwater pathway with a conservative dilution attenuation factor of 1 (DAF-1), representing no attenuation as a result of interaction with any organic carbon in soils.
- All chemicals concentrations were compared to U.S. EPA Region 9 PRGs for industrial workers.
- Dioxins and furans were compared to the toxicity equivalent concentration (TEQ) level of 50 parts per trillion (ppt) set by the Agency for Toxic Substances and Disease Registry (ATSDR).
- Polychlorinated biphenyls (PCBs) were compared to criteria established under the Toxic Control Substances Act (TOSCA) (Code of Federal Regulations [CFR], Title 40, Part 761).
- Concentrations of naturally occurring compounds, including metals and radiochemicals, were compared with provisional background concentrations as discussed earlier.

Finally, the reporting limits for all reported non-detects were compared with the PRGs or screening level for those compounds where available. This was done to ensure that the data sets were usable and appropriate for the comparisons that were being performed and to identify where changes may be needed in the analytical program that is being instituted for ongoing monitoring programs.

All of the data used in the CSM have been formally validated as part of a separate exercise by BRC; these validated datasets have been submitted to and approved by the NDEP.

5. Source Characterization

Source characterization at the CAMU Site has included the collection of soil gas, soil, and groundwater samples. While the soil samples are distributed across the entire CAMU Site and groundwater monitoring wells are located around the perimeter of the CAMU Site, soil gas sample results were focused on the STA. Due to the large number of chemical classes reported, tables presenting all analytical results have been included in Appendices C through E of this report. Appendix C presents the chemical analytic results of the soil gas sampling. Soils chemical analytic results for both surface and subsurface soils are presented in Appendix D. Groundwater chemical analytic results are presented in Appendix E. Figures 5-1 through 5-5 present the distribution of selected soil gas constituents. Analytical results for surrogate chemicals that represent chemical classes in surface and subsurface soil samples are presented on Figures 5-6 through 5-48. Groundwater results for selected chemicals are presented on Figures 5-49 through 5-60.

In addition to the surrogate chemicals used to represent chemical classes as discussed above, electronic ArcReader files on CD-ROM are included in Appendix F and illustrate the soil, soil gas, and groundwater sample concentrations for all chemicals detected at the CAMU Site. Viewing the files in Appendix F allows the reader to select and view soil sample results by depth interval for soil and soil gas, and by water-bearing zone in groundwater, for individual chemicals of interest.

The figures show not only all locations where a compound was detected, but also the reported detection limits for those samples reported as non-detect. For the most part, the reported detection limits were below the lowest screening level. For those samples where this was not the case, the sample locations are further highlighted so the reader can evaluate these non-detects as well.

5.1 Distribution of Site Chemicals in Soil Gas

During investigations of the STA, soil gas samples were collected in addition to soil matrix samples to evaluate the distribution of chemicals in the subsurface. Based in part on the results of previous investigations, and taking into account the relative volatility of the different chemical

classes, the investigation of the STA focused on VOCs. MWH performed an investigation of the STA during spring 2005 (MWH, 2005). The soil gas survey performed at the STA included the collection of soil vapor samples from 22 locations. Soil vapor 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 BMI Industrial Complex plant site. Samples were collected using drive points installed near the slit trenches at depths ranging from 10 to 50 feet bgs. Sample intervals from 10 to 30 feet bgs were selected to evaluate releases from the trenches, while the samples from 40 and 50 feet bgs were intended to also evaluate off-gassing from the alluvial aquifer (Aa).

The evaluation of the distribution of site chemicals in soil gas in this section is based upon data that have been collected and validated following EPA protocols. Data validation summary reports (DVSRs) have been submitted separately to the NDEP and approved for all of the data sets described herein. The DVSR Number associated with each analytical result has been referenced on the summary tables provided in Appendices C, D, and E.

Figures 5-1 through 5-5 show the distribution of the VOCs 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform with depth. The first three compounds were selected for this analysis because a review of the soils data revealed that these were the only compounds that exceeded their respective soil screening levels. Consequently, by performing a parallel analysis, it may be possible to correlate contaminant transport through the various media. Benzene and chloroform were also selected because groundwater has been shown to be impacted by these compounds.

Because official screening levels for these compounds do not exist, comparisons were made to OSHA permissible exposure levels (PELs), which are conservative in that they represent acceptable vapor concentrations assuming an 8-hour exposure to workers

5.1.1 1,2,4-Trichlorobenzene

Figure 5-1 presents the distribution of 1,2,4-trichlorobenzene in the vicinity of the STA. In this area 1,2,4-trichlorobenzene was detected at concentrations ranging from 47 to 2,107 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). These concentrations were compared with the PEL of 300,000 $\mu\text{g}/\text{m}^3$ that has been set for 1,2-dichlorobenzene (no PEL is listed for

1,2,4-trichlorobenzene). The highest concentrations were noted along the southern boundary of the STA at the SV-21 and SV-22 locations.

For comparison to the soil gas concentration results, figures 5-20 and 5-39 present the distribution of 1,2,4-trichlorobenzene in surface soil samples and in subsurface soil samples from the 5- to 10-foot bgs interval, respectively. Similar to the results described below for 1,2-dichlorobenzene and 1,4-dichlorobenzene, elevated STA soil sample concentrations were found nearest to SV-20 where 1,2,4 trichlorobenzene was non-detect, although the reported detection limits for soil gas sample results were elevated in the samples collected from SV-20. Soil concentrations were also elevated nearest to SV-13 though soil gas concentrations were non-detect at SV-13.

5.1.2 1,2-Dichlorobenzene

Figure 5-2 presents the distribution of 1,2-dichlorobenzene in the vicinity of the STA, where 1,2-dichlorobenzene was detected at concentrations ranging from 2.5 to 10,389 $\mu\text{g}/\text{m}^3$. The PEL for 1,2-dichlorobenzene is 300,000 $\mu\text{g}/\text{m}^3$. The highest concentrations were noted along the southern boundary of the STA at the SV-21 and SV-22 locations. At the SV-21 location, contamination extends to a depth of 40 feet bgs. This is the same location where the highest 1,2,4-trichlorobenzene concentrations were noted.

Figures 5-21 and 5-40 present the distribution of 1,2-dichlorobenzene in surface soil samples and subsurface soil samples from the 5- to 10-foot bgs interval respectively. For the 5- to 10-foot bgs sample interval, the highest concentrations in soil are closest to the SV-20 location, where 1,2-dichlorobenzene was not detected in soil gas (reported soil gas detection limits were elevated at this location and, for the 30-foot, 40-foot, and 50foot bgs samples, greater than the screening level). Other high soil sample concentrations were near soil gas sampling point SV-12, where no 1,2-dichlorobenzene was detected in soil gas. The highest soil sample concentrations are in the 20-foot bgs and 30-foot bgs samples nearest to SV-13, where soil gas concentrations were non-detect.

5.1.3 1,4-Dichlorobenzene

Figure 5-3 presents the distribution of 1,4-dichlorobenzene in the vicinity of the STA. In this area 1,4-dichlorobenzene was detected at concentrations ranging from 0.53 to 15,277 $\mu\text{g}/\text{m}^3$. The PEL for 1,4-dichlorobenzene is 450,000 $\mu\text{g}/\text{m}^3$. The highest concentrations were noted along the southern boundary of the STA at the SV-21 and SV-22 locations. At the SV-21 location, elevated concentrations extend to a depth of 40 feet bgs. This is the same location where the highest 1,2,4-trichlorobenzene and 1,2-dichlorobenzene concentrations were noted.

Figures 5-22 and 5-41 present the distribution of 1,4-dichlorobenzene in surface soil samples and subsurface soil samples from the 5- to 10-foot bgs interval, respectively. For the 5- to 10-foot bgs sample interval, the highest concentrations in soil are near the SV-20 location, where 1,2-dichlorobenzene was not detected in soil gas. Other high concentrations in soil samples were near soil gas sampling point SV-13, where 1,2-dichlorobenzene was detected at relatively lower concentrations in soil gas. Somewhat elevated soil sample concentrations were also observed near SV-12, where reported soil gas concentrations were non-detect.

5.1.4 Benzene

Figure 5-4 presents the distribution of benzene in soil vapors in the vicinity of the STA, where benzene was detected at concentrations ranging from 1.2 to 389,607 $\mu\text{g}/\text{m}^3$. The PEL for benzene is 34,425 $\mu\text{g}/\text{m}^3$. This PEL was exceeded in samples collected at 10 and 20 feet bgs at the SV-19 location. All samples with benzene concentrations in excess of 1,000 $\mu\text{g}/\text{m}^3$ were located along the southern transect in borings SV-19 through SV-22.

Figure 5-42 presents the distribution of benzene in subsurface soil samples from the 5- to 10-foot bgs sample interval. One soil sample from approximately 100 feet north of the southern soil vapor transect contained benzene (0.0056 milligrams per kilogram [mg/kg]) above the soil screening levels.

Figure 5-58 presents the distribution of benzene in the Aa. Benzene concentrations in groundwater near the SV-21 location are in excess of 12,000 micrograms per liter ($\mu\text{g}/\text{L}$). Given the fact that groundwater concentrations are much more elevated than the nearby soil

concentrations, it is likely that the measured concentrations in soil gas at this location are a result of off-gassing from the Aa.

5.1.5 Chloroform

Figure 5-5 presents the distribution of chloroform in soil vapors in the vicinity of the STA. Chloroform was detected in this area at concentrations ranging from 29 to 4,946,996 $\mu\text{g}/\text{m}^3$. The PEL for chloroform is 248,000 $\mu\text{g}/\text{m}^3$. All samples collected from the SV-20 location exceeded screening limits, with concentrations increasing with depth to the maximum concentration noted. Samples from the 20- and 40-foot bgs levels in adjoining borings SV-19 (west) and SV-21 (east) also exceeded criteria. Exceedances were also noted at the SV-6, SV-10, SV-13, and SV-14 locations.

Figures 5-24 and 5-43 show the chloroform concentrations detected in surface and subsurface soils respectively. Neither interval had chloroform at concentrations exceeding screening limits.

Figure 5-59 presents the chloroform concentrations within the Aa. The maximum concentrations of chloroform in groundwater trend to the north underneath those soil vapor sample locations where the maximum soil vapor concentrations were measured. Soil vapor readings may reflect a combination of off-gassing from the Aa and/or the degradation of carbon tetrachloride disposed of within the STA.

5.1.6 Other VOCs

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. 1,2-Dichloroethane (1,2-DCA) was detected at its highest concentration (3,416 $\mu\text{g}/\text{m}^3$) at SV-18 in samples collected at both 30 and 40 feet bgs. Similar concentrations of 1,2-DCA were also detected at this location in the 20- and 50-foot bgs samples. At SV-19, maximum concentrations were detected of benzene (389,607 $\mu\text{g}/\text{m}^3$), chlorobenzene (459,059 $\mu\text{g}/\text{m}^3$), and 1,3-dichlorobenzene (794 $\mu\text{g}/\text{m}^3$). The highest tetrachloroethene (PCE) concentration (4,946,966 $\mu\text{g}/\text{m}^3$) was detected at the SV-20 location at a depth of 50 feet bgs, while the highest 1,2-chlorobenzene concentration, 10,389 $\mu\text{g}/\text{m}^3$, was reported at the SV-21

location. Other maximum concentrations were noted along the central transect (TCE at 15,793 $\mu\text{g}/\text{m}^3$ at SV-14 and carbon tetrachloride at 50,576 $\mu\text{g}/\text{m}^3$ at SV-13).

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.

Appendix G presents additional side-by-side plots of soil gas sample concentrations and soil sample concentrations for volatile chemicals in the STA, based on data collected during the 2005 STA investigation (BRC and MWH, 2005). Soil gas sample concentrations are compared to soil vapor screening values based on construction worker outdoor air inhalation exposures, and the soil samples are compared to soil screening values based on U.S. EPA Region 9 Industrial PRGs. The screening values are used for comparative purposes only to allow identification of areas of relatively high or low concentration.

5.2 Distribution of Site Chemicals in Soils

The evaluation of the distribution of chemicals in CAMU Site soils in this section is based upon data that have been collected since 1996 and have been validated following EPA protocols. Included in this data set are the results from soil sampling conducted in the STA area 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). These additional step-out data are included and presented here for the first time. Data validation summary reports (DVSRs) have been submitted separately to the NDEP and approved for all of the data sets described herein. The DVSR Number associated with each analytical result has been referenced on the summary tables provided in Appendices C, D, and E.

For presentation purposes, analytical results for soils have been presented for three sample intervals: 0 to 1 feet bgs (representing surface soils), subsurface soils in the 5- to 10-foot bgs range, and subsurface soils at depths greater than 10 feet bgs. The 5- to 10-foot depth interval was selected as being the maximum depth generally considered for worker exposure in the risk assessment. Figures illustrating the soil sample concentrations for the above-described depth intervals are cited in the following text and listed in the List of Figures.

A discussion of detected compounds from samples collected at depths greater than 10 feet bgs is provided for the North and South Borrow Areas in Section 5.2.3 in the context that excavations in these areas are anticipated to proceed to a maximum depth of 40 feet. Section 5.2.4 presents a discussion of detected compounds from samples collected at depths greater than 10 feet bgs in the STA, an area in which it is known that disposal of waste in trenches to depths greater than 10 feet bgs took place. Section 5.2.5 presents a combined discussion of detected compounds from samples collected at depths greater than 10 feet bgs in the North and South Landfill Lobes and in the Eastern and Western W. Ditch Areas.

The SRCs for the CAMU site are identified in Section 4.2. These compounds are discussed in this section by chemical class. All chemical results for all chemicals analyzed have been tabulated and compared with the screening criteria listed in Table 4-1. Several of the chemical classes, while tabulated, are not discussed in the body of the text for the following reasons:

- Aldehydes were not detected in any of the samples analyzed at concentrations above their respective screening levels for surface or subsurface soils.
- Asbestos was not detected in any of the surface or subsurface soil samples analyzed.
- General chemistry as a class consisted of compounds such as bromide, chloride, nitrate, total organic carbon, nitrate, cyanide, sulfate, and pH. Cyanide and fluoride were the only general chemistry parameters with screening criteria other than background; both compounds also have an Industrial PRG. Neither of these compounds was detected at concentrations approaching the Industrial PRGs. Several compounds were detected at concentrations above background, including chloride, fluoride, nitrate and sulfate. It is recognized that chloride was a key ingredient in the process of refining magnesium ore

and producing chlorine and caustic soda. High chloride concentrations are also not unusual in a desert setting. These higher concentrations may be indicative of evaporative concentrations and/or releases.

- Glycols and alcohols were not detected in any of the samples analyzed at concentrations approaching screening levels. Ethylene glycol, for instance, was detected in only 6 subsurface soil samples at concentrations ranging from 0.022 to 0.15 mg/kg. The Industrial PRG for ethylene glycol is 100,000 mg/kg.
- Herbicides were not detected in any of the 27 surface soil samples analyzed. Of the 106 subsurface soil samples collected, the herbicide Mecaprop was detected in 18 samples, typically at estimated concentrations (J-flagged) between 20 and 1,700 mg/kg. There are no screening criteria for this herbicide.
- Organic acids were not detected in any samples at concentrations above screening criteria.
- Organophosphate pesticides were not detected in any of the surface or subsurface soil samples analyzed at concentrations exceeding screening limits.
- PAHs were identified in only 1 (of the more than 680 analyses) surface soil sample at a concentration above the Industrial PRG, and in only 1 (of the more than 4,050 analyses) subsurface soil sample at a concentration above the soil to groundwater DAF-1 screening criteria.

For the remaining chemical classes, one or two compounds are discussed in detail as being representative surrogates of the entire chemical class. These surrogate chemicals were selected based on the breadth of their presence across the CAMU Site. The following surrogates have been selected for this discussion:

- Dioxins and furans: presented and calculated as tetrachloro-dibenzo dioxins toxicity equivalents (TCDD TEQs)
- Metals: arsenic, total chromium, and hexavalent chromium

- Organochlorine pesticides: aldrin, alpha BHC, beta BHC, and gamma BHC (“Lindane”)
- Perchlorate: perchlorate
- PCBs: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260
- Radiochemicals: radium-226, radium-228, uranium-235, and uranium-238
- SVOCs: hexachlorobenzene,
- VOCs: 1,2,4-trichlorobenzene 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform

5.2.1 Surface Soils (0 to 1 feet below ground surface)

5.2.1.1 Dioxins and Furans

Dioxins and furans were detected in 20 of 24 surface soil samples (Figure 5-6). At 17 of the locations, the calculated TCDD TEQs were below the ATSDR TCDD TEQ screening level (the “ATSDR screening” level or criterion) of 50 picograms per gram (pg/g) (equivalent to 50 ppt by mass). TCDD TEQs are also calculated for non-detects using a summation of products of species-specific detection limits and weighting factors (ATSDR, 1997). Dioxins and furans were not detected in three samples and the TCDD TEQs were also below the ATSDR 50 pg/g screening level. Four samples contained dioxins and furans above the screening level, with exceedances ranging from 83 to 475 pg/g. The highest concentration was detected in a sample collected along the east CAMU Site boundary in the North Landfill Lobe.

5.2.1.2 Metals

The metals discussion focuses on arsenic and chromium due to their toxicity. Because these metals are also naturally occurring, sample concentrations discussed below are compared to the provisional shallow background concentrations.

5.2.1.2.1 Arsenic. Figure 5-7 presents the distribution of arsenic in surface soils. A total of 44 samples were analyzed for arsenic. Arsenic was detected in 37 samples with reported concentrations ranging from 1.9 to 8.4 mg/kg. All of the detected concentrations were above the DAF-1 of 1 mg/kg and the Industrial PRG of 1.6 mg/kg. Only one sample, collected along the eastern boundary of the Northern Landfill Lobe and with a concentration of 8.4 mg/kg, exceeded the maximum provisional background concentration of 7.2 mg/kg. The reported detection limits for the 7 samples with non-detects exceeded the DAF-1 and the Industrial PRG.

5.2.1.2.2 Total Chromium. Figure 5-8 presents the distribution of total chromium in surface soils. A total of 44 soil samples were analyzed for total chromium with detections in all of the samples. One sample had a reported concentration below the DAF-1 of 2 mg/kg. The other 43 samples had reported concentrations between 5.4 and 30 mg/kg. The upper end of this range is an order of magnitude below the Industrial PRG of 450 mg/kg.

5.2.1.2.3 Hexavalent Chromium. Figure 5-9 presents the distribution of hexavalent chromium in surface soils. Hexavalent chromium was not detected in any of the 43 soil samples analyzed, and all of the reported detection limits were below the DAF-1 of 2 mg/kg.

5.2.1.3 Organochlorine Pesticides

The discussion of organochlorine pesticides focuses on aldrin, alpha BHC, beta BHC, and gamma BHC due to their widespread distribution within surface and subsurface soils.

5.2.1.3.1 Aldrin. Figure 5-10 presents the distribution of aldrin in surface soils. Aldrin was analyzed in 53 samples with detectable concentrations reported in 2 samples. One sample from the STA contained a concentration of 0.26 mg/kg, and one sample from the Eastern W. Ditch Area contained a concentration of 0.99 mg/kg. These 2 samples contained aldrin above both the DAF-1 of 0.02 mg/kg and the Industrial PRG of 0.1 mg/kg.

5.2.1.3.2 Alpha BHC. Figure 5-11 presents the distribution of alpha BHC in surface soils. A total of 53 samples were analyzed for alpha BHC, with detectable concentrations reported in 18 of the samples. Seventeen of the 18 detections, ranging from 0.0019 to 0.32 mg/kg, exceeded the DAF-1 of 0.00003 mg/kg, but were below the Industrial PRG of 0.36 mg/kg. The reported detection limits for alpha BHC all exceeded the soil to groundwater DAF-1 screening level. One sample, collected in the STA, exceeded the Industrial PRG of 0.36 mg/kg, with a measured concentration of 86 mg/kg. The minimum reported detection limit for the non-detects exceeded the soil to groundwater DAF-1 screening level.

5.2.1.3.3 Beta BHC. Figure 5-12 presents the distribution of beta BHC in surface soils. A total of 53 samples were analyzed for beta BHC, with detectable concentrations reported in 38 samples. All of these concentrations, ranging from 0.005 to 9.4 mg/kg, exceeded the DAF-1 screening level of 0.0001 mg/kg. Two samples also exceeded the Industrial PRG of 1.3 mg/kg with reported concentrations of 3.1 and 9.4 mg/kg. These samples were taken from the Eastern

W. Ditch Area and the STA, respectively. The minimum reported detection limit for the non-detects exceeded the soil to groundwater DAF-1 screening level.

5.2.1.3.4 Gamma BHC. Figure 5-13 presents the distribution of gamma BHC (Lindane) in surface soils. A total of 53 samples were analyzed for gamma BHC, with detectable concentrations ranging from 0.011 to 17 mg/kg reported in 4 samples, 3 of which were located in the STA and the remaining sample located along the east side of the North Landfill Lobe. All 4 samples exceeded the soil to groundwater DAF-1 screening level of 0.0005 mg/kg, but only the sample with a concentration of 17 mg/kg exceeded the Industrial PRG of 1.7 mg/kg. The reported detection limits of all of the non-detects exceeded the soil to groundwater DAF-1 screening level.

5.2.1.4 PCBs

Surface soil samples were analyzed for seven different Aroclors at 25 locations. There are no DAF-1 screening levels for any of the seven, and only two, Aroclor 1016 and Aroclor 1254, have Industrial PRGs, with values of 21 mg/kg and 0.74 mg/kg, respectively. There were no reported detections of any PCBs. The reported detection limits for all Aroclors were below the Industrial PRGs for all of the samples. None of the samples were taken from the South Landfill Lobe or the Western W. Ditch Area.

5.2.1.5 Perchlorate

Figure 5-14 presents the distribution of perchlorate in surface soils. A total of 47 samples were analyzed for perchlorate, with reported concentrations ranging from 0.49 to 96 mg/kg in 37 of the samples. None of these samples contained perchlorate at concentrations above the Industrial PRG of 100 mg/kg. There is no DAF-1 for perchlorate.

5.2.1.6 Radiochemicals

The following discussion of radiochemicals focuses on radium-226 and radium-228, as well as uranium-235 and uranium-238. Because these radiochemicals are also naturally occurring, sample activities discussed below are compared to the provisional background activities.

5.2.1.6.1 Radium-226. Figure 5-15 presents the distribution of radium-226 in surface soils. A total of 23 surface soil samples were analyzed for radium-226. Radium-226 was detected in 22 of these samples at activities ranging from 0.451 to 2.76 picoCuries per gram (pCi/g). The

upper end of the provisional background range for radium-226 in soils at the CAMU Site is 2.4 pCi/g. Only 1 sample of the 22 was above the range of provisional background. All of the reported activities exceeded both the DAF-1 of 0.0161 pCi/g and the Industrial PRG of 0.026 pCi/g.

5.2.1.6.2 Radium-228. Figure 5-16 presents the distribution of radium-228 in surface soils. A total of 23 surface soil samples were analyzed for radium-228. Radium-228 was detected in 18 samples at activities ranging from 1.52 to 3.25 pCi/g. The upper end of the provisional background range for radium-228 in soils at the CAMU Site is 2.9 pCi/g. Only 1 sample was above the upper end of the provisional background. All of the reported activities exceeded both the DAF-1 of 0.0594 pCi/g and the Industrial PRG of 0.15 pCi/g.

5.2.1.6.3 Uranium-235. Figure 5-17 presents the distribution of uranium-235 in surface soils. A total of 23 surface soil samples were analyzed for uranium-235. Uranium-235 was detected in 15 samples at activities ranging from 0.0192 to 0.11 pCi/g. The upper end of the provisional background range for uranium-235 in soils at the CAMU Site is 0.21 pCi/g; therefore, all samples are within the range of the provisional background. All but two of the reported activities exceeded the DAF-1 of 0.0389 pCi/g and all of the reported activities were below the Industrial PRG of 0.4 pCi/g.

5.2.1.6.4 Uranium-238. Figure 5-18 presents the distribution of uranium-238 in surface soils. A total of 23 surface soil samples were analyzed for uranium-238 with detections in all of the samples at activities ranging from 0.575 to 2.17 pCi/g. The upper end of the provisional background range for uranium-238 in soils at the BMI site is 2.4 pCi/g; therefore, measured activities of all samples are within the range of the provisional background. All of the reported activities exceeded the DAF-1 of 0.006 pCi/g and all but 2 of the reported activities were below the Industrial PRG of 1.8 pCi/g.

5.2.1.7 SVOCs

Figure 5-19 presents the distribution of hexachlorobenzene in surface soils. Hexachlorobenzene was detected in 6 of 57 surface soil samples analyzed. One sample had a reported concentration of 0.072 mg/kg, which is below the soil to groundwater DAF-1 screening level of 0.1 mg/kg. The other 5 of those samples had reported concentrations ranging from 0.17

to 35 mg/kg, all of which are above the soil to groundwater DAF-1 screening level. Three of the detections were above the Industrial PRG, with measured concentrations ranging from 6.8 to 35 mg/kg. All 3 of these samples were located in the Western W. Ditch Area.

5.2.1.8 VOCs

5.2.1.8.1 1,2,4-Trichlorobenzene. Figure 5-20 presents the distribution of 1,2,4-trichlorobenzene in surface soils. A total of 47 soil samples were analyzed for 1,2,4-trichlorobenzene, with detectable concentrations noted in 6 samples. Three of these samples had concentrations below the soil to groundwater DAF-1 screening level of 0.3 mg/kg. The other three samples, all located in the Western W Ditch area, had reported concentrations above the DAF-1 screening level with concentrations ranging from 140 to 850 mg/kg.. Only the highest concentration among these three samples exceeded the Industrial PRG of 220 mg/kg.

5.2.1.8.2 1,2-Dichlorobenzene. Figure 5-21 presents the distribution of 1,2-dichlorobenzene in surface soils. A total of 47 soil samples were analyzed for 1,2-dichlorobenzene, with detectable concentrations ranging from 0.0004 to 750 mg/kg noted in 9 samples. Four of the 9 detections were above the soil to groundwater DAF-1 screening level of 0.9 mg/kg, with reported concentrations of 12 mg/kg, 74 mg/kg, 530 mg/kg, and 750 mg/kg, the greatest of which exceeded the Industrial PRG of 600 mg/kg. The 12-mg/kg sample was taken from the STA and the other 3 of these samples were located in the Western W. Ditch Area. The reported detection limits for all of the non-detects were lower than the DAF-1 screening level.

5.2.1.8.3 1,4-Dichlorobenzene. Figure 5-22 presents the distribution of 1,4-dichlorobenzene in surface soils. A total of 47 soil samples were analyzed for 1,4-dichlorobenzene, with detectable concentrations ranging from 0.00056 to 120 mg/kg noted in 9 samples. Four of the 9 detections, at concentrations ranging from 11 to 120 mg/kg, were above both the soil to groundwater DAF-1 screening level of 0.1 mg/kg and the Industrial PRG of 7.9 mg/kg. One of these samples, with a reported concentration of 17 mg/kg, was taken from the STA. The other 3 of these samples were located in the Western W. Ditch Area. All 4 of these samples are co-located with the 1,2-dichlorobenzene exceedances. The reported detection limits for 22 of the non-detects were lower than the DAF-1 screening level. The detection limits for the other 16 samples were all 0.33 mg/kg.

5.2.1.8.4 Benzene. Figure 5-23 presents the distribution of benzene in surface soils. A total of 31 soil samples were analyzed for benzene, with detections in 9 samples at reported concentrations of 0.00063 to 0.0029 mg/kg. Only one sample, from the North Landfill Lobe, had a reported concentration that exceeded the DAF-1 screening level of 0.002 mg/kg. The reported detection limits for all non-detects were greater than the DAF-1 screening level. Detection limits in two of the samples also exceeded the Industrial PRG of 1.4 mg/kg, and these samples are coincident with the samples that had high reported concentrations of the chlorinated benzenes.

5.2.1.8.5 Chloroform. Figure 5-24 presents the distribution of chloroform in surface soils. A total of 31 samples were analyzed for chloroform, with detections in 8 samples. The reported concentrations ranged between 0.0012 and 0.18 mg/kg. Only one of the reported concentrations, 0.18 mg/kg, was above the DAF-1 screening level of 0.03 mg/kg, but it was below the Industrial PRG of 0.47 mg/kg. Note that the reporting limits for 3 of the non-detects were above the DAF-1 screening level and the Industrial PRG and these samples are coincident with the samples that had high reported concentrations of the chlorinated benzenes.

5.2.2 Subsurface Soils (5 to 10 feet below ground surface)

The following subsections present an overview of the distribution of chemicals in the subsurface soils. For all chemicals presented on figures, the 5- to 10-foot bgs sample interval was used for internal consistency. This interval represents the basal depth of the construction worker exposure, except in the Borrow Areas, where the maximum excavation depth will be to a maximum anticipated depth of 40 feet bgs. Accordingly, this section focuses on the 5- to 10-foot bgs interval, and Section 5.2.3 focuses on the deeper soils in the Borrow Areas. No samples were collected from depths between 1 feet and 5 feet bgs.

5.2.2.1 Dioxins and Furans

Figure 5-25 presents the distribution of dioxins and furans in subsurface soils in the 5- to 10-foot bgs depth range. For this chemical class, all samples were collected between 9 and 10 feet bgs. Dioxins and furans congener soil sample results (along with calculated toxicity equivalents [TCDD TEQ]) for all depths are presented in Appendix D, Table D-3b.

A total of 40 samples were analyzed for the presence of dioxins and furans in the 9- to 10-foot bgs depth range, with detectable concentrations noted in 25 of the 40 samples. Of the 25 samples with detectable dioxin and furan concentrations, 11 had concentrations in excess of the ATSDR (1997) 50-pg/g screening criterion, with exceedances ranging from 64 to 9,788 ppt. All of the samples with dioxin and furan concentrations exceeding the ATSDR 50-pg/g TCDD TEQ were collected in the STA. The concentrations greater than 50 pg/g but less than 1,000 pg/g (1 ppb) are considered “evaluation levels” by ATSDR (1997). ATSDR describes “evaluation levels” as TCDD TEQ levels at which site-specific factors—including but not limited to bioavailability, ingestion rates, pathway analysis, soil cover, climate, other contaminants, community concerns, demographics, and background exposure—are considered to assess the nature and extent of contamination and its impact on the community. Three of the samples had concentrations above 1,000 pg/g (1 ppb), ranging from 7,836 to 9,788 pg/g.

5.2.2.2 *Metals*

Subsurface soil samples for metals analyses were collected from soil borings that extended through both the Qal and the TMCf. Data from the Qal as presented herein are compared to the currently available background data set for Qal soil materials. To date, ranges of background concentrations have only been calculated for the Qal in the depth interval 0 to 11 feet bgs, although a program to develop CAMU Site-specific background concentrations for the deeper portions of the Qal and the TMCf is currently planned (DBS&A, 2006c, currently under review by NDEP). Because of this, the following subsections address the Qal and TMCf data sets separately. A future deep soil background data set developed from samples collected at deeper depths may result in different background concentrations. BRC will update such comparisons when the deep background soil data set is available.

5.2.2.2.1 Arsenic. Figure 5-26 presents the distribution of arsenic for Qal subsurface soils from 5 to 10 feet bgs. A total of 49 samples were collected from this depth interval in the Qal and analyzed for arsenic, with detectable concentrations noted in 41 of the samples. None of the detections were found in samples taken from 5 feet bgs. The soil to groundwater DAF-1 is 1 mg/kg. The Industrial PRG is 2 mg/kg. All of the 41 detections were at concentrations greater than or equal to the Industrial PRG. The reporting limits for the 8 non-detects were above the Industrial PRG, but below the maximum provisional background concentration. The upper end of the provisional background concentration range for arsenic is 7.2 mg/kg. Arsenic was

detected at concentrations above the upper end of the provisional background range in 2 of the 49 samples collected from the 5- to 10-foot bgs interval: one sample from the STA at 7.5 mg/kg (location BS-11) and one sample from the South Borrow Pit Lobe at 7.6 mg/kg (location BP-08).

5.2.2.2.2 Total Chromium. Figure 5-27 presents the distribution of total chromium for Qal subsurface soils from 5 to 10 feet bgs. A total of 49 subsurface soil samples from this depth interval in the Qal were analyzed for total chromium, with total chromium detected in all 49 samples. All detections were above the DAF-1 screening criteria of 2.0 mg/kg. The upper end of the provisional background for total chromium in the Qal subsurface soils of 17 mg/kg was exceeded in 5 samples, at concentrations ranging from 19.5 to 120 mg/kg. None of the samples had total chromium concentrations above the Industrial PRG of 450 mg/kg.

5.2.2.2.3 Hexavalent Chromium. Figure 5-28 presents the distribution of hexavalent chromium in Qal subsurface soils from 5 to 10 feet bgs. A total of 47 samples were collected from this interval, with hexavalent chromium detected in 3 samples, all at the 5-foot bgs interval. The reported concentrations ranged from 0.4 to 1.2 mg/kg, below the soil to groundwater DAF-1 of 2.0 mg/kg and well below the Industrial PRG of 450 mg/kg.

5.2.2.3 Organochlorine Pesticides

Four organochlorine pesticides have been used as surrogates to detail the nature and extent of surface soil and subsurface distribution of this chemical class: aldrin, alpha BHC, beta BHC, and gamma BHC. Each of these is described below.

5.2.2.3.1 Aldrin. Figure 5-29 presents the distribution of aldrin in subsurface soils for Qal subsurface soils from the 5- to 10-foot bgs interval. A total of 81 samples from this depth interval were analyzed for aldrin. Of these 81 samples, aldrin was detected in 9 samples. Three samples from the 9- to 10-foot interval in the STA contained aldrin above the Industrial PRG of 0.1 mg/kg, with a reported concentrations ranging from 1.9 to 5.0 mg/kg. One other of the 9 samples with aldrin detections was above the DAF-1 screening level criteria of 0.02 mg/kg, with a reported concentration of 0.025 mg/kg.

5.2.2.3.2 Alpha BHC. Figure 5-30 presents the distribution of alpha BHC in subsurface soils from the 5- to 10-foot bgs interval. A total of 81 samples were analyzed from this depth interval for alpha BHC. Of these 81 samples, alpha BHC was detected in 32 samples. All 32 had

reported alpha BHC concentrations above the DAF-1 screening value of 0.00003 mg/kg, and 4 samples from the STA had alpha BHC above the Industrial PRG of 0.36 mg/kg, with concentrations reported between 1.3 and 28 mg/kg. The sample with the 28-mg/kg detection also yielded the high aldrin detection.

5.2.2.3.3 Beta BHC. Figure 5-31 presents the distribution of beta BHC in subsurface soils from the 5- to 10-foot bgs interval. A total of 81 samples from this depth interval were analyzed for beta BHC. Of these 81 samples beta BHC was detected in 43 samples. All detected concentrations exceeded the soil to groundwater DAF-1 screening level of 0.0001 mg/kg. Three samples in the STA exceeded the Industrial PRG of 1.3 mg/kg, with reported concentrations between 2.9 and 8.0 mg/kg. This sample, with a reported concentration of 8.0 mg/kg (at location BS-08-W20), also yielded the highest aldrin and alpha BHC concentrations (Sections 5.2.2.3.1 and 5.2.2.3.2).

5.2.2.3.4 Gamma BHC. Figure 5-32 presents the distribution of gamma BHC in subsurface soils from the 5- to 10-foot bgs interval. A total of 81 samples from this depth interval in the Qal were analyzed for gamma BHC. Of these 81 samples, gamma BHC was detected in 21 samples, at concentrations ranging from 0.0023 mg/kg to 7.6 mg/kg. The sample with a reported concentration of 7.6 mg/kg was the only one to exceed the Industrial PRG of 1.7 mg/kg. Although unknown, it is possible that all sample concentrations may be above the DAF-1 screening criterion of 0.0005 mg/kg because the minimum reported detection limit of 0.005 mg/kg for the non-detects exceeds the soil to groundwater DAF-1 screening level.

5.2.2.4 PCBs

Qal samples analyzed for PCBs were taken from the 9- to 10-foot bgs interval. No samples for these chemicals were collected between the 0- to 1-foot bgs depth interval and the 9- to 10-foot bgs depth interval. All of the samples analyzed for PCBs were taken from the Borrow Areas and the STA. There were five detections, all from the STA. One sample had a reported Aroclor 1242 concentration of 0.15 mg/kg. There are no screening levels for Aroclor 1242. The other reported concentrations are estimated values. Three of the detections were for Aroclor 1254 with reported concentrations of 4.0, 4.5, and 200 mg/kg, all of which exceed the Industrial PRG for Aroclor 1254 of 0.74 mg/kg. The other reported detection was for Aroclor 1260 with a reported concentration of 7.3 mg/kg. There are no screening levels for Aroclor 1260.

5.2.2.5 *Perchlorate*

Figure 5-33 presents the distribution of perchlorate in subsurface soils in the 5- to 10-foot bgs interval. A total of 35 subsurface soil samples were analyzed for perchlorate in this depth interval. Of these 35 samples, perchlorate was detected in 29 of these samples at concentrations ranging from 0.0478 to 7.87 mg/kg. None of these detections at any depth were above the Industrial PRG of 100 mg/kg.

5.2.2.6 *Radiochemicals*

The following discussion of radiochemicals focuses on radium-226 and radium-228, as well as uranium-235 and uranium-238. No samples for these chemicals were collected between the 0- to 1-foot bgs depth interval and the 9- to 10-foot bgs depth interval.

5.2.2.6.1 *Radium-226.* Figure 5-34 presents the distribution of radium-226 in subsurface soils in this depth interval. A total of 37 subsurface soil samples were collected from the Qal in the 9- to 10-foot bgs interval and analyzed for radium-226. Radium-226 was detected in 36 of these samples with detections ranging between 0.38 and 54.4 pCi/g. The reporting limits for the non-detect samples were above the soil to groundwater DAF-1 screening activity of 0.0161 pCi/g and the Industrial PRG of 0.026 pCi/g. A total of 4 samples within the STA had radium-226 activities above the upper end of the provisional background activity of 2.4 pCi/g, with a maximum reported activity of 54.4 pCi/g.

5.2.2.6.2 *Radium-228.* Figure 5-35 presents the distribution of radium-228 in subsurface soils in the 9- to 10-foot bgs interval. A total of 30 subsurface soil samples were collected from the Qal in this depth interval and analyzed for radium-228. Radium-228 was detected in 23 of these samples with detections ranging from 0.43 to 3.74 pCi/g. The reporting limits for the non-detect samples were above the soil to groundwater DAF-1 screening level of 0.0594 pCi/g, but below the upper end of the provisional radium-228 background activity of 2.9 pCi/g. One sample in the STA had a reported radium-228 activity of 3.74 pCi/g, which is greater than upper end of the provisional background of 2.9 pCi/g.

5.2.2.6.3 *Uranium-235.* Figure 5-36 presents the distribution of uranium-235 in subsurface soils in the 9- to 10-foot bgs interval. A total of 30 subsurface soil samples were collected from the Qal in this depth interval and analyzed for uranium-235. Uranium-235 was detected in 21 of

these samples. The reporting limits for 5 of the 9 non-detects were above the soil to groundwater DAF-1 activity of 0.0389 pCi/g. None of the uranium activities reported were above the upper end of the provisional site background activity of 0.21 pCi/g or the Industrial PRG of 0.4 pCi/g.

5.2.2.6.4 Uranium-238. Figure 5-37 presents the distribution of uranium-238 in subsurface soils in the 9- to 10-foot bgs interval. A total of 30 subsurface soil samples were collected from the Qal in this depth interval and analyzed for uranium-238. Uranium-238 was detected in all of these samples, with detected activities in 29 of the samples between the DAF-1 screening level of 0.006 pCi/g and the upper end of the provisional background activity of 2.4 pCi/g. One sample had a reported activity above the upper end of the provisional background, with an activity of 2.73 pCi/g.

5.2.2.7 SVOCs

Hexachlorobenzene is the only SVOC discussed in this report due to its widespread distribution. Though considered as SVOCs in some classification schemes, 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, and 1,4dichlorobenzene, are discussed in the section on VOCs (Section 5.2.2.8).

Figure 5-38 presents the distribution of hexachlorobenzene from 5 to 10 feet bgs. A total of 79 subsurface soil samples from this depth were analyzed for hexachlorobenzene. Of these 79 samples, hexachlorobenzene was detected in 20 of the samples, at concentrations ranging from 0.083 to 620 mg/kg. All of the reported non-detects had reporting limits greater than or equal to the soil to groundwater DAF-1 screening level of 0.1 mg/kg. Seventeen soil samples had detections above the soil to groundwater DAF-1 criteria. Seven of those 17 were also above the Industrial PRG of 1.1 mg/kg, with concentrations ranging from 1.2 to 620 mg/kg. Four of these samples were located in the Western W. Ditch Area and the other three samples were located in the STA.

5.2.2.8 VOCs

5.2.2.8.1 1,2,4-Trichlorobenzene. Figure 5-39 presents the distribution of 1,2,4-trichlorobenzene from 5 to 10 feet bgs. A total of 83 subsurface soil samples were analyzed for 1,2,4-trichlorobenzene. Of these, there were detectable concentrations in 26

samples, with concentrations ranging from 0.001 to 180 mg/kg. Twenty-four samples had detected concentrations above the DAF-1 soil screening criteria of 0.3 mg/kg, and none of the samples had detected concentrations above the Industrial PRG of 220 mg/kg. The highest concentration was 180 mg/kg and was measured in a sample collected from the Western W. Ditch Area at a depth of 5 feet bgs. Four of the next 5 highest concentrations reported (ranging from 5.7 to 90 mg/kg) were also in the Western W. Ditch Area, and one (with a reported concentration of 58 mg/kg) was in the STA.

5.2.2.8.2 1,2-Dichlorobenzene. Figure 5-40 presents the distribution of 1,2-dichlorobenzene from 5 to 10 feet bgs. A total of 83 subsurface soil samples were analyzed for 1,2,-dichlorobenzene in this depth interval. There were detectable concentrations in 48 samples. Twenty-two samples had detected concentrations above the DAF-1 soil screening criteria of 0.9 mg/kg with concentrations from 1.1 to 10,000 mg/kg. One sample from the STA with a reported concentration of 2,700 mg/kg and one sample from the Western W. Ditch with a reported concentration of 10,000 mg/kg were the only detections above the Industrial PRG of 600 mg/kg.

5.2.2.8.3 1,4-Dichlorobenzene. Figure 5-41 presents the distribution of 1,4-dichlorobenzene from 5 to 10 feet bgs. A total of 83 subsurface soil samples were analyzed for 1,4,-dichlorobenzene in this depth interval. Of these, there were detectable concentrations in 46 samples, with 24 samples having detected concentrations above the DAF-1 soil screening criteria of 0.1 mg/kg. Fourteen of the samples had detected concentrations above the Industrial PRG of 7.9 mg/kg, with sample concentrations ranging from 8.2 to 3,400 mg/kg. Eleven of these were from the STA and the other three were from the Western W. Ditch Area, with the highest concentration of 3,400 mg/kg being found in the STA.

5.2.2.8.4 Benzene. Figure 5-42 presents the distribution of benzene from 5 to 10 feet bgs. A total of 83 subsurface soil samples were analyzed for benzene in this depth interval, with detectable concentrations in 5 samples. Of the 5 detections, only 1 sample had a detected concentration (0.0056 mg/kg) above the DAF-1 soil screening criterion of 0.002 mg/kg. None had detected concentrations above the Industrial PRG of 1.4 mg/kg.

5.2.2.8.5 Chloroform. Figure 5-43 presents the distribution of chloroform from 5 to 10 feet bgs. A total of 83 subsurface soil samples in this depth interval were analyzed for chloroform, with detectable concentrations in 41 samples ranging from 0.0002 to 3.7 mg/kg. Of the 41 detections, 16 samples had concentrations detected above the DAF-1 soil screening criteria of 0.03 mg/kg, and 3 had a concentration detected above the Industrial PRG of 0.47, with concentrations ranging from 0.5 to 3.7 mg/kg. All of the detections were from the STA.

5.2.3 Subsurface Soils In Borrow Areas (depths greater than 10 feet bgs)

Although the majority of the earth-moving activities are not anticipated to extend to depths greater than 10 feet bgs, some work in the borrow areas will entail excavating to depths as great as 40 feet bgs. Consequently, the following subsections have been prepared to discuss contaminant distributions at depth within the borrow areas.

5.2.3.1 Dioxins and Furans

A total of six Qal subsurface samples were collected in the North Borrow Pit Lobe at depths ranging between 10 and 40 feet bgs. Dioxins and furans were only detected in one sample, with concentrations below the screening criterion of 50 ppt. Two subsurface soil samples were collected in the TMCf in the North Borrow Pit Lobe; neither of these samples had detectable concentrations of dioxins and furans.

A total of eight Qal subsurface samples were collected in the South Borrow Pit Lobe at depths ranging between 10 and 40 feet bgs. Dioxins and furans were not detected in any of the subsurface soil samples collected. Five subsurface soil samples were collected in the TMCf in the South Borrow Pit Lobe; none of these samples had detectable concentrations of dioxins and furans.

5.2.3.2 Metals

5.2.3.2.1 Arsenic. A total of 30 subsurface samples collected at depths between 10 and 40 feet bgs from the Qal in the North Borrow Pit Lobe were analyzed for arsenic, with arsenic detected in 26 samples. The reported concentrations ranged between 3 and 19 mg/kg. These concentrations are all greater than the Industrial PRG. A determination of the background arsenic concentration for these deeper soils has not been completed to date, although a work plan for doing so has been submitted to the NDEP (DBS&A, 2006) and is under review. A total

of 3 subsurface samples from the TMCf in the North Borrow Pit Lobe from depths between 40 and 50 feet bgs were analyzed for arsenic; concentrations in these 3 samples ranged between 12.1 and 35.1 mg/kg, with the highest concentration reported in boring BP-01 at a depth of 50 feet bgs. This depth is below the maximum excavation in the borrow pit area.

A total of 22 subsurface samples collected at depths between 10 and 40 feet bgs from the Qal in the South Borrow Pit Lobe were analyzed for arsenic, with arsenic detected in all samples. The reported concentrations ranged between 3.3 and 25.4 mg/kg, with the highest concentration detected in boring BP-08 at a depth of 30 feet bgs. All reported concentrations are greater than the Industrial PRG. As noted above, determination of the background arsenic concentration for these deeper soils has not been completed to date, although a work plan has been submitted to NDEP (DBS&A, 2006). A total of 5 subsurface samples from the TMCf in the South Borrow Pit Lobe from depths between 40 and 50 feet bgs were analyzed for arsenic; reported concentrations in these 3 samples ranged between 9.5 and 20.7 mg/kg, with the maximum concentration reported in boring BP-08 at a depth of 40 feet bgs.

5.2.3.2.2 Total Chromium. A total of 30 subsurface samples collected at depths between 10 and 40 feet bgs from the Qal in the North Borrow Pit Lobe were analyzed for total chromium, with total chromium detected in all samples, at concentrations ranging between 4.1 and 24 mg/kg. The DAF-1 soil to groundwater screening level for total chromium is 2.0 mg/kg, which is lower than all reported concentrations. All samples were below the Industrial PRG for total chromium, which is 450 mg/kg. A determination of the background total chromium concentration for these deeper soils has not been completed to date, although a work plan for doing so has been submitted to NDEP (DBS&A, 2006). A total of 3 subsurface samples from the TMCf in the North Borrow Pit Lobe from depths between 40 and 50 feet bgs were analyzed for total chromium; reported concentrations in these 3 samples ranged between 6.9 and 27.7 mg/kg, with the highest concentration reported in boring BP-05 at a depth of 40 feet bgs.

A total of 22 subsurface samples collected at depths between 10 and 35 feet bgs from the Qal in the South Borrow Pit Lobe were analyzed for total chromium, with total chromium detected in all samples, at concentrations ranging between 7 and 28 mg/kg. The DAF-1 screening criterion for total chromium is 2.0 mg/kg, which is lower than all reported concentrations. All samples were below the Industrial PRG for total chromium, which is 450 mg/kg. A determination of the

background total chromium concentration for these deeper soils has not been completed to date, although a work plan has been submitted to NDEP (DBS&A, 2006). A total of 5 subsurface samples from the TMCf in the South Borrow Pit Lobe from depths between 40 and 50 feet bgs were analyzed for total chromium; reported concentrations in these 3 samples ranged between 23.5 and 110 mg/kg, with the highest concentration reported in boring BP-10 at a depth of 40 feet bgs.

5.2.3.2.3 Hexavalent Chromium. A total of 30 subsurface samples collected at depths between 10 and 40 feet bgs from the Qal in the North Borrow Pit Lobe were analyzed for hexavalent chromium. A total of 3 subsurface soil samples from the TMCf in the North Borrow Pit Lobe were also analyzed for hexavalent chromium. Hexavalent chromium was not detected in any of the samples collected, although the reporting limit for all non-detects was below the DAF-1 screening level of 2.0 mg/kg.

A total of 22 subsurface samples collected at depths between 10 and 40 feet bgs from the Qal in the South Borrow Pit Lobe were analyzed for hexavalent chromium. A total of 5 subsurface samples from the TMCf in the South Borrow Pit Lobe from depths between 40 and 50 feet bgs were also analyzed for hexavalent chromium. Hexavalent chromium was not detected in any of the samples collected, although the reporting limit for all non-detects was below the DAF-1 screening level of 2.0 mg/kg.

5.2.3.3 Organochlorine Pesticides

Four organochlorine pesticides have been used as surrogates to exemplify the nature and extent of surface soil and subsurface distribution of this chemical class: aldrin, alpha BHC, beta BHC, and gamma BHC. These surrogates are discussed for the North and South Borrow Pit Lobes in the following subsections.

5.2.3.3.1 Aldrin. Aldrin was analyzed in 36 subsurface Qal samples from 10 to 40 feet bgs in the North Borrow Pit Lobe, with none of the samples containing aldrin at concentrations above their respective reporting limits; however, the reporting limit was below the Industrial PRG of 0.1 mg/kg. Aldrin was analyzed in 3 subsurface TMCf samples from 40 to 50 feet bgs in the North Borrow Pit Lobe with none of the samples containing aldrin at concentrations above their respective reporting limits

Aldrin was analyzed in 22 subsurface Qal samples from 10 to 40 feet bgs in the South Borrow Pit Lobe, with none of the samples containing aldrin at concentrations above their respective reporting limits; however the reporting limit was below the Industrial PRG of 0.1 mg/kg. Aldrin was analyzed in 5 subsurface TMCf samples from 40 to 50 feet bgs in the South Borrow Pit Lobe, with none of the samples containing aldrin at concentrations above their respective reporting limits; however the reporting limits were below the Industrial PRG of 0.1 mg/kg.

5.2.3.3.2 Alpha BHC. Alpha BHC was analyzed in 36 subsurface Qal samples from the 10 to 40 feet bgs in the North Borrow Pit Lobe, with detectable concentrations noted at 17 locations. Reported concentrations ranged between .006 and 0.180 mg/kg, all of which were above the soil to groundwater DAF-1 screening level of 0.00003 mg/kg. The maximum concentration reported was in sample GP_B-13-N1 at a depth of 20 feet bgs. The reporting limit for alpha BHC, which was as low as .0018 mg/kg, was elevated with regard to the soil to groundwater DAF-1 screening level of 0.00003 mg/kg. Alpha BHC was analyzed in 3 subsurface TMCf samples from 40 to 50 feet bgs in the North Borrow Pit Lobe. Two samples had reportable concentrations, with the maximum concentration reported being 0.012 mg/kg, which is well below the Industrial PRG.

Alpha BHC was analyzed in 22 subsurface Qal samples from 10 to 40 feet bgs in the South Borrow Pit Lobe, with one sample containing alpha BHC at an estimated concentration of .0055 mg/kg. The DAF-1 screening level is 0.00003 mg/kg. Alpha BHC was analyzed in 5 subsurface TMCf samples from 40 to 50 feet bgs in the South Borrow Pit Lobe, with none of the samples containing alpha BHC at concentrations above their respective reporting limits. It is important to note that the reporting limit for alpha BHC, which was as low as .0023 mg/kg, was still elevated with regard to the soil to groundwater DAF-1 screening level of 0.00003 mg/kg.

5.2.3.3.3 Beta BHC. Beta BHC was analyzed in 36 subsurface Qal samples from 10 to 40 feet bgs in the North Borrow Pit Lobe, with detectable concentrations noted at 11 locations. The minimum reporting limit of .0019 mg/kg exceeds the soil to groundwater DAF-1 screening level of 0.0001 mg/kg. Reported concentrations ranged between 0.0067 and 0.074 mg/kg, all of which were above the 0.0001-mg/kg DAF-1 screening level. The maximum concentration detected was in a sample from boring EB-1 collected at a depth of 35 feet bgs. Beta BHC was not detected in the three North Borrow Pit Lobe samples collected from the TMCf, although the

minimum reporting limit of 0.0022 mg/kg was elevated with respect to the DAF-1 screening level.

Beta BHC was analyzed in 22 subsurface Qal samples from 10 to 40 feet bgs in the South Borrow Pit Lobe, with alpha BHC detected in one sample at a concentration of 0.0055 mg/kg. The DAF-1 screening level of 0.0001 mg/kg is lower than the reporting limit for the non-detects and the one detection. Beta BHC was analyzed in 5 subsurface TMCf samples from 40 to 50 feet bgs in the South Borrow Pit Lobe, with none of the samples containing beta BHC at concentrations above their respective reporting limits. However, the reporting limit for beta BHC, which was as low as 0.0023 mg/kg, was still elevated with regard to the soil to groundwater DAF-1 screening level of 0.0022 mg/kg.

5.2.3.3.4 Gamma BHC. Gamma BHC (Lindane) was analyzed in 36 subsurface Qal samples from 10 to 40 feet bgs in the North Borrow Pit Lobe, with detectable concentrations noted at 14 locations. Reported concentrations ranged between .0057 and 0.022 mg/kg, all of which were above the soil to groundwater DAF-1 screening level of 0.0005 mg/kg. The maximum reported concentration of 0.022 mg/kg was in boring EB-7 at a depth of 30 feet bgs. The reporting limit for gamma BHC, which was as low as 0.0018 mg/kg, was elevated with regard to the 0.0005 mg/kg soil to groundwater DAF-1 screening level. Gamma BHC was analyzed in 3 subsurface TMCf samples from 40 to 50 feet bgs in the North Borrow Pit Lobe. Two samples had reportable concentrations, with the maximum concentration reported being 0.0073 mg/kg, which is well below the Industrial PRG of 1.7 mg/kg.

Gamma BHC was analyzed in 22 subsurface Qal soil samples from 10 to 40 feet bgs in the South Borrow Pit Lobe; none of the samples contained gamma BHC at concentrations above reporting limits. The DAF-1 screening level of 0.0005 mg/kg is lower than the reporting limit for the non-detects. Gamma BHC was analyzed in 5 subsurface TMCf samples from 40 to 50 feet bgs in the South Borrow Pit Lobe, with none of the samples containing beta BHC at concentrations above their respective reporting limits. The reporting limit for beta BHC, which was as low as 0.0023 mg/kg, was elevated with regard to the soil to groundwater DAF-1 screening level of 0.0005 mg/kg.

5.2.3.4 PCBs

A total of 14 subsurface samples were collected at depths between 18 and 40 feet bgs from the Qal in the Borrow Pit Lobes (6 from the North Borrow Pit Lobe and 8 from the South Borrow Pit Lobe) and analyzed for PCBs. PCBs were not detected in any of the samples. Two and 5 subsurface samples in the North and South Borrow Areas, respectively, were collected from the TMCf, at depths between 40 and 50 feet bgs, and analyzed for PCBs, with no detections.

5.2.3.5 Perchlorate

A total of 30 subsurface samples were collected at depths between 15 and 40 feet bgs from the Qal in the North Borrow Pit Lobe and analyzed for perchlorate, with perchlorate detected in 11 samples. The reported concentrations ranged between 0.048 and 0.15 mg/kg. These concentrations are all lower than the Industrial PRG (100 mg/kg). A total of 3 subsurface samples were collected from the TMCf in the North Borrow Pit Lobe, at depths ranging between 40 and 50 feet bgs, and analyzed for perchlorate, with no detections.

A total of 22 subsurface samples were collected at depths between 15 and 40 feet bgs from the Qal in the South Borrow Pit Lobe and analyzed for perchlorate, with perchlorate detected in 14 samples. The reported concentrations ranged between 0.059 and 46.1 mg/kg. These concentrations are all lower than the Industrial PRG (100 mg/kg). A total of 5 subsurface samples were collected from the TMCf in the South Borrow Pit Lobe, at depths ranging between 40 and 50 feet bgs and analyzed for perchlorate, with two detections at 0.094 and 0.169 mg/kg, both being below the Industrial PRG.

5.2.3.6 Radiochemicals

The following discussion of radiochemicals focuses on radium-226 and radium-228, as well as uranium-235 and uranium-238

5.2.3.6.1 Radium-226. A total of 14 samples were collected at depths between 18 and 40 feet bgs from the Qal in the North Borrow Pit Lobe and analyzed for radium-226, with detections in 13 samples. Measured activities ranged between 1.68 and 4.52 pCi/g. The activities in all of samples exceeded both the soil to groundwater DAF-1 screening level of 0.0161 pCi/g and the Industrial PRG of 0.026 pCi/g. A total of 2 Two samples were collected at depths between 40 and 50 feet bgs from the TMCf and analyzed for radium-226. Radium-226 was detected in both

samples. Activities were 2.26 and 2.51 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan for doing so has been submitted to the NDEP and is under review.

A total of 12 samples were collected from the Qal at depths between 18 and 40 feet bgs in the South Borrow Pit Lobe and analyzed for radium-226, with detections in all samples. Measured activities ranged between 1.52 and 2.99 pCi/g. The activities in all of samples exceeded both the soil to groundwater DAF-1 screening level of 0.0161 pCi/g and the PRG of 0.026 pCi/g.

A total of 5 samples were collected at depths between 40 and 50 feet bgs from the TMCf and analyzed for radium-226. Radium-226 was detected in both samples. Activities were 0.928 and 3.55 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities in Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

5.2.3.6.2 Radium-228. A total of 14 samples were collected at depths between 18 and 40 feet bgs in the North Borrow Pit Lobe and analyzed for radium-228, with detections in 11 of the samples. Measured activities ranged between 1.41 and 2.5 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0594 pCi/g and the Industrial PRG of 0.15 pCi/g, but were less than the provisional shallow soil background of 2.9 pCi/g. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

A total of 2 samples were collected at depths between 40 and 50 feet bgs in the North Borrow Pit Lobe and analyzed for radium-228. Radium-228 was detected in 1 sample with an activity of 2.06 pCi/g. In general, the activity reported for the sample from the TMCf was similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

A total of 12 samples were collected at depths between 18 and 40 feet bgs from the Qal in the South Borrow Pit Lobe and analyzed for radium-228, with detections in 8 of the samples. Measured activities ranged between 1.33 and 2.32 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0594 pCi/g and the Industrial

PRG of 0.15 pCi/g, but were less than the upper end of the provisional shallow soils background of 2.9 pCi/g.

A total of 5 samples were collected at depths between 40 and 50 feet bgs from the TMCf in the South Borrow Pit Lobe and analyzed for radium-228. Radium-228 was detected in 2 samples with activities that ranged between 0.781 and 0.9 pCi/g. In general, the activity reported for the sample from the TMCf was similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP and is under review.

5.2.3.6.3 Uranium-235. A total of 14 samples were collected at depths between 18 and 40 feet bgs from the Qal in the North Borrow Pit Lobe and analyzed for uranium-235, with detections in 7 samples. Measured activities ranged between 0.032 and 0.24 pCi/g. The activities in all samples exceeded the soil to groundwater DAF-1 screening level of 0.0389 pCi/g, but were below the Industrial PRG of 0.4 pCi/g. All but one of the sample activities were less than or equal to the provisional shallow soils background of 0.21 pCi/g.

A total of 2 samples were collected at depths between 40 and 50 feet bgs from the TMCf and analyzed for uranium-235. Uranium-235 was detected in only one sample, at an activity of 0.0263 pCi/g. The activity reported for the sample from the TMCf was similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan for doing so has been submitted to the NDEP and is under review. These activities may be comparable to deep soil background levels, which BRC will evaluate after such data are available.

A total of 12 samples were collected at depths between 18 and 40 feet bgs from the Qal in the South Borrow Pit Lobe and analyzed for uranium-235, with detections in 5 samples. Measured activities ranged between 0.0439 and 0.0911 pCi/g. The activities in all samples exceeded the soil to groundwater DAF-1 screening level of 0.0389 pCi/g, but were below the Industrial PRG of 0.4 pCi/g. All but one of the sample activities were less than or equal to the provisional shallow soils background of 0.21 pCi/g.

A total of 5 samples were collected at depths between 40 and 50 feet bgs from the TMCf and analyzed for uranium-235. Uranium-235 was detected in all 5 samples with activities ranging

between 0.0284 and 0.0619 pCi/g. The activities reported for the samples from the TMCf were similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP. These activities may be comparable to deep soil background levels, which BRC will evaluate after such data are available.

5.2.3.6.4 Uranium-238. A total of 14 samples were collected at depths between 18 and 40 feet bgs from the Qal in the North Borrow Pit Lobe and analyzed for uranium-238, with detections in all of the samples. Measured activities ranged between 0.769 and 2.1 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.006 pCi/g, and all but 3 sample activities were below the PRG of 1.8 pCi/g. All of the sample activities were less than or equal to the shallow soils provisional background of 2.4 pCi/g.

A total of 2 samples were collected at depths between 40 and 50 feet bgs from the TMCf and analyzed for uranium-238. Uranium-238 was detected in all of the samples. The concentration range was between 1.44 and 1.71 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan for doing so has been submitted to the NDEP. These activities may be comparable to deep soil background levels, which BRC will evaluate after such data are available.

A total of 12 samples were collected at depths between 18 and 40 feet bgs from the Qal in the North Borrow Pit Lobe and analyzed for uranium-238, with detections in all of the samples. Measured activities ranged between 1.3 and 2.57 pCi/g. The activities in all of samples exceeded both the soil to groundwater DAF-1 screening level of 0.006 pCi/g, and all but 2 samples, which had activities of 2.07 and 2.57 pCi/g, were below the PRG of 1.8 pCi/g.

A total of 5 samples were collected at depths between 40 and 50 feet bgs from the TMCf and analyzed for uranium-238. Uranium-238 was detected in all of the samples. The concentration range was between 0.765 and 1.18 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to

the NDEP. These activities may be comparable to deep soil background levels, which BRC will evaluate after such data are available.

5.2.3.7 SVOCs

A total of 37 subsurface samples, 20 from the North Borrow Pit Lobe and 17 from the South Borrow Pit Lobe, were collected at depths between 15 and 40 feet bgs from the Qal in the Borrow Pit Lobes and analyzed for hexachlorobenzene. Hexachlorobenzene was detected in 1 sample, located at GP_B-13-N1 in the North Borrow Pit Lobe, at a reported concentration of 1.9 mg/kg. This concentration exceeds the DAF-1 screening level of 0.1 mg/kg and the Industrial PRG of 1.1 mg/kg. A total of 7 subsurface samples from the TMCf in both Borrow Pit Lobes from depths between 40 and 50 feet bgs were analyzed for hexachlorobenzene with no detections in any of the samples.

5.2.3.8 VOCs

The following subsections describe the distribution of 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform in subsurface soils at depths greater than 10 feet bgs in the North and South Borrow Pit Lobes.

5.2.3.8.1 1,2,4-Trichlorobenzene. 1,2,4-Trichlorobenzene was analyzed in 38 subsurface Qal soil samples from 10 to 40 feet bgs in the North Borrow Pit Lobe. Only one sample, from soil boring GP_13_N-1 at a depth of 20 feet, contained detectable 1,2,4-trichlorobenzene; this concentration was 7.6 mg/kg, in excess of the DAF-1 screening level of 0.3 mg/kg. In all instances the reporting limits were below DAF-1 screening criterion. None of the sample results exceeded the Industrial PRG of 220 mg/kg. 1,2,4-Trichlorobenzene was analyzed in 2 subsurface TMCf soil samples from 40 to 50 feet bgs in the North Borrow Pit Lobe and was detected in only one sample at a concentration of 0.0055 mg/kg, well below the DAF-1 soil to groundwater screening criterion.

1,2,4-Trichlorobenzene was analyzed in 19 subsurface Qal soil samples from 10 to 40 feet bgs in the South Borrow Pit Lobe. None of the samples contained 1,2,4-trichlorobenzene at concentrations above reporting limits. The reporting limits for all samples were below the DAF-1 soil to groundwater screening level of 0.3 mg/kg. 1,2,4-Trichlorobenzene was analyzed in 5 subsurface TMCf soil samples from 40 to 50 feet bgs in the South Borrow Pit Lobe and was

detected in only one sample, at a concentration of 0.0065 mg/kg, which is well below the DAF-1 screening criteria.

5.2.3.8.2 1,2-Dichlorobenzene. 1,2-Dichlorobenzene was analyzed in 38 subsurface Qal soil samples from 10 to 40 feet bgs in the North Borrow Pit Lobe. One sample from soil boring GP_13_N-1 at a depth of 20 feet contained 1,2-dichlorobenzene at a concentration of 6.6 mg/kg, in excess of the DAF-1 screening level of 0.9 mg/kg, but below the Industrial PRG of 600 mg/kg. None of the other deep Qal soil samples analyzed in the North Borrow Pit Lobe contained detectable concentrations of 1,2-dichlorobenzene. 1,2-Dichlorobenzene was analyzed in 2 subsurface TMCf soil samples from 40 to 50 feet bgs in the North Borrow Pit Lobe, and was detected in one sample at a concentration of 0.0078 mg/kg, well below the DAF-1 soil to groundwater screening criteria.

5.2.3.8.3 1,4-Dichlorobenzene. 1,2-Dichlorobenzene was analyzed in 19 subsurface Qal soil samples from 10 to 40 feet bgs in the South Borrow Pit Lobe. Two of the samples contained 1,2-dichlorobenzene at concentrations above reporting limits, at 0.0042 and 0.0028 mg/kg, well below the DAF-1 soil to groundwater screening level of 0.9 mg/kg. The reporting limits for all samples were below the DAF-1 soil to groundwater screening level. 1,2-Dichlorobenzene was analyzed in 5 subsurface TMCf soil samples from 40 to 50 feet bgs in the South Borrow Pit Lobe and was not detected in any of the samples.

1,4-Dichlorobenzene was analyzed in 38 subsurface Qal soil samples from 10 to 40 feet bgs in the North Borrow Pit Lobe. One sample from soil boring GP_13_N-1 at a depth of 20 feet contained 1,4-dichlorobenzene at a concentration of 0.78 mg/kg, in excess of the DAF-1 screening level of 0.001 mg/kg, but below the Industrial PRG of 7.9 mg/kg. 1,4-Dichlorobenzene was not detected in any of the other deep Qal soil samples analyzed in the North Borrow Pit Lobe. 1,4-Dichlorobenzene was analyzed in 2 subsurface TMCf soil samples from 40 to 50 feet bgs in the North Borrow Pit Lobe and was detected in one sample at a concentration of 0.0091 mg/kg, below the DAF-1 soil to groundwater screening criteria.

1,4-Dichlorobenzene was analyzed in 19 subsurface Qal soil samples from 10 to 40 feet bgs in the South Borrow Pit Lobe. None of the samples contained 1,4-dichlorobenzene at concentrations above the reporting limits. The reporting limits for all samples were below the

DAF-1 soil to groundwater screening level. 1,4-Dichlorobenzene was analyzed in 5 subsurface TMCf soil samples from 40 to 50 feet bgs in the South Borrow Pit Lobe and was not detected in any of the samples at concentrations above the reporting limits. The reporting limits for all samples were below the DAF-1 soil to groundwater screening level.

5.2.3.8.4 Benzene. Benzene was analyzed in 38 subsurface Qal soil samples from 10 to 40 feet bgs in the North Borrow Pit Lobe. Benzene was reported in 7 of these samples at estimated concentrations ranging between 0.001 and 0.0016 mg/kg, all of which were below the DAF-1 soil to groundwater screening level of 0.002 mg/kg. The reporting limit for the non-detects was typically 0.005 mg/kg, which is above the DAF-1 screening level. Benzene was not detected at concentrations above the Industrial PRG of 1.4 mg/kg. Two TMCf subsurface samples from the North Borrow Pit Lobe were analyzed for benzene. Benzene was detected in a sample collected at a depth of 50 feet bgs from boring BP-01 at a concentration of 0.0026 mg/kg. This is slightly elevated with respect to the DAF-1 screening criterion. Benzene was not detected in the other sample collected (BP-05 at 40 feet bgs), although the reporting limit of 0.012 mg/kg was above the DAF-1 screening criteria of 0.002 mg/kg

Benzene was analyzed in 19 subsurface Qal soil samples from 10 to 40 feet bgs in the South Borrow Pit Lobe. Benzene was reported in 9 samples at estimated concentrations between 0.00052 and 0.0026 mg/kg. One sample from boring BP-09 at a depth of 30 feet bgs contained benzene at a concentration of 0.0026 mg/kg, which was slightly elevated with respect to the DAF-1 soil to groundwater screening level of 0.002 mg/kg. The reporting limit for the non-detects was typically 0.005 mg/kg, which is above the DAF-1 screening level. None of the samples contained benzene at concentrations above the Industrial PRG of 1.4 mg/kg. Benzene was analyzed in 5 subsurface TMCf soil samples from 40 to 50 feet bgs in the South Borrow Pit Lobe and was reported in one sample at a concentration of 0.0011 mg/kg.

5.2.3.8.5 Chloroform. Chloroform was analyzed in 38 subsurface Qal soil samples from 10 to 40 feet bgs in the North Borrow Pit Lobe. Chloroform was not detected in any of the samples analyzed, and the reporting limits, with a few exceptions, were below the DAF-1 screening level of 0.030 mg/kg. Two TMCf subsurface samples from the North Borrow Pit Lobe were analyzed for chloroform. Chloroform was detected in a sample collected at a depth of 50 feet bgs from

boring BP-01 at a concentration of 0.066 mg/kg. This is above the DAF-1 screening level of 0.030 mg/kg but below the Industrial PRG of 0.47 mg/kg.

Chloroform was analyzed in 19 subsurface Qal soil samples from 10 to 40 feet bgs in the South Borrow Pit Lobe. Chloroform was not detected in any of these samples, and the reporting limit in all instances was below the DAF-1 soil to groundwater screening level of 0.030 mg/kg. Chloroform was analyzed in 5 subsurface TMCf soil samples from 40 to 50 feet bgs in the South Borrow Pit Lobe and was reported in one sample at a concentration of 0.0011 mg/kg.

5.2.4 Subsurface Soils in the Slit Trench Area (depths greater than 10 feet bgs)

The following subsections have been prepared to discuss the contaminant distributions at depth within the STA. Tables are provided in Appendix D.

5.2.4.1 Dioxins and Furans

A total of 66 Qal subsurface samples were collected in the STA at depths ranging between 10 and 50 feet bgs. The dioxin and furan results for Qal and TMCf soil samples may be found in Appendix D. Dioxins and furans were detected in 43 samples; 23 of the 43 samples had detectable dioxin and furan concentrations in excess of the ATSDR 50 ppt TCDD TEQ screening criterion, with reported concentrations ranging from 56 to 569,966 ppt. Twenty of the 23 samples analyzed for dioxins and furans also exceeded the ATSDR Interim Action Level (1997) of 1 ppb, with exceedances ranging from 5.1 to 570 ppb. ATSDR describes Action Levels as concentrations of chemicals at which consideration of action to interdict exposure occurs (ATSDR, 1997). One TMCf sample was analyzed for dioxins and furans, and no dioxins and furans were detected.

5.2.4.2 Metals

The following text discusses the results for arsenic, total chromium, and hexavalent chromium for samples collected at depths greater than 10 feet bgs. The analytical results for the Qal and the TMCf may be found in Appendix D of this report.

5.2.4.2.1 Arsenic. A total of 91 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal in the STA and analyzed for arsenic, with arsenic detected in 81 samples. The reported concentrations ranged between 2 and 28.5 mg/kg. These

concentrations are all greater than the DAF-1 soil to groundwater screening level of 1 mg/kg and the Industrial PRG of 1.6 mg/kg. A determination of the background arsenic concentration for these deeper soils has not been completed to date, although a work plan for doing so has been submitted to NDEP (DBS&A, 2006) and is under review.

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for arsenic, with reported concentrations in these samples ranging between 4.2 and 18.9 mg/kg.

5.2.4.2.2 Total Chromium. A total of 91 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal in the STA and analyzed for total chromium, with total chromium detected in all 91 samples, at concentrations ranging between 4.1 and 62 mg/kg. The DAF-1 soil to groundwater screening level for total chromium is 2.0 mg/kg, which is lower than all reported concentrations. All reported concentrations were below the Industrial PRG for total chromium of 450 mg/kg. A determination of the background total chromium concentration for these deeper soils has not been completed to date, although a work plan has been submitted to NDEP (DBS&A, 2006).

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for total chromium, with reported concentrations in these samples ranging between 9.5 and 44.6 mg/kg, all of which are below the Industrial PRG.

5.2.4.2.3 Hexavalent Chromium. A total of 79 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal in the STA and analyzed for hexavalent chromium. A total of 4 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for hexavalent chromium. Hexavalent chromium was not detected in any of the samples collected. Note that the reporting limit for all non-detects was below the DAF-1 screening level of 2.0 mg/kg

5.2.4.3 Organochlorine Pesticides

Four organochlorine pesticides (aldrin, alpha BHC, beta BHC, and gamma BHC) have been used as surrogates to exemplify the nature and extent of the distribution of this chemical class in surface soil, subsurface soil, and borrow areas.. A copy of the analytical results for the Qal and TMCf may be found in Appendix D.

5.2.4.3.1 *Aldrin*. Aldrin was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable concentrations reported at 25 locations. Reported concentrations ranged between 0.0019 and 9.9 mg/kg, 22 of which were above the soil to groundwater DAF-1 screening level of 0.02 mg/kg. Reported concentrations in 20 samples exceeded the Industrial PRG of 0.1 mg/kg.

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for aldrin; it was not detected in any of these samples.

5.2.4.3.2 *Alpha BHC*. Alpha BHC was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable concentrations reported at 98 locations. Reported concentrations ranged between 0.0019 and 93 mg/kg, all of which were above the soil to groundwater DAF-1 screening level of 0.00003 mg/kg. Twenty-four of the samples had reported concentrations that exceeded the Industrial PRG of 0.36 mg/kg. The detection limits for all of the non-detects exceeded the DAF-1 screening level.

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for alpha BHC, and it was detected in 5 of these samples. Reported concentrations ranged between 0.013 and 56 mg/kg, all of which were above the soil to groundwater DAF-1 screening level.

5.2.4.3.3 *Beta BHC*. Beta BHC was analyzed in 124 subsurface samples that were collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable concentrations at 83 locations. Reported concentrations ranged between 0.002 and 23 mg/kg, all of which were above the soil to groundwater DAF-1 screening level of 0.0001 mg/kg. The detection limits for all of the non-detects exceeded the DAF-1 screening level.

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for beta BHC, and it was detected in 5 samples. Reported concentrations ranged between 0.014 and 2.4 mg/kg, all of which were above the soil to groundwater DAF-1 screening level.

5.2.4.3.4 *Gamma BHC*. Gamma BHC was analyzed in 124 subsurface samples that were collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable

concentrations at 71 locations. Reported concentrations ranged between 0.002 and 23 mg/kg, all of which were above the soil to groundwater DAF-1 screening level of 0.0005 mg/kg. The detection limits for all of the non-detects exceeded the DAF-1 screening level.

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for gamma BHC, and it was detected in two samples. Reported concentrations ranged between 0.008 and 2.0 mg/kg, all of which were above the soil to groundwater DAF-1 screening level.

5.2.4.4 PCBs

A total of 98 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal in the STA and analyzed for PCBs, with PCBs detected in 11 samples. The reported concentrations ranged between 0.047 and 1,200 mg/kg. Of the seven PCBs, only three were detected: PCB1242 (no DAF-1 or PRG has been established) had 3 detections ranging from 0.095 to 0.95 mg/kg, PCB1254 (Industrial PRG of 0.74 mg/kg) had 1 detection of 1,200 mg/kg, and PCB1260 (no DAF-1 or PRG has been established) had 7 detections ranging from 0.047 to 1.1 mg/kg.

A total of 4 subsurface TMCf samples in the STA from depths between 50 and 80 feet bgs were analyzed for PCBs, with no detections.

These PCB concentration levels are below the 25-mg/kg standard of cleanup specified in EPA's Guidance for PCB cleanup levels for Low Occupancy Areas. This guidance (U.S. EPA, 2005) was developed to facilitate compliance with the Toxic Substance Control Act (TOSCA), Code of Federal Regulations (CFR), Title 40, Part 761.

5.2.4.5 Perchlorate

A total of 46 subsurface samples were collected at depths between 18 and 50 feet bgs from the Qal in the STA and analyzed for perchlorate, with perchlorate detected in 32 samples. The reported concentrations ranged between 0.057 and 15 mg/kg. These concentrations are all lower than the Industrial PRG (100 mg/kg).

A total of 4 subsurface samples were collected from the TMCf in the STA, at depths ranging between 40 and 80 feet bgs and analyzed for perchlorate, with one sample having a reported concentration of 0.072 mg/kg.

5.2.4.6 *Radiochemicals*

The following discussion of radiochemicals focuses on radium-226 and radium-228, as well as uranium-235 and uranium-238

5.2.4.6.1 *Radium-226.* A total of 58 samples were collected at depths between 12 and 50 feet bgs from the Qal in the STA and analyzed for radium-226, with detections in all samples. Measured activities ranged between 0.74 and 2.48 pCi/g. The activities in all but one of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0161 pCi/g and the Industrial PRG of 0.026 pCi/g, but were less than or equal to the provisional background of 2.4 pCi/g that has been set for shallow Qal soils. One sample had a reported activity of 2.48 pCi/g, which exceeded the upper end of the provisional background.

A total of four samples were collected from the TMCf and analyzed for radium-226. Radium-226 was detected in all four samples. Activities ranged between 1.43 and 2.74 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan for doing so has been submitted to the NDEP and is currently under review.

5.2.4.6.2 *Radium-228.* A total of 46 samples were collected at depths between 18 and 50 feet bgs from the Qal in the STA and analyzed for radium-228, with detections in all of the samples. Measured activities ranged between 0.9 and 2.4 pCi/g. The activities in all of samples exceeded both the soil to groundwater DAF-1 screening level of 0.0594 pCi/g and the PRG of 0.15 pCi/g, but were less than the upper end of the provisional shallow soils background of 2.9 pCi/g.

A total of four samples were collected from the TMCf and analyzed for radium-228. Radium-228 was detected in all four samples. Activities ranged between 1.05 and 2.49 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities

from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

5.2.4.6.3 Uranium-235. A total of 46 samples were collected at depths between 18 and 50 feet bgs from the Qal in the STA and analyzed for uranium-235, with detections in 31 samples. Measured activities ranged between 0.039 and 0.28 pCi/g. The activities in all samples exceeded the soil to groundwater DAF-1 screening level of 0.0389 pCi/g, but were below the Industrial PRG of 0.4 pCi/g. All but one of the sample activities were less than or equal to the upper end of the provisional shallow soils background of 0.21 pCi/g.

A total of four samples were collected from the TMCf and analyzed for uranium-235. Uranium-235 was detected in only one sample, at an activity of 0.122 pCi/g. The activity reported for this TMCf sample was similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP. These activities may be comparable to deep soil background levels, which BRC will evaluate after such data are available.

5.2.4.6.4 Uranium-238. A total of 46 samples were collected at depths between 18 and 50 feet bgs from the Qal in the STA and analyzed for uranium-238, with detections in all of the samples. Measured activities ranged between 0.3 and 1.89 pCi/g. The activities in all of samples exceeded both the soil to groundwater DAF-1 screening level of 0.006 pCi/g, and all but three were below the PRG of 1.8 pCi/g. All of the sample activities were less than or equal to the upper end of the provisional shallow soils background of 2.4 pCi/g.

A total of four samples were collected from the TMCf and analyzed for uranium-238, which was detected in all of the samples. The concentration range was between 1.3 and 2.18 pCi/g. In general, activities reported for samples from the TMCf were similar to the measured activities from Qal samples. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP. These activities may be comparable to deep soil background levels, which BRC will evaluate after such data are available.

5.2.4.7 SVOCs

A total of 124 subsurface samples were collected at depths between 12 and 50 feet bgs from the Qal in the STA and analyzed for hexachlorobenzene, with hexachlorobenzene detected in 36 samples. The reported concentrations ranged between 0.11 and 1,200 mg/kg. These concentrations all exceeded the DAF-1 screening level of 0.1 mg/kg. Twenty-six sample concentrations with concentrations ranging between 1.2 and 1,200 mg/kg exceeded the Industrial PRG 1.1 mg/kg.

A total of 11 subsurface samples from the TMCf in the STA from depths between 40 and 80 feet bgs were analyzed for hexachlorobenzene, with no detections in any of the samples.

5.2.4.8 VOCs

The following subsections describe the distribution of 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform in subsurface soils at depths greater than 10 feet bgs in the STA.

5.2.4.8.1 1,2,4-Trichlorobenzene. 1,2,4-Trichlorobenzene was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable concentrations reported at 91 locations. Reported concentrations ranged between 0.001 and 1,000 mg/kg, 27 of which were above the soil to groundwater DAF-1 screening level of 0.3 mg/kg. The reported concentrations in 8 samples were above the Industrial PRG of 220 mg/kg. Eight of the samples that were non-detects had detection limits above the DAF-1 screening level.

A total of 11 subsurface samples were collected from the TMCf in the STA at depths between 40 and 80 feet bgs and analyzed for 1,2,4-trichlorobenzene, with reported concentrations in 6 samples ranging between 0.022 and 39 mg/kg. Two of the TMCf detections were above the DAF-1, but all were below the Industrial PRG.

5.2.4.8.2 1,2-Dichlorobenzene. 1,2-Dichlorobenzene was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA with detectable concentrations reported at 87 locations. Reported concentrations ranged between 0.001 and 25,000 mg/kg, 42 of which were above the soil to groundwater DAF-1 screening level

of 0.9 mg/kg. Twenty of the sample concentrations exceeded the Industrial PRG of 600 mg/kg. Six of the samples that were non-detects had detection limits above the DAF-1 screening level.

A total of 11 subsurface samples were collected from the TMCf in the STA at depths between 40 and 80 feet bgs and analyzed for 1,2-dichlorobenzene, with reported concentrations in 6 samples ranging between 0.035 and 31 mg/kg. Two of the TMCf detections were above the DAF-1, but all were below the Industrial PRG.

5.2.4.8.3 1,4-Dichlorobenzene. 1,4-Dichlorobenzene was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA with detectable concentrations reported at 88 locations. Reported concentrations ranged between 0.001 and 40,000 mg/kg, 54 of which were above the soil to groundwater DAF-1 screening level of 0.1 mg/kg. Twenty-six of the sample concentrations exceeded the Industrial PRG of 7.9 mg/kg. Three of the samples that were non-detects had detection limits above the DAF-1 screening level.

A total of 11 subsurface samples from the TMCf in the STA from depths between 40 and 80 feet bgs were analyzed for 1,4-dichlorobenzene, with 7 detections reported at concentrations ranging between 0.004 and 1.8 mg/kg. Three of the TMCf detections were above the DAF-1, but only one was above the Industrial PRG.

5.2.4.8.4 Benzene. Benzene was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable concentrations reported at 15 locations. Reported concentrations ranged between 0.00021 and 0.017 mg/kg; 5 were above the soil to groundwater DAF-1 screening level of 0.002 mg/kg, but all were below the Industrial PRG of 1.4 mg/kg. All of the non-detects had detection limits equal to or above the DAF-1 screening level.

A total of 11 subsurface TMCf samples in the STA from depths between 40 and 80 feet bgs were analyzed for benzene, with seven detections reported at concentrations ranging between 0.015 and 6.8 mg/kg. All 7 of the TMCf detections were above the DAF-1 screening level, but only one was above the Industrial PRG.

5.2.4.8.5 Chloroform. Chloroform was analyzed in 124 subsurface samples collected at depths between 12 and 50 feet bgs from the Qal in the STA, with detectable concentrations reported at 92 locations. Reported concentrations ranged between 0.00031 and 990 mg/kg, 53 of which were above the soil to groundwater DAF-1 screening level of 0.03 mg/kg. Eighteen of the sample concentrations exceeded the Industrial PRG of 0.47 mg/kg. Twenty of the samples that were non-detects had detection limits above the DAF-1 screening level.

A total of 11 subsurface samples from the TMCf in the STA, from depths between 40 and 80 feet bgs, were analyzed for chloroform, with 7 detections reported at concentrations ranging between 0.037 and 2 mg/kg. All seven of the TMCf detections were above the DAF-1, and four of them were above the Industrial PRG.

5.2.4.9 Supplemental Soil Sampling in the Slit Trench Area

The evaluation of the distribution of chemicals in STA soils in this section is based upon the results from soil sampling conducted in the STA 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). These additional step-out data are included and presented here for the first time. The data from the base locations from the sampling event conducted by MWH is presented along with the step-out data. Data validation summary reports (DVSRs) have been submitted separately to the NDEP and approved for all of the data sets described herein. The DVSR Number associated with each analytical result has been referenced on the summary tables provided in Appendices C, D, and E.

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, 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. Figure 5-44 shows a topographic view of the STA, indicating all of the sampling locations in the STA for soil vapor and soil samples, and

highlights the supplemental sampling locations. Figures 5-45 through Figure 5-48 illustrate the plan view of soil sample concentrations around the above-described four clusters of supplemental sampling locations.

The following subsections compare the concentrations of targeted SRCs in the original boring locations (referred to as the “base” concentrations) with those detected in the step-out borings.

5.2.4.9.1 BS-08 Step-out Sampling. Step-out sampling around base sample location BS-08 targeted dioxins and furans, organochlorine pesticides, SVOCs, and VOCs. Sampling was not conducted for metals, perchlorate, or radiochemicals. PCBs were not detected in any of the supplemental samples. A plan view of the supplemental sampling results around location BS-08 is shown in Figure 5-45.

Dioxins and Furans. At 10 feet bgs, the northern and southern samples were non-detects. The reported TCDD TEQ was 7,836 pg/g at BS-08-E10 and 824 pg/g at BS-08-E20. BS-08-W10 and BS-08-W20 had reported TCDD TEQs of 9,788 pg/g and 9,576 pg/g respectively. All of these samples exceed the base sample concentration.

The 20 foot bgs samples had reported TCDD TEQs that were uniformly higher than the 10-foot bgs samples. The 20-foot sample with the lowest concentration was BS-08-E20 with a reported TCDD TEQ of 14,117 pg/g. The northern TCDD TEQ was 17,467 pg/g, and the southern TCDD TEQ was 23,032 pg/g. The BS-08-E10 TCDD TEQ was the highest at this depth interval with a TCDD TEQ of 110,307 pg/g, which exceeded the original boring concentration. One sample taken at 15 feet bgs in boring BS-08-W10 had a reported TCDD TEQ of 569,966 pg/g, which exceeded the original boring concentration. At 30 feet, the step-out TCDD TEQs, 10 feet away from the base sample, yielded TCDD TEQs that were lower than the base value of 21,070 pg/g. The TCDD TEQ at BS-08-E20 was lower than at BS-08-E10, and the TCDD TEQ at BS-08-W20 was also lower than at BS-08-W10.

Organochlorine Pesticides. Aldrin was detected in the original sample at 10 feet bgs, with a reported concentration of 0.025 mg/kg, just above the DAF-1 of 0.02 mg/kg. The supplemental samples at the same depth were below the DAF-1 or non-detect except for two samples. The two samples with concentrations above the DAF-1 were BS-08-W10 and BS-08-W20, with reported concentrations of 1.9 mg/kg and 5 mg/kg, respectively, which are above the Industrial

PRG of 0.1 mg/kg. The sample at 15 feet bgs had the highest reported concentration, 6.8 mg/kg. At 20 feet bgs, the reported concentration of the base sample was 0.77 mg/kg and was only exceeded significantly at BS-08-W10 with a reported concentration of 5.1 mg/kg. All of the reported concentrations from step-out samples at 30 feet bgs were lower than the concentration of the base sample.

Alpha-BHC was detected at 10 feet bgs in the original boring, with a reported concentration of 0.094 mg/kg, just above the DAF-1 of 0.00003 mg/kg. The supplemental samples at the same depth were above the DAF-1 but below the Industrial PRG of 0.36 mg/kg except for two samples. The two samples with concentrations above the Industrial PRG were BS-08-W10 and BS-08-W20, with reported concentrations of 4.8 mg/kg and 28 mg/kg, respectively. The sample at 15 feet bgs had the second highest reported concentration of 65 mg/kg. At 20 feet bgs, the reported concentration of the base sample of 12 mg/kg was exceeded by all of the step-out samples except BS-08-W20. The highest reported concentration, 93 mg/kg, was at BS-08-E10. All of the reported concentrations from step-out samples at 30 feet bgs were lower than the concentration of the base sample.

Beta-BHC was detected at 10 feet bgs in the base sample at a reported concentration of 0.96 mg/kg, just above the DAF-1 of 0.0001 mg/kg. The supplemental samples at the same depth were below the DAF-1 or non-detect except for two samples. The two samples with concentrations above the DAF-1 were BS-08-W10 and BS-08-W20 with reported concentrations of 4.4 mg/kg and 8 mg/kg, respectively, and above the Industrial PRG of 1.3 mg/kg. The sample at 15 feet bgs had the second highest reported concentration, 21 mg/kg. At 20 feet bgs the reported concentration of the base sample was 2.4 mg/kg and was exceeded by all of the step-out samples except BS-08-W20, which was the same. Samples with reported concentrations significantly higher were BS-08-E10 at 23 mg/kg and BS-08-W10 at 11 mg/kg. All of the reported concentrations from step-out samples at 30 feet bgs were lower than the concentration of the base sample.

Gamma-BHC (Lindane) was not detected in the base sample at 10 feet bgs. The supplemental samples at the same depth were non-detect except for two samples. The two samples, BS-08-W10 and BS-08-W20, had reported concentrations of 0.32 mg/kg and 7.6 mg/kg, respectively, both of which are above the DAF-1 of 0.0005 mg/kg. The higher value was also above the

Industrial PRG of 1.7 mg/kg. The sample at 15 feet bgs had a reported concentration of 7.6 mg/kg. At 20 feet bgs, the reported concentration of the base sample was 2.4 mg/kg and was exceeded by all of the step-out samples except BS-08-W20, which was the same. Samples with reported concentrations significantly higher were BS-08-E10 at 23 mg/kg and BS-08-W10 at 11 mg/kg. All of the reported concentrations from step-out samples at 30 feet bgs were lower than the concentration of the base sample.

SVOCs. At 10 feet bgs, hexachlorobenzene was detected only in samples from BS-08-W10 and BS-08-W20, with reported concentrations of 620 mg/kg and 160 mg/kg respectively. The sample at 15 feet bgs at BS-08-W10 was 300 mg/kg. These concentrations exceed the reported base concentration of 0.23 mg/kg. At 20 feet bgs, only the sample at BS-08-W10 (77 mg/kg) significantly exceeded the base concentration of 22 mg/kg. The same holds true at 30 feet bgs, where only the sample at BS-08-W10 (76 mg/kg) significantly exceeded the base concentration of 25 mg/kg.

VOCs. At 10 feet bgs, 1,2,4-trichlorobenzene was detected at elevated levels in samples from BS-08-W10 and BS-08-W20, with reported concentrations of 1.7 mg/kg and 58 mg/kg respectively. The sample concentration at 15 feet bgs at BS-08-W10 was reported as 1,000 mg/kg. These concentrations exceed the reported base concentration of 0.029 mg/kg. At 20 feet bgs, the base sample was non-detect, while the step-out samples all had detections ranging from 110 mg/kg to 870 mg/kg. At 30 feet bgs the base sample was non-detect while the step-out samples all had detections ranging from 110 mg/kg to 220 mg/kg.

At 10 feet bgs, 1,2-dichlorobenzene was detected at elevated levels in the sample at BS-08-W20 with a reported concentration of 2,700 mg/kg. The sample at 15 feet bgs at BS-08-W10 was 25,000 mg/kg. These concentrations exceeded the base sample concentration of 3.3 mg/kg. At 20 feet bgs and 30 feet bgs, the reported base concentration was 17,000 mg/kg. The reported concentration at 20 feet bgs in BS-08-E10 was approximately the same at 11,000 mg/kg. The lowest concentration, at 20 feet bgs in BS-08-S10, was lower than the base concentration. The step-out concentrations at 30 feet bgs were also lower than the base concentration.

At 10 feet bgs, 1,4-dichlorobenzene was detected at an elevated level in the sample at BS-08-W20, with a reported concentration of 3,400 mg/kg. The sample at 15 feet bgs at BS-08-W10 was 40,000 mg/kg. These concentrations exceeded the base sample concentration of 3.8 mg/kg. At 20 feet bgs the reported base concentration was 23,000 mg/kg. The reported concentration at 20 feet bgs in BS-08-E10 was approximately the same at 21,000 mg/kg. The lowest concentration, at 20 feet bgs in BS-08-S10, was lower than the base concentration. The step-out concentrations at 30 feet bgs were also lower than the base sample concentration of 21,000 mg/kg.

Benzene was not detected in any of the supplemental samples at any depth.

Chloroform concentrations were elevated in only one sample each at 15 feet bgs and 20 feet bgs. The reported concentration at 15 feet bgs was 990 mg/kg and at 20 feet bgs the concentration was 160 mg/kg. Chloroform was not detected in the base samples at either 10 feet bgs or 20 feet bgs.

5.2.4.9.2 BS-11 Step-out Sampling. Step-out sampling around base sample BS-11 targeted metals, organochlorine pesticides, SVOCs, and VOCs. Sampling was not conducted for dioxins and furans, perchlorate, or radiochemicals. PCBs were not detected in any of the supplemental samples. A plan view of the supplemental sampling results around location BS-11 is shown in Figure 5-46.

Metals. Arsenic was detected in the sample at BS-11 and in all of the supplemental samples at concentrations above both the DAF-1 soil screening level and the Industrial PRG. None of the supplemental samples had a reported arsenic concentration greater than the upper end of the provisional background level, although the base sample BS-11 at 10 feet bgs did have one reported concentration of 7.5 mg/kg that exceeded the provisional background level of 7.2 mg/kg.

Total chromium was detected in the sample at BS-11 and in all of the supplemental samples above the DAF-1 soil screening level of 2 mg/kg but below the Industrial PRG of 450 mg/kg. A few samples had total chromium levels above the upper end of the reported provisional background level of 17 mg/kg. BS-11-N10 at 10 feet bgs had a reported concentration of 19.5 mg/kg. At 20 feet bgs, BS-11 and BS-11-E20 had reported concentrations of 23.7 mg/kg and

27.7 mg/kg, respectively. BS-11-W20 at 30 feet bgs had a reported concentration of 21.6 mg/kg.

Chromium (VI) was not detected in the base sample or any of the supplemental samples. The reported detection limit was below the DAF-1 soil screening level.

Organochlorine Pesticides. None of the supplemental samples for organochlorine pesticides had concentrations that exceeded the base sample concentrations. The highest reported concentration for any of the four organochlorine pesticide surrogates was 0.38 mg/kg for alpha-BHC, which is the only reported concentration that exceeded its Industrial PRG of 0.36 mg/kg. The highest aldrin concentration was 0.051 mg/kg. The highest beta-BHC concentration was 0.15 mg/kg.

SVOCs. The only SVOC detections in supplemental step-out borings at 10 feet bgs were at BS-11-W10 and BS-11-W20, with reported concentrations of 0.36 mg/kg and 0.15 mg/kg respectively. Both exceeded the base concentration of 0.093 mg/kg.

VOCs. At 10 feet bgs, 1,2,4-trichlorobenzene was not detected above its base sample concentration in any supplemental step-out sample. At 20 feet bgs 1,2,4-trichlorobenzene was detected at 7.2 mg/kg in BS-11-E10, which exceeded its base sample concentration of 1.7 mg/kg. At 30 feet bgs, 1,2,4-trichlorobenzene was not detected above its base sample concentration in any sample.

At 10 feet bgs 1,2-dichlorobenzene was detected in BS-11-E10 at 5.6 mg/kg, which exceeds its base sample concentration of 1.1 mg/kg. At 20 feet bgs, 1,2-dichlorobenzene was detected at BS-11-E10 at 140 mg/kg, which exceeds its base sample concentration of 39 mg/kg. At 30 feet bgs, 1,2-dichlorobenzene was not detected above its base sample concentration in any sample.

At 10 feet bgs 1,4-dichlorobenzene was detected in BS-11-E10 at 9.3 mg/kg which exceeds its base sample concentration of 1.7 mg/kg. At 20 feet bgs 1,4-dichlorobenzene was detected in BS-11-E10 at 160 mg/kg, which exceeds its base sample concentration of 44 mg/kg. At 30 feet bgs 1,4-dichlorobenzene was not detected above its base sample concentration in any sample.

Benzene and chloroform were not detected above their base sample concentrations in any of the supplemental samples at any depth.

5.2.4.9.3 BS-17 Step-out Sampling. Step-out sampling around base sample BS-17 targeted dioxins and furans, organochlorine pesticides, radiochemicals, SVOCs, and VOCs. Sampling was not conducted for metals or perchlorate. PCBs were not detected in any of the supplemental step-out samples. A plan view of the supplemental sampling results around location BS-17 is shown in Figure 5-47.

Dioxins and Furans. At 10 feet bgs all of the samples had TCDD TEQs less than the ATSDR 50-ppt TCDD TEQ screening criterion except the sample at BS-17-W20. The reported TCDD TEQ at BS-17-W20 was 19,458 pg/g. The reported TCDD TEQs from samples taken at 20 feet bgs show more variation. The base sample concentration of TCDD TEQ was 5,136 pg/g. The TCDD TEQs for the northern and southern samples were both below the ATSDR 50-ppt TCDD TEQ screening criterion. The sample at BS-17-E10 had a TCDD TEQ below the base sample concentration, but the sample at BS-17-E20 had a TCDD TEQ that exceeded the base sample concentration. The sample at BS-17-W10 had a TCDD TEQ of 5,547 pg/g that is just above the base sample concentration of 5,136 pg/g. The sample at BS-17-W20 had a TCDD TEQ of 11,823 pg/g.

Organochlorine Pesticides. At 10 feet bgs, only the sample at BS-17-W20 had concentrations detected above the base sample concentration. At this location the reported concentrations were aldrin at 2.2 mg/kg, alpha-BHC at 8.9 mg/kg, beta-BHC at 2.3 mg/kg, and Lindane at 2.2 mg/kg.

At 20 feet bgs, concentrations in the northern and southern samples were essentially the same as or less than the base sample concentration. The four supplemental samples along the slit trench, BS-17-E10, BS-17-E20, BS-17-W10, BS-17-W20, however, all had elevated concentrations relative to the base sample concentration. These four samples had reported ranges in concentrations of aldrin from 0.32 to 9.9 mg/kg, alpha-BHC from 1.2 to 20 mg/kg, beta-BHC from 3.2 to 4.7 mg/kg with a non-detect at BS-17-E10, and Lindane from 2 to 4.2 mg/kg with a non-detect at BS-17-E10.

Radiochemicals. The only radiochemical targeted in the supplemental sample analyses was radium-226. All but two of the reported activities at any depth were above the DAF-1 of 0.0161 pCi/g and the Industrial PRG of 0.026 pCi/g. All but two samples were below the upper end of the provisional background level of 2.4 pCi/g. Background for the deep Qal and TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

The base sample taken from 9 feet bgs at BS-17 had an activity of 12.4 pCi/g. A nearby sample, BS-17-E10 at 10 feet bgs, had a reported activity of 54.4 pCi/g. One other sample, BS-17-W20 at 24 feet bgs, had an activity of 2.48 pCi/g. All three of these detections exceed the upper end of the provisional background level.

SVOCs. Hexachlorobenzene was not detected in the base sample at either shallow depth (10 or 20 feet bgs). At 10 feet bgs in the step-out samples, however, hexachlorobenzene was detected in four of six samples. Two detections, at BS-17-E10 and BS-17-W10, exceeded the DAF-1 screening level of 0.1 mg/kg with reported concentrations of 0.5 mg/kg and 0.27, respectively. The samples from BS-17-S10 and BS-17-W20 had reported concentrations of 1.9 mg/kg and 1,200 mg/kg, respectively, that exceeded the Industrial PRG of 1.1 mg/kg.

At 20 feet bgs, both samples to the east and both samples to the west had reported concentrations that exceeded the Industrial PRG. The samples at BS-17-E10 and BS-17-E20 had reported concentrations of 26 mg/kg and 260 mg/kg, respectively. The samples at BS-17-W10 and BS-17-W20 had reported concentrations of 200 mg/kg and 300 mg/kg, respectively.

VOCs. At 10 feet bgs, 1,2,4-trichlorobenzene was detected in BS-17-W20 at 160 mg/kg, which exceeds its base sample concentration of 0.38 mg/kg. At 20 feet bgs, 1,2,4-trichlorobenzene was detected above the base sample concentration in all four step-out samples along the trench. Concentrations below the 20-foot bgs base sample concentration of 2.6 mg/kg were detected to the north and south. BS-17-E10 and BS-17-E20 had reported concentrations of 60 mg/kg and 190 mg/kg. BS-17-W10 and BS-17-W20 had reported concentrations of 350 and 260 mg/kg.

At 10 feet bgs, 1,2-dichlorobenzene was detected in BS-17-W20 at 4,700 mg/kg, which exceeds the base sample concentration of 22 mg/kg. At 20 feet bgs 1,2-dichlorobenzene was detected above the base sample concentration of 34 mg/kg in all four step-out samples along the trench,

but at lower concentrations, below the base sample concentration, to the north and south. BS-11-E10 and BS-11-E20 had reported concentrations of 1,700 mg/kg and 6,300 mg/kg. BS-11-W10 and BS-11-W20 had reported concentrations of 12,000 mg/kg and 8,900 mg/kg.

At 10 feet bgs, 1,4-dichlorobenzene was detected in BS-17-W20 at 6,200 mg/kg, which is above the base sample concentration of 25 mg/kg. At 20 feet bgs, 1,4-dichlorobenzene was detected above the base sample concentration of 37 mg/kg in all four step-out samples along the trench and at concentrations below the base sample to the north and south. BS-11-E10 and BS-11-E20 had reported concentrations of 2,100 mg/kg and 8,400 mg/kg. BS-11-W10 and BS-11-W20 had reported concentrations of 17,000 mg/kg and 13,000 mg/kg.

Benzene was not detected above the base sample concentration in any of the supplemental samples at any depth.

At 10 feet bgs, chloroform was not detected above the base sample concentration of 0.62 mg/kg. At 20 feet bgs, chloroform was detected at elevated levels in three step-out samples along the trench, but it was not detected at BS-17-E10. BS-11-E20 had a reported concentration of 52 mg/kg. BS-11-W10 and BS-11-W20 had reported concentrations of 500 mg/kg and 250 mg/kg, respectively. Chloroform was detected below the base sample concentration of 1.7 mg/kg in 20 foot bgs samples from the north and south step-out locations.

5.2.4.9.4 BS-20 Step-out Sampling. Step-out sampling around base sample location BS-20 targeted metals, organochlorine pesticides, PCBs, SVOCs, and VOCs. Sampling was not conducted for dioxins and furans, perchlorate, or radiochemicals. A plan view of the supplemental sampling results around location BS-20 is shown in Figure 5-48.

Metals. Arsenic was detected in base sample BS-20 and all of the supplemental step-out samples above both the DAF-1 soil screening level and the Industrial PRG. Four samples had a reported arsenic concentration greater than the upper end of the provisional background level (which is 7.2 mg/kg), including the base sample BS-20 at 30 feet bgs (20.9 mg/kg). As noted earlier for the metals, background for the deep Qal and TMCf has yet to be developed, although a work plan has been submitted to the NDEP. At 20 feet bgs, BS-20-E10 and BS-20-E20 had reported concentrations of 14.7 mg/kg and 28.5 mg/kg, respectively. The reported concentration for BS-20-N10 at 30 feet bgs was 14.6 mg/kg.

Total chromium was detected in the sample at BS-20 and in all of the supplemental samples above the DAF-1 soil screening level of 2 mg/kg but below the Industrial PRG of 450 mg/kg. Two samples, both at 20 feet bgs, had total chromium levels above the background level of 17 mg/kg. These reported concentrations, at BS-20-E10 and BS-20-E20, were 20.6 mg/kg and 25.9 mg/kg, respectively.

Chromium (VI) was not detected in the base sample or any of the supplemental step-out samples. The reported detection limit was below the DAF-1 soil screening level.

Organochlorine Pesticides. Organochlorine pesticides were not detected above a relatively low concentration of 0.35 mg/kg at any depth in base sample BS-20. This concentration was reported at 20 feet bgs (beta-BHC).

Aldrin was not detected in either the base sample or any of the step-out samples around BS-20. At 10 feet bgs, only the samples at BS-20-W10 and BS-20-W20 had concentrations above the base sample and only for beta-BHC. At these locations the reported concentrations were 0.62 mg/kg and 1.2 mg/kg, respectively. At 20 feet bgs and 30 feet bgs none of the reported concentrations from the step-out samples were higher than those reported at BS-20.

PCBs. PCBs were detected in only two supplemental samples, both for Aroclor 1260 at BS-20-W20. The detections were at 20 feet bgs and 30 feet bgs and the reported concentrations were 1.1 mg/kg and 0.43 mg/kg, respectively. Aroclor 1260 does not have an Industrial PRG, but the 20-foot bgs detection was above the Industrial PRG of 0.74 mg/kg for Aroclor 1254.

SVOCs. Hexachlorobenzene was not detected in the base sample at any depth. At 10 feet bgs hexachlorobenzene was detected only once, at BS-20-W10 with a low reported concentration of 0.1 mg/kg, which is the DAF-1 screening level. At 20 feet bgs and 30 feet bgs, both samples to the east and one sample to the west, BS-20-W20, had reported concentrations that exceeded the Industrial PRG of 1.1 mg/kg with maximum values of 2.6 mg/kg at 20 feet bgs and 2 mg/kg at 30 feet bgs.

VOCs. At 10 feet bgs, 1,2,4-trichlorobenzene was not detected in any of the supplemental samples above the base sample concentration of 1.4 mg/kg. 1,2,4-Trichlorobenzene was not detected in the base sample at 20 feet bgs, but was reported at 1.5 mg/kg in BS-20-W10. At 30

feet bgs, 1,2,4-trichlorobenzene was detected at 0.053 mg/kg in the base sample and at 5.3 mg/kg at BS-20-W20.

At 10 feet bgs, 1,2-dichlorobenzene was not detected in any of the supplemental samples above the base concentration of 8.5 mg/kg at 10 feet bgs. 1,2-Dichlorobenzene was not detected in the base sample at 20 feet bgs, but was reported at 1.5 mg/kg in BS-20-E20 and 1 mg/kg in BS-20-W20. It was detected at 0.074 mg/kg in the base sample at 30 feet bgs and was reported at 5.3 mg/kg at BS-20-E20 and 1.4 mg/kg at BS-20-W20.

At 10 feet bgs, 1,4-dichlorobenzene was not detected in any of the supplemental samples above the base concentration of 9.7 mg/kg at 10 feet bgs. 1,4-Dichlorobenzene was not detected in the base sample at 20 feet bgs, but was reported in the two eastern samples (BS-20-E10 and BS-20-E20) at 1 mg/kg and 1.7 mg/kg, respectively. 1,4-Dichlorobenzene was also detected in the two western step-out samples (BS-20-W10 and BS-20-W20) at 2.1 mg/kg and 1.2 mg/kg, respectively. At 30 feet bgs, 1,4-dichlorobenzene was detected at 0.064 mg/kg in the base sample and at 6.1 mg/kg in BS-20-E20 and 0.96 mg/kg in BS-20-W20.

Benzene was not detected in any of the supplemental samples at any depth.

At 10 feet bgs, chloroform was not detected in the supplemental samples above the base concentration of 0.11 mg/kg. Chloroform was not detected in the base sample at 20 feet bgs, but was reported in the two eastern samples (BS-20-E10 and BS-20-E20) at concentrations of 2.6 mg/kg and 1.2 mg/kg, respectively. Chloroform was also detected in the two western step-out samples (BS-20-W10 and BS-20-W20) at 2.2 mg/kg and 0.91 mg/kg, respectively. At 30 feet bgs, chloroform was detected at 0.082 mg/kg in the base sample and at 0.91 mg/kg in BS-20-W20.

5.2.4.9.5 Other Step-out Sampling Supplemental samples were also collected at three locations that were not part of the step-out sampling around a pre-existing boring. Two step-out samples were located between previous borings (between BS-02 and BS-06, and between BS-06 and BS-11); these two step-out samples BS-02/06 and BS-06/11) were labeled to designate the adjacent borings. The third step-out sample was in the same location as BS-15 and was labeled BRC-BS-15. Step-out sampling at these locations targeted organochlorine pesticides,

radiochemicals, and VOCs. Sampling was not conducted for dioxins and furans, PCBs, or perchlorate. The three locations are shown on Figure 5-44.

Organochlorine Pesticides. Organochlorine pesticides were not detected at these step-out locations above any concentrations reported in any of nearby previous samples, BS-02 and BS-06, or BS-11 and BS-15.

Radiochemicals. The only radiochemical analyzed in the supplemental step-out samples was radium-226. All but one of the reported activities from these three step-out locations were below background (2.4 pCi/g), but above the DAF-1 (0.0161 pCi/g) and above the Industrial PRG (0.026 pCi/g). One sample from BS-02/06 at 10 feet bgs had an activity above background at 2.9 pCi/g.

VOCs/SVOCs. None of the supplemental samples had reported concentrations of VOCs that exceeded concentrations of the nearby base samples or that exceeded their respective DAF-1 soil screening levels. Benzene was not detected in any of the samples.

SVOCs were not detected in any of the supplemental samples.

5.2.5 Subsurface Soils in the Western Ditch and Landfill Lobe Subareas (depths greater than 10 feet below ground surface)

The following subsections discuss detected chemical distributions at depths greater than 10 feet bgs within the Qal in the Western Ditch and Landfill Lobe subareas. Tables are provided in Appendix D.

5.2.5.1 Dioxins and Furans

A total of 12 Qal subsurface samples were collected and analyzed for dioxins and furans in the Western W. Ditch Area and North Landfill Lobe. Six samples were collected from each area at depths ranging between 10 and 50 feet bgs. Samples from the Eastern W. Ditch Area and the South Landfill Lobe were not analyzed for dioxins and furans.

Dioxins and furans were detected in three Qal samples, one in the North Landfill Lobe and two in the Western W. Ditch Area. Only the North Landfill Lobe sample, with a reported

concentration of 463 pg/g, had a detectable dioxin and furan concentration in excess of the ATSDR 50-pg/g TCDD TEQ screening criterion.

Using one-half the detection limit in the TCDD TEQ calculation, one Qal sample in the Western W. Ditch Area had a TCDD TEQ of 206 pg/g, although the sample was non-detect for all of the analytes. This is due in part because the detection limit for one analyte in this sample was 410 pg/g.

Three samples were analyzed for dioxins and furans in the TMCf, all in the North Landfill Lobe at 50 feet bgs. Dioxins and furans were detected in only one sample that represents a TCDD TEQ of 227. This value exceeds the ATSDR 50 pg/g TCDD TEQ screening criterion. The dioxin and furan results for the Qal and TMCf may be found in Appendix D.

5.2.5.2 Metals

The following sections present the results for arsenic, total chromium, and hexavalent chromium for samples collected at depths greater than 10 feet bgs. The analytical results for the Qal and the TMCf may be found in Appendix D.

5.2.5.2.1 Arsenic. A total of nine subsurface samples were collected at depths between 15 and 35 feet bgs from the Qal in the Landfill. Six were collected from the North Landfill Lobe and three were collected from the South Landfill Lobe. Arsenic was detected in each sample. The reported concentrations ranged between 3.9 and 10.3 mg/kg in the North Landfill Lobe, and between 4.1 and 6.7 mg/kg in the South Landfill Lobe. These concentrations are all greater than both the soil to groundwater DAF-1 screening level of 1 mg/kg and the Industrial PRG of 1.6 mg/kg. The upper end of the provisional background upper level for arsenic in shallow soils is 7.2 mg/kg. This value was exceeded in two North Landfill Lobe samples with reported concentrations of 8.8 and 10.3 mg/kg. The upper end of the provisional shallow soils background level for arsenic was not exceeded in the South Landfill Lobe samples.

A total of 30 subsurface samples were collected for arsenic analysis at depths between 15 and 50 feet bgs from the Qal beneath the Western Ditch. Ten samples were collected from the Eastern W. Ditch Area and 20 were collected from the Western W. Ditch Area.

Arsenic was detected in each sample from the Eastern W. Ditch Area and in 15 of the 20 samples from the Western W. Ditch Area. The reported concentrations in the Eastern W. Ditch Area ranged from 3.7 to 10.9 mg/kg. The reported concentrations in the Western W. Ditch Area ranged from 3.4 to 19 mg/kg. These concentrations are all greater than both the soil to groundwater DAF-1 screening level of 1 mg/kg and the Industrial PRG of 1.6 mg/kg. For the remaining 5 samples in which arsenic was non-detect, the detection limit was 5 mg/kg, which is above both the DAF-1 screening level and the Industrial PRG.

A total of six TMCf samples collected between 50 and 130 feet bgs were analyzed. Three samples were collected from the North Landfill Lobe and three were collected from the Eastern W. Ditch Area. Arsenic was detected in each sample. The reported concentrations ranged between 13.6 and 17 mg/kg in the North Landfill Lobe samples, and between 10.8 and 16.7 mg/kg in the Eastern W. Ditch Area. These concentrations are greater than both the soil to groundwater DAF-1 screening level of 1 mg/kg and the Industrial PRG of 1.6 mg/kg.

5.2.5.2.2 Total Chromium A total of nine subsurface samples were collected between 15 and 35 feet bgs from the Qal in the Landfill and analyzed for total chromium. Six were collected from the North Landfill Lobe and three were collected from the South Landfill Lobe. Total chromium was detected in each sample except one from the South Landfill Lobe. Concentrations in the North Landfill Lobe ranged from 9 to 36.2 mg/kg. Concentrations in the South Landfill Lobe ranged from 8.9 to 12 mg/kg. The detected concentrations are greater than the soil to groundwater DAF-1 screening level of 2 mg/kg, but are below the Industrial PRG of 450 mg/kg. The detection limit was 6.2 mg/kg for the one non-detect sample in the South Landfill Lobe. This value is greater than the DAF-1 screening level.

A total of 30 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal in the Western Ditch and analyzed for total chromium. Ten samples were collected in the Eastern W. Ditch Area and 20 were collected from the Western W. Ditch Area. Total chromium was detected in all 30 samples. The reported concentrations ranged between 6.3 and 20.9 mg/kg and 4.6 and 22 mg/kg in the Eastern W/ and Western W. Ditch Areas, respectively. These concentrations are all greater than the soil to groundwater DAF-1 screening level of 2 mg/kg but below the Industrial PRG of 450 mg/kg.

A total of 6 subsurface samples from the TMCf from depths between 50 and 130 feet bgs were analyzed for total chromium. Three were collected from the North Landfill Lobe and three were collected from the Eastern W. Ditch Area. Total chromium was detected in all 6 samples with reported concentrations ranging between 13 and 37.5 mg/kg and 8.9 and 52.4 mg/kg, respectively. These concentrations are all greater than the soil to groundwater DAF-1 screening level of 2 mg/kg but below the Industrial PRG of 450 mg/kg.

5.2.5.2.3 Hexavalent Chromium. A total of 39 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for hexavalent chromium. Six samples were taken from the North Landfill Lobe, 3 from the South Landfill Lobe, 10 from the Eastern W. Ditch Area, and 20 from the Western W. Ditch Area.

A total of 6 subsurface samples from the TMCf, from depths between 50 and 130 feet bgs, were analyzed for hexavalent chromium. Three were from the North Landfill Lobe and three were from the Eastern W. Ditch Area. Hexavalent chromium was not detected in any of the samples collected from either the Qal or the TMCf. The reporting limit for all non-detects was below the DAF-1 screening level of 2.0 mg/kg.

5.2.5.3 Organochlorine Pesticides

Four organochlorine pesticides (aldrin, alpha BHC, beta BHC, and gamma BHC) have been used as surrogates to detail the distribution, nature, and extent of this chemical class in surface and subsurface soils. The analytical results for the Qal and TMCf may be found in Appendix D.

5.2.5.3.1 Aldrin. Aldrin was analyzed in 43 subsurface samples collected at depths between 15 and 35 feet bgs from the Qal and was not detected in any of the samples. Two samples were taken from the North Landfill Lobe, 5 samples were taken from the South Landfill Lobe, 16 samples were taken from the Eastern W. Ditch Area, and 20 samples were taken from the Western W. Ditch Area. Reported detection limits ranged between 0.0018 and 0.25 mg/kg, three of which were above the soil to groundwater DAF-1 screening level of 0.02 mg/kg.

A total of 11 subsurface samples from the TMCf from depths between 40 and 130 feet bgs were analyzed for aldrin. Three samples were taken from the North Landfill Lobe, 3 samples were taken from the Eastern W. Ditch Area, and 5 samples were taken from the Western W. Ditch Area. Aldrin was not detected in any of the 11 samples analyzed from the TMCf. The detection

limits for the TMCf samples were all below the DAF-1 screening level. No samples from the TMCf from the South Landfill Lobe were analyzed for aldrin.

5.2.5.3.2 Alpha BHC. Alpha BHC was analyzed in 9 North Landfill Lobe and 5 South Landfill Lobe subsurface samples collected at depths between 15 and 35 feet bgs from the Qal, with detectable concentrations reported at 4 North Landfill Lobe locations and 3 South Landfill Lobe locations. The reported concentrations ranged between 0.002 and 0.13 mg/kg and 0.0067 and 0.056 mg/kg, respectively, which were all above the soil to groundwater DAF-1 screening level of 0.00003 mg/kg and below the Industrial PRG of 0.36 mg/kg. A total of 3 subsurface samples from the TMCf from the North Landfill Lobe from a depth of 50 feet bgs were analyzed for alpha BHC, and it was detected in 2 samples. Reported concentrations were 0.0052 and 0.011 mg/kg, which were above the soil to groundwater DAF-1 screening level but below the Industrial PRG. The reported detection limits all exceeded the DAF-1 screening level with values between 0.0018 and 0.25 mg/kg.

Alpha BHC was analyzed in 16 Eastern W. Ditch Area and 20 Western W. Ditch Area subsurface samples collected at depths between 15 and 50 feet bgs from the Qal, with detectable concentrations reported at 10 and 4 locations, respectively. The reported concentrations ranged between 0.0081 and 0.42 mg/kg and 0.0057 and 0.013 mg/kg, respectively, which were all above the soil to groundwater DAF-1 screening level of 0.00003 mg/kg. All but one Eastern W. Ditch Area sample had reported concentrations below the Industrial PRG of 0.36 mg/kg.

Eight total subsurface samples from the TMCf, 3 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area, from depths between 40 and 130 feet bgs, were analyzed for alpha BHC, and alpha BHC was not detected in any of the samples. The reported detection limits all exceeded the DAF-1 screening level, with values between 0.0023 and 0.025 mg/kg.

5.2.5.3.3 Beta BHC. Beta BHC was analyzed in 9 North Landfill Lobe and 5 South Landfill Lobe subsurface samples collected at depths between 15 and 35 feet bgs from the Qal, with detectable concentrations reported at 3 and 2 locations respectively. The reported concentrations ranged between 0.0037 and 0.034 mg/kg and 0.0053 and 0.0083 mg/kg, respectively, which were all above the soil to groundwater DAF-1 screening level of 0.0001

mg/kg but below the Industrial PRG of 1.3 mg/kg. A total of 3 subsurface samples from the TMCf from the North Landfill Lobe from a depth of 50 feet bgs were analyzed for beta BHC, and it was detected in 1 sample, at a reported concentration of 0.017 mg/kg. This value is above the soil to groundwater DAF-1 screening level but below the Industrial PRG. The reported detection limits all exceeded the DAF-1 screening level, with values between 0.0018 and 0.005 mg/kg.

Beta BHC was analyzed in 15 Eastern W. Ditch Area and 20 Western W. Ditch Area subsurface samples collected at depths between 15 and 50 feet bgs from the Qal, with detectable concentrations reported at 7 and 1 locations, respectively. The reported concentrations ranged between 0.0044 and 0.75 mg/kg in the Eastern W. Ditch. The reported concentration was 0.01 mg/kg in the one sample from the Western W. Ditch. All were above the soil to groundwater DAF-1 screening level of 0.0001 mg/kg. All but one Eastern W. Ditch Area sample had reported concentrations below the Industrial PRG of 1.3 mg/kg.

Eight total subsurface samples from depths between 40 and 130 feet bgs in the TMCf, 3 from the Eastern W. Ditch Area and 5 from the Western W. Ditch, were collected and analyzed for beta BHC. Beta BHC was not detected in any of the samples. The reported detection limits all exceeded the DAF-1 screening level, with values between 0.0022 and 0.005 mg/kg.

5.2.5.3.4 Gamma BHC. Gamma BHC was analyzed in 9 North Landfill Lobe and 5 South Landfill Lobe subsurface samples, collected at depths between 15 and 50 feet bgs from the Qal, with detectable concentrations reported at 3 and 2 locations, respectively. The reported concentrations ranged between 0.002 and 0.0053 mg/kg and 0.0083 and 0.017 mg/kg, respectively. Each value is above the soil to groundwater DAF-1 screening level of 0.0005 mg/kg but below the Industrial PRG of 1.7 mg/kg.

A total of 3 subsurface samples from the TMCf from the North Landfill Lobe, collected from a depth of 50 feet bgs, were analyzed for gamma BHC. It was detected in 1 sample, at a reported concentration of 0.032 mg/kg, which is above the soil to groundwater DAF-1 screening level but below the Industrial PRG. The reported detection limits, with values between 0.0018 and 0.005 mg/kg, exceeded the DAF-1 screening level.

Gamma BHC was analyzed in 16 Eastern W. Ditch Area and 20 Western W. Ditch Area subsurface samples collected at depths between 15 and 50 feet bgs from the Qal, with

detectable concentrations reported at 8 and 3 locations, respectively. The reported concentrations ranged between 0.0027 and 0.082 mg/kg and 0.006 and 0.029 mg/kg, respectively, which were all above the soil to groundwater DAF-1 screening level of 0.0005 mg/kg. All but one Eastern W. Ditch Area sample had reported concentrations below the Industrial PRG of 1.7 mg/kg.

Eight total subsurface samples were collected from the TMCf from depths between 40 and 130 feet bgs and analyzed for gamma BHC: 3 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area. Gamma BHC was not detected in any of the samples. The reported detection limits, with values between 0.0018 and 0.25 mg/kg, all exceeded the DAF-1 screening level.

5.2.5.4 PCBs

A total of 12 subsurface samples were collected at depths between 18 and 50 feet bgs from the Qal in the North Landfill Lobe and Eastern W. Ditch Area and analyzed for PCBs. No PCBs were detected in any of the 12 samples.

A total of 6 subsurface samples from depths between 50 and 130 feet bgs in the TMCf, 3 each from the North Landfill Lobe and the Eastern W. Ditch Area, , were analyzed for PCBs. PCBs were not detected.

5.2.5.5 Perchlorate

A total of 9 subsurface Landfill samples were collected at depths between 15 and 35 feet bgs from the Qal and analyzed for perchlorate: 6 from the North Landfill Lobe and 3 from the South Landfill Lobe. Perchlorate was detected in all of the samples. The reported concentrations ranged from 0.155 to 10 mg/kg and 0.074 and 0.12 mg/kg, respectively.

A total of 3 subsurface samples were collected from the TMCf from the North Landfill Lobe at a depth of 50 feet bgs and analyzed for perchlorate, with perchlorate detected in all 3 samples. The reported concentrations ranged from 0.127 to 1.99 mg/kg. These concentrations are all lower than the Industrial PRG of 100 mg/kg. No samples were collected from the TMCf beneath the South Landfill Lobe.

A total of 30 subsurface Western Ditch samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for perchlorate: 10 from the Eastern W. Ditch Area and 20 from the Western W. Ditch Area. Perchlorate was detected in 6 and 9 of the samples, respectively. The reported concentrations ranged from 0.091 to 17.7 mg/kg and 0.044 to 5 mg/kg, respectively.

A total of 3 subsurface samples were collected from the TMCf from the Eastern W. Ditch Area (none from the South Landfill Lobe), at depths of 50 to 130 feet bgs, and analyzed for perchlorate. Perchlorate was detected in 2 samples, with reported concentrations ranging from 0.058 to 1.28 mg/kg. These concentrations are all lower than the Industrial PRG of 100 mg/kg.

5.2.5.6 Radiochemicals

The following discussion of radiochemicals focuses on radium-226 and radium-228, and uranium-235 and uranium-238.

5.2.5.6.1 Radium-226. A total of 8 Landfill samples were collected at depths between 18 and 35 feet bgs from the Qal and analyzed for radium-226: 6 from the North Landfill Lobe and 2 from the South Landfill Lobe. Radium-226 was detected in all 8 samples. Measured activities ranged between 1.55 and 2.66 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0161 pCi/g and the PRG of 0.026 pCi/g. One sample from the North Landfill Lobe was the only one with an activity (2.66 pCi/g) that exceeded the upper end of the provisional background of 2.4 pCi/g for shallow Qal soils. As noted earlier, background for the deep Qal and TMCf has yet to be developed, although a work plan for doing so has been submitted to the NDEP.

Only 3 samples from the Landfill Lobes, all from the North Landfill Lobe, were collected at a depth of 50 feet bgs from the TMCf and analyzed for radium-226. Radium-226 was detected in all 3 samples. Activities ranged between 0.96 and 2.11 pCi/g. As noted earlier for the metals, background levels for the TMCf have yet to be developed, although a work plan for doing so has been submitted to the NDEP.

A total of 11 Western Ditch samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for radium-226: 5 from the Eastern W. Ditch Area and 6 from the Western W. Ditch Area. Radium-226 was detected in all 8 samples. Measured activities ranged

between 1.27 and 3.68 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0161 pCi/g and the PRG of 0.026 pCi/g. One sample from the Western W. Ditch Area was the only one with an activity (3.68 pCi/g) that exceeded the upper end of the provisional background 2.4 pCi/g for shallow Qal soils. One sample from the Eastern W. Ditch Area was non-detect with a detection limit greater than the DAF-1 screening level and Industrial PRG, but below the upper end of the provisional background.

Two samples from the Western Ditch, both from the Eastern W. Ditch Area, were collected at depths of 80 and 130 feet bgs from the TMCf and analyzed for radium-226. Radium-226 was detected in both samples. Reported activities were 1.38 and 1.08 pCi/g respectively. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

5.2.5.6.2 Radium-228. A total of 8 Landfill samples were collected at depths between 18 and 35 feet bgs from the Qal and analyzed for radium-228: 6 from the North Landfill Lobe and 2 from the South Landfill Lobe. Radium-228 was detected in all 8 samples. Measured activities ranged between 1.3 and 2.62 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0594 pCi/g and the PRG of 0.15 pCi/g. None of the samples had a reported activity (2.66 pCi/g) that exceeded the provisional background upper level of 2.9 pCi/g for shallow Qal soils.

Only 3 samples from the Landfill Lobes, all from the North Landfill Lobe, collected at a depth of 50 feet bgs from the TMCf, were analyzed for radium-228. Radium-228 was detected in all 3 samples. Activities ranged between 1.12 and 1.61 pCi/g. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

A total of 14 Western Ditch samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for radium-228: 8 from the Eastern W. Ditch Area and 6 from the Western W. Ditch Area. Radium-228 was detected in all 14 samples. Measured activities ranged between 1.18 and 2.27 pCi/g. The activities in all of the samples exceeded both the soil to groundwater DAF-1 screening level of 0.0594 pCi/g and the PRG of 0.15 pCi/g. None of the

samples had a reported activity that exceeded the provisional background upper level of 2.9 pCi/g for shallow Qal soils.

Only 3 samples from the Western Ditch, all from the Eastern W. Ditch Area, collected at depths between 73 and 130 feet bgs from the TMCf, were analyzed for radium-228. Radium-228 was detected in all 3 samples. Reported activities ranged from 0.67 to 1.79 pCi/g. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

5.2.5.6.3 Uranium-235. A total of 8 Landfill samples were collected at depths between 18 and 35 feet bgs from the Qal and analyzed for uranium-235: 6 from the North Landfill Lobe and 2 from the South Landfill Lobe. Uranium-235 was detected in all 8 samples. Measured activities ranged between 0.7 and 1.7 pCi/g. The activities in all of samples exceeded both the soil to groundwater DAF-1 screening level of 0.0389 pCi/g and the PRG of 0.4 pCi/g. The maximum detected activity was 0.21 pCi/g. None of the samples had a reported activity that exceeded the provisional background upper level of 2.9 pCi/g for shallow Qal soils. The one non-detection was from a sample in the North Landfill Lobe and the reported detection limit of 0.13 pCi/g is one third of the DAF-1 screening level.

Only 3 samples from the Landfill, all from the North Landfill Lobe, collected at a depth of 50 feet bgs from the TMCf, were analyzed for uranium-235. Uranium-235 was not detected in any of the samples. Two of the three detection limits exceeded the DAF-1 but were below the Industrial PRG. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

A total of 14 Western Ditch samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for uranium-235: 8 from the Eastern W. Ditch Area and 6 from the Western W. Ditch Area. Uranium-235 was detected in 2 samples, both from the Eastern W. Ditch Area. Measured activities were 0.058 and 0.061 pCi/g. The activities in both samples exceeded both the soil to groundwater DAF-1 screening level of 0.0389 pCi/g and the PRG of 0.4 pCi/g. None of the samples had a reported activity that exceeded the provisional background upper level of 0.21 pCi/g for shallow Qal soils. Four of the 6 non-detects from the Eastern W. Ditch Area had detection limits below the DAF-1 screening level and the other 2

were below the Industrial PRG. All 6 non-detects from the Western W. Ditch Area had reported detection limits above the DAF-1 screening level but below the Industrial PRG.

Only 3 samples from the Western Ditch, all from the Eastern W. Ditch, collected at depths between 73 and 130 feet bgs from the TMCf, were analyzed for uranium-235. Uranium-235 was detected in all 3 samples. Reported activities ranged from 0.086 to 0.123 pCi/g. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

5.2.5.6.4 Uranium-238. A total of 8 Landfill samples were collected at depths between 18 and 35 feet bgs from the Qal and analyzed for uranium-238: 6 from the North Landfill Lobe and 2 from the South Landfill Lobe. Uranium-238 was detected in all 8 samples. Measured activities ranged between 0.93 and 1.61 pCi/g. The activities in all of samples exceeded the soil to groundwater DAF-1 screening level of 0.006 pCi/g but were below the Industrial PRG of 1.8 pCi/g. The maximum reported activity was 1.76 pCi/g. None of the samples had a reported activity that exceeded the provisional background upper level of 2.4 pCi/g for shallow Qal soils.

Only 3 samples from the Landfill Lobes, all from the Northern Landfill Lobe, collected at a depth of 50 feet bgs from the TMCf, were analyzed for uranium-238. Uranium-238 was detected in all 3 samples. Activities ranged between 0.063 and 1.95 pCi/g. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

A total of 14 Western Ditch samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for uranium-238: 8 from the Eastern W. Ditch Area and 6 from the Western W. Ditch Area. Uranium-238 was detected in all 14 samples). Measured activities ranged between 0.81 and 2.55 pCi/g. The activities in all of the samples exceeded the soil to groundwater DAF-1 screening level of 0.006 pCi/g, and all but two were below the PRG of 1.8 pCi/g. The 2 exceedances were both from the Western W. Ditch Area with reported activities of 2.17 and 2.55 pCi/g. Only the sample with a reported activity of 2.55 pCi/g exceeded the provisional background upper level of 2.4 pCi/g for shallow Qal soils.

Only 3 samples from the Western Ditch, all from the Eastern W. Ditch Area, collected at depths between 73 and 130 feet bgs from the TMCf, were analyzed for uranium-238. Uranium-238

was detected in all 3 samples. Reported activities ranged from 0.84 to 1.1 pCi/g. As noted earlier for the metals, background for the TMCf has yet to be developed, although a work plan has been submitted to the NDEP.

5.2.5.7 SVOCs

A total of 46 subsurface samples were collected at depths between 15 and 50 feet bgs from the Qal and analyzed for hexachlorobenzene: 7 from the North Landfill Lobe, 4 from the South Landfill Lobe, 11 from the Eastern W. Ditch Area, and 24 from the Western W. Ditch Area. Hexachlorobenzene was detected in only 3 samples. The reported concentrations ranged from 0.31 to 1.1 mg/kg. These concentrations both exceed the DAF-1 screening level of 0.1 mg/kg but are below or equal to the Industrial PRG of 1.1 mg/kg. The reported detection limits for all but 2 samples, both from the Western W. Ditch Area, exceeded the DAF-1 screening level, and all of the detection limits were below the Industrial PRG.

A total of 11 subsurface TMCf samples, 3 from the North Landfill Lobe, 3 from the Eastern W. Ditch Area, and 5 from the Western W. Ditch Area, from depths between 40 and 130 feet bgs were analyzed for hexachlorobenzene with no detections in any of the samples. The reported detection limits were all greater than or equal to the DAF-1 screening level but less than the Industrial PRG. No TMCf samples from the South Landfill Lobe were analyzed for SVOCs.

5.2.5.8 VOCs

The following subsections describe the distribution of 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform in subsurface soils at depths greater than 10 feet bgs.

5.2.5.8.1 1,2,4-Trichlorobenzene. 1,2,4-Trichlorobenzene was analyzed in 14 subsurface samples collected from the Landfill Lobes at depths between 15 and 35 feet bgs from the Qal: 9 from the North Landfill Lobe and 5 from the South Landfill Lobe. Detectable concentrations were reported at 2 locations, both in the North Landfill Lobe. Reported concentrations were 0.0038 and 0.0041 mg/kg, which were below the soil to groundwater DAF-1 screening level of 0.3 mg/kg.

A total of 3 subsurface samples were collected from the TMCf at a depth of 50 feet bgs and analyzed for 1,2,4-trichlorobenzene, with reported concentrations in 2 samples of 0.0019 and 0.0022 mg/kg, both of which are below the DAF-1 screening level.

1,2,4-Trichlorobenzene was analyzed in 40 subsurface samples collected from the Western Ditch at depths between 15 and 50 feet bgs from the Qal: 16 from the Eastern W. Ditch Area and 24 from the Western W. Ditch Area. Detectable concentrations from the Eastern W. Ditch Area were reported at 2 locations, with reported concentrations of 0.00044 and 0.001 mg/kg. Both were below the soil to groundwater DAF-1 screening level of 0.3 mg/kg. Eight detections were reported for samples from the Western W. Ditch Area with reported concentrations ranging from 0.016 to 18 mg/kg. Six of the detections were above the DAF-1 screening level, but all 8 were below the Industrial PRG of 220 mg/kg.

A total of 9 subsurface samples were collected from the TMCf at depths from 40 to 130 feet bgs, 4 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area, and analyzed for 1,2,4-trichlorobenzene. The Eastern and Western W. Ditch Areas each had one detection, with reported concentrations of 0.027 and 0.0019 mg/kg, which are below the DAF-1 screening level. One sample from the Eastern W. Ditch Area had a detection limit of 0.62 mg/kg, above the DAF-1 screening level.

5.2.5.8.2 1,2-Dichlorobenzene. 1,2-Dichlorobenzene was analyzed in 14 subsurface samples collected from the Landfill Lobes at depths between 15 and 35 feet bgs from the Qal: 9 from the North Landfill Lobe and 5 from the South Landfill Lobe. Detectable concentrations were reported at 3 locations, all in the North Landfill Lobe. Reported concentrations ranged from 0.0007 to 0.0069 mg/kg, all below the soil to groundwater DAF-1 screening level of 0.9 mg/kg.

A total of 3 subsurface samples were collected from the TMCf at a depth of 50 feet bgs and analyzed for 1,2-dichlorobenzene, with reported concentrations in all 3 samples from 0.0039 and 0.022 mg/kg, which are below the DAF-1 screening level.

1,2-Dichlorobenzene was analyzed in 40 subsurface samples collected from the Western Ditch at depths between 15 and 50 feet bgs from the Qal: 16 from the Eastern W. Ditch Area and 24 from the Western W. Ditch Area. Detectable concentrations from the Eastern W. Ditch Area were reported at 3 locations, with reported concentrations ranging from 0.00037 to 0.0018

mg/kg. Both were below the soil to groundwater DAF-1 screening level of 0.9 mg/kg. Seven detections were reported for samples from the Western W. Ditch Area with reported concentrations ranging from 0.24 to 57 mg/kg. Four of the detections, with reported concentrations between 1.5 and 57 mg/kg, were above the DAF-1 screening level, but all 7 were well below the Industrial PRG of 600 mg/kg.

A total of 9 subsurface samples were collected from the TMCf at depths from 40 to 130 feet bgs, 4 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area, and analyzed for 1,2-dichlorobenzene. The Eastern W. Ditch Area had one detection with a reported concentration of 0.0015 mg/kg. The Western W. Ditch Area had 4 detections with reported concentrations between 0.002 and 0.089 mg/kg, which are all below the DAF-1 screening level (Table D-16c). None of the non-detects from the Western W. Ditch area exceeded the DAF-1 screening level.

5.2.5.8.3 1,4-Dichlorobenzene. 1,4-Dichlorobenzene was analyzed in 14 subsurface samples collected from the Landfill Lobes at depths between 15 and 35 feet bgs from the Qal: 9 from the North Landfill Lobe and 5 from the South Landfill Lobe. Detectable concentrations were reported at 3 locations, all in the North Landfill Lobe (Table D-16b). Reported concentrations ranged from 0.00058 to 0.0057 mg/kg, all below the soil to groundwater DAF-1 screening level of 0.1 mg/kg.

A total of 3 subsurface samples were collected from the TMCf at a depth of 50 feet bgs and analyzed for 1,4-dichlorobenzene. Reported concentrations in the 3 samples ranged from 0.0007 and 0.033 mg/kg, which are all below the DAF-1 screening level.

1,4-Dichlorobenzene was analyzed in 40 subsurface samples collected from the Western Ditch at depths between 15 and 50 feet bgs from the Qal: 16 from the Eastern W. Ditch Area and 24 from the Western W. Ditch Area. Detectable concentrations from the Eastern W. Ditch Area were reported at 2 locations, with reported concentrations of 0.00081 and 0.0022 mg/kg. Both were below the soil to groundwater DAF-1 screening level of 0.1 mg/kg. Five detections were reported for samples from the Western W. Ditch Area, with reported concentrations ranging from 0.0031 to 9.6 mg/kg. Three of the detections were above the DAF-1 screening level with reported concentrations of 0.7, 1.3, and 9.6 mg/kg, but only the 9.6-mg/kg sample was above the Industrial PRG of 7.9 mg/kg.

A total of 9 subsurface samples were collected from the TMCf at depths from 40 to 130 feet bgs, 4 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area, and analyzed for 1,4-dichlorobenzene. The Eastern W. Ditch Area had one detection with a reported concentration of 0.0035 mg/kg, and the Western W. Ditch Area had 3 detections with reported concentrations between 0.011 and 0.015 mg/kg, all below the DAF-1 screening level. Two of the non-detects from the TMCf from the Western Ditch, with reported detection limits of 0.125 and 0.5 mg/kg, exceeded the DAF-1 screening level.

5.2.5.8.4 Benzene. Benzene was analyzed in 14 subsurface samples collected from the Landfill Lobes at depths between 15 and 35 feet bgs from the Qal: 9 from the North Landfill Lobe and 5 from the South Landfill Lobe. Detectable concentrations were reported at 4 locations, all in the North Landfill Lobe. Reported concentrations ranged from 0.00047 to 0.00097 mg/kg, all below the soil to groundwater DAF-1 screening level of 0.002 mg/kg.

A total of 3 subsurface samples were collected from the TMCf at a depth of 50 feet bgs and analyzed for benzene, with reported concentrations of 0.00016, 0.0033, and 0.8 mg/kg. Two are above the DAF-1 screening level, but all 3 are below the Industrial PRG of 1.4 mg/kg. All of the non-detects exceeded the DAF-1 screening level.

Benzene was analyzed in 39 subsurface samples collected from the Western Ditch at depths between 15 and 50 feet bgs from the Qal: 16 from the Eastern W. Ditch Area and 23 from the Western W. Ditch Area. Detectable concentrations from the Eastern W. Ditch Area were reported at 3 locations, with reported concentrations of 0.00071, 0.00082 and 0.0078 mg/kg. Two were below the soil to groundwater DAF-1 screening level of 0.002 mg/kg and all 3 are below the Industrial PRG of 1.4 mg/kg. No detections were reported for samples from the Western W. Ditch Area, but two reported detection limits, 0.125 and 5 mg/kg, were above the DAF-1 screening level. The sample with the 5-mg/kg detection limit was also above the Industrial PRG of 1.4 mg/kg.

A total of 9 subsurface samples were collected and analyzed for benzene from the TMCf at depths from 40 to 130 feet bgs: 4 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area. The Eastern W. Ditch Area had 3 detections, with reported concentrations of 0.0019, 0.013, and 0.14 mg/kg, 2 of which exceed the DAF-1 screening level. The Western W.

Ditch Area had 3 detections, with reported concentrations between 0.0029 and 0.056 mg/kg, which are all above the DAF-1 screening level. All of the TMCf detections were below the Industrial PRG. Twenty-one of the non-detects from the Qal and 1 of the non-detects from the TMCf exceeded the DAF-1 screening level.

5.2.5.8.5 Chloroform. Chloroform was analyzed in 14 subsurface samples collected from the Landfill Lobes at depths between 15 and 35 feet bgs from the Qal: 9 from the North Landfill Lobe and 5 from the South Landfill Lobe. Detectable concentrations were reported at 5 locations, all in the North Landfill Lobe. Reported concentrations ranged from 0.00092 to 0.021 mg/kg and all were below the soil to groundwater DAF-1 screening level of 0.03 mg/kg.

A total of 3 subsurface samples were collected from the TMCf at a depth of 50 feet bgs and analyzed for chloroform with 2 detections. The reported concentrations were 0.0026 and 0.17 mg/kg. One detection is above the DAF-1 screening level, but both are below the Industrial PRG of 0.47 mg/kg. All of the non-detects were below the DAF-1 screening level.

Chloroform was analyzed in 39 subsurface samples collected from the Western Ditch at depths between 15 and 50 feet bgs from the Qal: 16 from the Eastern W. Ditch Area and 23 from the Western W. Ditch Area. Detectable concentrations from the Eastern W. Ditch Area were reported at 2 locations, with reported concentrations of 0.0038 and 0.0074 mg/kg, both below the soil to groundwater DAF-1 screening level of 0.03 mg/kg. One detection was reported for samples from the Western W. Ditch Area, with a reported concentration of 0.13 mg/kg which is below the DAF-1 screening level. Four reported detection limits, between 0.1 and 5 mg/kg, were above the DAF-1 screening level. The one sample with the 5-mg/kg detection limit was also above the Industrial PRG of 0.47 mg/kg.

A total of 9 subsurface samples were collected and analyzed for chloroform from the TMCf at depths from 40 to 130 feet bgs: 4 from the Eastern W. Ditch Area and 5 from the Western W. Ditch Area. The Eastern W. Ditch Area had one detection, with a reported concentration of 0.017 mg/kg. The Western W. Ditch Area had 5 detections, with reported concentrations between 0.0026 and 0.038 mg/kg, all below the DAF-1 screening level. Detection limits for all of the non-detects from the TMCf were below the DAF-1 screening level.

5.3 Distribution of Chemicals in Groundwater

The data for groundwater within the CAMU Site boundary include:

- Historical one-time groundwater grab samples collected from borings (HLA, 1998), performed for Montrose Chemical Company
- Data collected from groundwater monitoring wells installed in the past (ERM, 1999)
- Data collected from groundwater monitoring wells installed during the 2005 CAMU investigation (MWH, 2005) performed for BRC

BRC is aware that there are several upgradient sampling events in progress by Montrose, Pioneer, Stauffer and others. BRC is also aware of the recent completion of one downgradient investigation well, conducted jointly by Stauffer and Montrose. However, these data were not available for inclusion at the time of writing this report. BRC will include these data as the CSM is updated in the future.

5.3.1 Previous Investigations

The data from the first two sources (HLA, 1998; ERM, 1999) include a more limited list of chemical analytes than the data collected in 2005 (MWH, 2005). Monitoring wells located to the north, east, and south of the CAMU Site are owned and maintained by other private entities and were not sampled and reported contemporaneous with the groundwater sampling reported by MWH (2005). Groundwater data reported in 1998 and 1999 were evaluated for the general spatial trends that existed at the time of their reporting, as described in Sections 5.3.1.1 and 5.3.1.2. Data recorded in these previous investigations indicate that (1) upgradient sources exist that have impacted groundwater and (2) there have been significant impacts to groundwater that flows into and beneath the CAMU Site. The discussions in Section 5.3.2 compare historically reported sampling results with the contoured 2005 (MWH) groundwater sampling data. These historical data are posted with 2005 groundwater data presented in Figures 5-49 through 5-60, but are not used for the contouring presented for this CSM.

5.3.1.1 1998 Sampling Event

HLA sampled groundwater beneath the CAMU Site and vicinity in approximately February 1998 (HLA, 1998). This sampling represents the only known contemporaneous, area-wide sampling of chemical analytes in groundwater occurring in the Qal aquifer.

In 1998, benzene was detected in groundwater beneath the upgradient manufacturing facilities and mapped to extend as a plume northward beneath the CAMU Site toward the GWTS. The highest benzene concentration (400 mg/L) was reported in the upgradient monitoring well EC-3. The benzene concentration measured at EC-2, located at the southern boundary of the CAMU Site, was 150 mg/L.

Chloroform was also detected in groundwater beneath the upgradient manufacturing facilities and mapped to extend as a plume northward beneath the CAMU Site toward and including the GWTS. The highest 1998 chloroform concentration (100 mg/L) was reported in the upgradient monitoring well B01. The 1998 chloroform concentration at B14, located at the southern boundary of the CAMU Site, was 54 mg/L.

Chlorobenzene was also detected in groundwater beneath the upgradient facilities and mapped to extend as a plume northward beneath the CAMU Site toward and including the GWTS. The highest 1998 chlorobenzene concentration (200 mg/L) was reported in the upgradient monitoring well B-01. The 1998 chlorobenzene concentration at EC-2, located at the southern boundary of the CAMU Site, was 22 mg/L.

5.3.1.2 1999 Sampling Event

ERM (1999) reported groundwater monitoring results in the immediate vicinity of the CAMU Site. Reported results were contemporaneous and limited to the immediate vicinity of the CAMU Site, including upgradient, downgradient, and cross-gradient locations. These groundwater chemical analytical results reported by ERM were collected in March 1999. For benzene, chloroform, and chlorobenzene, the 1999 spatial concentration trends remained as indicated by the prior HLA (1998) data, with higher concentrations reported in locations upgradient of the CAMU Site than those reported from locations downgradient of the CAMU. From a temporal perspective, the highest reported 1999 benzene concentrations, those at the locations upgradient of the CAMU Site, generally decreased compared to the 1998 data.

Maximum chloroform concentrations increased slightly during the same time interval, while maximum chlorobenzene concentrations remained about the same.

The 1999 data also indicate that similar spatial trends were present for total dichlorobenzenes, total trichlorobenzenes, PCE, total BHC, and arsenic in that the highest concentrations in groundwater were generally detected in locations upgradient of the CAMU Site, with lower concentrations detected downgradient. Concentrations also generally declined toward both the western and eastern sides of the CAMU Site. In some cases, the comparison of concentration data for selected chemicals measured at different locations or dates is hindered or not possible due to the elevated laboratory reporting limits used at the time (higher than U.S. EPA maximum contaminant limits [MCLs]). This is true for dichlorobenzene, trichlorobenzene, and PCE in the 1999 data.

As reported by ERM (1999), other chemicals that have been historically detected at concentrations above laboratory reporting limits at least once in wells located upgradient of the CAMU Site include carbon disulfide, 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,2-DCA), dichloromethane, toluene, 1,1,2-trichloroethane (1,1,2-TCA), TCE, BHCs, p,p'-dichlorodiphenyl dichloroethane (4,4-DDD), p,p'-dichlorodiphenyldichloroethylene (4,4 DDE), p,p'-dichlorodiphenyltrichloroethane (4,4-DDT), Endosulfan II, heptachlor epoxide, methoxychlor, Aroclor 1248, bis-(2-ethyhexyl)-phthalate, butylbenzyl-phthalate, 2 chlorophenol, phenol, antimony, arsenic, chromium, copper, lead, mercury, selenium, thallium, and zinc.

Other chemicals that have been historically detected at concentrations above laboratory reporting limits at least once in wells located downgradient of the CAMU Site include 1,1-DCA, 1,2-DCA, dichloromethane, ethylbenzene, naphthalene, toluene, 1,1,2-TCA, TCE, 1,2,4-trimethylbenzene (1,2,4-TMB), xylenes, BHCs, 4,4-DDD, 4,4DDE, 4,4-DDT, Endosulfan II, endrin aldehyde, 2-chlorophenol, phenol, 2-methylphenol, antimony, arsenic, chromium, selenium, and thallium.

5.3.2 On-Site

In evaluating water quality beneath the CAMU Site, several sources of data were reviewed. These include the following:

- Groundwater grab samples from the B-13-C, B-13-N2, B-13-S2, B-1C, B-1N, B-1N, B-1S, B-5C, B-5N, and B-5S locations.
- Water quality data from wells installed by ERM (1999): H-39, H-40, H-41, LG-033, B-14, and B-14R.
- Water quality data from wells installed by MWH (2005). The data locations within the CAMU Site boundary that comprise the monitoring well array sampled by MWH in 2005 include BW-01A, BW-02A, BW-03A, AA-BW-04, AA-BW-05, AA-BW-06, AA-BW-07, AA-BW-08A, AA-BW-09, and AA-BW-12. Monitoring well AA-BW-13, located approximately 1,450 feet west of the northwest corner of the CAMU Site, was also included.

The first two data sets were not used for contouring purposes because these may not be representative of current conditions. Data collected from monitoring wells installed, developed, and contemporaneously sampled by MWH (2005) within the boundaries of the CAMU Site were, therefore, used as the basis for interpreting chemical isoconcentration contours on Figures 5-49 through 5-60, to represent the most recent distribution of chemicals in groundwater beneath the CAMU Site.

Relative to groundwater flow in the CAMU Site area as shown on Figure 2-10, the monitoring network may be summarized as follows:

- The upgradient wells include three wells (AA-BW-12, AA-BW-08A, and AA-BW-09) located on or very near the southern CAMU Site boundary and characterize the quality of groundwater that flows onto the CAMU Site.
- The downgradient wells include four wells (AA-BW-04, AA-BW-05, and AA-BW-06) located on or very near the northern CAMU Site boundary and characterize the quality of groundwater moving off the CAMU Site.
- The eastern cross-gradient wells (three wells: BW-01, BW-02, and BW-03) are located on the eastern CAMU Site boundary and characterize the quality of water on the eastern

edge of the groundwater plume that has been historically mapped and recognized to be located beneath the CAMU Site and upgradient facilities. Similarly, the western cross-gradient well (AA-BW-07) characterizes the water quality on the western side of the plume. Additionally, monitoring well AA-BW-13, located approximately 1,450 feet west of the northwest corner of the CAMU Site was also sampled and included in the development of isoconcentration contours to provide a data context to the west of the CAMU Site.

Groundwater quality figures are presented for a selected list of chemicals as surrogates for the different classes of chemicals:

- Metals: arsenic (Figure 5-49) and total chromium (Figure 5-50)
- Pesticides: alpha-BHC (Figure 5-51) and gamma BHC (Figure 5-52)
- Perchlorate (Figure 5-53)
- Radionuclides: radium-226 and radium-228 (Figure 5-54)
- SVOCs: 1,2,4-trichlorobenzene (Figure 5-55), 1,2-dichlorobenzene (Figure 5-56), and 1,4-dichlorobenzene (Figure 5-57)
- VOCs: benzene (Figure 5-58), chloroform (Figure 5-59), and chlorobenzene (Figure 5-60)

Where practical, water quality was contoured to the U.S. EPA MCL. The data were contoured taking into account knowledge of the previous work performed by HLA (1998) and ERM (1999), but as noted above, the data themselves from these studies were not used. The discussions in the following subsections compare the 2005 data with historically collected groundwater sample data. All groundwater sampling data are presented in figures included in the electronic Appendix F, which can be accessed and reviewed using ArcReader version 9.2.

The water quality plots include data from wells BW-01, BW-02, and BW-03. These three wells were previously described as being completed in the TMCf along the east side of the CAMU Site because the Qal has been dewatered by the KMCC groundwater extraction system (MWH, 2005). Despite the completion of wells in different water-bearing units, the distribution of chemicals in groundwater is internally consistent, which supports the hypothesis that water in

these zones originates from the same source and is in hydraulic communication, and that much of the contamination beneath the CAMU Site is migrating from an upgradient source.

5.3.2.1 *Metals*

This chemical class of compounds is represented by contour plots of arsenic (Figure 5-49) and total chromium (Figure 5-50).

5.3.2.1.1 Arsenic. The highest arsenic concentration (636 µg/L) was detected in well AA-BW-12, located on the southern boundary of the CAMU Site. The highest detected concentration (177 µg/L) of arsenic in a monitoring well located at the northern boundary of the CAMU Site was in well AA-BW-04. Monitoring wells BW-03, BW-02, and BW-01 had arsenic concentrations of 76.5, 195, and 241 µg/L, respectively. Historical concentrations south of the CAMU Site were consistently in the range of 300 µg/L among four monitoring wells, with the highest historical arsenic groundwater well concentration south of the CAMU Site detected at monitoring well H-38 (360 µg/L). In the north CAMU Site boundary area, the maximum historical concentration was in well H-23 (190 µg/L). Historical groundwater grab sample arsenic concentrations collected from the CAMU Site interior area were consistently lower and ranged from 0.052 to 29 µg/L.

Consequently, it appears that sources of arsenic to groundwater, if not attributable to background, originate from locations to the south of the CAMU Site. The arsenic plume is oriented along a north-south axis that extends beneath the CAMU Site. However, the arsenic plume is not as narrowly constrained around the axis as is the case with organic chemicals, and concentrations do not drop off as rapidly to the east or west away from the nominal centerline of the CAMU Site.

5.3.2.1.2 Total Chromium. The highest total chromium concentration (7.5 µg/L) was detected in well AA-BW-13, located approximately 1,500 feet west of the northwest corner of the CAMU Site boundary. Monitoring well AA-BW-12, located along the southern boundary of the CAMU Site, had a total chromium concentration of 6.0 µg/L. All other monitoring wells adjacent to the CAMU Site were non-detect for total chromium, with a detection limit of 10 µg/L. Total chromium was also non-detect in historical groundwater well sampling conducted south of the CAMU Site, with a detection limit of 5 µg/L. Historical groundwater grab sample total chromium

concentrations collected from the CAMU Site interior area were also non-detect, with a detection limit that varied from 5.0 to 10.0 µg/L. Because of the large number of non-detect sample results for total chromium, a contaminant plume cannot be defined. All groundwater samples were below the MCL for total chromium.

5.3.2.1.3 Organochlorine Pesticides. This chemical class of compounds is represented by contour plots of alpha BHC (Figure 5-51) and gamma BHC (Figure 5-52).

Alpha BHC. The highest alpha BHC concentration (370 µg/L) was detected in well AA-BW-08A, located along the southern boundary of the CAMU Site. The highest detected concentration of alpha BHC in a monitoring well located at the northern boundary of the CAMU Site was in well AA-BW-04 (130 µg/L). The highest historical groundwater well concentration detected south of the CAMU Site was at monitoring well H-3 (120 µg/L). In the north CAMU Site boundary area the maximum historical concentration (180 µg/L) was in well H-23. Historical groundwater grab sample alpha BHC concentrations collected from the CAMU Site interior area were lower and ranged from 0.5 µg/L to 53 µg/L. It appears that sources of alpha BHC impacts to groundwater occur south of the CAMU Site as well as within the interior of the CAMU Site, in the STA. The alpha BHC plume is oriented along a north-south axis that extends beneath the CAMU Site. Alpha BHC concentrations drop off in monitoring wells located to the east and west of the nominal north-south centerline of the CAMU Site. An area of lower alpha BHC concentration is located in the southeastern corner of the CAMU Site at monitoring well AA-BW-09.

Gamma BHC. The highest gamma BHC concentration (50 µg/L) was detected in well AA-BW-08A, located along the southern boundary of the CAMU Site. The highest detected concentration of gamma BHC in a monitoring well located at the northern boundary of the CAMU Site was in well AA-BW-04 (9.7 µg/L). The highest historical groundwater well concentration detected south of the CAMU Site was at monitoring well H-38 (2.5 µg/L). In the north CAMU Site boundary area, the maximum historical concentration was in well H-23 (20 µg/L). Historical groundwater grab sample concentrations collected from the CAMU Site interior area were lower and ranged from non-detect (detection level of 0.1 µg/L) to 13 µg/L. The gamma BHC plume is oriented along a north-south axis that extends beneath the CAMU Site. Gamma BHC concentrations drop off in monitoring wells located to the east and west of the

nominal north-south centerline of the CAMU Site. An area of lower gamma BHC concentration is located in the southeastern corner of the CAMU Site at monitoring well AA-BW-09.

5.3.2.2 *Perchlorate*

A contour plot of perchlorate, based on groundwater monitoring well concentrations from samples collected in 2005 (MWH, 2005), is presented in Figure 5-53. The highest groundwater concentrations of perchlorate were detected in samples collected from monitoring wells located along the southern boundary of the CAMU Site. The highest perchlorate concentration (20,300 µg/L) was detected in well AA-BW-09. Monitoring wells located along the northern boundary of the CAMU Site had elevated concentrations of perchlorate, with the maximum perchlorate concentration of 1,400 µg/L detected in AA-BW-04. Perchlorate data from historical groundwater monitoring or grab sampling were not available for locations within the CAMU Site interior or to the south of the CAMU Site. Three historical groundwater grab samples collected west of the CAMU Site, in what has been referred to as the Western Ditch Extension Area, had perchlorate concentrations ranging from 260 to 1,300 µg/L. The second highest concentration detected was collected from AA-BW-13, located approximately 1,450 feet west of the northwest corner of the CAMU Site, also within the area formerly known as the Western Ditch Extension. The highest perchlorate concentration was detected in the southeastern corner of the CAMU Site at monitoring well AA-BW-09. A perchlorate plume appears to be migrating northward from south-southeast of the CAMU Site. It also appears that the Tronox groundwater extraction system is affecting the northward migration of the perchlorate plume and capturing a portion of the plume. However, a portion of the northward migrating perchlorate plume is apparently escaping capture by the Tronox groundwater extraction system (Tronox, 2006). As discussed below, the perchlorate detection, off-site west of the northwest corner of the CAMU Site, at AA-BW-13, occurs within the mapped contours of the AMPAC perchlorate plume, which originates southwest of the CAMU Site.

5.3.2.3 *Radionuclides*

This chemical class of compounds is represented by a combined contour plot of radium-226 and radium-228 (Figure 5-54). The two chemicals are presented in a combined plot to conform to the MCL promulgation by EPA that lists a combined MCL for radium-226 and radium-228. Historical data for radium-226 and radium-228 are not available.

The highest radium-226/228 concentration (3.05 pCi/L) was detected in well AA-BW-12, located along the southern boundary of the CAMU Site. The highest concentration of radium-226/228 along the northern CAMU Site boundary was 2.55 pCi/L. The radium-226/228 distribution can be interpreted as a plume with an axis that runs from south to north through the eastern one-third of the CAMU Site. Sources of total radium-226/228 impacts to groundwater are likely attributable to background as there are no known source areas upgradient. All of the detected concentrations of radium-226/228 in groundwater, which ranged from 0.26 to 3.05 pCi/L, are below the MCL of 5.0 pCi/L.

5.3.2.4 VOCs

This chemical class of compounds is represented by contour plots of 1,2,4-trichlorobenzene (Figure 5-55), 1,2-dichlorobenzene (Figure 5-56), 1,4-dichlorobenzene (Figure 5-57), benzene (Figure 5-58), chloroform (Figure 5-59), and chlorobenzene (Figure 5-60).

1,2,4-Trichlorobenzene. The highest groundwater concentrations of 1,2,4-trichlorobenzene were detected in samples collected from monitoring wells located on the southern boundary of the CAMU Site. The highest detected 1,2,4-trichlorobenzene concentration (550 µg/L) was in well AA-BW-08A. The concentration of 1,2,4-trichlorobenzene in the northern well AA-BW-05 was non-detect at a detection level of 2,000 µg/L. Therefore, while the sampling data are not definitive because of the elevated detection level, groundwater located at the northern boundary of the CAMU Site is assumed to potentially contain elevated concentrations of 1,2,4-trichlorobenzene. Historical samples collected from wells south of the southern CAMU Site boundary contained 1,2,4-trichlorobenzene concentrations that ranged as high as 360 µg/L (well H-3). The highest historically reported concentration in the CAMU Site interior (120 µg/L) came from a groundwater grab sample (location B-5S). Historical groundwater grab samples taken from other CAMU Site interior locations were either an order of magnitude lower or non-detect.

There appears to be a zone of groundwater with a higher concentration of 1,2,4-trichlorobenzene that extends from the middle of the southern CAMU Site boundary to the middle of the northern CAMU Site boundary along a north-south axis. Based on the groundwater data reviewed, it appears that sources of 1,2,4-trichlorobenzene to groundwater are present off-site to the south and within the CAMU Site boundary. Soil vapor data indicate

that relatively low concentrations were detected in soil vapor samples collected from the northern portion of the STA. 1,2,4-Trichlorobenzene concentrations drop off in monitoring wells located to the east and west of the nominal north-south centerline of the CAMU Site. An area of lower 1,2,4-trichlorobenzene concentration is located in the southeastern corner of the CAMU Site at monitoring well AA-BW-09.

1,2-Dichlorobenzene. The highest 1,2-dichlorobenzene concentration (940 µg/L) was in well AA-BW-12, located on the southern boundary of the CAMU Site. The highest detected concentration of 1,2-dichlorobenzene in a monitoring well located at the northern boundary of the CAMU Site was in well AA-BW-06 (340 µg/L). Historical groundwater well concentrations were also higher south of the CAMU Site (monitoring well H-3 at 2,300 µg/L) than to the north of the CAMU Site (well H-21 at 1,900 µg/L). Historical groundwater grab and monitoring well samples from the CAMU Site interior were generally an order of magnitude or more lower for 1,2-dichlorobenzene.

The data indicate a 1,2-dichlorobenzene source to groundwater south of the CAMU Site and within the CAMU Site boundary. Soil vapor data indicate that relatively small concentrations were detected in soil vapor samples collected from the northern and western portions of the STA. The 1,2-dichlorobenzene plume is oriented along a north-south axis that extends beneath the CAMU Site. 1,2-Dichlorobenzene concentrations drop off in monitoring wells located to the east and west of the nominal north-south centerline of the CAMU Site. An area of lower 1,2-dichlorobenzene concentration is located in the southeastern corner of the CAMU Site at monitoring well AA-BW-09.

1,4-Dichlorobenzene. The highest 1,4-dichlorobenzene concentration (490 µg/L) was detected in well AA-BW-06, located on the northern boundary of the CAMU Site. The highest detected concentration of 1,4-dichlorobenzene in a monitoring well located at the southern end of the CAMU Site was in well AA-BW-01A (620 µg/L). Two key wells, AA-BW-12 and AA-BW-08A, had elevated detection levels (1,000 µg/L), thus precluding a more definitive interpretation of 1,4-dichlorobenzene isoconcentration contours in this vicinity. Historical groundwater well concentrations were elevated south of the CAMU Site (monitoring well H-3 with a concentration of 4,100 µg/L) and to the north of the CAMU Site (maximum concentration of 3,300 µg/L at well H-21). Historical groundwater grab and monitoring well samples from the CAMU interior were

generally an order of magnitude or more lower for 1,4-dichlorobenzene. However, grab sample locations B-5C, B-1N, and B-1S contained elevated concentrations relative to other contemporaneously grab-sampled locations in the vicinity. These grab samples are located generally downgradient from the 9- to 10-foot bgs soil samples collected from BS-17 and BS-18.

The data indicate 1,2-dichlorobenzene sources to groundwater south of the CAMU Site and within the CAMU Site boundary. Soil vapor data indicate that relatively low concentrations were detected in soil vapor samples collected from the northern and western portions of the STA. Based on an interpretation of the groundwater isoconcentration contours while plotting non-detects as one-half the detection limit, the 1,4-dichlorobenzene plume appears to be generally oriented along a north-south axis that extends beneath the CAMU Site. North CAMU Site boundary monitoring well AA-BW-05 is non-detect with a detection level of 1.0 µg/L, with higher concentrations detected in north CAMU Site boundary wells to both the east and west. The result is that the 1,4-dichlorobenzene plume appears to bifurcate, resulting in two separate lobes migrating to the north, one east and one west of monitoring well AA-BW-05. This appears to be the result of the effect of the GWTS operation located directly to the north. 1,4-Dichlorobenzene concentrations drop off in monitoring wells located to the east and to the west of the nominal north-south centerline of the CAMU Site. An area of lower 1,4-dichlorobenzene concentration is located in the southeastern corner of the CAMU Site at monitoring well AA-BW-09.

Benzene. The highest groundwater concentrations of benzene collected from monitoring wells were detected in samples located on the southern boundary of the CAMU Site. The highest benzene concentration (23,000 µg/L) was in well AA-BW-12. Monitoring wells located at the northern boundary of the CAMU Site also had elevated concentrations of benzene; for example, the concentration of benzene in AA-BW-05 was 19,000 µg/L. These results represent duplicate analyses of samples from monitoring wells AA-BW-05 and AA-BW-12 that were re-run in order to be within the calibration range of the laboratory instruments. Both original and duplicate results are posted on Figure 5-58.

Historical groundwater samples collected south of the CAMU Site had elevated concentrations of benzene (H-3 with 28,000 µg/L). Historical groundwater grab samples collected from within the CAMU Site interior (in the STA) were also elevated with respect to benzene concentrations.

Locations B-1N, B-1S, and B-1C had detected benzene concentrations of 120,000, 120,000, and 97,000 µg/L, respectively. Historical groundwater well samples and grab samples collected at locations between the STA and the southern CAMU Site boundary were lower in concentration by orders of magnitude. Concentrations of benzene this high may be indicative of the presence of nonaqueous-phase liquids (NAPLs).

Cohen and Mercer (1993) state that “for a single-component DNAPL, the pure-phase solubility of the organic constituent can be used to estimate the theoretical upper-level concentration of organics in aquifers for performing dissolution calculations. For DNAPLs comprised of a mixture of chemicals, however, the effective solubility concept should be employed . . .” The effective solubility concept involves calculating the mole fraction that an individual chemical represents in a mixture. This same approach can be used for light nonaqueous-phase liquids (LNAPLs). Because of heterogeneities and variable mixing of chemicals in the subsurface, Mercer and Cohen (1993) suggest the use of inferential indicators of the presence of NAPL in the subsurface in lieu of rigorous (and potentially misleading) calculations. It is suggested that concentrations of chemicals in groundwater at greater than 1 percent of their pure phase or effective solubility are indicative of the presence of NAPL.

Based on the pure phase solubility of benzene as presented in the Table 7-1 (1,760 mg/L), a benzene concentration of 17.6 mg/L (17,600 µg/L) would be suggestive of the presence of NAPL. As presented in Figure 5-58, these concentrations have been recorded in upgradient off-site monitoring well H-3, upgradient southern boundary monitoring well AA-BW-12, downgradient northern boundary monitoring well AA-BW-05, off-site downgradient monitoring well H-21, and in historical groundwater grab sampling locations B-1C, B-1S, and B-1N (with benzene concentrations of 97,000, 120,000, and 120,000 µg/L, respectively).

The much higher concentrations noted in the groundwater grab samples than in the monitoring well samples is likely due to the narrow aquifer interval from which the grab sample is pulled compared to that sampled by a conventionally completed and developed groundwater monitoring well. The fact that contemporaneously collected grab samples collected in nearby locations were lower might indicate a LNAPL source in the B-1C/B-1S/B-1N vicinity. However, Newell et al. (1995) state that, “It is not uncommon to observe a ‘patchy’ distribution of LNAPL over a relatively small area at a site, or the transient presence of LNAPL in a well.”

No free-phase NAPL has been observed in the southern CAMU Site boundary monitoring wells. The need for periodic monitoring of these wells, including observations for the presence of LNAPL, to collect more data on this issue is recognized and addressed in Section 9.2 on Data Gaps. As presented in Figure 5-4, the nearest soil vapor sampling locations are low in benzene vapor concentrations in comparison to those observed on the southern CAMU Site boundary at SV-18, SV-19, and SV-20. Although a less sensitive indicator, soil sample results are also relatively low for benzene in the B-1C/B-1S/B-1N vicinity. Thus, while it is possible that LNAPL may be sourced in the vicinity of B-1C/B-1S/B-1N, there is no definitive evidence from which to conclude that such is the case. Meanwhile, the known fact remains that a 6,000-gallon benzene spill occurred approximately 2,000 feet to the south of the CAMU Site onto groundwater with a northerly gradient.

The benzene plume is oriented along a north-south axis that extends beneath the CAMU Site. Benzene concentrations decrease in monitoring wells located to the east and west of the nominal north-south centerline of the CAMU Site. An area of lower benzene concentration is located in the southeastern corner of the CAMU Site at monitoring well AA-BW-09.

Chloroform. The highest groundwater concentrations of chloroform were detected in samples collected from a monitoring well (well AA-BW-04) located on the northern boundary of the CAMU Site. The highest of the chloroform concentrations from this well was 16,000 µg/L. Lower concentrations of chloroform were detected in monitoring wells located at the southern boundary of the CAMU Site. For example, the highest concentration of chloroform in a southern CAMU Site boundary well was in AA-BW-09 (4,400 µg/L). Historical groundwater grab samples collected south of the eastern one-third of the CAMU Site contained detected chloroform concentrations that ranged from 40,000 to 94,000 µg/L. Historical groundwater grab samples collected from the interior of the CAMU Site, in the STA, included concentrations as high as 15,000, 16,000, and 28,000 µg/L (locations B-5N, B-5S, and B-5C, respectively).

There appears to be a groundwater chloroform plume with a north-south axis extending across the eastern one-third of the CAMU Site. Chloroform concentrations drop off in monitoring wells located to the east and west of the north-south plume axis. Carbon tetrachloride was reportedly disposed of in the CAMU Site area. Because chloroform is a degradation product of carbon tetrachloride, it is possible that, in addition to an off-site source to the south, historical disposal

activities in the CAMU Site area are a potential source of elevated concentrations of chloroform, through degradation of carbon tetrachloride to chloroform, in groundwater beneath the CAMU Site.

5.3.3 Off-Site

Reports submitted by companies that have operated at locations upgradient of the CAMU Site were reviewed for the preparation of this CSM. While additional environmental investigations are ongoing at the upgradient sites, the following information is currently available to characterize the potential impacts to the subsurface at upgradient locations.

Montrose conducted chemical production activities at its former plant site, which was approximately 15 acres in total size. Organic chemicals were manufactured at the Montrose facility from 1947 to 1983. The former Montrose facility has been identified as a potential source of chemicals impacting groundwater, including the VOCs benzene and carbon tetrachloride, the SVOCs 1,2-dichlorobenzene, 1,4-dichlorobenzene, and hexachlorobenzene, and the organochlorine pesticides DDT, DDD, and DDE.

An evaluation of soil and groundwater conditions of a second water-bearing zone, at a depth of 115 to 130 feet bgs in the Montrose closed ponds and former plant site areas, has also been conducted that identified concentrations of VOCs in the second water-bearing zone wells and possible zones of dense nonaqueous-phase liquid (DNAPL)-like material (Montrose, 2005a).

Stauffer also conducted operations on property upgradient from the CAMU Site that produced chlorine, caustic soda (sodium hydroxide), hydrochloric acid, and several agricultural chemical products. The upgradient property was first occupied in 1942, when a chlor-alkali plant was constructed to produce chlorine (and co-product caustic soda), which was essential to the magnesium production process. The Stauffer property was leased, then owned and operated, by Stauffer from 1945 to 1988. The property is currently owned and used by Pioneer to produce chlorine, caustic soda, hydrochloric acid, and bleach. Source areas are described in Section 3 of this report. The primary chemicals reported to date in soil and groundwater samples include chlorinated benzenes, chloroform, carbophenothion (Trithion), Phosmet (Imidan), and BHC compounds. The groundwater also contains elevated concentrations of TDS (total dissolved solids), composed of chlorides and sulfates.

Groundwater investigations have revealed that the shallow aquifer (50 to 60 feet bgs) and deeper aquifer (115 to 130 feet bgs) are both contaminated with VOCs, with a DNAPL identified in the second aquifer. This work has suggested that contamination is migrating from the former upgradient impoundments toward the CAMU Site (Montrose, 2005a). Wells in a third aquifer (approximately 160 feet bgs) did not identify chemicals exceeding ARARs.

Chemical production operations also have been conducted on the property located immediately east of the CAMU Site since 1942. The property is currently owned and operated by Tronox. Since 1942, the Tronox property has reportedly been the site of production of magnesium, magnesium oxide, sodium chlorate, various perchlorates, elemental boron, boron trichloride, and boron tribromide (NDEP, 2006b).

Tronox has implemented remedial activities to address chromium and perchlorate in groundwater beneath the property. As stipulated in several Consent Orders between NDEP and Tronox, the groundwater remediation system consists currently of monitoring wells, groundwater interceptor wells, a groundwater treatment system for the reduction of chromium, and two trenches for the injection of treated groundwater. The treatment began in 1987 and has continued to this date (NDEP, 2006b). Tronox remedial activities for perchlorate in groundwater consist of an on-site groundwater barrier wall together with an upgradient collection well field and a treatment process that removes perchlorate, along with chromium, and then discharges the water in accordance with an NPDES permit (NDEP, 2006b).

Tronox has reported the apparent movement of groundwater around the west end of the slurry wall, adjacent to the east side of the CAMU Site, and plans to propose appropriate measures to remediate the situation to NDEP (Tronox, 2006). Perchlorate concentrations in groundwater contoured beneath the CAMU Site suggest that groundwater beneath the western side of the CAMU are impacted by perchlorate in groundwater that is moving around the west side of the Tronox slurry wall system. These contours also suggest that the perchlorate in this groundwater may not be subject to capture by the Stauffer-Montrose GWTS and that this plume may move to the east of the GWTS and continue to flow downgradient toward the Las Vegas Wash.

There is an apparent decline in concentrations of a number of chemicals in the samples collected at the CAMU Site monitoring well AA-BW-09, located at the southeastern boundary of

the CAMU Site. This is evident for the contoured chemicals 1,2,4-trichlorobenzene, benzene, chlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, alpha-BHC, and gamma-BHC. Groundwater sample data collected to the southeast of the CAMU Site contemporaneously with CAMU monitoring well data could provide the basis for a more definitive explanation of this observation. One potential explanation may be that groundwater flow patterns, and thus chemical migration, have been altered by the Tronox slurry wall/extraction system to the east. The need for this type of data in the future is addressed in Section 9.2, Data Gaps.

The extent of impacts to soil and groundwater at the Tronox site from other SRCs has not fully been determined at this writing, though additional site-wide investigations are reportedly planned in 2006 (NDEP, 2006b; Tronox, 2006).

The former PEPCON facility operated from approximately 1958 until 1988 and manufactured ammonium perchlorate and related propulsion systems. The original PEPCON plant footprint covered approximately 15 acres, and AMPAC owned more than 300 contiguous acres. Groundwater sampling at this site has demonstrated the presence of perchlorate (NDEP, 2005b). As reported (Kerr-McGee Chemical Corporation, 2005), the AMPAC perchlorate plume originates in the vicinity of the former Pepcon plant and stretches north-northeast. Concentrations as high as 10 mg/L have been mapped approximately 16,000 feet north-northeast at the BMI property line on the southern boundary of the Western Hook Subarea. As indicated by the 1-mg/L contour interval, the AMPAC perchlorate plume is approximately 3,000 feet wide as it passes through the western vicinity of the CAMU Site. The nearest data point contoured was located west of the CAMU Site northwest corner, at monitoring well MW-AHX with perchlorate concentration of 12 mg/L. This concentration is consistent with the MWH sample collected in 2005 in monitoring well AA-BW-13, located approximately 750 feet west-northwest of MW-AHX, in which the perchlorate concentration was 19.5 mg/L. The data indicate that the AMPAC perchlorate plume has impacted groundwater beneath the west portion of the CAMU Site.

6. Fate and Transport

As stated in Section 5, based on a thorough evaluation of all of the chemical data for the various media, as well as potential receptors, the list of chemicals detected has been limited to identify only ARARs. At this point in the CAMU Site investigation process, the purpose of the screening process is not to remove any chemicals from further consideration as to their potential for posing a risk to human health or the environment. Rather, the screening process is intended to produce a manageable and representative group of chemicals that facilitate an assessment of the fate and transport of the larger group of chemicals that have been or may have been disposed of at the CAMU Site or released from on-site and off-site sources.

6.1 On-Site

6.1.1 North Landfill Lobe

The limited data available (only one soil sample location, sampled in 1985) to assess subsurface impacts to the westernmost extent of the North Landfill Lobe indicate that chemicals have been released at the surface, possibly related to a surface spill in connection with the historical transfer of effluent to the Trade Effluent Ponds via the elevated flume, or possibly related to an apparent spillway feature used in connection with the Trade Effluent Ponds. The high concentration of hexachlorobenzene at 10 feet bgs (510 mg/kg), coupled with the lower concentration at 30 feet bgs indicates that hexachlorobenzene released at the surface has migrated downward at this location, with concentrations attenuating with increasing depth. Similar concentration trends are evident for metals, including vanadium, chromium, antimony, iron, and manganese. Pentachlorophenol (45 mg/kg) was also detected in the sample collected from 10 feet bgs, but not in the sample collected from 30 feet bgs. This trend is likely indicative of the high sorption coefficient for pentachlorophenol and thus low mobility and low potential for leaching deeper in the soil column.

Anecdotal information indicated that, at some point after 1942, burn dump operations were performed in the North Landfill Lobe. This practice could have led to the formation of dioxins and furans in the North Landfill Lobe, although not in the South Landfill Lobe because waste

burning apparently did not occur there. Additionally, the North Landfill Lobe is located above some former liquid impoundments and liquid waste was also disposed of at this location.

Dioxins and furans were found in detectable concentrations in one of three soil samples collected from the Qal depth interval greater than 10 feet bgs in excess of the ATSDR 50-ppt TEQ screening criterion. One of the samples had a calculated TEQ of 206 based on a high detection limit (where one-half the detection limit is used in the calculation), but was non-detect for all of the analytes. One of three samples from the TMCf also had a calculated TEQ of 227. ATSDR guidance (1997) calls for additional evaluation of concentrations above 50 ppt. As discussed in Section 7, dioxins and furans have low solubility, low vapor pressure, and high octanol-water partition coefficients, resulting in low mobility in the subsurface environment. Thus, as indicated by the chemical and physical properties discussed in Section 7 and previous experience with dioxins and furans (EPA, 2006a), dioxins and furans are not anticipated to migrate appreciable distances from the detected locations.

Arsenic was detected in all six samples from the Qal depth interval greater than 10 feet bgs at concentrations ranging above the DAF-1 soil to groundwater screening level. Only two of the samples were above the provisional shallow Qal soil background level. All three samples collected from the TMCf also contained concentrations greater than the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that arsenic would leach from the soils and enter groundwater at sporadic locations. The presence of chloroform and the absence of carbon tetrachloride in groundwater indicate that reducing groundwater conditions may be favoring the anaerobic degradation of carbon tetrachloride to chloroform. If this is the case, normally insoluble ferric hydroxide may become reduced and dissolved, releasing associated arsenic into the groundwater. Additional data regarding the redox condition of the groundwater would allow assessment of this issue.

Total chromium was detected in the Qal depth interval greater than 10 feet bgs at concentrations ranging above the DAF-1 soil to groundwater screening level. Three of the six samples had total chromium concentrations above the provisional background level (17 mg/kg). All six samples from the TMCf also contained concentrations greater than the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that total chromium would leach from the soils and enter groundwater at sporadic

locations. Once in groundwater, chromium would exist as a cation and be retarded as it moves with groundwater, subject to geochemical reactions that could chemically complex it further or alter its solubility and possibly its toxicity. Hexavalent chromium, the most toxic form of chromium, was not detected in deep soil samples.

Both arsenic and chromium are naturally occurring compounds, and it is possible that part or all of the observed concentrations may originate from natural sources. BRC is currently finalizing the report for the shallow soil background study and has submitted a work plan to NDEP to conduct a study that will establish the background concentrations of arsenic and chromium (total and hexavalent) in deep soils.

Of the organochlorine pesticides, aldrin was not detected in any of nine samples collected from the Qal depth interval greater than 10 feet bgs. Alpha BHC, beta BHC, and gamma BHC were detected at concentrations ranging above the DAF-1 soil to groundwater screening level. Alpha BHC (two samples), beta BHC (one sample) and gamma BHC (one sample) were also detected in the TMCf above the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that these organochlorine pesticides would leach from the CAMU Site soils and enter groundwater at sporadic locations. As discussed in Section 7, the organochlorine pesticides have relatively low solubility, low vapor pressure, and high organic carbon to water (K_{oc}) coefficients, resulting in low mobility in the subsurface environment. It is anticipated that the organochlorine pesticide concentrations would attenuate rapidly with distance along a groundwater flow path.

PCBs were not detected in any of the six soil samples collected from the Qal depth interval greater than 10 feet bgs or from the TMCf.

Perchlorate was detected in all three samples collected from the Qal depth interval greater than 10 feet bgs. Perchlorate is an anion and is expected to be mobile and easily leachable in the presence of percolating water. Once in groundwater, perchlorate is unretarded and moves at essentially the same speed as groundwater.

The radiochemicals radium-226 and radium-228 were detected in the six soil samples collected from the Qal depth interval greater than 10 feet bgs and from the TMCf. All six radium-226 samples collected from the Qal depth interval greater than 10 feet bgs had activities greater

than the DAF-1 soil to groundwater screening level (0.0161 pCi/g). However, only one of the six samples had activities that exceeded provisional background levels (2.4 pCi/g). No TMCf samples had activities that exceed the shallow Qal provisional background levels. Though background levels for the TMCf have not yet been established, the data imply that the observed radium-226 is largely a result of background activities. A very similar pattern was observed in the radium-228, uranium-235, and uranium-238 data.

Hexachlorobenzene was not detected in any of the seven samples collected in the depth interval greater than 10 feet; however, detection limits in all samples were above the DAF-1 soil to groundwater screening level. Hexachlorobenzene was not detected in the three TMCf samples, but again, detection limits were above the DAF-1 level. Based on use of the conservative DAF-1 criterion and the presence of hexachlorobenzene in a surface sample at elevated concentrations, it would be expected that hexachlorobenzene would leach from the soils and enter groundwater at isolated locations. Once in groundwater, hexachlorobenzene would be retarded and sorbed as it flowed with groundwater such that concentrations would attenuate in the downgradient direction.

The VOCs 1,2-dichlorobenzene and 1,4-dichlorobenzene (3 of 7 samples), benzene (4 of 7 samples), and chloroform (5 of 7 samples) were detected in the 7 Qal soil samples collected from depths greater than 10 feet bgs; 1,2,4-trichlorobenzene was not detected. None of the detections were at concentrations higher than the DAF-1 soil to groundwater screening level. One sample, collected from a depth of 50 ft bgs at location BW-07, was above the DAF-1 for benzene and chloroform. While recognizing that the data set is limited, based on other soil sampling data and the significant concentrations of benzene and chloroform in groundwater, it does not appear that VOCs are sourced from soils in the North Landfill Lobe subarea. However, if these compounds did emanate from the North Landfill, they would be expected to flow in aqueous solution in groundwater and attenuate in concentration to varying degrees through the combined processes of sorption, dispersion, dilution, and biodegradation. No samples were above the DAF-1 screening level for chloroform.

6.1.2 South Landfill Lobe

It is likely that the waste materials disposed of in the South Landfill Lobe are quite similar to those disposed of in the North Landfill Lobe. For the most part, data and/or information do not exist that identify different waste streams from those disposed of in the North Landfill Lobe. Anecdotal information has suggested that old transformer banks may have been disposed of in the South Landfill Lobe; consequently, there is a potential for PCBs or Aroclors to be present in the surrounding soils. As noted in Section 6.1.1, there is no evidence that liquid chlorinated organics were dumped and/or burned here, as they apparently were in the North Landfill Lobe.

6.1.3 North Borrow Pit Lobe

In 1999, Parsons Environmental Services, Inc. (PESI) conducted a sampling effort in the North Borrow Pit Lobe that detected no VOCs in soil samples, but did detect low levels of SVOCs, pesticides, and perchlorate in several of the soil samples. Specifically, perchlorate and gamma-BHC were detected in a surface soil sample, and 1,2-dichlorobenzene and 1,2-trichlorobenzene were detected in a soil sample from 20 feet bgs at concentrations above U.S. EPA Region 9 industrial PRGs. No VOCs or SVOCs were detected in the two groundwater samples collected beneath the CAMU Site, although pesticides and perchlorate were detected in one of the samples.

Sampling and analytical work done at the North Borrow Pit by Geotechnical Environmental Services, Inc. (GES) (2000a) resulted in the identification of a number of organic compounds in soils, including 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, hexachlorobenzene, pentachlorophenol, and hexachlorobutadiene. Inorganic chemicals detected included perchlorate, chromium, hexavalent chromium, and lead.

GES performed a limited investigation of the proposed CAMU (GES, 2003) and compared soil sample chemical analytical results for alpha BHC, beta BHC, delta BHC, gamma BHC (Lindane), 2-hexanone, cis-1,3-dichloropropene, and naphthalene to U.S. EPA Region 9 industrial PRGs. Although they reported no exceedances, this reporting was in error. The highest concentrations of beta BHC (50 µg/kg), alpha BHC (73 µg/kg), and Lindane (28 µg/kg) all exceeded the industrial PRGs. Delta BHC was also detected at concentrations as high as 100 µg/kg, although a site screening level (SSL) for this compound does not exist. Soil samples

were also collected for asbestos analyses. In 2003, Aeolus concluded that asbestos-related risks attendant to the excavation, handling, and use of soils from the North Borrow Pit Lobe would result in risks to workers that are substantially less than one in a million. In October 2003, MWH conducted an evaluation of the potential health risks of detected radionuclides in the North Borrow Pit soils. Results of this assessment indicated that, given the planned use, North Borrow Pit soils would not pose an unacceptable risk to human health. As noted in Section 3.1.3, BRC has submitted a comprehensive Risk Assessment for the North Borrow Pit Lobe, pursuant to NDEP's approval of the work plan, prior to excavation activities. BRC has also submitted a draft Risk Assessment for the export of soils in these areas, and it is currently under review by NDEP.

Dioxins and furans in excess of the ATSDR 50-ppt TEQ screening criterion were not found in 11 soil samples collected from the Qal depth interval greater than 10 feet bgs, or in the 2 samples collected from the TMCf. Dioxins and furans are not expected to impact groundwater from the North Borrow Pit Lobe.

Arsenic was detected above the DAF-1 soil to groundwater screening level in 26 of 30 samples collected from the Qal depth interval greater than 10 feet bgs. Three samples from the TMCf also had arsenic concentrations above the DAF-1. Chromium was detected above the DAF-1 screening level in all 30 samples collected from the Qal depth interval greater than 10 feet bgs. Three samples from the TMCf also had chromium concentrations above the DAF-1. Based on use of the conservative DAF-1, it is expected that arsenic and chromium will leach to groundwater from the South Borrow Pit Lobe soils. However, as both arsenic and chromium are naturally occurring compounds it is possible that part or all of the observed concentrations may originate from natural sources. Hexavalent chromium, the most toxic form of chromium, was not detected in deep soil samples.

Of the organochlorine pesticides, aldrin was not detected in any of the samples. Alpha BHC, beta BHC, and gamma BHC were detected in samples collected from the Qal depth interval greater than 10 feet bgs at concentrations ranging above the DAF-1 soil to groundwater screening level. Because the reporting limit for these three compounds was elevated relative to the DAF-1 value, the possibility of DAF-1 exceedances may be greater than the current data set reveals. Alpha BHC and beta BHC were also detected in the TMCf, but below the DAF-1 soil to

groundwater screening level. Two gamma-BHC samples had TMCf soil sample concentrations above the DAF-1. Based on use of the conservative DAF-1 criterion, it would be expected that these organochlorine pesticides would leach from the CAMU soils and enter groundwater at sporadic locations. As discussed in Section 7, the organochlorine pesticides have relatively low solubility, low vapor pressure, and high K_{oc} coefficients, resulting in low mobility in the subsurface environment. It is anticipated that the organochlorine pesticide concentrations would attenuate rapidly with distance along a groundwater flow path.

Samples analyzed for VOCs were mostly non-detect in Qal soil samples collected from the depth interval greater than 10 feet bgs. One sample, GP_13_N-1, had concentrations of 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, and 1,4-dichlorobenzene above the DAF-1 soil to groundwater screening levels. These compounds were not detected in the other 37 Qal samples collected from the depth interval greater than 10 feet bgs. Benzene was detected in 2 of the 38 samples collected but none of the concentrations were above the DAF-1 level. Chloroform was not detected in the 42 samples (2 of the samples had a detection limit greater than the DAF-1 level). TMCf samples had concentrations less than the DAF-1 for 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene and benzene. One sample collected at a depth of 50 feet bgs had a chloroform concentration greater than the DAF-1 level. This slightly elevated chloroform detection is likely related to the presence of chloroform in groundwater and not to a soil source. The North Borrow Pit Lobe does not appear to be a source area for VOCs to groundwater.

6.1.4 South Borrow Pit Lobe

As discussed in Section 3.1.4, no known waste disposal activities have taken place in the South Borrow Pit Lobe. BRC plans to extract borrow materials from this area to support the construction of the proposed CAMU. BRC has submitted a draft Risk Assessment for the export of soils in these areas, and it is currently under review by NDEP.

The same studies conducted to determine the suitability of the North Borrow Pit Lobe as a borrow source for the planned mining activities also characterized the South Borrow Pit Lobe. Most of the borings in those investigations were located in the northeast end of the North Borrow Pit Lobe.

Dioxins and furans in excess of the ATSDR 50-ppt TEQ screening criterion were not found in eight soil samples collected from the Qal depth interval greater than 10 feet bgs, or in the five samples collected from the TMCf. Dioxins and furans are not expected to impact groundwater from the North Borrow Pit Lobe.

Arsenic was detected above the DAF-1 soil to groundwater screening level (1 mg/kg) in 30 of 30 samples collected from the Qal depth interval greater than 10 feet bgs and in 5 of 5 samples from the TMCf. Chromium was detected above the DAF-1 screening level in 22 of 22 samples collected from the Qal depth interval greater than 10 feet bgs and in 5 of 5 samples from the TMCf. Based on use of the conservative DAF-1, it is expected that arsenic and chromium will leach to groundwater from the South Borrow Pit Lobe soils. However, as both arsenic and chromium are naturally occurring compounds, it is possible that part or all of the observed concentrations may originate from natural sources. Hexavalent chromium, the most toxic form of chromium, was not detected in deep soil samples.

Of the organochlorine pesticides, aldrin was not detected in any of the samples. Alpha BHC and beta BHC were detected in samples collected from the Qal depth interval greater than 10 feet bgs at concentrations above the DAF-1 soil to groundwater screening level. Gamma-BHC was not detected above the DAF-1. Because the reporting limit for these three compounds was elevated relative to the DAF-1 value, the possibility of exceedances may be greater than the current data set reveals. Alpha BHC and beta BHC were detected in the TMCf, but reporting limits were greater than the DAF-1 soil to groundwater screening level. Gamma-BHC TMCf soil sample results were all non-detect, but the gamma-BHC reporting limits were again all above the DAF-1. Based on use of the conservative DAF-1 criterion, it would be expected that these organochlorine pesticides would leach from the CAMU Site soils and enter groundwater at sporadic locations. As discussed in Section 7, the organochlorine pesticides have relatively low solubility, low vapor pressure, and high K_{oc} coefficients, resulting in low mobility in the subsurface environment. It is anticipated that the organochlorine pesticide concentrations would attenuate rapidly with distance along a groundwater flow path.

Concentrations of VOCs (1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform) were mostly non-detect in soil samples collected from the depth interval greater than 10 feet bgs and with one exception were below the DAF-1 screening level.

Benzene was detected in one sample at a concentration slightly above the DAF-1 level. Concentrations of these same VOCs (1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform) in samples from the TMCf were also mostly non-detect, and all were below the DAF-1 screening level. The South Borrow Pit Lobe does not appear to be a source area for VOCs to groundwater.

6.1.5 Western W. Ditch Area

The U.S. government (and its contractor Anaconda), Stauffer, and Montrose used the Western W. Ditch Area for the discharge of process effluents (initially from the chlor-alkali plant) from 1942 to 1970. Most of the information regarding waste disposal at the Western W. Ditch Area focused on inorganics, including acid effluents, waste caustic liquor, brine sludge, sodium hypochlorite, sodium chloride, hydrochloric acid, sulfuric acid, magnesium oxide, and sodium hydroxide. These compounds can alter subsurface redox conditions and potentially mobilize metals in soils under low-redox conditions. Metals detected in the area soils included chromium and lead. The concentrations were highest at the surface and decreased with depth, indicating limited leaching and migration to groundwater. Perchlorate has also been identified in shallow soils, but was not listed as a waste product, nor was it detected in deeper soil samples.

No samples were collected and analyzed for dioxins and furans from the Qal depth interval greater than 10 feet bgs in this subarea. As discussed in Section 7, dioxins and furans have low solubility, low vapor pressure, and high octanol-water partition coefficients, resulting in low mobility in the subsurface environment. Thus, it is not anticipated that dioxins and furans will migrate appreciable distances from any release point.

Arsenic was detected in 15 of 20 samples collected from the Qal depth interval greater than 10 feet bgs, at concentrations above the DAF-1 soil to groundwater screening level. However, only 1 of the samples was above the provisional shallow Qal soil background level. No samples were collected from the TMCf. Based on use of the conservative DAF-1 criterion, it would be expected that arsenic would leach from the soils and enter groundwater at sporadic locations. The presence of chloroform and the absence of carbon tetrachloride in groundwater indicate that reducing groundwater conditions may be favoring the anaerobic degradation of carbon tetrachloride to chloroform. If this is the case, normally insoluble ferric hydroxide may become

reduced and dissolved, releasing associated arsenic into the groundwater. Additional data regarding the redox condition of the groundwater would allow assessment of this issue.

Total chromium was detected in all 20 Qal depth interval samples collected from depths greater than 10 feet bgs at concentrations above the DAF-1 soil to groundwater screening level, but only 1 of the 20 samples had total chromium concentrations above the provisional background level (17 mg/kg). No samples were collected from the TMCf. Based on use of the conservative DAF-1 criterion, it would be expected that total chromium would leach from the soils and enter groundwater at sporadic locations. Once in groundwater, chromium would exist as a cation and be retarded as it moves with groundwater, subject to geochemical reactions that could chemically complex it further or alter its solubility and possibly its toxicity. Hexavalent chromium, the most toxic form of chromium, was not detected in deep soil samples.

Both arsenic and chromium are naturally occurring compounds and it is possible that part or all of the observed concentrations may originate from natural sources. BRC is currently finalizing the report for the shallow soil background concentrations study and has submitted a work plan to NDEP to conduct a study that will establish the background concentrations in deep Qal and TMCf soils for arsenic and chromium (total and hexavalent).

Of the organochlorine pesticides, aldrin was not detected in any of the 20 samples collected from the Qal depth interval greater than 10 feet bgs. Alpha BHC, beta BHC, and gamma BHC were detected at concentrations above the DAF-1 soil to groundwater screening level. Though not detected in the 5 samples collected from the TMCf, the detection limits were higher than the DAF-1 for alpha BHC, beta BHC, and gamma BHC. Based on use of the conservative DAF-1 criterion, it would be expected that these organochlorine pesticides could leach from the Western W. Ditch Area soils and enter groundwater at sporadic locations. As discussed in Section 7, the organochlorine pesticides have relatively low solubility, low vapor pressure, and high K_{oc} coefficients, resulting in low mobility in the subsurface environment. It is anticipated that the organochlorine pesticide concentrations would attenuate rapidly with distance along a groundwater flow path.

No samples from the Western W. Ditch Area were collected and analyzed for PCBs.

Perchlorate was detected in 9 of 20 samples collected from the Qal depth interval greater than 10 feet bgs. Perchlorate is an anion and is expected to be mobile and easily leachable in the presence of percolating water. Once in groundwater, perchlorate is unretarded and moves at essentially the same speed as groundwater.

The radiochemicals radium-226 and radium-228 were detected in the 6 soil samples collected from the Qal depth interval greater than 10 feet bgs and from the TMCf. All 6 radium-226 samples collected from the Qal depth interval greater than 10 feet bgs had activities greater than the DAF-1 soil to groundwater screening level (0.0161 pCi/g). However, only 1 of 6 samples had activities that exceeded provisional background levels (2.4 pCi/g). No TMCf samples had activities that exceed the shallow Qal provisional background levels. Though background levels for the TMCf have not yet been established, the data imply that the observed radium-226 is largely a result of background activities. A very similar pattern was observed in the radium-228, uranium-235, and uranium-238 data.

Hexachlorobenzene was detected in 3 of 24 samples collected in the depth interval greater than 10 feet at concentrations exceeding the DAF-1 soil to groundwater level. However, detection limits in all samples were above the DAF-1 soil to groundwater screening level (100 mg/kg). Hexachlorobenzene was not detected in the 3 TMCf samples, but detection limits were also above the DAF-1 level. Based on use of the conservative DAF-1 criterion and the presence of hexachlorobenzene in a surface sample at elevated concentrations, it would be expected that hexachlorobenzene would leach from the soils and enter groundwater at isolated locations. Once in groundwater, hexachlorobenzene would be retarded and sorbed as it flowed in aqueous solution with groundwater such that concentrations would attenuate in the downgradient direction.

The VOCs 1,2,4-trichlorobenzene (6 of 24 samples), 1,2-dichlorobenzene (4 of 24 samples), 1,4-dichlorobenzene (3 of 24 samples), benzene (1 of 24 samples), and chloroform (6 of 24 samples) were detected at concentrations greater than the DAF-1 level in Qal soil samples collected from depths greater than 10 feet bgs. Many of the detection levels were higher than the DAF-1 level. These VOCs were also detected in the samples collected from the TMCf, although not at concentrations above the DAF-1. Based on use of the conservative DAF-1 criterion, it would be expected that these VOCs would leach from the soils and enter

groundwater. Detections of significant concentrations of 1,2-dichlorobenzene and 1,2,4-trichlorobenzene in deep soil samples collected from this area indicate that polychlorinated benzene compounds have leached within the soil profile and likely historically impacted groundwater. Once in the groundwater, these compounds would be expected to flow in aqueous phase in groundwater and attenuate in concentration to varying degrees through the combined processes of sorption, dispersion, dilution, and biodegradation.

6.1.6 Eastern W. Ditch Area

No historical information was identified regarding disposal practices in the Eastern W. Ditch Area. It is conservatively assumed that similar chemicals to those placed in the Western W. Ditch Area were likely disposed of here, or that impacts may have occurred as a result of overflows.

Dioxins and furans were found in detectable concentrations in 2 of 6 soil samples collected from the Qal depth interval greater than 10 feet bgs. Though non-detect for all individual constituents, one sample had a calculated TEQ in excess of the ATSDR 50-ppt TEQ screening criterion, based on a high detection limit (where one-half the detection limit is used in the calculation). ATSDR guidance (1997) calls for additional evaluation of concentrations above 50 ppt. As discussed in Section 7, dioxins and furans have low solubility, low vapor pressure, and high octanol-water partition coefficients, resulting in low mobility in the subsurface environment. Thus, it is not anticipated that dioxins and furans will migrate appreciable distances from the detected locations.

Arsenic was detected in all 10 samples collected from the Qal depth interval greater than 10 feet bgs at concentrations ranging above the DAF-1 soil to groundwater screening level. Only 1 of the samples was above the provisional shallow Qal soil background level. No samples were collected from the TMCf. Based on use of the conservative DAF-1 criterion, it would be expected that arsenic would leach from the soils and enter groundwater at sporadic locations. The presence of chloroform and the absence of carbon tetrachloride in groundwater indicate that reducing groundwater conditions may be favoring the anaerobic degradation of carbon tetrachloride to chloroform. If this is the case, normally insoluble ferric hydroxide may become

reduced and dissolved, releasing associated arsenic into the groundwater. Additional data regarding the redox condition of the groundwater would allow assessment of this issue.

Total chromium was detected in 2 of 10 Qal depth interval samples collected from depths greater than 10 feet bgs at concentrations above the DAF-1 soil to groundwater screening level, and 2 of 10 samples had total chromium concentrations above the provisional background level (17 mg/kg). No samples were collected from the TMCf. Based on use of the conservative DAF-1 criterion, it would be expected that total chromium would leach from the soils and enter groundwater at sporadic locations. Once in groundwater, chromium would exist as a cation and be retarded as it moves with groundwater, subject to geochemical reactions that could chemically complex it further or alter its solubility and possibly its toxicity. Hexavalent chromium, the most toxic form of chromium, was not detected in deep soil samples.

Both arsenic and chromium are naturally occurring compounds, and it is possible that part or all of the observed concentrations may originate from natural sources. BRC is currently developing a work plan to conduct a study that will establish the background concentration of arsenic and chromium (total and hexavalent).

Of the organochlorine pesticides, aldrin was not detected in any of 14 samples collected from the Qal depth interval greater than 10 feet bgs. Alpha BHC, beta BHC, and gamma BHC were detected at concentrations ranging above the DAF-1 soil to groundwater screening level. Though not detected in the 3 samples collected from the TMCf, the detection limits were higher than the DAF-1 for alpha BHC, beta BHC, and gamma BHC. Based on use of the conservative DAF-1 criterion, it would be expected that these organochlorine pesticides could leach from the Eastern W. Ditch Area soils and enter groundwater at sporadic locations. As discussed in Section 7, the organochlorine pesticides have relatively low solubility, low vapor pressure, and high K_{oc} coefficients, resulting in low mobility in the subsurface environment. It is anticipated that the organochlorine pesticide concentrations would attenuate rapidly with distance along a groundwater flow path.

PCBs were not detected in the 12 samples collected from the depth interval greater than 10 feet bgs from the Western W. Ditch Area .

Perchlorate was detected in 2 of 3 samples collected from the Qal depth interval greater than 10 feet bgs. Perchlorate is an anion and is expected to be mobile and easily leachable in the presence of percolating water. Once in groundwater, perchlorate is unretarded and moves at essentially the same speed as groundwater.

The radiochemicals radium-226 and radium-228 were detected in the 6 soil samples collected from the Qal depth interval greater than 10 feet bgs and in 3 samples collected from the TMCf. All 6 radium-226 samples collected from the Qal depth interval greater than 10 feet bgs had activities greater than the DAF-1 soil to groundwater screening level (0.0161 pCi/g). However, no Qal samples had activities that exceeded provisional background levels (2.4 pCi/g). Though background levels for the TMCf have not yet been established, no TMCf samples had activities that exceed the shallow Qal provisional background levels. Thus the data imply that the observed radium-226 is largely due to background activities. A similar pattern was observed in the radium-228, uranium-235, and uranium-238 data.

Hexachlorobenzene was not detected in the 12 samples collected in the depth interval greater than 10 feet at concentrations exceeding the DAF-1 soil to groundwater level. However, detection limits in all samples were above the DAF-1 soil to groundwater screening level (100 mg/kg). Hexachlorobenzene was also not detected in the 3 TMCf samples, but again, detection limits were above the DAF-1 level. Based on use of the conservative DAF-1 criterion, it might be expected that hexachlorobenzene would leach from the soils and enter groundwater at isolated locations. Once in groundwater, hexachlorobenzene would be retarded and sorbed as it flowed in aqueous solution with groundwater such that concentrations would attenuate in the downgradient direction.

Of the 16 samples collected from the Qal depth interval greater than 10 feet bgs and analyzed for the VOCs 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, 1,4-dichlorobenzene, benzene, and chloroform, benzene and chloroform were detected at estimated concentrations greater than the DAF-1 level. In several cases, detection levels were higher than the DAF-1 level. These VOCs were also detected above the DAF-1 in 2 of 3 samples collected from the TMCf. Based on the data, it does not appear that VOCs are sourced in the Eastern W. Ditch Area.

6.1.7 The Slit Trench Area

Geraghty and Miller (1993) stated, based on reports by Stauffer (1979, 1980a), that sludge "... produced in the old Hooker cells, included chloroform and hexachloroethane in a carbon tetrachloride base." They went on to report that, "... documents reviewed indicate that at various times this waste stream may have gone to both a leach bed area on the Stauffer site and the BMI landfill." They also cited reports that "Ten tons of carbon tetrachloride material containing carbon tetrachloride and nitrogen trichloride were buried in the BMI landfill from 1977 until 1980 (Stauffer Chemical Co., 1979, 1980a, 1980b).

Examination of analytical results for sampled media in the STA (BRC and MWH, 2005) indicates that carbon tetrachloride was detected in 18 out of 62 soil samples and in 43 out of 67 soil vapor samples collected and analyzed. However, carbon tetrachloride was not detected in groundwater. Carbon tetrachloride is subject to anaerobic degradation through reductive dechlorination to chloroform, which may explain the lack of detections of carbon tetrachloride in groundwater even though chloroform has been shown to be widespread. It is possible that anaerobic conditions are maintained in the STA due to consumption of oxygen by microorganisms degrading the solid wastes (paper, for example) buried in the slit trenches.

Observations made during the 2005 slit trench investigation (BRC and MWH, 2005) revealed that a significant volume of debris or trash was disposed of in the trenches. Sludge was not observed to be present in the STA subsurface. Work performed by GES (2000b) showed soils impacted with organochlorine pesticides and Aroclors extending to the total depth of all borings advanced (25 feet bgs). Elevated concentrations of the chlorinated organics DCA, TCE, PCE, hexachlorobutadiene, chloroform, and acetone were detected in both soil and soil vapor samples.

Of the 45 soil samples collected and analyzed for dioxins and furans from the depth interval greater than 10 feet bgs, 25 had detectable concentrations, and 5 of the 25 soil samples with detections had concentrations greater than the ATSDR 50-ppt TEQ screening criterion, with reported concentrations ranging from 56 to 31,000. Dioxins and furans were not detected from the one sample collected from the TMCf. ATSDR guidance (1997) calls for additional evaluation of concentrations above 50 ppt. As discussed in Section 7, dioxins and furans have

low solubility, low vapor pressure, and high octanol-water partition coefficients, resulting in low mobility in the subsurface environment. Thus, it is not anticipated that dioxins and furans will migrate appreciable distances from the detected locations.

Arsenic was detected in the Qal depth interval greater than 10 feet bgs at concentrations above the DAF-1 soil to groundwater screening level. Concentrations in a number of the samples were also above the provisional shallow Qal soil background level. Ten of 11 samples collected from the TMCf also contained concentrations greater than the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that arsenic would leach from the soils and enter groundwater at sporadic locations. The presence of chloroform and the absence of carbon tetrachloride in groundwater indicate that reducing groundwater conditions may be favoring the anaerobic degradation of carbon tetrachloride to chloroform. If this is the case, normally insoluble ferric hydroxide may become reduced and dissolved, releasing associated arsenic into the groundwater. Additional data regarding the redox condition of the groundwater would allow assessment of this issue.

Total chromium was detected in all samples collected from the Qal depth interval greater than 10 feet bgs at concentrations above the DAF-1 soil to groundwater screening level. Many of the 67 samples had total chromium concentrations above provisional background. All 11 samples from the TMCf also contained concentrations greater than the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that total chromium would leach from the soils and enter groundwater. Once in groundwater, chromium would exist as a cation and be retarded as it moves with groundwater, subject to geochemical reactions that could chemically complex it further or alter its solubility and possibly its toxicity. Hexavalent chromium, the most toxic form of chromium, was not detected in any of the 55 soil samples collected from the Qal depth interval greater than 10 feet bgs.

Of the organochlorine pesticides, aldrin was detected in 6 of the 67 samples collected from the Qal depth interval greater than 10 feet bgs. Aldrin was not detected in any of the 10 TMCf soil samples collected. Alpha BHC, beta BHC, and gamma BHC were detected in all 71 samples collected from the Qal depth interval greater than 10 feet bgs at concentrations above the DAF-1 soil to groundwater screening level. Alpha BHC (5 of 11 samples), beta BHC (5 of 11 samples), and gamma BHC (2 of 11 samples) were also detected in the TMCf soil samples

above the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that these organochlorine pesticides would leach from the CAMU STA soils and enter groundwater. As discussed in Section 7, the organochlorine pesticides have relatively low solubility, low vapor pressure, and high K_{oc} coefficients, resulting in low mobility in the subsurface environment. It is anticipated that the organochlorine pesticide aqueous concentrations would attenuate rapidly with distance along a groundwater flow path.

PCBs were detected in 9 of 67 soil samples collected from the Qal depth interval greater than 10 ft bgs. PCBs were not detected in the 4 samples collected from the TMCf. PCBs have low solubility, low vapor pressure, and high octanol-water partition coefficients, resulting in low mobility in the subsurface environment. They are very immobile in the subsurface and are not expected to impact groundwater unless transported sorbed to suspended colloids.

Perchlorate was detected in 32 of 46 samples collected from the Qal depth interval greater than 10 feet bgs, and in 1 of 4 samples collected from the TMCf. Perchlorate is an anion and is expected to be mobile and easily leachable in the presence of percolating water. Once in groundwater, perchlorate is highly soluble and unretarded, and it moves at essentially the same speed as groundwater.

The radiochemicals radium-226 and radium-228 were detected in soil samples collected from the Qal depth interval greater than 10 feet bgs and from the TMCf. All 46 radium-226 samples collected from the Qal depth interval greater than 10 feet bgs had activities greater than the DAF-1 soil to groundwater screening level. However, all samples had activities equal to or less than provisional background levels. Four TMCf samples had activities similar to those of the shallow Qal samples. Though background levels for the TMCf have not yet been established, the data imply that the observed radium-226 is largely due to background activities. A very similar pattern was observed in the radium-228, uranium-235, and uranium-238 data. The STA does not appear to act as a source of radiochemicals to groundwater.

Hexachlorobenzene was detected above the DAF-1 soil to groundwater screening level in 9 of 75 samples, but was not detected in the 11 soil samples collected from the TMCf. Based on use of the conservative DAF-1 criterion, it would be expected that hexachlorobenzene would leach from the soils and enter groundwater at sporadic locations. Once in groundwater,

hexachlorobenzene concentrations would be attenuated through the mechanisms of dilution, dispersion, sorption, and biodegradation as it flowed in aqueous phase with groundwater such that concentrations would attenuate in the downgradient direction.

The VOCs 1,2,4-trichlorobenzene (4 of 75 samples), 1,2-dichlorobenzene (9 of 75), 1,4-dichlorobenzene (17 of 75 samples), benzene (4 of 75 samples), and chloroform (35 of 75 samples) were detected in Qal soil samples collected from depths greater than 10 feet bgs at concentrations greater than the DAF-1 soil to groundwater screening level. These VOCs were also detected in TMCf soil samples at concentrations exceeding the DAF-1 soil to groundwater screening level. Based on use of the conservative DAF-1 criterion, it would be expected that these VOCs would leach from the soils and enter groundwater at sporadic locations. Once in the groundwater, these compounds would be expected to flow in aqueous phase in groundwater and attenuate in concentration to varying degrees through the combined processes of sorption, dispersion, dilution, and biodegradation.

Recently MWH completed a focused “step-out” investigation of subsurface conditions in the immediate vicinity of the slit trenches in accordance with the sampling and analysis plan (BRC, 2006) that had been approved by the NDEP. The field program included the advancement of 27 soil borings to depths as great as 30 feet bgs and the collection and analysis of soil samples at targeted intervals. The step-out borings consisted of clustered supplemental boring locations that radiate outward (by 10 and 20 feet) to the north, south, east, and west from four previously existing boring locations within the STA: boring location 8, boring location 11, boring location 17, and boring location 20 (BS-08, BS-11, BS-17, and BS-20). These locations were selected because previous sampling had indicated that these locations had the highest impacts.

For dioxins and furans, the concentrations were generally higher in the step-out borings than at the original boring locations. At BS-08, the highest calculated TCDD TEQ concentration of 569,966 pg/g (equivalent to parts per trillion) was at BS-08-W10 (10 feet to the west of BS-08) at a depth of 15 feet. At BS-17, the calculated TCDD TEQ concentrations from samples 20 feet bgs were two to three times greater in step-out borings 20 feet to the east and west, along the general line of the trench. These calculated values ranged from 11,823 pg/g to 15,567 pg/g. Concentrations were lowest in the step-out borings to the north and south of the trench, located

generally orthogonal to the line of the trench and outside the trench area, with values ranging from 2.9 to 4.0 pg/g at the 20-foot bgs depth. No data were collected at BS-20.

For metals, data were collected at step-out borings in the vicinity of locations BS-11 and BS-20. There were generally no substantial differences between concentrations in the step-out borings and the original borings.

For organochlorine pesticides, data were collected at step-out borings BS-08, BS-11, BS-17, and BS-20. At BS-08, concentrations were higher in the step-out boring samples at the 20-foot depth. Organochlorine pesticide concentrations in the step-out borings generally decreased in the 30-foot depth samples from those in the 20-foot step-out samples, and the 30-foot step-out concentrations were generally lower than those in original boring BS-08, but still greater than soil screening levels. With the exception of alpha BHC (at the 20-foot depth), organochlorine pesticide concentrations in the step-out borings to the north and south generally were lower compared to the original boring and to the step-out borings to the east and west. At BS-11, organochlorine pesticide concentrations generally decreased in the step-out borings as compared to the original boring. At BS-17, the organochlorine pesticide concentrations in the original boring were relatively low (non-detect to 10s of mg/kg). The organochlorine pesticide concentrations in the step-out boring 20 feet west of the original boring at 12 feet bgs were in the 1000s of mg/kg. In step-out borings to the east and west, organochlorine pesticide concentrations increased and were in the mid to high 1000s of mg/kg. At BS-20, with one exception there were generally no substantial differences between concentrations in the step-out borings and the original borings. Increased concentrations of beta BHC were found in the west step-out boring in both the 10-foot bgs and 20-foot bgs samples.

For the radiochemicals, data were collected for Ra-226 at step-out boring BS-17. The Ra-226 concentration in the 10-foot bgs sample in the step-out boring located 10 feet west of the original boring was 54.4 pCi/g, while the concentration at the same depth in the original boring was 12.4 pCi/g; both concentrations are above the upper end of the range of provisional background.

For SVOCs, data were collected at step-out borings BS-08, BS-11, BS-17 and BS-20. At BS-08, concentrations of hexachlorobenzene were higher than in the original boring in the

western 10-foot step-out boring at the 10, 20 and 30-foot depth intervals, and in the 20-foot step-out boring at the 10-foot depth interval. The highest hexachlorobenzene concentration at BS-08-W10 was 620 mg/kg. The lower concentrations were typically found in the north and south step-out borings. At BS-11, there were generally no substantial differences between concentrations in the step-out borings and those in the original borings. At BS-17, hexachlorobenzene concentration at the west 20-foot step out in the 10-foot depth sample was elevated at 1,200 mg/kg; the concentration declined to 200 mg/kg at 20 feet bgs in the same boring. The concentration at the west 10-foot step-out boring in the 20-foot depth sample was similar to that in the 20-foot west step-out boring at 320 mg/kg. The lower concentrations were typically found in the north and south step-out borings. At BS-20, there were generally no substantial differences between concentrations in the step-out borings and the original borings.

For VOCs, data were collected at step-out borings BS-08, BS-11, BS-17 and BS-20. At BS-08, the concentration of 1,2,4 trichlorobenzene increases in all step-out boring directions from the single digits to the 100s of mg/kg at the 20-foot and 30-foot bgs depth intervals. The highest concentrations were typically found in the 15- to 20-foot depth range. For 1,2-dichlorobenzene and 1,4-dichlorobenzene, concentrations in the step-out borings are as high as the 10,000+ mg/kg range at the 20-foot bgs depth samples and decrease by one order of magnitude in the 30-foot bgs samples. Samples from the north and south step-out borings are typically lower in concentration than samples collected from step-out borings to the east and west.

Generally, concentrations of chemicals (dioxins and furans, organochlorine pesticides, SVOCs, and VOCs) collected from step-out borings were variable. Within the trenches, no pattern could be discerned as to how the occurrence of elevated concentrations might be predicted. This lack of pattern is consistent with anecdotal evidence that dumping of waste materials into the Slit Trenches was haphazard. In several cases, sample concentrations collected from step-out borings to the east or west (that is, generally in line with the line of the trenches) were equal to or greater than those collected from the original boring. Concentrations collected from step-out borings to the north and south were often the lowest of the step-out borings and often less than the concentration from the original borings. The general decline of chemical sample concentrations in step-out borings to the north and south of the individual slit trenches (i.e., outside of the slit trenches) is consistent with an interpretation that impacts are mostly confined

to the slit trenches themselves, that chemical migration into soil outside of the trench has been limited, and that preferential migration occurs within the trench fill.

6.2 Off-Site

Numerous potential and actual off-site sources to the south of the CAMU Site have historically existed and have been documented in site-specific environmental investigation reports. These include a 30,000-gallon benzene release, railcar loading and storage areas, lined and unlined disposal ponds, chemical storage tanks, wastewater ponds, tank farms, and process equipment associated with four chemical plants (the Stauffer/Pioneer chlor-alkali plant, the Montrose agricultural chemical plant, the Stauffer ACD plant, and the Montrose/Pioneer HCL plant). As summarized in Section 3.2, a variety of chemical manufacturing, storage, handling, distribution, and waste disposal facilities have been historically operated at facilities south and upgradient of the CAMU Site. Chemical handling, processing, and disposal activities are known to have resulted in the impact of soil and groundwater by VOCs, SVOCs, pesticides, and metals beneath these upgradient facilities, and additional impacts may exist. However, a complete interpretation comparable to the one given the CAMU Site is not possible because of the limited analyte list used for analyzing samples collected from the upgradient locations.

7. Migration Pathway Analysis

Contaminants disposed of within the CAMU Site fall into several large categories, with their potential to migrate a function of both their physical characteristics and the timing of the release. Contaminant partitioning among water, air, and soil is quantified by aqueous solubility, vapor pressure, Henry's Law constant (H), and the octanol-water coefficient (expressed as the log K_{ow}). These variables are also influenced by the degradation half-lives of the particular compound in water, air, and soil, which reflect the susceptibility of a compound to biotic and abiotic degradation.

Table 7-1 summarizes the physiochemical properties for the primary chemicals of interest at the CAMU Site. This table also provides a brief commentary for each chemical (e.g., will rapidly volatilize, will adsorb to soils, is generally non-mobile, etc.).

7.1 Groundwater Pathway

Contaminant migration from soils to groundwater is in large part a function of the partitioning coefficients and solubility, as well as the texture and organic composition of the soils. In sandy soils with a small fraction of organic carbon (f_{oc}) the aromatic hydrocarbons (for example the BTEX constituents) are relatively mobile with respect to soil leaching to groundwater. As such, these compounds, where present, have the potential to leach to groundwater. High K_{ow} values for pesticides, Aroclors, and dichlorobenzene compounds indicate that these compounds are strongly adsorbed onto soil and sediment. This tendency limits significant groundwater transport of these compounds, especially in fine-grained sediments (silts or clays) with significant f_{oc} . But at the CAMU Site, pesticides and the dichlorobenzene compounds are present in both soil and groundwater. This may be explained by the upgradient continuing sources of contamination, the depth of disposal in the slit trenches, the coarse-grained nature of the sediments, and the low f_{oc} .

7.2 Surface Water Pathway

Similar to partitioning into groundwater, chemicals can partition into surface water provided that they have high aqueous solubilities. The CAMU Site area does not contain any perennial or ephemeral surface water features to suggest a completed surface water pathway.

7.3 Air Pathway

The volatility of a chemical increases as its vapor pressure increases. Vapor pressures greater than 1 millimeter mercury (mm Hg) indicate high volatility, whereas vapor pressures ranging from 0.001 to 0.1 mm Hg are considered semivolatile. Chemicals with vapor pressures less than 0.001 mm Hg are essentially nonvolatile under standard conditions. Henry's Law constant (K_H) is a measure of a compound's ability to volatilize from a dilute aqueous solution. Higher K_H s are associated with increased ability of a compound to volatilize. Chemicals that are readily volatilized from groundwater have K_H s exceeding 10^3 atmospheres-cubic meters per mole ($\text{atm}\cdot\text{m}^3/\text{mol}$), whereas chemicals with low volatility have K_H s less than 10^7 $\text{atm}\cdot\text{m}^3/\text{mol}$.

In subsurface soils, aromatic hydrocarbons readily partition among pore fluid, soil vapor, and the soil matrix; the apportionment is a function of the f_{oc} present in soil and the general soil physical properties such as porosity, effective porosity, grain size distribution, and moisture content.

A substantial body of evidence has indicated that aromatic hydrocarbons, including a number of benzene compounds, were disposed of in the landfill area, as well as in the slit trenches and borrow pits. Given the typically low vapor pressure, the moderate solubility, and the high potential for aerobic degradation of these compounds, it is not surprising that they are not detected in more locations at higher concentrations.

The dichlorobenzene compounds (1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene) were also disposed of in appreciable concentrations. These compounds have lower solubilities than benzene and a greater affinity for the vapor phase or sorption onto soils. These compounds readily partition from soil, sediment, surface water, and groundwater into the vapor phase.

7.4 Direct Soil Contact

Octanol-water coefficients (K_{ow}) are indicative measures of chemical ability to sorb to organic matter contained in soil relative to dissolution in soil-water (groundwater). The higher the K_{ow} , the greater the tendency for adsorption. Chemicals with high K_{ow} values strongly partition to the soil organic phase in water-soil mixtures.

Pesticides and herbicides detected on the CAMU Site include 4,4-DDE, 4,4-DDT, alpha BHC, beta BHC, delta BHC, and gamma BHC (Lindane). PCBs, including Aroclor 1254 and Aroclor 1260, were also identified. The chlorinated pesticides and PCBs are generally considered immobile. They have extremely low vapor pressures and Henry's Law constants, and volatilization is not generally a significant process.

Pentachlorophenol occurs at the CAMU Site and the one reported detection, in the Eastern W. Ditch Area, slightly exceeds the DAF-1 screening limit. For many of the analyses, the reported detection limit exceeds the DAF-1 value of 1. Pentachlorophenol has a very low vapor pressure and Henry's Law constant, with volatilization not considered significant.

Chlorinated aliphatic hydrocarbons (CAHs) detected on-site include TCE, PCE, chloroform, and carbon tetrachloride. Hexachlorobutadiene, a byproduct of the production of carbon tetrachloride, was also detected at relatively high concentrations. TCE, PCE, chloroform, and carbon tetrachloride all have high vapor pressures and Henry's Law constants. TCE and carbon tetrachloride have moderate solubilities, while the solubilities of the other compounds listed are lower. In general, these compounds have a propensity to adsorb to soils.

8. Receptor Analysis

For a complete exposure pathway to exist, each of the following elements must be present (U.S. EPA, 1989):

- A source and mechanism for chemical release
- An environmental transport medium (i.e., air, soil)
- A point of potential human and ecological contact with the medium
- A route of exposure (e.g., inhalation, ingestion, dermal contact)

Sources of contamination have been identified, and mechanisms for chemical release are understood to include spills, disposal practices, and process waste management (e.g., conveyance along unlined ditches). Sections 8.1 and 8.2 identify the potential human and ecological receptors that may be exposed to contaminants at the CAMU Site.

8.1 Human Receptors

The potential human receptors and primary exposure pathways for each of the receptors at the CAMU Site are.

The potentially exposed populations and their potential routes of exposure are identified in Table 8-1 and presented in Figure 8-1. As indicated in Figure 8-1, outdoor maintenance workers, construction workers, and trespassers could be exposed to chemicals in soil through skin contact, inhalation of VOCs in outdoor air, inhalation of chemicals absorbed to fugitive dust, or incidental ingestion of soil when soiled hands or objects are placed in or near the mouth. For radionuclides, external radiation is also a potential soil-related exposure pathway for all receptors. For asbestos, inhalation of fugitive dust is considered the only potential soil-related exposure pathway for all receptors. Exposures to potential nearby, off-site receptors that may be impacted during construction activities will be less than those for the on-site receptors.

Groundwater beneath the CAMU Site has been impacted by both on-site and off-site releases. Though extraction wells of the GWTS are located downgradient of the CAMU Site, NDEP has expressed concerns about the effectiveness of the GWTS to capture and treat impacted

groundwater (Attachment A dated January, 2005 entitled “Comparison of 1983 Consent Order with Current Methodologies and Knowledge” to the NDEP letter to Montrose and Stauffer dated March 9, 2005). Institutional controls in the form of a deed restriction will be emplaced to prevent future users from utilizing groundwater beneath the CAMU Site. Accordingly, the use of private water wells by residents or businesses for drinking water, irrigation water, or other non-potable uses (e.g., washing cars, filling swimming pools) will not occur. Therefore, these exposure pathways are not complete.

8.2 Ecological Receptors

The following ecological trophic categories are typically considered as terrestrial receptor (functional) groups, thus providing broadly protective coverage for each of the major taxa according to the functional food web categories:

- Photosynthetic macrophytic plants
- Invertebrates as primary decomposers (soil dwelling herbivores and detritivores)
- Mammals
 - Herbivores (all plant diet)
 - Omnivores (mixed plant, flesh, and invertebrate diet)
 - Insectivores (all invertebrate diet)
 - Carnivores (all flesh diet)
- Birds
 - Herbivores (all plant diet)
 - Omnivores (mixed plant, flesh, and invertebrate diet)
 - Insectivores (all invertebrate diet)
 - Carnivores (all flesh diet)
- Reptiles
 - Herbivores (all plant diet)
 - Insectivores (all invertebrate diet)
 - Carnivores (all flesh diet)
- Amphibians (land phase)
 - Insectivore (all invertebrate diet)

Receptors of ecological concern are biota that have a societal or ecological value (U.S. EPA, 1992, 1998) and are defined based on the following regulatory, ecological, commercial, and/or recreational considerations:

- *Regulatory Considerations:* Federal- and state-listed endangered species, federal- and state-listed threatened species, and federal- and state-listed candidate species
- *Ecological Considerations:* Biota that mediate processes or interactions that affect the structure and function of existing habitats, communities, or ecosystems (e.g., keystone species), and biota that provide shelter and/or food for threatened or endangered species
- *Commercial Considerations:* Biota having an economic value (e.g., crops, livestock, commercial fish and shellfish)
- *Recreational Considerations:* Biota having a sporting or aesthetic value (e.g., sport fish and game)

Receptors of concern may be identified at the individual, population, guild, community, and/or ecosystem level. Consistent with available U.S. EPA guidance (U.S. EPA, 1992, 1996), all taxa and trophic levels are considered.

The area surrounding the CAMU Site currently supports or is planned to support residential, commercial, or industrial uses. These areas are not intended to and do not support habitat attractive to support native plant and wildlife populations. Rather they are developed with buildings or are hardtopped or landscaped with a variety of native and non-native ornamental plants. Wildlife that may be observed in these areas are likely to be transient, introduced species that are tolerant of human activity and typical of highly disturbed areas (e.g., European starling, rock dove).

Exposure areas of ecological concern are areas that support (or are suitable to support) plants, invertebrates, and/or wildlife receptors of ecological concern. The CAMU Site is primarily vacant, undeveloped land with creosote bush (*Larrea tridentata*) found sporadically throughout

the site. A recent aerial photograph and several photographs of the CAMU Site that illustrate the sparse nature of the vegetation on the site are shown on Figure 8-2. Given the current and future planned use, the CAMU Site itself does not and is not anticipated to support intact natural communities. Based on available information for similar land uses, the CAMU Site is anticipated to support wildlife that are likely to be transient, introduced species that are tolerant of human activity and typical of highly disturbed areas (e.g., European starling). Accordingly, for the CAMU Site, no potential receptors of ecological concern are identified.

9. Summary

The uppermost unconsolidated materials consist of two units, an upper permeable alluvial unit (Qal) that overlies a lower-permeability unit (TMCf). The water table is encountered in the uppermost alluvial unit and is known as the Aa. Groundwater flow in the Aa is to the north toward Las Vegas Wash. Groundwater in the TMCf unit is confined, with an upward vertical gradient from the deep to shallow water-bearing zones, indicating that at least under current conditions, downward migration of contamination from the Aa to the TMCf is likely inhibited by the pressure gradient. The contact between the Qal and the TMCf is an upward flux boundary. Despite the fact that drilling observations indicate that water in the upper TMCf is confined by overlying finer-textured sediments (that would tend to impede or restrict groundwater flow), the distance between the water-bearing units in some locations is small and it is likely that there is upward leakage from the water-bearing lenses in the upper TMCf to the Qal. Several existing monitoring wells are screened across the Qal/TMCf contact, resulting in hydraulic communication.

Information on the use history, release mechanisms, and fate and transport of chemicals in the CAMU Site area is provided in a series of four illustrations (Figures 9-1 through 9-4) that summarize conditions from 1943 through the future. Each of these figures is described below.

Figure 9-1 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 Stauffer's operations to the south were located along both the northern and southern boundaries of the CAMU Site. 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 these releases is uncertain.

Figure 9-2 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 2004 (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 Aa. 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 Aa 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 9-3 presents conditions that existed in 2005. The use of the slit trenches has long since ceased, the STA is covered, and landfills to the north and south of the STA have been capped. Contaminant migration from the slit trenches potentially continues in both the vapor and aqueous phases. Dissolved-phase contamination from other upgradient sources discussed in Section 3.2 is also migrating in the Aa 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 9-4 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 Qal.

9.1 Synopsis of the Conceptual Site Model

9.1.1 Site Soil

Impacts to soil on the CAMU Site have been documented to exist in the North Landfill Lobe, beneath the Western Drainage Ditch (beneath pieces of Western W. Ditch Area and the Eastern W. Ditch Area), and in the STA. These impacts include VOCs, SVOCs, pesticides, metals, Aroclors, and dioxins/furans. Though specific information does not exist on historical waste disposal activities or subsurface investigations at the South Landfill Lobe, it is logical to assume that similar impacts exist here that exist beneath the North Landfill Lobe. Investigations and studies have indicated that limited soil impacts have occurred in the North Borrow Pit Lobe and the South Borrow Pit Lobe. Excluding the portion of land through which the Western Drainage Ditch traversed and based on the absence of historical waste disposal activities, no impacts to soil are known at the Eastern W. Ditch Area.

9.1.2 Off-Site Soil

A variety of chemical manufacturing, storage, handling, distribution, and waste disposal facilities have been historically operated at facilities south and upgradient of the CAMU Site. Environmental investigation reports document that activities at these facilities have resulted in soil impacts beneath the facilities. These impacts include VOCs, SVOCs, pesticides, and metals, and additional impacts may exist. However, a complete interpretation comparable to the one given the CAMU Site is not possible because of the limited analyte list used for analyzing samples collected from the upgradient locations.

9.1.3 Groundwater

Impacts to groundwater have occurred in the Aa beneath and upgradient of the CAMU Site. Chemicals detected in this groundwater in the CAMU Site perimeter wells (BRC and MWH, 2005) include VOCs, SVOCs, pesticides, metals, PCBs, dioxins/furans, TDS, and radionuclides. Chemicals that exceed MCLs in the Aa in both the CAMU Site upgradient and downgradient wells are significantly fewer in both number and type, and include VOCs, SVOCs, pesticides, dioxins (only in the upgradient wells), and metals. Fewer chemicals were found in the CAMU

Site downgradient wells than in the upgradient wells. Notable chemicals detected at concentrations above MCLs in the upgradient wells that were not detected above MCLs in the downgradient wells include vinyl chloride, uranium-238, and dioxins. TCE was detected above the MCL in a downgradient well but not in the upgradient wells. While further investigation of upgradient groundwater conditions is needed (and is being conducted), it is suspected that the presence of this compound is the result of biodegradation of PCE moving in groundwater from upgradient locations or from compounds that have entered groundwater from sources such as the BMI Landfill or the STA in the CAMU Site and were subsequently degraded.

Based on comparison of soil sample results from the Qal depth interval greater than 10 ft bgs to the DAF-1 soil screening criteria for representative chemicals, impacts to groundwater beneath the CAMU may have resulted from historical disposal of wastes in the CAMU Site in the North Landfill Lobe, the South Landfill Lobe, the STA, the Eastern W. Ditch Area, and the Western W. Ditch Area. These impacts include metals, organochlorine pesticides, PCBs, perchlorate, radiochemicals, SVOCs, and VOCs. The data indicate that detections of metals and radiochemicals may be attributable, in whole or in part, to natural sources and that the concentrations may be representative of background levels. BRC has conducted some work to evaluate shallow soil background levels and is developing a study to evaluate background concentrations of deeper (greater than 10 feet bgs) Qal and TMCf soils. Additional evaluation of the data will be conducted when this study is completed.

Historically, all of the chemicals found in any of the wells downgradient or cross-gradient from the CAMU Site were also found in the upgradient wells. For chemicals found at the highest concentrations, such as benzene, chlorobenzene, polychlorinated benzenes, and chloroform, historical CAMU Site well concentrations upgradient of the CAMU were typically high. Historical isoconcentration plots indicate that significant groundwater sources exist for these chemicals at off-site, upgradient locations. Isoconcentration plots of the boundary wells based on contemporaneous data collected in 2005 show a repeated pattern that likewise indicates that significant upgradient sources exist for these chemicals.

Impacts to groundwater occurring in the TMCf lenses have also occurred. In samples collected from wells located upgradient of the CAMU Site, 21 chemicals were detected at concentrations above the MCLs in TMCf groundwater lenses. These chemicals included VOCs, SVOCs, a

pesticide, metals, and a radionuclide (uranium-238). All of the chemicals detected above MCLs in the TMCf groundwater samples were also detected above MCLs in samples collected from CAMU Site upgradient perimeter wells. Many were also detected above MCLs in CAMU Site downgradient perimeter wells.

9.2 Data Gaps

Historical investigations have revealed significant data and information regarding the nature and character of chemical impacts at the CAMU Site. BRC is aware of ongoing additional investigations off-site by Stauffer, Montrose, and Tronox. The results of these and future investigations will be evaluated to update this CSM. At the present time, the following data gaps are identified:

1. Metals and radiochemicals often occur in deep Qal soil samples from the CAMU Site at concentrations above the DAF-1 screening value, implying that the CAMU Site may be a source of these constituents to groundwater. Many of these sample concentrations are below the respective provisional shallow soil background concentration for these chemicals. It would be more appropriate to compare these sample concentrations to background levels evaluated for deeper depth intervals in the Qal and TMCf. A background study is therefore needed to evaluate deep soil background concentrations for metals and radiochemicals in the deep Qal and TMCf. A program to develop CAMU Site-specific background for the deeper portions of the Qal and the TMCf is currently planned (DBS&A, 2006c, currently under review by NDEP).
2. Paleochannels may exert control over groundwater flow and chemical migration beneath the CAMU Site. Limited geologic borelog data exist for the area south of the southeastern corner of the CAMU Site, on off-site upgradient properties, between boring locations AA-BW-12 AND H-38. Additional data in this area are needed to more completely evaluate the potential presence of paleochannels and the nature of the contact between the Qal and TMCf in this area. BRC will participate with others (Montrose and Tronox) to determine how these data gaps should be filled.
3. The extent of hydraulic connectivity between groundwater in the Qal and in the TMCf at the CAMU Site has not been evaluated. BRC is aware of the deeper soil investigations

being conducted by Montrose upgradient at the present time. It may be necessary to conduct aquifer testing in well pairs such that the potential connection between the Aa and the TMCf can be further evaluated. This should also be done in conjunction with similar efforts by others in upgradient and cross-gradient locations.

4. Additional groundwater data have recently been collected upgradient, downgradient, and cross-gradient of the CAMU Site by others (Stauffer, Montrose). Additionally, quarterly groundwater monitoring by Tronox continues. BRC is also aware that Montrose and Stauffer will continue to collect periodic groundwater data. These data are now available for a significantly expanded list of compounds than previously analyzed. BRC will continue to track these new data and assess the understanding of the CAMU Site accordingly. BRC also hopes to implement periodic groundwater monitoring in conjunction with the placement of the CAMU in this area. This groundwater monitoring will be conducted at regular intervals and temporally coordinated with others. Collectively, these monitoring efforts will improve understanding of chemical migration onto and off the CAMU Site.
5. The extent of chemical biodegradation in the subsurface has not been fully assessed. The current data set indicates that chemical biodegradation may be occurring in the CAMU Site subsurface. Collection and evaluation of dissolved oxygen and redox data are needed to evaluate this fate and transport mechanism at the CAMU Site. Determining whether a particular compound originates as a released contaminant or from the degradation of another, mother compound can greatly assist in determining the source of that particular compound. This type of data can be collected during the periodic groundwater monitoring discussed earlier.
6. Though samples have been collected and analyzed, accurate concentrations for some chemical analytes at some locations remain unknown. Due to the large number of chemicals that impact the CAMU Site subsurface, it is inevitable that at least one compound at a high concentration will result in such high reporting limits for other compounds that the true concentration of those other compounds remains unknown. BRC will continue to work with project laboratories to obtain the lowest detection limits; however, BRC recognizes that even so, some of the detection limits may be too high given present analytical capabilities.

References

- Aeolus, Inc. 2003. *Evaluation of asbestos measurements and assessment of risks attendant to excavation and use of soils within the proposed borrow area of the BRC Corrective Action Management Unit, Henderson, NV*. December 2003.
- Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Dioxin and Dioxin-Like Compounds in Soil, Part 1: ATSDR Interim Policy Guideline
- Berman, D.W., and A.J. Kolk. 2000. *Draft: Modified elutiator method for the determination of asbestos in soils and bulk materials, Revision I*. Submitted to the U.S. Environmental Protection Agency, Region 8. May 23, 2000.
- Bohannon, R.G. 1984. *Nonmarine sedimentary rocks of Tertiary age in the Lake Mead region, southeastern Nevada and northwestern Arizona*. U.S. Geological Survey Professional Paper 1259, 72 p.
- BRC, 2006. Site Related Chemicals List., dated and submitted to NDEP February 9, 2006.
- BRC, ERM, MWH, and Daniel B. Stephens & Associates, 2006a. BRC Closure Plan, BMI Common Areas, Henderson, Nevada. submitted to NDEP August, 2006.
- Basic Remediation Company (BRC) and MWH Americas, Inc. (MWH). 2005. *BRC CAMU area, 2005 soil, soil vapor, groundwater, and slit trench investigation report*. October 2005.
- Basic Remediation Company (BRC) and Titanium Metals Corporation, 2006. Background Soils Summary Report, BMI Complex and Common Areas Vicinity. Submitted to NDEP May 15, 2006.
- BRC and Daniel B. Stephens & Associates, Inc. (DBS&A). 2005. *Sampling and analysis plan to conduct soil characterization of borrow areas, Henderson, Nevada*. October 10, 2005.
- BRC and MWH, 2006. Data Validation Summary Report for the 2006 Borrow Area Investigation (Dataset 36), BRC Corrective Action Management Unit (CAMU) Area, Clark County, Nevada. September, 2006.

BRC, MWH, Environmental Resource Management (ERM), and DBS&A. 2004. *Closure plan, BMI Upper and Lower Ponds and Ditches, Henderson, Nevada*. October 2004.

Carlsen, C.L., R.C. Lunnis, and D.E. Prudie, 1991. *Changes in water levels and water quality in shallow ground water, Pittman-Henderson Area, Clark County, Nevada, Resulting from diversion of industrial cooling water from ditch to pipeline in 1985*. U.S. Geological Survey Water-Resources Investigation Report 89-4093. Carson City, Nevada.

City of Henderson. 2006. *Water quality report*. June 2006.

City of Henderson. 2005. *Water conservation program*. Available online at <<http://www.cityofhenderson.com/utilities/php/index2.php>>.

Cohen, Robert M., and Mercer, James W., 1993. *DNAPL Site Evaluation*, EPA/600/R-93/022, Robert S. Kerr Environmental Research Laboratory.

Converse Environmental Consultants (Converse). 1993. *Phase I environmental conditions assessment for former Montrose Chemical Corporation facility*. April 1993.

Converse. 1999. *Preliminary geotechnical and geologic investigation, Industrial non-hazardous disposal facility, Basic Management Incorporated, Clark County, Nevada*.

Daniel B. Stephens & Associates, Inc. (DBS&A). 2005. Letter report from Stephen J. Cullen to Brian A. Rakvica, Nevada Division of Environmental Protection, regarding Sampling and analysis plan to conduct soil characterization of borrow areas, Henderson, Nevada. October 10, 2005

Daniel B. Stephens & Associates, Inc.. 2006a. *Groundwater modeling work plan for BMI Upper and Lower Ponds Area*. Prepared for Basic Remediation Company, Henderson, Nevada. August 17, 2006.

Daniel B. Stephens & Associates, Inc.. 2006b. *Aquifer testing work plan, BMI Common Area Eastside, Henderson, Nevada*. Prepared for Basic Remediation Company, Henderson, Nevada. September 11, 2006.

- Daniel B. Stephens & Associates, Inc.. 2007. *Revised Work plan for determination of deep Quaternary alluvium and Upper Muddy Creek Formation background soil chemistry and upgradient alluvial aquifer conditions, BMI Common Areas and Complex vicinity*. Prepared for Basic Remediation Company, Henderson, Nevada. September 29, 2006.
- Ecology and Environment (E&E). 1999. *Stauffer Chemical Company site inspection, Data presentation of the Phase I, IIA, and IIB sampling: 1984-1985*. June 1989.
- ENVIRON Corporation (ENVIRON). 2003. *Risk assessment for the water reclamation facility expansion site, Henderson, Nevada*. Prepared for City of Henderson, Nevada. October 15, 2003.
- Environmental Resource Management (ERM). 1999. *Groundwater sampling results, Former BMI Landfill*. October 1999.
- ERM. 2003. *Closure plan, BMI Upper and Lower Ponds and Ditches, Henderson, Nevada*.
- Geotechnical & Environmental Services, Inc. (GES). 2000a. *Implementation of sampling plan for the proposed gravel pit site, located in Henderson, Nevada*. Prepared for BRC, Henderson, Nevada. File No. 99949V4. May 19, 2000.
- GES. 2000b. Letter report from Daniel C. Burns and Gregory P. DeSart to Robin Bain, BRC, regarding Implementation of sampling plan for the Slit Trench Site, located in Henderson, Nevada. Project No. 99949V7. June 14, 2000.
- GES. 2000c. Letter report from Richard Cooke and Gregory P. DeSart to Robin Bain, BRC, regarding Implementation of supplemental sampling plan for Western Ditch and Slit Trench Site, located in Henderson, Nevada. Project No. 99949V9. August 22, 2000.
- GES. 2000d. Letter report from Richard Cooke and Gregory P. DeSart to Ranajit Sahu, BRC, regarding Implementation of sampling plan for Western Ditch Extension, located in Henderson, Nevada. Project No. 99949V10. November 27, 2000.
- GES. 2003. *Limited environmental Phase II investigation, proposed BRC Landfill, Henderson, Nevada*. Prepared for BRC, Henderson, Nevada. File No. 20031553V1. June 3, 2003.

- Geraghty & Miller (G&M). 1993. *Phase I environmental conditions assessment for the Basic Management, Inc. Industrial Complex – Clark County, Nevada*. April 1993.
- Hargis & Associates (Hargis). 2005. Presentation to the All Companies Meeting, sponsored by Nevada Department of Environmental Protection and the Basic Remediation Company, Henderson, Nevada, May 24, 2005.
- Harding Lawson Associates (HLA). 1998. *Groundwater treatment system evaluation, Stauffer Chemical Company/Pioneer Chlor Alkali Company, Inc. site, Henderson, Nevada*. August 3, 1998.
- HLA. 1999. *Site conceptual model, Stauffer/Pioneer/Montrose Site, Henderson, Nevada*. September 30, 1999.
- Kerr-McGee Chemical Corporation (KMCC). 1999. Lithologic logs of TR-Series monitoring wells. September and October 1999.
- Kerr-McGee Chemical Corporation, 2005. Plate 2, Groundwater Perchlorate Map Quaternary Alluvium Aquifer, May 2005.
- Kleinfelder. 1983. TIMET RCRA Part B Application.
- Kleinfelder. 1999. *Hydrogeologic investigation, American Pacific Corporation*. April 1999.
- Las Vegas Valley Water District (LVVWD), 2005. Groundwater Bank Program information. Available online at <http://www.lvvwd.com/html/groundwater_bank.html>.
- Malmberg, G.T. 1965. *Available water supply of the Las Vegas Ground-Water Basin, Nevada*. U.S. Geological Survey Water Supply Paper 1780.
- MWH Americas, Inc. (MWH). 2003a. Memorandum regarding Borrow Area radionuclide risk calculations. October 2003.
- MWH. 2003b. Memorandum regarding Borrow Area pesticide leachability evaluation. November 2003.

MWH. 2004. *Workplan to Conduct Supplemental Subsurface Characterization, Landfill Corrective Action Management Unit, BMI Complex, Henderson, Nevada*. July 23.

MWH and DBS&A. 2004. *2004 Hydrogeologic characterization summary, BMI Upper and lower Ponds and Ditches, Henderson, Nevada*. October 2004.

MWH. 2006. *BRC Human Health Risk Assessment Work Plan, Borrow Area, Clark County, Nevada. Prepared for Basic Remediation Company (BRC)*. October.

Montrose Chemical Corporation (Montrose). 2005a. Presentation at the All-Companies Meeting, Henderson, Nevada. May 24, 2005.

Montrose. 2005b. E-mail from Paul Sundberg to Ranajit Sahu regarding Montrose debris. July 8, 2005.

Nevada Division of Environmental Protection (NDEP). 2001. *Record of decision, Remediation of soils and sediments in the Upper and Lower Ponds at the BMI Complex*. November 2, 2001.

NDEP. 2005. Letter from Todd J. Croft to Jeff Gibson, American Pacific Corporation, and Susan Crowley, KMCC, regarding Groundwater extraction well field system model evaluation. March 9, 2005.

NDEP, 2005b. Remediation Fact Sheet, UIC Temporary Permit Issuance, pursuant to NAC445A.874, September 23, 2005. Prepared by Becky E. Lindvill.

NDEP, 2005c. Factsheet (pursuant to NAC 445A.874). American Pacific Corporation (AMPAC), Permit Number UNEV2005213.

NDEP. 2006. Draft Nevada Division of Environmental Protection Fact Sheet (Pursuant to NAC 445A.236). Prepared by James T. Hogan, Bureau of Water Pollution Control, May 25, 2006.

NDEP, 2006b. Tronox LLC Henderson Facility Fact Sheet. Nevada Division of Environmental Protection Fact Sheet, February 1, 2006.

Newell, Charles, J., Steven D. Acree, Randall R. Ross, and Scott G. Huling, 1995. Ground Water Issue, Light Nonaqueous Phase Liquids, EPA/540/S-95/500.

- Parsons Engineering Science, Inc. (PESI). 2000a. *Draft evaluation of remedial alternatives for the Slit-Trench Area south of the closed BMI Landfill*. Prepared for Nevada Division of Environmental Protection. March 13, 2000.
- PESI. 2000b. *Environmental assessment, Proposed aggregate mining operation, Henderson, Nevada*. Prepared for BRC, Henderson, Nevada. Submitted to NDEP, Carson City, Nevada. April 2000.
- PESI. 2002. *Draft proposed BRC Corrective Action Management Unit (CAMU) area conceptual site model, BMI Complex, Henderson, Nevada*. January 2002.
- PES Environmental, Inc., 2006. Revised Work Plan for Additional Vadose Zone Characterization, Former Stauffer Chemical Company Facility, Henderson, Nevada, June 16, 2006.
- Sahu, R. 2005. Personal communication between Ranajit Sahu, BRC, and Steve Cullen, DBS&A. May 25, 2005.
- Schmidt, D.L. 2000. *Integration of the Colorado River across the Western Colorado Plateau in Northwestern Arizona between about 10-5 Ma on the basis of the composition of Muddy Creek Formation of Southeastern Nevada* (abstract). Grand Canyon Symposium, Grand Canyon National Park, Arizona. June 2000.
- SECOR International Incorporated (SECOR). 1997. *Draft Phase II environmental conditions investigation report, Former Montrose facility, Henderson, Nevada*. August 21, 1997.
- SECOR. 2002a. Revised draft conceptual site model, Closed Montrose ponds, Former Montrose facility, Henderson, Nevada. February 2002.
- SECOR. 2002b. *Revised report of the investigation of the deeper water-bearing zones at the former closed ponds and former plant site, Former Montrose facility, Henderson, Nevada*. March 2002.
- Southern Nevada Water Authority (SNWA). 2005. Groundwater monitoring well telemetry map. Available online at <http://www.lasvegasgmp.com/html/telemetry_map.html>.

Spectrum Geophysics (Spectrum). 2000. *Geophysical investigation report, BRC Landfill, Henderson, Nevada*. Prepared for GeoSyntec Consultants. June 2000.

State of Nevada, 2006. Department of Conservation and Natural Resources, Division of Water Resources, Well Log Database Query Tool (web-based). <<http://water.nv.gov/engineering/wlog/wlog.cfm>>

Stauffer Chemical Co., 1979. G.R. Stewart, inter-office correspondence to Jim Call, Course of Action Trees, April 25, 1979.

Stauffer Chemical Co., 1980a. G.R. Stewart, letter to Clyde B. Eller, U.S. EPA Region IX, April 23, 1980.

Stauffer Chemical Co. 1980b. G. R. Stewart, Letter to Clyde B. Eller, U.S. EPA Region IX, July 16, 1980.

Tetra Tech EM Inc. (Tetra Tech). 1998. *Final environmental conditions investigation report*. Prepared for TIMET. October 15, 1998.

Tetra Tech. 1999. *Environmental conditions investigation addendum draft report, Titanium Metals Corporation Facility, Environmental conditions investigation, Henderson, Nevada*. Prepared for TIMET. September 24, 1999.

Tronox, 2006. Semi-annual Performance Report Chromium Mitigation Program, Tronox LLC, Henderson Nevada, July 25, 2006.

U.S. Environmental Protection Agency (EPA). 1989. Risk assessment guidance for Superfund: Volume I—Human Health Evaluation Manual (Part A). Interim Final. Office of Emergency and Remedial Response, Washington, D.C. USEPA/540/1-89/002. December.

U.S. Environmental Protection Agency (EPA). 2004. Perchlorate inn Henderson, NV - Significant Controls Are Operating. U.S. EPA Region 9 Public Memorandum. <http://www.epa.gov/fedfac/pdf/kerrmcgee_072004.pdf>

U.S. Environmental Protection Agency (EPA). 2005. Polychlorinated Biphenyl (PCB) Site Revitalization Guidance under the Toxic Substances Control Act (TOSCA). OPPT-2004-0123, November ,2005. <<http://www.epa.gov/opptintr/pcb/pubs/pcbrevitalguid3-06.pdf>>

U.S. Environmental Protection Agency (EPA), 2006. Perchlorate Monitoring Results Henderson, Nevada to the Lower Colorado River, December 2005 Report.

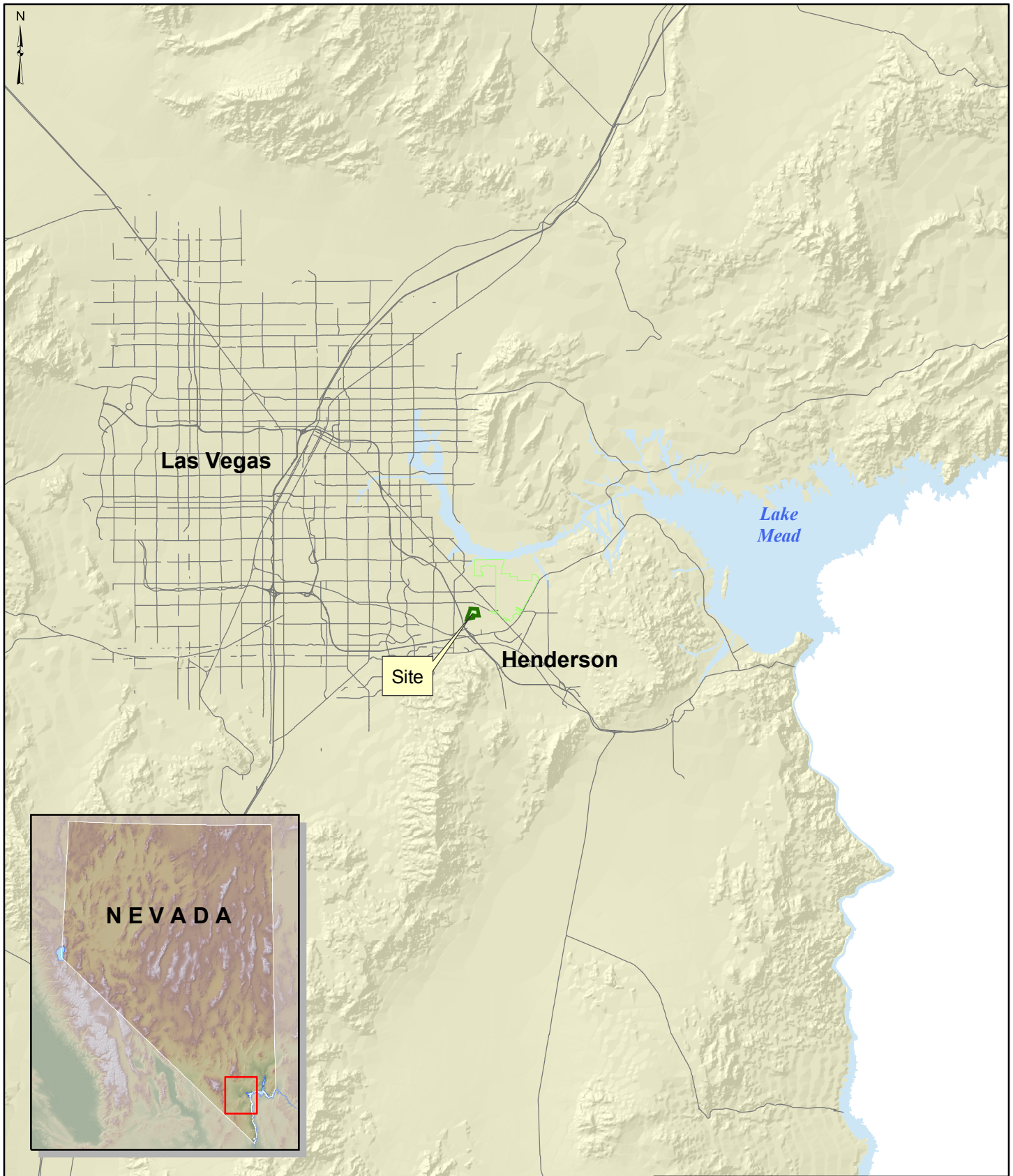
U.S. Environmental Protection Agency (EPA), 2006a. Technical Factsheet on: DIOXIN (2,3,7,8-TCDD), updated November 28,2006. < <http://www.epa.gov/OGWDW/dwh/t-soc/dioxin.html>>

Western Technologies, Inc. (WTI). 1996a. *Phase I subsurface soil evaluation, Warm Springs Road extension, U.S. Highway 95 to Eastgate Road, Henderson, Nevada*. April 30, 1996.

WTI. 1996b. *Phase II subsurface soil evaluation, Warm Springs Road extension, Eastgate Road to Boulder Highway, Henderson, Nevada*. June 24, 1996.

Weston Solutions, Inc. (Weston). 1993. *Phase I environmental conditions assessment report*. March 1993.

Figures



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

FIGURE 1-1

SITE LOCATION



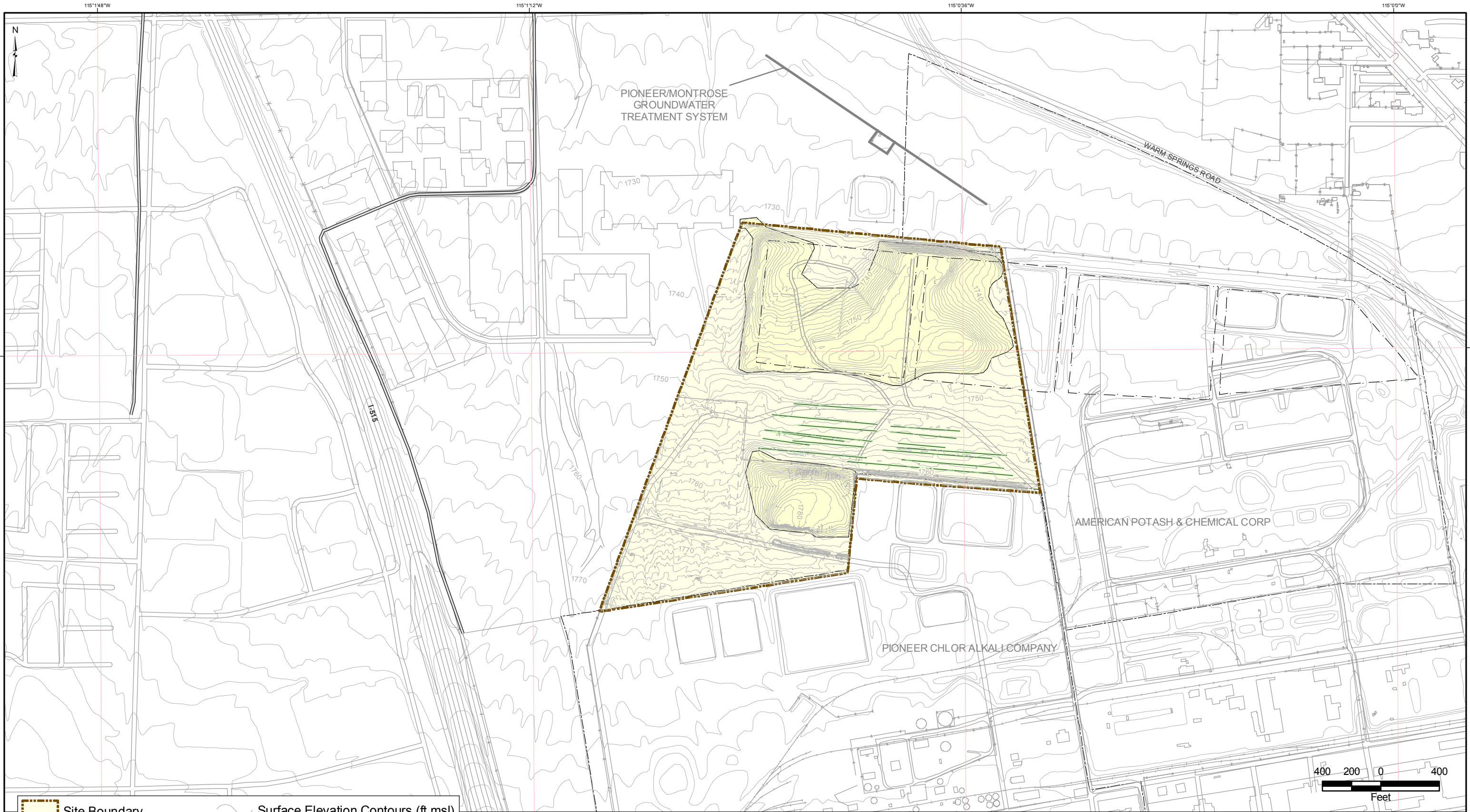
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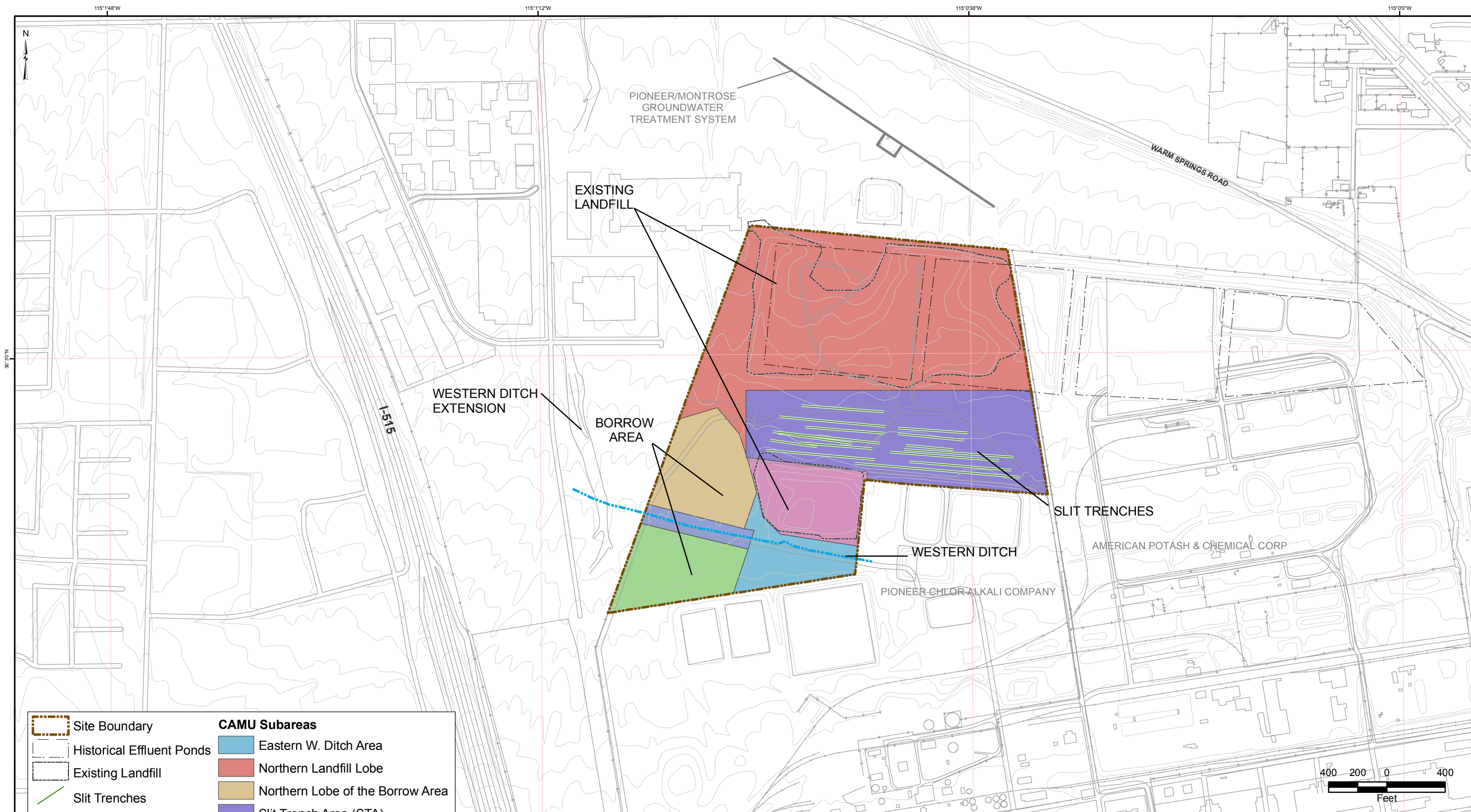


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JN ES05.0067



- Site Boundary
- Historical Effluent Ponds
- Existing Landfill
- Slit Trenches
- Surface Elevation Contours (ft msl)



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 1-3

SITE PLAN

Prepared by:
MWH

Date
10/16/06

JOB No. 1881425
FILE: GIS/BRC/CAMU/FIGURE_1-3.MXD

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- Site Boundary
- Existing Landfill
- Proposed Landfill

Current (Fall 2005) Aerial Photograph (from Clark County)

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

FIGURE 1-4
SITE BOUNDARY



Key to Quaternary Lithology

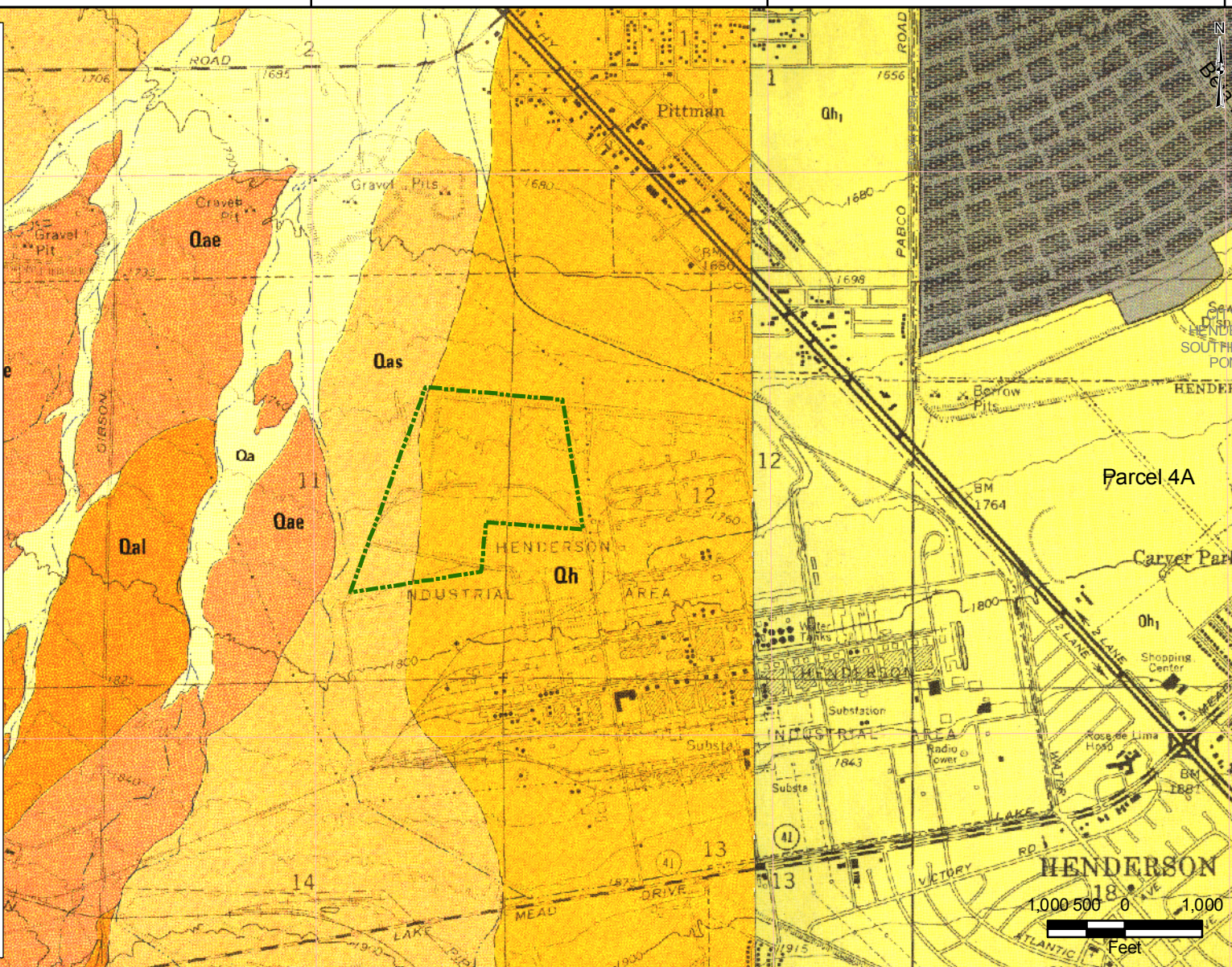
Qa = Thin alluvial deposits of uncemented and unweathered cobble to small pebble gravel, gravelly sand, sand, and silt. Locally cemented in modern washes by calcite cement.

Qae = Boulder to cobble sandy gravel and pebbly cobbly gravel composed gray to brown and light bluish-gray andesite, basalt, and limestone clasts. Weakly bedded and poorly sorted. Well-developed petrocalcic horizon at or near the top of the deposits.

Qal = Large boulder to cobble sandy gravel composed of greenish-brown, gray, and light bluish-gray andesite, and basaltic andesite. Average clast size greater than in the Qae. Very well developed petrocalcic horizon greater than 1 m thick near or at the top of the deposits; many individual clasts are rimmed with caliche rinds about 1cm thick.

Qas = Thin deposits of unconsolidated and weakly-bedded bouldery small-pebble gravel and muddy sandy gravel composed of about equal amount of bluish-gray to greenish-gray andesite and darkish-gray vesicular basalt; most clasts subrounded to subangular. Calcium carbonate caliche sparse to absent.

Qh = Moderately well-sorted, unconsolidated gray to pinkish-gray, medium pebble gravel composed almost entirely of gray, friable, sparsely porphyritic andesite. Weakly weathered, discontinuous horizons moderately cemented by calcium carbonate caliche.



Proposed CAMU

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

FIGURE 2-1

REGIONAL
GEOLOGIC MAP



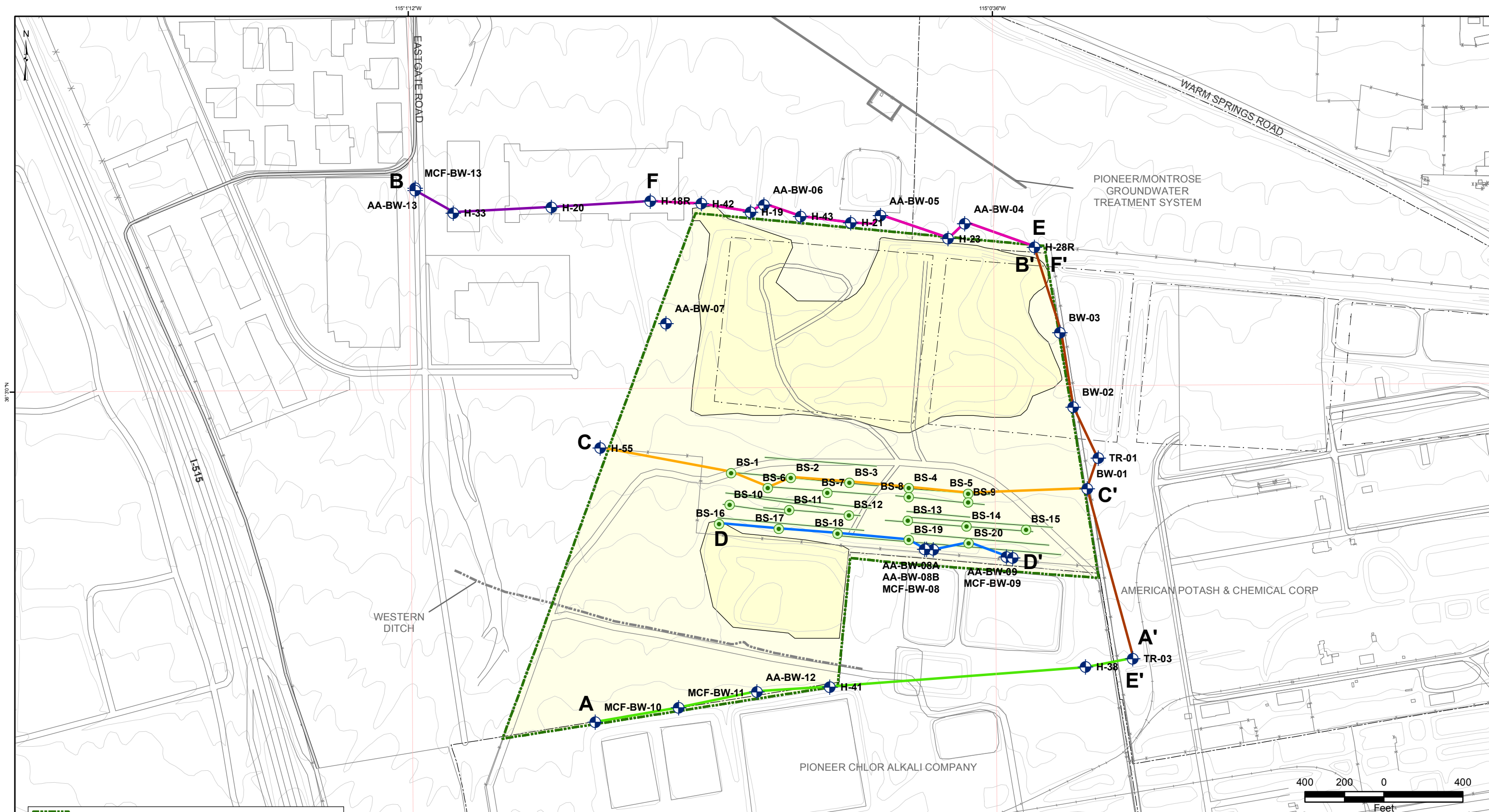
Daniel B. Stephens & Associates, Inc.

JN ES05.0067

Prepared by:
MWH MKJ

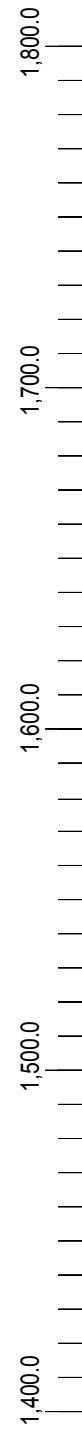
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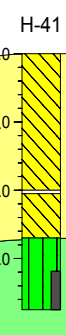
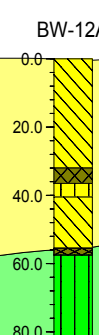
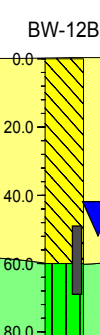
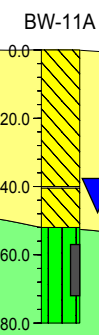
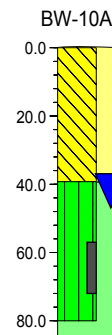


- Site Boundary
- Former Effluent Ponds
- Existing Landfill
- Slit Trenches
- Monitoring Well
- STA Soil Boring

Feet msl



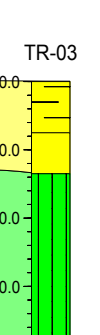
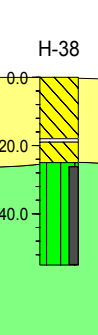
A



Qa

TMCf

A'



Feet msl



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

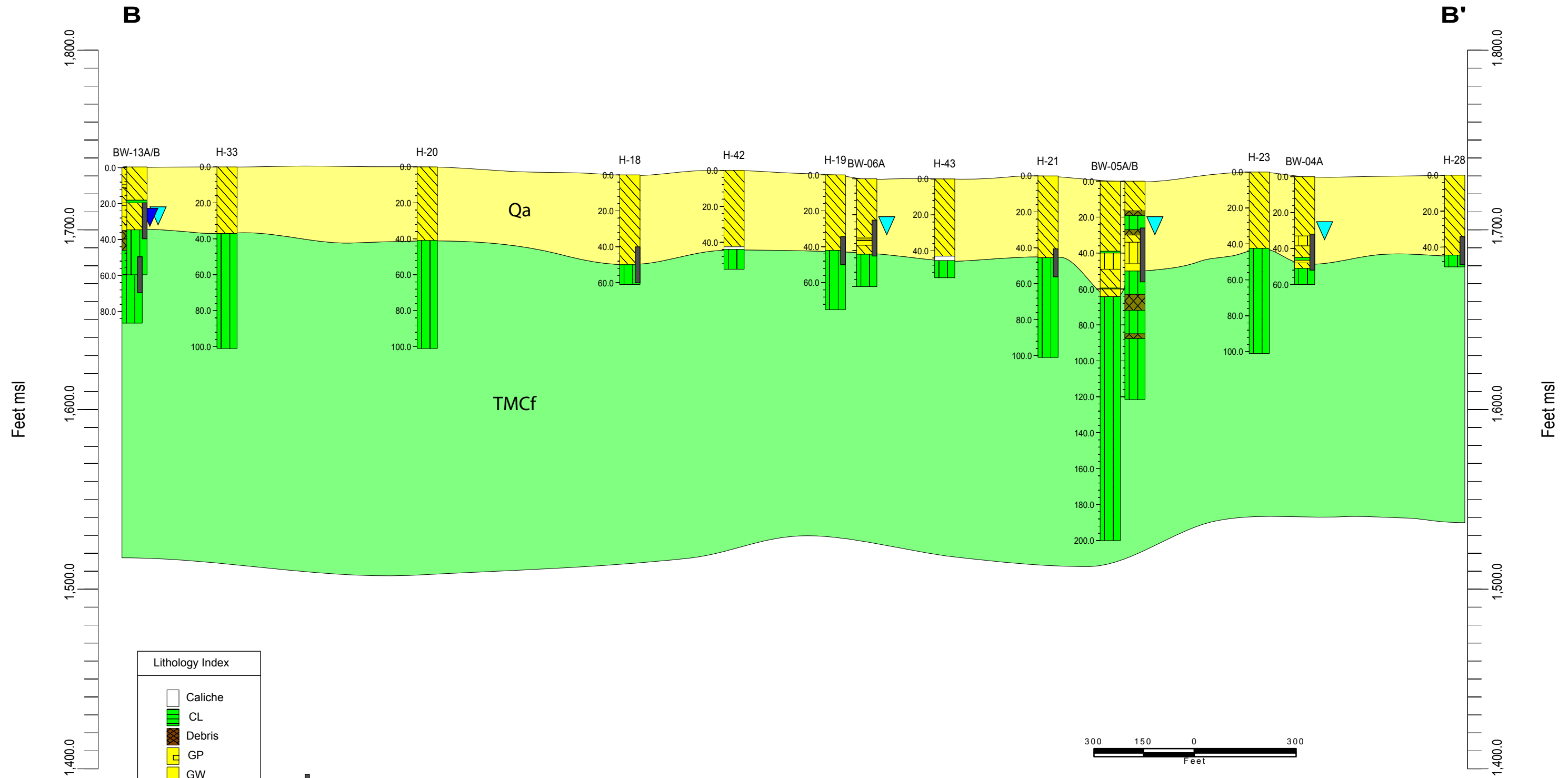
- = Screen Interval
- = Qa Water Level
- = UMCf Water Level

Vertical Scale = 4x Horizontal 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.





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

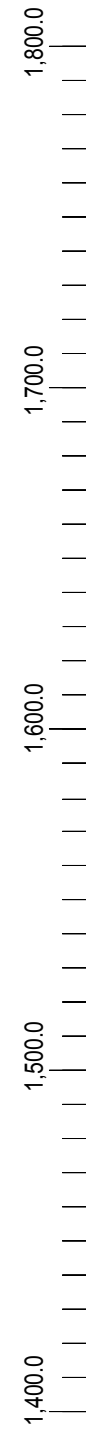
- = Screen Interval
- = Qa Water Level
- = UMCf Water Level

Vertical Scale = 4x Horizontal 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.

Corrective Action Management Unit (CAMU) BMI Complex, Henderson, Nevada		
FIGURE 2-4		
BRC CAMU AREA CROSS-SECTION B-B'		
Prepared by: MWH	Date: 10/16/06	JOB No. 1881425 FILE: GIS/BRC/CAMU/FIGURE_2-4.AI

Feet msl

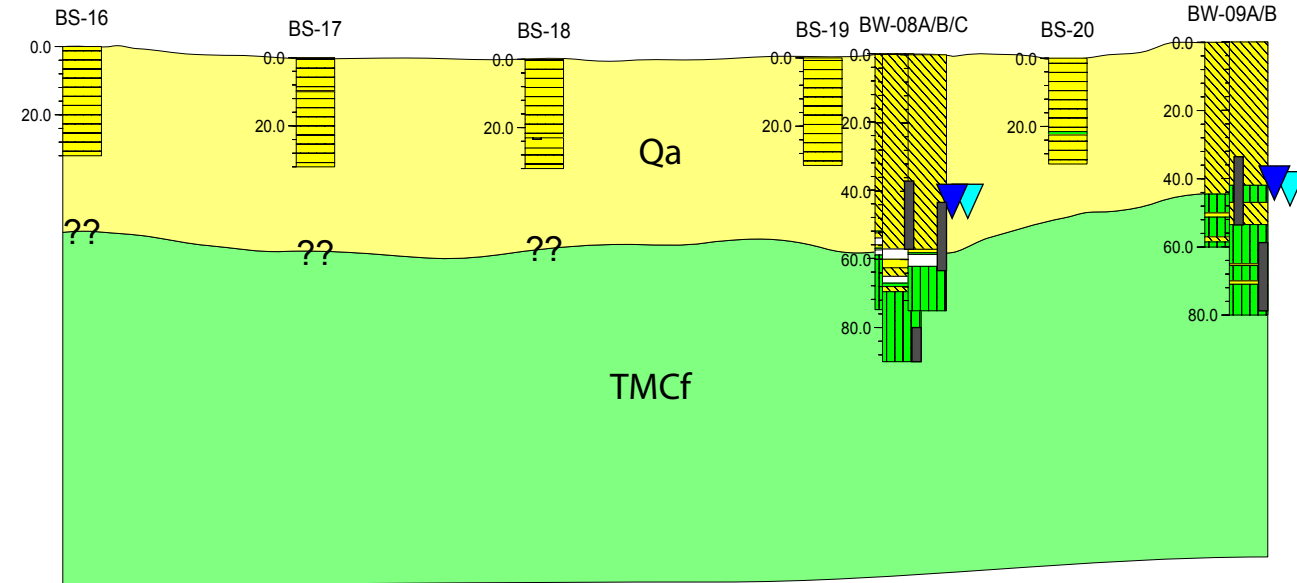


Lithology Index	
	Caliche
	CL
	Debris
	GP
	GW
	ML
	SC
	SM
	SM-ML
	SP
	SP-SM
	SW

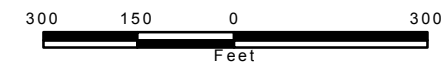
- = Screen Interval
- = Qa Water Level
- = UMCf Water Level

Vertical Scale = 4x Horizontal Scale
Qa = Quaternary alluvium
TMCf = Tertiary Muddy Creek formation

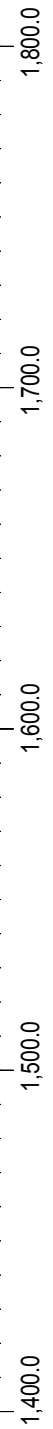
D



D'

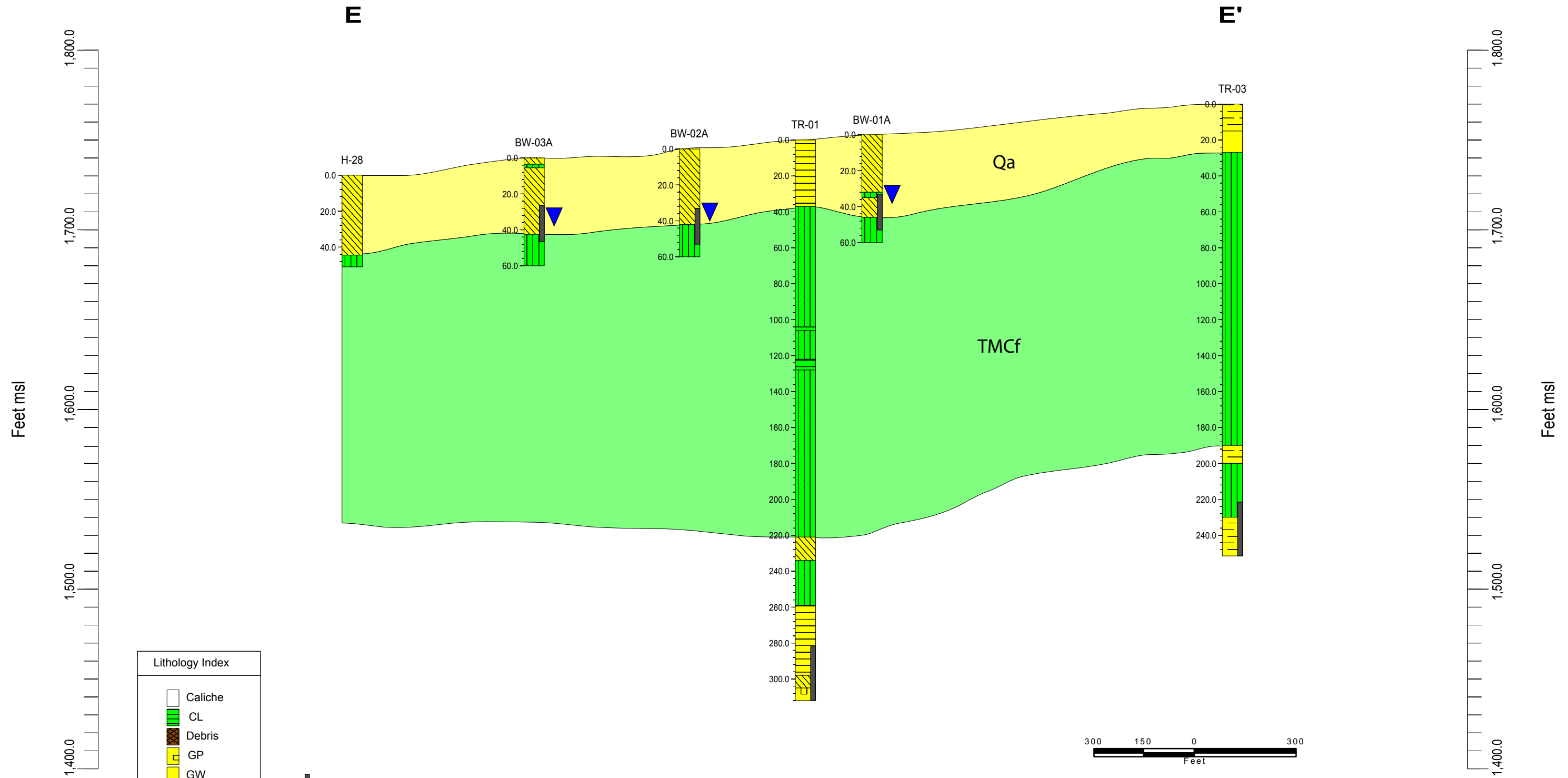


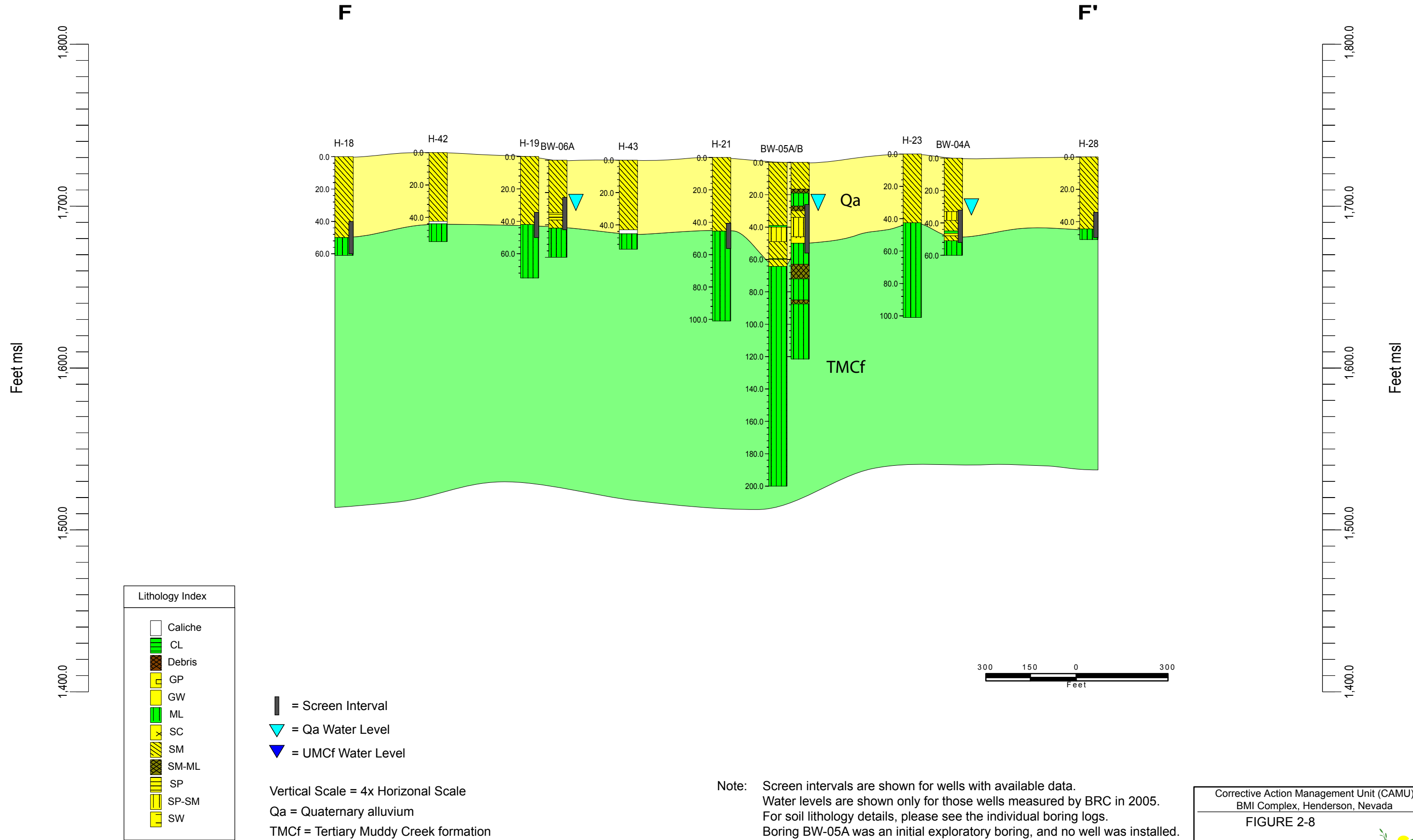
Feet msl

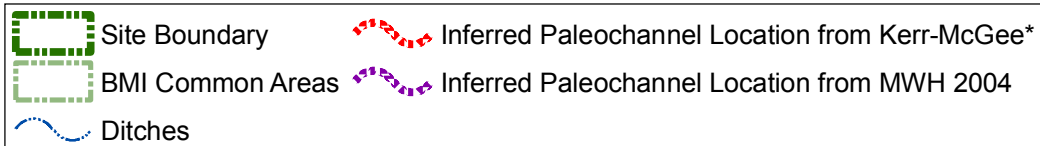
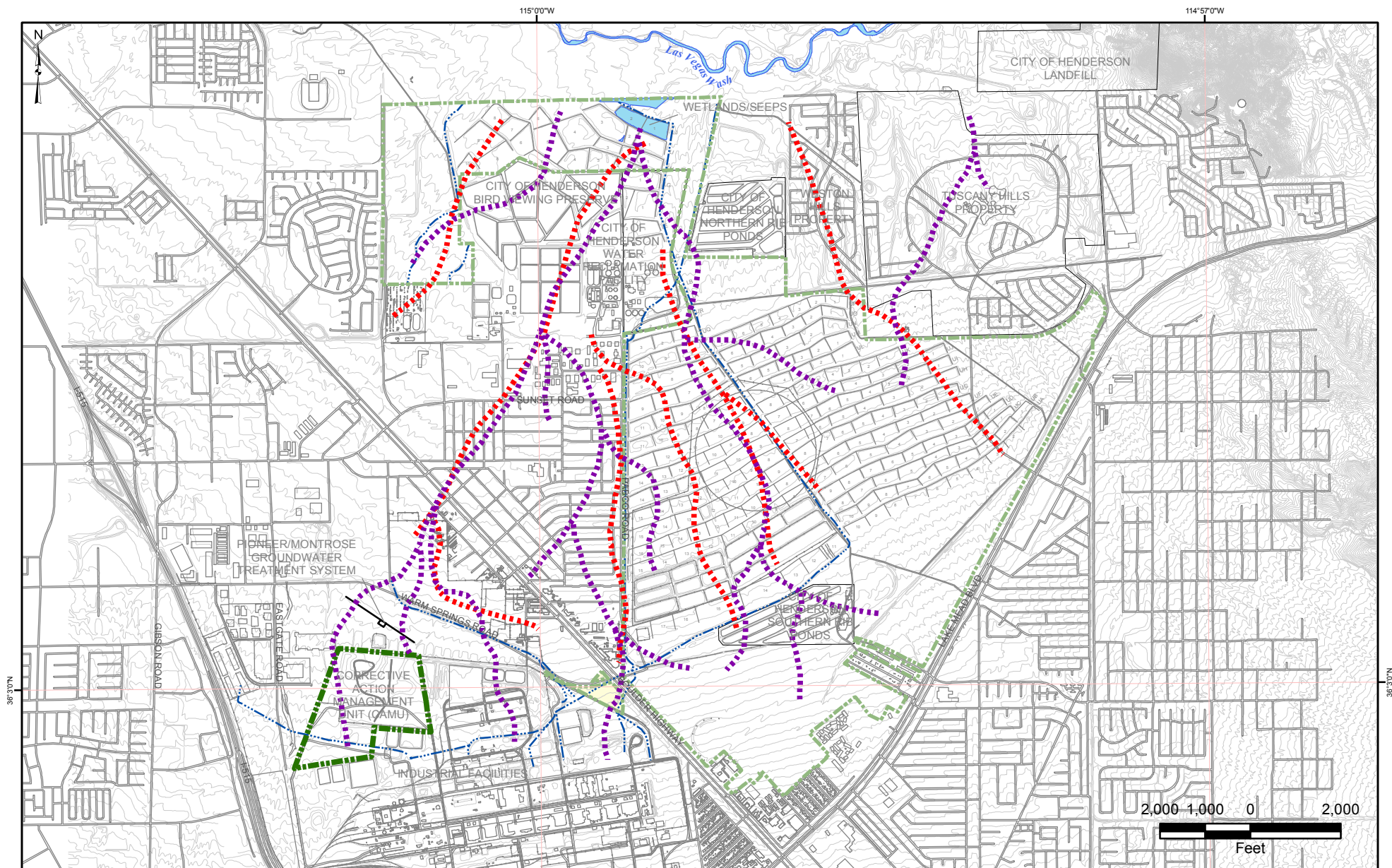


Note: Screen intervals are shown for wells with available data.
Water levels are shown only for those wells measured by BRC in 2005.
For soil lithology details, please see the individual boring logs.









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

FIGURE 2-9

INFERRED
PALEOCHANNELS



*From Kerr-McGee Phase II Ground Water
Perchlorate Investigation Report. July 1998.



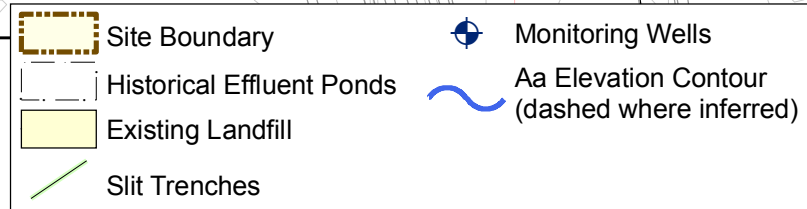
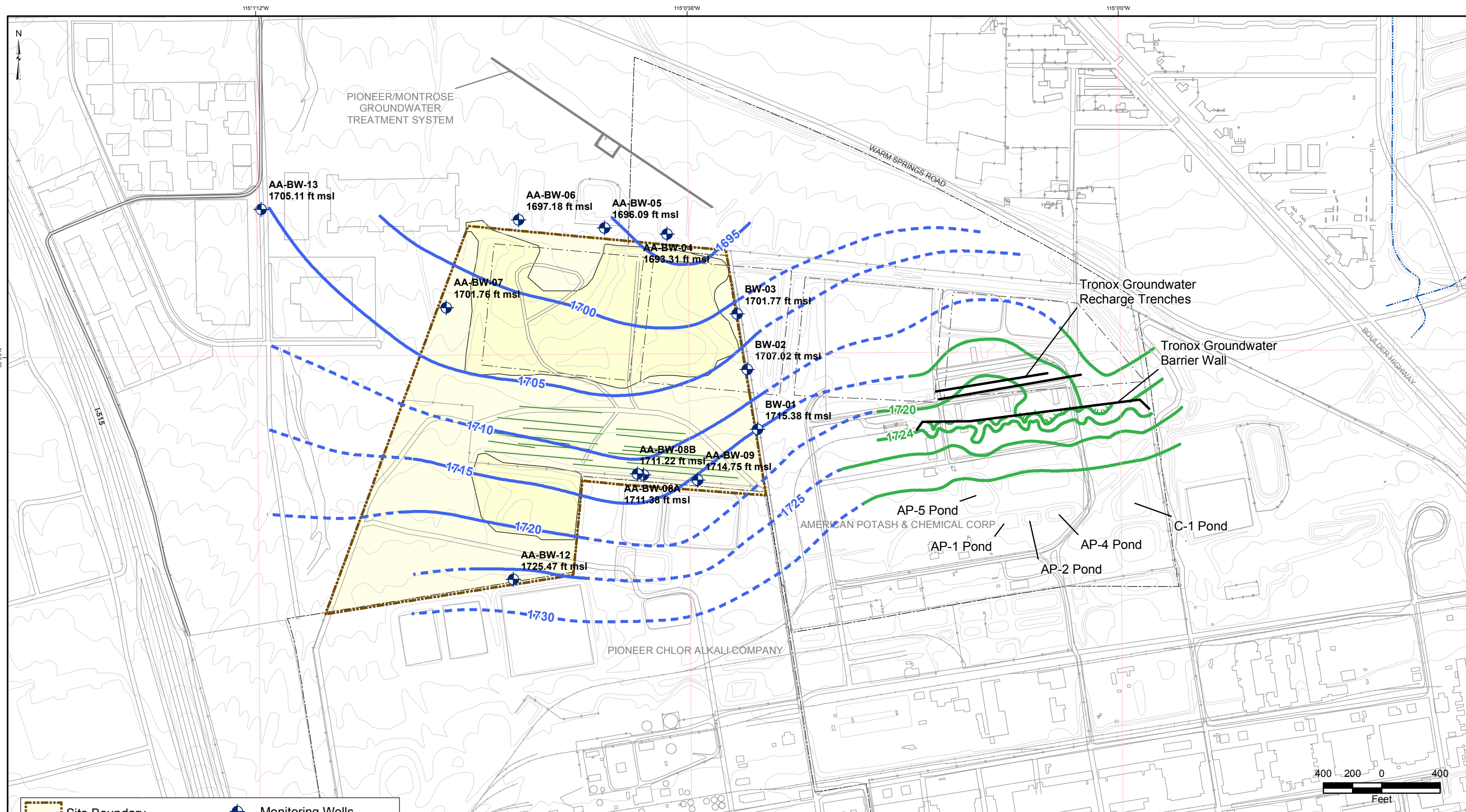
Daniel B. Stephens & Associates, Inc.

JN ES05.0067

Prepared by:
MWH MKJ

Date
10/16/06

JOB No. 1881425
FILE: GIS/BRO/CAMU/FIGURE_2-9.MXD



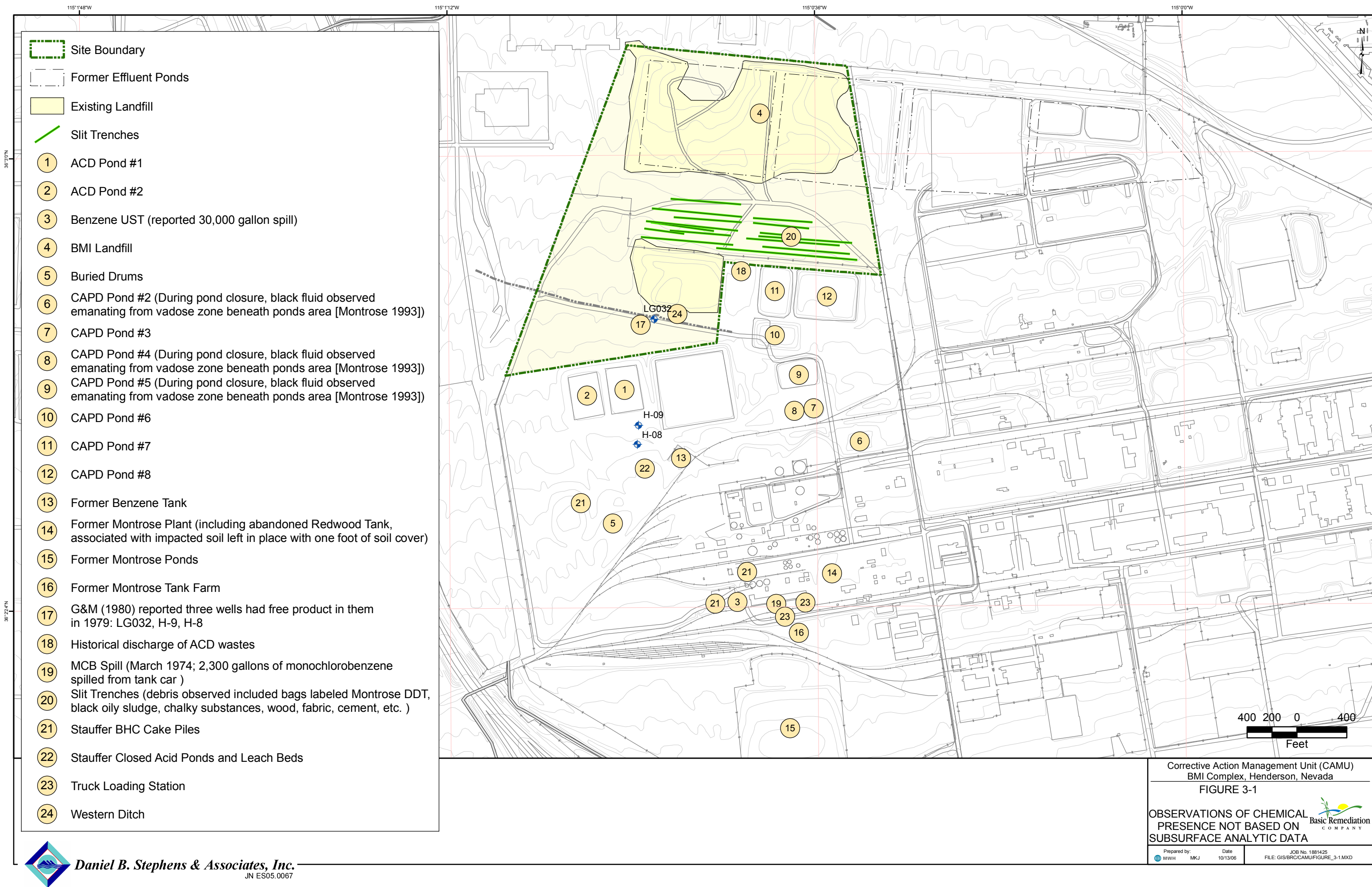
Notes:
 All data are elevations in feet above mean sea level (msl).
 Contours in blue are from measurements made April 2005 (MWH, July 2005).
 Contours in green are from measurements made in May 2006 (Tronox, July 2006).

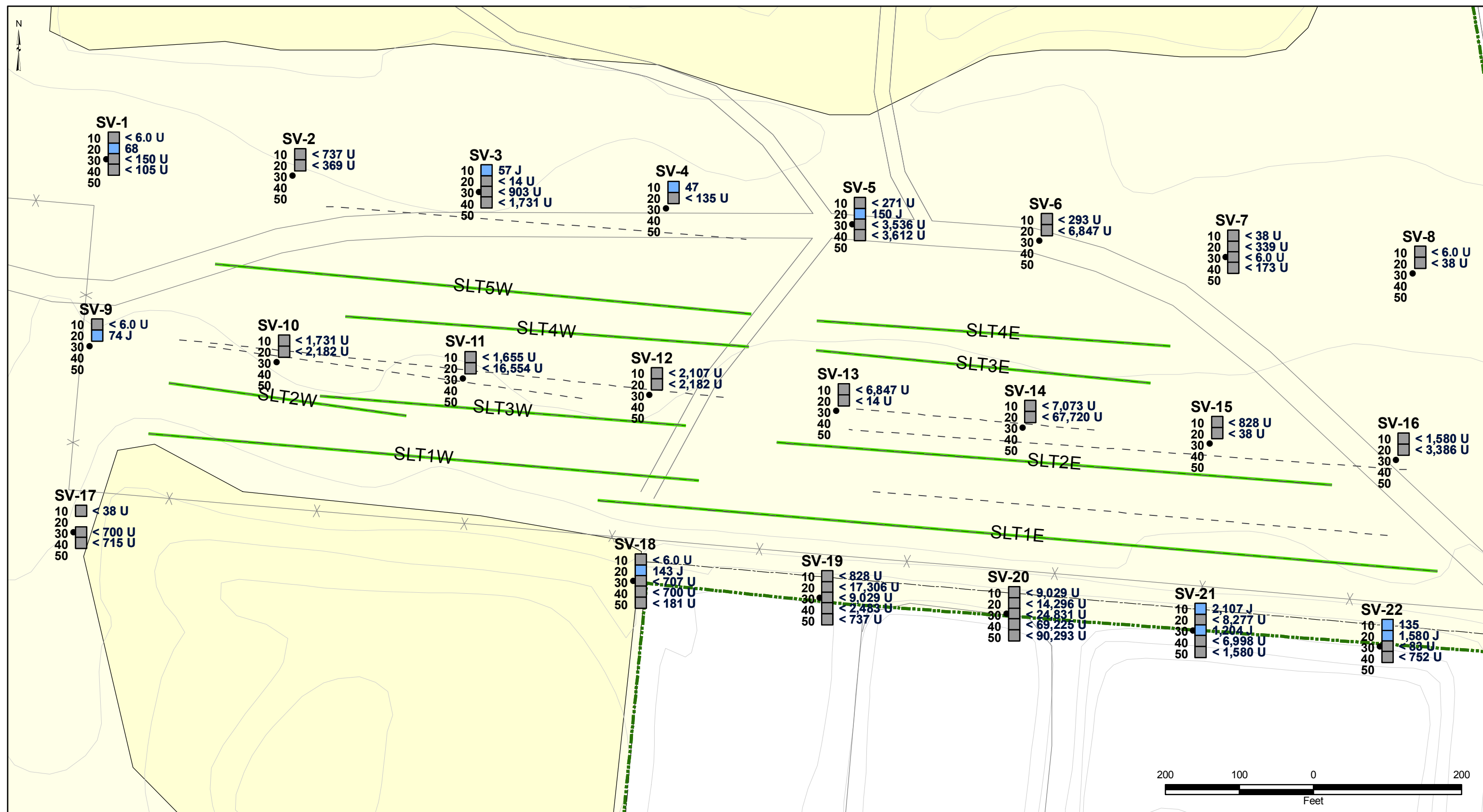
Corrective Action Management Unit (CAMU)
 BMI Complex, Henderson, Nevada
FIGURE 2-10

**POTENTIOMETRIC
 SURFACE MAP,
 ALLUVIAL AQUIFER**



Prepared by: MWH Date: 10/16/06
 JOB No. 1881425
 FILE: GIS/BRC/CAMU/WATER_ELEV.MXD





Soil Vapor Concentration

- Not Detected
- Not Detected (DL Exceeds OSHA PEL)
- ≤ 300,000 µg/m³ (OSHA PEL*)
- > 300,000 µg/m³

Sample Depth

- 10 ft bgs
- 20 ft bgs
- 30 ft bgs
- 40 ft bgs
- 50 ft bgs

- - - Line Features Identified in Historical Aerials but Not Verified with Geophysics
- Slit Trench Identified from Historical Aerials and Verified with Geophysics

*Note: An OSHA PEL has not been established for 1,2,4-trichlorobenzene. The value used is that for 1,2-dichlorobenzene.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Vapor Screening Value (based on OSHA PEL) = 300,000 µg/m³
(Maximum Soil Vapor Concentration = 2,107 µg/m³)

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

FIGURE 5-1 1,2,4-TRICHLOROBENZENE SOIL VAPOR SAMPLING RESULTS



Prepared by:
MWW MKJ

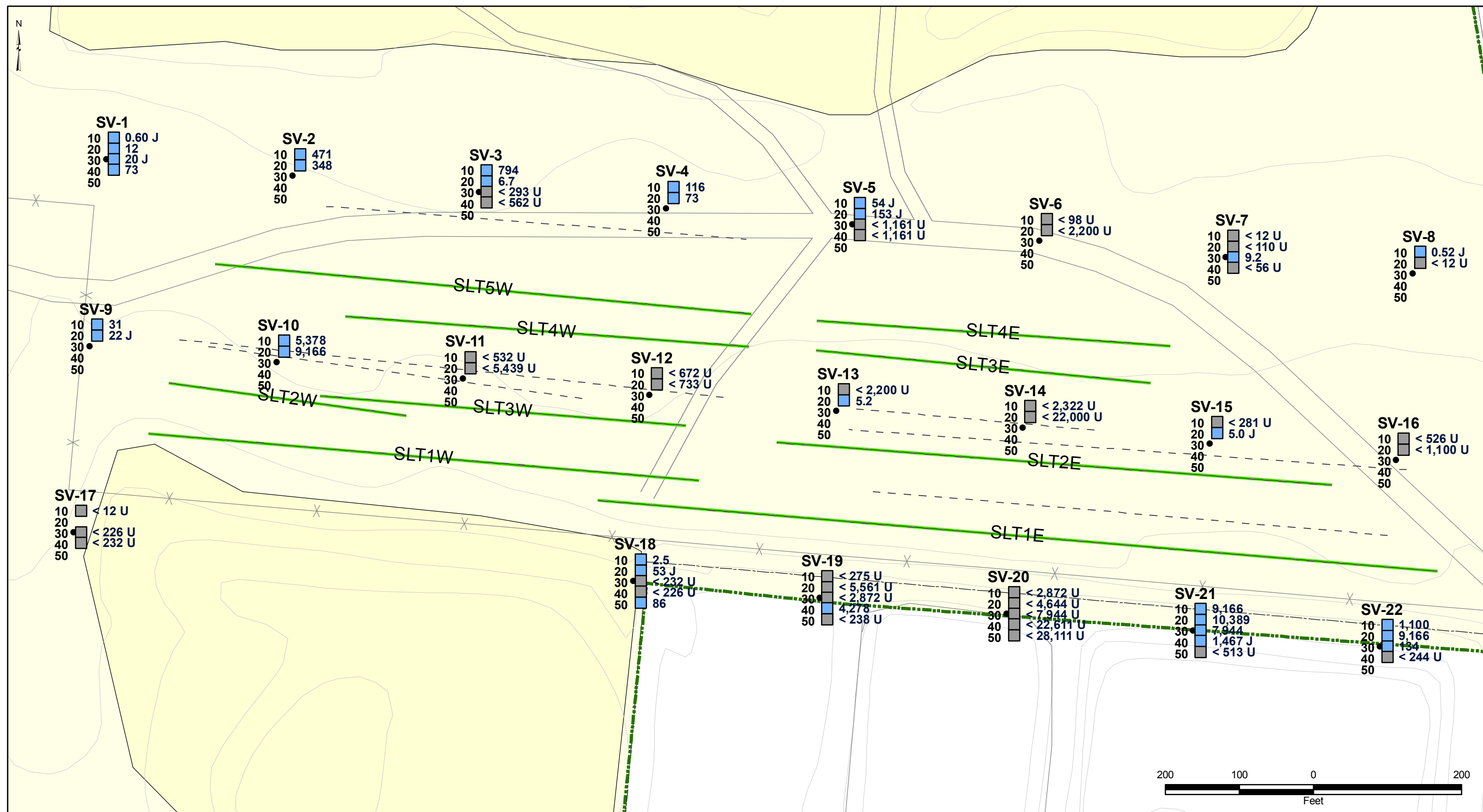
Date:
10/20/06

JOB No. 1881426
FILE: GIS/BRC/2005_CAMU/SV_PLOTS.MXD



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JN ES05.0067



Soil Vapor Concentration

- Not Detected
- Not Detected (DL Exceeds OSHA PEL)
- $\leq 300,000 \mu\text{g}/\text{m}^3$ (OSHA PEL)
- $> 300,000 \mu\text{g}/\text{m}^3$

Sample Depth

- 10 ft bgs
- 20 ft bgs
- 30 ft bgs
- 40 ft bgs
- 50 ft bgs

Line Features Identified in Historical Aerials but Not Verified with Geophysics

Slit Trench Identified from Historical Aerials and Verified with Geophysics

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Vapor Screening Value (based on OSHA PEL) = $300,000 \mu\text{g}/\text{m}^3$
(Maximum Soil Vapor Concentration = $10,389 \mu\text{g}/\text{m}^3$)

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

FIGURE 5-2

1,2-DICHLOROBENZENE
SOIL VAPOR
SAMPLING RESULTS



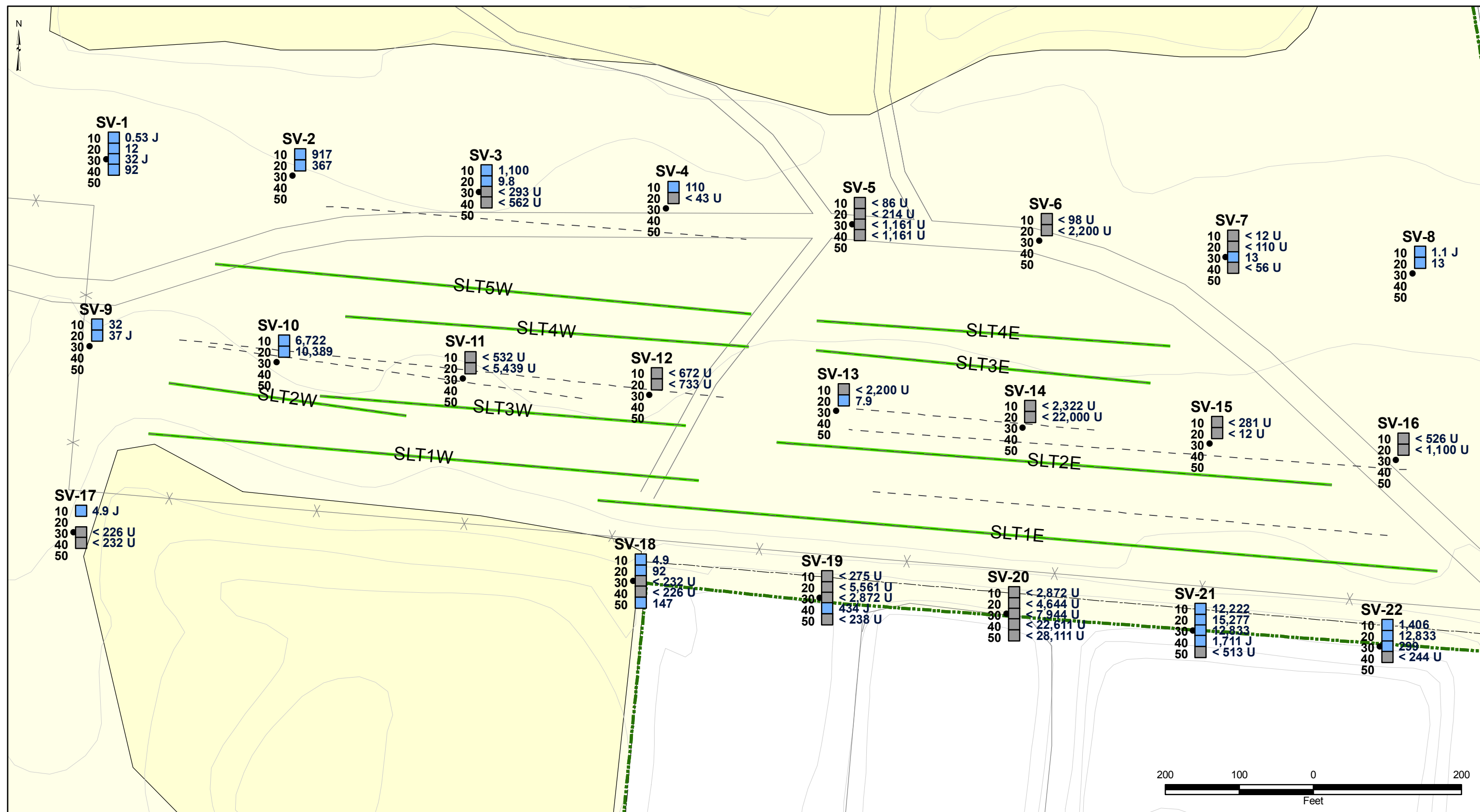
Daniel B. Stephens & Associates, Inc.

JN ES05.0067

Prepared by:
MWH MKJ

Date:
10/20/06

JOB No. 1881426
FILE: GIS/BRC/2005_CAMU/SV_PLOTS.MXD



Soil Vapor Concentration

- Not Detected
- Not Detected (DL Exceeds OSHA PEL)
- $\leq 450,000 \mu\text{g}/\text{m}^3$ (OSHA PEL)
- $> 450,000 \mu\text{g}/\text{m}^3$

Sample Depth

- 10 ft bgs
- 20 ft bgs
- 30 ft bgs
- 40 ft bgs
- 50 ft bgs

- Line Features Identified in Historical Aerials but Not Verified with Geophysics
- Slit Trench Identified from Historical Aerials and Verified with Geophysics

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Vapor Screening Value (based on OSHA PEL) = $450,000 \mu\text{g}/\text{m}^3$
(Maximum Soil Vapor Concentration = $15,277 \mu\text{g}/\text{m}^3$)

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

FIGURE 5-3

1,4-DICHLOROBENZENE
SOIL VAPOR
SAMPLING RESULTS



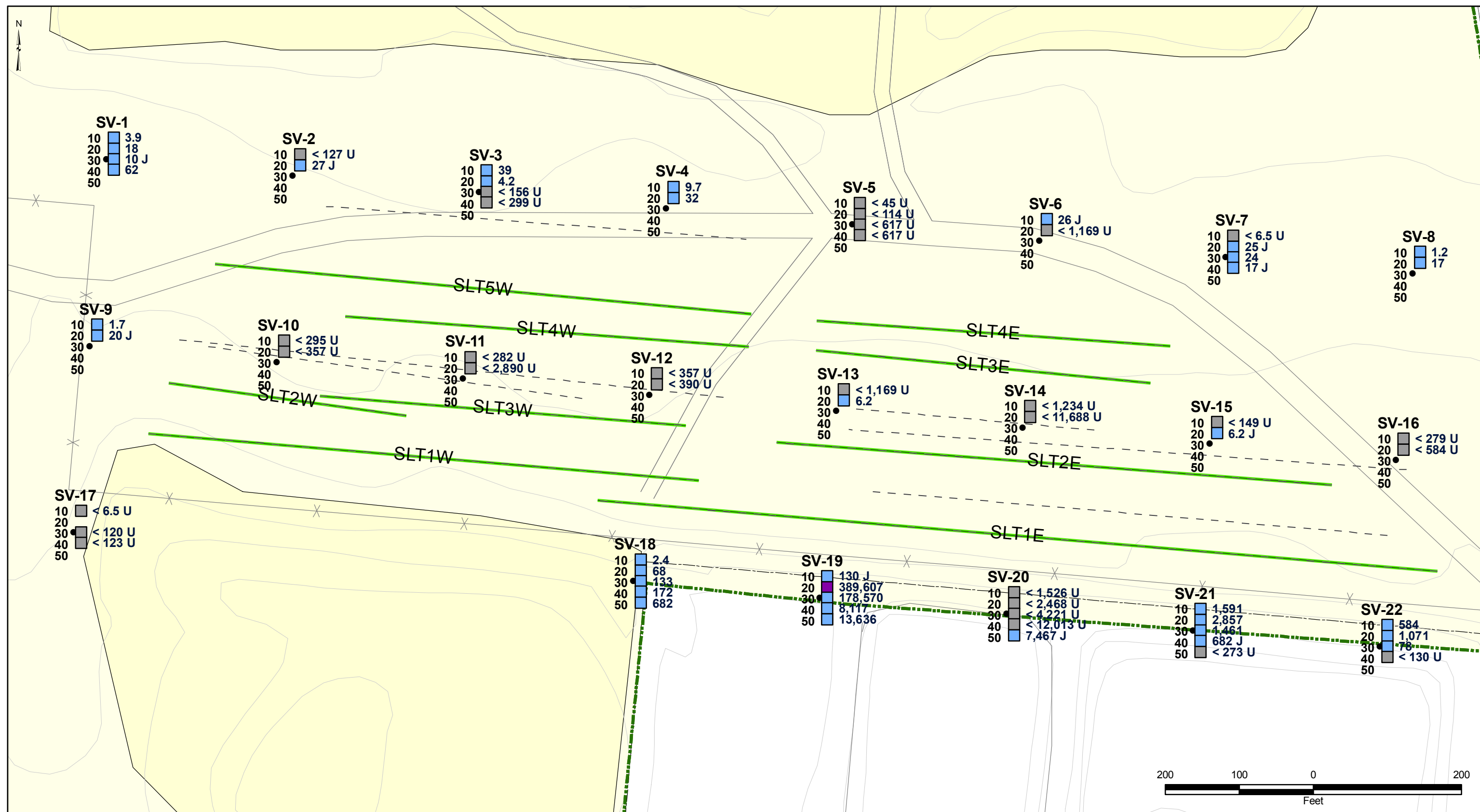
Daniel B. Stephens & Associates, Inc.

JN ES05.0067

Prepared by:
MWH MKJ

Date:
10/20/06

JOB No. 1881426
FILE: GIS/BRC/2005_CAMU/SV_PLOTS.MXD



Soil Vapor Concentration

- Not Detected
- Not Detected (DL Exceeds OSHA PEL)
- $\leq 32,425 \mu\text{g}/\text{m}^3$ (OSHA PEL)
- $> 32,425 \mu\text{g}/\text{m}^3$

Sample Depth

- 10 ft bgs
- 20 ft bgs
- 30 ft bgs
- 40 ft bgs
- 50 ft bgs

- Line Features Identified in Historical Aerials but Not Verified with Geophysics
- Slit Trench Identified from Historical Aerials and Verified with Geophysics

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Vapor Screening Value (based on OSHA PEL) = $32,425 \mu\text{g}/\text{m}^3$
(Maximum Soil Vapor Concentration = $389,607 \mu\text{g}/\text{m}^3$)

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

FIGURE 5-4

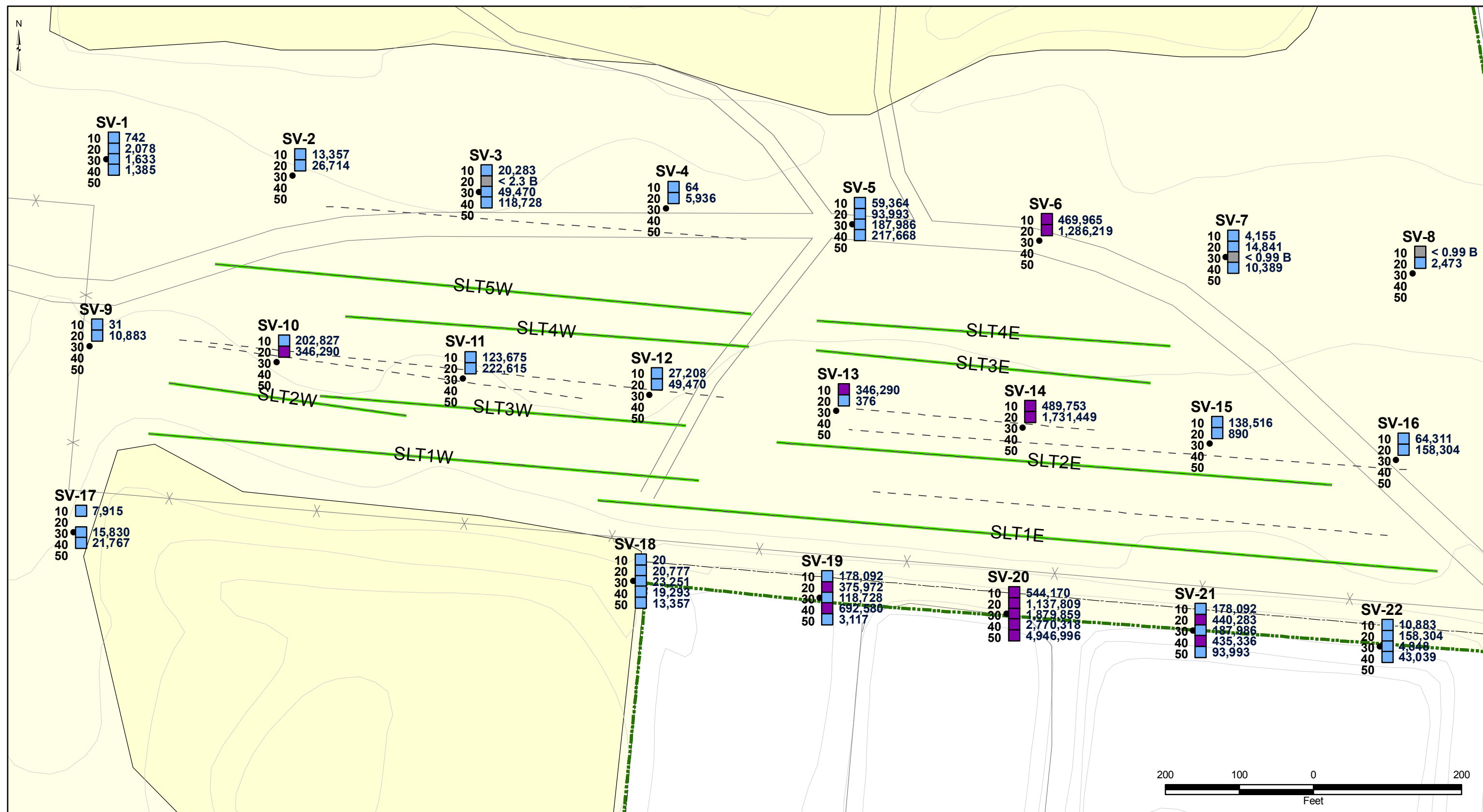
BENZENE SOIL VAPOR SAMPLING RESULTS



Prepared by:
MWH MKJ

Date:
10/20/06

JOB No. 1881426
FILE: GIS/BRC/2005_CAMU/SV_PLOTS.MXD



Soil Vapor Concentration

- Not Detected
- Not Detected (DL Exceeds OSHA PEL)
- $\leq 248,000 \mu\text{g}/\text{m}^3$ (OSHA PEL)
- $> 248,000 \mu\text{g}/\text{m}^3$

Sample Depth

- 10 ft bgs
- 20 ft bgs
- 30 ft bgs
- 40 ft bgs
- 50 ft bgs

- Line Features Identified in Historical Aerials but Not Verified with Geophysics
- Slit Trench Identified from Historical Aerials and Verified with Geophysics

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Vapor Screening Value (based on OSHA PEL) = $248,000 \mu\text{g}/\text{m}^3$
(Maximum Soil Vapor Concentration = $4,946,996 \mu\text{g}/\text{m}^3$)

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

FIGURE 5-5

CHLOROFORM SOIL VAPOR SAMPLING RESULTS



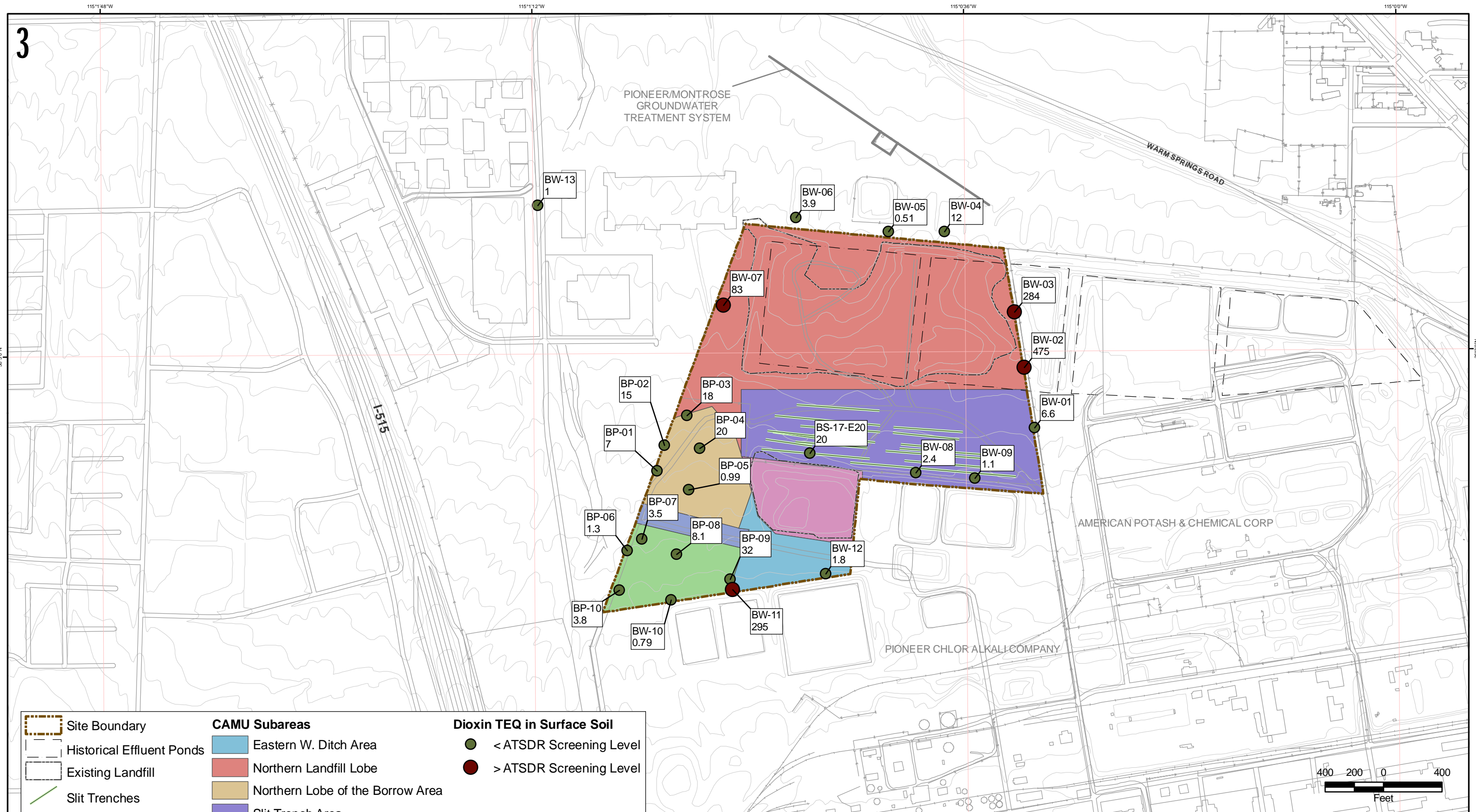
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JN ES05.0067

Prepared by:
MWH

Date:
10/20/06

JOB No. 1881426
FILE: GIS/BRC/2005_CAMU/SV_PLOTS.MXD



Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Dioxin TEQ in Surface Soil

< ATSDR Screening Level

> ATSDR Screening Level

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pg/g.

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

FIGURE 5-6

**TCCDD TEQs
IN SURFACE SOIL
(0 TO 1 FT BGS)**

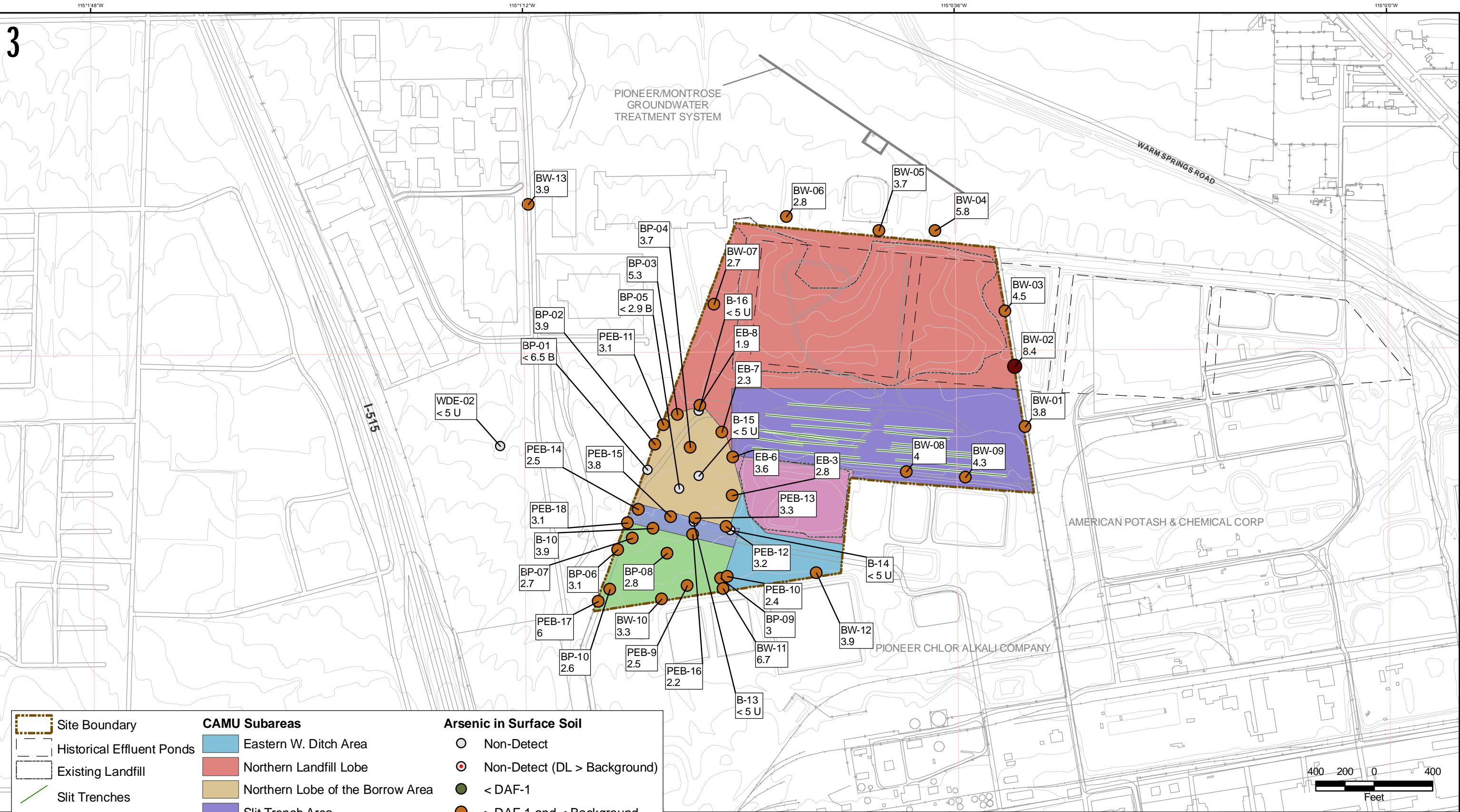
Prepared by:
MWH

Date
01/30/07

Job No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD

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JN ES05.0067



Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Arsenic in Surface Soil

Non-Detect

Non-Detect (DL > Background)

< DAF-1

> DAF-1 and < Background

> Background

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

FIGURE 5-7

ARSENIC
IN SURFACE SOIL
(0 TO 1 FT BGS)

Prepared by:
MWH

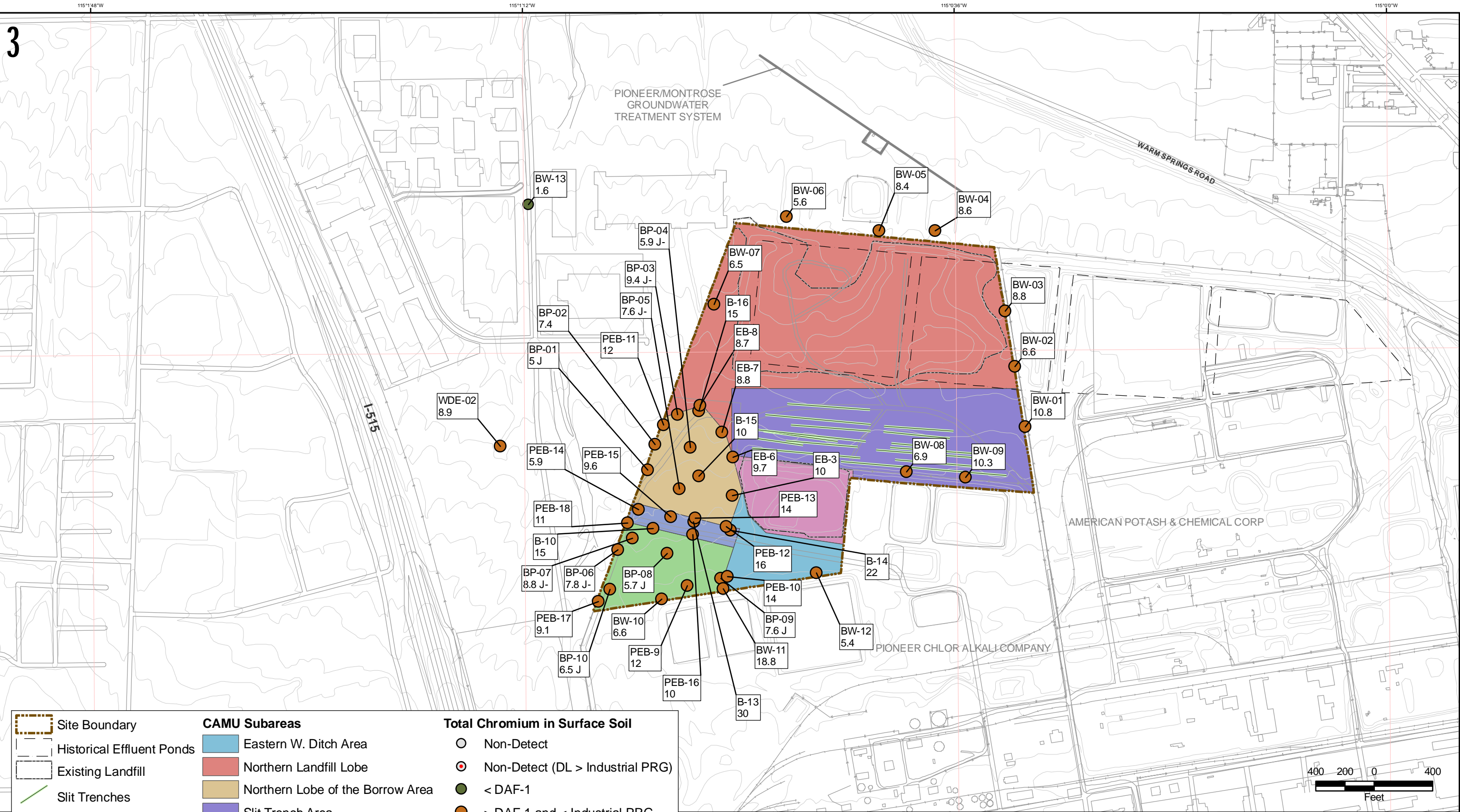
Date
01/30/07

Job No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD

Basic Remediation
COMPANY

Daniel B. Stephens & Associates, Inc.

JN ES05.0067



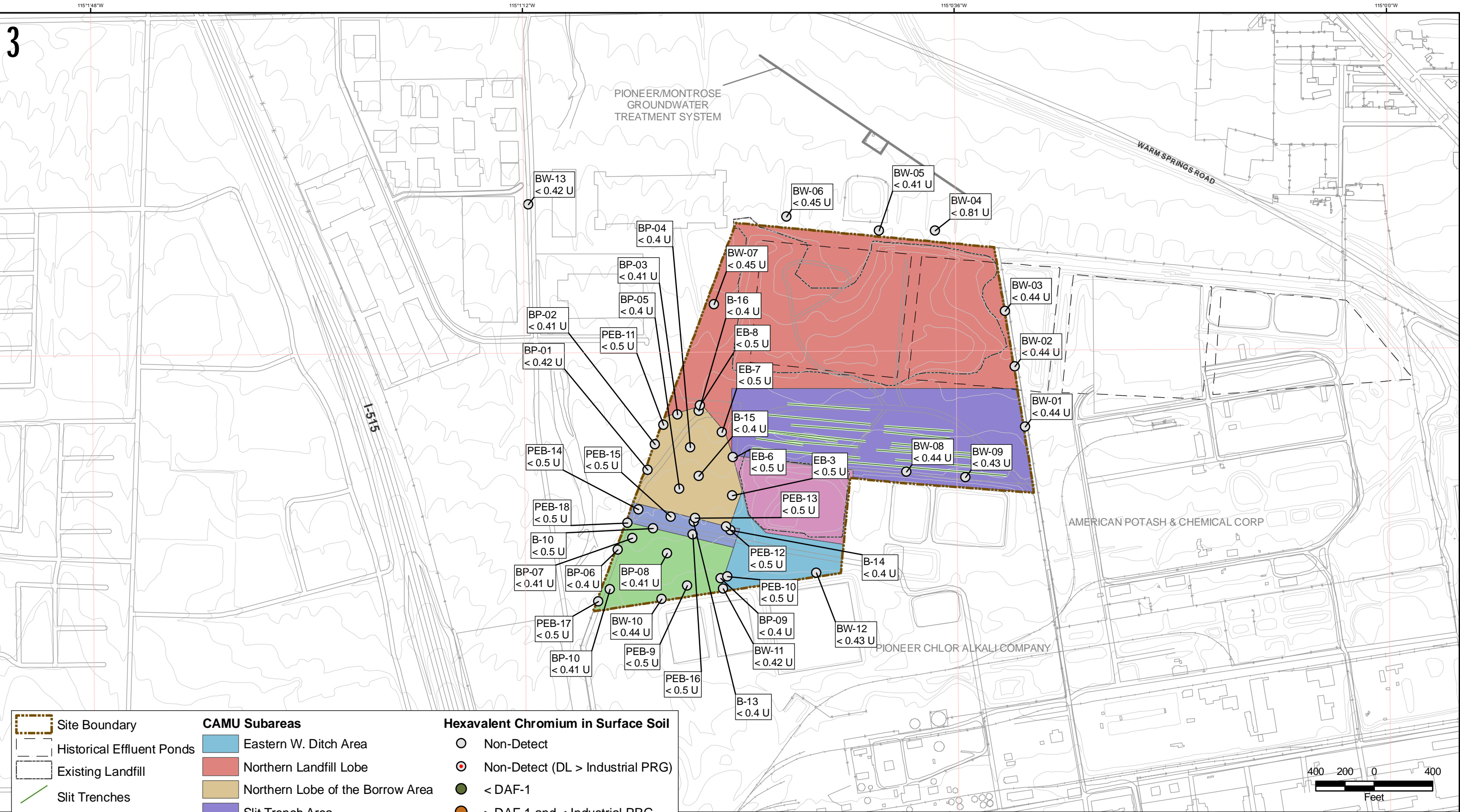
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

FIGURE 5-8

**TOTAL CHROMIUM
IN SURFACE SOIL
(0 TO 1 FT BGS)**





Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Hexavalent Chromium in Surface Soil

Non-Detect

Non-Detect (DL > Industrial PRG)

< DAF-1

> DAF-1 and < Industrial PRG

> Industrial PRG

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

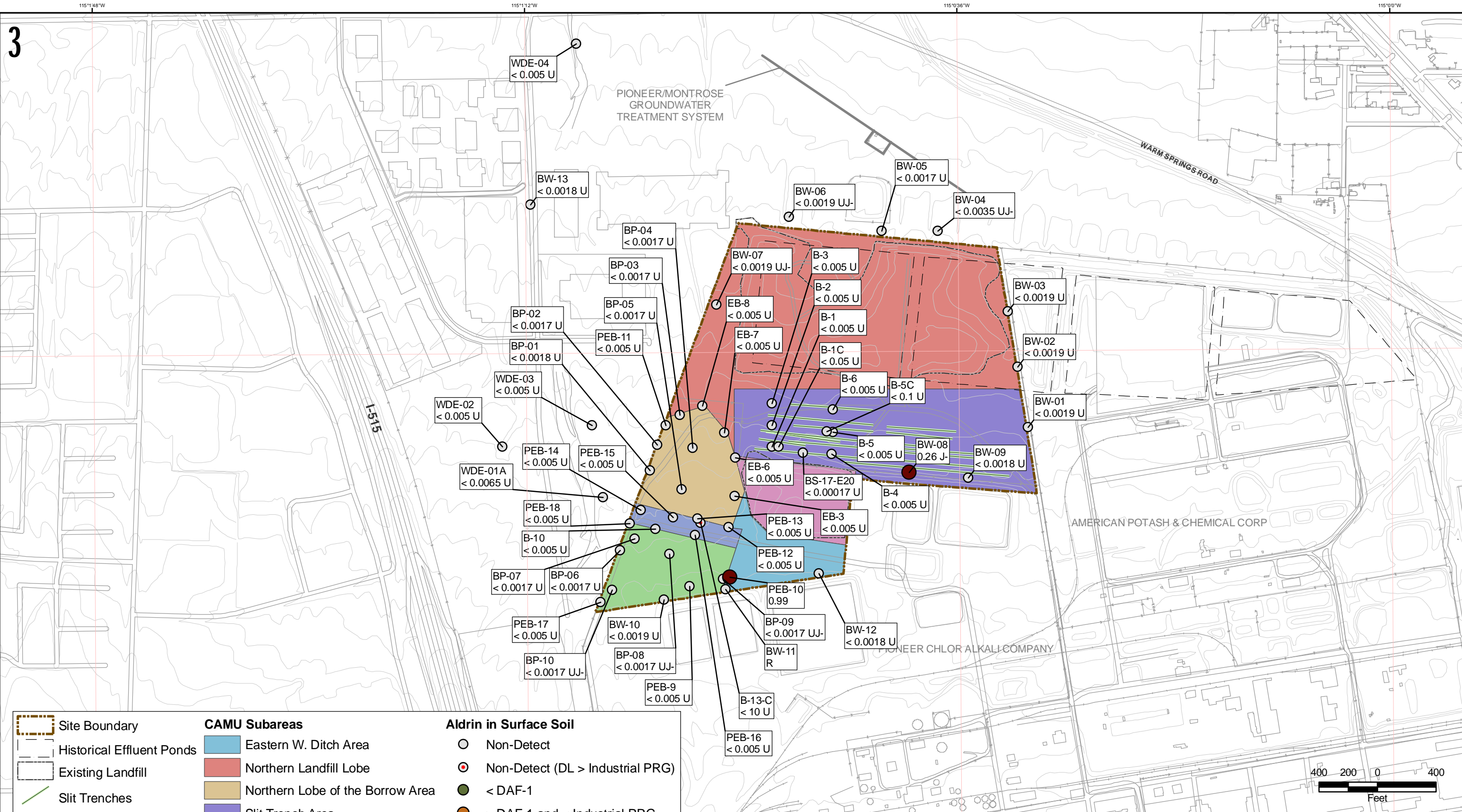
FIGURE 5-9

**HEXAVALENT CHROMIUM
IN SURFACE SOIL
(0 TO 1 FT BGS)**

Prepared by:
MWW

Date
01/30/07

JOB No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD



Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Aldrin in Surface Soil

Non-Detect

Non-Detect (DL > Industrial PRG)

< DAF-1

> DAF-1 and < Industrial PRG

> Industrial PRG

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

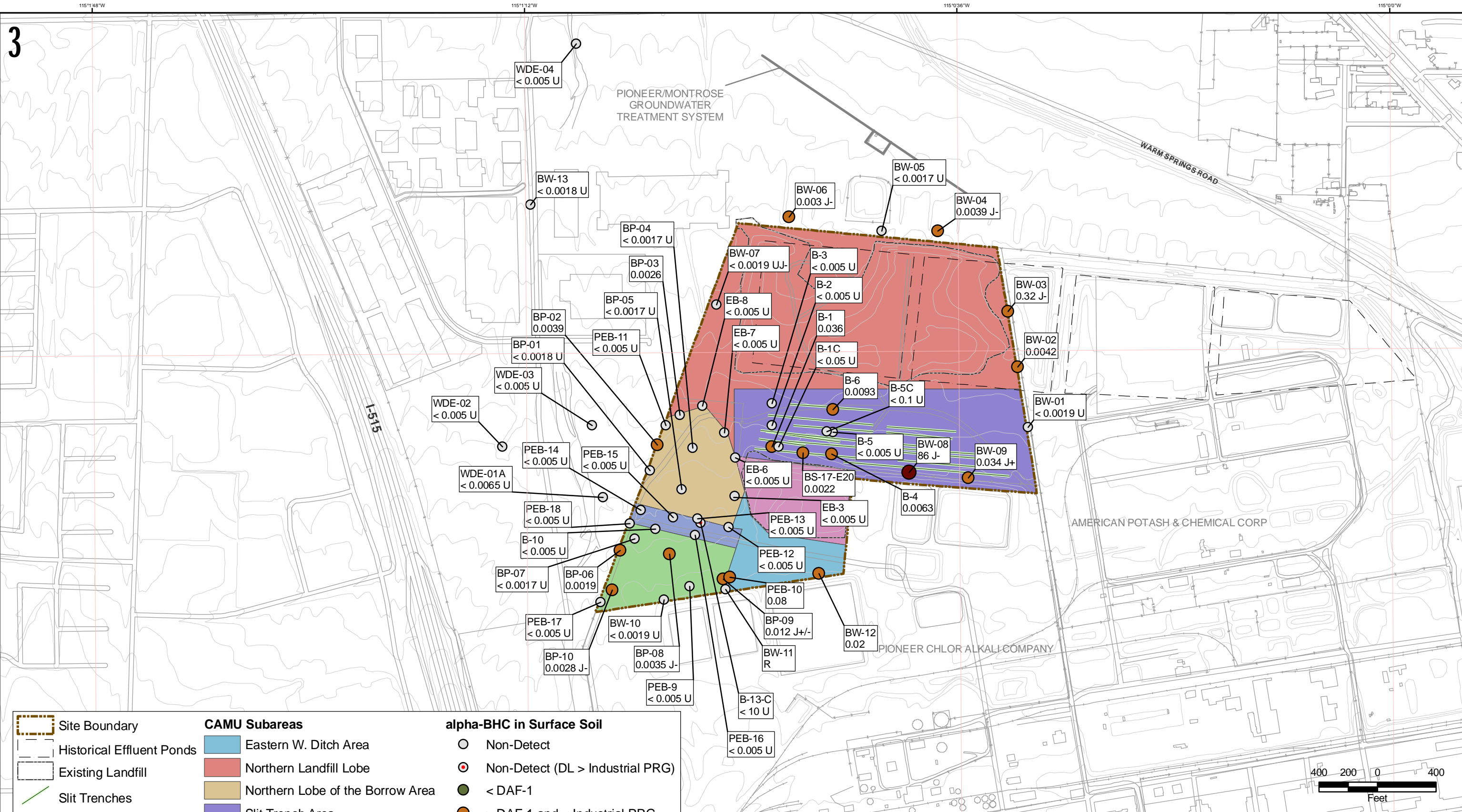
FIGURE 5-10

ALDRIN
IN SURFACE SOIL
(0 TO 1 FT BGS)

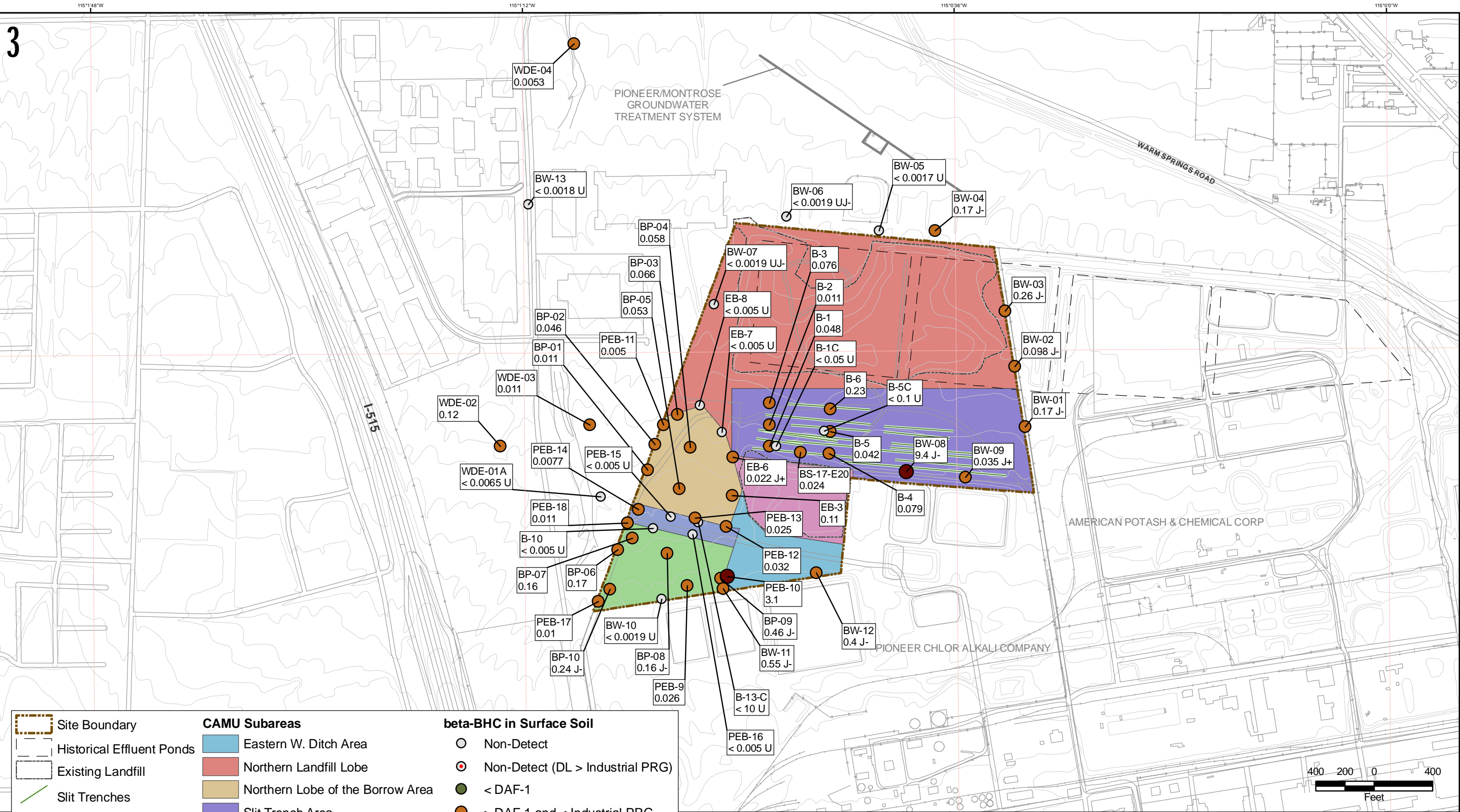
Prepared by:
MWH

Date:
01/30/07

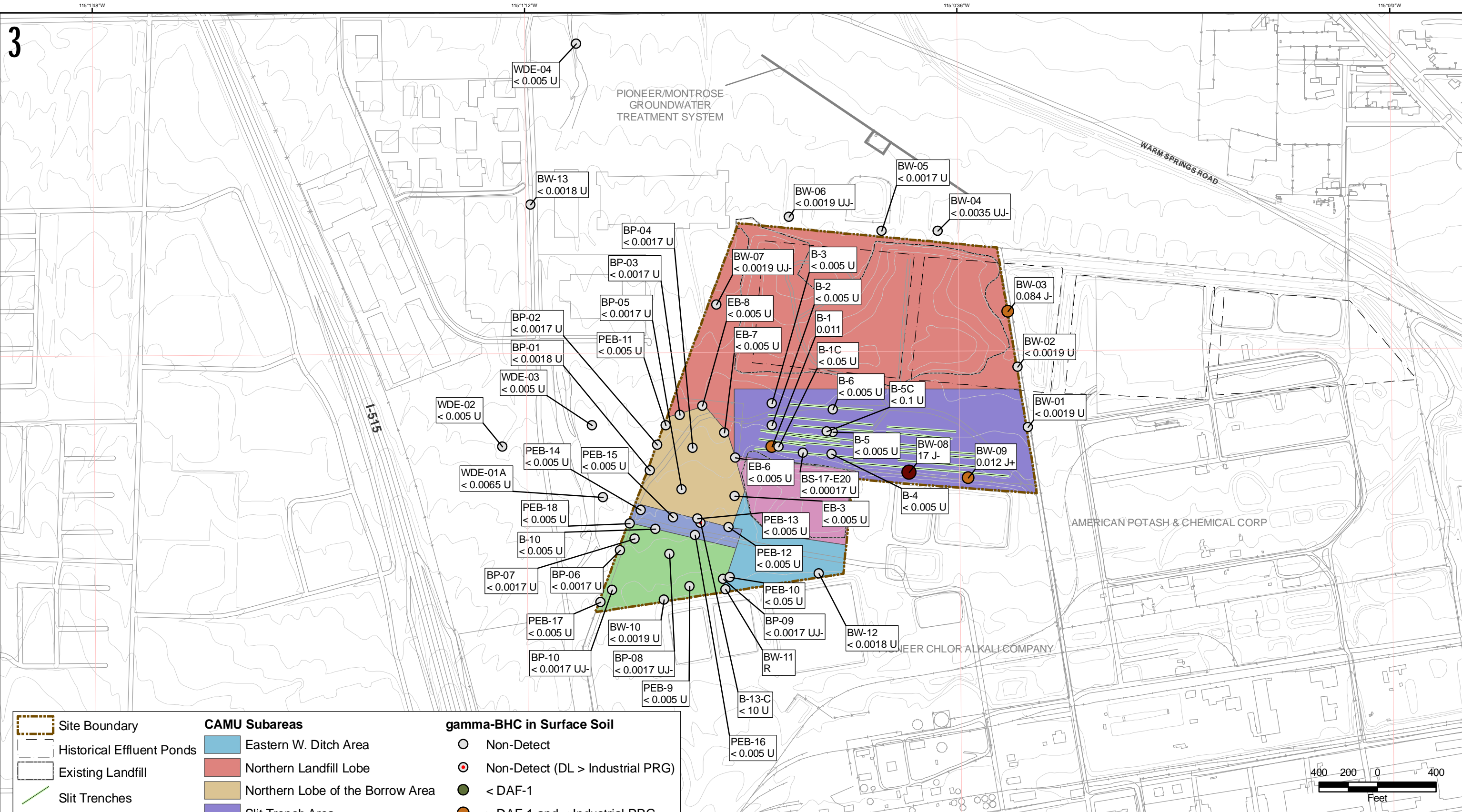
Job No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD



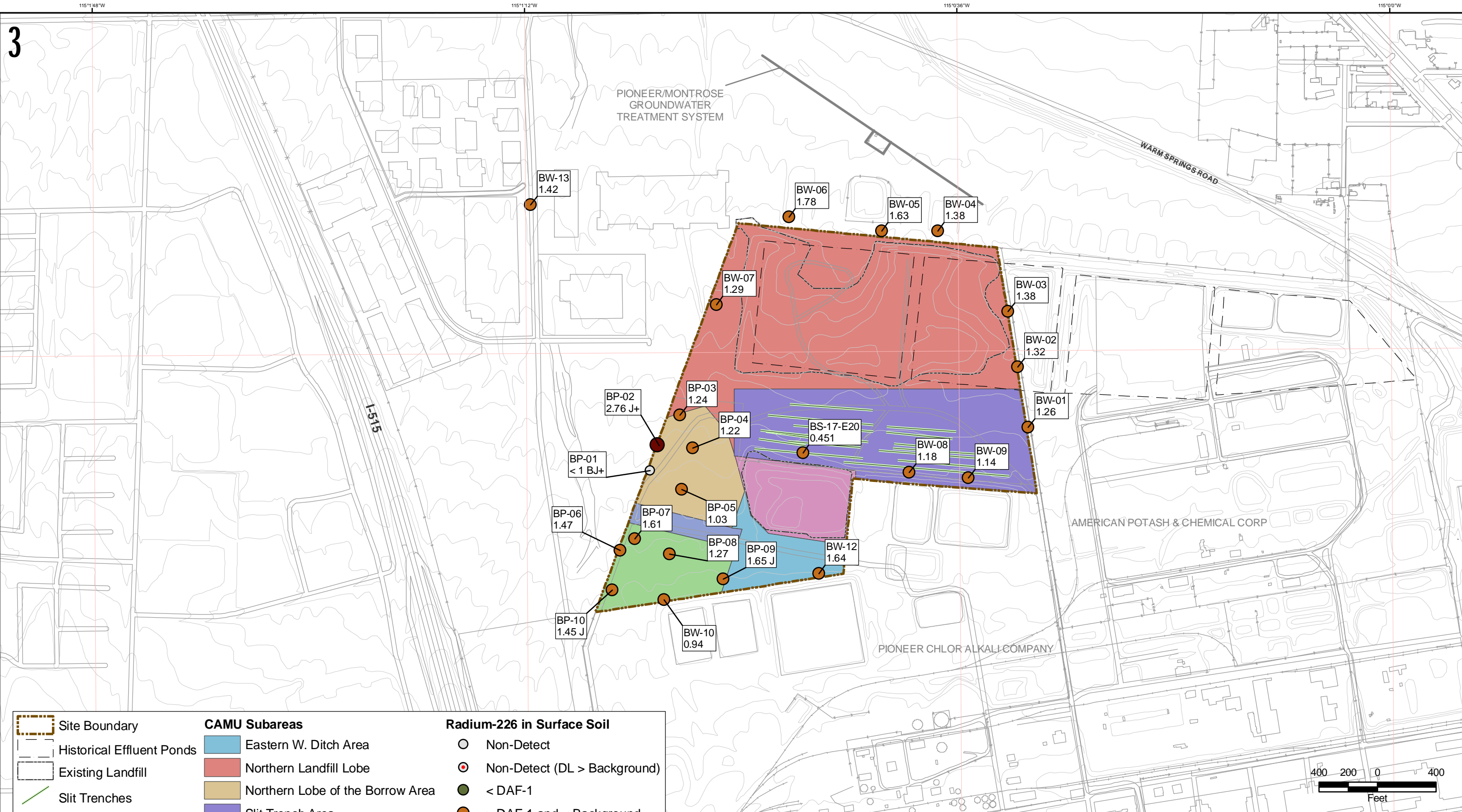
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.



















Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.



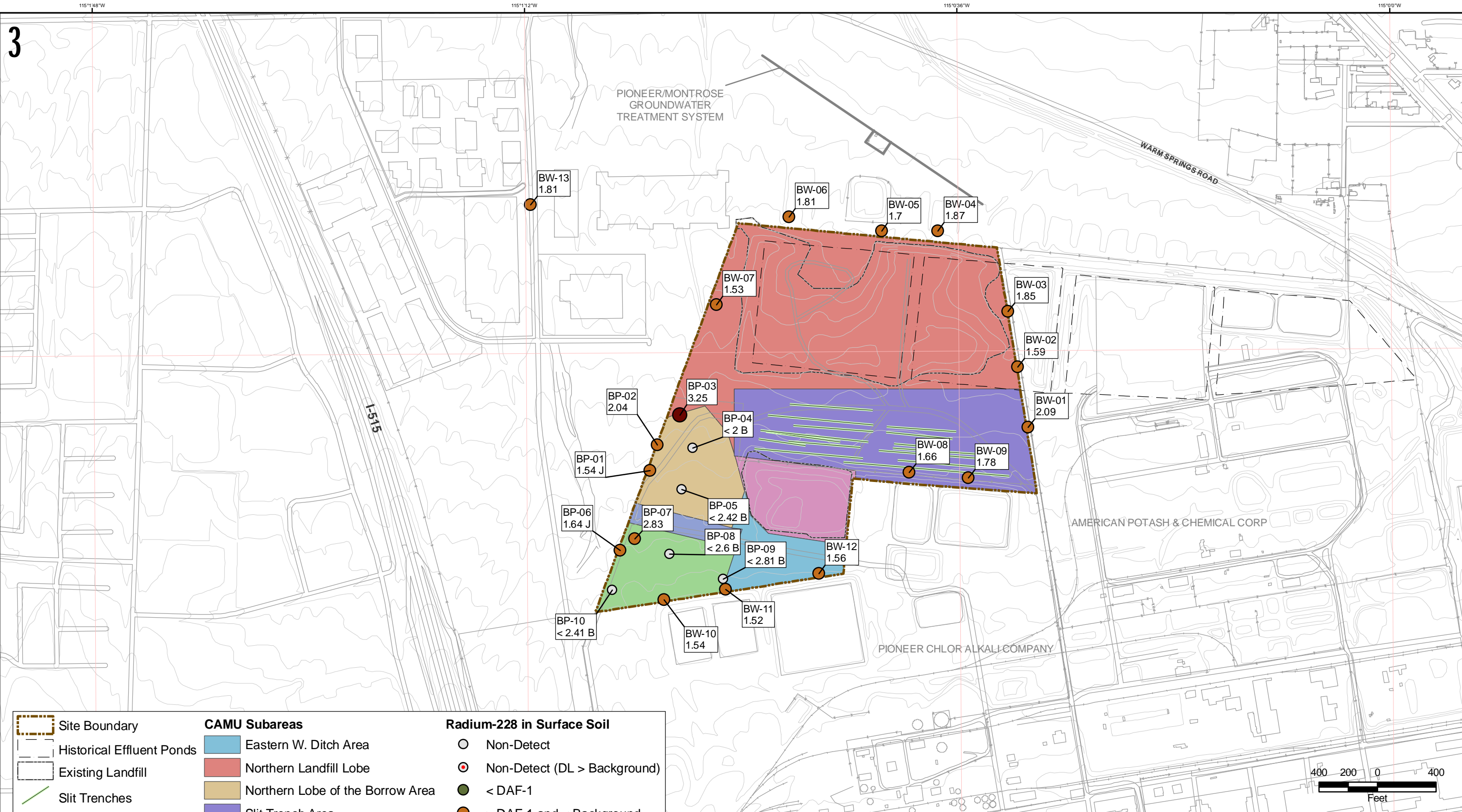
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.



 Site Boundary	CAMU Subareas	Radium-226 in Surface Soil
 Historical Effluent Ponds	 Eastern W. Ditch Area	 Non-Detect
 Existing Landfill	 Northern Landfill Lobe	 Non-Detect (DL > Background)
 Slit Trenches	 Northern Lobe of the Borrow Area	 < DAF-1
	 Slit Trench Area	 > DAF-1 and < Background
	 Southern Landfill Lobe	 > Background
	 Southern Lobe of the Borrow Area	
	 Western W. Ditch Area	

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pCi/g.

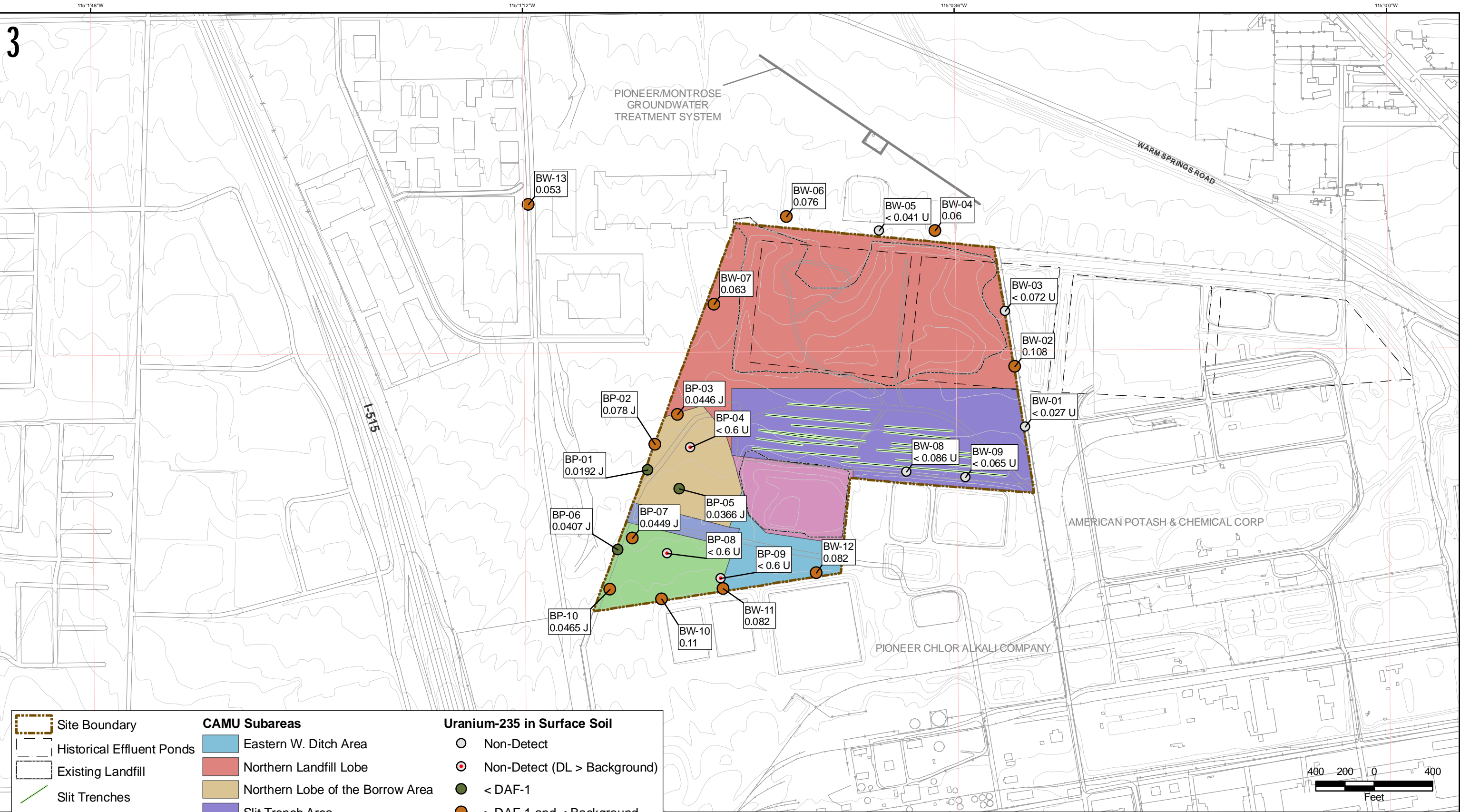
Corrective Action Management Unit (CAMU) BMI Complex, Henderson, Nevada	
FIGURE 5-15	
RADIUM-226 IN SURFACE SOIL (0 TO 1 FT BGS)	
Prepared by: MWH	Date 01/30/07
JOB No. 1881425 FILE: GIS\BRC\CAMU\SOIL_DATAPLOTS.MXD	



Site Boundary	CAMU Subareas	Radium-228 in Surface Soil
Historical Effluent Ponds	Eastern W. Ditch Area	Non-Detect
Existing Landfill	Northern Landfill Lobe	Non-Detect (DL > Background)
Slit Trenches	Northern Lobe of the Borrow Area	< DAF-1
	Slit Trench Area	> DAF-1 and < Background
	Southern Landfill Lobe	> Background
	Southern Lobe of the Borrow Area	
	Western W. Ditch Area	

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pCi/g.

Corrective Action Management Unit (CAMU) BMI Complex, Henderson, Nevada	
FIGURE 5-16	
RADIUM-228 IN SURFACE SOIL (0 TO 1 FT BGS)	
Prepared by: MWH	Date 01/30/07
JOB No. 1881425 FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD	



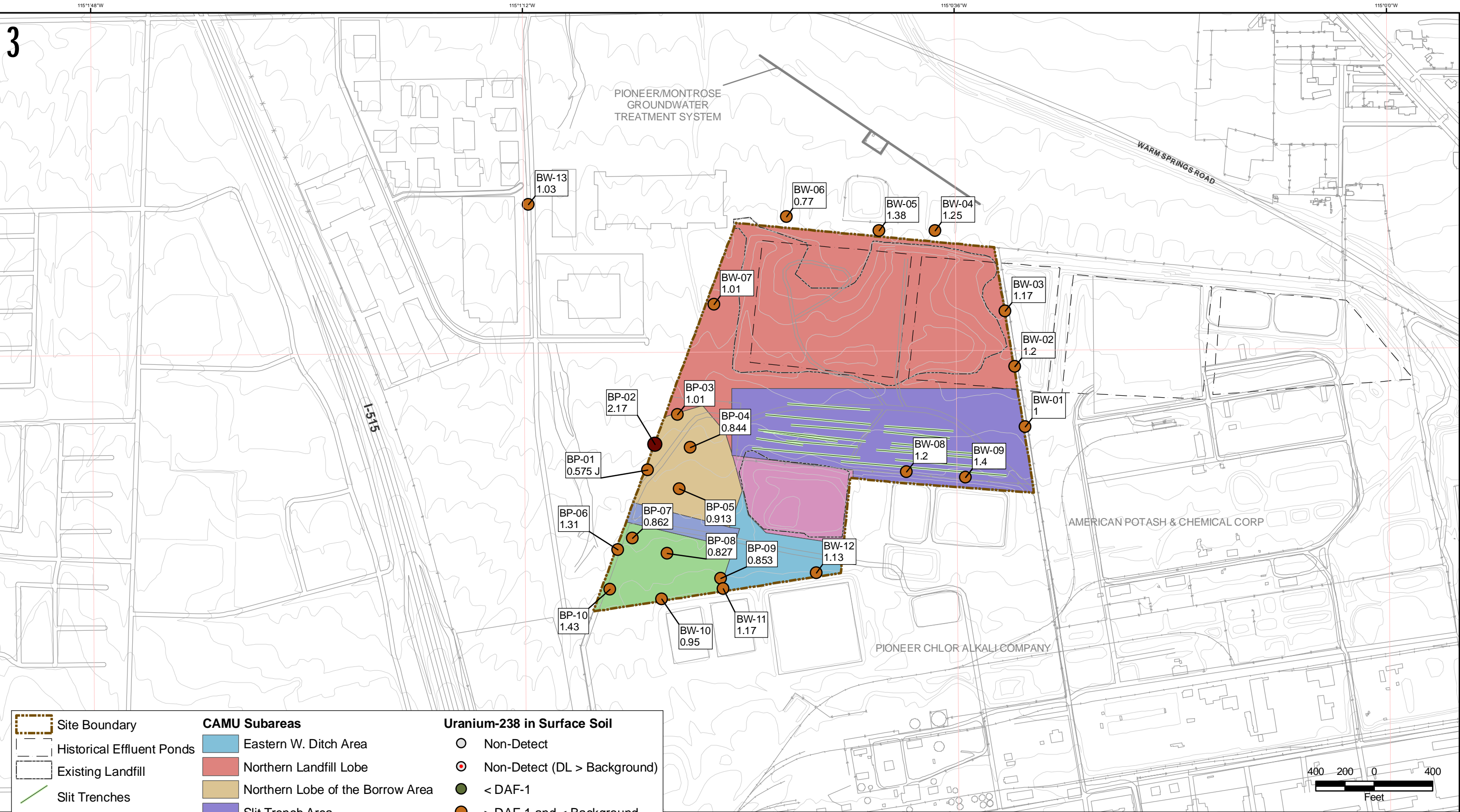
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pCi/g.





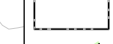











Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

FIGURE 5-17

URANIUM-235
IN SURFACE SOIL
(0 TO 1 FT BGS)





 Site Boundary	CAMU Subareas	Uranium-238 in Surface Soil
 Historical Effluent Ponds	 Eastern W. Ditch Area	 Non-Detect
 Existing Landfill	 Northern Landfill Lobe	 Non-Detect (DL > Background)
 Slit Trenches	 Northern Lobe of the Borrow Area	 < DAF-1
	 Slit Trench Area	 > DAF-1 and < Background
	 Southern Landfill Lobe	 > Background
	 Southern Lobe of the Borrow Area	
	 Western W. Ditch Area	

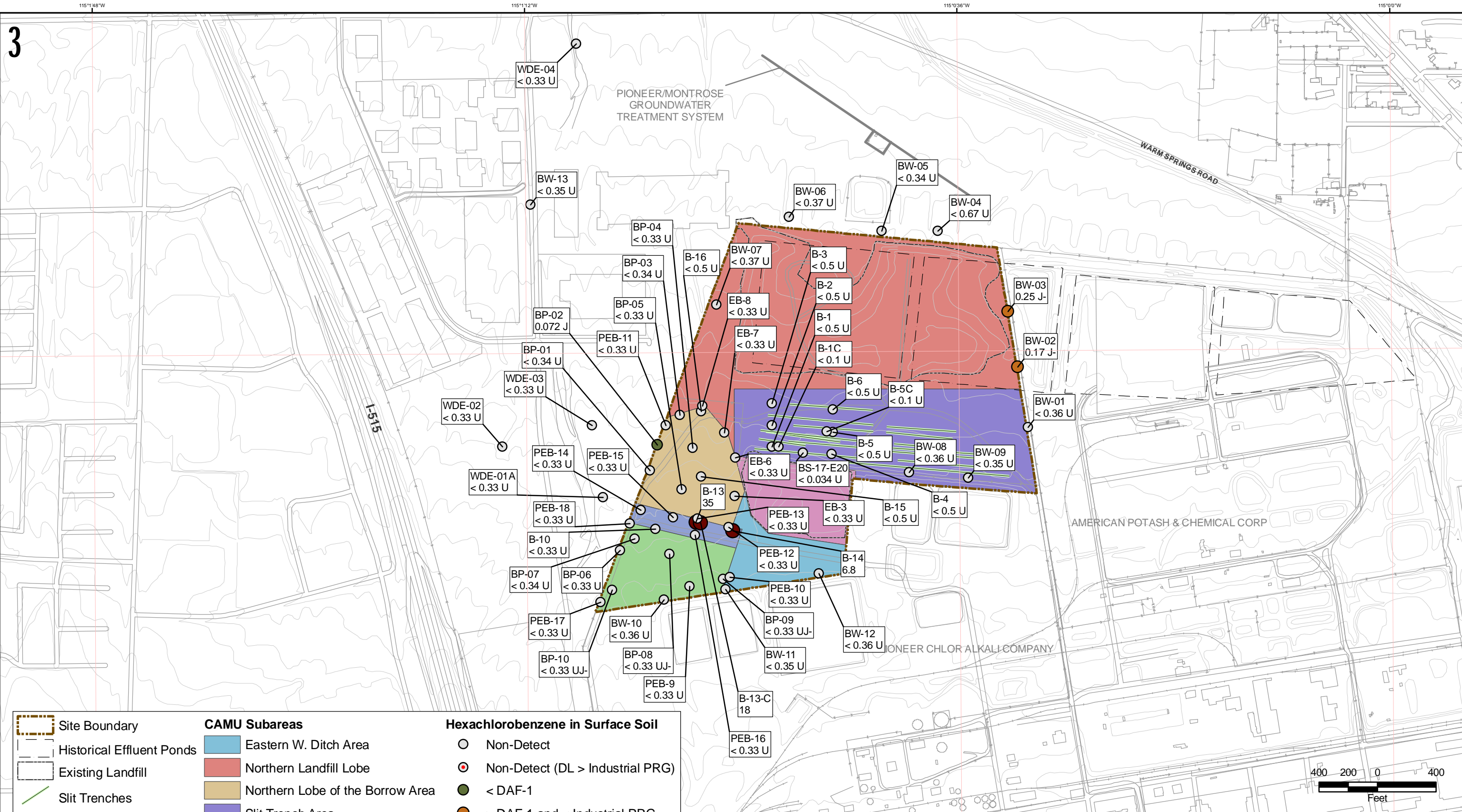
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pCi/g.

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

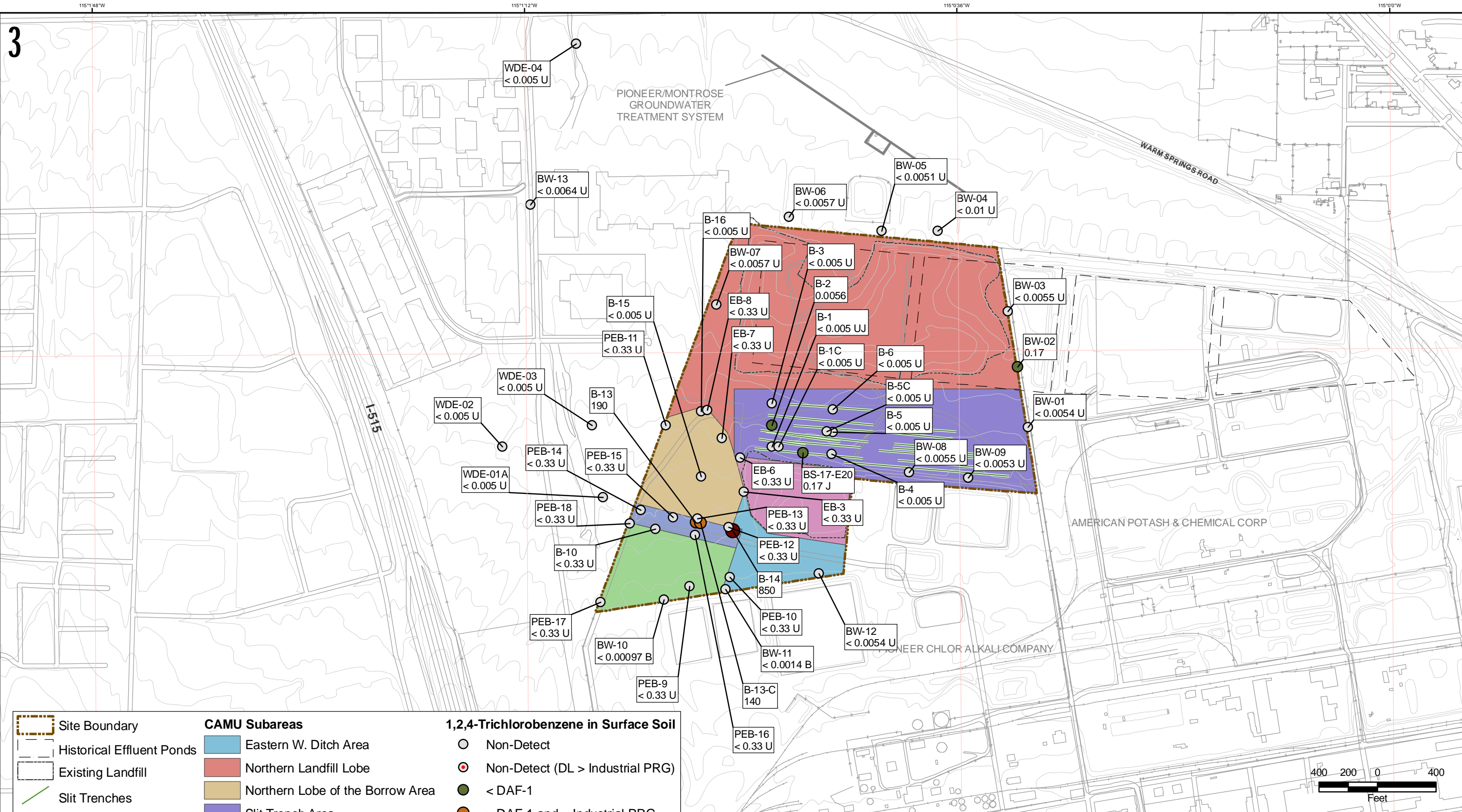
FIGURE 5-18

URANIUM-238
IN SURFACE SOIL
(0 TO 1 FT BGS)

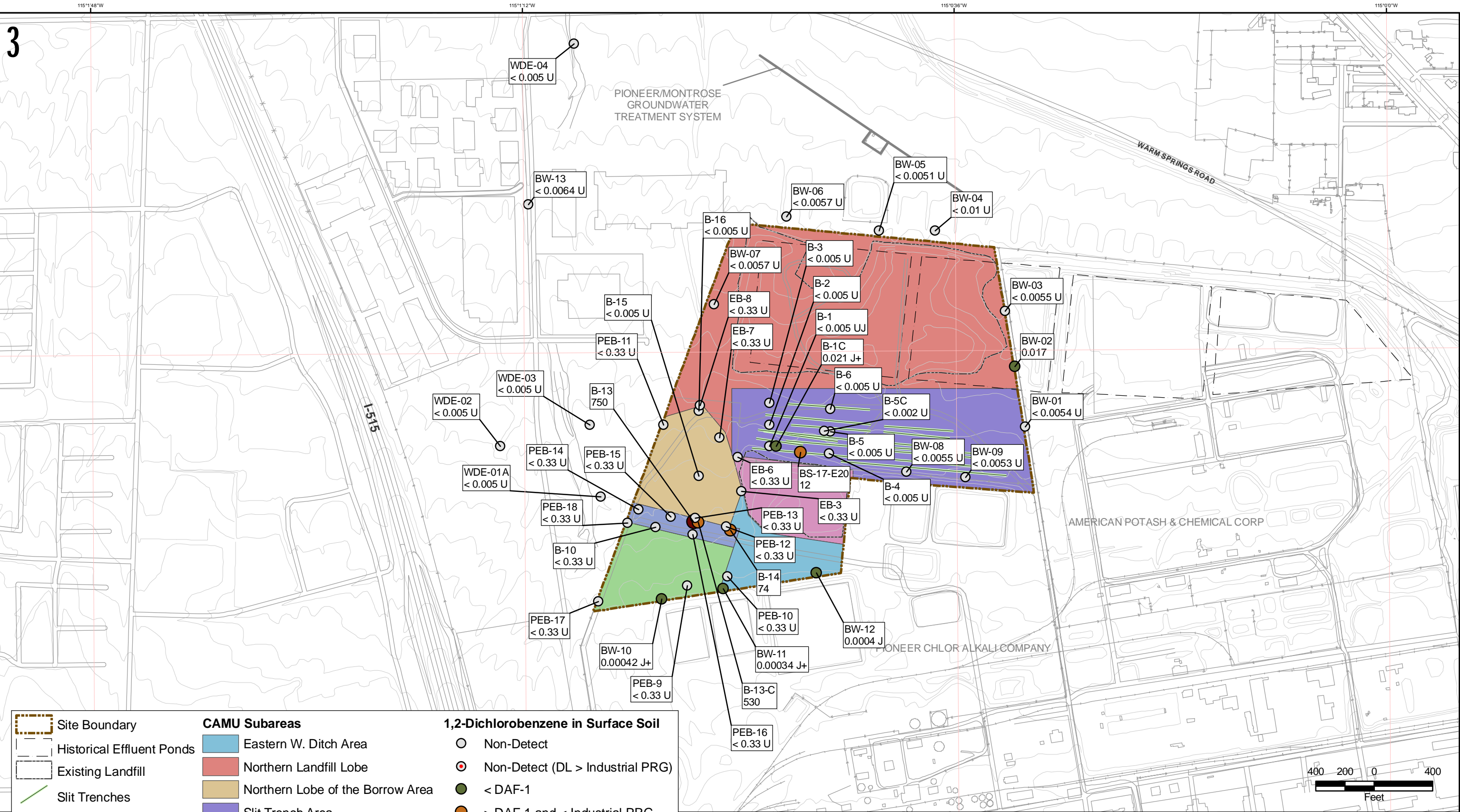




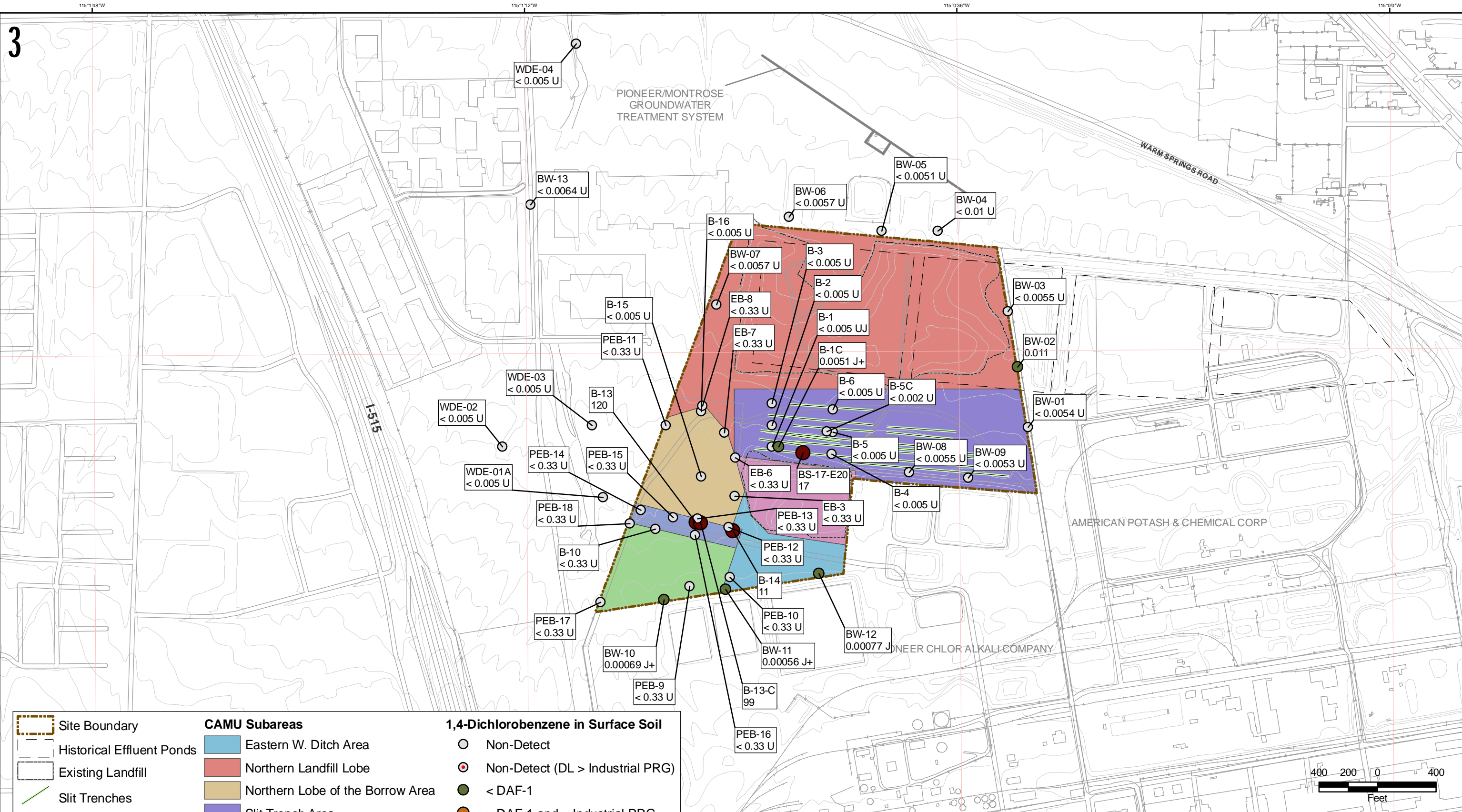
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.



Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.



Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.



Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

1,4-Dichlorobenzene in Surface Soil

Non-Detect

Non-Detect (DL > Industrial PRG)

< DAF-1

> DAF-1 and < Industrial PRG

> Industrial PRG

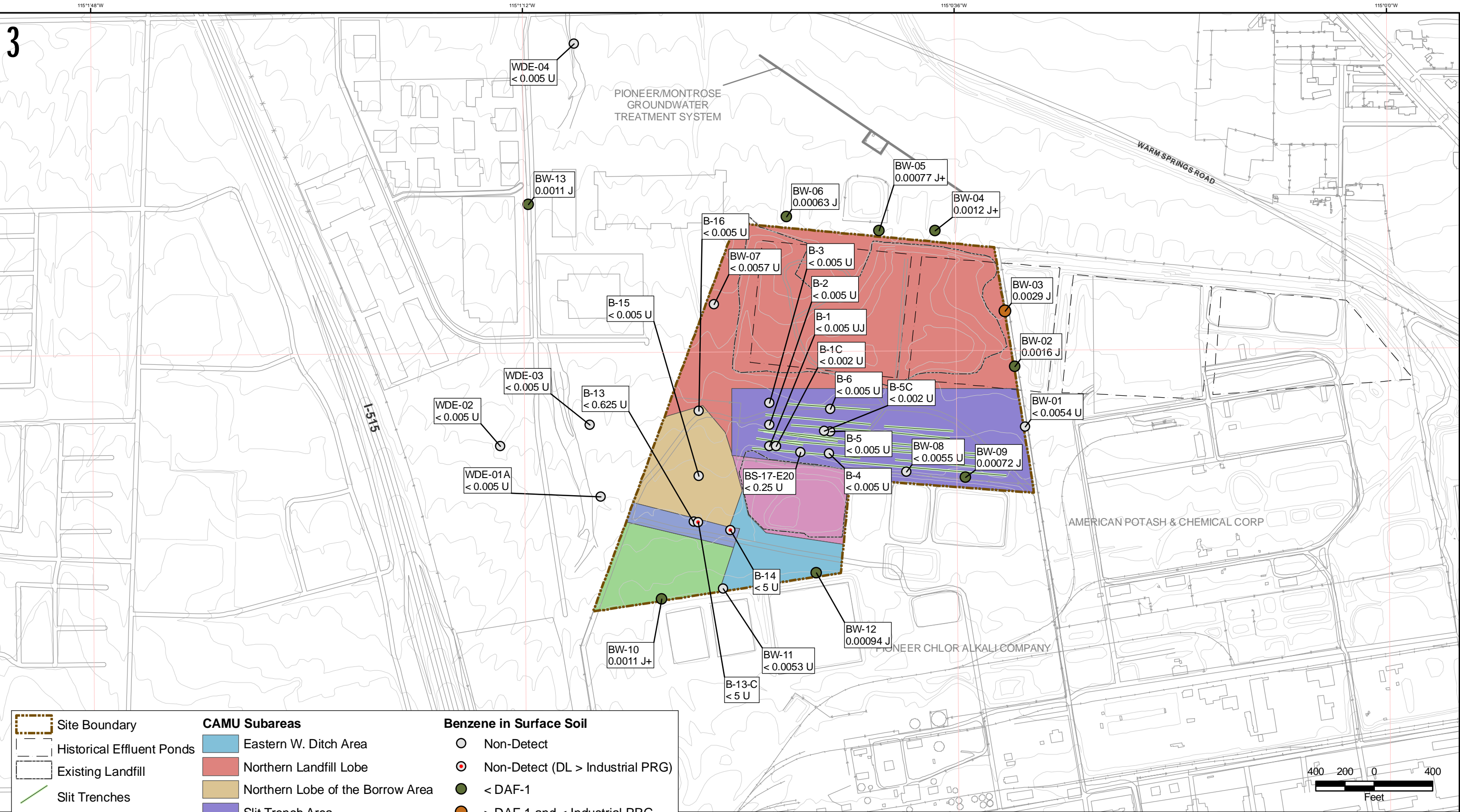
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

FIGURE 5-22

1,4-DICHLOROBENZENE
IN SURFACE SOIL
(0 TO 1 FT BGS)





Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Benzene in Surface Soil

Non-Detect

Non-Detect (DL > Industrial PRG)

< DAF-1

> DAF-1 and < Industrial PRG

> Industrial PRG

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

FIGURE 5-23

BENZENE
IN SURFACE SOIL
(0 TO 1 FT BGS)

Prepared by:
MWH

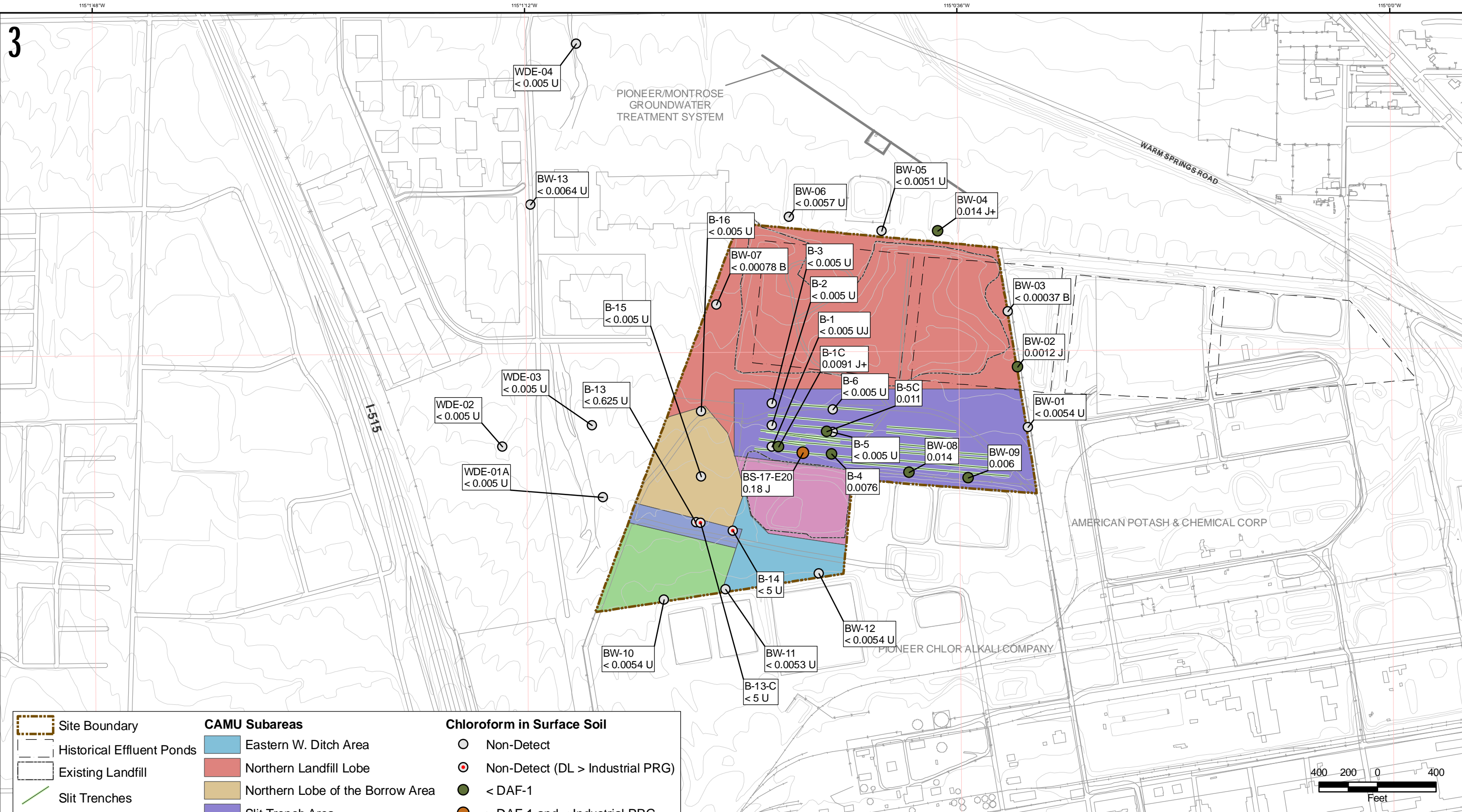
Date
01/30/07

Job No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD

Basic Remediation
COMPANY

Daniel B. Stephens & Associates, Inc.

JN ES05.0067



Site Boundary	CAMU Subareas	Chloroform in Surface Soil
Historical Effluent Ponds	Eastern W. Ditch Area	○ Non-Detect
Existing Landfill	Northern Landfill Lobe	● Non-Detect (DL > Industrial PRG)
Slit Trenches	Northern Lobe of the Borrow Area	● < DAF-1
	Slit Trench Area	● > DAF-1 and < Industrial PRG
	Southern Landfill Lobe	● > Industrial PRG
	Southern Lobe of the Borrow Area	
	Western W. Ditch Area	

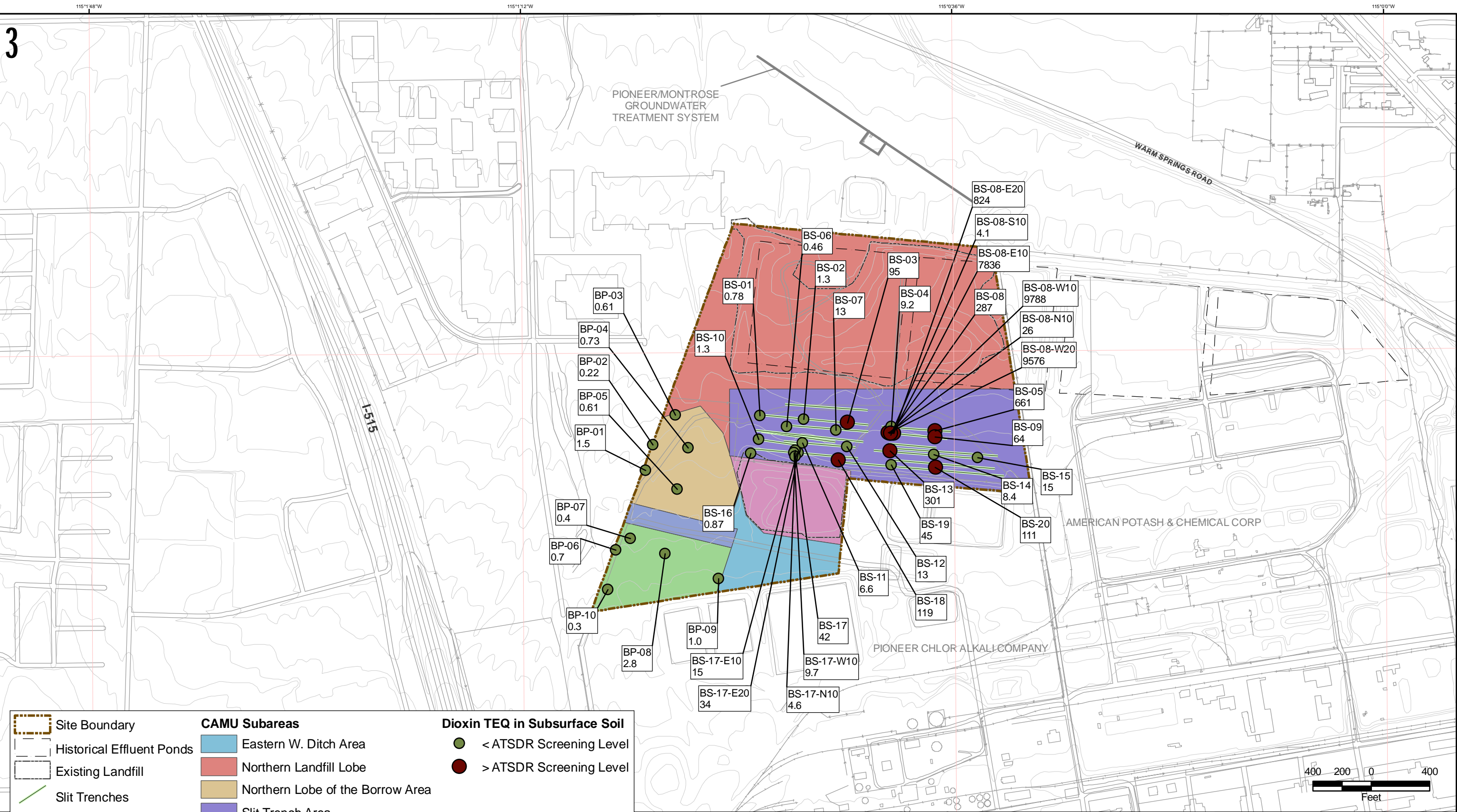
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

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

FIGURE 5-24

CHLOROFORM
IN SURFACE SOIL
(0 TO 1 FT BGS)





Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Dioxin TEQ in Subsurface Soil

< ATSDR Screening Level

> ATSDR Screening Level

Indicates
9-10 ft bgs
sample result

Indicates
5 ft bgs
sample result

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pg/g.

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

FIGURE 5-25

TCCD TEQs
IN SUBSURFACE SOIL
(5 TO 10 FT BGS)

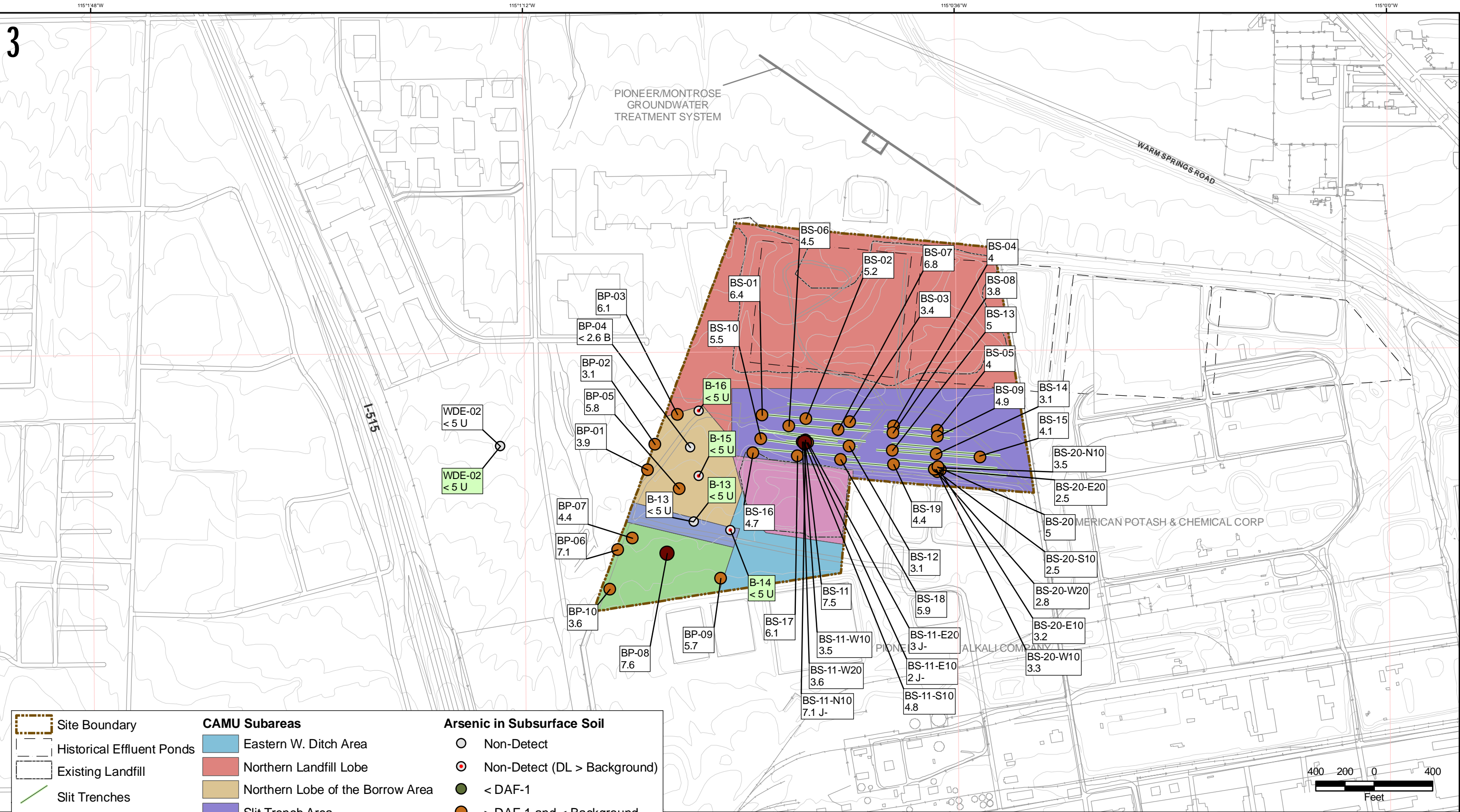
Prepared by:
MWH

Date:
01/31/07

Job No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD

Daniel B. Stephens & Associates, Inc.

JN ES05.0067



Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Arsenic in Subsurface Soil

Non-Detect

Non-Detect (DL > Background)

< DAF-1

> DAF-1 and < Background

> Background

Indicates
9-10 ft bgs
sample result

Indicates
5 ft bgs
sample result

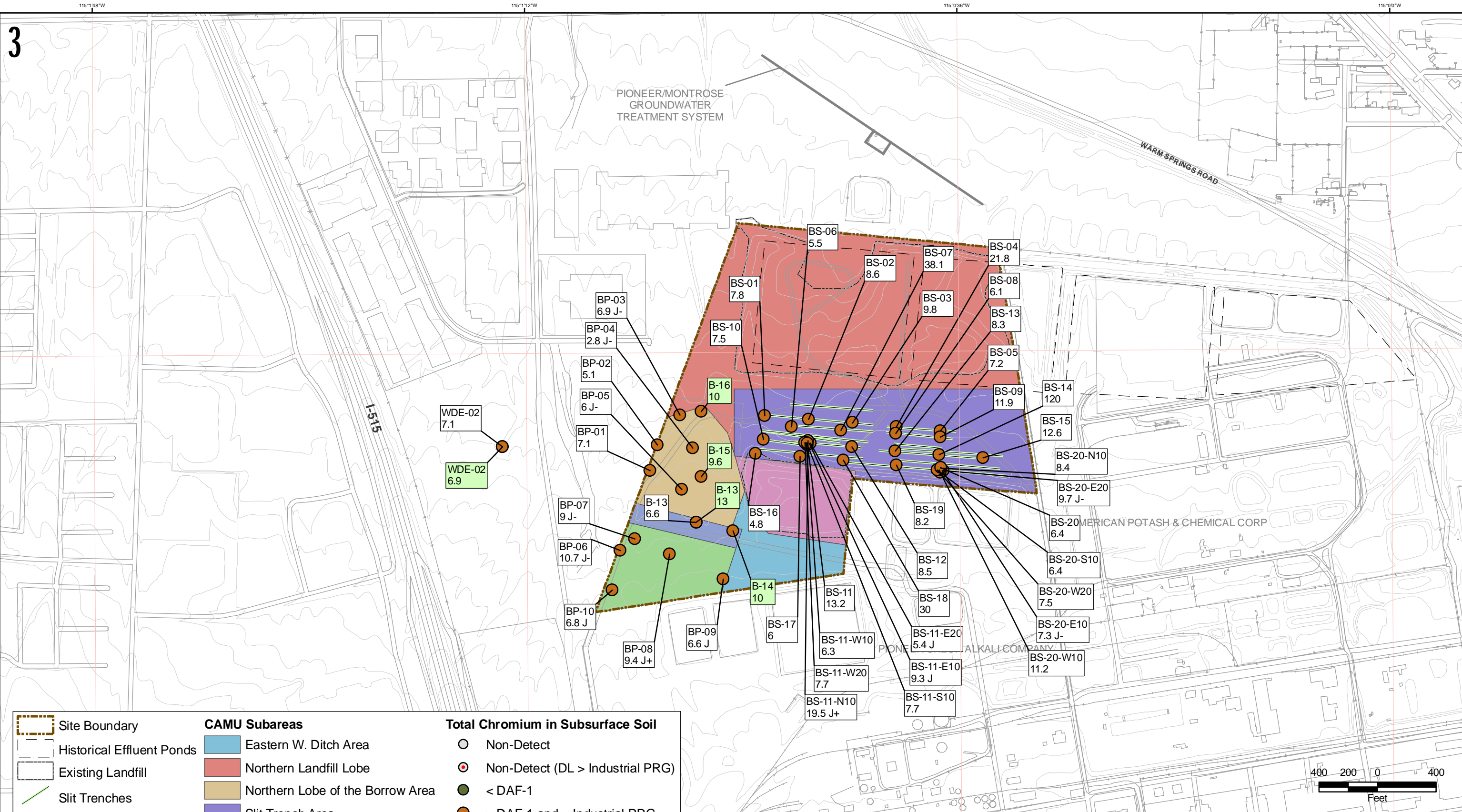
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE 5-26

ARSENIC
IN SUBSURFACE SOIL
(5 TO 10 FT BGS)

Prepared by: MWH Date: 01/31/07 JOB No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD

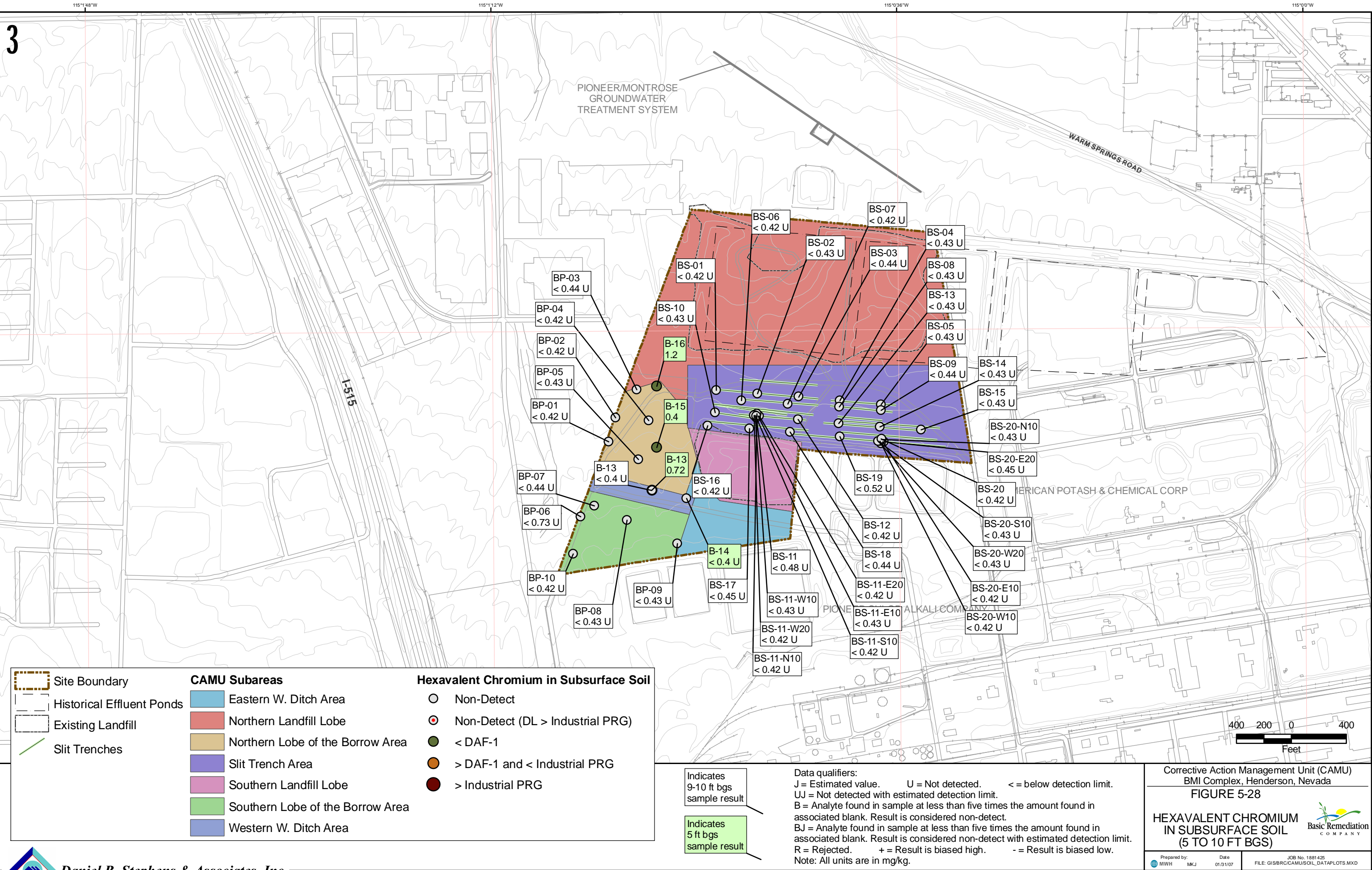
Daniel B. Stephens & Associates, Inc.
JN ES05.0067

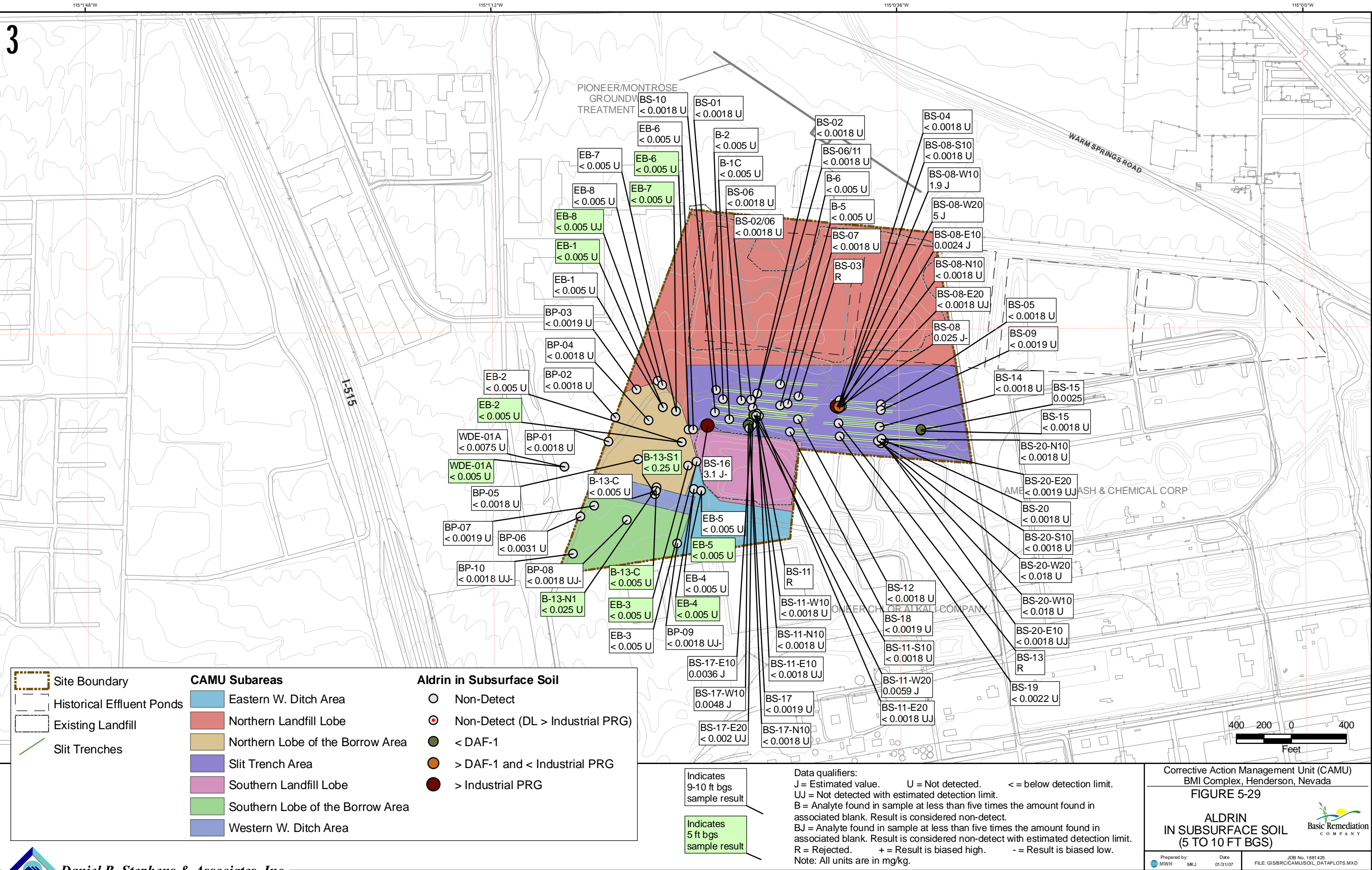


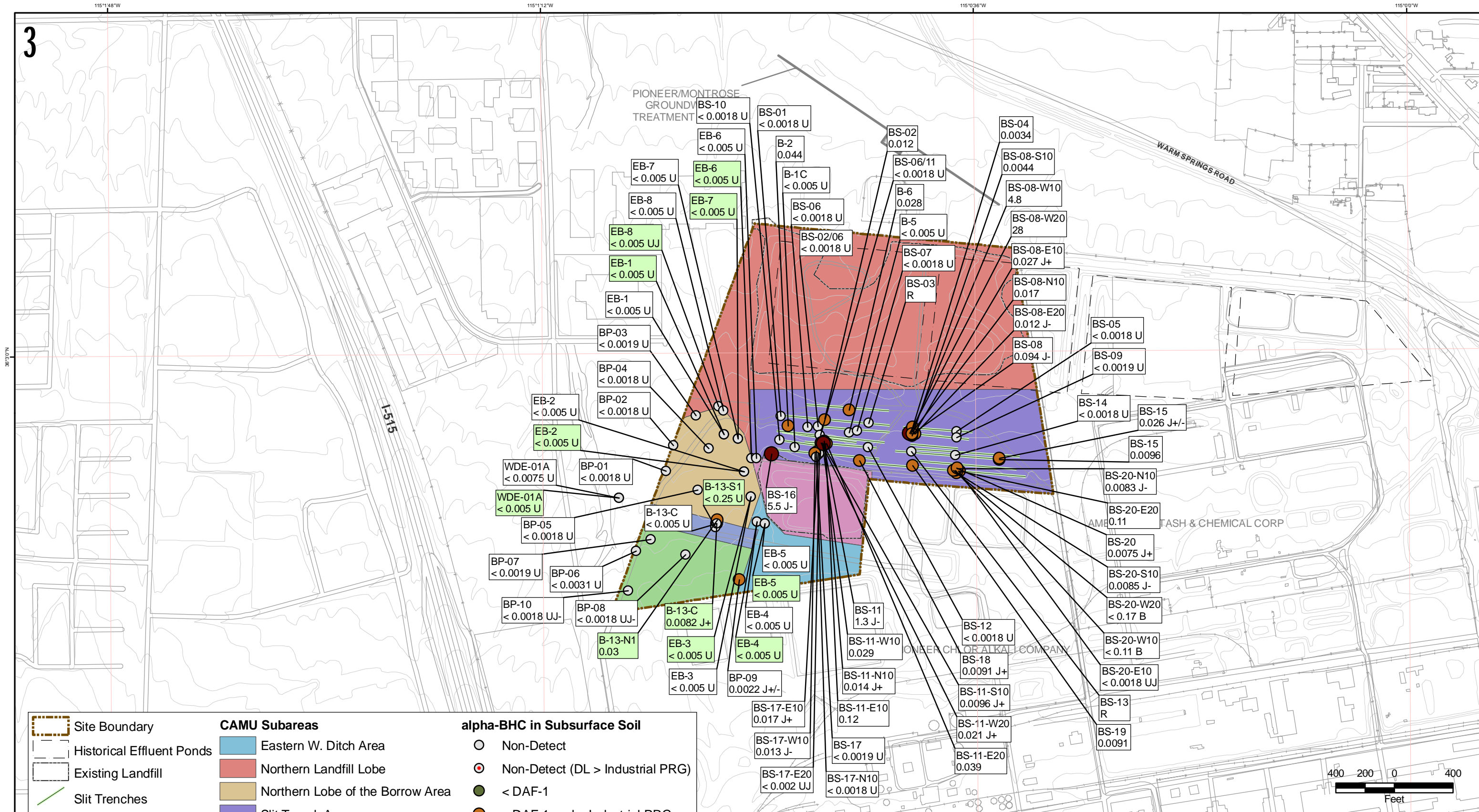
Indicates
9-10 ft bgs
sample result

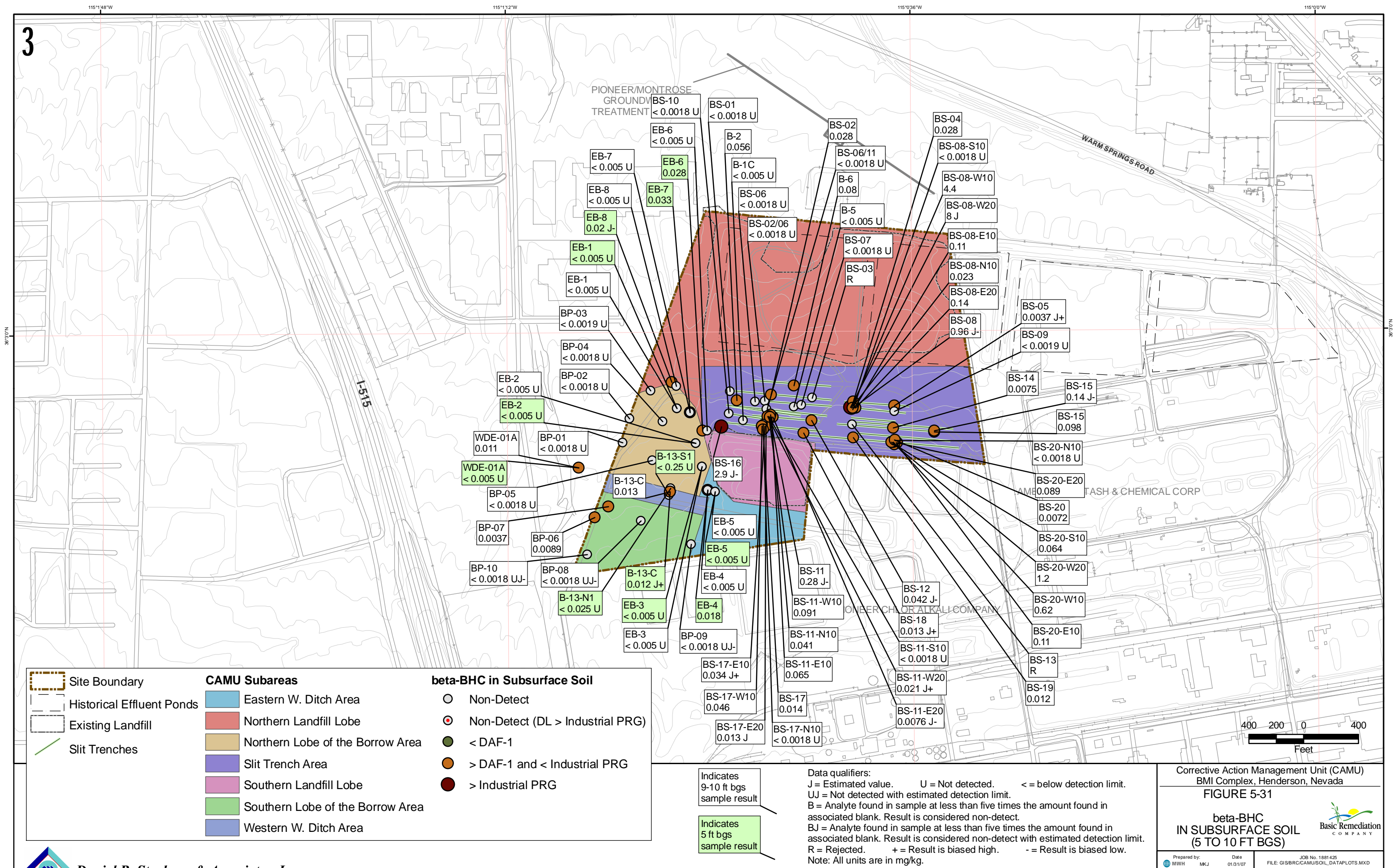
Indicates
5 ft bgs
sample result

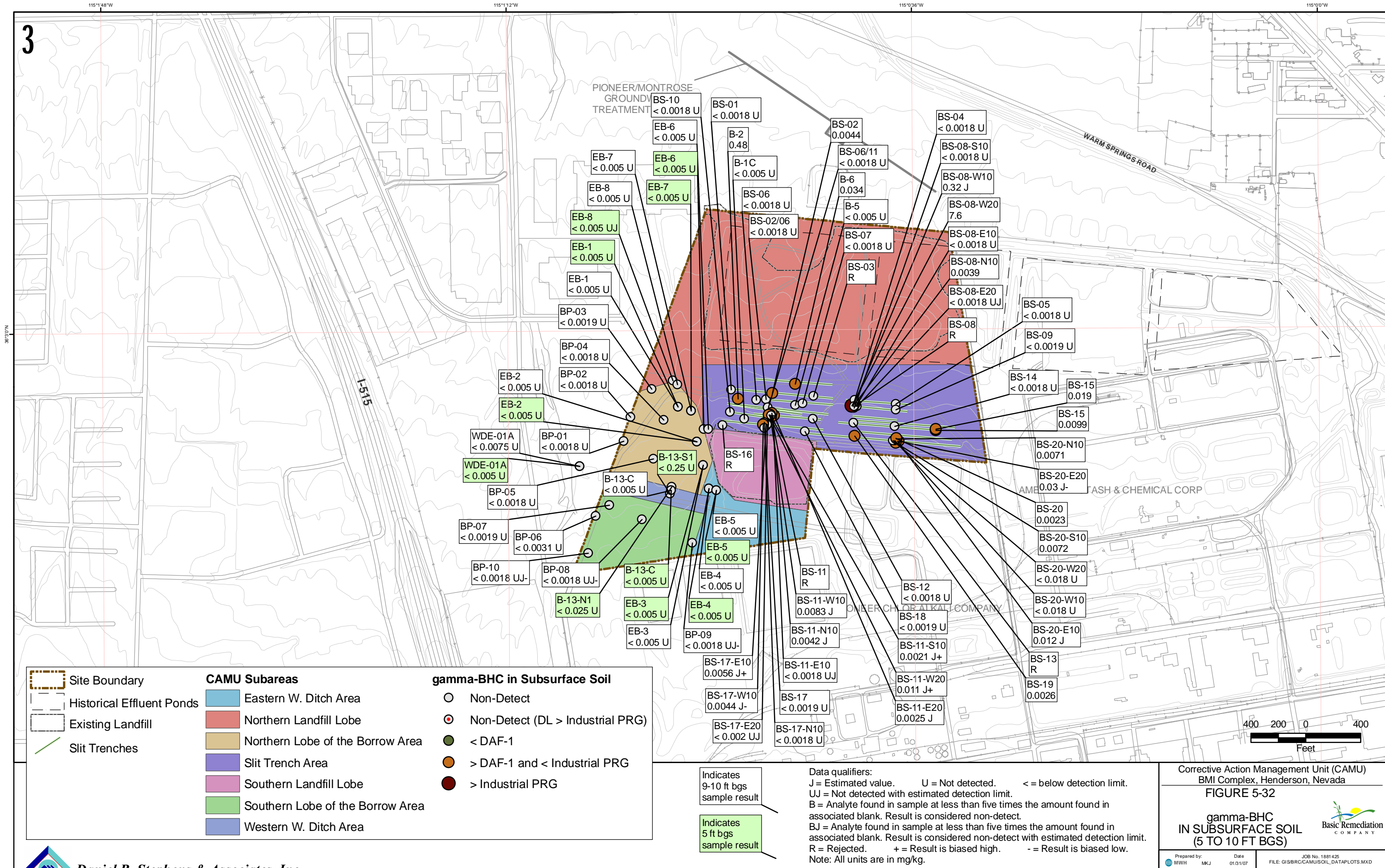
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

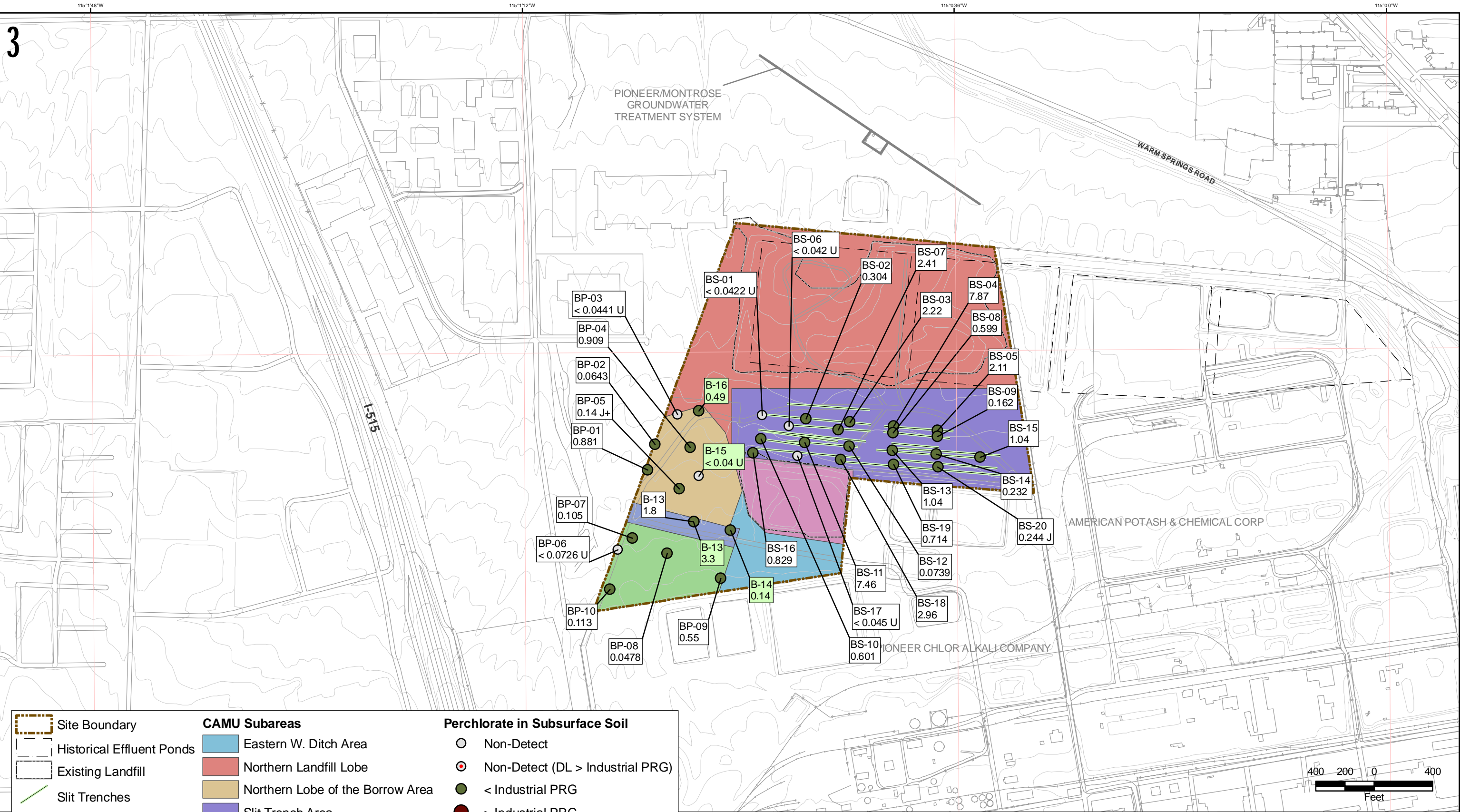












Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Perchlorate in Subsurface Soil

Non-Detect

Non-Detect (DL > Industrial PRG)

< Industrial PRG

> Industrial PRG

Indicates
9-10 ft bgs
sample result

Indicates
5 ft bgs
sample result

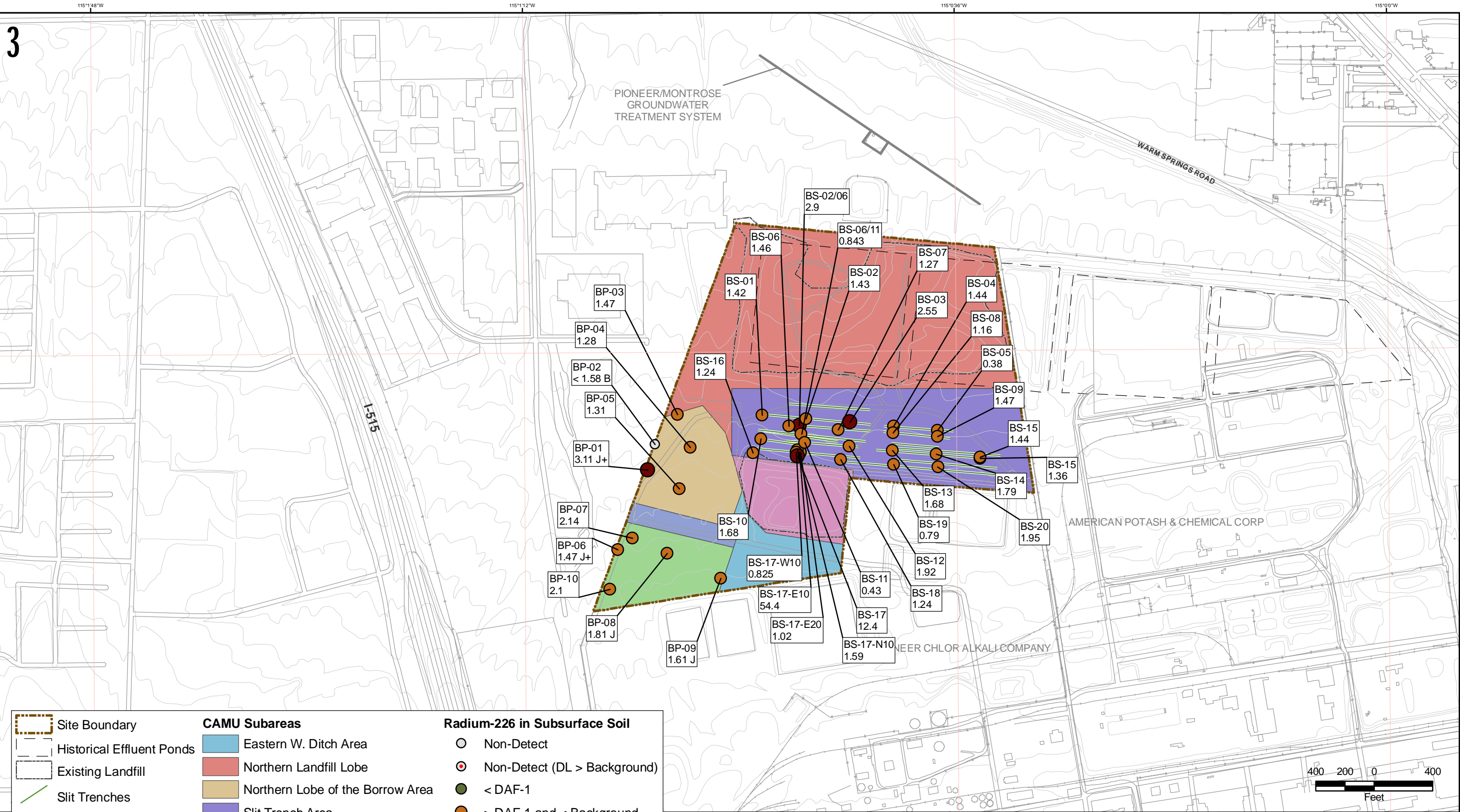
Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in mg/kg.

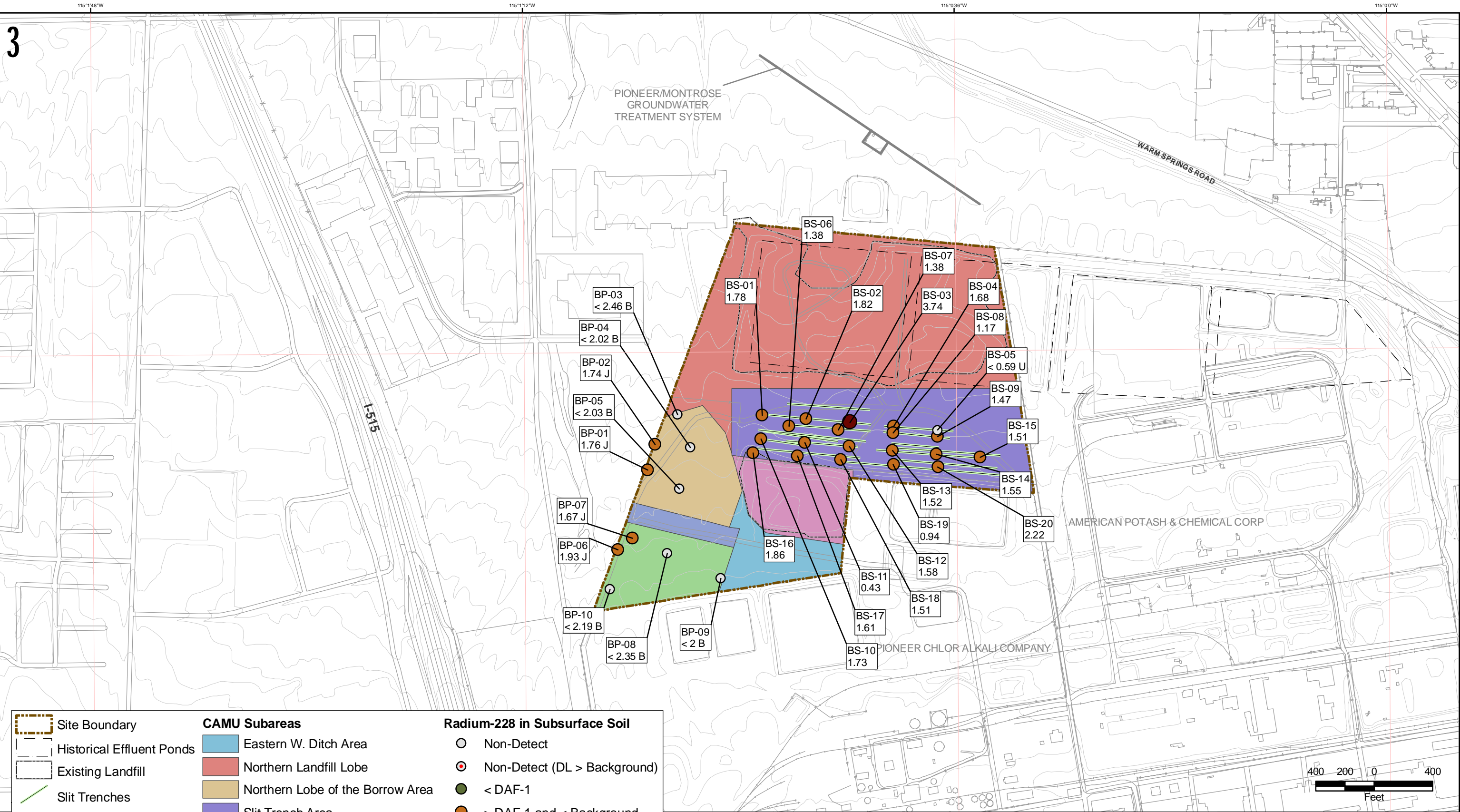
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

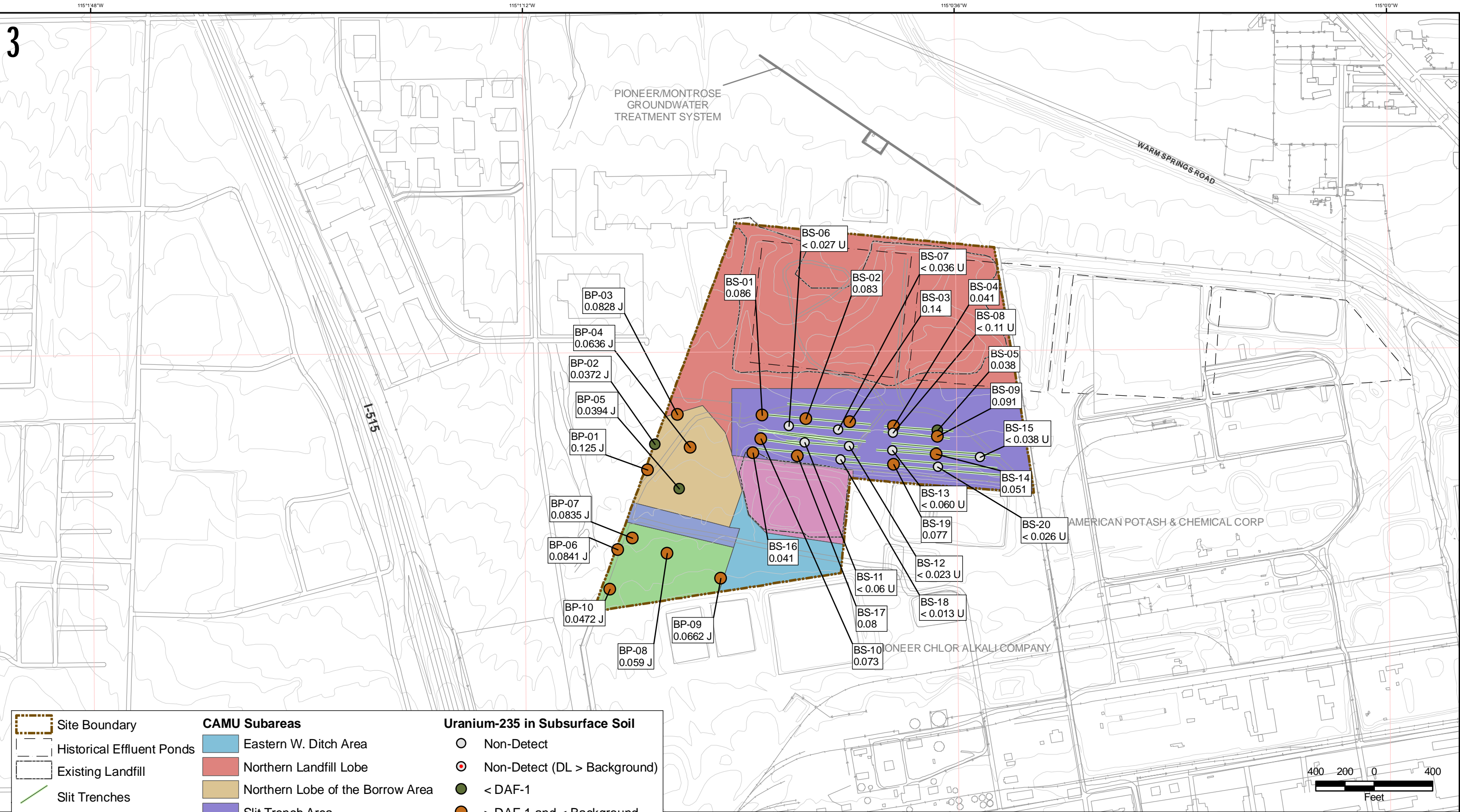
FIGURE 5-33

PERCHLORATE
IN SUBSURFACE SOIL
(5 TO 10 FT BGS)





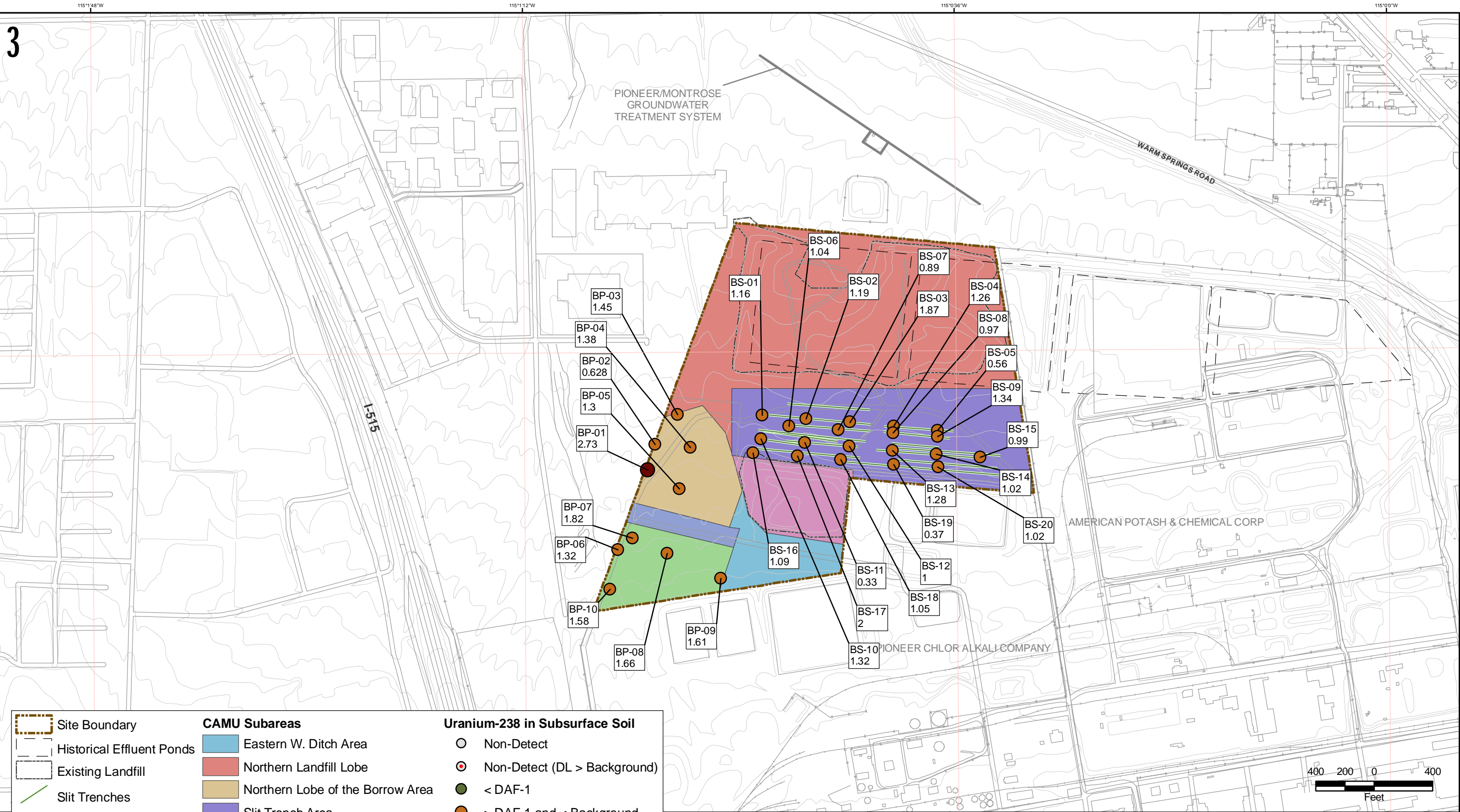




Indicates
9-10 ft bgs
sample result

Indicates
5 ft bgs
sample result

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pCi/g.



Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

CAMU Subareas

Eastern W. Ditch Area

Northern Landfill Lobe

Northern Lobe of the Borrow Area

Slit Trench Area

Southern Landfill Lobe

Southern Lobe of the Borrow Area

Western W. Ditch Area

Uranium-238 in Subsurface Soil

Non-Detect

Non-Detect (DL > Background)

< DAF-1

> DAF-1 and < Background

> Background

Indicates
9-10 ft bgs
sample result

Indicates
5 ft bgs
sample result

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.
Note: All units are in pCi/g.

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

FIGURE 5-37

URANIUM-238
IN SUBSURFACE SOIL
(5 TO 10 FT BGS)

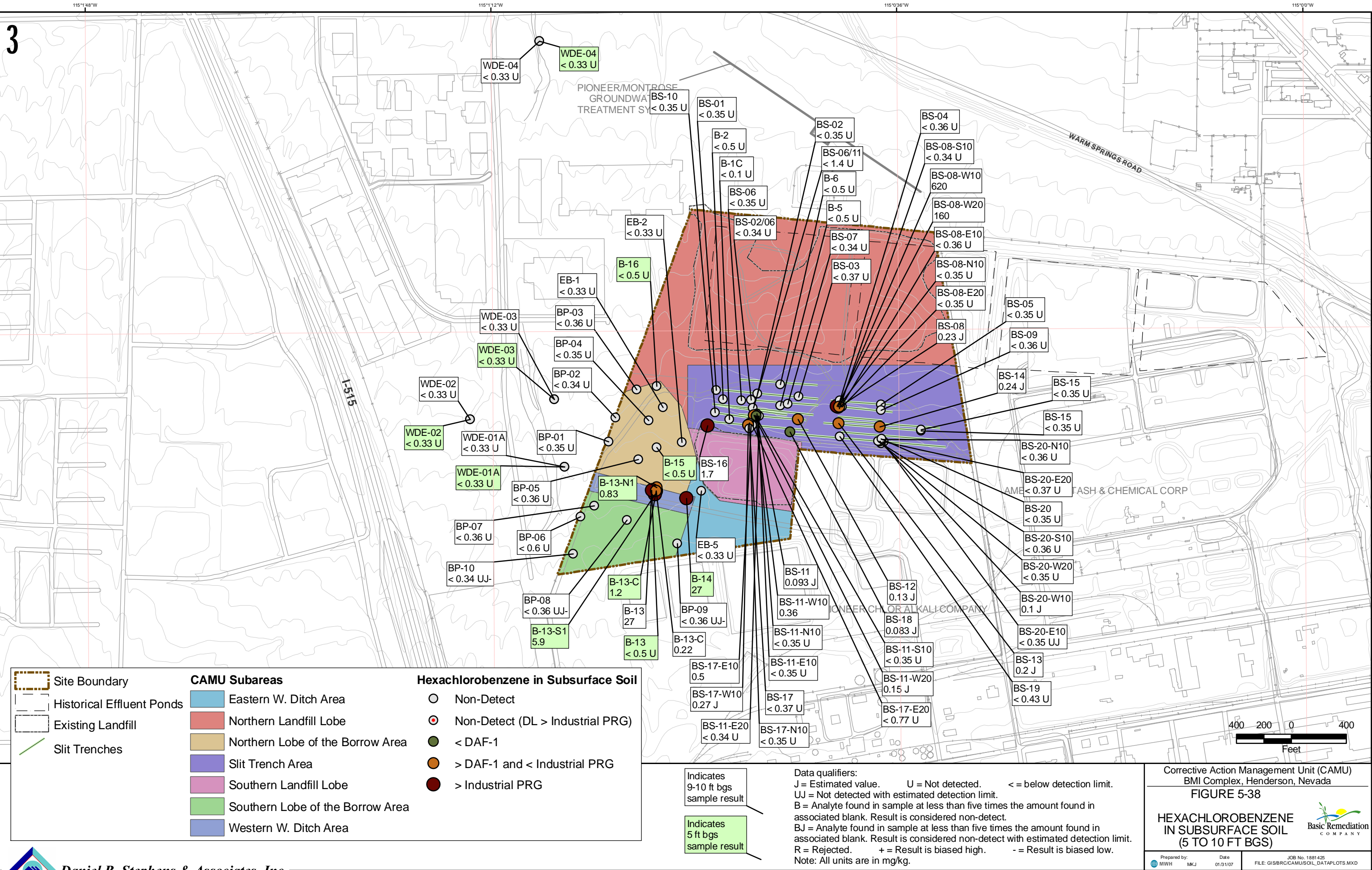
Prepared by:
MWH

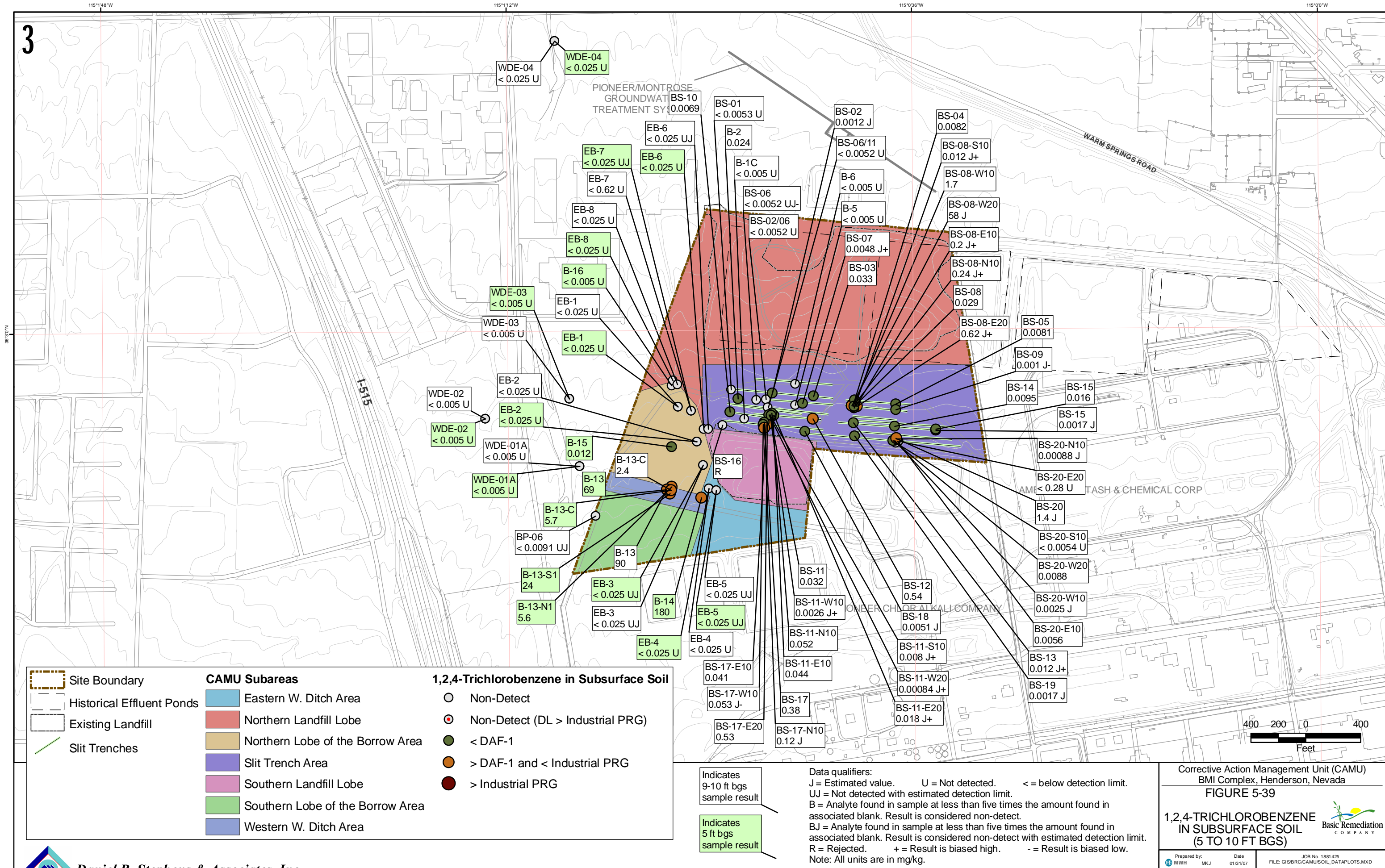
Date:
01/31/07

Job No. 1881425
FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD

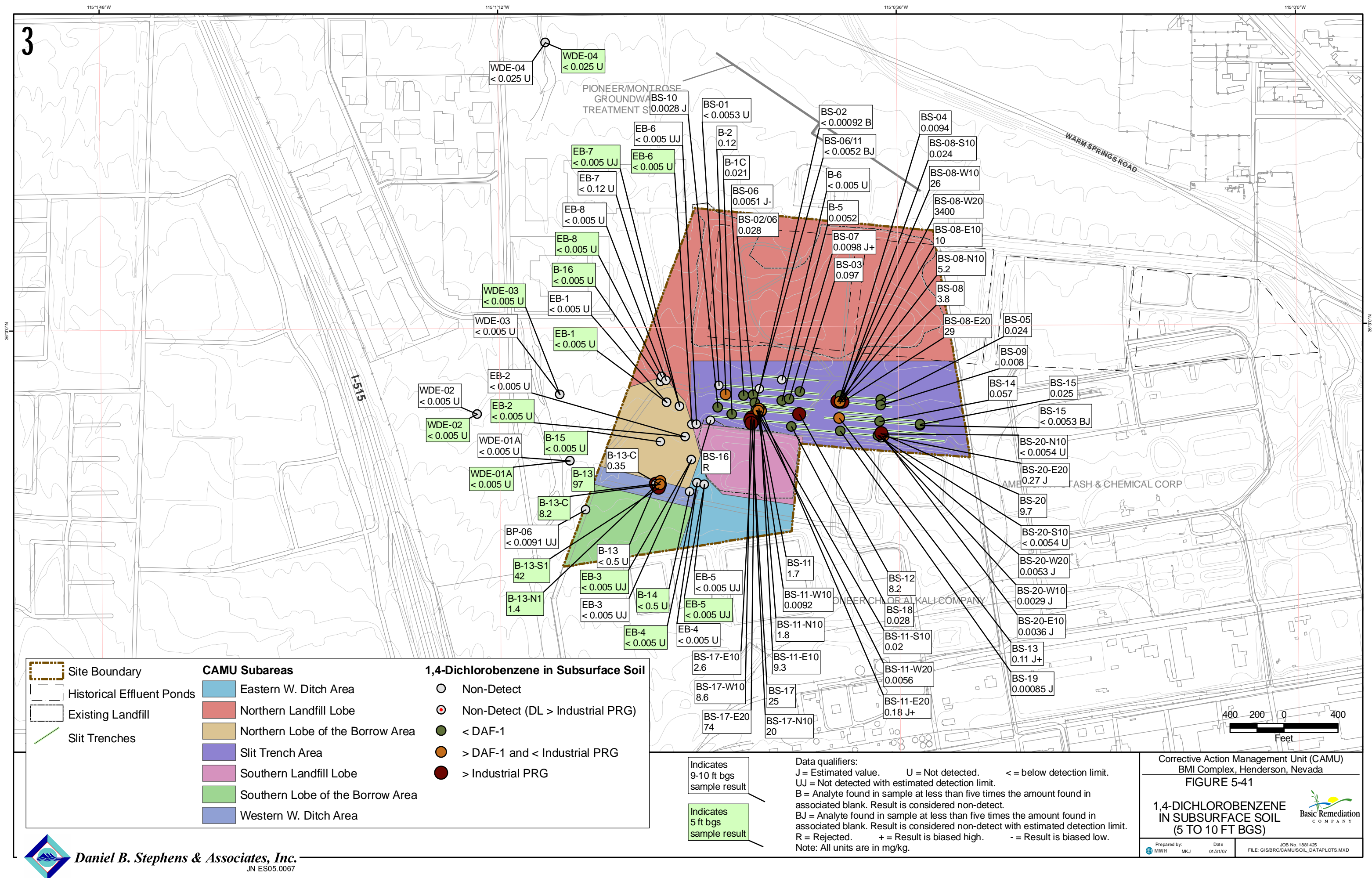
Daniel B. Stephens & Associates, Inc.

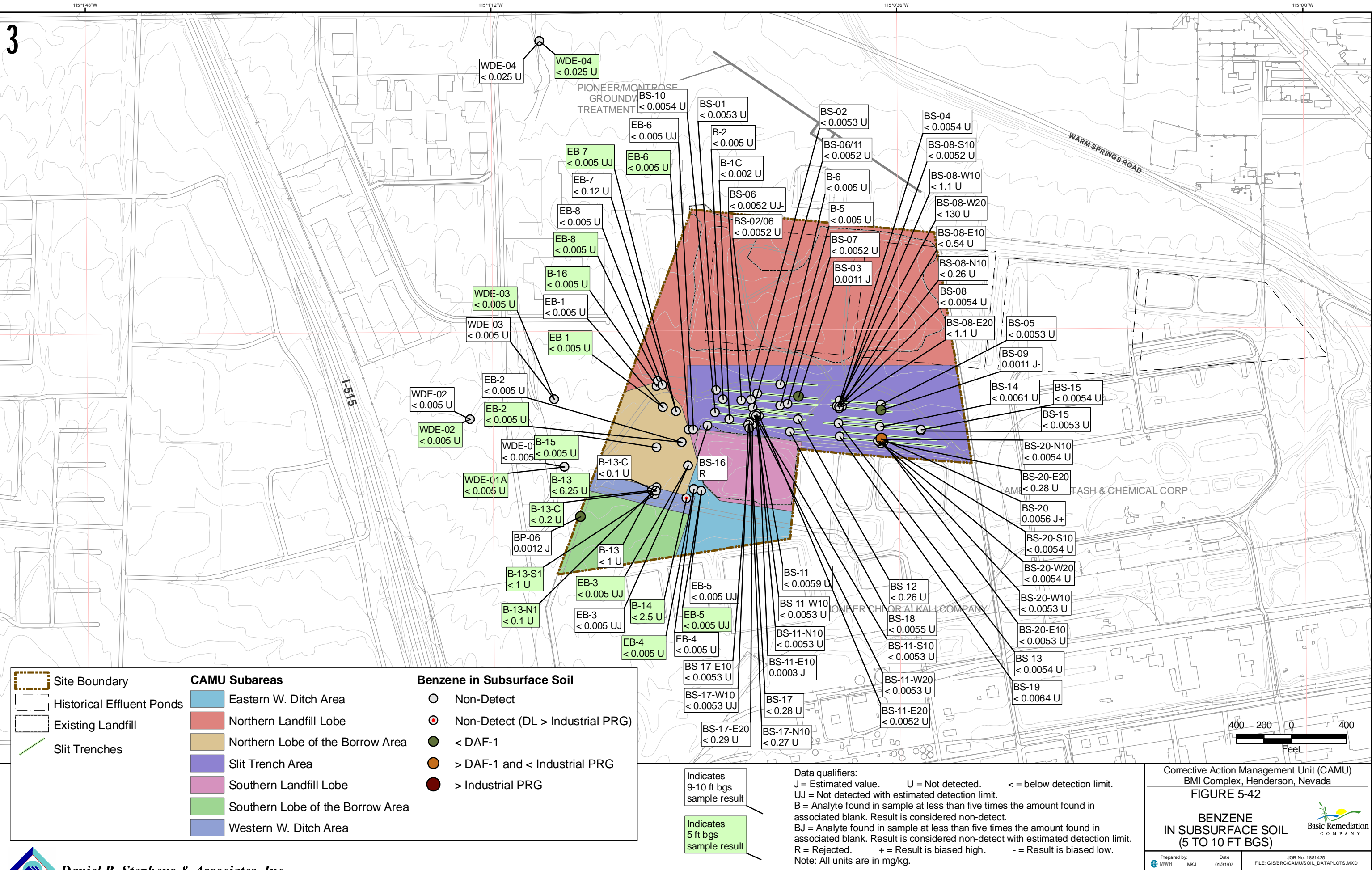
JN ES05.0067

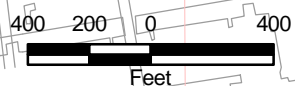






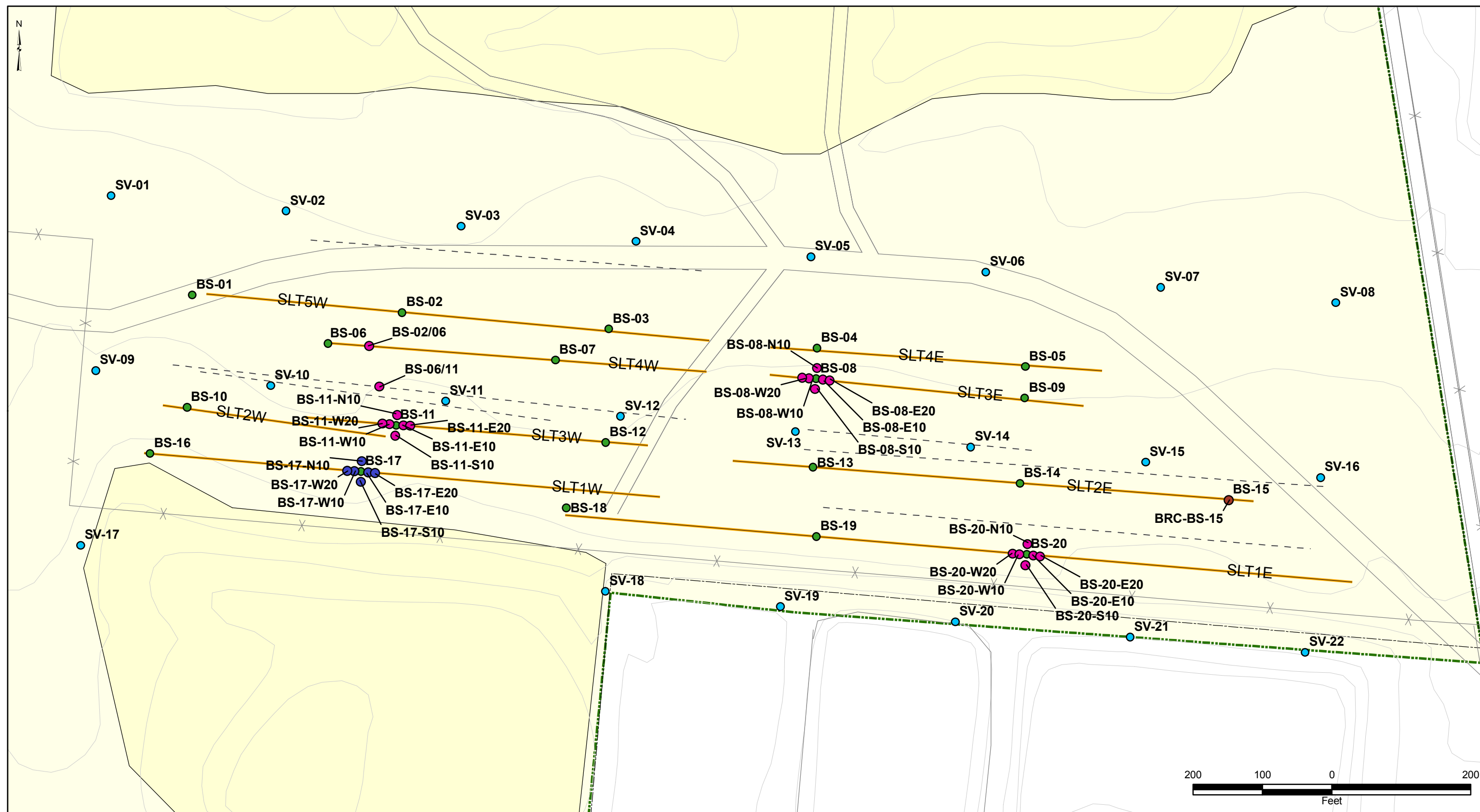




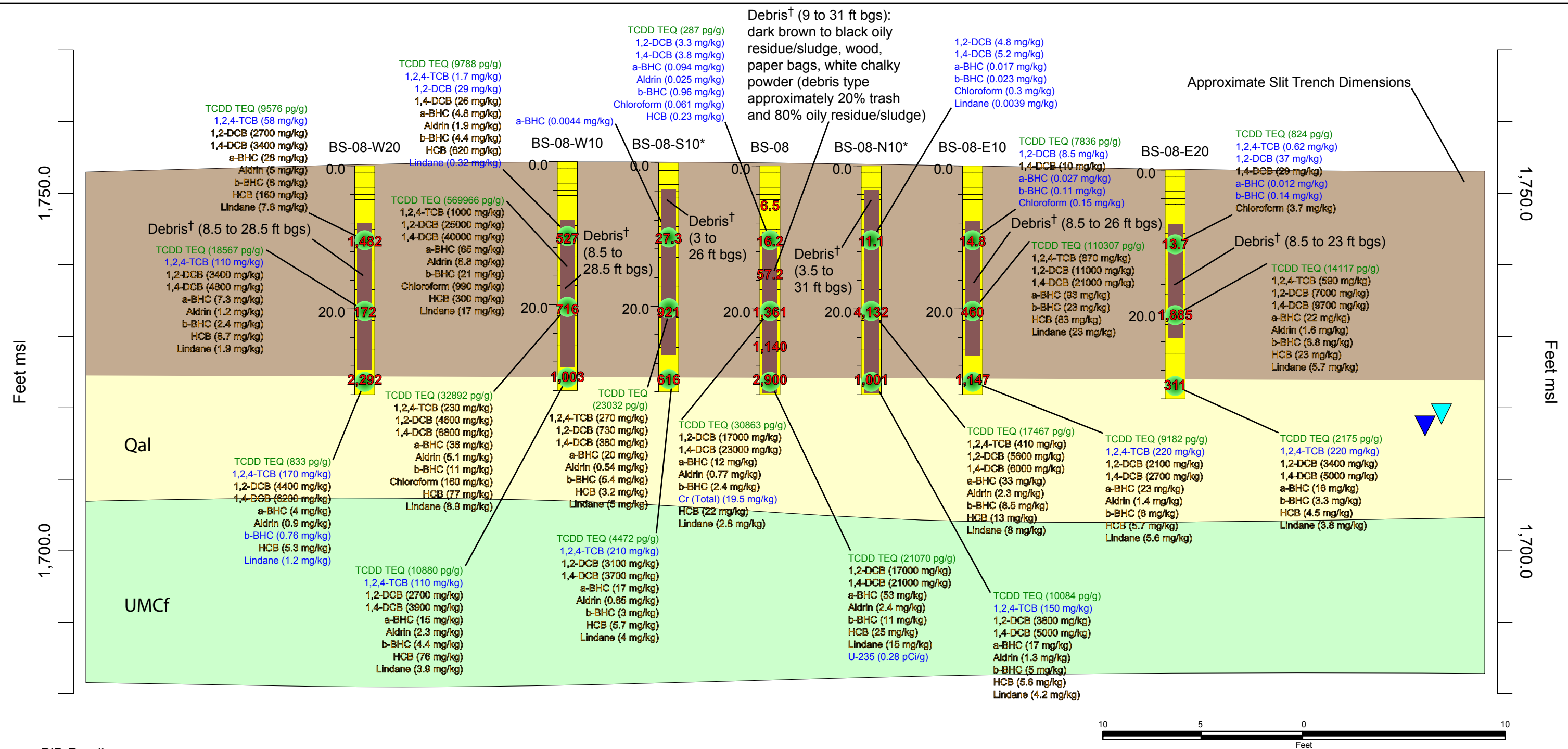


Indicates
5 ft bgs
sample result

Prepared by: MWH MKJ	Date 01/31/07	JOB No. 1881425 FILE: GIS/BRC/CAMU/SOIL_DATAPLOTS.MXD
--	------------------	--



Site Boundary Existing Landfill	Previous Slit Trench Boring Locations Soil Boring Soil Vapor	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	Corrective Action Management Unit (CAMU) BMI Complex, Henderson, Nevada FIGURE 5-44 SLIT TRENCH AREA SUPPLEMENTAL SAMPLING	
Daniel B. Stephens & Associates, Inc. JN ES05.0067		Prepared by: MWH MKJ Date: 02/13/07 JOB No. 1881425 FILE: GIS/BRC/CAMU/SLIT_TRENCH/FIGURE.MXD			



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

1,2,4-TCB = 1,2,4-Trichlorobenzene

1,2-DCB = 1,2-Dichlorobenzene

1,4-DCB = 1,4-Dichlorobenzene

HCB = Hexachlorobenzene

Notes:

Concentrations shown are for surrogate chemicals representing chemical classes as discussed in text. Soil chemicals listed are those that exceed either or both of the EPA Region 9 Industrial PRG (or ATSDR screening value of 50 ppt for TCDD TEQs) and the SSL (DAF-1) at each sample location and depth. Metals and radionuclide concentrations are posted where they exceed the upper end of the background concentration range as discussed in text.

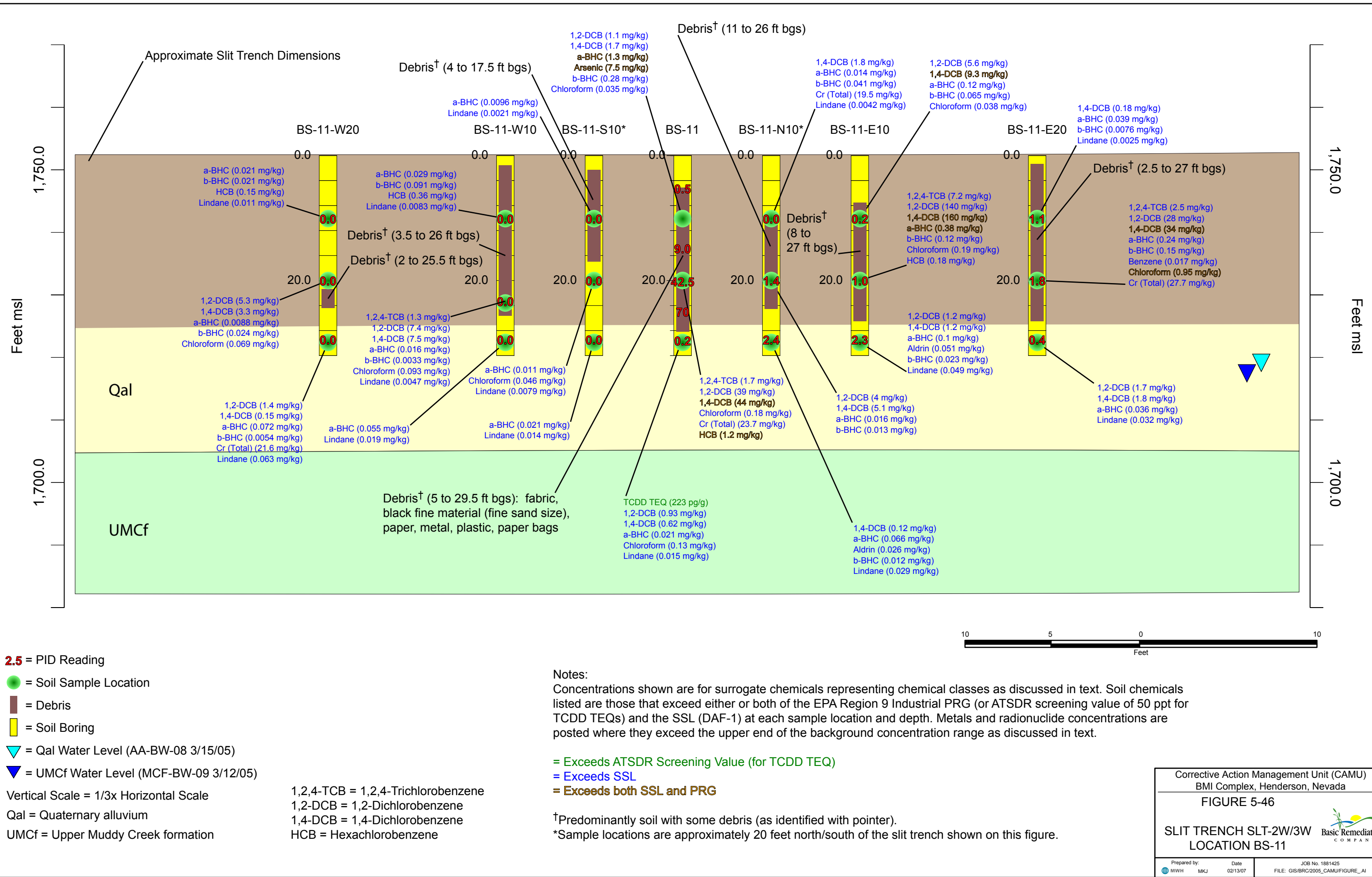
■ = Exceeds ATSDR Screening Value (for TCDD TEQ)

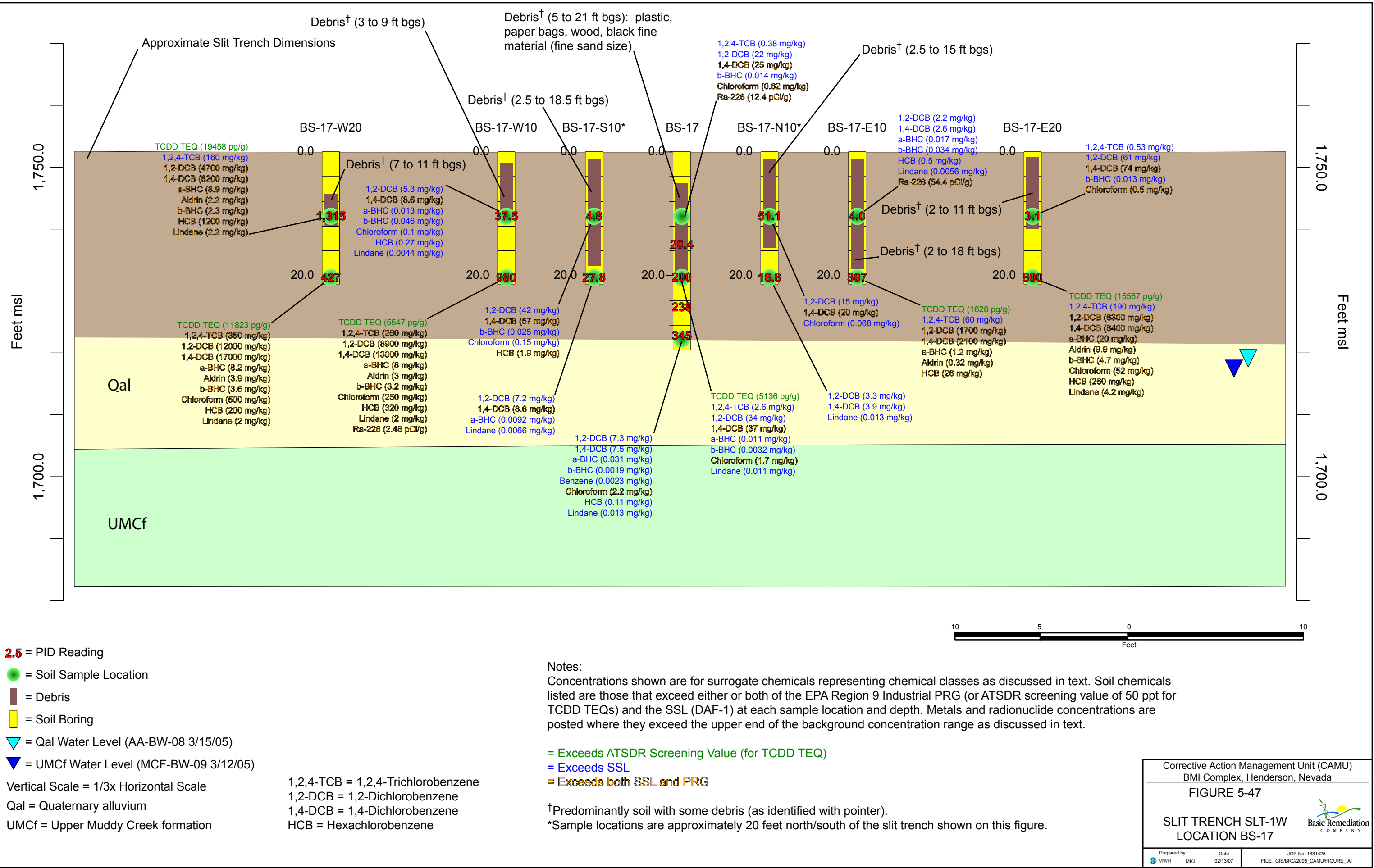
■ = Exceeds SSL

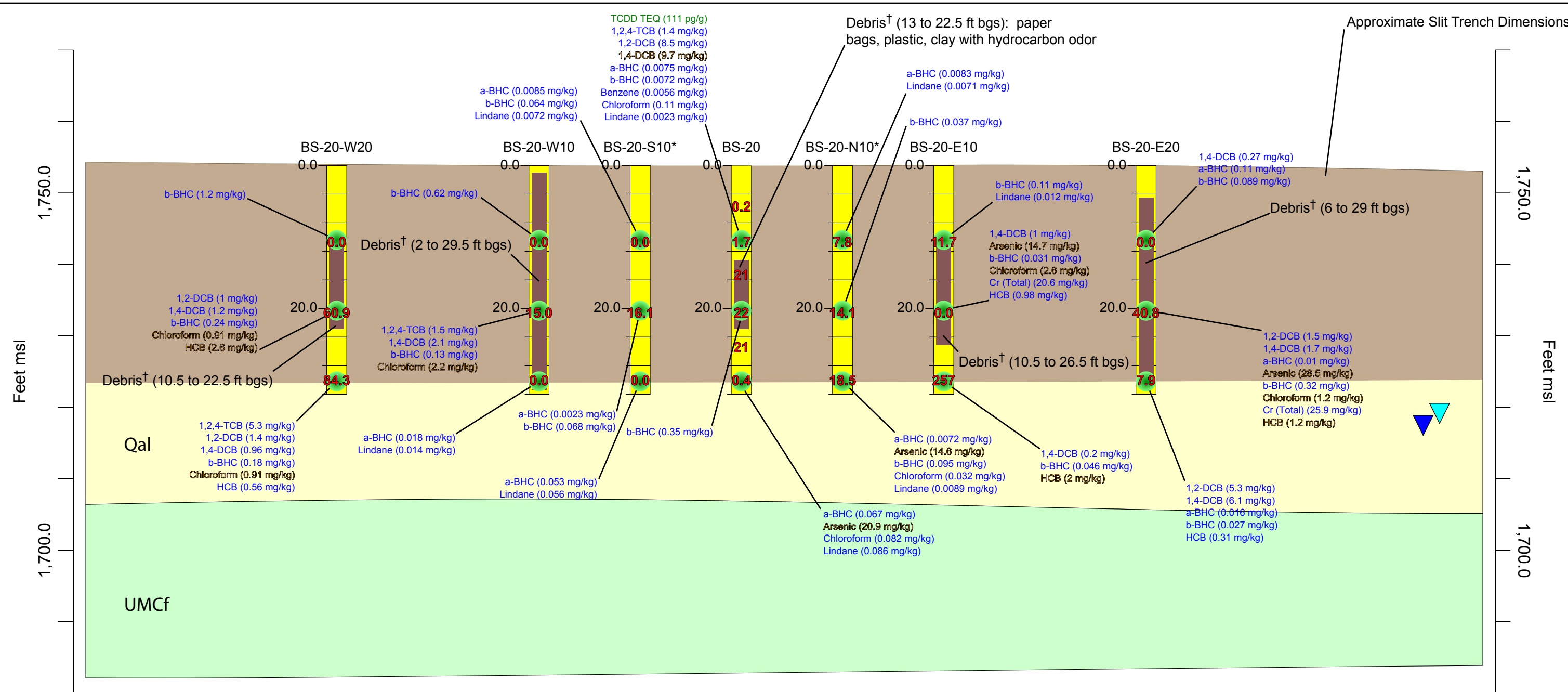
■ = Exceeds both SSL and PRG

†Predominantly soil with some debris (as identified with pointer).

*Sample locations are approximately 20 feet north/south of the slit trench shown on this figure.







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

1,2,4-TCB = 1,2,4-Trichlorobenzene

1,2-DCB = 1,2-Dichlorobenzene

1,4-DCB = 1,4-Dichlorobenzene

HCb = Hexachlorobenzene

Notes:

Concentrations shown are for surrogate chemicals representing chemical classes as discussed in text. Soil chemicals listed are those that exceed either or both of the EPA Region 9 Industrial PRG (or ATSDR screening value of 50 ppt for TCDD TEQs) and the SSL (DAF-1) at each sample location and depth. Metals and radionuclide concentrations are posted where they exceed the upper end of the background concentration range as discussed in text.

= Exceeds ATSDR Screening Value (for TCDD TEQ)

= Exceeds SSL

= Exceeds both SSL and PRG

†Predominantly soil with some debris (as identified with pointer).

*Sample locations are approximately 20 feet north/south of the slit trench shown on this figure.

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

FIGURE 5-48

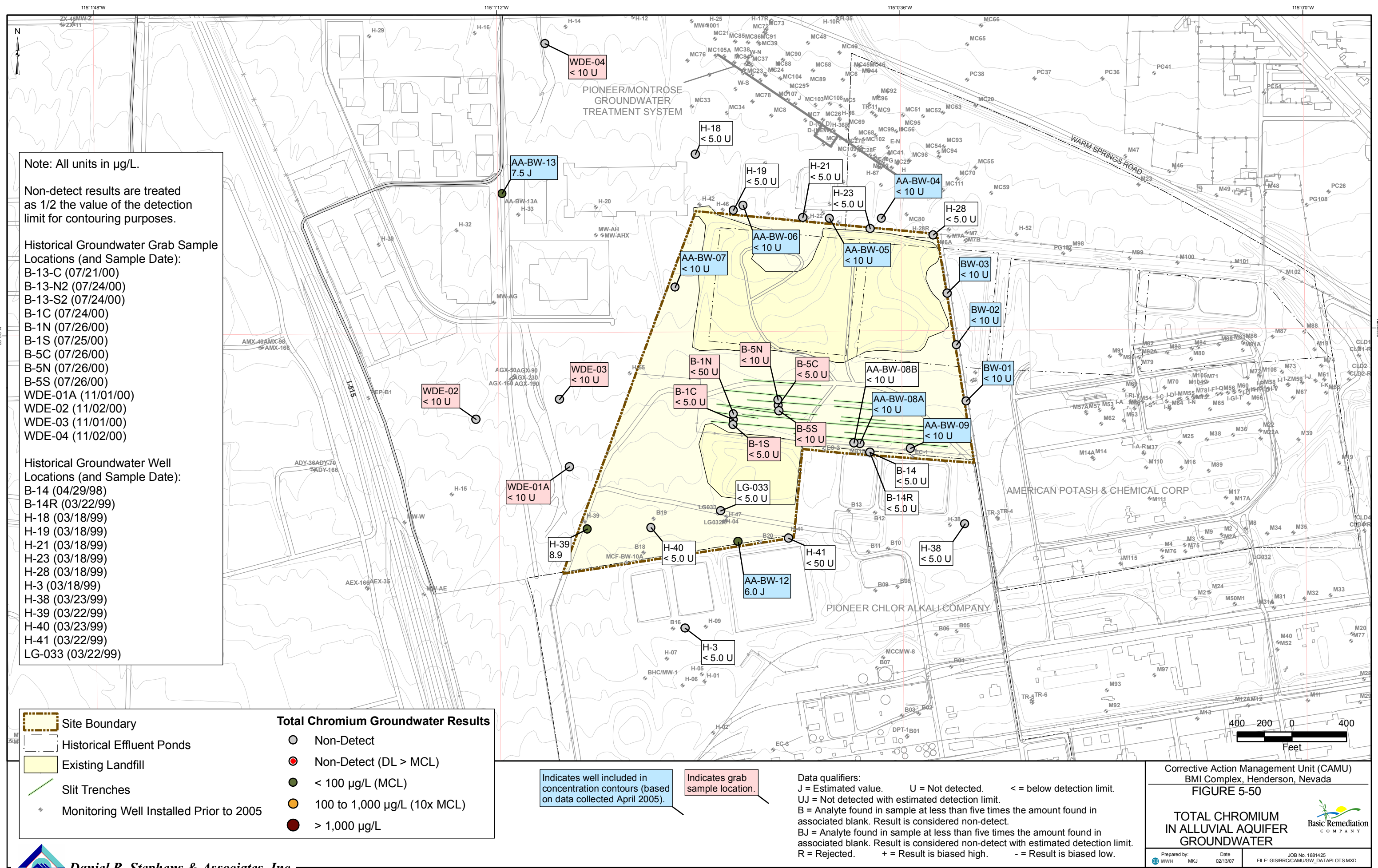
SLIT TRENCH SLT-1E
LOCATION BS-20



Prepared by:
MWH

Date:
02/13/07

JOB No. 1881425
FILE: GIS/BRC/2005_CAMU/FIGURE_AI



Note: All units in µg/L.

Non-detect results are treated as 1/2 the value of the detection limit for contouring purposes.

Historical Groundwater Grab Sample Locations (and Sample Date):
B-13-C (07/21/00)
B-13-N2 (07/24/00)
B-13-S2 (07/24/00)
B-1C (07/24/00)
B-1N (07/26/00)
B-1S (07/25/00)
B-5C (07/26/00)
B-5N (07/26/00)
B-5S (07/26/00)
WDE-01A (11/01/00)
WDE-02 (11/02/00)
WDE-03 (11/01/00)
WDE-04 (11/02/00)

Historical Groundwater Well Locations (and Sample Date):
B-14 (04/29/98)
B-14R (03/22/99)
H-18 (03/18/99)
H-19 (03/18/99)
H-21 (03/18/99)
H-23 (03/18/99)
H-28 (03/18/99)
H-3 (03/18/99)
H-38 (03/23/99)
H-39 (03/22/99)
H-40 (03/23/99)
H-41 (03/22/99)
LG-033 (03/22/99)

Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

Monitoring Well Installed Prior to 2005

Total Chromium Groundwater Results

Non-Detect

Non-Detect (DL > MCL)

< 100 µg/L (MCL)

100 to 1,000 µg/L (10x MCL)

> 1,000 µg/L

Indicates well included in concentration contours (based on data collected April 2005).

Indicates grab sample location.

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE 5-50

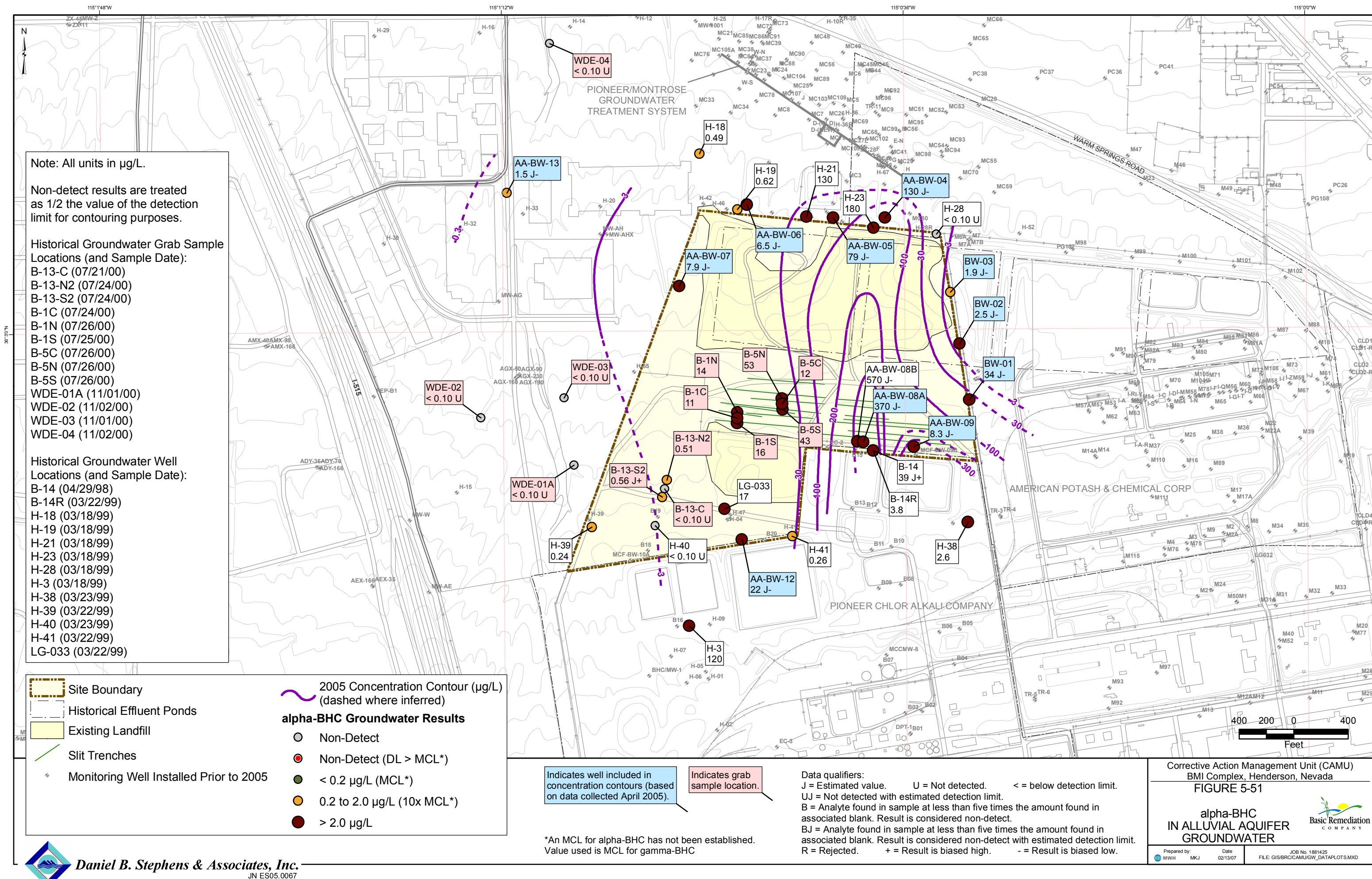
TOTAL CHROMIUM
IN ALLUVIAL AQUIFER
GROUNDWATER

Prepared by:
MWH

Date:
02/13/07

JOB No. 1881425
FILE: GIS\BRC\CAMU\GW_DATA\PLOTS\MXD

Basic Remediation
COMPANY



Note: All units in $\mu\text{g/L}$.

Non-detect results are treated as 1/2 the value of the detection limit for contouring purposes.

Historical Groundwater Grab Sample Locations (and Sample Date):

- B-13-C (07/21/00)
- B-13-N2 (07/24/00)
- B-13-S2 (07/24/00)
- B-1C (07/24/00)
- B-1N (07/26/00)
- B-1S (07/25/00)
- B-5C (07/26/00)
- B-5N (07/26/00)
- B-5S (07/26/00)
- WDE-01A (11/01/00)
- WDE-02 (11/02/00)
- WDE-03 (11/01/00)
- WDE-04 (11/02/00)

Historical Groundwater Well Locations (and Sample Date):

- B-14 (04/29/98)
- B-14R (03/22/99)
- H-18 (03/18/99)
- H-19 (03/18/99)
- H-21 (03/18/99)
- H-23 (03/18/99)
- H-28 (03/18/99)
- H-3 (03/18/99)
- H-38 (03/23/99)
- H-39 (03/22/99)
- H-40 (03/23/99)
- H-41 (03/22/99)
- LG-033 (03/22/99)

- Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

Monitoring Well Installed Prior to 2005
- 2005 Concentration Contour ($\mu\text{g/L}$) (dashed where inferred)

alpha-BHC Groundwater Results

Non-Detect

Non-Detect (DL > MCL*)

< 0.2 $\mu\text{g/L}$ (MCL*)

0.2 to 2.0 $\mu\text{g/L}$ (10x MCL*)

> 2.0 $\mu\text{g/L}$

Indicates well included in concentration contours (based on data collected April 2005).

Indicates grab sample location.

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.

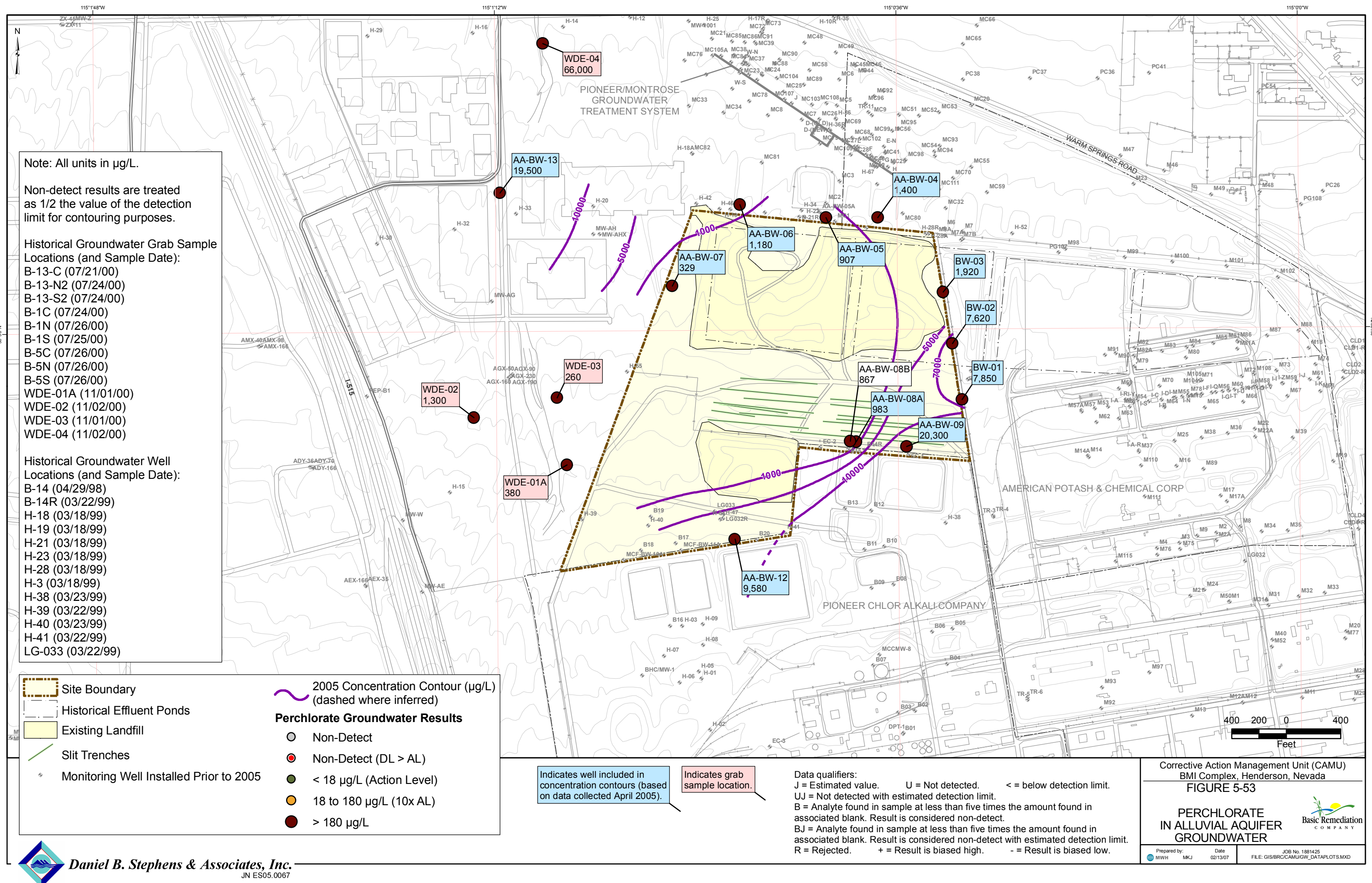
*An MCL for alpha-BHC has not been established. Value used is MCL for gamma-BHC

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE 5-51

alpha-BHC
IN ALLUVIAL AQUIFER
GROUNDWATER



Prepared by: MWH Date: 02/13/07
JOB No. 1881425
FILE: GIS/BRC/CAMU/GW_DATAPLOTS.MXD



Note: All units in µg/L.

Non-detect results are treated as 1/2 the value of the detection limit for contouring purposes.

Historical Groundwater Grab Sample Locations (and Sample Date):

- B-13-C (07/21/00)
- B-13-N2 (07/24/00)
- B-13-S2 (07/24/00)
- B-1C (07/24/00)
- B-1N (07/26/00)
- B-1S (07/25/00)
- B-5C (07/26/00)
- B-5N (07/26/00)
- B-5S (07/26/00)
- WDE-01A (11/01/00)
- WDE-02 (11/02/00)
- WDE-03 (11/01/00)
- WDE-04 (11/02/00)

Historical Groundwater Well Locations (and Sample Date):

- B-14 (04/29/98)
- B-14R (03/22/99)
- H-18 (03/18/99)
- H-19 (03/18/99)
- H-21 (03/18/99)
- H-23 (03/18/99)
- H-28 (03/18/99)
- H-3 (03/18/99)
- H-38 (03/23/99)
- H-39 (03/22/99)
- H-40 (03/23/99)
- H-41 (03/22/99)
- LG-033 (03/22/99)

Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

Monitoring Well Installed Prior to 2005

2005 Concentration Contour (µg/L)
(dashed where inferred)

Perchlorate Groundwater Results

Non-Detect

Non-Detect (DL > AL)

< 18 µg/L (Action Level)

18 to 180 µg/L (10x AL)

> 180 µg/L

Indicates well included in concentration contours (based on data collected April 2005).

Indicates grab sample location.


Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.

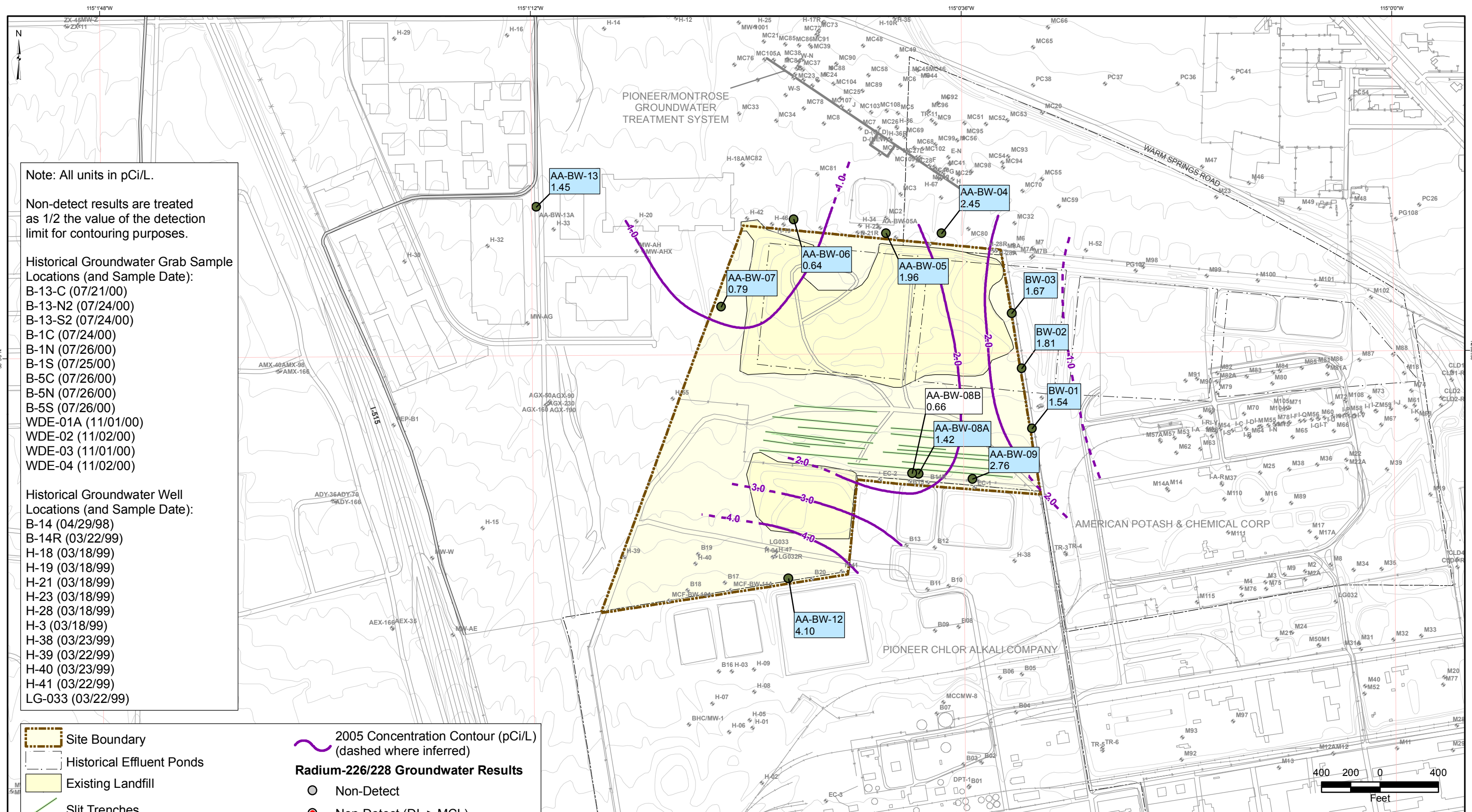
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE 5-53

PERCHLORATE
IN ALLUVIAL AQUIFER
GROUNDWATER

Prepared by: MWH Date: 02/13/07
JOB No. 1881425
FILE: GIS\BRC\CAMU\GW_DATA\PLOTS\MXD

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JN ES05.0067



Note: All units in pCi/L.

Non-detect results are treated as 1/2 the value of the detection limit for contouring purposes.

Historical Groundwater Grab Sample Locations (and Sample Date):

B-13-C (07/21/00)
B-13-N2 (07/24/00)
B-13-S2 (07/24/00)
B-1C (07/24/00)
B-1N (07/26/00)
B-1S (07/25/00)
B-5C (07/26/00)
B-5N (07/26/00)
B-5S (07/26/00)
WDE-01A (11/01/00)
WDE-02 (11/02/00)
WDE-03 (11/01/00)
WDE-04 (11/02/00)

Historical Groundwater Well Locations (and Sample Date):

B-14 (04/29/98)
B-14R (03/22/99)
H-18 (03/18/99)
H-19 (03/18/99)
H-21 (03/18/99)
H-23 (03/18/99)
H-28 (03/18/99)
H-3 (03/18/99)
H-38 (03/23/99)
H-39 (03/22/99)
H-40 (03/23/99)
H-41 (03/22/99)
LG-033 (03/22/99)

Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

Monitoring Well Installed Prior to 2005

2005 Concentration Contour (pCi/L)
(dashed where inferred)

Radium-226/228 Groundwater Results

○ Non-Detect

● Non-Detect (DL > MCL)

● < 5.0 pCi/L (MCL)

● 5.0 to 50 pCi/L (10x MCL)

● > 50 pCi/L

Indicates well included in concentration contours (based on data collected April 2005).

Indicates grab sample location.

Data qualifiers:

J = Estimated value. U = Not detected. < = below detection limit.

UJ = Not detected with estimated detection limit.

B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.

BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.

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

FIGURE 5-54

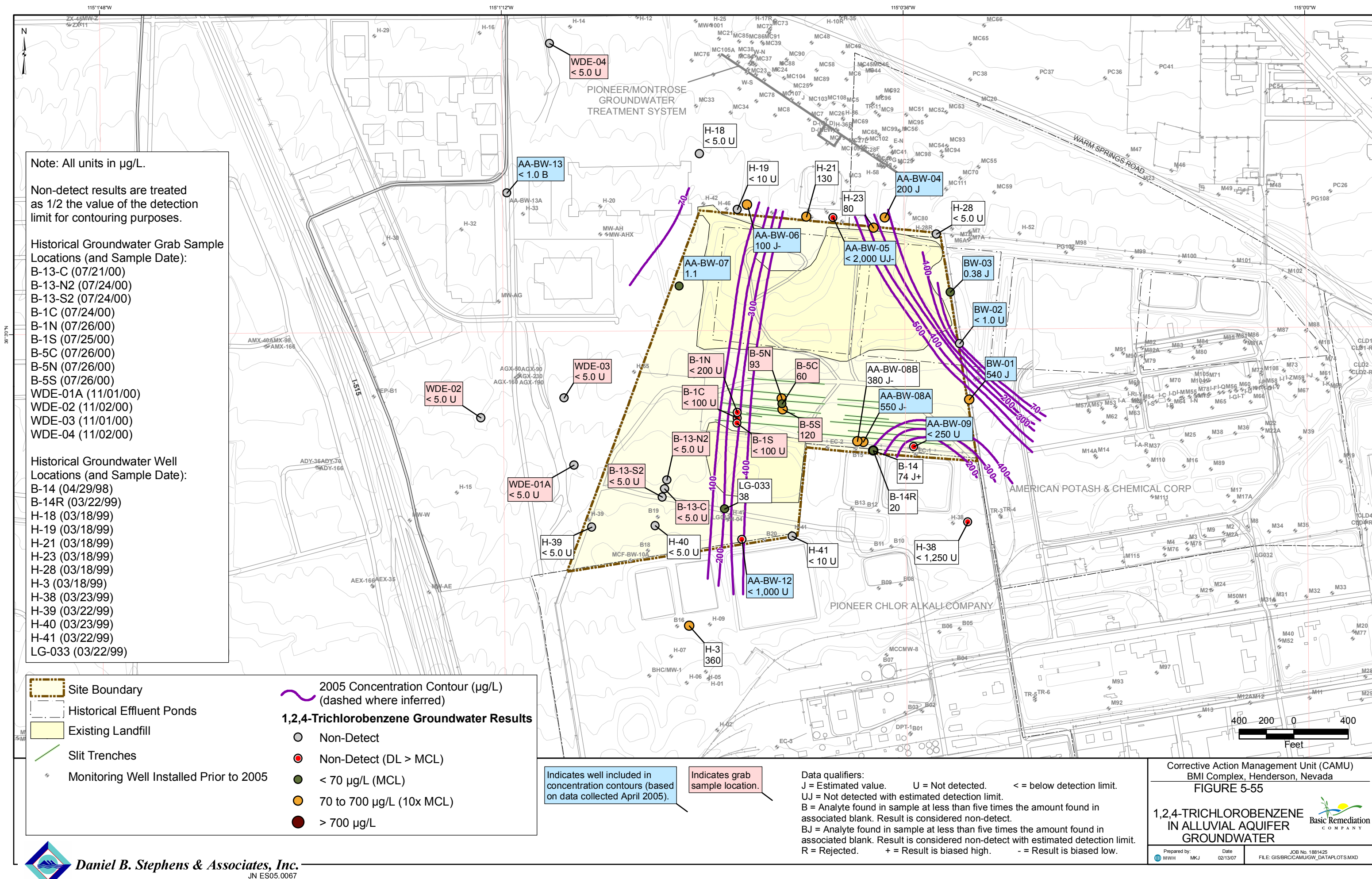
**RADIUM-226/228
IN ALLUVIAL AQUIFER
GROUNDWATER**

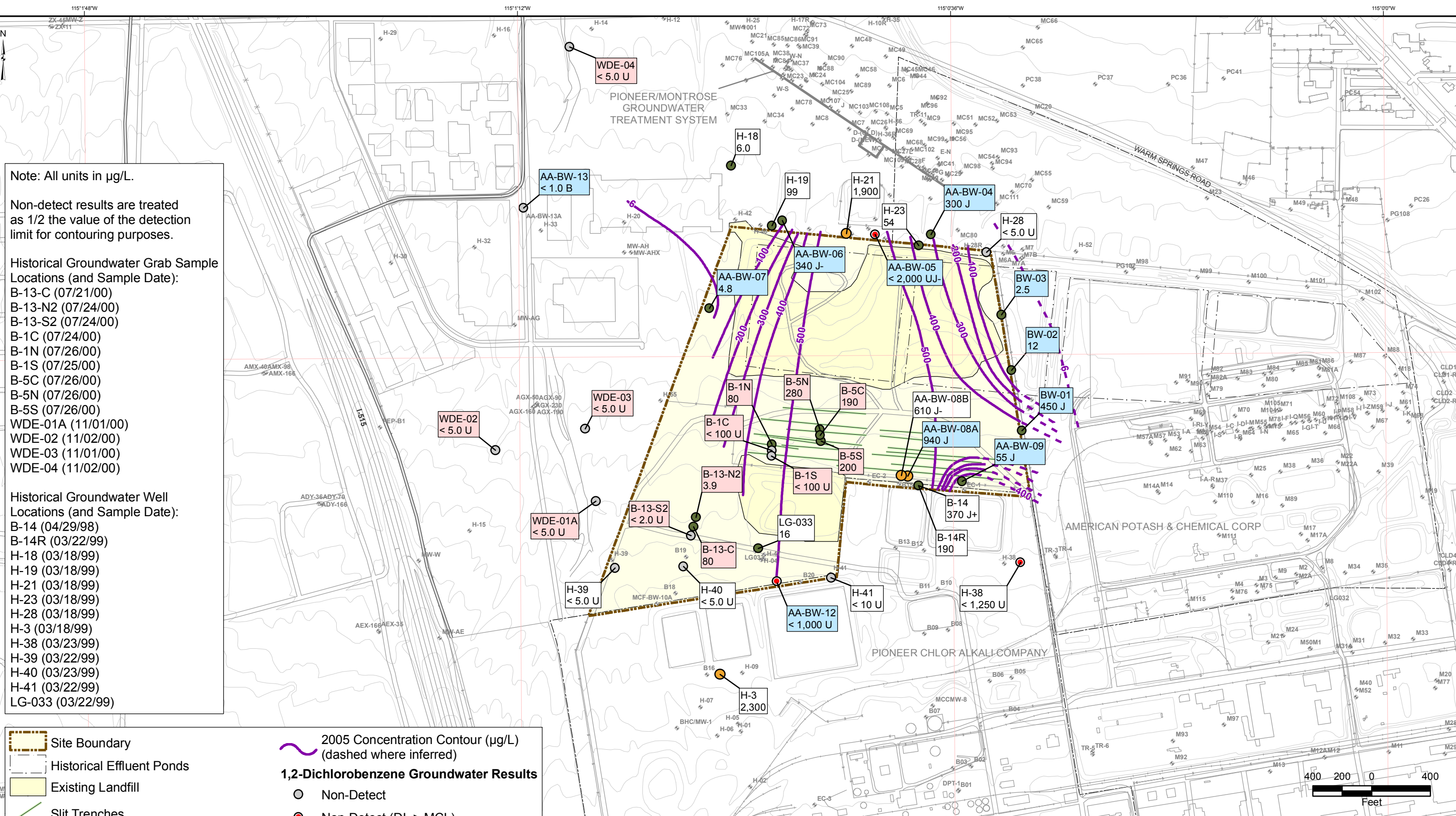


Prepared by:
MWH MKJ

Date:
02/13/07

JOB No. 1881425
FILE: GIS\BRC\CAMU\GW_DATAPLOTS.MXD





Note: All units in µg/L.

Non-detect results are treated as 1/2 the value of the detection limit for contouring purposes.

Historical Groundwater Grab Sample Locations (and Sample Date):

- B-13-C (07/21/00)
- B-13-N2 (07/24/00)
- B-13-S2 (07/24/00)
- B-1C (07/24/00)
- B-1N (07/26/00)
- B-1S (07/25/00)
- B-5C (07/26/00)
- B-5N (07/26/00)
- B-5S (07/26/00)
- WDE-01A (11/01/00)
- WDE-02 (11/02/00)
- WDE-03 (11/01/00)
- WDE-04 (11/02/00)

Historical Groundwater Well Locations (and Sample Date):

- B-14 (04/29/98)
- B-14R (03/22/99)
- H-18 (03/18/99)
- H-19 (03/18/99)
- H-21 (03/18/99)
- H-23 (03/18/99)
- H-28 (03/18/99)
- H-3 (03/18/99)
- H-38 (03/23/99)
- H-39 (03/22/99)
- H-40 (03/23/99)
- H-41 (03/22/99)
- LG-033 (03/22/99)

Site Boundary

Historical Effluent Ponds

Existing Landfill

Slit Trenches

Monitoring Well Installed Prior to 2005

2005 Concentration Contour (µg/L)
(dashed where inferred)

1,2-Dichlorobenzene Groundwater Results

Non-Detect

Non-Detect (DL > MCL)

< 600 µg/L (MCL)

600 to 6,000 µg/L (10x MCL)

> 6,000 µg/L

Indicates well included in concentration contours (based on data collected April 2005).

Indicates grab sample location.

Data qualifiers:
J = Estimated value. U = Not detected. < = below detection limit.
UJ = Not detected with estimated detection limit.
B = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect.
BJ = Analyte found in sample at less than five times the amount found in associated blank. Result is considered non-detect with estimated detection limit.
R = Rejected. + = Result is biased high. - = Result is biased low.

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BMI Complex, Henderson, Nevada

FIGURE 5-56

1,2-DICHLOROBENZENE
IN ALLUVIAL AQUIFER
GROUNDWATER

Prepared by:
MWH

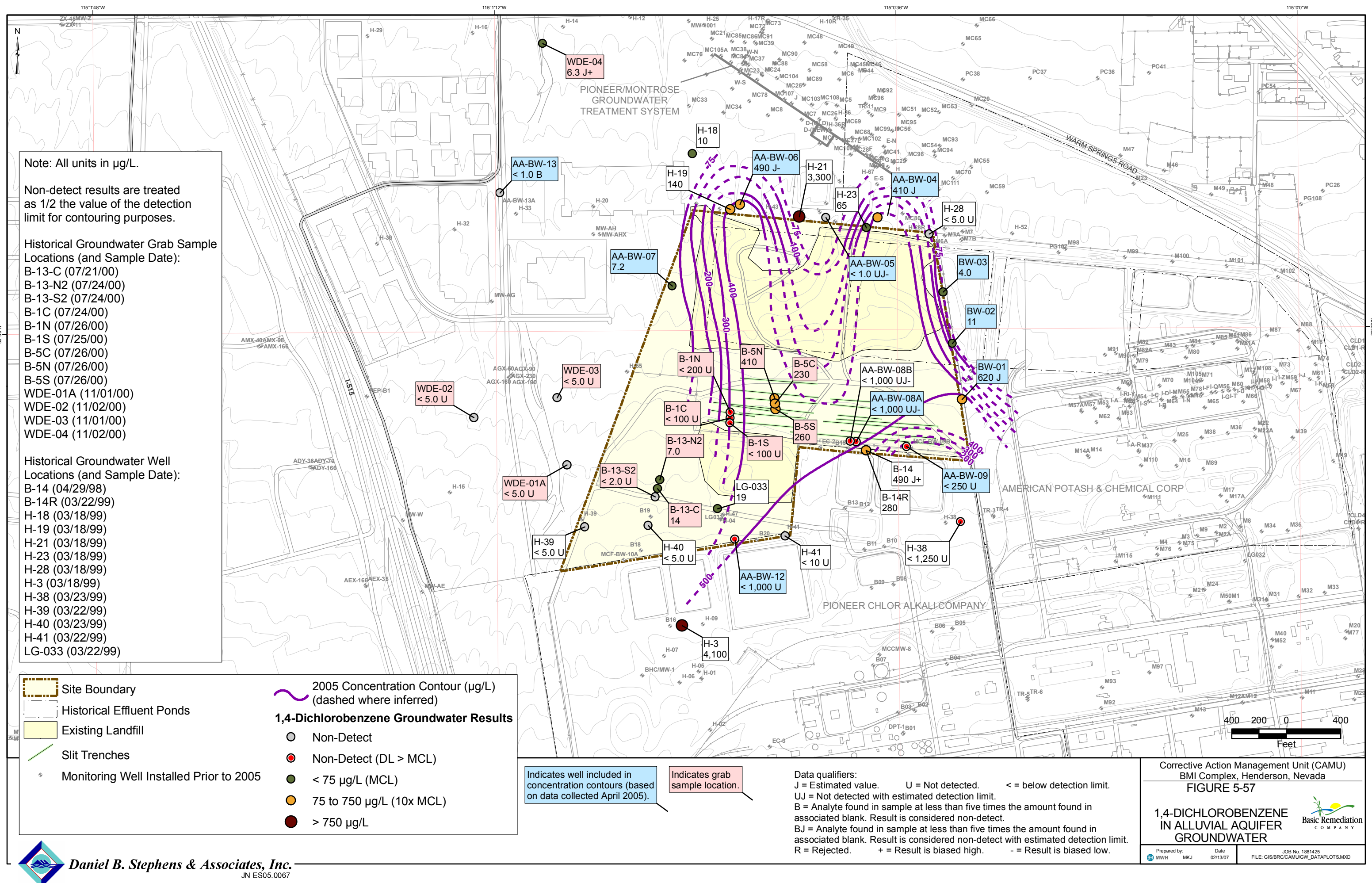
Date:
02/13/07

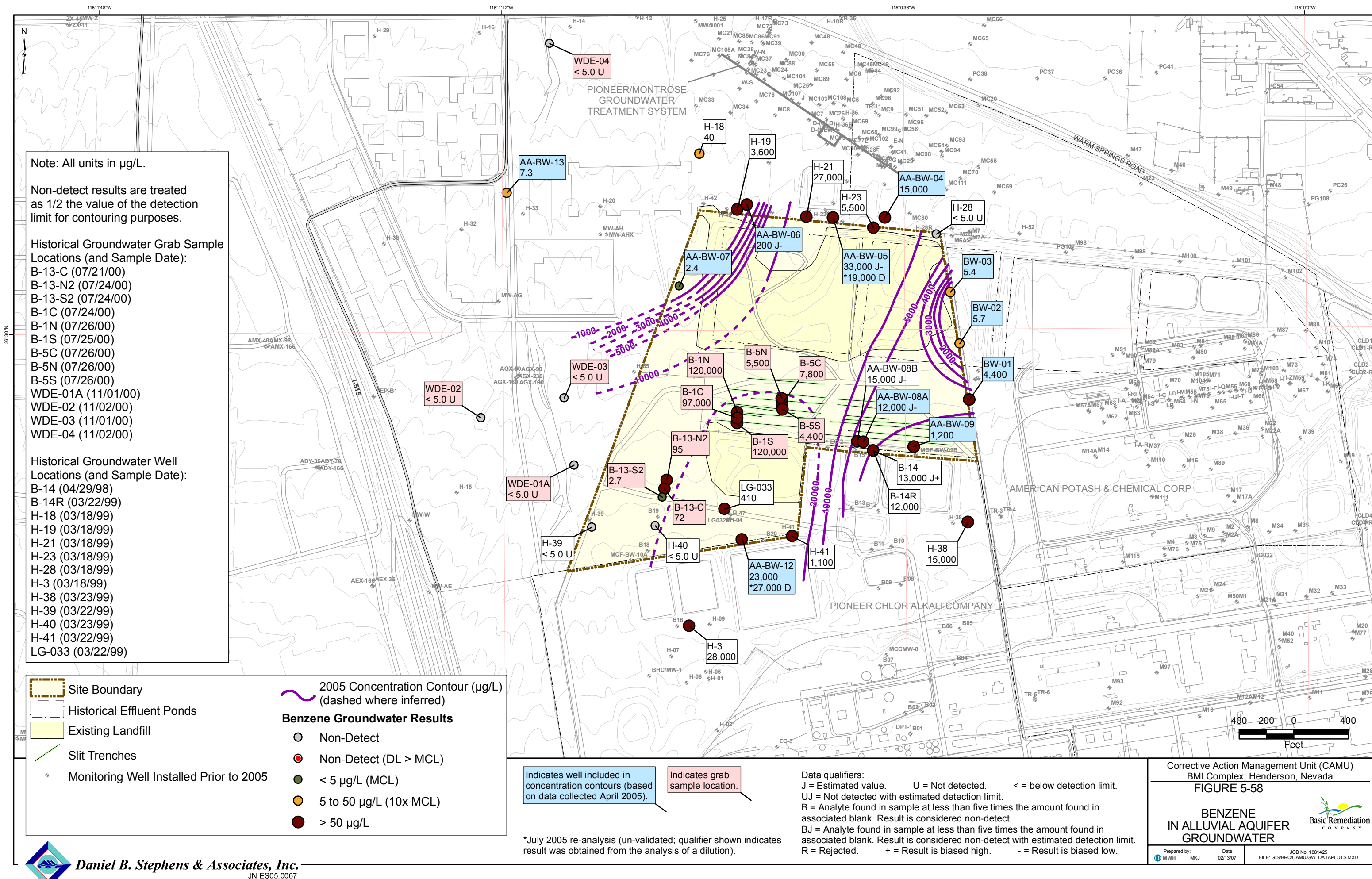
JOB No. 1881425
FILE: GIS\BRC\CAMU\GW_DATA\PLOTS\MXD

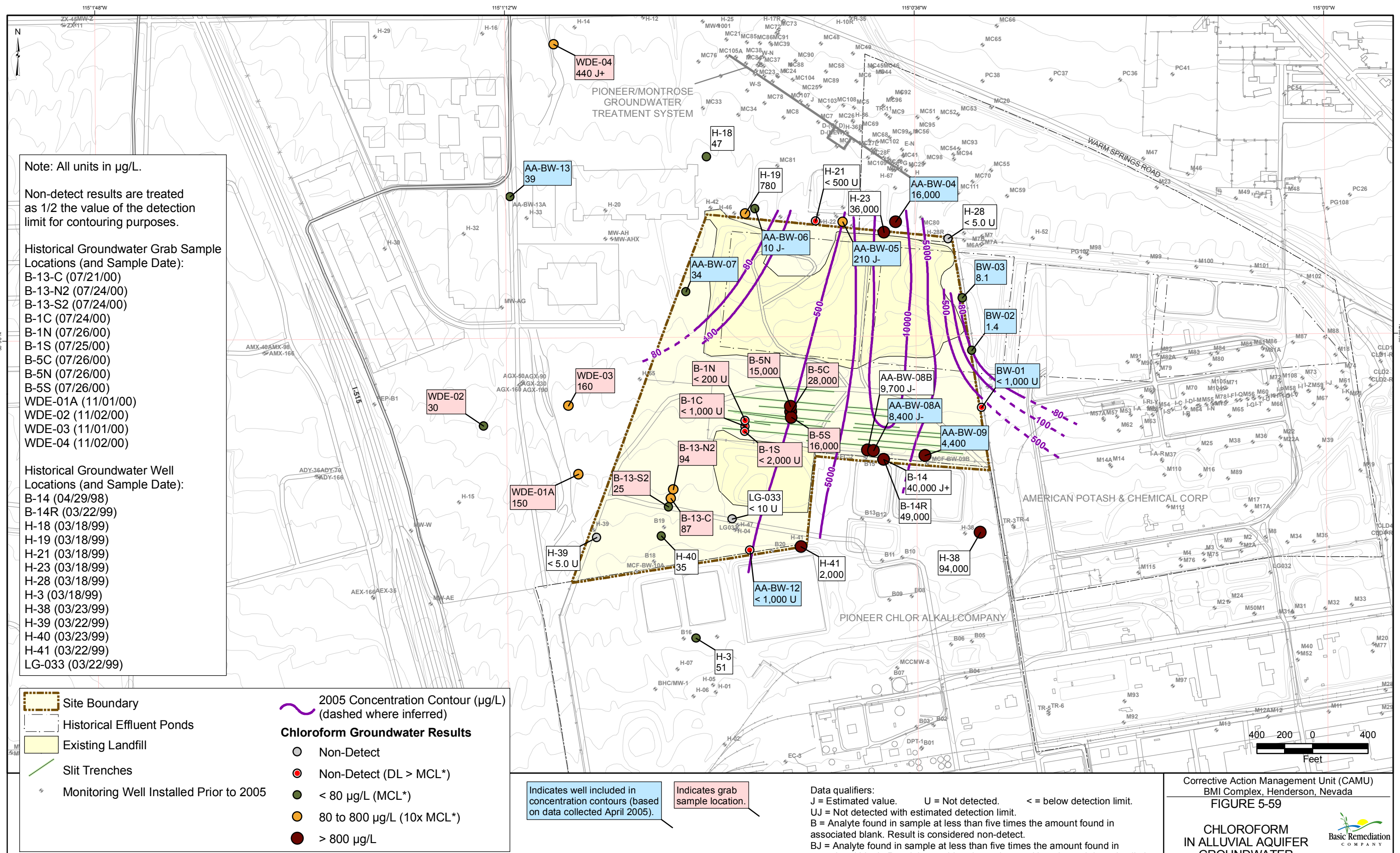
Basic Remediation
COMPANY

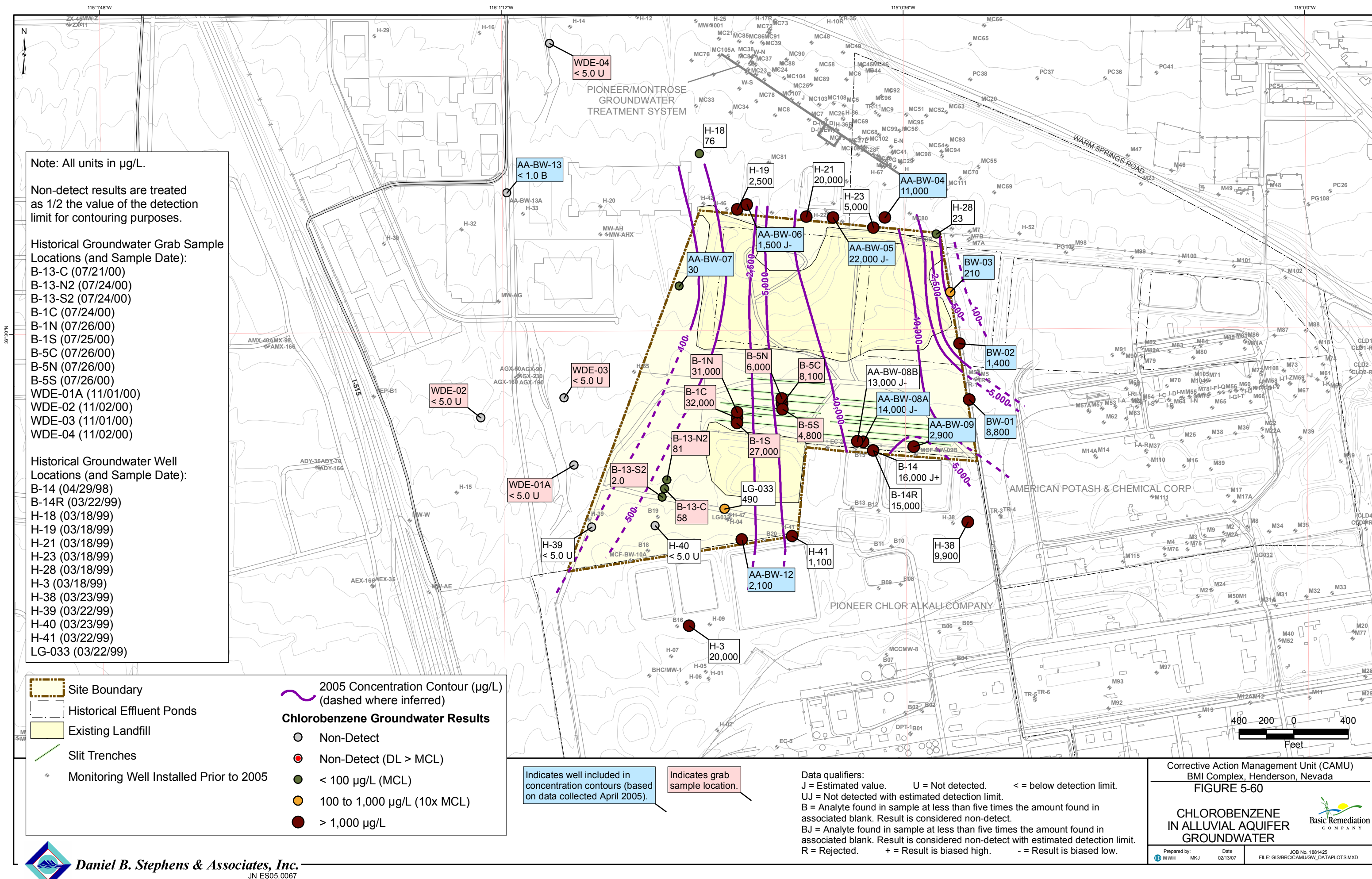
Daniel B. Stephens & Associates, Inc.

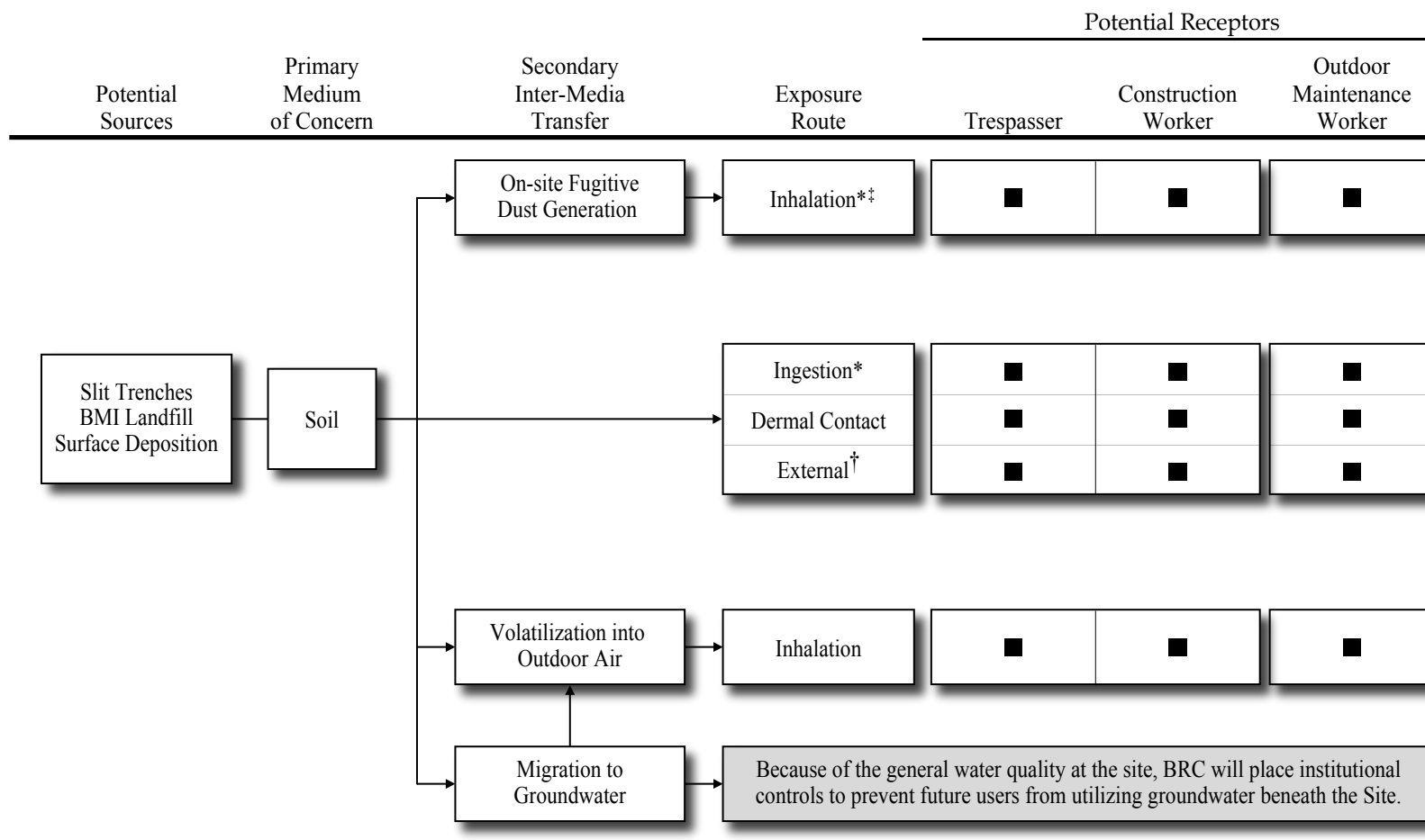
JN ES05.0067











□ - Incomplete or insignificant exposure pathway.

■ - Complete exposure pathway to CAMU site soil.

*Includes radionuclide exposures.

†Only radionuclide exposures.

‡Includes asbestos exposures.

Notes:

- Current receptors that may access the property include construction workers and trespassers. Outdoor maintenance workers are assumed to only access the soil following CAMU construction.
- Because the future anticipated use of the CAMU site precludes use for residential, future residential exposures are not considered.
- Because of the nature of the CAMU site, no ecological receptors of concern have been identified (see Section 8.2).
- Exposures to potential nearby, off-site receptors that may be impacted during construction activities will be less than those for on-site receptors.

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

FIGURE 8-1

CONCEPTUAL SITE
MODEL DIAGRAM FOR
POTENTIAL EXPOSURES



Prepared by:
MWH MKJ

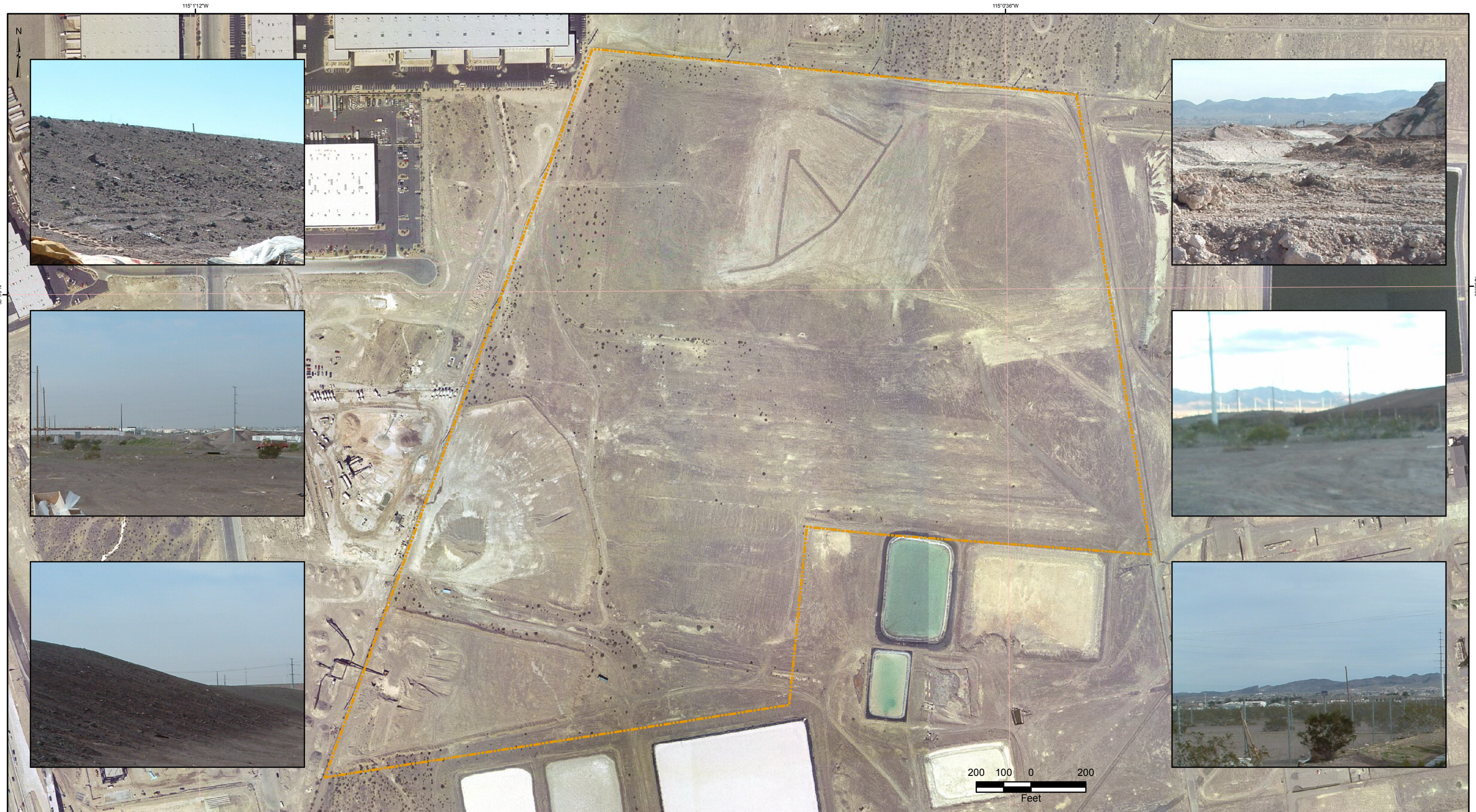
Date:
10/16/06

JOB No. 1881425
FILE: GIS/BRC/CAMU/CSM_DIAGRAM.AI



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Fall 2005 Aerial Photo.

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

FIGURE 8-2
AERIAL PHOTOGRAPH
AND SITE PHOTOS



Prepared by:
MWH MKJ

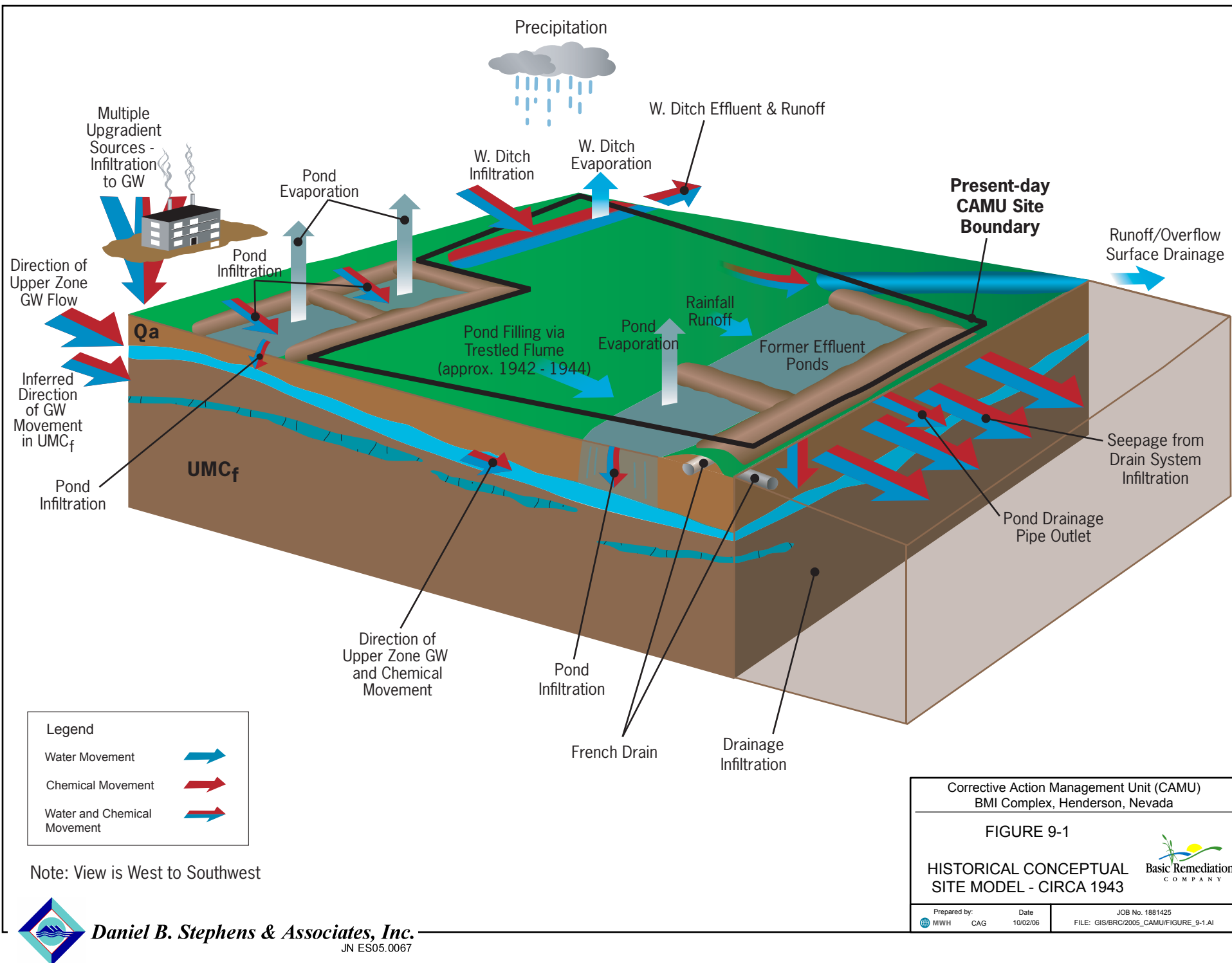
Date
10/16/06

JOB No. 1881425
FILE: GIS/BRC/CAMU/AERIAL.MXD

Site Boundary

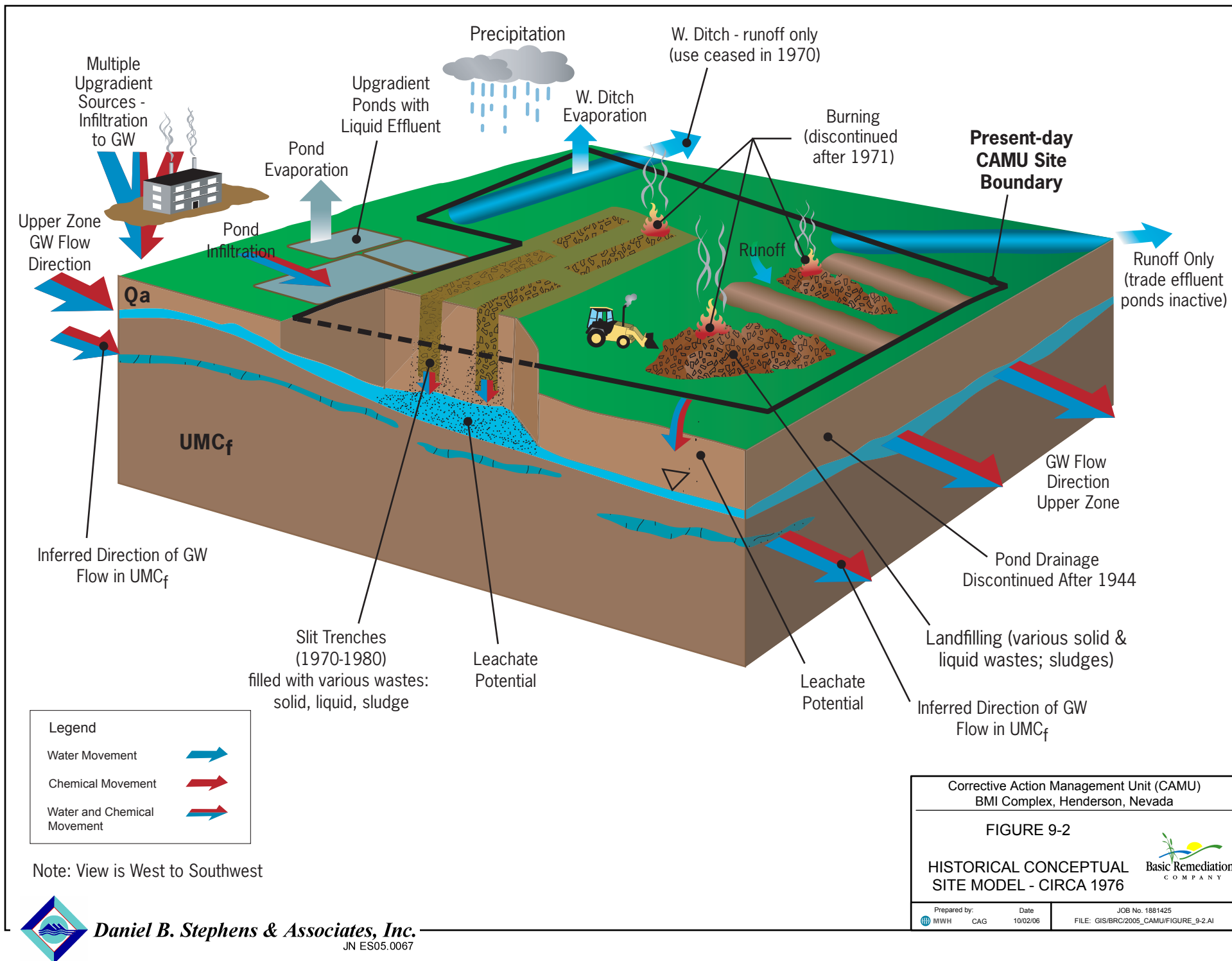


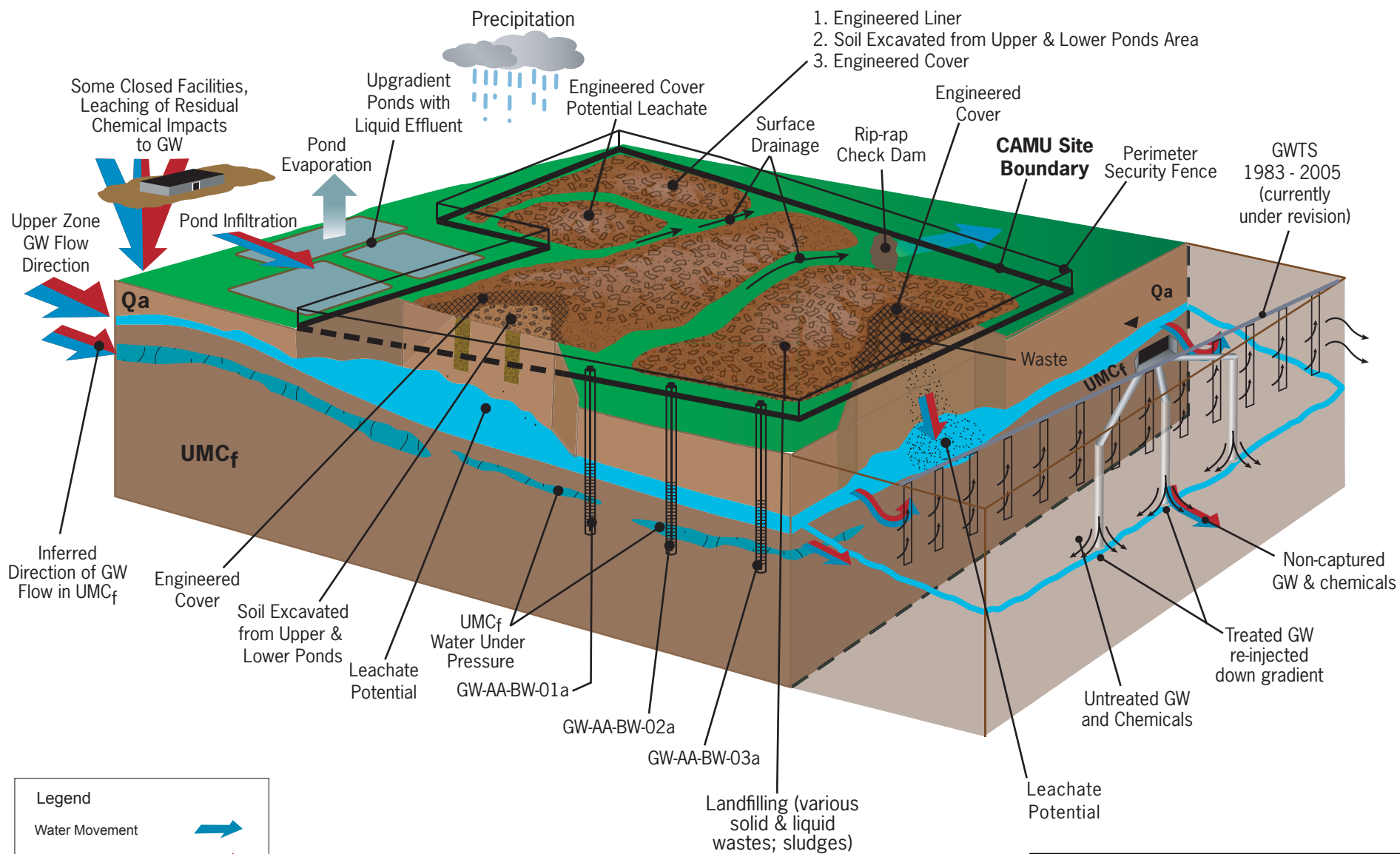
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Note: View is West to Southwest



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

FIGURE 9-4

**CONCEPTUAL SITE MODEL
FUTURE SCENARIO WITH
CAMU IN PLACE**



Prepared by: MWH CAG Date: 10/02/06 JOB No. 1881425
FILE: GIS/BRC/2005_CAMU/FIGURE_9-4.AI

Tables

Table 3-1. Materials Disposed of in the North Landfill Lobe

<i>Solid Waste</i>	
<ul style="list-style-type: none"> • Refinery slag • Concrete cell parts • Asbestos-containing wastes • Miscellaneous operating wastes (paper, wood, cardboard, etc.) • DDT paper bag packaging • Chlorate filter cake wastes (silica, graphite, calcium carbonate, calcium sulfate) • Dried residue from ammonium perchlorate, potassium chlorate and perchlorate, sodium perchlorate, and Boron operations waste • Solidified waste paints • Dolomitic stone • Waste steel • Floor sweepings • Baking soda • Borax • Sodium chloride • Noncombustible trash (glass, bricks, etc.) • Scrap titanium fines • Chlorinator bed dump materials (consisting of unreacted rutile, coke, zircon, and quartz) 	<ul style="list-style-type: none"> • Spent packing tower material • Chlorinator cleanings • Graphite anodes • Asbestos sludge • Mechanical equipment and non-metallic scrap • Unidentified drums • Elemental carbon powder • Type "S" hydrated lime • Kiln flue dust (10% CaO-MgO, 90% CaCO₃-MgCO₃) • Asbestos pipe wrapping • Soda ash • Diatomaceous earth • Vermiculite clays • Sodium sulfate • Sludge dryer residue (Coke, rutile ore, zirconium, silicon dioxide and metal oxides) • Magnesium cell smut (MgO, MgCl, CaCl₂, NaCl, KCl, Mg metal) • Dust collectors (Ti metal, MgCl₂, Mg metal)
<i>Liquid Waste</i>	
<ul style="list-style-type: none"> • Acid effluent • Waste caustic liquor • Chlorine liquefaction sludge 	<ul style="list-style-type: none"> • Carbon tetrachloride waste • High paraffin fuel oil • Polychlorinated benzene still bottom residues

Table 3-2. Off-Site Operations Potentially Resulting in Impacts to Soil and Groundwater

<ul style="list-style-type: none">• Benzene storage and loading facility	<ul style="list-style-type: none">• A one-acre bulk chemical tank farm area
<ul style="list-style-type: none">• Rail car loading and unloading areas	<ul style="list-style-type: none">• Wastewater treatment ponds
<ul style="list-style-type: none">• Salt storage area	<ul style="list-style-type: none">• Waste disposal areas
<ul style="list-style-type: none">• Two wastewater ponds (Stauffer)	<ul style="list-style-type: none">• Chemical storage areas
<ul style="list-style-type: none">• Five wastewater ponds and one SBR disposal pond (Montrose)	<ul style="list-style-type: none">• Former Stauffer ACD and Lindane plants

SBR = Still bottom residue

ACD = Agricultural Chemical Division

Table 4-1. Soil Screening Criteria
Page 1 of 11

CAS	Analyte	DAF 1	Industrial PRG	Background
630-20-6	1,1,1,2-Tetrachloroethane		7.3	
71-55-6	1,1,1-Trichloroethane	0.1	1200	
79-34-5	1,1,2,2-Tetrachloroethane	0.0002	0.93	
79-00-5	1,1,2-Trichloroethane	0.0009	1.6	
2050-68-2	1,1'-Biphenyl, 4,4'-dichloro-			
782-08-1	1,1-Bis(4-chlorophenyl)chloromethane			
75-34-3	1,1-Dichloroethane	1	1700	
75-35-4	1,1-Dichloroethylene	0.003	410	
563-58-6	1,1-Dichloropropene			
67562-39-4	1,2,3,4,6,7,8-Heptachlorodibenzofuran			
35822-46-9	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin			
55673-89-7	1,2,3,4,7,8,9-Heptachlorodibenzofuran			
70648-26-9	1,2,3,4,7,8-Hexachlorodibenzofuran			
39227-28-6	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin			
57117-44-9	1,2,3,6,7,8-Hexachlorodibenzofuran			
57653-85-7	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin			
72918-21-9	1,2,3,7,8,9-Hexachlorodibenzofuran			
19408-74-3	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin			
57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran			
40321-76-4	1,2,3,7,8-Pentachlorodibenzo-p-dioxin			
87-61-6	1,2,3-Trichlorobenzene			
96-18-4	1,2,3-Trichloropropane		0.076	
95-94-3	1,2,4,5-Tetrachlorobenzene		180	
291-22-5	1,2,4,5-Tetrathiane			
120-82-1	1,2,4-Trichlorobenzene	0.3	220	
95-63-6	1,2,4-Trimethylbenzene		170	
289-16-7	1,2,4-Trithiolane			
6576-93-8	1,2,5-Trithiepane			
34006-77-4	1,2-Benzenedicarboxylic acid,			
84-69-5	1,2-Benzenedicarboxylic acid,			
96-12-8	1,2-Dibromo-3-chloropropane (DBCP)		2	
106-93-4	1,2-Dibromoethane		0.073	
95-50-1	1,2-Dichlorobenzene	0.9	600	
107-06-2	1,2-Dichloroethane	0.001	0.6	
540-59-0	1,2-Dichloroethylene			
78-87-5	1,2-Dichloropropane	0.001	0.74	
76-14-2	1,2-Dichlorotetrafluoroethane; Fluorocarbon 114			
108-70-3	1,3,5- Trichlorobenzene			
108-67-8	1,3,5-Trimethylbenzene		70	
106-99-0	1,3-Butadiene		0.12	
55880-77-8	1,3-Butadiene, pentachloro-			
541-73-1	1,3-Dichlorobenzene		600	
142-28-9	1,3-Dichloropropane		360	
106-46-7	1,4-Dichlorobenzene	0.1	7.9	
123-91-1	1,4-Dioxane		160	
17351-34-7	14-Pentadecenoic acid			
4764-72-1	15-Octadecenoic acid, methyl e			
628-34-2	1-Chloro-2-ethoxyethane			

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

All chemical concentrations are in mg/kg and
radionuclide concentrations are in pCi/g.

Table 4-1. Soil Screening Criteria
Page 2 of 11

CAS	Analyte	DAF 1	Industrial PRG	Background
124-19-6	1-Nonanal			
464-06-2	2,2,3-Trimethylbutane			
540-84-1	2,2,4-Trimethylpentane			
Dichlorobenzil	2,2'-/4,4'-Dichlorobenzil			
594-20-7	2,2-Dichloropropane			
75-99-0	2,2-Dichloropropionic acid		18000	
590-35-2	2,2-Dimethylpentane			
60851-34-5	2,3,4,6,7,8-Hexachlorodibenzofuran			
57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran			
51207-31-9	2,3,7,8-Tetrachlorodibenzofuran			
1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin		0.000016	
565-59-3	2,3-Dimethylpentane			
93-76-5	2,4,5-T		6200	
93-72-1	2,4,5-TP		4900	
95-95-4	2,4,5-Trichlorophenol	14	62000	
88-06-2	2,4,6-Trichlorophenol	0.008	62	
94-75-7	2,4-D		7700	
53-19-0	2,4-DDD			
3424-82-6	2,4-DDE			
120-83-2	2,4-Dichlorophenol	0.05	1800	
108-08-7	2,4-Dimethylpentane			
105-67-9	2,4-Dimethylphenol	0.4	12000	
51-28-5	2,4-Dinitrophenol	0.01	1200	
121-14-2	2,4-Dinitrotoluene	0.00004	1200	
1618-26-4	2,4-Dithiapentane			
1123-84-8	2,5-Dichlorostyrene			
606-20-2	2,6-Dinitrotoluene	0.00003	620	
126-99-8	2-Chlor-1,3-butadiene		12	
110-75-8	2-Chloroethyl vinyl ether			
91-58-7	2-Chloronaphthalene		23000	
95-57-8	2-Chlorophenol	0.2	240	
95-49-8	2-Chlorotoluene		560	
1121-05-7	2-Cyclopenten-1-one, 2,3-dimet			
3913-81-3	2-Decenal, (e)-			
78-83-1	2-Methyl-1-propanol		40000	
91-57-6	2-Methylnaphthalene			
88-74-4	2-Nitroaniline		1800	
88-75-5	2-Nitrophenol			
79-46-9	2-Nitropropane			
135-98-8	2-Phenylbutane			
2463-77-6	2-Undecenal			
91-94-1	3,3'-Dichlorobenzidine	0.0003	3.8	
562-49-2	3,3-dimethylpentane			
4867-37-2	3-Chlorothioanisole			
617-78-7	3-ethylpentane			
589-34-4	3-Methylhexane			
65794-96-9	3-Methylphenol & 4-Methylphenol			
99-09-2	3-Nitroaniline		82	

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

All chemical concentrations are in mg/kg and
radionuclide concentrations are in pCi/g.

Table 4-1. Soil Screening Criteria
Page 3 of 11

CAS	Analyte	DAF 1	Industrial PRG	Background
94-82-6	4-(2,4-Dichlorophenoxy)butyric acid		4900	
72-54-8	4,4-DDD	0.8	10	
72-55-9	4,4-DDE	3	7	
50-29-3	4,4-DDT	2	7	
534-52-1	4,6-Dinitro-o-cresol		62	
1918-02-1	4-Amino-3,5,6-trichloropicolinic acid		43000	
101-55-3	4-Bromophenyl phenyl ether			
35421-08-0	4-Chloro-3-methyl phenol			
59-50-7	4-Chloro-3-Methylphenol			
98-66-8	4-Chlorobenzenesulfonic acid			
7005-72-3	4-Chlorophenyl phenyl ether			
123-09-1	4-Chlorothioanisole			
106-43-4	4-Chlorotoluene			
100-02-7	4-Nitrophenol			
60-33-3	9,12-Octadecadienoic acid (Z,Z			
301-02-0	9-Octadecenamide			
112-79-8	9-Octadecenoic acid, (e)-			
83-32-9	Acenaphthene	29	29000	
208-96-8	Acenaphthylene			
75-07-0	Acetaldehyde		23	
67-64-1	Acetone	0.8	54000	
75-05-8	Acetonitrile		1800	
98-86-2	Acetophenone			
107-02-8	Acrolein		0.34	
107-13-1	Acrylonitrile		0.49	
14331-83-0	Actinium-228	0	1200	3.4
14331-83-1	Actinium-228			
309-00-2	Aldrin	0.02	0.1	
107-05-1	Allyl chloride		180	
319-84-6	alpha-BHC	0.00003	0.36	
5103-71-9	alpha-Chlordane			
7429-90-5	Aluminum		100000	15000
14596-10-2	Americium-241	0.129	5.7	
7664-41-7	Ammonia			
62-53-3	Aniline		300	
120-12-7	Anthracene	590	100000	
7440-36-0	Antimony	0.3	410	0.5
12674-11-2	Aroclor 1016		21	
11104-28-2	Aroclor 1221			
11141-16-5	Aroclor 1232			
53469-21-9	Aroclor 1242			
12672-29-6	Aroclor 1248			
11097-69-1	Aroclor 1254		0.74	
11096-82-5	Aroclor 1260			
7440-38-2	Arsenic	1	1.6	7.2
1332-21-4	Asbestos			
3244-90-4	Aspon			
1912-24-9	Atrazine		7.8	

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

All chemical concentrations are in mg/kg and
radionuclide concentrations are in pCi/g.

Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
2642-71-9	Azinphos-ethyl			
86-50-0	Azinphos-methyl			
103-33-3	Azobenzene		16	
7440-39-3	Barium	82	67000	840
100-52-7	Benzaldehyde		62000	
134-96-3	Benzaldehyde, 4-hydroxy-3,5-di			
55-21-0	Benzamide			
71-43-2	Benzene	0.002	1.4	
622-38-8	Benzene, (ethylthio)-			
1193-82-4	Benzene, (methylsulfinyl)-			
98-57-7	Benzene, 1-chloro-4-(methylsulfonyl)			
45892-47-5	Benzene, 2,4-dichloro-1-(2-chl			
1078-71-3	Benzene, heptyl-			
1878-66-6	Benzeneacetic acid, 4-chloro-			
98-11-3	Benzenesulfonic acid			
1212-08-4	Benzenesulfonylthioic acid, s-p			
108-98-5	Benzenethiol			
92-87-5	Benzidine		0.0075	
56-55-3	Benzo(a)anthracene	0.08	2.1	
50-32-8	Benzo(a)pyrene	0.4	0.21	
B(b&k)F	Benzo(b&k)fluoranthene			
205-99-2	Benzo(b)fluoranthene	0.2	2.1	
191-24-2	Benzo(g,h,i)perylene			
207-08-9	Benzo(k)fluoranthene	2	21	
65-85-0	Benzoic acid	20	100000	
535-80-8	Benzoic acid, 3-chloro-			
100-51-6	Benzyl alcohol		100000	
85-68-7	Benzyl butyl phthalate	810	100000	
100-44-7	Benzyl chloride		2.2	
7440-41-7	Beryllium	3	1900	0.89
319-85-7	beta-BHC	0.0001	1.3	
Q017	Bicarbonate alkalinity			
141-66-2	Bidrin		62	
111-91-1	bis(2-Chloroethoxy) methane			
111-44-4	bis(2-Chloroethyl) ether	0.00002	0.58	
108-60-1	bis(2-Chloroisopropyl) ether		7.4	
117-81-7	bis(2-Ethylhexyl) phthalate		120	
1142-19-4	bis(p-Chlorophenyl) disulfide			
80-07-9	bis(p-Chlorophenyl) sulfone		5100	
14331-79-4	Bismuth-210	0	0.21	2.2
14913-49-6	Bismuth-212	0	37000	1.8
14733-03-0	Bismuth-214	0	13000	1.6
80-05-7	Bisphenol A		31000	
7440-42-8	Boron		100000	12
24959-67-9	Bromide			
108-86-1	Bromobenzene		92	
75-27-4	Bromodichloromethane	0.03	1.8	
74-83-9	Bromomethane	0.01	13	

DAF-1= Dilution attenuation Factor
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All chemical concentrations are in mg/kg and
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Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
7440-43-9	Cadmium	0.4	450	0.13
7440-70-2	Calcium			83000
86-74-8	Carbazole	0.03	86	
75-15-0	Carbon disulfide	2	720	
56-23-5	Carbon tetrachloride	0.003	0.55	
3812-32-6	Carbonate alkalinity			
786-19-6	Carbophenothion			
953-17-3	Carbophenothion-methyl			
CEC	Cation Exchange Capacity			
10045-97-3	Cesium-137	2.8	0.11	
75-69-4	CFC-11		2000	
75-71-8	CFC-12		310	
75-87-6	Chloral			
7790-93-4	Chlorate			
57-74-9	Chlordane			
470-90-6	Chlorfenvinfos			
16887-00-6	Chloride			1100
76-13-1	Chlorinated fluorocarbon (Freon 113)		5600	
107-20-0	Chloroacetaldehyde			
108-90-7	Chlorobenzene	0.07	530	
74-97-5	Chlorobromomethane			
124-48-1	Chlorodibromomethane	0.02	2.6	
75-00-3	Chloroethane		6.5	
67-66-3	Chloroform	0.03	0.47	
593-71-5	Chloriodomethane			
74-87-3	Chloromethane		160	
5598-13-0	Chloropyrifos-methyl		6200	
2921-88-2	Chlorpyrifos		1800	
ChlorpyrophosME	Chlorpyrophos methyl ester			
7440-47-3	Chromium (Total)	2	450	17
18540-29-9	Chromium (VI)	2	64	0.32
218-01-9	Chrysene	8	210	
156-59-2	cis-1,2-Dichloroethylene	0.02	150	
10061-01-5	cis-1,3-Dichloropropylene			
7440-48-4	Cobalt		1900	16
13981-50-5	Cobalt-57	8.4	14	0.08
10198-40-0	Cobalt-60	0.12	0.06	0.16
Q181	Conductivity			
7440-50-8	Copper		41000	31
56-72-4	Coumaphos			
7700-17-6	Crotoxypfos			
57-12-5	Cyanide (Total)		12000	
10544-50-0	Cyclic octaatomic sulfur			
2597-49-1	Cyclobutane, ethenyl-			
110-82-7	Cyclohexane		140	
10498-35-8	Cyclohexane, 1,2-dichloro-, ci			
822-86-6	Cyclohexane, 1,2-dichloro-, trans-			
80-53-5	Cyclohexanemethanol, 4-hydroxy			

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

All chemical concentrations are in mg/kg and
radionuclide concentrations are in pCi/g.

Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
55255-41-9	Cyclopentane, (trichloroetheny			
2453-00-1	Cyclopentane, 1,3-dimethyl-			
1640-89-7	Cyclopentane, ethyl-			
541-02-6	Cyclopentasiloxane, decamethyl			
99-87-6	Cymene			
319-86-8	delta-BHC			
8065-48-3	Demeton		25	
298-03-3	Demeton-O			
126-75-0	Demeton-S			
333-41-5	Diazinon		560	
53-70-3	Dibenzo(a,h)anthracene	0.08	0.21	
132-64-9	Dibenzofuran		1600	
132-65-0	Dibenzothiophene			
74-95-3	Dibromomethane		230	
84-74-2	Dibutyl phthalate	270	62000	
1918-00-9	Dicamba		18000	
97-17-6	Dichlorfenthion			
79-02-7	Dichloroacetaldehyde			
594-04-7	Dichloriodomethane			
75-09-2	Dichloromethane	0.001	21	
120-36-5	Dichlorprop			
62-73-7	Dichlorvos		6	
60-57-1	Dieldrin	0.0002	0.1	
110-81-6	Diethyl disulfide			
298-06-6	Diethyl phosphorodithioic acid			
84-66-2	Diethyl phthalate		100000	
352-93-2	Diethyl sulfide			
60-51-5	Dimethoate		120	
756-80-9	Dimethyl phosphorodithioic acid			
131-11-3	Dimethyl phthalate		100000	
3658-80-8	Dimethyl trisulfide			
88-85-7	Dinitrobutyl phenol		620	
117-84-0	Di-n-octyl phthalate	10000	25000	
78-34-2	Dioxathion			
127-63-9	Diphenyl sulfone		1800	
298-04-4	Disulfoton		25	
959-98-8	Endosulfan I			
33213-65-9	Endosulfan II			
1031-07-8	Endosulfan sulfate			
72-20-8	Endrin	0.05	180	
7421-93-4	Endrin aldehyde			
53494-70-5	Endrin ketone			
112-84-5	Erucylamide			
74-84-0	Ethane			
619-33-0	Ethane, 1,1-dichloro-2,2-dieth			
6628-18-8	Ethane, 1,2-bis(methylthio)-			
27-72-1	Ethane, hexachloro-			
134-81-6	Ethanedione, diphenyl-			

DAF-1= Dilution attenuation Factor
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Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
64-17-5	Ethanol			
563-12-2	Ethion		310	
13194-48-4	Ethoprophos			
100022-54-1	Ethyl 2-chloro-2-(3-chlorobenz			
141-78-6	Ethyl acetate		37000	
60-29-7	Ethyl ether		1800	
2104-64-5	Ethyl p-nitrophenyl phenylphosphorothioate		6.2	
100-41-4	Ethylbenzene	0.7	400	
74-85-1	Ethylene			
107-21-1	Ethylene glycol		100000	
111-76-2	Ethylene glycol monobutyl ether		100000	
25550-14-5	Ethyltoluene			
52-85-7	Famphur			
115-90-2	Fensulfothion			
55-38-9	Fenthion			
206-44-0	Fluoranthene	210	22000	
86-73-7	Fluorene	28	26000	
16984-48-8	Fluoride		37000	2.5
944-22-9	Fonofos		1200	
50-00-0	Formaldehyde		100000	
5103-74-2	gamma-Chlordane			
G_Alpha	Gross alpha			
G_Beta	Gross beta			
HARD	Hardness, Total			
76-44-8	Heptachlor	1	0.38	
1024-57-3	Heptachlor epoxide	0.03	0.19	
87-68-3	Hexachloro-1,3-butadiene	0.1	22	
118-74-1	Hexachlorobenzene	0.1	1.1	
77-47-4	Hexachlorocyclopentadiene	20	3700	
67-72-1	Hexachloroethane	0.02	120	
57-10-3	Hexadecanoic acid			
23470-00-0	Hexadecanoic acid, 2-hydroxy-1			
680-31-9	Hexamethylphosphoramide			
66-25-1	Hexanal			
110-54-3	Hexane		110	
591-76-4	Hexane, 2-methyl-			
Q021	Hydroxide alkalinity			
118-29-6	Hydroxymethyl phthalimide			
193-39-5	Indeno(1,2,3-cd)pyrene	0.7	2.1	
20461-54-5	Iodide			
7439-89-6	Iron		100000	20000
78-59-1	Isophorone	0.03	510	
67-63-0	Isopropyl alcohol (Manufacturing-Strong Acid)			
98-82-8	Isopropylbenzene		2000	
7439-92-1	Lead		800	35
14255-04-0	Lead-210	0.00055	1.2	2.2
15092-94-1	Lead-212	3490000	6100	2.1
15067-28-4	Lead-214	1.43E+11	76000	1.7

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

All chemical concentrations are in mg/kg and
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Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
21609-90-5	Leptophos			
58-89-9	Lindane	0.0005	1.7	
7439-93-2	Lithium		20000	27
mp-cresol	m,p-Cresols			
136777-61-2	m,p-Xylene			
7439-95-4	Magnesium			18000
121-75-5	Malathion		12000	
7439-96-5	Manganese		19000	1100
94-74-6	MCPA (2-Methyl-4-chlorophenoxyacetic acid)		310	
93-65-2	MCPP		620	
7085-19-0	Mecoprop			
7439-97-6	Mercury			0.11
150-50-5	Merphos		18	
122-14-5	Metathione			
74-82-8	Methane			
67-56-1	Methanol		100000	
134-85-0	Methanone, (4-chlorophenyl)phe			
72-43-5	Methoxychlor	8	3100	
624-92-0	Methyl disulfide			
20333-39-5	Methyl ethyl disulphide			
2033-39-5	Methyl ethyl dusulfide			
78-93-3	Methyl ethyl ketone		11000	
74-88-4	Methyl iodide			
108-10-1	Methyl isobutyl ketone		47000	
80-62-6	Methyl methacrylate		2700	
591-78-6	Methyl n-butyl ketone			
298-00-0	Methyl parathion		150	
75-18-3	Methyl sulfide			
126-98-7	Methylacrylonitrile		8.4	
25013-15-4	METHYLSTYRENE		540	
7786-34-7	Mevinphos			
7439-98-7	Molybdenum		5100	2
6923-22-4	Monocrotophos			
1634-04-4	MTBE (Methyl tert-butyl ether)		70	
300-76-5	Naled		1200	
91-20-3	Naphthalene	4	190	
493-02-7	Naphthalene, decahydro- trans-			
104-51-8	n-Butyl benzene		240	
142-82-5	n-Heptane			
7440-02-0	Nickel	7	20000	30
7440-03-1	Niobium			2.8
14797-55-8	Nitrate (as N)			100
14797-65-0	Nitrite (as N)			0.21
98-95-3	Nitrobenzene	0.007	100	
55-18-5	N-nitrosodiethylamine		0.011	
62-75-9	N-Nitrosodimethylamine		0.034	
621-64-7	N-nitrosodi-n-propylamine	0.000002	0.25	
86-30-6	N-nitrosodiphenylamine	0.06	350	

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

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Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
103-65-1	n-Propyl benzene		240	
629-50-5	n-Tridecane			
1120-21-4	n-Undecane			
126-68-1	O,O,O-Triethyl phosphorothioate			
297-97-2	o,o-Diethyl o-pyrazinyl phosphorothioate			
100022-65-2	O,o'-diethyl s-methyl thiophos			
95-48-7	o-Cresol	0.8	31000	
OCDD	Octachlorodibenzodioxin			
OCDF	Octachlorodibenzofuran			
29082-74-4	Octachlorostyrene			
57-11-4	Octadecanoic acid			
124-13-0	Octanal			
111-65-9	Octane			
O-PO4	Orthophosphate as P			
100022-28-6	Oxime-, methoxy-phenyl_			
95-47-6	o-Xylene			
7440-05-3	Palladium			1.5
56-38-2	Parathion		3700	
106-47-8	p-Chloroaniline	0.03	2500	
106-54-7	p-Chlorothiophenol			
106-44-5	p-Cresol		3100	
608-93-5	Pentachlorobenzene		500	
76-01-7	Pentachloroethane			
87-86-5	Pentachlorophenol	0.001	9	
1921-70-6	Pentadecane, 2,6,10,14-tetrame			
%MOISTURE	Percent Moisture			
14797-73-0	Perchlorate		100	
PHC	Petroleum Hydrocarbons			
pH	pH (Hydrogen Ion)			
PHCD	PHC as Diesel Fuel			
PHCG	PHC as Gasoline			
85-01-8	Phenanthrene			
108-95-2	Phenol	5	100000	
882-33-7	Phenyl Disulfide			
139-66-2	Phenyl Sulfide			
298-02-2	Phorate		120	
732-11-6	Phosmet		12000	
13171-21-6	Phosphamidon			
2524-04-1	Phosphorochloridothioic acid,			
2953-29-9	Phosphorodithioic acid, o,o,s-			
3734-95-0	Phosphorothioic acid, s-[2-[(1			
7723-14-0	Phosphorus (as P)			2000
88-99-3	Phthalic acid			
7440-06-4	Platinum			0.099
100-01-6	p-Nitroaniline		82	
13981-52-7	Polonium-210	0	270	2.2
15389-34-1	Polonium-212			1.2
15735-67-8	Polonium-214	0	1.8E+15	1.6

DAF-1= Dilution attenuation Factor
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Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
15756-58-8	Polonium-216	0	1E+13	2.1
15422-74-9	Polonium-218	0	1.5E+10	2.4
7440-09-7	Potassium			3900
13966-00-2	Potassium-40	0	0.27	35
55191-51-0	Pregn-1,4,6-triene-3,20-dione,			
107-12-0	Propionitrile			
115-07-1	Propylene (Propene)			
57-55-6	Propylene glycol		100000	
15100-28-4	Protactinium-234	0	570	0.26
129-00-0	Pyrene	210	29000	
110-86-1	Pyridine		620	
15623-45-7	Radium-223	284	270	0.8
13233-32-4	Radium-224	3920	7900	2.1
13982-63-3	Radium-226	0.0161	0.026	2.4
15262-20-1	Radium-228	0.0594	0.15	2.9
22481-48-7	Radon-220	0	1200000000	
14859-67-7	Radon-222	119	210000	
141-22-0	Ricinoleic acid			
299-84-3	Ronnel		31000	
7782-49-2	Selenium	0.3	5100	0.6
7440-21-3	Silicon			4200
7440-22-4	Silver	2	5100	0.26
122-34-9	Simazine		14	
2949-92-0	S-methyl methanethiosulphonate			
7440-23-5	Sodium			1300
SOLID	SOLIDS, PERCENT			
7683-64-9	Squalene			
22248-79-9	Stiropfos (tetrachlorovinphos)			
7440-24-6	Strontium		100000	800
100-42-5	Styrene (monomer)	0.2	1700	
14808-79-8	Sulfate			4100
18496-25-8	Sulfide			
Q609	Sulfite			
3112-85-4	Sulfone, methyl phenyl			
3689-24-5	Sulfotep		310	
7704-34-9	Sulfur			
35400-43-2	Sulprofos			
8017-34-3	Technical chlorophenothane			
107-49-3	Tepp			
13071-79-9	Terbufos		15	
98-06-6	tert-Butyl benzene		390	
127-18-4	Tetrachloroethylene	0.003	1.3	
961-11-5	Tetrachlorvinphos (Stiropfos)		72	
21646-99-1	Tetraethyl pyrophosphite			
109-99-9	Tetrahydrofuran		21	
7440-28-0	Thallium		67	1.8
14913-50-9	Thallium-208	0	37000	0.72
3172-52-9	Thiophene, 2,5-dichloro-			

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

All chemical concentrations are in mg/kg and
radionuclide concentrations are in pCi/g.

Table 4-1. Soil Screening Criteria
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CAS	Analyte	DAF 1	Industrial PRG	Background
6012-97-1	Thiophene, tetrachloro-			
15623-47-9	Thorium-227	3340	194	0.8
14274-82-9	Thorium-228	3.3	0.26	2.3
14269-63-7	Thorium-230	0.303	20	3
7440-29-1 (232)	Thorium-232	0.303	19	2.2
15065-10-8	Thorium-234	4130	3300	2.5
7440-31-5	Tin		100000	0.8
7440-32-6	Titanium		100000	1000
Tokuthion	Tokuthion			
34643-46-4	Tokuthion (Protothiofos)			
108-88-3	Toluene	0.6	520	
Q18	Total Alkalinity			
Q594	Total Dissolved Solids			
TDS	Total Dissolved Solids			
Q129	Total Inorganic Carbon			
TIC	Total Inorganic Carbon			
TKN	Total Kjeldahl Nitrogen (TKN)			
TOC	Total Organic Carbon			
7440-44-0	Total Organic Carbon (TOC)			
PHCGD	Total Petroleum Hydrocarbons (TPH) gas/diesel			
PHCGDO	Total Petroleum Hydrocarbons (TPH) gas/diesel/oil			
Q595	Total Suspended Solids			
8001-35-2	Toxaphene	2	1.6	
156-60-5	trans-1,2-Dichloroethylene	0.03	230	
10061-02-6	trans-1,3-Dichloropropylene			
110-57-6	trans-1,4-Dichlorobutene			
75-25-2	Tribromomethane	0.04	220	
52-68-6	Trichlorfon			
115-20-8	Trichloroethanol			
79-01-6	Trichloroethylene	0.003	0.11	
327-98-0	Trichloronate			
78-30-8	Tri-o-Cresyl Phosphate (TOCP)			
791-28-6	Triphenylphosphine oxide		12000	
7440-33-7	Tungsten			2.5
7440-61-1	Uranium		200	2.7
13966-29-5	Uranium-234	112	32	2.8
15117-96-1	Uranium-235	0.0389	0.4	0.21
7440-61-1 (238)	Uranium-238	0.006	1.8	2.4
7440-69-1	Uranium-238			
7440-62-2	Vanadium	300	1000	59
108-05-4	Vinyl acetate	8	1400	
593-60-2	Vinyl bromide		0.42	
75-01-4	Vinyl chloride	0.0007	0.75	
1330-20-7	Xylenes (total)	10	420	
7440-66-6	Zinc	620	100000	120
7440-67-7	Zirconium			180

DAF-1= Dilution attenuation Factor
PRG= Preliminary Remediation Goal

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radionuclide concentrations are in pCi/g.

Table 7-1. Physiochemical Properties of Chemicals Exceeding Screening Limits
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Compound	Molecular Weight	Density (g/cm ³)	Vapor Pressure (mm Hg)	Henry's Law Constant K _H (atm-m ³ /mole)	Solubility in Water at 25°C (mg/L)	Organic Carbon to Water Partition Coefficient (log K _{oc})	Octanol to Water Partition Coefficient (log K _{ow})
Pesticides							
Aldrin	364.92	1.7	7.5 x 10 ⁻⁵	4.96 x 10 ⁻⁴	1.7 x 10 ⁷	2.61 – 5.38	5.52 – 7.4
Alpha-BHC	290.83	1.87	4.5 x 10 ⁻⁵	6.86 x 10 ⁻⁶	10	3.57	3.8
Beta BHC	290.83	1.89	3.6 x 10 ⁻⁷	4.5 x 10 ⁻⁷	5	3.57	3.78
Gamma BHC (Lindane)	290.8	1.85	3.5 x 10 ⁻⁵	2.1 x 10 ⁻⁷	10	3.8	4.14
<i>p,p'</i> -DDE	318.03	ND	6.0 x 10 ⁻⁶	2.1 x 10 ⁻⁵	0.12	4.7	6.51
<i>p,p'</i> -DDT	354.49	0.98 – 0.99	1.60 x 10 ⁻⁷	8.3 x 10 ⁻⁶	0.025	5.18	6.91
PCBs							
Arochlor 1254	328	1.54	7.71 x 10 ⁻⁵	0.002	0.012	ND	6.5
VOCs and SVOCs							
Benzene	78.11	0.87891	95.2	4.74 x 10 ⁻³	1.76 x 10 ³	1.9	1.97
Chlorobenzene	112.56	1.10646	9	3.79 x 10 ⁻³	496	1.89	2.96
1,2,4 Trichlorobenzene	181.46	1.43	0.29	1.42 x 10 ⁻³	48.8	3.3-3.5	4.02
1,2-dichlorobenzene	147	1.3048	1.03	0.00192	145	2.46	3.7
1,3-dichlorobenzene	147	1.2881	2.15	0.00214	143	4.6	3.55
1,4-dichlorobenzene	147	1.2475	0.7	0.00186	81.4	2.92	3.23
1,2-dichloroethane	98.96	1.2528	87	9.84 x 10 ⁻⁴	8524	1.68	1.46
Carbon tetrachloride	153.82	1.59472	113	0.0382	785	2.62	2.38
Chloroform	119.38	1.4832	160	3.69 x 10 ⁻³	8700	1.7	1.86
Hexachloro-1,3-butadiene (hexachlorobutadiene)	260.76	1.682	0.15	15.3	3.23	6.1	4.9
Hexachlorobenzene	284.78	2.049	7.5 x 10 ⁻⁶	17 x 10 ⁻⁴	5	5.6	5.46
Hexachloroethane	236.74	2.091	0.18	0.00591	50	3.34	4.62

g/cm³ = Grams per cubic centimeter
mm Hg = Millimeters of mercury
Atm-m³/mole = Atmosphere-cubic meters per mole

mg/L = Milligrams per liter
NA = Not available

Table 7-1. Physiochemical Properties of Chemicals Exceeding Screening Limits
Page 2 of 2

Compound	Molecular Weight	Density (g/cm ³)	Vapor Pressure (mm Hg)	Henry's Law Constant K _H (atm-m ³ /mole)	Solubility in Water at 25°C (mg/L)	Organic Carbon to Water Partition Coefficient (log K _{oc})	Octanol to Water Partition Coefficient (log K _{ow})
Tetrachloroethylene (PCE)	165.83	1.623	20	0.0153	150	2.83	2.1
Trichloroethylene (TCE)	131.39	1.461	74	0.00909	1100	1.81	2.27
Dibenzofuran	168.2	1.0886	0.0044	NA	10	-0.19	-0.19
Dioxins							
Monochlorodibenzo-p-dioxins	218.6	NA	0.90 x 10 ⁻⁴ to 51.3 x 10 ⁻⁴	8.27 x 10 ⁻⁷ to 14.6 x 10 ⁻⁷	-0.199	NA	-0.07
Dichlorodibenzo-p-dioxins	253.1	NA	0.90 x 10 ⁻⁶ to 2.9 x 10 ⁻⁶	2.10 x 10 ⁻⁷ to 8.00 x 10 ⁻⁷	-0.01295	NA	-0.53
Trichlorodibenzo-p-dioxins	287.5	NA	0.0646 x 10 ⁻⁶ to 37.9 x 10 ⁻⁶	<10 ⁻⁶	-0.00366	NA	-0.59
Tetrachlorodibenzo-p-dioxins	322	NA	0.15 x 10 ⁻⁸ to 4.8 x 10 ⁻⁸	7.01 x 10 ⁻⁶ to 101.7 x 10 ⁻⁶	0.079 x 10 ⁻⁴ to 4.7 x 10 ⁻⁴	NA	-2.1
Pentachlorodibenzo-p-dioxins	356.4	NA	6.6 x 10 ⁻¹⁰	2.6 x 10 ⁻⁶	1.18 x 10 ⁻⁴	NA	-0.84
Hexachlorodibenzo-p-dioxins	390.9	NA	3.8 x 10 ⁻¹¹	4.46 x 10 ⁻⁷	4.42 x 10 ⁻⁶	NA	-1.21
Heptachlorodibenzo-p-dioxins	425.3	NA	0.00056 x 10 ⁻⁸ to 7.4 x 10 ⁻⁸	0.13 x 10 ⁻⁵ to 2.18 x 10 ⁻⁵	0.0024 to 10 ⁻³ to 1.9 x 10 ⁻³	NA	-1.69
Octachlorodibenzo-p-dioxins	459.8	NA	8.25 x 10 ⁻¹³	6.74 x 10 ⁻⁶	0.23 x 10 ⁻⁸ to 7.4 x 10 ⁻⁸	NA	-4.59
Metals							
Arsenic	74.9	5.73	0		insoluble	NA	NA
Chromium	52.0	7.14	0		insoluble	NA	NA

g/cm³ = Grams per cubic centimeter
mm Hg = Millimeters of mercury
Atm-m³/mole = Atmosphere-cubic meters per mole

mg/L = Milligrams per liter
NA = Not available

Table 8-1. Potential Human Receptors and Primary Exposure Pathways

Exposure Pathway	Construction Workers	Trespasser	Outdoor Maintenance Workers
Incidental soil ingestion*	X	X	X
External exposure from soil†	X	X	X
Dermal contact with soil	X	X	X
Outdoor inhalation of dust*‡	X	X	X
Outdoor inhalation of VOCs from soil and groundwater	X	X	X

* Includes radionuclide exposures

† Only radionuclide exposures

‡ Includes asbestos exposures

Appendices

Appendix A

Aerial Photographs



200 100 0 200
Feet

BMI Site
Henderson, Nevada

FIGURE A-1

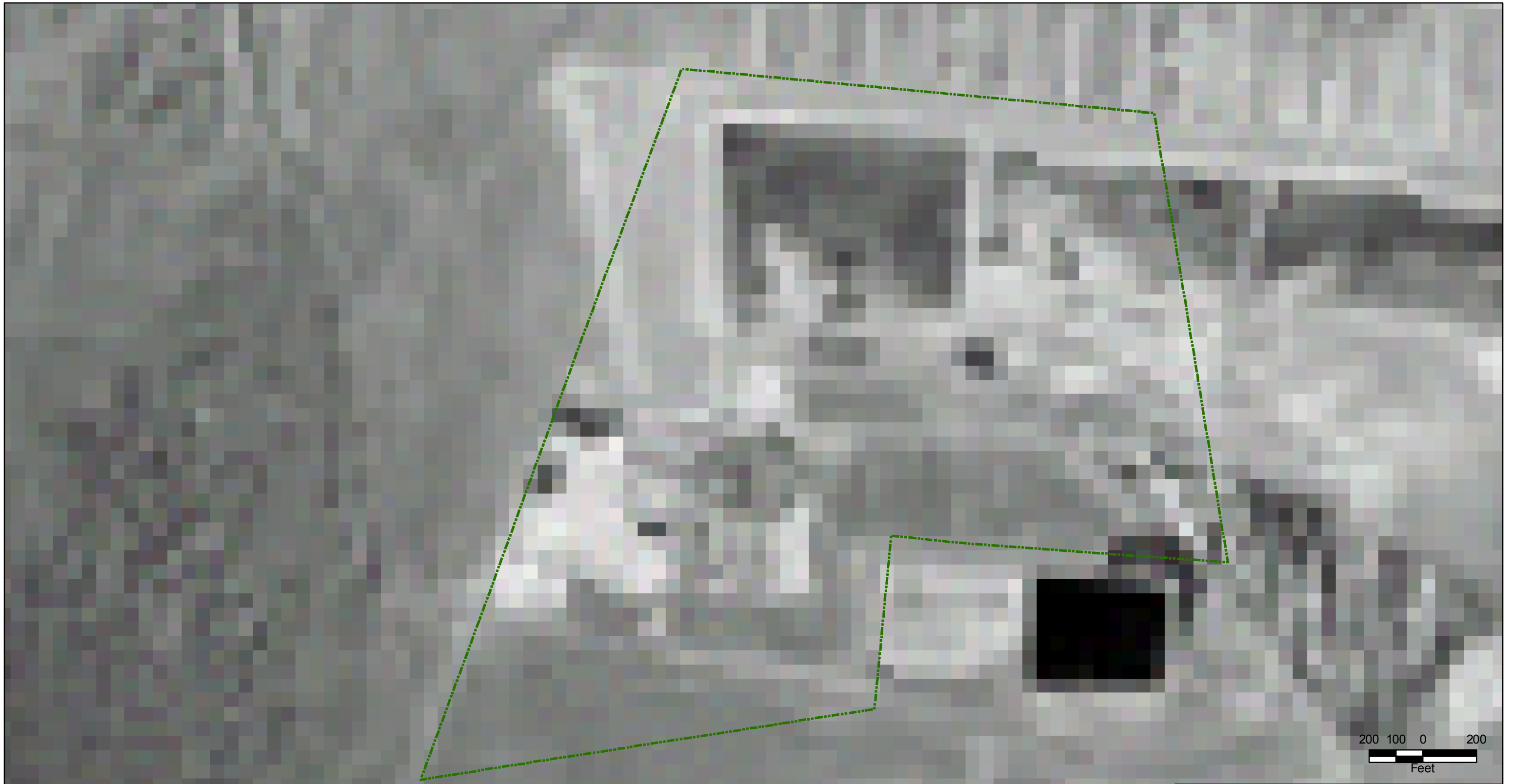
1943 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



BMI Site
Henderson, Nevada



FIGURE A-2
1950 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



BMI Site
Henderson, Nevada

FIGURE A-3

1967 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



BMI Site Henderson, Nevada		
N ↑	FIGURE A-4	
	1972 HISTORICAL AERIAL	
Prepared by: MWH MKJ		Date: 04/05/05
JOB No. 1881264 FILE: GIS/BRC/FIGURE_.MXD		Basic Remediation COMPANY



BMI Site
Henderson, Nevada

FIGURE A-5

1974 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



200 100 0 200
Feet

BMI Site
Henderson, Nevada

FIGURE A-6

1976 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



BMI Site
Henderson, Nevada



FIGURE A-7
1980 HISTORICAL AERIAL



Prepared by: MWH MKJ
Date: 04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



BMI Site
Henderson, Nevada



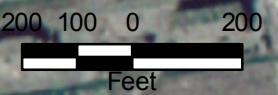
FIGURE A-8
1987 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



BMI Site Henderson, Nevada		
N ↑	FIGURE A-9	
	1990 HISTORICAL AERIAL	
Prepared by: MWH MKJ	Date 04/05/05	JOB No. 1881264 FILE: GIS/BRC/FIGURE_MXD





BMI Site
Henderson, Nevada

FIGURE A-10

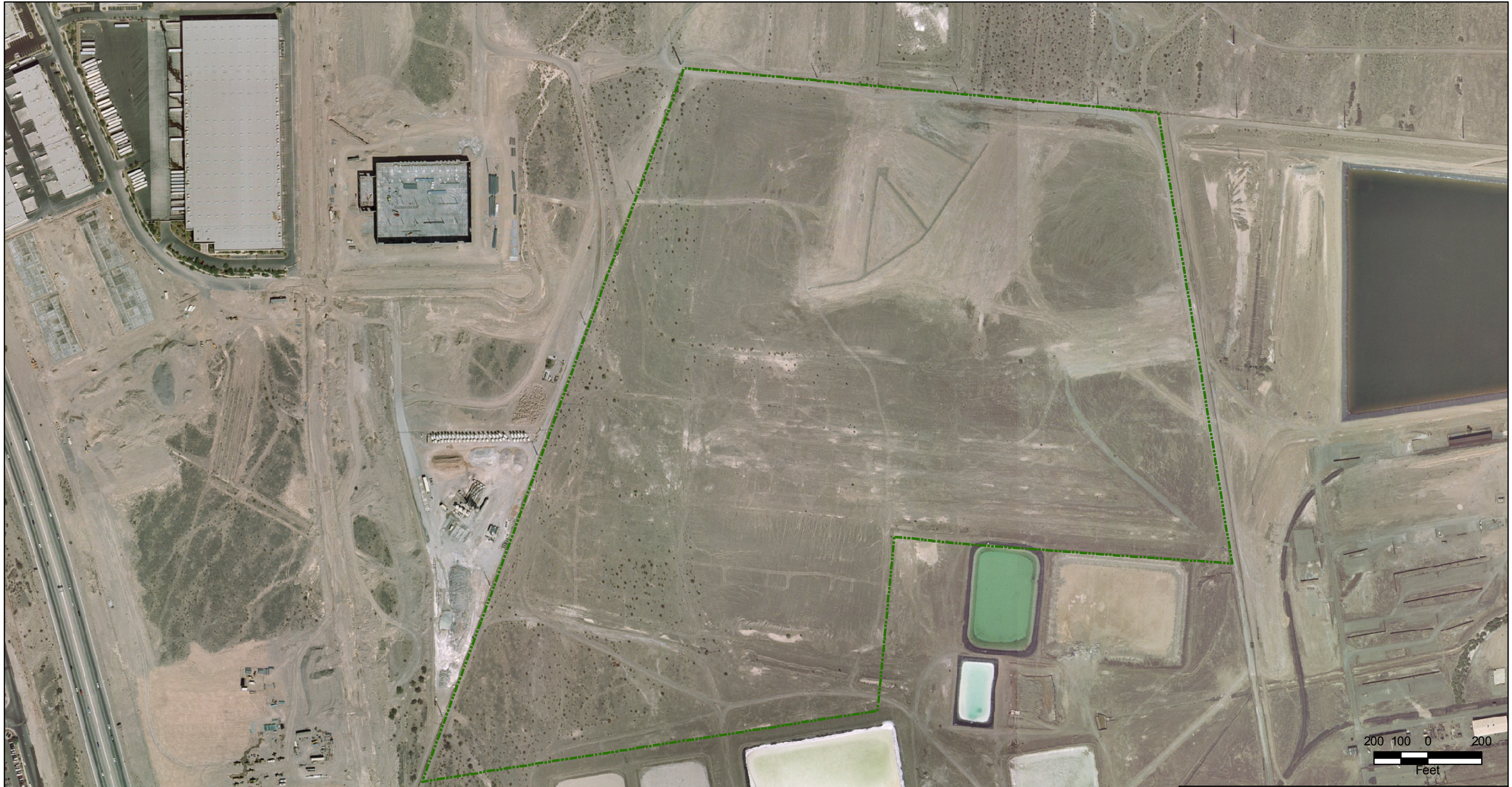
1999 HISTORICAL AERIAL



Prepared by:
MWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD



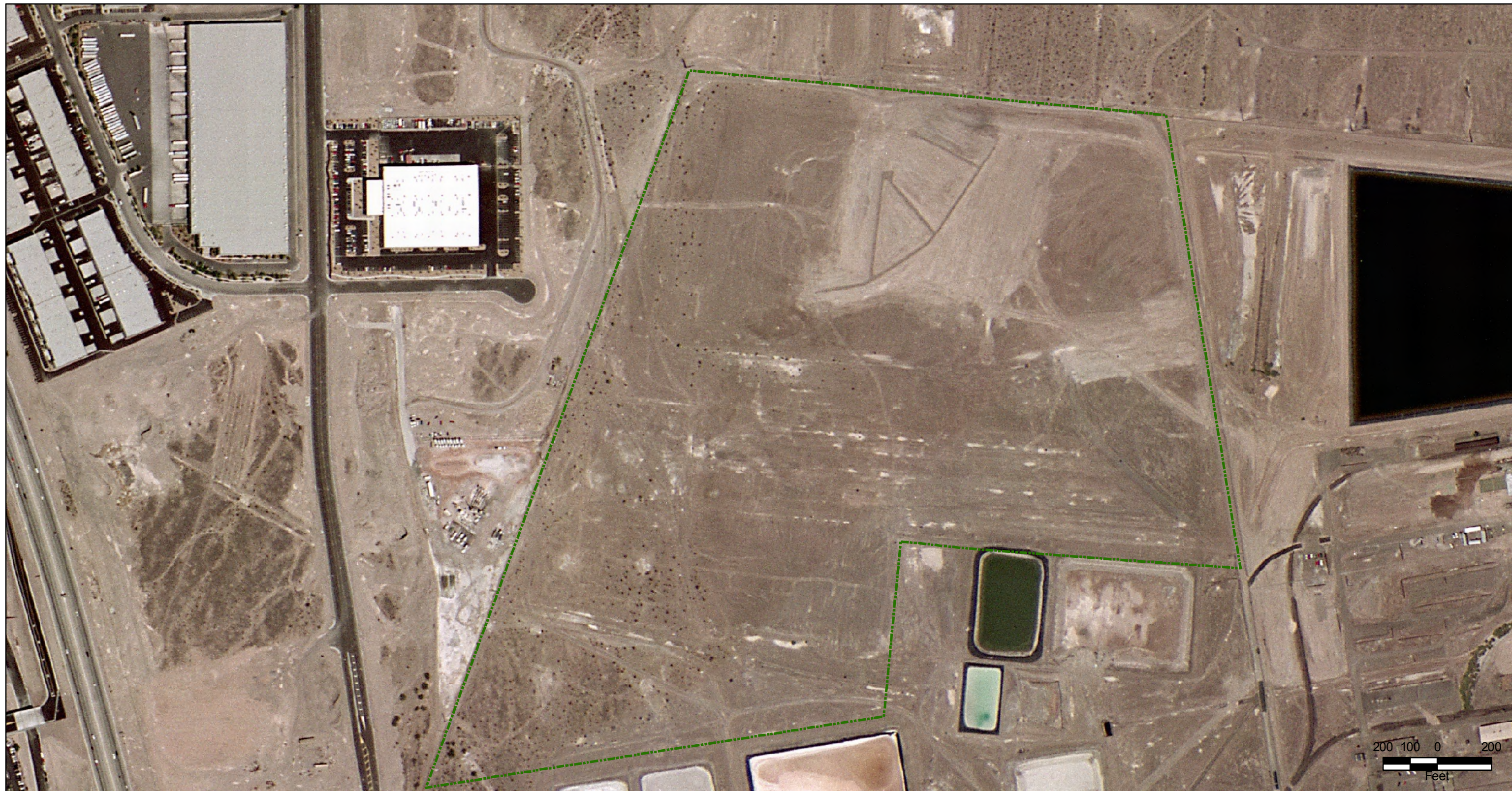
BMI Site
Henderson, Nevada

FIGURE A-11

2002 HISTORICAL AERIAL



Prepared by:		Date	JOB No. 1881264
MWH MKJ		04/05/05	FILE: GIS/BRC/FIGURE_MXD



BMI Site
Henderson, Nevada



FIGURE A-12
CURRENT (2003) AERIAL



Prepared by:
MIWH MKJ

Date
04/05/05

JOB No. 1881264
FILE: GIS/BRC/FIGURE_MXD

Appendix B

Summary of Previous Investigations

Appendix B. Site and Vicinity Environmental Investigations

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Appendix B. Site and Vicinity Environmental Investigations

B.1 On-Site Investigations

Investigations have been performed on the CAMU site since approximately 1970. These investigation reports, along with the results of the latest field work (BRC and MWH, 2005), have been reviewed to develop this CSM, and are summarized below.

B.1.1 Geraghty & Miller, 1993

G&M prepared the report Phase I Environmental Conditions Assessment for the Basic Management, Inc. Industrial Complex - Clark County, Nevada, dated April 14, 1993 (G&M, 1993), which addresses the BMI Common Areas of the BMI Industrial Complex located near Henderson, Nevada, for submittal in accordance with the Consent Agreement dated April 25, 1991 between the NDEP and Chem Star, Inc., KMCC, Montrose, Pioneer, Stauffer, Inc. (SMC) and TIMET, collectively known as the "Participating Companies". The report was developed upon a thorough review of documents from the individual companies, from BMI's files, and from various public repositories and agencies. A summary of the G&M report is presented below. Note that several historical details in this report were in error and have been corrected in the history section of the draft closure work plan (BRC et al., 2004), which should be taken as definitive.

The CAMU site and its environs was originally natural desert. Site historical industrial use was initiated by the U.S. government in 1941 for production of magnesium to support the war effort until May 1945. After May 1945, the U.S. government promoted the facility as an industrial production site and leased portions of the site to several chemical producers including Stauffer, Montrose, and WECCO. The U.S. government sold the site in 1948 to the State of Nevada through its Colorado River Commission (CRC), which owned and operated the site until 1952. During this period, U.S. Lime and TIMET leased portions of the CAMU site. In December 1951, the five principal operating companies, WECCO, Stauffer, U.S. Lime, TIMET, and Combined Metal Reduction Co., formed BMI as the only shareholders. Beginning in June 1952, each of the five companies purchased the facilities it was operating in separate conveyances from CRC, and BMI was given the responsibility to manage the properties, utilities, and facilities common to

all users of the BMI Industrial Complex. These properties included common disposal areas (BMI Landfill and ponds) that are currently closed. G&M (1993) reported that, at the time the report was written, BMI owned and managed the common areas of the complex.

The various production processes operated by the U.S. government and private industry since the early 1940s resulted in the generation of a variety of waste by-products that were disposed of in the currently closed BMI Landfill (formerly referred to as the trade effluent disposal ponds and STA) and closed BMI ponds (including the Upper and Lower Ponds, and the unlined caustic evaporation ponds). The BMI Landfill received wastes from 1942 until February 1980, at which time it was closed and capped. Process wastes were conveyed to the BMI ponds from approximately 1942 until late 1976, at which time the BMI Industrial Complex reached a zero discharge status. The BMI Landfill, ponds, and the unlined caustic evaporation ponds were the only common area properties routinely used for disposal of solid and liquid wastes. Although G&M (1993) reported that demolition debris resulting from the dismantling of the former Montrose facility appears to have been disposed of in an area of BMI property south of TIMET's Pabco Road Ponds, more recent study of historical aerial photographs has indicated that debris was not likely disposed of in that location (Montrose, 2005b [Appendix B]). No other areas of waste were reported on BMI Common Area property.

G&M compiled previously collected environmental conditions data from 342 sampling locations across the BMI Commons and adjoining off-site areas into three similar chemical compound groups: pesticide/PCBs, organic compounds, and metals.

The BMI Landfill areas were reportedly first operated from 1942 to 1944 as four unlined process effluent ponds that received magnesium production acid and caustic liquor effluent, waste cell liquor from the chlorine plant, and stormwater runoff (G&M, 1993). These 79-acre, 7.5-foot-deep containments were constructed with 20-foot earthen dikes on the north, east, and west sides from materials derived from within the containment area. They were designed to allow dike seepage fluids to flow north from the dike and percolate into the native soils. Though the historical record is sporadic here, from May 23, 1952 until February 25, 1980, the two westernmost containment areas were used as a landfill area. Liquid and solid waste generated from the production of synthetic detergents, chlorinated organics, insecticides, chlorinated solvents, ammonium tungstate, ferromanganese alloy, and ammonium perchlorate were disposed of in these areas. Unknown waste from the transformer bank operated by the U.S.

Bureau of Reclamation was also disposed of within these areas. Prior to 1970, the waste was regularly burned, until an uncontrolled fire from spontaneous combustion prompted waste burial as a change in operational practice, and sprinklers were used to reduce combustibility of material until buried. Maximum disposal depth within the BMI Landfill was reported to be 20 feet bgs. A list of companies, disposal periods, and estimated quantities of solid and liquid waste disposed of was presented in Table 5-2 of the report (G&M, 1993).

The unlined BMI ponds, off-site to the northeast (including the Upper and Lower Ponds and the unlined caustic evaporation ponds), were in operation from 1942 to 1985 to receive acid effluent and waste caustic liquors, asbestos sludge, sulfuric acid, hydrochloric acid, sulfonated metabolites of DDT, sodium chlorate filter cake wastes, ammonium perchlorate filter cakes wastes, potassium perchlorate process wastes, aqueous boron solution, sodium dichromate, industrial wastes from cooling and dust control operations, leach liquors (hydrogen, magnesium, calcium, sodium, and titanium, chlorides, nitrate, sulfate, sodium hypochlorate, mixed metal chlorides, borox, soda ash, phosphate chemicals, cyanide, municipal sewage effluent, and stormwater) from the participating companies operations. The ditch system (including Alpha Ditch, Beta Ditch, Western Drainage Ditch, Northwest Drainage Ditch, and Western Trench System) conveyed the fluid wastes from the BMI Industrial Complex to the BMI ponds and containments, and to Las Vegas Wash.

Upon review of the documented information presented by G&M for the BMI Common Areas, and in consideration of the waste management areas identified in their report, the Henderson Industrial Site Steering Committee (HISSC) recommended specific areas for possible further investigation and nine sites for exclusion from further study.

B.1.2 Converse Consultants, 1999

In 1999, Converse Consultants (Converse) prepared the report Preliminary Geotechnical and Geologic Investigation, Industrial Non-Hazardous Disposal Facility, Basic Management Incorporated, Clark County, Nevada (Converse, 1999), detailing a geological and geotechnical investigation of the borrow pit area. The purpose of this investigation was to evaluate the suitability of the borrow materials as aggregate. The investigation was divided into an Area A to the south of the borrow pit area, and Area B, which appears to coincide with the southern lobe of the borrow pit area. In the report, Converse indicated that several samples from the borrow

pit were collected for chemical analysis, and that the results would be provided under separate cover. Further review indicated that these samples were from Area A off-site, and no samples were collected from the borrow pit area.

B.1.3 Environmental Resource Management, 1999

ERM conducted a monitoring program on behalf of the HISSC to assess potential impacts on groundwater quality from operations associated with the former BMI Landfill. In the report Groundwater Sampling Results, Former BMI Landfill (ERM, 1999), ERM reported that the BMI Landfill covers approximately 66 acres northwest of the active plant area in the BMI Industrial Complex, Henderson, Nevada. It was initially used as trade effluent disposal ponds for the Basic magnesium refinery. Following closure of the refinery in November 1944, the two westernmost ponds were converted to a solid waste disposal area. Use of this area continued until its closure in February 1980.

The NDEP-approved monitoring program consisted of four sampling events (April 1998, August 1998, November 1998, and March 1999), when samples were collected from six upgradient monitor wells (B-14, LG-33, H-32, H 39, H-40, and H-41) and five downgradient monitor wells (H-18, H-19, H-21, H-23, and H-28) in close proximity to the BMI Landfill and with appropriate geometric configuration such as to provide the basis for differentiating BMI Landfill water quality impacts from potential sources upgradient of the landfill. These monitor wells were previously installed in the vicinity of the BMI Landfill as part of other investigations. Groundwater flow under the landfill area appears to be generally to the north-northeast. However, ERM (1999) posited that local stratigraphic heterogeneities (e.g., sand and clay lenses and paleochannels) may produce unknown preferential flow paths (Further field investigation to test this hypothesis was not performed.). Groundwater samples obtained from monitor wells were analyzed for the following compound classes: volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), aroclors, pesticides, total petroleum hydrocarbons (TPH), and metals.

Based on comparisons of upgradient and downgradient detections of chemicals of concern (COCs), ERM (1999) concluded that the groundwater data associated with the BMI Landfill monitoring program indicate that the historical landfill operations do not appear to have significantly impacted groundwater quality. However, the detections of a number of compounds were of greater concentration in downgradient well samples than in upgradient well samples,

including chlorobenzene, 1,2-dichlorobenzene (DCB), 1,3-DCB, 1,4 DCB, 1,2,3-trichlorobenzene (TCB), 1,2,4-TCB, perchloroethene (PCE), and total benzenehexachloride (BHC). Benzene and chloroform concentrations were greater upgradient. The highest concentrations of COCs were primarily associated with wells near an inferred paleochannel beneath the landfill area. No temporal variation was observed, suggesting the absence of seasonal variations.

B.1.4 Geotechnical & Environmental Services, Inc., 2000a

On April 24, 2000, Geotechnical Environmental Services, Inc. (GES) conducted a sampling event to provide analytical data for the proposed location of a gravel pit. The results of this sampling event were provided in the report Implementation of Sampling Plan for the Proposed Gravel Pit Site, dated May 19, 2000 (GES, 2000a). GES drilled boreholes B-13, B-14, B-15 and B-16 to total depths ranging from 30 to 32.5 feet bgs using a hollow-stem auger (HSA) drill rig. Soil samples were field screened for VOCs using a Microtip 2020 photoionization detector (PID) (GES, 2000a).

Soil samples were analyzed for VOCs (U.S. Environmental Protection Agency [EPA] method 8150), SVOCs (EPA method 8270), organochlorine pesticides (EPA method 8150), perchlorate (CA DHSM-IC), and metals (EPA method SW 6010). Asbestos samples were collected from all four boring locations, at the surface only. Three soil samples from borehole B 13 were submitted for radionuclide analysis. Samples analyzed indicate the presence of VOCs, SVOCs, organochloride pesticide compounds, perchlorate, and metals (GES, 2000a).

VOCs detected were: 1,2-DCB, 1,3-DCB, 1,4-DCB, 1,2,3 TCB, 1,2,4-TCB, and 4-methyl-2-pentanone. These compounds were detected at the highest concentrations in boreholes B-15 and B-16. Also, methyl-2-pentanone was detected in borehole B-15 at the surface (GES, 2000a).

SVOCs 1,2-DCB, 1,4-DCB, and 1,2,4-dichlorobenzene were present at concentrations above reporting limits. Dichlorobenzene was detected at a concentration above the reporting limit at 30 feet bgs in borehole B-13. Other SVOCs present include 1,3-DCB, fluoranthene, hexachlorobenzene, hexachlorobutadiene, and phenanthrene. Boreholes B-15 and B-16 were non-detect for all SVOCs at all sample intervals. SVOCs were detected at the highest concentrations in borehole B-13. In all four borehole locations, the concentrations of

perchlorate were highest in surface soil samples and dropped rapidly with depth. Perchlorate concentrations were low to non-detect in samples collected at 30 feet bgs (GES, 2000a).

Organochlorine pesticide compounds 2,4 dichlorobenzene, MCP, dichloroprop, pentachlorophenol dicamba, and silvex were present in surface samples. Concentrations decreased with depth to low or non-detect levels at 30 feet bgs. Borehole B-15 was non-detect for almost all constituents, in all sample intervals analyzed. Borehole B-16 indicated dicamba present at 20 and 30 feet bgs (GES, 2000a).

In general, metal concentrations were highest in the surface and near-surface samples (0, 5, and 10 feet bgs). Metals present in the analyzed samples include barium, cadmium, chromium, hexavalent chromium, lead, mercury, and silver. Lead and chromium concentrations were highest at the surface and decreased with depth, while barium concentrations were more consistent throughout the depth intervals. Cadmium and silver detections were limited to surface samples from boreholes B-13 and B-14. Mercury was detected only in the surface sample from borehole B 14 (GES, 2000a).

Asbestos was found to be non-detect in all four borehole samples collected at the surface. Radionuclides were detected in all three samples collected. Field screening with the PID indicates that the readings were taken from borehole B-13. Also, strong odors were observed at borehole B-13, and moderate odors were noted at borehole B-14 (GES, 2000a).

B.1.5 Parsons Engineering Science, Inc., 2000b

In September 1999, Parsons Engineering Science, Inc. (PESI) conducted a limited environmental investigation to assess conditions at the Borrow Area. The results of this investigation were provided in the report Environmental Assessment, Proposed Aggregate Mining Operation, Henderson, Nevada, dated April 2000 (PESI, 2000b). The purpose of the environmental sampling was to provide a preliminary indication regarding the presence of contamination on that portion of the CAMU site. Soil samples were collected at various depths from six boreholes (B-1, B-4, B-5, B-8, B-10, and B 12) using HSA drilling. Samples were analyzed for VOCs, SVOCs, organochlorine pesticides, perchlorate, gross alpha, nonvolatile beta, and metals. Groundwater samples were collected from two of the borings and analyzed for the same constituents (PESI, 2000b).

Near-surface and subsurface soils observed during this investigation consisted primarily of alluvial granular soils overlying fine-grained soils, the top of which generally coincides with the groundwater table. Groundwater was encountered at depths ranging from approximately 38 to 58 feet bgs. No VOCs or SVOCs were detected in the soil samples, although low levels of pesticides and perchlorate were detected in several of the samples. Concentrations of detected metals in soil were interpreted to be consistent with naturally occurring background levels for the western United States. No VOCs or SVOCs were detected in the two groundwater samples collected beneath the site, although pesticides (4,4'-DDT at 2,700 micrograms per liter [µg/L]) were detected in one of the samples. Perchlorate was detected in both of the samples (17 and 65 µg/L) (PESI, 2000b).

B.1.6 Spectrum Geophysics, 2000

Spectrum initiated a field investigation to delineate the lateral and vertical extent of buried waste trenches to a depth of 15 feet or more, as well as to identify possible metallic interferences to planned ground intrusion activities within the designated area. The results of this investigation were provided in the report Geophysical Investigation Report, BRC Landfill, Henderson, Nevada, dated June 2000 (Spectrum, 2000). Five independent pieces of field instrumentation were used to characterize: (1) the alignment and lateral boundaries of the waste trenches by inducing an electromagnetic field (EM-31), (2) the depths of trenches and lateral changes with depth within each trench by passing an electrical current through the soil (sting 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), and (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) (Spectrum, 2000).

A total of 8 trenches (1A, 2A, 3A, 4A, 1B, 2B, 3B, and 4B) were interpreted from the data. Trenches vary from 6 to 12 meters in width from 130 to 250 meters in length. The data indicated a division or "clean area" trending north-south in the middle of the investigation site (lines 274 to 304). Spectrum used three cross-sections to exemplify the data: A-A', B-B', and C-C'. At line B-B', trenches 3B and 4B were interpreted with widths of 4 to 6 meters and depths of approximately 4 meters. At line C-C', trenches 1B, 2B, 3B, and 4B were interpreted with

widths of 6, 8, 6, and 6 meters, respectively, and depths of 4, 4, 3.5, and “?” meters, respectively. The depth of trench 4B was reported with a question mark (?) due to the limitations of the geophysical tools used during the investigation. At line A-A’, trenches 1A, 2A, 3A, and 4A were interpreted with widths of 4 to 5, 14, 6, and 6 to 8 meters, respectively, and depths of 4, 4, 4?, and 4? meters, respectively. Trenches 3A and 4A depths were reported with “?” by each numerical value (Spectrum, 2000).

Work performed by Spectrum was not always in agreement with other investigations. While Spectrum identified 8 trenches during their investigation, a review of aerial photographs that documented site activities indicated that as many as 16 trenches were present over the life of the operations. It appears that the geophysical signal in some instances grouped two or more trenches into a single geophysical signature.

More recent work (BRC and MWH, 2005) also showed the slit trenches to be deeper. Boring logs obtained from recent field investigations by MWH identify the maximum depth of solid waste disposal within the trenches (BRC and MWH, 2005). These logs (BS-1 through BS-20) report the observation of debris between 3 and 32 feet bgs in the STA. The most commonly observed depth to trench bottom was nominally 30 feet bgs with the next most common trench bottom depth being 25 feet bgs. Nonetheless, work performed by Spectrum was instrumental in defining the scope for subsequent intrusive investigations.

B.1.7 Geotechnical & Environmental Services, Inc., 2003

In 2003 GES conducted a limited Phase II environmental investigation at the Borrow Area. The results of this investigation were provided in the report Limited Environmental Phase II Investigation, Proposed BRC Landfill, Henderson, Nevada, dated June 3, 2003 (GES, 2003). The purpose of this investigation was to verify the northern and eastern boundaries of the Borrow Area and estimate the volume of “useable” material within the Borrow Area.

A total of eight soil borings, EB-1 through EB-8, were advanced to depths of approximately 35 feet bgs. Groundwater was not encountered at any of these locations. Samples collected from these borings were analyzed for SVOCs, with samples retained for additional analyses. Later, split samples were analyzed for a combination of the following suites of analyses: VOCs, organochlorine pesticides, organophosphorous pesticides (broad suite), metals (aluminum,

antimony, arsenic, barium, beryllium, cadmium, chromium [total and VI], cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, selenium, silver, thallium, titanium, tungsten, vanadium, and zinc), perchlorate, and radionuclides (GES, 2003).

Sample results were compared to EPA Region 9 preliminary remediation goals (PRGs) for industrial soils. None of the samples contained SVOCs (including dichlorobenzene and TCB isomers), asbestos, or organophosphorous pesticides. A total of 8 samples collected from these from EB-1 at 30 and 35 feet contained alpha-BHC and gamma-BHC at concentrations above the industrial PRGs for these two compounds of 0.36 and 1.7 micrograms per kilogram ($\mu\text{g/kg}$), respectively. Samples from the 35-foot depth contained alpha-BHC and gamma-BHC at concentrations of 68 and 17 $\mu\text{g/kg}$, respectively. This same sample also contained beta-BHC at a concentration of 74 $\mu\text{g/kg}$, although no PRG had been set for this compound. These are the highest concentrations noted for these compounds. VOCs were not detected in any of the soil samples collected during this investigation. None of the samples were analyzed for total metals (GES, 2003).

B.1.8 Aeolus, 2003

In October 2003, MWH conducted asbestos sampling within the Borrow Area. The sampling consisted of the collection of surface and shallow subsurface soil samples from 50 locations, combined into 10 soil composites (5 from each of two depths). The samples were prepared and analyzed per the modified elutriatory method (Berman and Kolk, 2000). Using the results of these samples, Aeolus (2003) then evaluated the potential risks posed by the presence of asbestos in Borrow Area soils. The results of this evaluation were presented in the report Evaluation of Asbestos Measurements and Assessment of Risks Attendant to Excavation and Use of Soils within the Proposed Borrow Area of the BRC Corrective Action Management Unit, Henderson, NV, dated December 2003 (Aeolus, 2003). Aeolus (2003) reported that the results suggested that the asbestos-related risks were very low. The hypothesis that asbestos would only be found at the surface was confirmed by sampling and analytical results in which asbestos was only detected in the shallowest 2 inches of soil. None of the samples from the deeper soil (between 2 and 4 inches) showed detectable asbestos. Aeolus (2003) concluded that asbestos-related risks attendant to the excavation, handling, and use of soils from the Borrow Area would result in risks to workers that are substantially less than one in a million.

B.1.9 MWH Americas, Inc., 2003a

In October 2003, MWH conducted an evaluation of the potential health risks of detected radionuclides in the Borrow Area soils. The results of this evaluation were presented in an October 2003 memorandum (MWH, 2003a). The evaluation included a statistical comparison with background radionuclide levels, using background data collected by ENVIRON for the City of Henderson Water Reclamation Facility expansion project. The risk assessment evaluated the human health risks to construction worker receptors. Radionuclide analytical results for soil samples collected from the Borrow Area soils during the GES 2003 supplemental investigation were used. Results of this assessment indicated that, given the planned use, Borrow Area soils would not pose an unacceptable risk to human health (MWH, 2003a).

B.1.10 MWH Americas, Inc., 2003b

In November 2003, MWH conducted an evaluation of the potential of detected organochlorine pesticides in the Borrow Area soils to impact groundwater assuming the use of the soil to construct a 35-foot-high berm. The results of this evaluation were presented in a November 2003 memorandum (MWH, 2003b). The evaluation was conducted using the VLEACH vertical migration model and site-specific soil analytical results. Pesticide analytical results for soil samples collected from the Borrow Area soils were used (MWH, 2003b).

Organochlorine pesticides analytical results for soil samples collected from the Borrow Area soils during the GES 2003 supplemental investigation were used. Seven pesticides were detected in at least one sample from these samples. The detected pesticides were 4,4'-DDE, 4,4'-DDT, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC (Lindane), and methoxychlor. The VLEACH modeling results represent a conservative evaluation of the migration potential of detected soil pesticides to groundwater. Examples of the conservative assumptions include 100 percent rainfall infiltration rate and no groundwater dilution. Using conservative assumptions, the results indicate minimal potential to significantly impact groundwater (MWH, 2003b).

B.1.11 Geotechnical & Environmental Services, Inc., 2000d

GES conducted a sampling event to provide analytical data for the proposed location of a gravel pit. The results of this sampling event were presented in a November 2000 letter report (GES,

2000d). The boreholes were designated B-13, B-14, B-15 and B-16. It is important to note that borings B-13 and B-14 were located within the area defined as the Western W. Ditch Extension, while B-15 and B-16 were actually in the North Borrow Area.

Boreholes were drilled to depths ranging between 30 and 32.5 feet bgs using HSA. Soil samples for each sample interval were field screened for VOCs using a Microtip 2020 PID. Collected soil samples were analyzed for VOCs (EPA method 8150), SVOCs (EPA method 8270), organochlorine pesticides (EPA method 8150), perchlorate (CA DHSM-IC); and metals (EPA method SW 6010). Asbestos samples were collected from all four boring locations, at the surface only. Three soil samples from borehole B-13 (collected at 0, 5, and 10 feet bgs) were submitted for radionuclide analysis (GES, 2000d).

Samples analyzed indicated the presence of VOCs, SVOCs, organochlorine pesticide compounds, perchlorate, and metals. The primary VOC chemicals present were 1,2 DCB, 1,3 DCB, 1,4-DCB, 1,2,3-TCB, and 1,2,4-TCB. These compounds were detected at the highest concentrations in boreholes B-13 and B-14 (Western W. Ditch Area), and at lower concentrations in boreholes B 15 and B-16 (North Borrow Area) (GES, 2000d).

Methyl-z-pentanone was also detected in borehole B-15 at the surface. Borehole B-15 was non-detect for all SVOC chemicals at all sample intervals. Borehole B-16 was non-detect for almost all constituents (except for dicamba) in all sample intervals analyzed. Borehole B-16 indicated dicamba present at 20 and 30 feet bgs (GES, 2000d).

SVOCs were detected at the highest concentrations in borehole B-13. The concentration of dichlorobenzene remained above reporting limits at 30 feet bgs in borehole B 13. Other SVOC chemicals that were present include 1,3-DCB, fluoranthene, hexachlorobenzene, hexachlorobutadiene, and phenanthrene. Field screening with a PID indicated that the highest VOC chemical readings were taken from borehole B-13. Also, strong odors were detected at borehole B-13, and moderate odors were detected at borehole B-14. Cadmium and silver detections were limited to surface samples from boreholes B-13 and B-14. Mercury was detected only in the surface sample from borehole B-14. Gross alpha and gross beta were detected in samples collected from the surface and at 5 and 10 feet bgs at borehole B-13, with little variation in concentration between the three depths sampled (GES, 2000d).

In general, metal concentrations were highest in the surface and near-surface samples (0, 5, and 10 feet bgs). Metals present in the analyzed samples include barium, cadmium, chromium, hexavalent chromium, lead, mercury, and silver. Lead and chromium concentrations were highest at the surface and decreased with depth, while barium concentrations were more consistent throughout the depth intervals (GES, 2000d).

Asbestos results were non-detect in all four borehole samples collected from the surface.

Organochlorine pesticide compounds 2,4-dichlorobenzene, MCP, dichloroprop, pentachlorophenol, dicamba, and silvex were present in surface samples. Concentrations decreased with depth to low or non-detect levels at 30 feet bgs.

In all four borehole locations perchlorate concentrations were highest at the surface and decreased rapidly with depth. The concentration of perchlorate was low to non-detect by 30 feet bgs (GES, 2000d).

B.1.12 Parsons Engineering Science, Inc., 2000a

PESI prepared the report Draft Evaluation of Remedial Alternatives for the Slit-Trench Area South of the Closed BMI Landfill, dated March 13, 2000 (PESI, 2000a) to identify and evaluate options for implementing the remedial alternatives proposed by BRC and selected by the NDEP for the remediation of the Upper and Lower Ponds soils (NDEP, 2001).

This study included consideration of the STA and posed four potential alternatives: (1) no-action, (2) excavation and off-site disposal of STA wastes, (3) capping the area with an impermeable cover, and (4) excavation of the trench wastes followed by disposal of the excavated wastes and impacted soils within the CAMU site. These four general response actions (GRAs) for remediation of identified volumes and areas of affected soils were assessed considering the remedial action objectives (RAOs).

The RAOs presented for STA remediation were: (1) continue to prevent the impact of the slit trenches on groundwater, (2) avoid unacceptable risk to human health under current or future potential land use (including construction workers), and (3) avoid other unacceptable

environmental impacts such as fugitive dust. The four potential alternatives were evaluated to assess the relative performance of each alternative with respect to the following criteria:

- Overall protection of human health and the environment
- Effectiveness and permanence
- Implementability
- Cost
- Regulatory (NDEP) and community acceptance.

The current and future zoning for the STA is M-2, or Heavy Industrial, reflecting its historical use. The report stated that the area was vacant with no structures, and is proposed to be used as the BRC CAMU. Based on available documentation, it was assumed that prior to construction of the slit trenches, this area had not been used, that the native soils were undisturbed, and that the area had not been impacted by previous site operations. The soils in the vicinity are generally medium dense to very dense granular soil with occasional zones of moderately hard to hard cemented sand and gravel overlying very stiff clays and silts (Converse, 1999). PESI (2000a) hypothesized that wastes disposed in the trenches would migrate vertically with limited lateral migration. Based on an estimated trench depth of 25 feet and the planimetric area of 10 acres, the anticipated impacted waste soil volume pertinent to the slit trenches was estimated to be a little over 400,000 cubic yards.

PESI (2000a) concluded the following:

- The groundwater treatment system (GWTS) is effectively capturing groundwater flow containing chemicals from potential upgradient source areas.
- The closed BMI Landfill does not appear to be a contributing source of benzene, chlorobenzene, chloroform, metals, specific conductivity or petroleum hydrocarbons detected in groundwater (ERM, 1999).
- The monitoring data indicate that carbon tetrachloride (CCl₄) wastes reportedly disposed of in the trenches are not adversely impacting groundwater quality.

- Past impacts to groundwater, if any, are not identified by the available data, nor could they be detected by future data gathering efforts.

PESI (2000a) therefore recommended alternative 3 (capping the STA with an impermeable cover) as the preferred alternative for the following reasons:

- It provides a high degree of health and environmental protection.
- It avoids the secondary health and environmental impacts of alternatives 2 and 4.
- It is comparably permanent and effective relative to alternatives 2 and 4.
- It is much easier to implement than alternatives 2 and 4.
- It is much less costly than alternatives 2 and 4.

B.1.13 Geotechnical & Environmental Services, Inc., 2000c

GES implemented a sampling and analysis plan (SAP) provided by PESI. The results of these activities were presented in an August 2000 letter report (GES, 2000c). Six boreholes (B-1 through B-6) were advanced in the STA, and samples were collected using an HSA. Soil samples were collected at depths of 0, 10, 15, 20, and 25 feet bgs. In some instances, soil samples were not collected at depths between 9 and 25 feet bgs due to the presence of debris. Waste material was dry and consisted of plastic, fabric, wood, paper, and glass. Seven soil gas locations (SG-1 through SG-7) were advanced to depths of 5, 15, and 25 feet bgs using direct-push technology. Soil vapor samples were collected in stainless steel Summa canisters (GES, 2000c).

In 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 4-1). Each of these sets has a single boring installed within the trench that is identified by a "C" designation (e.g., B1-C or B5-C), 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 were collected from each boring at roughly 5-foot intervals until groundwater was encountered. A groundwater sample was also collected from the open borehole at each location. 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 analyzed for PCBs (GES, 2000c).

Soil samples were analyzed for VOCs, SVOCs, organochlorine pesticides, PCBs, metals, gross alpha, gross beta, and asbestos (EPA method 600/R-93/116). The soil gas samples were analyzed for VOCs (EPA method TO-14). Both the soil and soil gas analytical results established the presence of analytes at the 25 feet bgs interval (GES, 2000c).

B.1.13.1 Boring B1

Boring B1 was impacted throughout by chlorobenzene compounds and chlorinated solvent compounds. The compounds 1,2-DCB and 1,4-DCB were detected at concentrations of 6,000 and 7,400 µg/kg, respectively, in a sample collected at 15 feet bgs. PCE was also detected at this same interval at a concentration of 6,100 µg/kg, while hexachlorobutadiene was reported at 2,100 µg/kg. Other VOCs detected included carbon tetrachloride (CCl₄) (34 µg/kg), chloroform (930 µg/kg), and TCE (29 µg/kg). The dichlorobenzene compounds were also detected during the EPA method 8270 analysis for SVOCs. The pesticides 4,4-DDD, 4,4-DDE, and 4,4-DDT were detected at this location at concentrations of 12, 160, and 240 µg/kg, respectively. Aroclor 1260 was detected at a maximum concentration of 170 µg/kg in a sample collected at 15 feet bgs (GES, 2000c).

B.1.13.2 Boring B2

VOC detections were not as significant at this location, although PCE was detected at a concentration of 42 µg/kg. The most significant detections were of the pesticides, with concentrations of 4,4-DDD (1,200 µg/kg at 20 feet bgs), 4,4-DDE (5,300 µg/kg at 20 feet bgs), and 4,4-DDT (96,000 µg/kg at 20 feet bgs), as well as BHC compounds, exceeding screening levels. Aroclor 1242 was detected at a maximum concentration of 180 µg/kg in a sample collected at 15 feet bgs (GES, 2000c).

B.1.13.3 Boring B3

Similar compounds were detected in this boring as were detected in borings B1 and B2, although at much lower concentrations.

B.1.13.4 Boring B4

Similar compounds were detected in this boring as were detected in borings B1 and B2, although at much lower concentrations.

B.1.13.5 Boring B5

In boring B5, chloroform, hexachlorobutadiene, and PCE were detected at concentrations of 48,000, 36,000, and 76,000 µg/kg, respectively, at 25 feet bgs. TCE was also detected at this interval at a concentration of 5,300 µg/kg. DDT was detected at a concentration of 2,200 µg/kg at 20 feet bgs.

B.1.13.6 Boring B6

Similar compounds were detected in this boring as were detected in borings B1 and B2, although at much lower concentrations. Aroclor 1242 was detected at a maximum concentration of 170 µg/kg in a sample collected at 15 feet bgs.

Antimony, barium, chromium, lead, and manganese were present in all samples analyzed. Mercury was present in all samples analyzed from locations B1 and B2, and cadmium was present in location B1 at 15 feet bgs. No arsenic, hexavalent chromium, selenium, silver, or thallium was detected. Gross alpha and gross beta were detected in all samples. Asbestos was not detected at any locations except for location B4 at 25 feet bgs. The soil gas analyses confirmed the compounds in the soil samples. Analytes that were detected throughout the sampling locations (although not always present in all sampling intervals) included acetone, dichloroethene (DCE) compounds, chloroform, TCE, xylene compounds, and PCE. The analytes that were detected consistently at highest concentration were chloroform and PCE.

Toxicity characteristic leaching procedure (TCLP) analysis was run on two samples that contained metals exceeding TCLP criteria. For the B2 sample from 25 feet bgs, TCLP was analyzed for lead, and for the B1 sample from 15 feet bgs, TCLP was analyzed for mercury. All TCLP analyses were non-detect.

B.1.13.7 BRC and MWH Americas, Inc., 2005

MWH performed a thorough investigation of the STA during spring 2005 in accordance with the scope of services proposed in the draft closure work plan (BRC et al., 2004). The results of this investigation were presented in the report BMI Landfill CAMU Investigation Summary, BMI Soil, Soil Vapor, Groundwater, and Slit Trench Investigation Report, dated May 2005 (BRC and MWH, 2005). The investigation included the advancement of soil borings, the completion of monitor wells, the collection of soil vapor samples, and the collection of groundwater samples.

A total of 20 soil borings (BRC-BS-01 through BRC-BS-20) were advanced within the STA using HSA. The locations of the borings are shown on Figure 4-1. Soil vapor sample locations are shown on Figure 4-2. Debris encountered and characterized during the drilling and sampling of STA borings included rubber cord, belt pieces, paper, wood, fabric, plastic, paper bags, chalky white powder, concrete, visqueen, 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, rusted metal pipe fragments with insulation material coating, and clay with hydrocarbon odor. Two paper bags had legible labels that read "Montrose brand of DDT" (BRC-BS-12 and BRC-BS-13) and two bags were labeled "Lime" (BRC and MWH, 2005). Table B-1 summarizes the waste materials identified in the soil borings during this field investigation.

A total of 59 primary soil samples were collected and submitted for chemical analyses, with the results compared to preliminary risk-based screening levels (RBSLs). The analyses were performed for the full suite of analytes proposed in the draft closure work plan (BRC et al., 2004).

Table B-2 identifies all compounds detected in soils during the STA investigation and provides the RBSLs used for site evaluation. For the most part, chemicals exceeding RBSLs consisted of organics. In one sample, the concentration of iron (99,700 milligrams per kilogram [mg/kg]), exceeded its preliminary RBSL of 99,909 mg/kg. This minor exceedance in one sample is not thought to be indicative of a release, nor is it a threat to human health or the environment. No other metals were detected at concentrations above RBSLs (BRC and MWH, 2005).

Figures associated with the following text have only been prepared for those compounds that exceeded RBSLs in both the soil and soil vapor media. This information will be useful in future discussions regarding contaminant fate and transport, as well as in discussion of potential sources of contamination.

Within the slit trenches, 1,4-DCB and 1,2-DCB were detected at maximum concentrations of 23,000 mg/kg (screening level 903 mg/kg) and 1,700 mg/kg (screening level 27,846 mg/kg), respectively, at location BRC-BS-08 at a depth of 19 feet bgs. Elevated reporting limits precluded the identification of other compounds in this sample. PCE was detected at a maximum concentration of 2,300 mg/kg at the BRC-BS-20 location. 4,4'-DDE was detected at a

maximum concentration of 320 mg/kg at location BRC-BS-16 at a depth of 9 feet bgs. Aldrin was detected at a maximum concentration of 3.1 mg/kg at this same location. 4,4' DDT was detected at a maximum concentration of 1,000 mg/kg at location BRC-BS-11 at 20 feet bgs. Alpha-BHC was detected at a maximum concentration of 53 mg/kg at location BRC-BS-08 at 29 feet bgs. Aroclor 1254 was detected at a maximum concentration of 1,200 mg/kg at location BRC-BS-11 at 29 feet bgs. Hexachloro-1,3-butadiene was detected at a maximum concentration of 100 mg/kg at location BRC-BS-20 at 29 feet bgs. Hexachloroethane was detected at a maximum concentration of 2,000 mg/kg at this same location. Hexachlorobenzene was detected at a maximum concentration of 25 mg/kg at location BRC-BS-08 at 29 feet bgs. Tetrachlorodibenzo dioxins (TCDD) toxicity equivalents (TEQ) was detected at a maximum concentration of 30,849.68 picograms per gram (pg/g) in boring BRC BS-08 at 19 feet bgs.

Soil vapor samples were also collected from a series of 22 drive points in near proximity to the slit trenches at depths of up to 50 feet. Soil vapor 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. The vapor samples were collected by first advancing a boring with HSA to 5 feet above the target interval. A soil vapor probe was then advanced 5 feet into the undisturbed sediments. Soil samples were collected in Summa canisters and analyzed using EPA method TO 14. Samples were analyzed for benzene, 1,2-DCB, 1,3-DCB, 1,4-DCB, chlorobenzene, chloroform, CCl₄, PCE, TCE, and 1,2-dichloroethane (1,2-DCA).

The majority of the soil vapor contamination was noted along the southern transect, with the highest concentrations of most constituents found east of the northern tip of the South Landfill Lobe at locations SV-18 through SV-22. 1,2-DCA was detected at its highest concentration (2,416 micrograms per cubic meter [µg/m³]) at SV-18. Similar concentrations were detected at this location from 20 to 50 feet bgs. At the SV-19 location, maximum concentrations of benzene (389,607 µg/m³), chlorobenzene (459,059 µg/m³), and 1,3-DCB were detected. The highest chloroform (Figure 4-8) and PCE concentrations (4,946,966 and 689,254 µg/m³, respectively) were detected at the SV-20 location, at depths of 50 and 40 feet, respectively, while the highest concentrations of 1,2-chlorobenzene (10,388 µg/m³) and 1,4-DCB (15,277 µg/m³) were reported at the SV 21 location. Other maximum concentrations were noted along the central

transect (TCE at 15,793 µg/m³ at location SV-14 [Figure 4-9] and CCl₄ at 50,576 µg/m³ at location SV 13.

None of the highest contaminant concentrations were noted along the northernmost transect, and in general, the highest concentrations were found at depths of more than 20 feet bgs, with contaminant concentrations increasing with depth. This trend suggests that the majority of the organic waste materials were placed in the trenches within the southern and central portion of the STA at depth, or that contaminants are being transported from the south via groundwater, off-gassing from groundwater, and impacts to the lower portion of the vadose zone beneath the landfill. These off-site sources to the south are suggested by the contaminant distributions for 1,1,2-TCA (Figure 4-11) and 1,1,2,2-TCA.

A total of 19 soil borings were advanced using the rotary sonic drill method at locations BW-1 through BW-13 along the CAMU site boundary. The soil borings were completed to depths ranging from 60 to 200 feet bgs. A total of 40 primary soil samples were collected and submitted for chemical analyses. The pesticides alpha-BHC and Lindane were detected at location BRC-BW-01A at 30 feet bgs at concentrations of 0.890 and 0.260 mg/kg, respectively. Four radionuclides were also identified in soils. Potassium-40 was detected at a maximum concentration of 32.7 picocuries per gram (pCi/g) at location BRC BW 04A at 30 feet bgs. Radium-226 was detected at a maximum concentration of 2.74 pCi/g at location BRC-BW-01A at 50 feet bgs. Radium-228 was detected at a maximum concentration of 3.4 pCi/g at location BRC-BW-07A at 18 feet bgs. Thorium-228 was detected at a maximum concentration of 3.30 pCi/g at location BRC-BW-02A at 0 feet bgs.

In addition to the soil and soil gas investigation, groundwater samples were collected from a total of 17 monitor wells that were installed during this investigation. At the same time, depth-to-water measurements were made, and a potentiometric surface map was prepared depicting the direction of groundwater flow beneath the site. The wells sampled included AABW04, AABW05, AABW06, AABW07, AABW08A, AABW08B, AABW09, AABW12, and AABW13. Groundwater samples from these wells were analyzed for a number of constituents, including total metals, SVOCs, VOCs, pesticides and herbicides, aroclors, radionuclides, and general chemistry parameters.

In general, data show that groundwater flow beneath the CAMU site is to the north-northeast, with an average gradient of approximately 0.017.

A review of the groundwater analytical data revealed that nine of the chemicals of interest detected in groundwater were VOCs: 1,2-DCB, 1,4-DCB, chlorobenzene, benzene, chloroform, PCE, TCE, 1,2-DCA, and dichloromethane. Detection of these compounds in groundwater is not surprising given the information regarding historical disposal practices, historical upgradient releases, and data for site and off-site soils. Benzene was the VOC detected at the highest concentration, with a reported concentration of 23,000 µg/L in well AABW05. Although CCl₄ was not detected in groundwater, its degradation product, chloroform, was detected at concentrations as high as 16,000 µg/L in well AABW04. VOCs of interest for groundwater were primarily detected at greatest concentration along the northern and southern site boundary (wells AABW04A and AABW06A, and wells AABW08A, AABW09A, AABW12A, MCFBW08, MCFBW09B, respectively). Lindane, a pesticide, was detected at greatest concentration along the southern site boundary (well location MCFBW08), as could be expected given the upgradient source. Perchlorate was detected at greatest concentration along the southern site boundary (well location MCFBW09B).

B.2 Off-Site Investigations

Off-site investigations have been performed in the vicinity of the CAMU site since 1989. Following is a summary of the results of the investigations that BRC was able to acquire and review in preparation of this report.

B.2.1 Weston Solutions, Inc., 1993

Weston prepared the report Phase I Environmental Conditions Assessment Report, dated March 1993 (Weston, 1993), which describes the facilities, processes, waste streams, and environmental investigation and remediation work associated with the Pioneer/Stauffer facility.

B.2.2 Converse Consultants, 1993

Converse conducted a Phase I environmental conditions assessment for the former Montrose facility. The results of this evaluation were presented in the report Phase I Environmental

Conditions Assessment for Former Montrose Chemical Corporation Facility, dated April 1993 (Converse, 1993).

As part of its post-closure permit application, Montrose installed four monitor wells in 1989 (one upgradient and three downgradient) to meet the groundwater monitoring requirements of 40 CFR § 270.14(c). Double-lined Ponds No. 1 through 5 were used to dispose of sulfuric and hydrochloric wastewater. Ponds No. 2 and 5 were the only RCRA-regulated facilities on-site. Lined Pond No. 6 accepted SBR. Records from the Montrose facility (Converse, 1993) reported evidence of infrequent, purportedly minor spills and releases of raw material, byproducts and products of chloral, dichlorobenzil, and hydrochloric acid.

Converse (1993) hypothesized that releases from the Montrose facility process area could have migrated through the foundation into the underlying soils and groundwater. At the time of closure, the underlying soil was excavated to 50 parts per million (ppm) maximum PCB concentration. The SBR storage area contained SBR after closure of Pond No. 6. Released contaminated fluids from a shallow perched water table were reportedly encountered at the sump. The fluid was recovered from a silty soil zone at approximately 6 to 8 feet bgs (Converse, 1993).

Elevated levels of organic compounds were detected in the areas of Montrose's lined wastewater Ponds No. 1, 3, and 4 (Converse, 1993). Converse (1993) suggested that fluids had been released from the ponds and had reached groundwater at 55 feet bgs. A total of 22 lysimeters and 5 piezometers were installed. Sulfate pond fluid was encountered at 17 feet bgs and chloride pond fluid was encountered at 20 feet bgs.

Four lysimeters were installed at Montrose's lined wastewater Ponds No. 2 and 5. In addition, four monitor wells (three downgradient and one upgradient) were installed. At the time the report was written, Converse (1993) reported that these wells (MW-1, MW-2, MW -3, and MW 4) had been sampled and analyzed on a quarterly basis. With the exception of CCl_4 (which is sporadically detected in MW-2 at concentrations slightly above the detection limit), none of the analytes required by the Consent Order have been detected in these monitor wells.

Soil sampling was also conducted in this vicinity. Converse (1993) interpreted that the lysimeter samples indicated that fluid from Pond No. 2 had escaped. Soil sampling detected DDT, DDE,

BHC, benzene, chlorinated benzene compounds, dioxin, nickel, cyanide, and benzoic acid. Chlorobenzene, chloroform, 1,2 dichlorobenzene and 1, 4-dichlorobenzene have been detected in the three downgradient wells. Only chloroform is present in the upgradient well.

Soil borings from lined Pond 6 indicated no detectable amounts of PCBs or polychlorinated benzene but did contain 1,2-DCB (30 ppm), 1,4-DCB (30 ppm), alpha-BHC (0.35 ppm) and 4,4 DDE (0.56 ppm). The ponds were certified dry at the time of closure. Converse (1993) reported that the RCRA cap prevents infiltration and concluded that it is unlikely that the ponds serve as an ongoing contaminant source.

B.2.3 Western Technologies, Inc., 1996a

Western Technologies, Inc. (WTI) performed a limited investigation of the Warm Springs Road Extension from U.S. Highway 95/I-515 to Eastgate Road in Henderson, Nevada to investigate both the surface and subsurface soil for potential chemical constituents that could have originated from the adjoining BMI Industrial Complex located upgradient from the project area. The results of this evaluation were presented in the report Phase I Subsurface Soil Evaluation, Warm Springs Road Extension, U.S. Highway 95 to Eastgate Road, Henderson, Nevada, dated April 30, 1996 (WTI, 1996a).

The Phase I assessment included drilling nine soil borings extended to a depth of 15 feet bgs, including one drilled in the main channel of the Western Drainage Ditch, where it crosses the road right-of-way. The remaining eight soil borings were drilled at various points along the centerline of the proposed road. Soil samples were analyzed for asbestos, VOCs, SVOCs, pesticides, PCBs, and total metals. The report concluded that soils had been impacted with trace amounts of pesticides and asbestos, although no analytical results were provided. No groundwater was encountered in any of the nine boreholes.

B.2.4 Western Technologies, Inc., 1996b

WTI performed a Phase II subsurface soil evaluation for the proposed Warm Springs Road Extension. The results of this evaluation were presented in the report Phase II Subsurface Soil Evaluation, Warm Springs Road Extension, Eastgate Road to Boulder Highway, Henderson, Nevada, dated June 24, 1996 (WTI, 1996b). This evaluation was designed to look at both

surface and subsurface soils and the potential for chemical and radionuclide constituents to have been transported to the location by overland flow during flood events, or by diversion into a manmade drainage channel that originates from the BMI Industrial Complex, via the Northwest Drainage Ditch.

The Phase II site locations extended from Eastgate Road on the west to Boulder Highway on the east. The Northwest Drainage Ditch trends southeast-northwest across the road easement. A portion of the Western Drainage Ditch is situated at the western portion of the road extension and is a natural alluvial fan wash, with a dominant main channel and several related smaller flood channels.

A total of 16 soil borings were drilled between March 4 and 6, 1996 to depths between 12 and 15 feet bgs to obtain surface composite and discrete soil samples for field screening and analytical testing.

Surface soils from the Northwest Drainage Ditch were impacted with asbestos. PCB-impacted surface soils were found in the areas west of the Northwest Drainage Ditch. HCB and DCB concentrations were detected within the Northwest Drainage Ditch. Aroclor 1260 was detected in boring IIB-13 at a concentration of 3,600 mg/kg. Alpha-BHC, beta-BHC, gamma-BHC, 4,4'-DDE, and 4,4'-DDT pesticides were detected at various locations in the investigation site. Total metal concentrations were detected at similar levels for each sample analyzed, except for a slightly elevated level of zinc (150 mg/kg) in one sample. WTI interpreted the metals concentrations to indicate natural background conditions. Radionuclide concentrations were also reported at low levels; WTI suggested that these results represented natural background conditions. Isotopic thorium ranged from 1.24 to 2.02 pCi/g. Isotopic uranium concentrations ranged from 0.38 to 3.15 pCi/g, while isotopic radium concentrations ranged from 1.4 to 2.08 pCi/g. VOCs detected included 1,2,4-TCB (310 µg/kg) and 1,2,3-TCB (240 µg/kg), detected in samples taken from boring IIB-4 at 14 feet bgs. The SVOC HCB was only detected in the surface soil samples taken from borings IIBC-7 (1,100 µg/kg) and IIBC-8 (4,100 µg/kg).

B.2.5 SECOR International Incorporated, 1997

SECOR International Incorporated (SECOR) prepared the report Draft Phase II Environmental Conditions Investigation Report, Former Montrose Facility, Henderson, Nevada, dated August

21, 1997 (SECOR, 1997). This report summarizes the operational history of the Montrose site, and presents the results of an investigation that included the installation of 33 primary and several confirmatory soil borings based on the historical record. In addition, 4 groundwater monitor wells were installed, although the analytical results associated with these wells were not provided in this report.

SECOR identified a total of 24 “study items” for some sort of assessment, whether it be through the use of analytical samples or site activities documentation. At those sites where soil borings were proposed, the primary borings extended to depths of approximately 10 feet bgs, with samples collected from 0, 2, 6, and 10 feet bgs. Soil samples were analyzed for a list of target constituents including pH, chloride, sulfate, benzene, MCB, 1,2-DCB, 1,3-DCB, 1,4-DCB, TCB, tetrachlorobenzene, pentachlorobenzene, hexachlorobenzene, dichlorobenzil, chloral, aroclors, DDT, DDD, DDE, acetaldehyde, chloroacetaldehyde, dichloroacetaldehyde, chloroform, and CCl₄. It is important to note that not all samples were analyzed for all target constituents.

Table B-4 summarizes the findings of this investigation. Despite the limited number of target constituents and shallow boring depths, a number of compounds were frequently detected at concentrations above NDEP action levels, including benzene, MCB, 1,2-DCB, 1,3-DCB, 1,4-DCB, TCB, DDT, DDD, DDE, and CCl₄. Based on this investigation, SECOR concluded that the plant site and ponds could not be disregarded as potential sources of groundwater contamination.

B.2.6 Harding Lawson Associates, 1999

In preparation of the report Site Conceptual Model, Stauffer/Pioneer/Montrose Site, Henderson, Nevada, dated September 30, 1999 (HLA, 1999), Harding Lawson Associates (HLA) focused on nine discrete areas to evaluate potential sources of groundwater contamination:

- Areas I and V were the phosphoric acid pond, leach beds, associated trenching and piping. In 1971, the pond and trenches were neutralized with lime and capped with 1 foot of compacted clay.

- Area II was the ACD drum burial area that contained drummed waste associated with the production of phosmet, carbophenothion, and phosphoric acid. In 1980, this area was capped with 1 foot of compacted clay.
- Area III was the site of the wastewater treatment pond and associated concrete conduits. These ponds were partially covered by CAPD Ponds No. 7 and 8, which received only chlor-alkali wastewater and stormwater runoff.
- Area IV consisted of ACD Ponds No. 1 and 2 and their associated piping. These ponds were constructed in 1975 and double lined with 10-mil polyethylene top liners and 20-mil PVC bottom liners.
- Area VI was the former location of the Lindane plant, the BHC Cake Piles 1 through 3, and the haul route.
- Area VII was the location of two underground 40,000-gallon single-walled benzene storage tanks that were abandoned in place and filled with an unspecified inert material.
- Area VIII consisted of the wastewater ponds 1 through 6.
- Area IX was the location of the Montrose plant.

The investigation focused on water quality, although soil samples were collected in Areas III, IV, VII, VIII, and IX. The COCs for this investigation were benzene, chlorobenzene, chloroform, dimethyldisulfide, monochlorobenzene sulfonic acid (MCBS), diethylphosphorodithioic acid (DEPT), dimethylphosphorodithioic acid (DMPT), phthalic acid, benzene sulfonic acid, S-[(p-chlorophenylthio)methyl]0,0-diethylphosphorodithioate (phosmet), n(mercaptomethyl) phthalimide-S-(0,0-dimethylphosphorodithioate) ("carbophenothion"), and BHC.

The majority of this assessment was based on the comparison of upgradient and downgradient water quality. Table B-3 summarizes this evaluation. In general, based on a review of water quality data, HLA concluded that Areas I, II, III, V, V, VIII, and IX had impacted groundwater.

The Area VI results were confirmed with soils analyses that revealed the alpha-BHC isomer at a maximum highest concentration (up to 48,000 mg/kg). Harding Lawson reported that concentrations of all BHC isomers found in surface soil samples tended to decrease with depth. Surface soil samples from Area VIII did not exhibit significant concentrations of COCs. Soil sample analyses from Area IX detected the presence of benzene, monochlorobenzene, 1,2 DCB, 1,3-DCB, CCl₄, hexachlorobenzene (HCB), DDT, DDD, and DDE, with concentrations decreasing with depth.

B.2.7 SECOR International Incorporated, 2002b

SECOR performed an investigation of the deeper water-bearing zones at the former Montrose facility and presented the results of this investigation in the report Revised Report of the Investigation of the Deeper Water-Bearing Zones at the Former Closed Ponds and Former Plant Site, Former Montrose Facility, Henderson, Nevada, dated March 2002 (SECOR, 2002b). The primary objectives of this investigation were to assess the hydrostratigraphy in the vicinity of the closed ponds in the Tertiary Muddy Creek Formation (TMCf) and in the Qa and TMCf near the former plant site. To accomplish this, SECOR performed the following tasks:

- Advanced a soil boring downgradient of the closed ponds to a depth of approximately 135 feet bgs and subsequently completed the boring as a monitor well (CP-1)
- Performed a step-drawdown test
- Performed geophysical logging of existing wells at the former plant site
- Installed a shallow soil boring near the redwood tank that was abandoned at 20 feet bgs due to health and safety issues
- Installed a soil boring adjacent to existing well B-01 to a depth of 136 feet and subsequently completed the boring as a monitor well (DPT-1). This boring/well was completed over a 45-day span due to health and safety issues.
- Collected soil and groundwater samples from both borings/wells

Several key findings were made at the CP-1 location north of Pond No. 5. A saturated zone was identified at 58 feet bgs, with unsaturated sediments encountered until the well completion interval of 115 to 125 feet bgs. A groundwater sample collected from this well contained MCB, 1,2-DCB, and 1,4 DCB at concentrations above applicable maximum contaminant levels (MCLs). The step-drawdown test from this well resulted in a calculated transmissivity of 140 gallons per day per foot (gpd/ft), a hydraulic conductivity of 12 ft/day, and a sustainable discharge of approximately 1 gpm. A soil sample collected at a depth of 100 feet bgs contained MCB at a concentration of 6,300 mg/kg. This compound was not detected at 128 feet bgs.

At the DPT-1 location at the former plant site immediately south of Pond No. 1, two saturated zones were encountered: at 50 feet bgs and at 124 to 128 feet bgs, where the well was eventually screened. Soil samples were collected at depths of 72, 90, and 136 feet bgs. Contaminant concentrations were similar in the upper and lower sample intervals for benzene and 1,4-DCB, with minimal decreases in concentrations (benzene: 17 to 12 mg/kg; 1,4-DCB: 3.2 to 2.2 mg/kg). More importantly, dense nonaqueous-phase liquid (DNAPL) was noted at 97.5 and 116 feet bgs, although DNAPL samples were not collected. The DNAPL was apparently present above sand stringers, and was acting as a continuing source of contamination. Benzene, MCB, and 1,4-DCB were detected at concentrations of 58, 180, and 16 mg/L, respectively, all of which exceed EPA MCLs.

B.3 Historical Environmental Remediation Conducted at the Site and Vicinity

The GWTS is operated by Pioneer, with technical and financial assistance from Montrose, Stauffer, and Syngenta. The GWTS has been operating under the April 1983 Consent Order between NDEP, Stauffer, and Montrose. The well field of the GWTS is located in the northern portion of the BMI Industrial Complex, south of Warm Springs Road. The GWTS, constructed in 1983, was designed and constructed to provide extraction and treatment of alluvial aquifer groundwater in order to capture and treat VOC-impacted groundwater emanating from the Stauffer/Montrose plant site located upgradient of the CAMU site. The GWTS was not designed to treat groundwater to remove chemicals other than VOCs. The GWTS is comprised of a groundwater extraction well field physically oriented perpendicular to groundwater flow direction, an air-stripping tower used to treat extracted groundwater, and a series of three subgrade

trenches for recharging treated groundwater (also oriented perpendicular to the flow of groundwater). These recharge trenches are located just downgradient of and parallel to the extraction well system (Hargis, 2005).

In January 2005, NDEP evaluated and summarized current site conditions and GWTS operations and stated that the evaluation supported modification of the GWTS remedial operations (Attachment A, NDEP, 2005 [Appendix D]). NDEP stated that the GWTS did not appear to be capturing the entire plume of contaminants in groundwater and that, while recent upgrades have increased the pumping rates, it is not clear that the new pumping rates will result in complete plume capture. The GWTS was originally designed to remove only VOCs from the pumped water. NDEP stated that while modifications are planned to also remove pesticides and SVOCs, contaminants that might not be treated include organic acids, TDS, and other chemicals not treatable by air stripping or activated carbon. NDEP also stated that contaminants more dense than water, those migrating below the screens, and those migrating around the cones of depression might not be treated by the GWTS. Impacted water migrating beneath the GWTS well field screens may include water migrating in the more permeable, coarse-grained lenses of the TMCf.

The line of extraction wells extends over a distance of approximately 1,800 feet, on an east-west axis. The 13 extraction wells operate at a reported combined influent flow rate of approximately 250 gpm; flow rates of individual wells range from 3 to 70 gpm. The reported combined influent concentrations of total VOCs averaged 4.47 mg/L during the first quarter of 2005. During the same period, approximately 1,160 pounds of VOCs were removed by the GWTS (Hargis, 2005).

The Companies are reportedly currently involved in renovating and updating all of the major components of the GWTS, including the extraction well field and monitor well network, the treatment system, and the recharge trench system (Hargis, 2005). It is also reported that the treatment system will be upgraded to treat SVOCs and pesticides.

Tables

Table B-1. Waste Materials Identified During Slit Trench Investigation
Page 1 of 2

Boring	Top of Waste (ft bgs)	Bottom of Waste (ft bgs)	Debris Type	Odor Type	Odor Depth (ft bgs)	Comments
BRC-BS-01	3	5	Rubber cord, belt pieces	Solvent	30	Gray discolored soil from 3 to 5 feet
BRC-BS-02	12.5	19.5	Paper, wood, fabric, plastic, paper bags, chalky white powder	Solvent	18.5 - 19.5	Wet white chalky substance encountered 18.5 to 19.5 feet
BRC-BS-03	8	27	Plastic, concrete, fabric, visqueen, paper, cardboard, traces of greenish-white powder, plastic bottles	None	---	One plastic bottle labeled "Janitorial Toilet Bowl Cleaner" came up auger flights
BRC-BS-04	11.5	21	Paper, paper bags, wood, white powder, plastic, metal scraps	None	---	Plastic debris included several plastic 4-inch-diameter lids
BRC-BS-05	5	23.5	Wood, metal, plastic, paper bags, white chalky powder, paper, newspaper	None	---	
BRC-BS-06	3	23	Wood, fabric, plastic	Solvent	3 - 27	
BRC-BS-07	7	25	Plastic, fabric	---	---	Pre-designated Level C PPE, no odor detection possible
BRC-BS-08	9	31	Dark brown to black oily residue/sludge, wood, paper bags, white chalky powder (debris type approximately 20% trash and 80% oily residue/sludge)	Solvent	9 - TD (31.5)	Heavy oily residue coating grains and sludge between grains, sheen when washing grains, Level C PPE upgrade during boring
BRC-BS-09	9	31.5	White chalky powder, concrete/cement, wood, paper, fabric, plastic, glass, metal	None	---	One small empty plastic bottle came up augers (approximately 2-ounce. capacity)
BRC-BS-10	---	---	None encountered	None	---	No debris encountered, native soil encountered at 9 feet and 19 feet, therefore terminated boring at 22 feet
BRC-BS-11	5	29.5	Fabric, black fine material (fine sand size), paper, metal, plastic, paper bags	Solvent	20 - 29.5	

ft bgs = Feet below ground surface
 --- = Not applicable
 PPE = Personal protective equipment

Table B-1. Waste Materials Identified During Slit Trench Investigation
Page 2 of 2

Boring	Top of Waste (ft bgs)	Bottom of Waste (ft bgs)	Debris Type	Odor Type	Odor Depth (ft bgs)	Comments
BRC-BS-12	3	29	Plastic, paper, paper bags, cement fragments	None	---	Paper bags had legible labels, "Montrose brand of DDT", black writing on light brown bags
BRC-BS-13	5	23	Glass, visqueen, rope, paper bags (some burned)	Solvent	15 - 23	Paper bags had legible labels, "Montrose brand of DDT", black writing on light brown bags and "lime" green writing on light brown bags
BRC-BS-14	5	30.5	Fabric, paper bags, plastic, wood, charred wood, red brick	None	---	
BRC-BS-15	3	13	Wood, paper bags ,glass, black oily residue	Solvent	13 - 32	Debris type approximately 90% trash and 10% oily residue/sludge
BRC-BS-16	Surface	7	White chalky powder, wood	Strong solvent	5 - 27	
BRC-BS-17	5	21	Plastic, paper bags, wood, black fine material (fine sand size)	Strong solvent	22 - 32	
BRC-BS-18	9	26	Rusted metal pipe fragments with insulation material coating, fabric, wood	None	---	
BRC-BS-19	7.5	30	White chalky powder, wood, paper bags	None	---	Paper bags had legible labels, "lime" green writing on light brown bags
BRC-BS-20	13	22.5	Paper bags, plastic, clay with hydrocarbon odor	Solvent / hydrocarbon	13 - 20.5 / 21.5 - 22.5	Thin wet clay layer from 21.5 to 22.5 feet had strong petroleum hydrocarbon odor

ft bgs = Feet below ground surface

--- = Not applicable

PPE = Personal protective equipment

Table B-2. Chemicals Detected in Soils During the Slit Trench Investigation
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Chemical	No. of Samples	No. of Detects	Frequency of Detects (%)	Maximum Detected Value (mg/kg)	Minimum Detected Value (mg/kg)
1,1,1,2-Tetrachloroethane	59	6	10.2	0.11	0.0034
1,1,1-Trichloroethane	62	1	1.6	0.0011	0.0011
1,1,2,2-Tetrachloroethane	59	4	6.8	0.036	0.0079
1,1,2-Trichloroethane	62	11	17.7	0.12	0.00087
1,1-Dichloroethane	62	1	1.6	0.0043	0.0043
1,1-Dichloroethylene	62	1	1.6	0.0049	0.0049
1,2,3-TCB	59	31	52.5	0.68	0.002
1,2,3-Trichloropropane	62	3	4.8	0.021	0.009
1,2,4,5-Tetrachlorobenzene	60	10	16.7	72	0.077
1,2,4-Trichlorobenzene	59	46	78.0	2.6	0.001
1,2,4-Trimethylbenzene	59	10	16.9	0.071	0.00075
1,2-Dibromo-3-chloropropane	62	1	1.6	0.01	0.01
1,2-Dichlorobenzene	59	45	76.3	17000	0.001
1,2-Dichloroethane	62	3	4.8	0.012	0.0047
1,3,5-Trimethylbenzene	62	4	6.5	0.17	0.0017
1,4-Dichlorobenzene	59	49	83.1	23000	0.00085
2,2'-/4,4'-Dichlorobenzil	59	17	28.8	220	0.11
2,2-Dichloropropionic acid	59	2	3.4	0.54	0.06
2,4,5-T	59	3	5.1	0.48	0.027
2,4,5-TP	59	4	6.8	0.16	0.025
2,4,6-Trichlorophenol	60	6	10.0	18	0.085
2,4'-DDE	59	11	18.6	43	0.025
2,4-D	59	1	1.7	0.43	0.43
2,4-Dichlorophenol	60	4	6.7	0.66	0.074
2-Chlorophenol	60	1	1.7	0.21	0.21
2-Chlorotoluene	62	1	1.6	0.047	0.047
2-Methylnaphthalene	60	3	5.0	23	0.079
2-Nitrophenol	60	0	0.0		
2-Phenylbutane	62	1	1.6	0.0084	0.0084
3-Methylphenol, 4-Methylphenol	60	1	1.7	0.08	0.08
4-(2,4-Dichlorophenoxy)butyric acid	59	1	1.7	0.093	0.093
4,4'-DDD	59	37	62.7	5.1	0.0022
4,4'-DDE	59	54	91.5	320	0.0019
4,4'-DDT	59	58	98.3	1000	0.0018

mg/kg = Milligrams per kilogram
NE = Not evaluated
--- = Not applicable

Table B-2. Chemicals Detected in Soils During the Slit Trench Investigation
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Chemical	No. of Samples	No. of Detects	Frequency of Detects (%)	Maximum Detected Value (mg/kg)	Minimum Detected Value (mg/kg)
4-Chlorobenzenesulfonic acid	59	3	5.1	7.5	1
4-Chlorotoluene	62	1	1.6	0.043	0.043
Acetaldehyde	59	11	18.6	0.31	0.096
Acetone	59	25	42.4	2.2	0.013
Acetophenone	60	5	8.3	15	0.1
Aldrin	59	8	13.6	3.1	0.0019
alpha-BHC	59	43	72.9	56	0.0019
Aluminum	59	59	100.0	22000	2590
Ammonia	59	33	55.9	183	0.63
Antimony	59	11	18.6	3.6	0.28
Arochlor 1254	62	7	11.3	1200	0.67
Arochlor 1260	59	3	5.1	7.3	0.1
Arsenic	59	59	100.0	20.9	2
Azinphos-ethyl	59	1	1.7	0.023	0.023
Azinphos-methyl	59	3	5.1	0.16	0.013
Barium	59	59	100.0	408	48.3
Benzene	62	11	17.7	0.0056	0.0008
Benzenesulfonic acid	59	1	1.7	2.7	2.7
Benzoic acid	62	14	22.6	360	0.14
Benzyl alcohol	60	1	1.7	0.37	0.37
Benzyl butyl phthalate	60	1	1.7	0.18	0.18
Beryllium	59	50	84.7	1.2	0.23
beta-BHC	59	36	61.0	11	0.0019
bis(2-Ethylhexyl) phthalate	61	19	31.1	17	0.084
bis(p-Chlorophenyl) disulfide	61	2	3.3	7.1	6.5
bis(p-Chlorophenyl) sulfone	61	4	6.6	6.6	0.44
Boron	59	26	44.1	49.3	3.9
Bromide	59	12	20.3	7.6	0.58
Bromomethane	62	17	27.4	0.21	0.001
Cadmium	59	13	22.0	13.2	0.077
Calcium	59	59	100.0	233000	12300
Carbazole	60	1	1.7	0.086	0.086
Carbon disulfide	62	3	4.8	0.0018	0.00044
Carbon tetrachloride	62	18	29.0	0.23	0.00028
Carbophenothion	59	1	1.7	0.033	0.033

mg/kg = Milligrams per kilogram

NE = Not evaluated

--- = Not applicable

Table B-2. Chemicals Detected in Soils During the Slit Trench Investigation
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Chemical	No. of Samples	No. of Detects	Frequency of Detects (%)	Maximum Detected Value (mg/kg)	Minimum Detected Value (mg/kg)
Chloral	59	5	8.5	0.26	0.011
Chlorate	59	14	23.7	81.2	1.9
Chloride	59	59	100.0	41100	19.2
Chloroacetaldehyde	59	9	15.3	1.1	0.26
Chlorobenzene	59	23	39.0	3.2	0.00058
Chloroethane	62	1	1.6	0.0017	0.0017
Chloroform	59	50	84.7	14	0.00096
Chloromethane	62	49	79.0	0.021	0.0011
Chromium (Total)	59	59	100.0	120	4.2
Cobalt	59	59	100.0	11	1.8
Copper	59	59	100.0	172	9.6
Coumaphos	59	1	1.7	0.014	0.014
Cyanide (Total)	59	3	5.1	4.8	0.27
Cymene	59	9	15.3	0.21	0.0014
delta-BHC	59	21	35.6	0.11	0.0023
Dibutyl phthalate	60	3	5.0	0.15	0.084
Dicamba	59	2	3.4	0.33	0.18
Dichloromethane	62	21	33.9	0.33	0.0029
Dichlorprop	59	6	10.2	0.51	0.099
Dichlorvos	59	1	1.7	0.13	0.13
Diethyl phthalate	60	2	3.3	0.24	0.11
Dimethyl phosphorodithioic acid (756-80)	59	5	8.5	9.4	1.6
Dimethyl phthalate	60	1	1.7	0.73	0.73
Dinitrobutyl phenol	59	1	1.7	0.014	0.014
Endosulfan sulfate	59	3	5.1	0.054	0.014
Endrin aldehyde	60	9	15.0	0.056	0.002
Endrin ketone	59	1	1.7	0.002	0.002
Ethoprophos	59	5	8.5	0.15	0.0018
Ethylbenzene	62	6	9.7	0.073	0.00055
Ethylene glycol	59	2	3.4	160	62
Fluoride	59	49	83.1	171	0.19
Formaldehyde	59	27	45.8	2.1	0.2
gamma-Chlordane	59	1	1.7	0.0026	0.0026
Gross alpha	59	59	100.0	132	5

mg/kg = Milligrams per kilogram
NE = Not evaluated
--- = Not applicable

Table B-2. Chemicals Detected in Soils During the Slit Trench Investigation
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Chemical	No. of Samples	No. of Detects	Frequency of Detects (%)	Maximum Detected Value (mg/kg)	Minimum Detected Value (mg/kg)
Gross beta	59	59	100.0	68.2	10.6
Heptachlor	59	2	3.4	0.48	0.35
Heptachlor epoxide	59	7	11.9	1.7	0.0023
Hexachloro-1,3-butadiene	60	4	6.7	100	0.13
Hexachlorobenzene	61	14	23.0	25	0.083
Hexachloroethane	62	23	37.1	2000	0.083
Iodide	59	2	3.4	6.5	5.8
Iron	59	59	100.0	99700	4730
Isopropylbenzene	62	3	4.8	0.015	0.001
Lead	59	59	100.0	417	3.6
Lindane	62	32	51.6	15	0.0023
Lithium	59	59	100.0	56.2	1.2
m,p-Xylene	62	3	4.8	0.15	0.017
Magnesium	59	59	100.0	65000	5110
Malathion	59	1	1.7	0.0015	0.0015
Manganese	59	59	100.0	2070	152
MCPA	59	1	1.7	70	70
m-Dichlorobenzene	59	29	49.2	1.7	0.00058
Mecoprop	59	21	35.6	1700	20
Mercury	59	28	47.5	19.1	0.02
Methoxychlor	60	1	1.7	0.015	0.015
Methyl disulfide	57	1	1.8	0.018	0.018
Methyl ethyl ketone	59	8	13.6	0.53	0.012
Methyl iodide	62	2	3.2	0.0079	0.0038
Methyl isobutyl ketone	62	2	3.2	0.045	0.018
Methyl n-butyl ketone	62	4	6.5	0.11	0.023
Methyl parathion	59	4	6.8	0.13	0.0045
Mevinphos	59	1	1.7	0.0072	0.0072
Molybdenum	59	59	100.0	136	0.31
Naphthalene	60	2	3.3	5.8	0.3
n-Butyl benzene	62	3	4.8	0.24	0.00099
Nickel	59	59	100.0	134	9.5
Niobium	59	15	25.4	16.5	1.2
Nitrate (as N)	59	45	76.3	7.2	0.095
Nitrite (as N)	59	7	11.9	0.55	0.2

mg/kg = Milligrams per kilogram

NE = Not evaluated

--- = Not applicable

Table B-2. Chemicals Detected in Soils During the Slit Trench Investigation
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Chemical	No. of Samples	No. of Detects	Frequency of Detects (%)	Maximum Detected Value (mg/kg)	Minimum Detected Value (mg/kg)
n-Propyl benzene	62	3	4.8	0.04	0.0017
Orthophosphate as P	59	33	55.9	2960	0.55
o-Xylene	62	4	6.5	0.11	0.0041
Palladium	59	59	100.0	1.9	0.2
p-Chlorothiophenol	61	2	3.3	15	14
Pentachlorobenzene	61	9	14.8	41	0.073
Pentachlorophenol	60	1	1.7	2.1	2.1
Perchlorate	59	44	74.6	14.7	0.0571
Phenanthrene	59	3	5.1	1	0.06
Phenol	60	3	5.0	0.55	0.17
Phosmet	59	1	1.7	0.027	0.027
Phosphorus (as P)	59	59	100.0	1330	174
Phthalic acid	59	18	30.5	12	0.38
Platinum	59	2	3.4	0.1	0.063
p-Nitroaniline	60	0	0.0		
Potassium	59	59	100.0	9810	1280
Silicon	59	59	100.0	2120	483
Silver	59	3	5.1	29.9	2.1
Sodium	59	59	100.0	33100	420
Strontium	59	59	100.0	978	109
Styrene (monomer)	62	1	1.6	0.0025	0.0025
Sulfate	59	59	100.0	11000	2.6
Sulfotep	59	1	1.7	0.0012	0.0012
TCDD TEQ (pg/g)	59	40	67.8	30849.68	0.0337
tert-Butyl benzene	62	6	9.7	0.12	0.0019
Tetrachloroethylene	59	50	84.7	2300	0.00037
Thallium	59	39	66.1	3.8	0.52
Tin	59	59	100.0	8.7	0.21
Titanium	59	59	100.0	961	250
Toluene	62	15	24.2	0.063	0.00064
Total Kjeldahl Nitrogen (TKN)	59	18	30.5	103	28.3
Trichloroethylene	59	17	28.8	1.5	0.00032
Tungsten	59	59	100.0	53.1	0.19
Uranium	59	59	100.0	4.2	0.6
Vanadium	59	59	100.0	87	10.4

mg/kg = Milligrams per kilogram

NE = Not evaluated

--- = Not applicable

Table B-2. Chemicals Detected in Soils During the Slit Trench Investigation
Page 6 of 6

Chemical	No. of Samples	No. of Detects	Frequency of Detects (%)	Maximum Detected Value (mg/kg)	Minimum Detected Value (mg/kg)
Xylenes (total)	62	4	6.5	0.26	0.0041
Zinc	59	59	100.0	316	13.1
Zirconium	59	59	100.0	37.3	5.2
Radionuclides					
Actinium-228	59	59	100.0	4.3	0.27
Bismuth-210 (From PB-210)	59	59	100.0	5.8	-0.8
Bismuth-212	59	59	100.0	2.6	0.23
Bismuth-214	59	59	100.0	9.7	0.26
Cobalt 57	59	59	100.0	0.038	-0.026
Cobalt-60	59	59	100.0	0.09	-0.062
Lead-210	59	59	100.0	5.8	-0.8
Lead-212	59	59	100.0	4.03	0.179
Lead-214	59	59	100.0	9.8	0.25
Polonium-210 (from bi-210)	59	59	100.0	5.8	-0.8
Polonium-212 (from bi-212)	59	59	100.0	1.66	0.15
Polonium-214 (from bi-214)	59	59	100.0	9.7	0.26
Polonium-216 (from ra-224)	59	59	100.0	20.9	0.77
Polonium-218 (from ra-226)	59	59	100.0	12.3	0
Potassium-40	59	59	100.0	32.9	4.6
Protactinium-234 (from u-238)	59	59	100.0	0.15	-0.39
Radium-223	59	59	100.0	0.76	-0.27
Radium-224	59	59	100.0	21	0.77
Radium-226	59	59	100.0	12.4	0.38
Radium-228	59	59	100.0	3.74	0.59
Thallium-208	59	59	100.0	1.18	0.103
Thorium-228	59	59	100.0	3.26	0.35
Thorium-230	59	59	100.0	2.86	0.32
Thorium-232	59	59	100.0	3.11	0.3
Thorium-234	59	59	100.0	4.33	0.06
Uranium-234	59	59	100.0	2.2	0.3
Uranium-235	59	59	100.0	0.28	0
Uranium-238	63	63	100.0	2	0.3

mg/kg = Milligrams per kilogram

NE = Not evaluated

--- = Not applicable

Table B-3. Summary of Harding Lawson Findings at the Montrose Site

Area	Name	Upgradient Well(s)	Downgradient Well(s)	Findings
I, V	Phosphoric acid pond, leach beds, associated trenching and piping	EC-4	H9, B16	Benzene, dimethyldisulfide, carbophenothion, DMPT, DEPT, monochlorobenzene, sulfonic acid and phthalic acid detected at higher concentrations downgradient than upgradient
II	ACD drum burial area			Groundwater quality assessed in conjunction with Areas I, IV, and V
III	Waste water treatment pond and associated concrete conduits	H38, B12, and H41	EC-1, EC-2, B14	Phthalic acid, chlorobenzene, sulfonic acid, and benzene detected, benzene release speculated from west side of area
IV	ACD ponds 1 and 2 and their associated piping	B16	B19, LG-033	No appreciable change in water quality
VI	Lindane plant, BHC Cake Piles 1 through 3, and the haul route		EC-3	BHC isomers at < 1 µg/L; benzene, chlorobenzene, chloroform and MCB in well suggest release from Lindane plant
VII	Two underground 40,000-gallon single-walled benzene storage tanks	MW-3, MW-4	EC-5	Benzene concentrations not significantly different in downgradient and upgradient wells
VIII	Wastewater ponds 1 through 6	MW-1	MW-2, MW-3, MW-4	Elevated benzene, MCB, and DCB concentrations in downgradient wells suggest a release from the ponds
IX	Montrose Plant	MW-2, MW-3	B1 B2, B7	Elevated benzene and chloroform likely associated with plant operations

DMPT = Dimethylphosphorodithioic acid

DEPT = Diethylphosphorodithioic acid

ACD = Agricultural Chemical Division

BHC = Benzenehexachloride

µg/L = Micrograms per liter

MCB = Monochlorobenzene

DCB = Dichlorobenzene

-

Table B-4. Summary of SECOR Findings at the Montrose Site
Page 1 of 2

Area	Study Item	Soil Borings	Results	SECOR Conclusions
Process Storm Sewers	1	3	• No TCs > NDEP action levels	Cannot rule out possibility of GW impact from within the plant site
Chemical Production Plant	2	8	<ul style="list-style-type: none"> • MCB, benzene > NDEP action levels (FPS-8) • HCB, aroclor 1254 > NDEP action levels to 2 feet (FPS-4) • MCB, benzene > NDEP action levels to 40 feet (FPS-4D) • HCB, DDT, DDE, aroclor 1254 DDE > NDEP action levels at 2 feet (FPS-12) • DDT > NDEP action levels to total depth; DDE, DDD > NDEP action levels to 6 feet; MCB > NDEP action levels at 10 feet (FPS-14) 	Cannot rule out possibility of GW impact from within the plant site
Rail Car Loading Area	3	2	• No TCs > NDEP action levels	NFA
HCl Truck Loading Station	4	4	• No TCs > NDEP action levels	NFA
Former "F" Tank	5	2	<ul style="list-style-type: none"> • Headspace 920 ppmv • MCB, 1,4-DCB increasing with depth • MCB, HCB, DDT, DDD, and DDE > NDEP action levels 	Cannot rule out possibility of GW impact from within the plant site
Still Bottom Residue (SBR) Storage Tank	6	None	NS	SBR has not impacted soils based on 1988 sampling event, NFA
Process Air Emissions	7-12	None	NS	NFA
Perimeter Drainage Ditches	13	4	<ul style="list-style-type: none"> • DDT, DDE, DDD > NDEP action levels in 2-foot samples • MCB, benzene, CCl₄, DDT, DDE > NDEP action levels in deep samples (FPS-11) 	Cannot rule out possibility of GW impact from within the plant site
Former Transformer (former plant site)	14	1	• No TCs > NDEP action levels	Cannot rule out possibility of GW impact from within the plant site
Pond Areas	15-17		NS	Pond 6 closed in 1981 via excavation, NFA (Item 17);

TC = Target compounds
 NDEP = Nevada Division of Environmental Protection
 GW = Groundwater
 MCB = Monochlorobenzene
 HCB = Hexachlorobenzene

NFA = No further action
 HCl = Hydrochloric acid
 ppmv = Parts per million by volume
 NS = No sampling of these areas associated with this report

DCB = Dichlorobenzene
 CCl₄ = Carbon tetrachloride
 TCB = Trichlorobenzene
 FID = Flame ionization detector

Table B-4. Summary of SECOR Findings at the Montrose Site
Page 2 of 2

Area	Study Item	Soil Borings	Results	SECOR Conclusions
				remaining ponds to be assessed
SBR Drum Storage Area	18		NS	NFA
Former Tank Farm	19	6	<ul style="list-style-type: none"> • HCB > NDEP action level in one sample no other TCs > NDEP action levels 	NFA
Redwood Tank	20	3	<ul style="list-style-type: none"> • Headspace 760 ppmv • MCB, benzene > NDEP action levels; increasing with depth • DDT, DDE, MCB, benzene > NDEP action levels at 40 feet in deep boring 	Cannot rule out possibility of GW impact from within the plant site
Benzene Tank	21	2	<ul style="list-style-type: none"> • No TCs > NDEP action levels 	NFA
Settling Basin	22	3	<ul style="list-style-type: none"> • Headspace 21 to 300 ppmv • Benzene, 1,2-DCB, 1,4-DCB, MCB, 1,2,4-TCB, chloroform, DDD, DDE > NDEP action levels • Supplemental boring terminated due to high FID readings • Benzene, CCl₄, DDE > NDEP action levels 	Cannot rule out possibility of GW impact from within the plant site
Monochlorobenzene spill	23	2	<ul style="list-style-type: none"> • No TCs > NDEP action levels in 6-foot samples 	NFA
Demolition debris	24			NFA

TC = Target compounds
NDEP = Nevada Division of Environmental Protection
GW = Groundwater
MCB = Monochlorobenzene
HCB = Hexachlorobenzene

NFA = No further action
HCl = Hydrochloric acid
ppmv = Parts per million by volume
NS = No sampling of these areas associated with this report

DCB = Dichlorobenzene
CCl₄ = Carbon tetrachloride
TCB = Trichlorobenzene
FID = Flame ionization detector

Appendix C

Soil Gas Analytical Results

Appendix C. Soil Gas Analytical Results

This appendix consists of electronic files of sampling data in Microsoft Excel format. These files are provided in the Appendix_C folder on this CD.

Appendix D

Validated Analytical Results for Soils

Appendix D. Validated Analytical Results for Soil

This appendix consists of electronic files of sampling data in Microsoft Excel format. These files are provided in the Appendix_D folder on this CD.

Appendix E

Validated Analytical Results for Groundwater

Appendix E. Validated Analytical Results for Groundwater

This appendix consists of electronic files of sampling data in Microsoft Excel format. These files are provided in the Appendix_D folder on this CD.

Appendix D. Validated Analytical Results for Groundwater

This appendix consists of electronic files of sampling data in Microsoft Excel format. These files are provided in the Appendix_D folder on this CD.

Appendix F

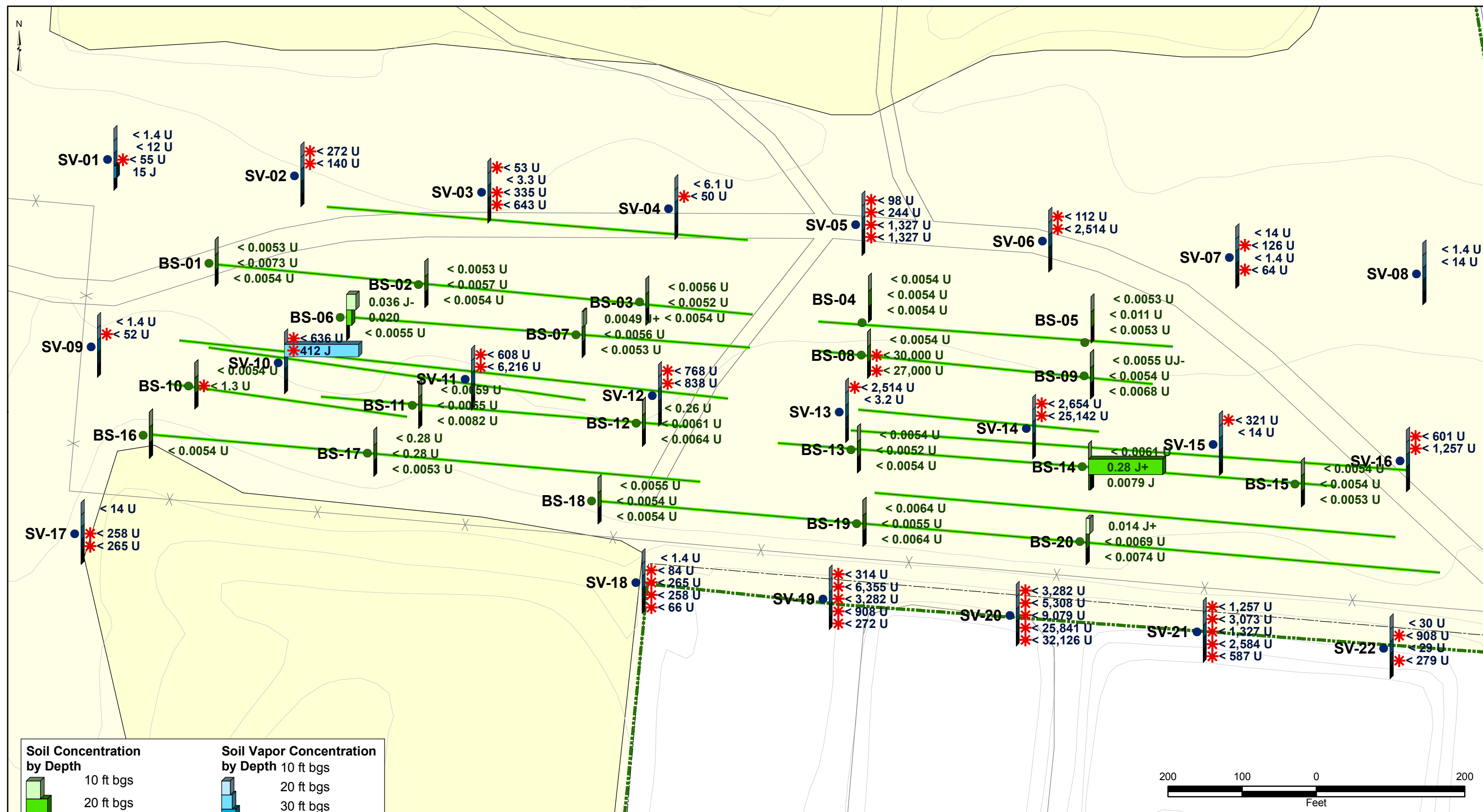
**Intensity Plots of
CAMU Site Chemicals**

Appendix F. ArcReader Files

This appendix consists of electronic files of sampling data in ArcReader Version 9.2 format, along with program files. These files are provided in the Appendix_F folder on this CD.

Appendix G

Volatile Chemicals in Soil and Soil Gas in the Slit Trench Area



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 0.93 mg/kg
(Maximum Soil Concentration = 0.28 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 33 µg/m³
(Maximum Soil Vapor Concentration = 412 µg/m³)

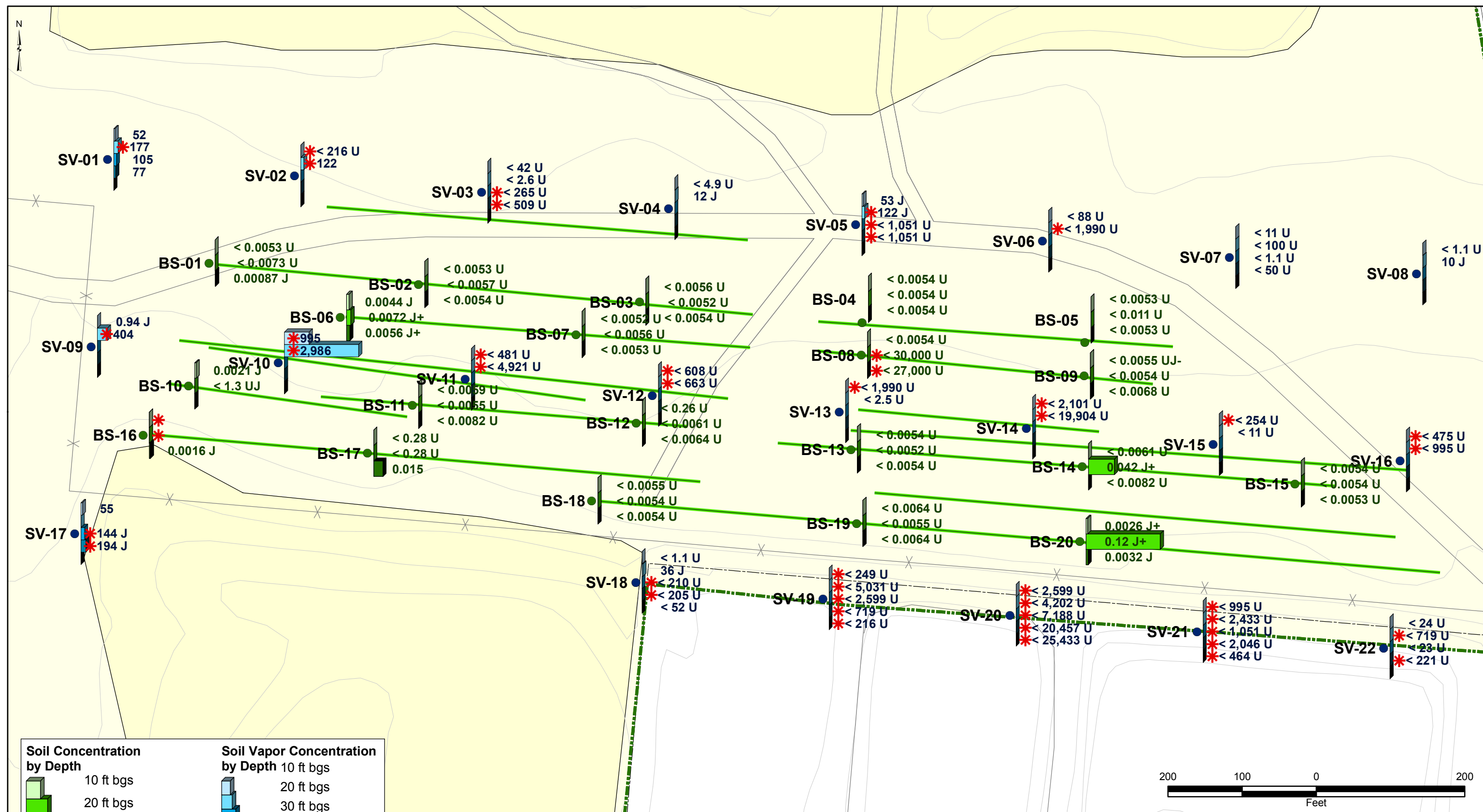
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

1,1,2,2-TETRACHLOROETHANE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS

Prepared by:
MWW

Date:
02/15/07

JOB No. 1881425
FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 1.6 mg/kg
(Maximum Soil Concentration = 0.12 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 110 µg/m³
(Maximum Soil Vapor Concentration = 2,985 µg/m³)

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

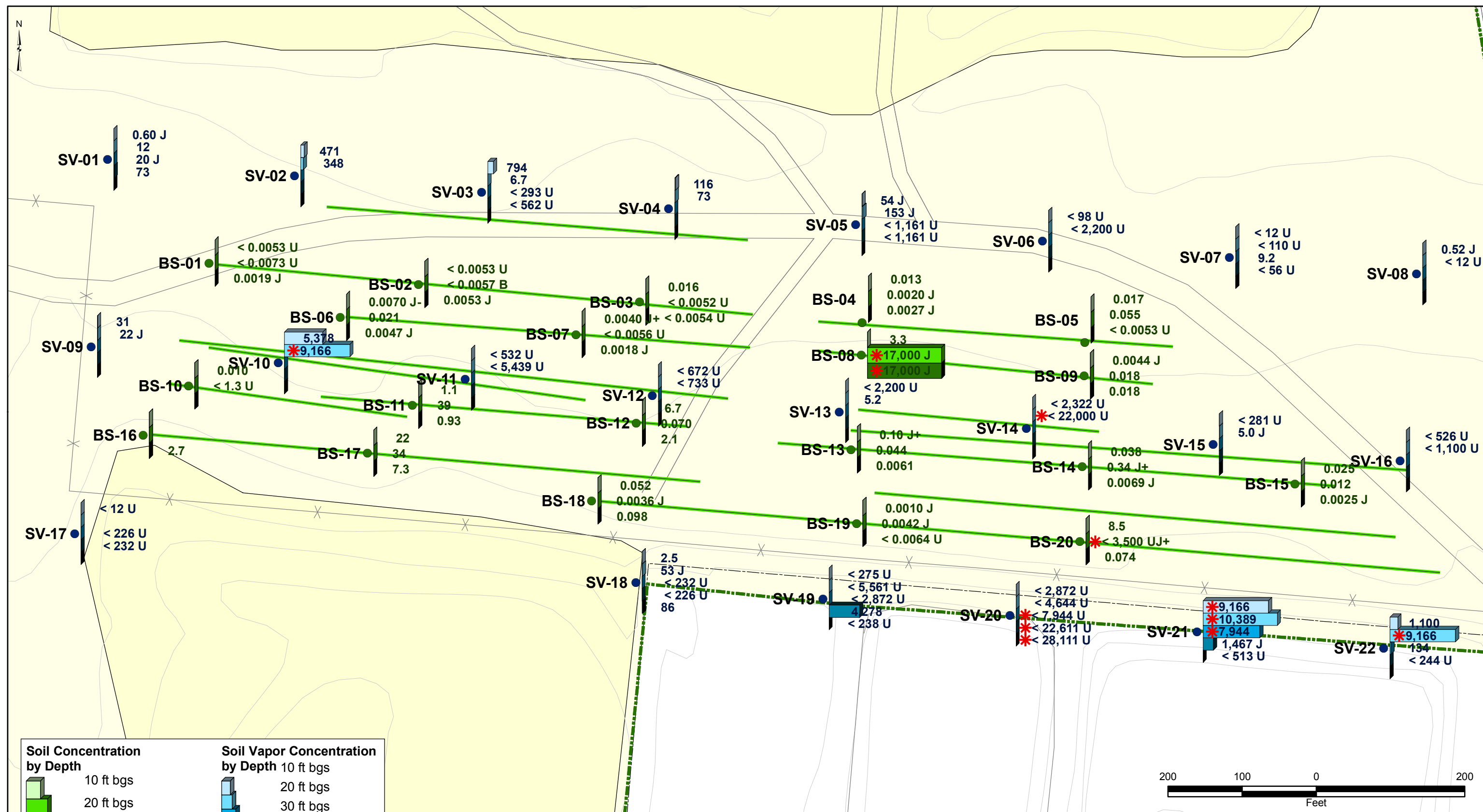
FIGURE G-2

1,1,2-TRICHLOROETHANE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS

Basic Remediation Company

Prepared by: MWW Date: 02/15/07

JOB No. 1881425
FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 600 mg/kg
(Maximum Soil Concentration = 17,000 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 5,700 $\mu\text{g}/\text{m}^3$
(Maximum Soil Vapor Concentration = 10,389 $\mu\text{g}/\text{m}^3$)

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

FIGURE G-3

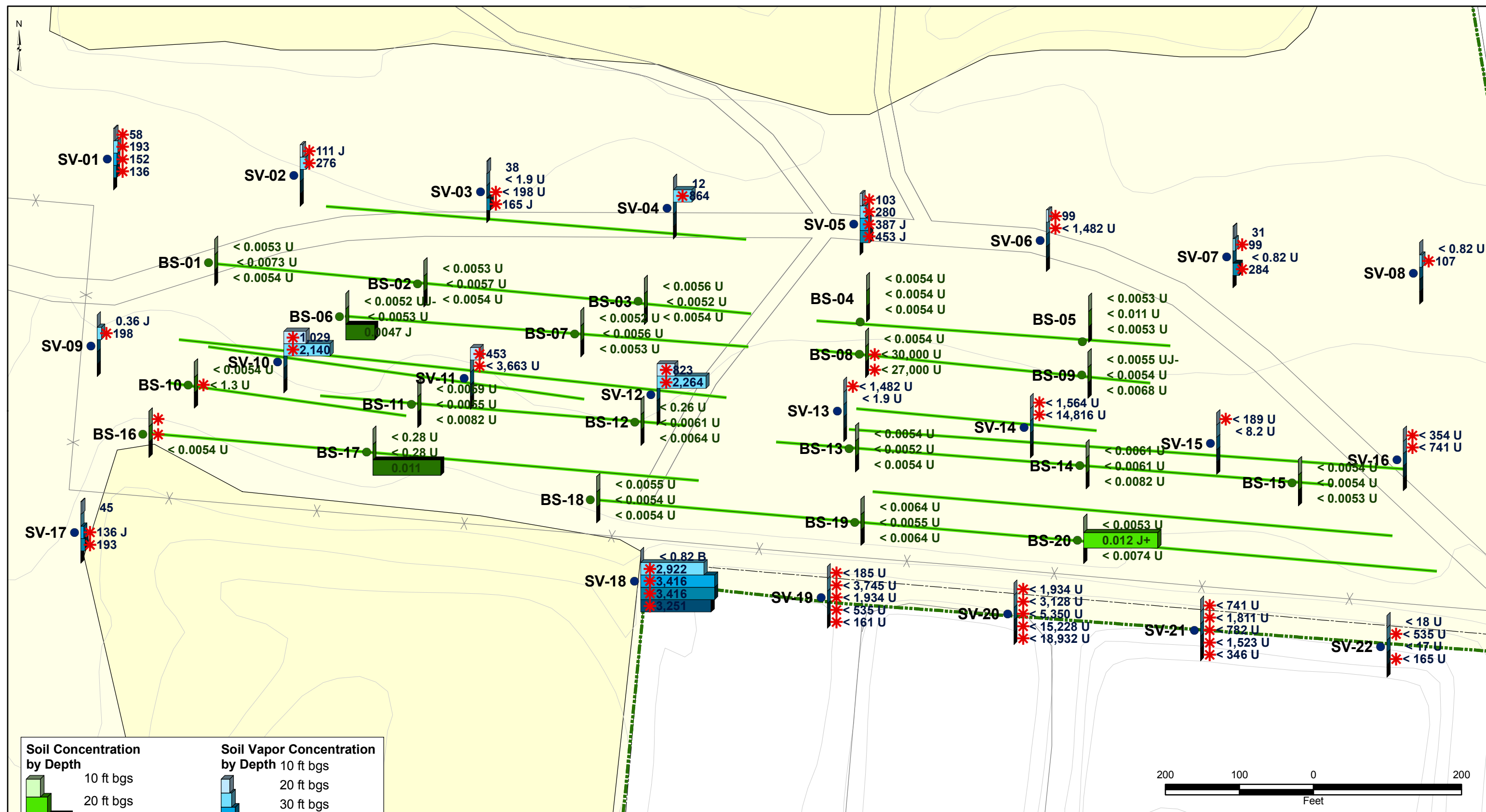
**1,2-DICHLOROBENZENE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS**

Prepared by: MWW

Date: 02/15/07

JOB No. 1881425

FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD



Daniel B. Stephens & Associates, Inc.

JN ES05.0067

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE G-4

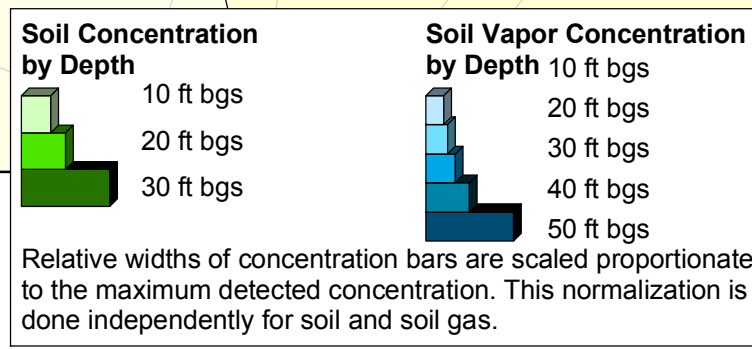
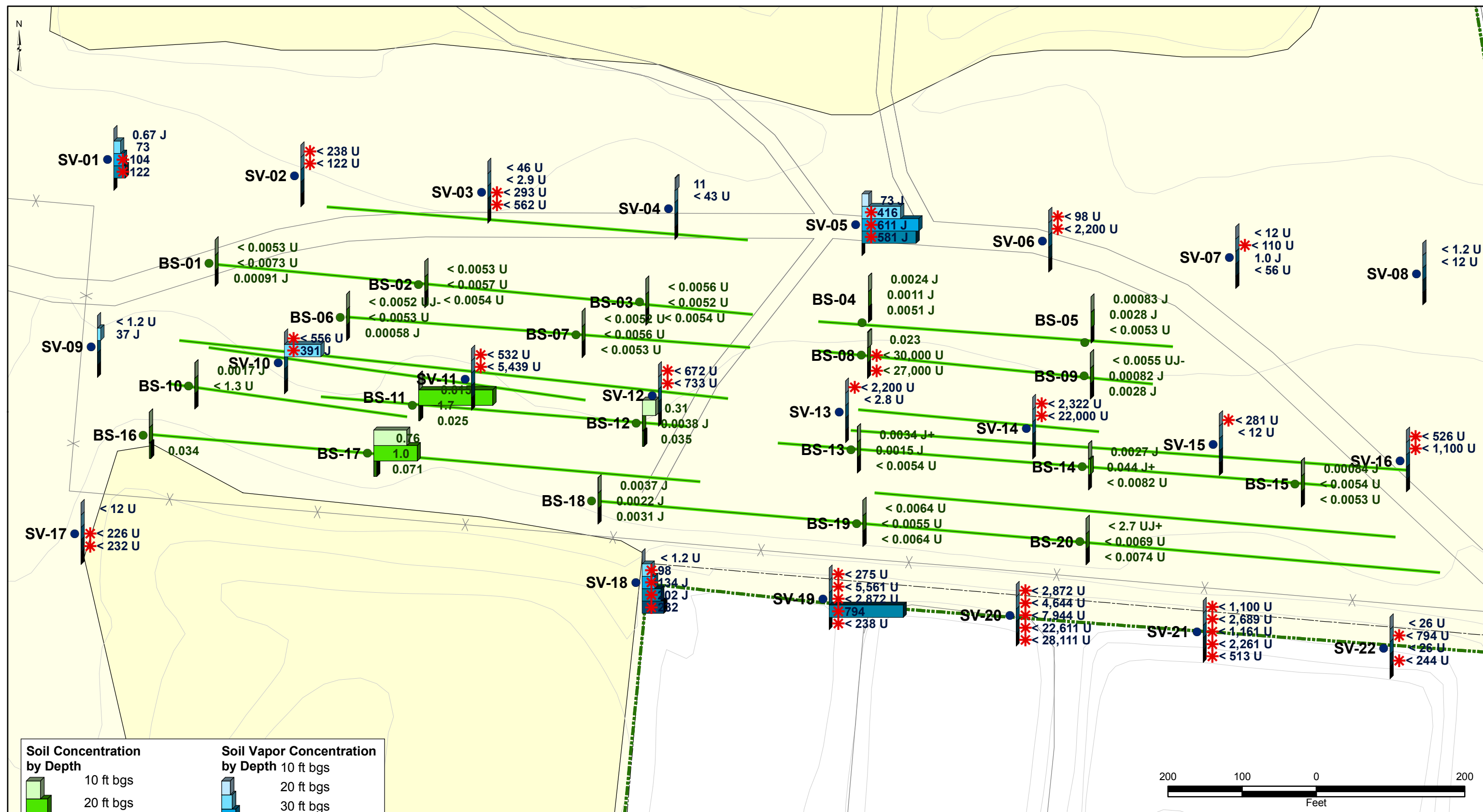
1,2-DICHLOROETHANE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS



Prepared by:
MWWH MKJ

Date:
02/15/07

JOB No. 1881425
FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

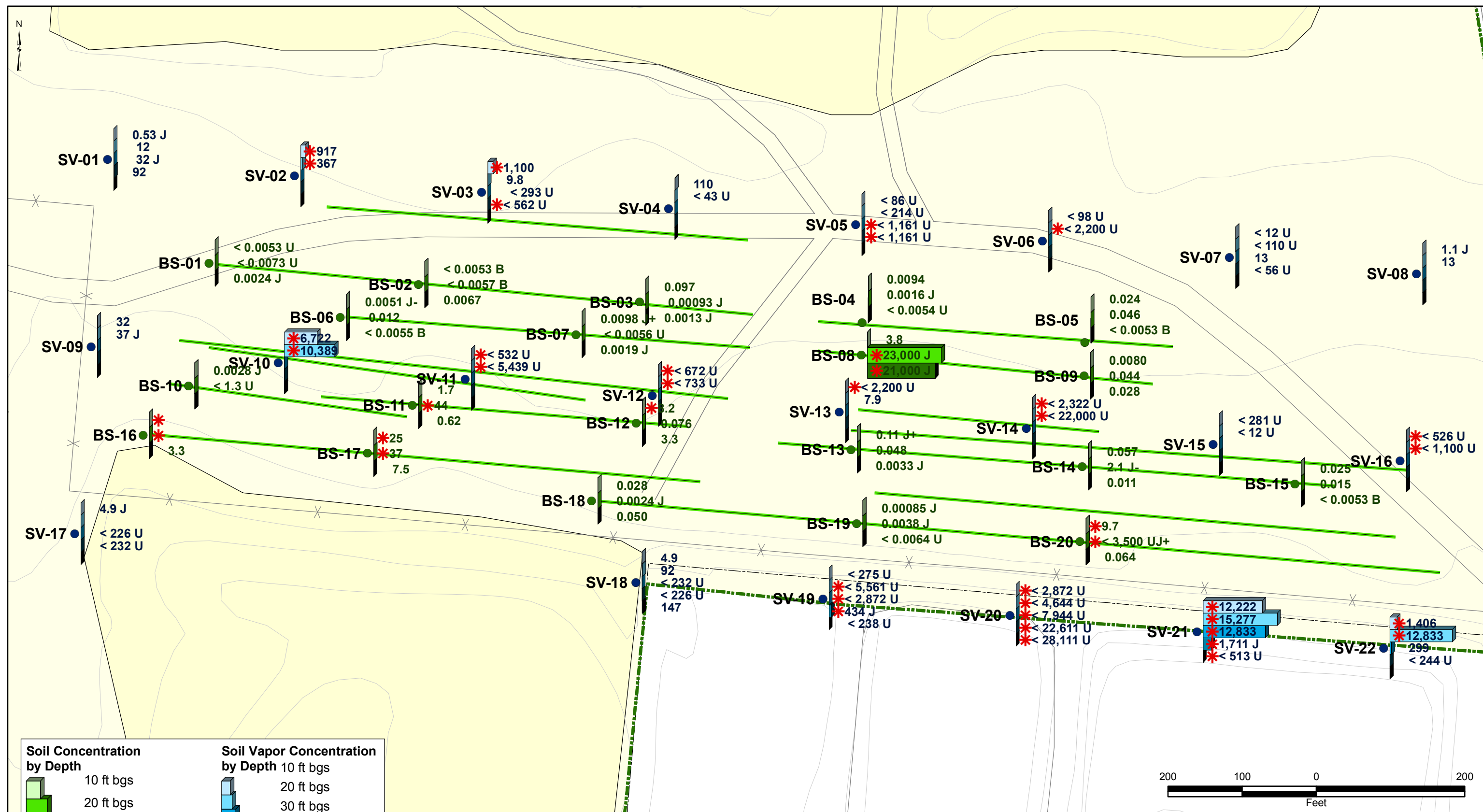
Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

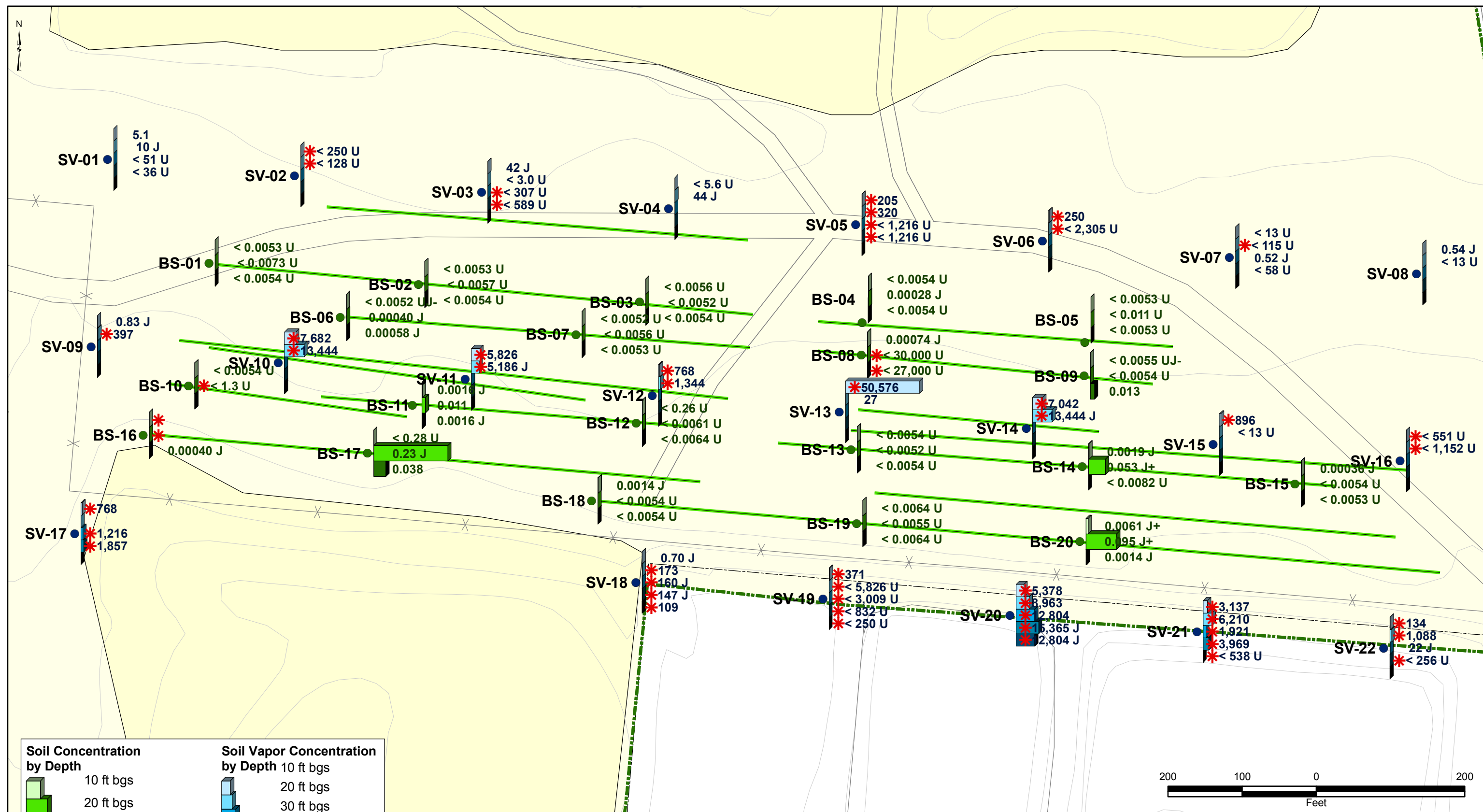
Soil Screening Value (Industrial PRG) = 600 mg/kg
(Maximum Soil Concentration = 1.7 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 90 µg/m³
(Maximum Soil Vapor Concentration = 794 µg/m³)

Corrective Action Management Unit (CAMU) BMI Complex, Henderson, Nevada	
FIGURE G-5	
1,3-DICHLOROBENZENE SLIT TRENCH SOIL AND SOIL VAPOR SAMPLING RESULTS	
Prepared by: MWH	Date: 02/15/07
JOB No. 1881425 FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD	







* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 0.55 mg/kg
(Maximum Soil Concentration = 0.23 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 62 µg/m³
(Maximum Soil Vapor Concentration = 50,576 µg/m³)

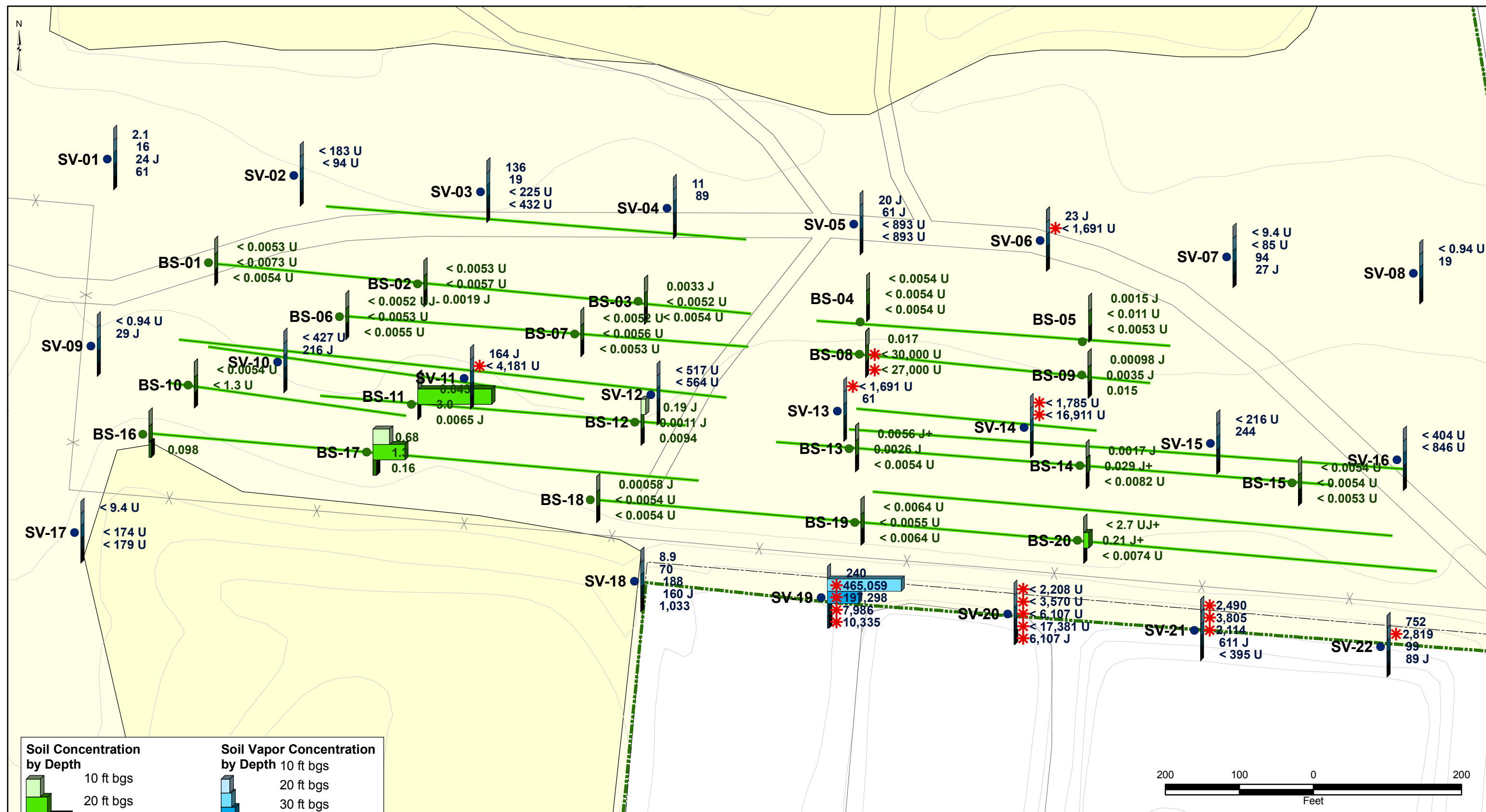
Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE G-7

CARBON TETRACHLORIDE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS

Prepared by:
MWW

Date:
02/15/07

JOB No. 1881425
FILE: GIS/BR/CAMU_CSM/FIGURE_G.MXD



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 530 mg/kg
(Maximum Soil Concentration = 3.0 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 1,600 µg/m³
(Maximum Soil Vapor Concentration = 465,059 µg/m³)

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada
FIGURE G-8

CHLOROBENZENE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS



Prepared by:
MWH

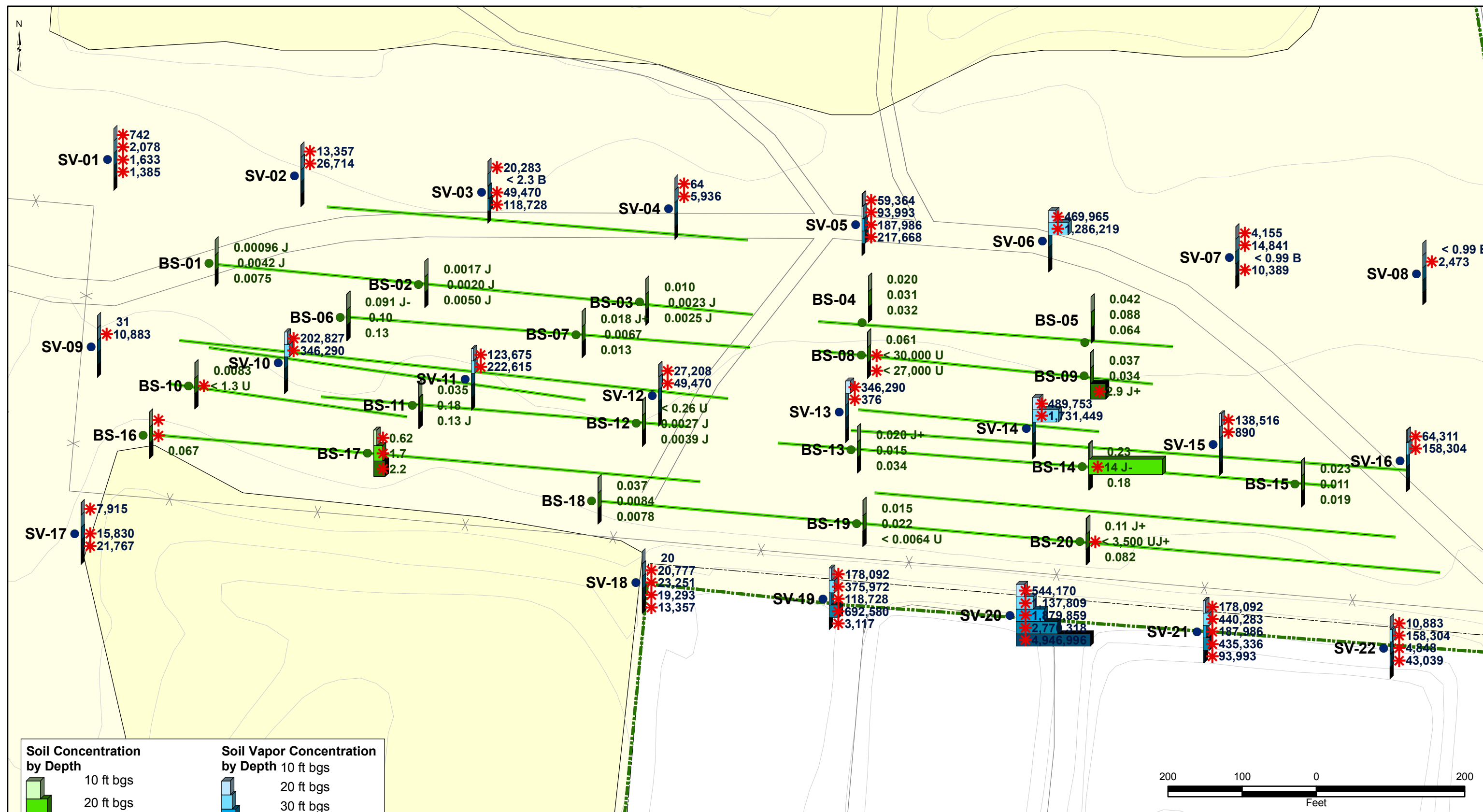
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02/15/07

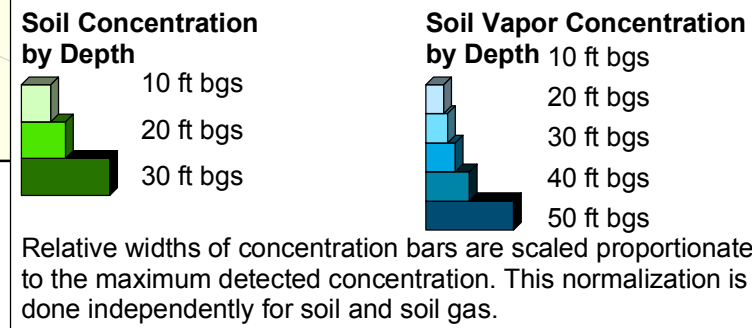
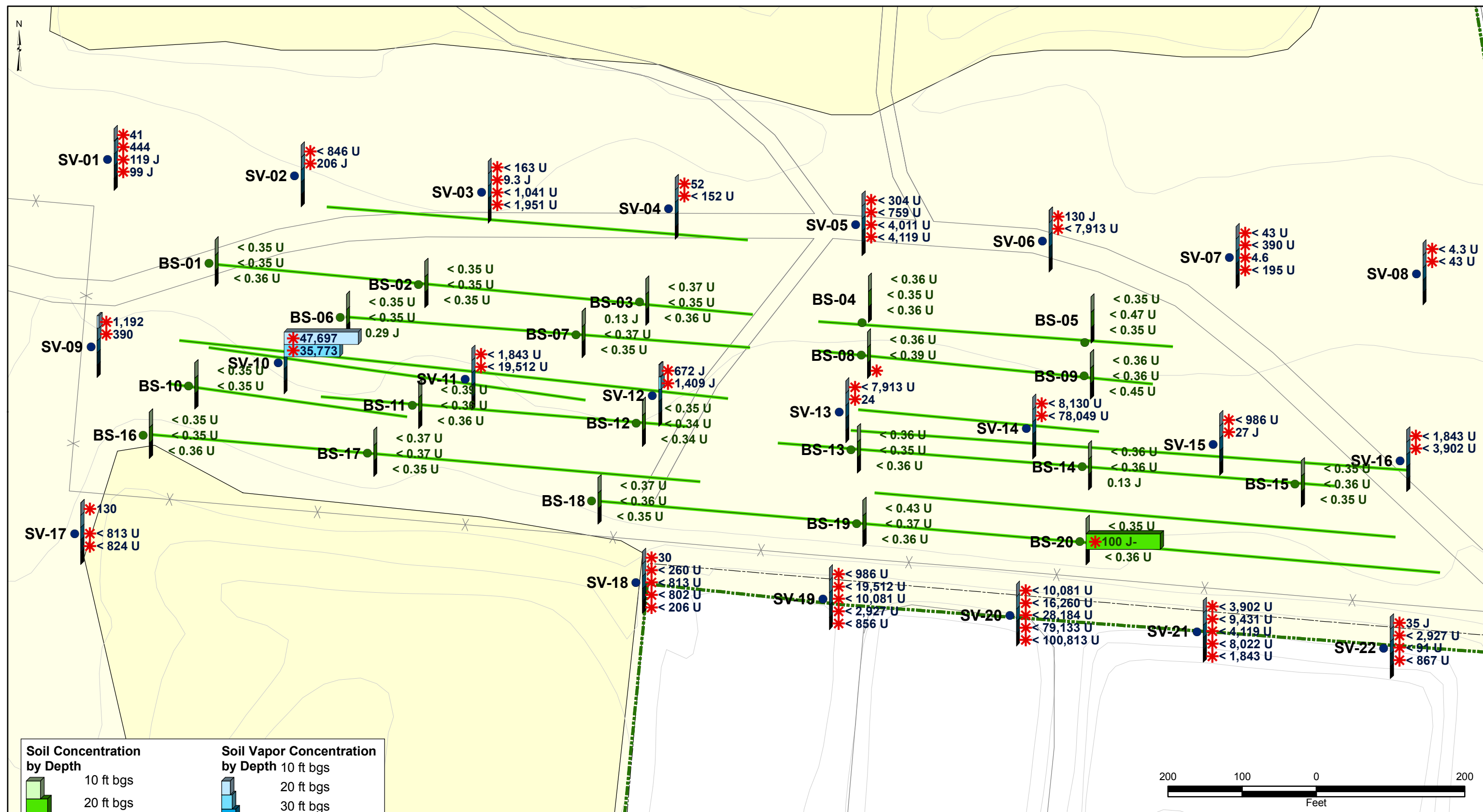
JOB No. 1881425
FILE: GIS/BR/CAMU_CSM/FIGURE_G.MXD



Daniel B. Stephens & Associates, Inc.

JN ES05.0067





* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 22 mg/kg
(Maximum Soil Concentration = 100 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 3.0 µg/m³
(Maximum Soil Vapor Concentration = 47,697 µg/m³)

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

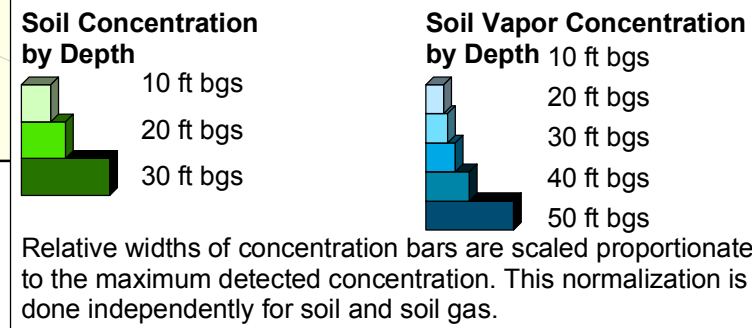
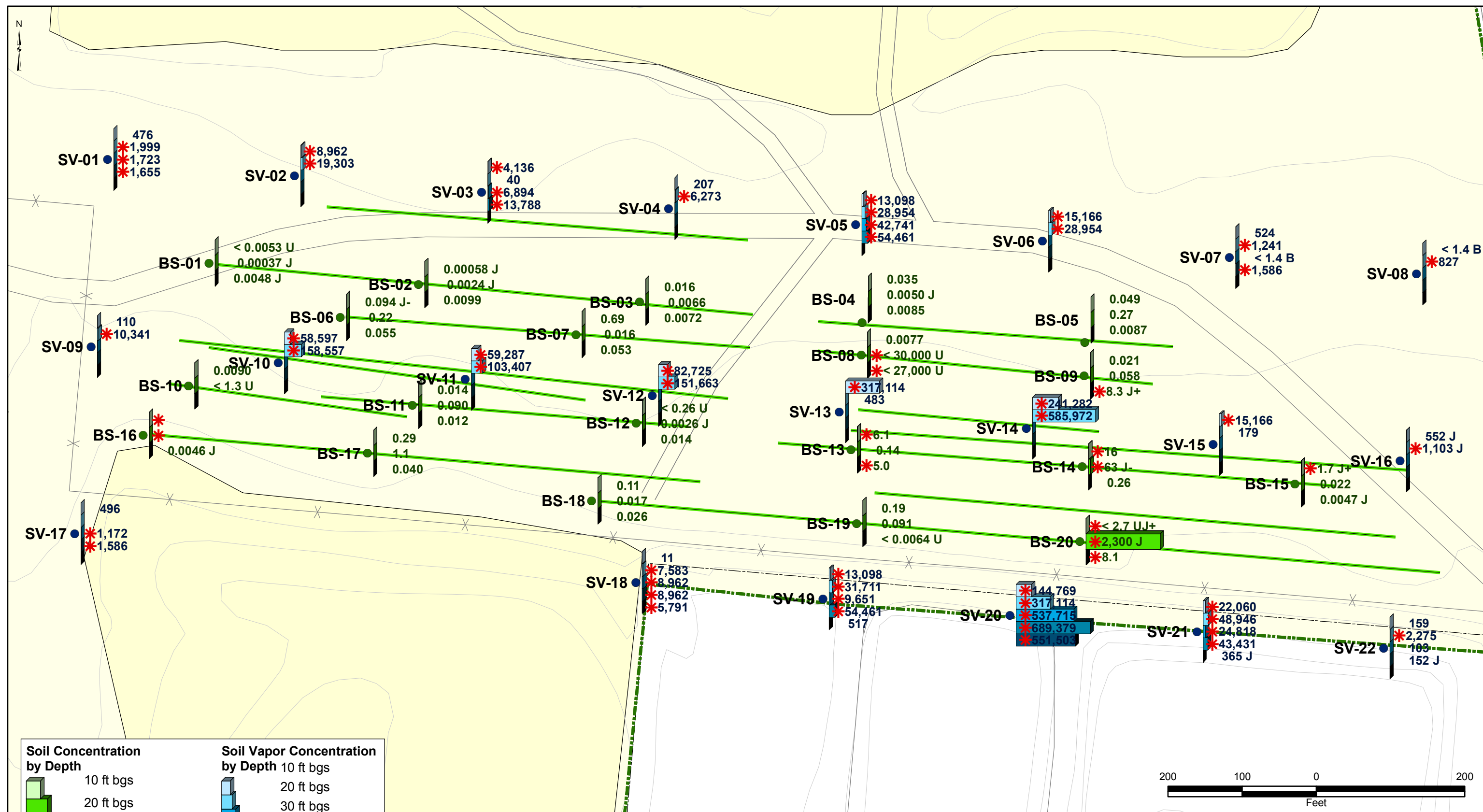
FIGURE G-10

**HEXACHLOROBUTADIENE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS**

Prepared by: MWH Date: 02/15/07

JOB No. 1881425
FILE: GIS/BR/CAMU_CSM/FIGURE_G.MXD

Basic Remediation Company



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 1.3 mg/kg
(Maximum Soil Concentration = 2,300 mg/kg)

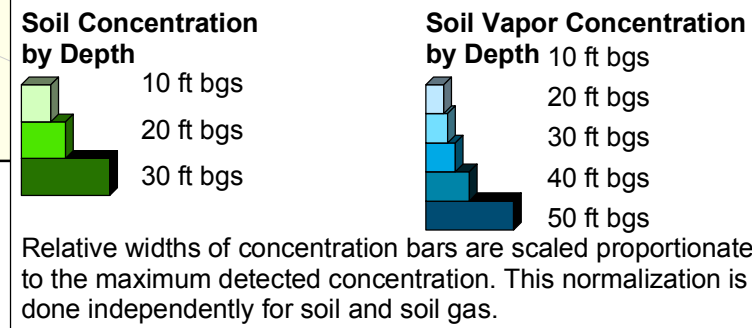
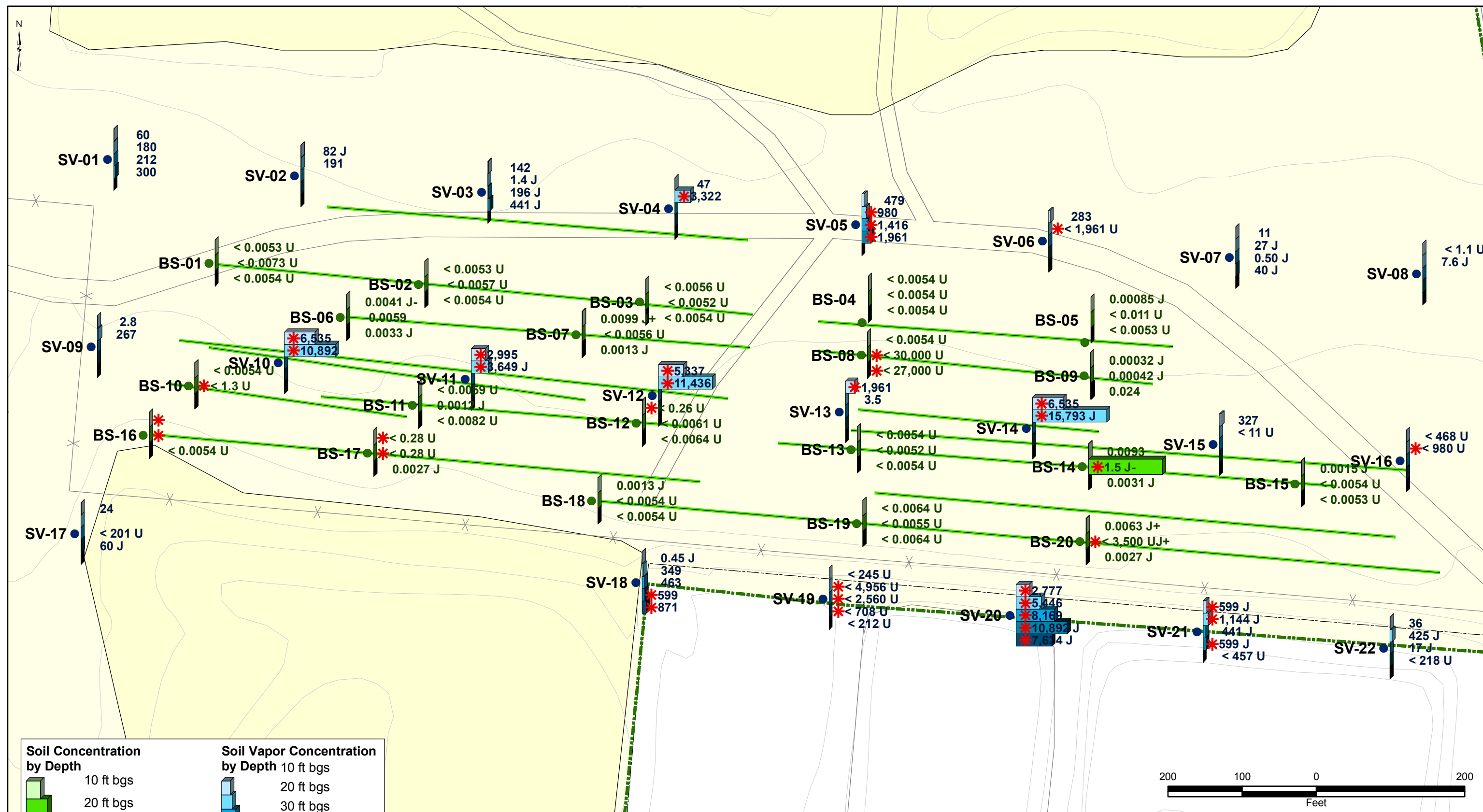
Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 670 µg/m³
(Maximum Soil Vapor Concentration = 689,379 µg/m³)

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

FIGURE G-11

**TETRACHLOROETHYLENE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS**

Prepared by: MWW Date: 02/15/07
JOB No. 1881425
FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD



* Indicates concentration (or detection limit) at this location/depth is above screening level.

Actual detection limits were used when comparing non-detect values against the screening level.

Blank values indicate a sample was not collected at that location/depth or data was 'R' flagged.

Soil Screening Value (Industrial PRG) = 0.11 mg/kg
(Maximum Soil Concentration = 1.5 mg/kg)

Soil Vapor Screening Value (based on Construction Worker Outdoor Air Inhalation Exposures) = 520 µg/m³
(Maximum Soil Vapor Concentration = 15,793 µg/m³)

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

FIGURE G-12

**TRICHLOROETHYLENE
SLIT TRENCH SOIL
AND SOIL VAPOR
SAMPLING RESULTS**

Prepared by: MWW Date: 02/15/07

JOB No. 1881425
FILE: GIS/BRC/CAMU_CSM/FIGURE_G.MXD