TETRA TECH

October 12, 2010

Maryland Square Shopping Center, LLC
Herman Kishner Trust
c/o Mr. Tom Vandenburg
Dongell Lawrence Finney LLP
707 Wilshire Boulevard, Suite 4500
Los Angeles, California 90017

RE: **DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER**
MARYLAND SQUARE SHOPPING CENTER
3661 SOUTH MARYLAND PARKWAY
LAS VEGAS, NEVADA
FACILITY ID NO. H-000086

Dear Mr. Vandenburg:

Enclosed please find one copy of the Draft Corrective Action Plan for Groundwater for the above referenced project as requested by the Nevada Division of Environmental Protection Bureau of Corrective Actions (BCA) in a letter dated July 9, 2010. This report is being provided to BCA in both hard copy and electronic Adobe Acrobat format on this date, October 12, 2010.

Should you have questions or require additional information, please do not hesitate to contact Robert Manriquez, Program Manager, at 619.321.6748, or myself at 775.333.8457. Thank you for your time and consideration in this matter.

Regards,

Tamara Pelham
CEM No. 1537, Exp. Sept. 11, 2012
Class A 60505

Enclosure(s) Draft Corrective Action Plan for Groundwater

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DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER
MARYLAND SQUARE SHOPPING CENTER
3661 SOUTH MARYLAND PARKWAY
LAS VEGAS, NEVADA

SUBMITTED TO
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
BUREAU OF CORRECTIVE ACTIONS
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October 11, 2010

EXECUTIVE SUMMARY

This document develops a Corrective Action Plan (CAP) to mitigate tetrachloroethene, also known as perchloroethene (PCE), impacts to shallow groundwater identified at the Maryland Square Shopping Center (MSSC) site (the Site), located near downtown Las Vegas, Nevada. The objectives of the CAP are to:

1. Provide a basis for identifying and screening general remedial actions (GRAs), technology types, and process options to mitigate PCE impacts to groundwater, soil gas, and indoor air;
2. Combine process options into general Corrective Action Alternatives and evaluate the Corrective Action Alternatives against criteria identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and,
3. Identify Corrective Action Alternatives, or specific components thereof, for further evaluation using bench-scale and pilot testing.

The identification and evaluation of Corrective Action Alternatives is intended to ensure that appropriate corrective action alternatives are developed and an appropriate corrective action is selected.

Existing data quantity and quality is insufficient to complete a baseline risk assessment. A baseline risk assessment predicting and quantifying potential human health risk will be presented in the final CAP after adequate data is obtained. Preliminary corrective action objectives (CAO) and preliminary numerical remediation standards were developed based on readily available information to guide the identification and evaluation of appropriate corrective actions. The preliminary CAOs and numerical remediation standards will be refined and finalized after completion of a baseline risk assessment and when a final corrective action is selected in a record of decision (ROD). The preliminary CAOs developed in the draft CAP are:

- Prevent the use of shallow groundwater with concentrations of PCE above the remediation standard for groundwater as a source of drinking water.
- If vapor intrusion to indoor air from PCE in groundwater is above the remediation standard for indoor air, prevent indirect contact with PCE in groundwater via vapor intrusion to indoor air.

The preliminary numerical remediation standards developed in the draft CAP are:

- Groundwater - the maximum contaminant level (MCL) for PCE of 5.0 micrograms per liter [µg/L]
- Indoor air - the NDEP interim action level for PCE of 32 micrograms per cubic meter [$\mu g/m^3$]

General response actions (GRA) were identified using these preliminary CAOs and numerical remediation standards and were evaluated based on implementability, effectiveness, and cost. Those technologies found to be viable based on these three criteria were subsequently assembled into Corrective Action Alternatives for detailed analysis based on eight NCP evaluation criteria: (1) overall protection of human health and the environment; (2) long-term effectiveness and permanence; (3) reduction in toxicity, mobility, and volume through treatment; (4) short-term effectiveness; (5) implementability; (6) cost; (7) state acceptance and (8) community acceptance. The alternatives developed for detailed analysis include:

- Alternative 1 - No Action
- Alternative 2A - In Situ Chemical Treatment of Hotspots and Residential Area, Institutional Controls (IC), Subslab Depressurization (SSD) Systems, and Monitored Natural Attenuation (MNA)
- Alternative 2B - In Situ Chemical Treatment, ICs, SSD Systems, and MNA

- Alternative 3 - Permeable Reactive Barrier (PRB), ICs, SSD Systems, and MNA
- Alternative 4 – Air Sparge (AS)/Soil Vapor Extraction (SVE) ICs, SSD Systems, and MNA
- Alternative 5 – Extraction and Treatment, ICs, SSD Systems, and MNA
- Alternative 6 - In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA.

Based on the NCP criteria, the most promising technologies include chemical treatment, a PRB, AS/SVE, and in situ enhanced bioremediation. These technologies are identified for bench-scale testing. Technologies with favorable bench-scale test results will be the subject of subsequent pilot tests. Until an adequate understanding of the environmental conditions and characteristics can be determined through bench-scale and pilot testing, the practical application or effectiveness of a particular Corrective Action Alternative to meet CAOs and numerical remedial standards cannot be confirmed.

Based on a review existing data population, additional data is needed to adequately describe and understand:

- Aquifer production and soil properties (including soil fraction organic carbon content);
- Geologic characteristics and contacts;
- Soil gas and indoor air properties (validated soil gas, indoor air, subslab, and groundwater concentration); and
- Subsurface characteristics at and downgradient of the golf course.

Necessary field activities and testing programs to complete the required data population are expected to be described in subsequent planning documents submitted to NDEP for concurrence prior to execution.

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1.0 INTRODUCTION

The Maryland Square Shopping Center site (the Site) is located near downtown Las Vegas, Nevada. The Site generally extends from a few hundred feet west of Maryland Parkway to nearly Eastern Avenue on the east, East Twain on the south, and Comanche Avenue on the north. The Site includes the footprint of a former Maryland Square Shopping Center strip mall (including the Al Phillips the Cleaner facility, the Property), an existing mall (The Boulevard Mall), a residential area, and a golf course (Figure 1). Releases of tetrachloroethene, also known as perchloroethene (PCE), are documented at the Site in near-surface soil and shallow groundwater. The former APTC facility that was located at 3661 South Maryland Parkway has been identified as a source of PCE releases to soil and shallow groundwater. Releases of PCE may also have occurred at additional locations, some of which are outside the primary bounds of the Site, with the PCE migrating to within downgradient areas of the Site boundaries.

1.1 Purpose and Organization of the Report

The purpose of this document is to develop a Corrective Action Plan (CAP) to mitigate impacts to shallow groundwater and related impacts to soil gas and indoor air at the Site from releases of PCE from the Property. The CAP describes existing information for the Site and presents a scope and schedule to proceed with mitigation of PCE impacts. The CAP first summarizes past land uses across the Site, results of previous investigations, the physical setting, the nature and extent of contamination, and the fate and transport characteristics of the primary contaminant (PCE) and its breakdown products. Section 5 references the need for a risk assessment. The preliminary remediation standards are described in Section 6, followed by a screening of possible general remedial actions (GRA). A detailed evaluation of seven alternatives for the remediation of shallow groundwater is included in Section 8. Section 9 includes (1) recommendations to fill data gaps, (2) a discussion of the need for bench pilot-scale testing to further assess the corrective action alternatives, and (3) a proposed schedule. A baseline risk assessment will be conducted once enough new data can be obtained to fill existing data gaps in order to develop final corrective action goals for the Site.

The objectives of the CAP are to:

1. Provide a basis for identifying and screening general remedial actions (GRAs), technology types, and process options to mitigate PCE impacts to groundwater, soil gas, and indoor air;
2. Combine process options into general Corrective Action Alternatives and evaluate the Corrective Action Alternatives against criteria identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and,
3. Identify Corrective Action Alternatives, or specific components thereof, for further evaluation using bench-scale and pilot testing.

The identification and evaluation of Corrective Action Alternatives is intended to ensure that appropriate corrective action alternatives are developed and an appropriate corrective action is selected. This CAP establishes a preliminary set of viable remedial alternatives proposed for further evaluation through bench-scale testing. Results from bench-scale testing will be used to develop a pilot test program to confirm field application and establish a design basis for remedial system expansion and full-scale implementation.

1.2 Site Background

APTC operated a dry cleaner facility in the Maryland Square Shopping Center at 3661 South Maryland Parkway, Las Vegas, Nevada from 1969 to 2000 (Figure 2). The former APTC facility is on the northwest corner of Maryland Parkway and Twain Avenue, across the street from The Boulevard Mall.

The former APTC facility has been identified as a source of PCE resulting in contamination of the shallow groundwater at the Site (Figure 3). PCE has been detected in shallow groundwater at properties located

downgradient of the former APTC facility, including The Boulevard Mall, residential properties, and a golf course. A groundwater irrigation well is located within the golf course at the distal end of the shallow groundwater PCE plume.

1.2.1 Site Description

The Site is located in the Las Vegas Valley (Valley) approximately 1.6 miles northeast of the Las Vegas' McCarran International Airport. Originally, the site was dominated by the presence of a number of west-to-east trending shallow washes, but now the surface topography at the Site gently slopes to the east (Figure 4). Surface drainage also generally flows toward the east, with stormwater sewers collecting runoff water along major streets for diversion toward the north and east into engineered drainage channels. Current uses of the Site are commercial/industrial and residential. Residential properties are generally single-family homes.

1.2.2 Site History

The APTC facility was first developed in 1969 as a dry cleaning operation in a shopping center. Al Phillips took over operation of the site later that same year from the original operator, and continued to operate the dry cleaning facility until 2000. The facility was owned by the Herman Kishner Trust until Maryland Square Shopping Center LLC (MSSC) purchased the property in 1999 (Converse 1999). During a Phase II Environmental Site Assessment in 2000 as a result of the property transaction, PCE was detected in the soil and groundwater at the southeast corner of the APTC facility (Converse 2000).

MSSC demolished the former shopping center, including the concrete floor and foundation, in the summer of 2006. Currently, the site of the former shopping center is covered with asphalt, except for the former APTC facility which is fenced and covered by uncapped native soil. The property use in the immediate area is commercial/industrial.

Boulevard Mall

The Boulevard Mall opened in 1968 and is the oldest Mall in the Las Vegas Valley. Several former structures on the east side of Maryland Parkway, downgradient of the APTC facility, were demolished when the Boulevard Mall was expanded in approximately 1993. Other structures on the west side of Maryland Parkway were demolished more recently. Figure 5 illustrates the locations of previous or existing commercial or industrial properties identified in the vicinity of the Site.

Historically across the project area, the highest concentrations of PCE in groundwater have been reported from monitoring wells MW-6, MW-13, and MW-14 located near the aboveground parking structure on the southwestern portion of the Boulevard Mall property, east of the former APTC property (Figure 3). Historical concentrations of PCE from monitoring well MW-13 range up to 5,310 micrograms per liter (µg/L) (in May 2005), suggesting a possibly unidentified source of PCE in the immediate area. Investigations involving soil sampling above the water table (in the vadose zone) have not been performed in the area of these wells.

Residential Areas

Construction of the residential neighborhoods to the east (downgradient) of the Boulevard Mall began in the early 1960s. The Property was undeveloped prior to construction of the residential neighborhoods based on a review of historical aerial photos. Traditional slabongrade homes are typical for the area. Residences are on City of Las Vegas (City) water that comes primarily from Lake Mead, although some water (approximately 10 percent) is supplied from deep groundwater wells located in the northern portion of Las Vegas.

Las Vegas National Golf Course

""The National Golf Course" was constructed in 1961 and was originally called the Stardust Country Club. The shallow groundwater PCE plume extends to the golf course. The golf course has at least one deep water well (PW-1) located on the property for irrigation (Figure 3). According to the property management, over 8 million gallons of fresh water are pumped from the well during a normal week in the summer months. Samples from Well PW-1 have detectable levels of PCE ranging from 130 µg/L in 2002 down to 4.9 µg/L in 2006 (NDEP 2007). PW-1 is screened from 500 to 750 feet below ground surface (bgs) in the deep aquifer. Communication between the shallow aquifer and the deep aquifer may result from extension of the golf course well's gravel pack around the casing to a depth of 130 feet bgs.

1.2.3 Previous Investigations

A series of assessments, soil and groundwater investigations, and preparations of corrective action plans have occurred from 1999 to 2010 to evaluate distribution of PCE beneath the Site and to determine the extent of impacts to downgradient groundwater. Investigations were conducted by Converse Consultants from 2002 through 2004, and subsequently from 2008 to 2010, and by URS Corporation (URS) in 2005 through 2008. The reports relevant to preparation of the groundwater CAP include the following:

- Converse. *Phase I Environmental Site Assessment*. September 28, 1999.
- Converse. *Limited Phase II Subsurface Assessment*. August 22, 2000.
- Converse. *A Through K Data Research and Report*. August 22, 2001.
- Converse. *Additional Soil and Groundwater Investigation*. November 13, 2002.
- Converse. *Additional Soil and Groundwater Investigation*. May 16, 2003.
- Converse. *Preliminary Corrective Action Plan*. June 27, 2003.
- Converse. *Well Installation/Slug Testing/Groundwater Monitoring Report-4th Quarter 2003 and 1st Quarter 2004*. March 26, 2004.
- URS. *Report, Subsurface Investigation*. July 11, 2005.
- URS. *Source Removal Corrective Action Plan*. November 13, 2006.
- URS. *Quarterly Groundwater Sampling*. December 6, 2006.
- URS. *Quarterly Groundwater Sampling*. March 6, 2006.
- URS. *Quarterly Groundwater Sampling*. June 6, 2006.
- URS. *Quarterly Groundwater Sampling*. 3rd Quarter, November 14, 2006.
- URS. *Quarterly Groundwater Sampling*. 4th Quarter, January 5, 2007
- NDEP. *Groundwater Data from Golf Course Well PW-1,* February 2007
- URS. *Quarterly Source Area Soil Assessment*. February 23, 2007.
- URS. *Quarterly Groundwater Sampling, 1st Quarter 2007,* April 2, 2007.
- URS. *Offsite Soil Vapor Assessment Report*. April 13, 2007.
- URS. *Quarterly Groundwater Sampling , 2nd Quarter 2007,* July 25, 2007.
- URS. *Quarterly Groundwater Sampling , 3rd Quarter 2007,* December 6, 2007.
- URS. *Installation of Downgradient Groundwater Monitoring Wells,* November 26, 2007.
- URS. *Quarterly Groundwater Sampling , Fourth Quarter 2007,* January 16, 2008.
- URS. *Quarterly Groundwater Sampling , First Quarter 2008,* April 14, 2008
- Converse. *Groundwater Monitoring Report -4th quarter 2008.* December 9, 2008
- Converse. *Groundwater Monitoring Report -1st quarter 2009.* April 15, 2009
- Converse. *Groundwater Monitoring Report -2nd quarter 2009.* July 21, 2009
- Converse. *Groundwater Monitoring Report -3rd quarter 2009.* October 9, 2009
- TRC. *Groundwater Monitoring Well Investigation, Sampling and Capping.* December 9, 2009
- Converse. *Groundwater Monitoring Report -4th quarter 2009.* January 13, 2010
- Converse. *Groundwater Monitoring Report -1st quarter 2010.* April 14, 2010
- Tetra Tech EM, Inc. (Tetra Tech). *Quarterly Groundwater Monitoring Report 2nd Quarter 2010,* July, 23, 2010

Quarterly groundwater monitoring has been conducted by various consultants at and downgradient of the former APTC property since late 2005 to assess the extent of PCE contamination in groundwater. Most groundwater data consist of analytical data from monitoring wells to define the overall extent of PCE in the shallow groundwater.

Only limited data characterizing aquifer properties and soil gas have been obtained for the Site, and this data is contained in two reports: an investigation by Converse in 2004 and another by URS in 2005. During the Converse 2004 investigation, some limited-scope slug tests were performed at the Site along with some limited soil property tests. In the URS 2005 investigation, at a limited number of wells on the Site, the presence of dechlorinating bacteria was investigated and reported, and samples were taken to analyze concentrations of major cations and anions, total organic carbon, and dissolved oxygen, and to measure specific conductance, oxidation-reduction potential, and turbidity. Based on a review of the historic documents, data gaps remain that are discussed and identified in Section 9.0.

2.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The Valley covers roughly 1,550 square miles in southern Nevada, with the eastern edge extending approximately 5 miles west of Lake Mead and the Colorado River. The Valley is bounded by mountain ranges that reach a maximum elevation of almost 12,000 feet above sea level to the west. The Valley floor elevation ranges from about 3,000 feet in the west to 1,500 feet in the east at the outflow of the Valley. (Zikmund 1996).

The Valley floor is arid, while higher elevations are subhumid. Precipitation on the Valley floor averages 4.16 inches per year as reported by the western region Climate Center (WRCC 2010). Most precipitation occurs during the months of July and August and during the winter (Wild 1990). Potential evapotranspiration ranges from 1 to 19 inches per month from winter to summer months (Lisa Shevenell 1996). Mountains surrounding the basin may receive up to 20 inches of precipitation per year, usually the result of snow fall. All surface water flows in the valley are tributary to Lake Mead through Las Vegas Wash (Brothers and Katzer 1988).

2.1 Regional Hydrogeology

Las Vegas Valley is a structural basin filled with 3,000 to 5,000 feet of sediments in the Basin and Range Province of the northern Mojave Desert. The upper 1,000 feet of sediments in the basin consist of coarse-grained sand and gravel and fine-grained silt and clay. The physiographic and geologic setting is characterized as desert playa deposits that interfinger with alluvial fans from erosion of the surrounding mountain ranges, as shown on Figure 6. In the central valley area, including the Site, the coarse-grained sediments interfinger with heterogeneous deposits (e.g., sandy silt, silty sand, clayey sand, sandy clay, caliche) and fine-grained silt and clay deposits (Plume 2000). The coarse material generally serves as aquifers, while the silts, clays, and caliche often act as confining layers (Zikmund 1996). The boundaries between the aquifers and confining units (aquitards) in the alluvial-basin fill are difficult to delineate due to the complexity of the sediment distribution (Harrill 1976, Bernholtz 1993).

Two separate aquifer systems exist in the Las Vegas Valley: a deep, confined artesian aquifer system and a shallow water table aquifer (Figure 7). Most groundwater obtained in the Valley is from the deeper artesian aquifer system at depths of greater than 500 feet in the center of the Valley and from depths of 250 to 300 feet bgs near the mountains. The shallow aquifer is composed primarily of silts and clays and poorly sorted sands and gravels generally of low transmissivity (Woessner 1980, Wyman and others 1993, Converse 1985). The general flow gradient for the shallow system is eastward toward Las Vegas Wash. Localized variations from the eastward flow have been observed in irrigation recharge areas, in pockets of higher transmissive coarse gravels and sands, and due to water level fluctuations from variations in seasonal water usage (Converse 1985).

Groundwater in the shallow aquifer is generally brackish to saline and considered non-potable, with total dissolved solids (TDS) ranging from 550 to greater than 7,000 milligrams per liter (mg/L) as shown in Appendix A, Table 1. Water quality in the shallow aquifer generally degrades in an easterly, downgradient direction as shown on the TDS map (Figure 8). The elevated salinity results from evapotranspiration, dissolution of saline minerals in soils and rocks, and infiltration of irrigation water. Some parts of the flow system also exhibit elevated concentrations of boron and nitrate (Zikmund 1996). The shallow aquifer is not a distinct lithologic unit, but is differentiated from other water bearing units based upon the groundwater chemistry (Bernholtz 1993, Zikmund 1996).

Recharge to the shallow aquifer is attributed to upward vertical flow from the deeper aquifer, by surface infiltration of runoff, and from over-irrigation (either agricultural or residential) (Bernholtz 1993). However, in some areas where water supply wells produce from the deeper aquifer, the vertical gradient has been reversed to downward, and in some cases, the shallow aquifer may be pumped and blended with groundwater from the deeper aquifer for irrigation and industrial uses (Zikmund 1996).

Below the shallow system is a confining unit defining the top of the near-surface reservoir. The bottom of the near-surface reservoir, approximately 250-300 feet bgs, is defined as the top of the first significant water producing gravel zone (Harrill 1976). The principal water-producing zone has been defined as composed of anywhere from one aquifer (Harrill 1976) to three aquifers (Maxey and Jameson 1948 and Donovan 1996).

2.2 Site Geology

The geology of the Site is complex and consists of interbedded sequences of sand, sandy silt, sandy clay, and silty clay with frequent caliche zones scattered throughout. Figure 9 shows the location of two cross-sections prepared from logs of soil borings and wells drilled near and downgradient of the former APTC facility. Boring logs and well construction forms are provided in Appendix B. The cross-section on Figure 10 illustrates that sands and silty sands exist beneath the former APTC facility, with lithology changing to silty clay and sandy clay to the east (downgradient). Figure 11 shows that east of The Boulevard Mall along Algonquin Drive, sand and gravel exist under the southern portions of The Boulevard Mall, with the lithology to the north grading into complex mixtures of sands, silts, and clays with some gravel.

Figures 12 through 14 show cross sections prepared by URS (2007a) of the downgradient area east of Algonquin Drive. Figure 13 shows that sediments along Algonquin Drive consist of gravelly sand near the surface and grade into silt at approximately 10 feet bgs. Figure 14 shows silts grading into clay beneath much of the residential area located adjacent to Seneca Lane, with a gravelly sand layer present near the surface between wells MW-26 and 27.

2.3 Hydraulic Properties of the Shallow Aquifer

Groundwater occurs in the shallow aquifer at approximately 9 to 25 feet bgs across the Site (URS 2005). Based on water level data obtained in June 2010, shallow-aquifer groundwater flows east with a gradient that ranges from 0.0124 to 0.0132 feet/foot (Figure 15) (Tetra Tech 2010). Historic groundwater elevations suggest seasonal fluctuations that can vary by up to 5 feet throughout the year, as illustrated on Figure 16.

Converse (2004) conducted slug tests in monitoring wells MW-2, MW-3, MW-13, MW-15, MW-16, MW-19, and MW-20 in 2004 to estimate the hydraulic conductivity (K) at the Site. Calculated K values developed using the Bouwer-Rice Method (Bouwer and Rice 1976) ranged from 1.9 to 17 feet/day, while K values calculated using the Hvorslev Method (Hvorslev 1951) ranged from 0.8 to 6.4 feet/day. Converse (2004) also measured total porosity and bulk density for two sandy clay samples with results of 0.49 to 0.57 for porosity, and 1.14 to 1.49 grams/cubic centimeter (g/cc) for bulk density. URS (2007a) conducted bulk density and grain size analyses for samples from three borings that ranged in grain size from silt to gravel; the results ranged from 99.6 to 119 pounds per cubic foot or 1.6 to 1.91 g/cc.

Zikmund (1996) reported results from two studies that were conducted to characterize basic hydraulic parameters for the shallow aquifer across the Las Vegas Valley. Western Technologies (1991) tested 2-inch and 4-inch diameter wells completed to depths of 25 to 30 feet bgs in downtown Las Vegas. The results of the Western Technologies study are summarized below and are considered representative of shallow wells in the downtown area (near the intersection of U.S. 95 and Interstate 15, approximately 3 miles north-northwest from the Property).

- Yield — 0.15 to 8.5 gallons per minute (gpm)
- Average Transmissivity — 4.79×10^2 gallons per day/foot (gpd/ft)
- Horizontal Hydraulic Conductivity — 7 to 116 gallons per day/foot^2 (gpd/ft^2)

The second study conducted by Converse (1995) included 15 sites from across the Valley. The shallow aquifer test wells included 2-inch, 4-inch, 8-inch, and 12-inch diameter wells constructed primarily of

polyvinyl chloride (PVC) or steel, with screen slot sizes ranging from 0.0100 to 0.25 inch. Completion depths for the wells ranged from 10 to 200 feet bgs. The results of the Converse study are summarized below. Converse concluded that a wide range of values existed for the shallow system due in part to the variety of well constructions and completion depths.

- Yield — 1 to 950* gpm
- Transmissivity — T = 10 to >$5x10^5$ gpd/ft
- Storativity — S = 10^{-6} to 0.1
- Horizontal Hydraulic Conductivity — K(h) = 1 to 1.5 x 10^4 gpd/ft^2

* If the two upper values of 950 gpm and 197 gpm (wells drilled in old wash beds) are eliminated, the yield ranges from 1 to 30 gpm.

Aquifer properties at the Site are anticipated to most closely resemble those reported by Western Technologies.

URS (2005) performed limited water chemistry analyses from eight wells across the Site. The results indicate that chloride and sulfate are the dominant anions that make up the TDS in shallow groundwater at the Site (Appendix A, Table 4 (URS) and Table 1(Zikmund)) and total organic carbon is generally low, ranging from 1.7 to 6 percent. URS (2005) also reported field monitoring parameters for 25 monitoring wells at the Site. The reported ranges are as follows:

- pH — 6.35 to 7.16
- Temperature — 22 to 27.7 degrees Celsius (°C)
- Specific Conductance — 1.32 to 4.0 microsiemens/cm
- Dissolved Oxygen — 1.02 to 5.94 mg/L
- Oxidation-Reduction Potential — -253 to +219 millivolts
- Turbidity — 22 to >999 nephlometric units

3.0 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the distribution of reported chemical results available for groundwater, soil and soil gas, and indoor air relevant to the objectives of this CAP. Groundwater results used in this section are limited to data acquired over the last 4 years, which is regarded as reasonably contemporaneous for purposes of deriving current site conditions and relevant response actions. Other historical results are discussed in terms of defining the general nature and extent of contamination.

3.1 Shallow Groundwater

The results for the June 2010 monitoring event indicated concentrations of PCE in groundwater wells at 3661 Maryland Parkway (the former APTC facility, Figure 3) ranging from 6.6 to 400 µg/L (Tetra Tech 2010). The highest concentrations of PCE in the 2nd quarter 2010 event were detected in well MW-6 (2,500 µg/L), located across Maryland Parkway, immediately east of the site. PCE was detected at 1,100 µg/L at well MW-18, located roughly 1,400 feet from the former APTC site, and PCE was detected at 330 µg/L at well MW-27, located roughly 3,200 feet downgradient of the former APTC facility. Figure 3 shows an aerial distribution of the June 2010 monitoring results. Based on the June 2010 data, PCE occurs in shallow groundwater to approximately 4,000 feet east of the former APTC facility.

All wells at the Site are scheduled to be monitored during each 4th quarter monitoring event. Data from the November 2009 monitoring event indicate that, at a distance of roughly 1,600 feet east of Maryland Parkway, the PCE groundwater plume is no more than 700 feet wide. The highest concentrations of PCE in groundwater have been reported consistently from monitoring wells MW-6, MW-13, and MW-14 located near the aboveground parking structure on the southwestern portion of the Boulevard Mall, east of the former APTC property (Figure 17). The highest concentration of PCE reported for the Site is from well MW-13 in May 2005 (5,300 µg/L). In June 2010, the highest reported concentration of PCE in shallow groundwater was 2,500 µg/L from MW-6. PCE is below 100 µg/L in wells MW-30 and MW-31, located east of the western fairway of the golf course.

As shown by Fluor Daniel, GTI (Table 1) Appendix A, benzene and several other hydrocarbon-related contaminants were found at low levels in well MW-11, located on the east side of The Boulevard Mall, behind Dillard's. According to the files reviewed at NDEP, approximately 7,000 gallons of weathered petroleum and groundwater were pumped from monitoring well MW-11, after it was installed by Converse Consultants in 2003 in an attempt to skim petroleum product from the groundwater. Benzene and xylenes are still reported at this location. No source for this release has ever been identified (SECOR International, Inc. 2005).

3.2 Soil Gas

In 2007, URS measured soil gas concentrations beneath the eastern edge of the Boulevard Mall and in accessible portions of the residential area. Soil borings were advanced to 10 feet bgs and to 20 feet bgs at three locations on the Boulevard Mall property. Borings were continuously cored, and then soil gas rods were inserted and upper sections of the hole were grouted so that short-term-duration soil gas samples could be collected. Soil gas concentrations reported were the highest at the top of the groundwater table in probe SVB-14 (Figure 18) at 170,000 micrograms per cubic meter (µg/m^3). The highest concentration found in a shallow soil gas probe (46,000 µg/m^3) was obtained from 5 feet bgs at SVB-03 (Figure 19). Reported concentrations were generally erratic, in which case, a clear relationship between soil gas and associated or proximal groundwater concentrations could not be ascertained.

The observed lack of consistency of the reported results may be attributed to variability from sampling and analysis techniques or small-scale changes in the underlying geology. Additional studies are needed before soil gas measurements can be considered a valid tool for predicting potential risk to indoor air at the Site.

3.3 Indoor Air

The NDEP conducted neighborhood sampling events between Fall 2007 and Winter 2007-2008. During these events, 97 homes were sampled for PCE and related compounds in indoor air. Of the homes sampled, 15 homes exhibited PCE concentrations greater than the NDEP indoor air interim action level of 32 µg/m^3 (Broadbent 2010). Subslab depressurization (SSD) systems were installed at 14 of these homes, which were subsequently retested to assure that systems successfully mitigated identified vapor concentrations. If concentrations were above the NDEP interim action level, SSD systems were modified to achieve indoor PCE concentrations in air below 32 µg/L. Subsequent sampling confirmed that homes which accepted the SSD systems, with necessary modifications, exhibited indoor PCE concentrations below 32 µg/m^3 (Broadbent 2010). Additional sampling is proposed to reaffirm that homes with concentrations above the NDEP interim action level remain safely mitigated and to further understand the relationships between contaminated groundwater, geology, and potential threats to indoor air at the Site.

4.0 CONTAMINANT FATE AND TRANSPORT

PCE was used in dry cleaning operations at the Property from 1969 to 2000. Floor drains collected spills at the site which drained to a sump in the north central portion of the building. A "cooker" was operated in a half basement on the north side of the building and overflow from the cooker would drain to the sewer. The sewer line drained to the City sewer under Maryland Parkway. PCE may have migrated to east of Maryland Parkway via the sewer lines with releases occurring from leaks in the sewer lines. However, there is a potential for similar sewer-line-related releases from other potential source areas.

Site data indicates PCE seeped through the floor drain and sump to shallow groundwater, as indicated by PCE being detected in soil at concentrations up to 120 mg/kg at 10 feet beneath the sump (URS 2005). MSSC demolished the building, including the concrete floor and foundation, in the summer of 2006. Results from the June 2010 groundwater monitoring event indicate concentrations of PCE in groundwater wells at the former APTC facility (Figure 3) that range from 6.6 to 400 µg/L (Tetra Tech 2010). Once in groundwater, PCE migrated to the east forming a relatively narrow dispersion pattern. Data from the November 2009 monitoring event indicate that at a distance of roughly 1,600 feet east of Maryland Parkway, the PCE groundwater plume is no more than 700 feet wide. Yet, at the National Golf Course well PW-1, located roughly 3,500 feet from the Property, PCE has been detected in groundwater from well PW-1 at levels ranging from 130 µg/L in 2002 down to 4.9 µg/L in 2006 (NDEP 2007). Although concentrations of PCE have been observed at, and in the vicinity of, the PW-1 irrigation well, the affect of irrigation pumping on plume dimensions or migration has not been sufficiently investigated or definitively determined.

PCE has been detected at wells location MW-29 (0.58 µg/L), MW-30 (41.0 µg/L), and MW-31 (34.0 µg/L) which are located in residential areas on the east side of the National Golf Course (Figure 3) (Tetra Tech, 2010). These relatively attenuated concentrations suggest that these wells may be located near the distal limit of the eastern extent of the plume. Using this assumption as a preliminary boundary and based on the June 2010 data, PCE is considered to extend to approximately 4,000 feet east of the former APTC facility. However, additional data is needed near the distal end of the plume to confirm plume characteristics near the Flamingo Wash.

Bacteria typically degrade PCE in groundwater and soil to trichloroethene (TCE), and *cis*-1,2-dichloroethene (DCE) under anaerobic/reducing conditions, and subsequently to vinyl chloride, ethane, and carbon dioxide under aerobic/oxidizing conditions. The concentrations of TCE and *cis*-1,2-DCE in groundwater across the Site (Table 3-1) are very low considering that the APTC facility was present since as early as 1969. The persistence of PCE reflects the limited amount of degradation occurring in the groundwater, and is evidence of the generally aerobic environment within the shallow aquifer. Given the arid site conditions and presence of evaporate minerals with little organic matter in the soil, soil and groundwater conditions do not appear sufficiently favorable to support natural anaerobic bacteria. The lack of naturally occurring anaerobes that degrade PCE is also well documented at other PCE sites in the Las Vegas area (Converse 2009b).

In relative absence of substantial retardation factors, data collected from the Site support a conclusion that PCE is primarily migrating in groundwater by advective transport with moderate dispersion, and minimal attenuation. Assuming a gradient of 0.013 ft/ft (Tetra Tech, 2010), and an assumed average hydraulic conductivity of 15 ft/day (based on reported values provided in Section 2.3) and a porosity of 0.30, yields an average groundwater annual flow rate of 237 ft/yr for the shallow aquifer. Assuming total migration of 4,000 feet and that the release began in 1970 (40 years for transport) yields a potential retardation factor of 2.4 which is within the expected range for PCE and TCE.

The brackish and saline characteristics of groundwater render the shallow aquifer non-potable, with TDS ranging from 550 to greater than 7,000 mg/l (Zikmund, 1996). Because groundwater is not a suitable drinking water supply, residents in the area of the plume are connected to the City water supply. Therefore, domestic pumping wells are not considered a contributor to plume migration characteristics.

In order to more fully assess groundwater flow characteristics and dynamic principals contributing to the fate and transport of PCE mass in the shallow aquifer, Tetra Tech proposes to construct a groundwater flow and contaminant transport model. Conclusions derived from this model will be used to assess the feasibility and application of screened remedial alternatives established for further evaluation. In addition, a steady-state groundwater flow model will be constructed and calibrated using available geologic and hydrogeologic data. The steady-state model results will be used to construct and calibrate a transient groundwater flow model using temporal Site groundwater elevation data that form the basis for a calibrated PCE transport model. The PCE transport model will allow evaluation of remedial options and prediction of PCE transport under the various alternatives. The model construction, calibration, and results will be documented in a subsequent data report.

5.0 HUMAN HEALTH RISK ASSESSMENT

Existing data quantity and quality is insufficient to complete a reliable and defensible baseline risk assessment. It is anticipated that the results of a baseline risk assessment predicting and quantifying potential risk from indoor air exposure, as well as other potentially complete exposure pathways, will be presented in the final CAP after adequate data is obtained.

6.0 IDENTIFICATION OF PRELIMINARY CORRECTIVE ACTION OBJECTIVES AND REMEDIATION STANDARDS

Preliminary corrective action objectives (CAO) and preliminary numerical remediation standards are assigned to protect human health and the environment and are used to guide the evaluation of potential corrective actions. The preliminary CAOs and numerical remediation standards used for this site were established to address site-specific COCs, affected media, and potential exposure pathways.

Preliminary CAOs address potential risks to human health and the environment. The following CAOs are specified:

- Where PCE concentrations exceed the remediation standard for groundwater, prevent use of shallow groundwater as a source of drinking water
- Prevent exposure of current residents to PCE in indoor air above the remediation standard

These preliminary CAOs will be refined after completion of a human health risk assessment that will be presented in the final CAP. CAOs will become final when the corrective action is selected in a record of decision.

The development of preliminary numerical remediation standards involves four steps:

(1) Identification of potentially applicable regulatory standards promulgated under *Nevada Administrative Code* (NAC) 445A.226, et seq. as amended under Adopted Regulation R189-08, that contain health or risk-based numerical values or requirements.

(2) Calculation of risk-based concentrations in the absence of promulgated regulatory standards.

(3) Identification of laboratory practical quantitation limits (PQL).

(4) Comparison of the concentrations identified through the previous steps.

The first step identifies potential regulatory standards potentially applicable to a release from the Property. NAC 445A.22735 establishes action levels for groundwater. These groundwater action levels are either maximum contaminant levels (MCL) established under the Safe Drinking Water Act, or background concentrations if these exceed the MCL. If a MCL has not been established for a hazardous substance, hazardous waste, or regulated substance, provisions for using background concentrations or an appropriate concentration based on protection of public health and safety and the environment (risk) can be invoked to derive relevant action levels (NAC 445A.22735). A MCL for PCE of 5 µg/L has been established under the Safe Drinking Water Act. MCLs and drinking water standards promulgated under the Safe Drinking Water Act are standards applicable to public water supplies “at the tap” that is, at the point of end use. These drinking water standards are not directly applicable to in situ groundwater, like the in situ shallow groundwater at the site. Furthermore, a drinking water standard, like the MCL, may not be appropriate for the shallow groundwater at the site because naturally-occurring groundwater quality is so poor it is not likely to serve as a potential source of drinking water.

No promulgated numerical standards apply to indoor air concentrations of PCE.

The second step identifies potential site-specific risk-based concentrations. Risk-based concentrations are typically calculated in the absence of promulgated regulatory requirements for protection of a particular receptor or exposure pathway in a given medium. Risk-based concentrations for groundwater will be calculated, if necessary, for groundwater exposure pathways identified as complete or potentially complete in the human health risk assessment to be completed as part of the final CAP. NDEP’s interim action level of 32 $\mu g/m^3$ for PCE is a risk-based concentration protective of residential receptor exposure to PCE in indoor air.

The third step involves consideration of laboratory PQLs. The PQL is the lowest concentration that can be reliably measured within specified limits of precision and accuracy by individual analytical methods under routine laboratory conditions. PQLs are based on a general estimate for an analytical method, and not a determination for individual chemicals. Numeric remediation standards cannot be set below the laboratory PQL because concentrations lower than the PQL cannot be reliably measured. The laboratory PQL for PCE in water is 0.5 µg/L. The laboratory PQL for PCE in indoor air varies by laboratory and analytical method but is generally less than 10 $\mu g/m^3$.

The final step compares the values generated by the previous steps. The only numbers generated in the previous three steps for PCE in groundwater were the MCL, identified as the Nevada regulatory standard under NAC 445A.22735, and the laboratory PQL. The MCL for PCE (5.0 µg/L) is used in the draft CAP as the preliminary remediation standard for groundwater because it is higher than the laboratory PQL, and it is a regulatory standard that can be reliably measured. The only numbers generated in the previous three steps for PCE in indoor air were NDEP's interim action level (a risk-based concentration of 32 $\mu g/m^3$) and the laboratory PQL. The NDEP interim action level for PCE (32 $\mu g/m^3$) is used in the draft CAP as the preliminary remediation standard because it also is a standard that can be reliably measured.

These preliminary numerical remediation standards will be refined after completion of a human health risk assessment, which will be presented in the final CAP. The numerical remediation standards will become final when the corrective action is selected in a record of decision.

7.0 IDENTIFICATION OF SCREENING TECHNOLOGIES

This section presents GRAs, remedial technologies, and process options evaluated to address groundwater above the remediation standard. In general, consistent GRAs, remedial technologies and process options are applicable in the source, Boulevard Mall, and residential areas; therefore, these areas have been combined for evaluation. Given the lack of recent and consistent data for groundwater at the golf course, this area cannot be assessed without additional investigation. Remedial technologies and process options are developed and screened based on implementability, effectiveness, and cost (EPA 1988). After the remedial technologies are evaluated, they are combined into corrective action alternatives.

7.1 General Response Actions

GRAs were derived from engineering judgment and experience with corrective actions proven successful for PCE. The following GRAs were identified to achieve the preliminary remediation standard for groundwater in the source, Boulevard Mall, and residential areas:

- No action – Required for consideration.
- Institutional controls (IC) – land-use and groundwater-use restrictions.
- Engineering controls – mitigation measures like vapor barriers, SSD systems, and well abandonment.
- Monitored natural attenuation (MNA) – Organic contaminants are allowed to naturally attenuate via biodegradation, dispersion, dilution, or adsorption.
- Treatment – in situ and ex situ treatment and monitoring of groundwater contamination.
- Containment – capping and vertical barriers to contain the contamination.

Process options for these GRAs are evaluated below.

7.2 Identification, Screening, and Evaluation of Technology Types and Process Options for the Source, Boulevard Mall, and Residential Areas

This section analyzes the technology types and process options for each GRA in terms of three broad screening evaluation criteria: effectiveness, implementability, and cost (EPA 1988). Potentially applicable GRAs identified for groundwater consist of (1) no action, (2) ICs, (3) engineering controls, (4) MNA, (5) treatment, and (6) containment. Process options for containment were not retained after the initial screening based on difficulty of implementation and ineffectiveness. The five remaining GRAs are discussed in this section.

The screening of process options incorporating the remedial technology types for these GRAs is provided in Table 7-1. The rationale for eliminating process options from further evaluation is also presented in the table, and eliminated process options are not discussed further.

TABLE 7-1

GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR GROUNDWATER ABOVE PRELIMINARY REMEDIATION STANDARD

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Comment
No Action	Not applicable (NA)	NA	No actions are taken at the site.	Low	Easy	Low	Retained for comparison purposes.
Institutional Controls	Deed Restrictions	Deed Restrictions	Could include well restrictions, testing for indoor air quality, and requirement for individual home air treatment units.	Moderate	Moderate	Low	Potentially applicable in conjunction with other GRAs. Residents impacted by vapor intrusion have individual subslab depressurization (SSD) systems.
	Access Restrictions	Access Restrictions	Currently, homes are on municipal water; could include abandonment of unauthorized wells.	Moderate	Easy	Low	Potentially applicable in conjunction with other GRAs.
Engineering Controls	Vapor Barriers	Epoxy Coating	The floor of the building is sealed with an epoxy-based sealant, providing a physical barrier to vapor migration into buildings.	Low – Moderate	Easy - Moderate	Low – Moderate	Poor performance record; most effective when implemented in conjunction with subslab depressurization. It is difficult to ensure that all cracks are sealed, and sealant itself cracks over time; may be used in conjunction with subslab depressurization for improved effectiveness.
		Subslab Depressurization	Blowers and vapor collection points are installed below the building to prevent vapor intrusion.	Moderate – High	Easy - Moderate	Low – Moderate	Currently used at 14 residences at the Site.
		Raised-Floor System	A new sub floor and depressurization system is installed between the floors to maintain a negative pressure gradient and prevent vapor intrusion.	Moderate – High	Moderate	High	Effective for buildings where subslab depressurization is not implementable. Difficult to implement in existing buildings; reduces the functionality of the structure.
	Wellhead Treatment	Well Abandonment	Abandon unauthorized wells to prevent exposure to tetrachloroethene (PCE) in groundwater.	High	Easy	Low	Location and status of potential residential groundwater wells is being assessed; additional information is required.
		Granular Activated Carbon (GAC) Treatment Unit	Utilize individual GAC units to treat PCE at individual wells.	High	Easy	Low	Location and status of potential residential groundwater wells is being assessed; additional information is required.
Monitored Natural Attenuation (MNA)	MNA	MNA	Monitor wells to track natural declines of contaminants that occur with source removal. Organic contaminants are allowed to naturally attenuate via biodegradation, dispersion, dilution, or adsorption	Low	Easy	Low	Potentially applicable in conjunction with other GRAs. Preliminary assessment of site conditions shows limited evidence of natural attenuation; requires long-term monitoring to assess recovery rates and success.
Treatment	In Situ Biological Treatment	Enhanced Bioremediation	The activity of naturally occurring or augmented (bioaugmentation) microbes is stimulated (biostimulation) by circulating electron donors, electron acceptors, or nutrients, through contaminated groundwater to enhance in situ biological degradation of organic contaminants.	Moderate – High	Moderate -Difficult	Moderate – High	Potentially applicable. May be difficult to implement in situ; nutrients are difficult to deliver. Aquifer shows no signs of ongoing bioremediation.
		Phytoremediation	Plants are used to remove, transfer, stabilize, and destroy contaminants in groundwater	Low	Difficult	Moderate	Not effective for deeper groundwater.
	In Situ Physical/Chemical Treatment	Air Sparging/Soil Vapor Extraction	Inject air into the saturated subsurface to volatilize organic contaminants in groundwater. May be used in conjunction with soil vapor extraction, where a vacuum is applied to soil to induce controlled air flow and remove volatile and semivolatile contaminants from the unsaturated zone.	Moderate – High	Moderate	Moderate – High	Potentially applicable. Design and effectiveness of system depends on geology and depth of contaminants; operations and maintenance (O&M) intensive. Air stream may require treatment.
		In Situ Thermal Treatment	The subsurface is heated to vaporize VOCs; vaporized contaminants can then be removed from the unsaturated zone by vacuum extraction and treated.	Moderate – High	Difficult	High	Success and required treatment time depend heavily on site-specific characteristics such as soil type, contaminant characteristics and concentrations, geology, and hydrogeology; volatilized VOCs are difficult to capture and may accumulate in buildings or follow preferential pathways; may require a large number of wells. Effective for VOCs; depends on the ability to capture vaporized contaminants.
	In Situ Chemical Treatment	In Situ Chemical Oxidation	Chemicals (such as ozone, potassium permanganate, or Fenton's reagent) are injected into the contaminated groundwater to oxidize the contaminants	Moderate – High	Moderate – Difficult	Moderate – High	Potentially applicable. Depends on site geology, which may inhibit adequate dispersion of injected chemicals; multiple injections may be necessary to achieve remediation goals. Could add total dissolved solids (TDS) within the aquifer.
		In Situ Chemical Reduction	Chemicals (such as zero valent iron) are injected into the contaminated groundwater to chemically reduce the contaminants	Moderate – High	Moderate – Difficult	Moderate – High	Potentially applicable. Depends on site geology, which may inhibit adequate dispersion of injected chemicals; multiple injections may be necessary to achieve remediation goals.
		Permeable Reactive Barriers	A permeable wall is created (often zero valent iron) to treat contaminated groundwater while groundwater passively flows through.	High	Moderate – Difficult	High	Potentially applicable. Limited to subsurface lithology that has a continuous aquitard; can be difficult to install at depths greater than conventional trenching equipment. Possibility of precipitate formation due to site geochemistry.

TABLE 7-1 (CONTINUED)

GENERAL RESPONSE ACTIONS AND PROCESS OPTIONS FOR GROUNDWATER ABOVE PRELIMINARY REMEDIATION STANDARD

General Response Action	Remedial Technology Type	Process Option	Description	Effectiveness	Implementability	Cost	Comment
Removal/ Treatment	Ex Situ Physical/Chemical Treatment	Extraction and Treatment	Contaminated groundwater is removed by pumping, and contaminants are removed ex situ through treatment such as advanced oxidation processes, air stripping, GAC adsorption, ion exchange, or separation	Moderate – High	Moderate	High	Potentially applicable. Effective for organic compounds; often generates a secondary waste stream; may leave significant concentrations of COCs behind as the aquifer is dewatered. Aquifer has exhibited slow recharge of groundwater indicating low hydraulic conductivity; may be difficult to implement; long remedial time frame. TDS may complicate treated water discharge.
		Dual-Phase Extraction	A high vacuum system is used to extract liquid and vapor from the subsurface; liquid and vapor are then separated and treated.	Moderate – High	Moderate – Difficult	High	Requires both water treatment and vapor treatment; more applicable to light non-aqueous phase liquids (petroleum releases) than to chlorinated solvent releases
Containment	Capping	Asphalt.	Pave with asphalt over areas of contamination. Can be used to minimize vapor intrusion and infiltration.	Moderate	Easy	Low – Moderate	May prevent vapor intrusion into areas that are not developed, will not reduce concentrations in groundwater or reduce vapor intrusion into buildings that have already been constructed.
		Concrete	Place concrete over areas of contamination. Can be used to minimize vapor intrusion and infiltration	Moderate	Easy	Low – Moderate	May prevent vapor intrusion into areas that are not developed, will not reduce concentrations in groundwater or reduce vapor intrusion into buildings that have already been constructed.
		Compacted Clay & Soil	Place compacted clay and soil over areas of contamination. Can be used to minimize vapor intrusion and infiltration	Moderate	Easy	Low – Moderate	May prevent vapor intrusion into areas that are not developed, will not reduce concentrations in groundwater or reduce vapor intrusion into buildings that have already been constructed.
	Vertical Barriers	Grout Curtain	Pressure injection of grout in a regular pattern of drilled holes.	Moderate	Difficult	High	Contamination has already moved off site; containment technologies would be ineffective in treating the entire plume but could be used to isolate the source area.
		Slurry Wall.	Trench around area of contamination is filled with bentonite slurry	Moderate	Difficult	High	Contamination has already moved off site; containment technologies would be ineffective in treating the entire plume but could be used to isolate the source area.

Notes:
Gray shading indicates a technology or process option was eliminated from consideration.
Effectiveness and cost scales defined as low, medium and, high.
Implementability scale defined as easy, moderate, and difficult.

No Action

The NCP requires that the no-action alternative be carried through the detailed analysis of alternatives. Under this GRA, no corrective action is taken. Groundwater would be left as is without implementing any ICs, engineering controls, removal, treatment, containment, or other mitigating actions. Because groundwater poses a potential risk to human health of current and future residents, the no-action response would not be an effective alternative. As quarterly groundwater and annual air monitoring are ongoing at the Site, these monitoring costs were included as part of the no-action alternative.

Institutional Controls

ICs can effectively prevent human contact with PCE in groundwater and can include access restrictions and deed restrictions carried out by legal and/or administrative mechanisms. The main risk for exposure to contaminants is through vapor intrusion in buildings and residences at the Site. Exposure to volatile contaminants can be prevented with ICs requiring engineering controls on existing and/or newly constructed buildings and residences. Groundwater at the site is not a potential source of drinking water due to poor water quality. Wells at the Site are not permitted by the Department of Conservation and Natural Resources, Division of Water Resources. There is a potential that some residents or businesses may continue to pump and use shallow groundwater without regulatory or municipal authorization. ICs may mitigate unauthorized use and exposure to shallow groundwater by virtue of education and awareness; however, unauthorized or unlawful uses of groundwater cannot be reasonably precluded through ICs or other administrative or engineering controls. When used properly and as intended, ICs are effective, implementable, and low cost. Therefore, ICs will be retained for development and evaluation of corrective action alternatives.

Engineering Controls

Engineering controls can effectively mitigate vapor intrusion and prevent human contact with PCE in groundwater when used in conjunction with ICs. Process options pertaining to vapor intrusion mitigation were evaluated during the initial screening process, including: epoxy coating for future construction, SSD systems, and raised floor systems for future construction. SSD systems are being used effectively to mitigate vapor intrusion at 14 residences. Given the effectiveness of SSD systems currently in use at the Site, this process option is retained. Because (1) the location and status of unauthorized groundwater wells is unclear and (2) groundwater is not a potential source of drinking water, engineering controls (e.g. individual wellhead treatment units) addressing individual unauthorized groundwater wells were not considered.

Monitored Natural Attenuation

MNA "… refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored clean-up approach) to achieve site-specific remedial objectives within a time frame that is reasonable compared to other methods. The "natural attenuation processes" at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil and groundwater. These in situ processes include: biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants (EPA 1997).

MNA was not retained for further evaluation as a stand-alone technology in the corrective action alternatives. MNA alone would not reduce the concentrations of PCE within a reasonable timeframe and would not be sufficient to prevent the expansion or migration of the groundwater contaminants. However, after treatment is complete in areas of the highest concentrations of contamination, MNA may be effective as a polishing step to further reduce the concentrations of contaminants to achieve remediation goals. Therefore, MNA is retained as part of a groundwater treatment train, in conjunction with a more aggressive treatment technology.

Treatment

Treatment processes directly reduce the toxicity, mobility, or volume of contaminants. The following in situ treatment process options were evaluated and retained during the screening process: in situ chemical treatment, air sparging (AS), soil vapor extraction (SVE), permeable reactive barrier (PRB) using in situ chemical dechlorination, and enhanced bioremediation. Extraction and treatment was retained as an ex situ process option. Technologies screened out can be identified in Table 8-1.

In Situ Chemical Oxidation

In situ chemical oxidation involves injection of chemical oxidants into the groundwater to oxidize and degrade the PCE. Chemical oxidation has been shown to destroy PCE and its breakdown products. The most commonly used oxidants for in situ chemical oxidation are hydrogen peroxide, Fenton's reagent, potassium (or sodium) permanganate, ozone, and sodium persulfate. In situ chemical oxidation is effectively treats PCE, and the costs are expected to be moderate to high. Chemical oxidation is also implementable; however, success implementing the technology depends on site geology. Chemical oxidant is typically injected via direct push; given the presence of caliche at the site, permanent wells would likely be installed with a drill rig, allowing for repeat applications of the chemical oxidant.

Bench scale and pilot testing should be conducted to determine the effectiveness of chemical oxidation and the associated soil oxidant demand (SOD), as well as the radius of influence (ROI) for injection. In addition, careful planning should be used when injecting near residences or underground utilities that could provide preferential pathways.

In Situ Chemical Reduction

In situ chemical reduction is similar to in situ chemical oxidation. Reducing chemicals are injected into groundwater to reduce and degrade PCE. Reduction has been shown to degrade PCE and its breakdown products by creating a reducing environment through direct or microbially-mediated dechlorination. Typically zero-valent iron (ZVI) or ZVI combined with a carrier (e.g. clay or granular activated carbon) are employed. In situ chemical reduction can effectively treat PCE, and the costs are expected to be moderate to high. Chemical reduction is implementable; however, success implementing the technology depends on site geology. The reducing agent is typically injected via direct push, but given the presence of caliche at the site, a drill rig would be required. Bench scale and pilot tests should be conducted to determine the effectiveness of chemical reduction, the influence of site specific geochemistry, and the ROI for injection. Careful planning should be used when injecting near residences or underground utilities that will provide preferential pathways.

Air Sparging/Soil Vapor Extraction

AS/SVE are often used in conjunction for the treatment of volatile organic compounds (VOC) in groundwater. Air sparging is an in situ technology that injects air into the saturated zone below or within the chemical plume through a system of injection wells. Injected air flows vertically and horizontally through permeable (interconnected) void spaces within the geologic media. As air is driven through these void spaces, it strips (desorbs) chlorinated solvents from the geologic media, and volatilizes chlorinated solvents dissolved in the groundwater. The function of the SVE system is to capture and extract VOCs from the vadose zone by applying a negative pressure, or vacuum, to the subsurface.

A blower applies the subsurface vacuum through a network of extraction wells installed within the contaminated area. The pressure gradient that results from the applied vacuum induces air flow through the vadose zone to the extraction points, and the soil gas containing vapor-phase contaminant(s) is

removed. VOCs in blower effluent are typically removed or destroyed before the treated air is discharged to the atmosphere. The effectiveness of these technologies depends on the subsurface geology. Pilot tests should be conducted to determine the effectiveness of AS/SVE, as well as the ROI for injection and extraction. Because AS/SVE may increase vapors present beneath homes, its use in the residential areas should consider if SVE can be used effectively to safely mitigate any potential increase in soil gas and indoor air vapors.

Permeable Reactive Barrier

PRBs can be used to intercept and treat PCE in groundwater. PRBs consist of engineered zones that are installed in the subsurface perpendicular to the path of a groundwater plume. As groundwater flows through the PRB, contaminants are removed or treated. Often a reactive material, typically ZVI, is utilized to treat groundwater. Depending on the type of PRB, they are typically installed by excavation into the saturated zone followed by backfilling the trench with the reactive material; however, drilling, hydraulic fracturing, and pressurized injection can also be used to place a PRB. The subsurface geology can influence the performance and longevity of PRBs. If carbonate or other solid-phase precipitates form within the PRB, hydraulic conductivity and reactivity may decrease. Bench scale treatability testing is necessary to evaluate the likelihood of precipitate formation, and pilot testing should be conducted to help evaluate installation procedures and determine how the PRB would perform at the site.

Enhanced Bioremediation

In situ bioremediation describes microbial degradation of contaminants in groundwater. Microbial populations require a source of carbon, an electron donor, an electron acceptor, nutrients, a suitable temperature and pH range, and other favorable environmental conditions. Enhanced in situ bioremediation systems stimulate the biodegradation of chlorinated solvents by manipulating these conditions or requirements in the subsurface (bioenhancement). Some systems further stimulate biodegradation by adding naturally occurring or engineered microorganisms particularly suited for the breakdown of certain chemicals (bioaugmentation). Several different designs of enhanced in situ bioremediation systems for groundwater use various delivery mechanisms, degradation mechanisms, and nutrient/biological amendments that depend on site-specific characteristics. Bench-scale testing is required to determine the most effective form of enhancement and/or augmentation.

8.0 DEVELOPMENT AND DETAILED ANALYSIS OF ALTERNATIVES

Preliminary CAOs and numerical remediation standards are identified in the draft CAP, and viable corrective action alternatives were developed and evaluated based on the CAOs and numerical remediation standards; however, additional data acquisition is necessary to evaluate current site conditions, conduct groundwater modeling, evaluate risks, and more fully assess the viability of the cleanup applications. These sampling efforts will also be used to ultimately satisfy provisions for terminating remediation established under Adopted Regulation R189-08, Section 14 (NAC 445A.22725) and Section 15 (NAC 445A.22745).

This section identifies corrective action alternatives for groundwater and provides a detailed analysis of each corrective action alternative. The alternatives were developed and screened based on the requirements of NAC 445A.2271; guidance issued and offered by NDEP; and in a manner consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988).

The following groundwater alternatives were developed for analysis in this CAP:

- Alternative 1 – No Action
- Alternative 2A – In Situ Chemical Treatment of Hotspots and Residential Area, ICs, SSD Systems, and MNA
- Alternative 2B – In Situ Chemical Treatment, ICs, SSD Systems, and MNA
- Alternative 3 – Permeable Reactive Barrier, ICs, SSD Systems, and MNA
- Alternative 4 – AS/SVE ICs, SSD Systems, and MNA
- Alternative 5 – Extraction and Treatment, ICs, SSD Systems, and MNA
- Alternative 6 – In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA.

Section 8.1 describes the evaluation criteria. The corrective action alternatives for groundwater are described and individually evaluated in Sections 8.2.1 through 8.2.7. General assumptions made in developing cost estimates for these alternatives are presented in Appendix C. Section 8.3 provides a comparative analysis of the alternatives based on the evaluation criteria.

8.1 Evaluation Criteria

Each corrective action alternative was developed and evaluated according to seven evaluation criteria. The NCP details the expectations for remedy selection in 40 *Code of Federal Regulations* (CFR) § 300.430 (a)(1)(iii), and these are described below. After completion of additional data acquisition, the risk assessment and development and assessment of the treatment alternatives can be refined. Section 9 of this CAP proposes bench-scale and pilot studies that will allow for better assessment of corrective action alternative effectiveness and cost based on site-specific conditions.

Overall Protection of Human Health and the Environment

This criterion assesses whether each alternative adequately protects human health and the environment. The overall assessment of protection draws on evaluations of long-term effectiveness and permanence and short-term effectiveness. Protectiveness focuses on how risks are reduced, eliminated, or controlled by each alternative. Risk reductions are associated with the effectiveness of an alternative in meeting the

preliminary remediation standard. This criterion is considered a threshold that the selected alternative must meet. Given no pathway for exposure of ecological receptors to groundwater at the Site, only human health was considered as part of this evaluation.

Long-Term Effectiveness and Permanence

Each alternative is evaluated in terms of risk remaining at the site after the preliminary remediation standard has been met. The primary focus of this evaluation is on extent and effectiveness of controls used to manage the risk posed by treatment residuals or untreated wastes. This criterion addresses the long-term adequacy, reliability, and permanence of the corrective action.

Components of this analysis include the following:

- Expected long-term reduction in risk posed by the site
- Level of effort needed to maintain the corrective action and monitor the area for changes in site conditions
- Compatibility of the corrective action with planned future use of the site.

Reduction in Toxicity, Mobility, and Volume through Treatment

This evaluation criterion addresses the statutory preference for treatment options that permanently and significantly reduce toxicity, mobility, or volume of the contaminants. This preference is satisfied when treatment reduces the principal threats through the following:

- Destruction of toxic contaminants
- Reduction in contaminant mobility
- Reduction of the total mass of toxic contaminants
- Reduction of total volumes of contaminated media.

Short-Term Effectiveness

This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until the preliminary remediation standard is met. Under this criterion, alternatives are evaluated in terms of their effects on human health and the environment during implementation of the corrective action. The following factors are considered:

- Protection of the community during the corrective action, including protection from effects of potential releases from the site, transport of contaminated materials, and air-quality impacts from on-site treatment
- Exposure of the workers during construction
- Potential environmental impacts of the corrective action, and effectiveness and reliability of protective measures
- Time required to achieve the remediation standard. It should be noted that engineering judgment has been utilized to assume remediation timeframes for each of the alternatives. Groundwater modeling with site-specific parameters will be conducted for the site when adequate data are obtained. Bench-scale and pilot testing will also be conducted. Modeling and bench-scale and pilot studies will allow for better determination of corrective action timeframes.

Implementability

This criterion addresses the technical and administrative feasibility of implementing an alternative, and availability of various services and materials required during its implementation. Factors considered in assessing this criterion include the following:

Technical feasibility

- Construction and operation − technical difficulties and unknowns associated with construction and operation of a technology
- Reliability of the technology − likelihood that technical problems associated with implementation would lead to schedule delays
- Ease of undertaking additional corrective actions
- Ability to monitor effectiveness of the corrective action

Availability of materials

- Availability of adequate off-site treatment, storage capacity, and disposal capacity and services
- Reliability of the technology − likelihood that technical problems associated with implementation would delay the schedule
- Availability of services and materials
- Availability of prospective technologies

Administrative feasibility

- Implementability with current and future development scenarios
- Activities needed to coordinate with other offices and agencies
- Ability and time required to obtain any necessary approvals and permits from those agencies.

Cost

The cost analysis for each alternative is based on estimates of capital, annual operation and maintenance (O&M), and periodic cost elements in combination with a calculation of net present value of these cost elements. Capital costs consist of direct and indirect costs. Direct costs include purchase of equipment, contractor and subcontractor labor, and materials necessary to construct the corrective action alternative. Indirect costs include those for engineering, legal, construction management, and other technical and professional services such as testing and monitoring. Annual O&M costs for each alternative include maintenance materials, supplies, and utilities, as well as operating labor. Periodic costs are those that occur only once every few years. These costs may be capital or O&M, but because they are periodic, are considered separately from other capital and O&M costs.

Cost estimates for the corrective action alternatives are generally based on costs derived from the following sources:

- Historical cost data
- Estimates from similar projects
- Engineering judgment

- Site-specific quantities and information
- Vendor quotes and estimates.

A present value analysis of each alternative is presented in Appendix C of this document. The present value analysis is a method to evaluate expenditures, either capital or O&M, that occur over different periods extending into the future. The discount rate used for this project is 5 percent, the suggested rate for projects extending at least 30 years into the future. This discount rate was used for all present value analyses, regardless of actual future project duration.

The accuracy of the cost estimate for each alternative is intended to be within the range of plus 50 percent to minus 30 percent of actual costs (EPA 1988). However, additional site-specific data are required to fully assess and estimate costs for the alternatives. The level of detail employed in developing these estimates is considered appropriate for making choices between alternatives, but the cost estimates are not intended for use in detailed budgetary planning. Costs for each alternative are compiled in Appendix C. Upon completion of future bench-scale and pilot studies, additional information regarding design of corrective actions will allow further refinement of the cost estimates.

NDEP Acceptance

NDEP's concerns regarding the proposed corrective action alternatives may not be fully assessed until comments on this and future documents are received.

Community Acceptance

This involves assessment of community support for, reservations about, or opposition to various components of the alternatives. This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.2 Descriptions and Individual Analyses of Alternatives

8.2.1 Alternative 1: No Action

The no-action alternative is required for analysis according to the NCP (40 CFR § 300.430[e][6]). The no-action alternative is the baseline alternative against which to judge the effectiveness of all other corrective action alternatives. Under the no-action alternative, no corrective actions would be conducted at the site. It was assumed that current groundwater and indoor air monitoring would continue for 30 years. No additional attempts would be made to control the vapor intrusion of PCE to indoor air.

Overall Protection of Human Health

Groundwater poses a risk to human health through the vapor intrusion pathway. This alternative would not reduce, eliminate, or control the potential risk; therefore, Alternative 1 is not protective of human health.

Long-Term Effectiveness and Permanence

Under Alternative 1, groundwater contamination at concentrations above the remediation goal would not be addressed. No controls to prevent exposure, and no long-term management measures such as ICs, would be implemented. Therefore, Alternative 1 would not provide a long-term effective solution for the permanent protection of human health.

Reduction in Toxicity, Mobility, and Volume through Treatment

Alternative 1 would not reduce the toxicity, mobility, or volume of hazardous substances because no action would be taken at the site. PCE in groundwater would not be treated, contained, or removed.

Short-Term Effectiveness

The following four factors are considered as part of the short-term effectiveness criterion. These are assessed below for Alternative 1:

- No corrective actions would occur, and the on-site community would not be exposed to additional risks from groundwater; the current risks would remain.
- Workers conducting groundwater sampling may be exposed to health risks during implementation of Alternative 1. Because no corrective actions would be taken, construction workers would not be exposed to human health risk due to the implementation of the alternative; however, construction workers in the area may be exposed incidentally while doing work at the Site.
- No adverse environmental impacts would result from implementation of Alternative 1 because no corrective action would be taken.
- No time would be required to complete Alternative 1 because no action would be taken; however, groundwater would remain contaminated until the PCE mass flows off site. Groundwater modeling with site-specific parameters would allow for better determination of this timeframe. However, for this document, groundwater and air monitoring were considered to continue for 30 years.

Implementability

No action, including implementation of ICs or construction and operation of a remedial system, would be required to implement this alternative. Therefore, Alternative 1 would be easily implemented.

Cost

No capital costs are included. O&M costs associated with quarterly groundwater and annual indoor air monitoring would total $3,840,000 for the assumed 30-year lifespan.

State Acceptance

Presumably, Alternative 1 would not be acceptable to the NDEP.

Community Acceptance

Presumably, Alternative 1 would not be acceptable to the community.

8.2.2 Alternative 2A: In Situ Chemical Treatment of Hotspot and Residential Area, Institutional Controls, Subslab Depressurization Systems, and MNA

Alternative 2A combines in situ chemical treatment of the plume hotspot and upgradient of the residential area, ICs, the SSD systems, and MNA. Under this alternative, a chemical oxidant is injected into the subsurface in the plume hotspot to treat the greatest mass of PCE, and in a line of injection wells perpendicular to the plume upgradient of the residential area to treat groundwater as it flows into the residential area. MNA would further reduce concentrations of PCE in groundwater. ICs and SSDs would protect residents from PCE in indoor air until groundwater is treated to protective levels.

For this CAP, the oxidant selected for injection is potassium permanganate; however, bench-scale testing may determine that a different oxidant or chemical reducing agent is preferable based on site-specific conditions. Potassium permanganate was chosen for this CAP because it is generally more stable and easier to handle than hydrogen peroxide or ozone; is effective over a large pH range (3.5 to 12); can persist in the soil for several months; and is the most effective for the site contaminants. Potassium permanganate is typically provided as a liquid or solid. The assumptions made for the purposes of this CAP and costing are detailed in Appendix C.

Injection would occur over the top 20 feet of the shallow aquifer in the plume hotspot (concentrations of PCE greater than 1,000 µg/L) and upgradient of the residents and in a line perpendicular to the plume (in the Boulevard Mall eastern parking lot). The injection wells in the hotspot would likely require a second (or possibly third) injection of potassium permanganate, and 10 years of annual injections would be required as contaminated groundwater flows toward the residences. The assumptions made for the purposes of this CAP and costing are detailed in Appendix C.

Bench-scale testing will determine reagent effectiveness, dosing rates, and potential geochemical interference at the Site. High TDS or reagent demand at the site may be problematic. If bench-scale testing is successful, pilot studies will be conducted in the area before full-scale implementation of in situ chemical treatment to establish effective dosage rates, the distance the reagent can be expected to travel underground (ROI), optimal well spacing, and the injection pumping rates. These tests will also allow for refinement of costs. The bench-scale and pilot studies will also evaluate the potential increase in TDS or loss of permeability in the subsurface.

Fourteen SSD systems are currently in use at the site, effectively protecting residents from risk caused by vapor intrusions of PCE in indoor air. If new SSD systems are required as determined by indoor air sampling, they would be installed. These systems would stay in place until groundwater concentrations decrease to levels protective of indoor air. ICs could be utilized to ensure the continued operation of SSD systems.

After in situ chemical treatment, MNA would decrease any residual PCE concentrations below the remediation standard. Upon completion of data gathering and pilot testing, groundwater modeling could be used to better predict the timeframe in which the remediation standards would be met.

Before, during, and after treatment, groundwater would be monitored to evaluate the effectiveness of the alternative and whether the remediation standard has been met. Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air.

More specific assumptions for costing the alternatives are listed in Appendix C.

Overall Protection of Human Health

Alternative 2A protects human health and the environment because groundwater that poses an unacceptable risk to human health would be treated with in situ chemical treatment. The injection of an reagent would reduce concentrations of PCE in groundwater to below the preliminary remediation standards. While the level of contaminants decrease in groundwater (occurring quickly with chemical treatment), residents would be protected from the risk of PCE in indoor air by the previously installed SSD systems, which would be operated until groundwater concentrations decrease to levels protective of indoor air.

Long-Term Effectiveness and Permanence

PCE in groundwater would be permanently treated in situ with chemical treatment. Groundwater monitoring would be conducted to determine that the concentrations of VOCs are reduced to below the

preliminary remediation standards and would not pose a long-term risk to human health. No long-term activities would be required to maintain the effectiveness of this alternative.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes treatment of the VOCs in groundwater. Chemical treatment would reduce the toxicity and volume of contamination in the groundwater.

Short-Term Effectiveness

Four factors considered as part of the short-term effectiveness criteria are assessed below for Alternative 2A:

- Alternative 2A would present minimal risks to the community because the corrective action would be applied in situ. Drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures.
- On-site workers may be exposed to risks while installing injection or monitoring wells, handling the chemicals for injection, or sampling contaminated groundwater; these risks would be minimized by proper handling and housekeeping, and by use of appropriate personal protective equipment. Remediation activities would be carried out under a health and safety program designed to minimize worker exposure.
- Environmental impacts in the injection areas would be minimal because the remediation is in situ. However, chemical treatment may increase TDS in the aquifer.
- The corrective action is estimated to take 10 years with two rounds of injections in the plume hotspot and 10 rounds upgradient of the residences. For cost estimating proposes it was assumed that the SSD systems could be turned off after the second round of chemical injection. Site-specific testing and groundwater modeling would refine these estimates of remediation time.

Implementability

Three factors considered as part of the implementability criteria are assessed below for Alternative 2A:

- The alternative is considered technically feasible; however there are several considerations. Well installation, chemical injection, groundwater and indoor air monitoring, and installation of SSD systems are fairly routine activities. Bench-scale and pilot testing would be required to assess the effectiveness of chemical treatment and the impact of site-specific conditions on effective dosage, ROI, and well spacing. Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence injection. Groundwater velocities of 0.5 to 1 foot per day are assumed based on previous site data. However, faster velocities have been associated with sand and gravel areas found in the subsurface of the Site; flow at higher rates (e.g., 2 to 4 feet per day) may cause the chemical to wash out of the system too quickly. High TDS or reagent demand may be problematic. The number of injection points may increase significantly if the estimated ROI of the injection is not achieved. The potential loss of permeability, mobilization of metals, or transformation of chemicals would be monitored during the pilot study and may affect the implementability and effectiveness of chemical treatment. Careful planning should be used when injecting near residences or underground utilities that could provide preferential pathways. Problems with site access or drilling issues could impact the schedule.

- The materials required for the implementation of chemical treatment and any additional SSD system installation are readily available. Services for well installation, chemical injection, groundwater and indoor air monitoring, and SSD system installation are also readily available.

- The alternative is considered administratively feasible. A permit for injection of the chemical or reducing agent would be required.

Cost

The capital cost of Alternative 2A would be $1,070,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $3,040,000. The total present value cost for Alternative 2A would be $4,110,000.

State Acceptance

This criterion will be evaluated after comments on this CAP have been received from NDEP.

Community Acceptance

This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.2.3 Alternative 2B: In Situ Chemical Treatment, Institutional Controls, Subslab Depressurization Systems, and MNA

Alternative 2B combines in situ chemical treatment, ICs, the SSD systems, and MNA. Under this alternative, a chemical oxidant or reducing agent injected into the subsurface over the areal extent of the plume would chemically treat the groundwater at concentrations exceeding 100 µg/L. ICs and SSDs would protect residents from PCE in indoor air until groundwater is treated to protective levels. Given the developed nature of the Site and difficulty injecting into the entire plume due to buildings and private residences, chemical treatment would be unlikely to treat all groundwater to below the remediation standard; therefore, after in situ chemical treatment has decreased concentrations of PCE at the site, MNA would be relied on to further decrease concentrations of remaining contamination found in groundwater.

In situ chemical oxidation (by potassium permanganate) would be applied to groundwater with concentrations of PCE exceeding 100 µg/L where practicable at the Site, including at the Property; in streets, public right of ways, and parking lots at the Boulevard Mall; and in streets and public right of ways within residential areas. It was assumed that all injection wells would require a second (and possibly third) injection of potassium permanganate. Chemical oxidant or a reducing agent would not be directly injected beneath buildings or private residences. The assumptions made for the purposes of this CAP and costing are detailed in Appendix D. Bench-scale and pilot testing are required. See the description of Alternative 2A in Section 8.2.2 for additional description of chemical treatment and testing requirements.

SSD systems, ICs, groundwater and indoor air monitoring, and MNA would be similar to the descriptions detailed in Alternative 2A in Section 8.2.2. If new SSD systems are required as determined by indoor air sampling, they would be installed. SSD systems would stay in place until groundwater concentrations decrease to levels protective of indoor air. ICs could be utilized to ensure continued operation of SSD systems. After chemical treatment, MNA would be relied on to decrease residual PCE concentrations below the remediation standard. Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed to be 2 years).

More specific assumptions made for costing the alternatives are listed in Appendix C.

Overall Protection of Human Health

Alternative 2B protects human health and the environment because groundwater that poses an unacceptable risk to human health would be treated. The injection of an oxidant or reducing agent would reduce concentrations of PCE in groundwater to below the preliminary remediation standards. While the level of contaminants decrease in groundwater (quickly occurring with chemical treatment), residents would be protected from the risk of PCE in indoor air by the previously installed SSD systems, which would be operated until groundwater concentrations decrease to levels protective of indoor air.

Long-Term Effectiveness and Permanence

PCE in groundwater would be permanently treated in situ. Groundwater monitoring would be conducted to determine that the concentrations of VOCs are reduced to below the preliminary remediation standards and would not pose a long-term risk to human health. No long-term activities would be required to maintain the effectiveness of this alternative.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes treatment of the VOCs in groundwater. Chemical treatment would reduce the toxicity and volume of contamination in the groundwater.

Short-Term Effectiveness

Four factors considered as part of the short-term effectiveness criteria are assessed below for Alternative 2B:

- Alternative 2B would present minimal risks to the community because the corrective action would be applied in situ. Drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures.
- On-site workers may be exposed to risks while installing injection or monitoring wells, handling the chemical for injection, or sampling contaminated groundwater; these risks would be minimized by proper handling and housekeeping and use of appropriate personal protective equipment. Remediation activities would be carried out under a health and safety program designed to minimize worker exposure.
- Environmental impacts in the injection areas would be minimal because the remediation is in situ. However, chemical treatment may increase TDS in the aquifer.
- The corrective action is estimated to take 2 years with two rounds of injections. An additional 2 years of MNA and groundwater monitoring would be required to evaluate the reduction in concentrations of VOCs and monitor for rebound of VOCs. It was assumed for cost estimating purposes that the SSD systems could be turned off after the second round of chemical injection. Site-specific testing and groundwater modeling would refine these estimates of remediation time.

Implementability

Three factors considered as part of the implementability criteria are assessed below for Alternative 2B:

- The alternative is considered technically feasible; however there are several considerations. Well installation, injection, groundwater and indoor air monitoring, and installation of SSD systems are fairly routine activities. Bench-scale and pilot testing would be required to assess the effectiveness of chemical treatment and the impact of site-specific conditions on effective dosage, the ROI, and well spacing. The hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence injection. Groundwater velocities of 0.5 to 1 foot per day are assumed based on previous site data. However, faster velocities have been associated with sand and gravel areas found in the subsurface of the Site;

flow at higher rates (e.g., 2-4 feet per day) may cause the chemical to wash out of the system too quickly. High TDS or reagent demand may be problematic. The number of injection points may increase significantly if the estimated ROI of the injection is not achieved. The potential loss of permeability, mobilization of metals, or transformation of chemicals would be monitored during the pilot study and may affect the implementability and effectiveness of chemical treatment. Careful planning should be used when injecting near residences or underground utilities that would provide preferential pathways. Problems with site access or drilling issues could impact the schedule.

- Materials required for implementation of chemical treatment and any additional SSD system installation are readily available. Services for well installation, chemical injection, groundwater and indoor air monitoring, and SSD system installation are also readily available.

- The alternative is considered administratively feasible. A permit for injection of the chemical would be required.

Cost

The capital cost of Alternative 2B would be $4,660,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $12,040,000. The total present value cost for Alternative 2B would be $16,700,000.

State Acceptance

This criterion will be evaluated after comments on this CAP have been received from NDEP.

Community Acceptance

This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.2.4 Alternative 3: Permeable Reactive Barrier, Institutional Controls, Subslab Depressurization Systems, and MNA

Alternative 3 combines a PRB, ICs, the SSD systems, and MNA. Under this alternative, a ZVI PRB would be utilized upgradient of the residential area to treat contaminated groundwater as it flows into the residential area. MNA would be relied on to further reduce concentrations of PCE in groundwater. ICs and SSDs would protect residents from PCE in indoor air until groundwater is treated to protective levels.

For the CAP, it was assumed that the ZVI PRB would be placed via trenching across the top 20 feet of the aquifer. Given the estimated installation depth, trenching may be challenging. The PRB could also be installed via hydraulic fracturing and injection if this method would be found preferable. The PRB would stretch across the plume and treat groundwater with PCE concentrations exceeding 5 µg/L, the preliminary remediation standard. Groundwater monitoring wells would be installed in the leading edge and downgradient edge of the PRB to measure effectiveness. The assumptions made for the purposes of this CAP and costing are detailed in Appendix C.

Bench-scale and pilot testing would determine the effectiveness, dosing rates, and any geochemical interference at the Site. Given the high TDS, precipitate formation may occur within the PRB, which may reduce the reactive capacity or permeability. If bench-scale testing is successful, pilot studies would be conducted in the area before full-scale implementation to establish the effectiveness, best method for

emplacement, potential for loss of reactivity or permeability due to precipitate formation, and potential increase in TDS. These tests would also allow for refinement of costs.

SSD systems, ICs, groundwater and indoor air monitoring, and MNA are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. If new SSD systems are required as determined by indoor air sampling, they would be installed. SSD systems would stay in place until groundwater concentrations decrease to levels protective of indoor air. ICs could be utilized to ensure continued operation of SSD systems. In addition to treatment by the PRB, MNA would be relied on to decrease PCE concentrations below the remediation standard. For cost estimating purposes it was assumed that groundwater monitoring would be necessary for 20 years. Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed to be 2 years).

More specific assumptions made for costing the alternatives are listed in Appendix C.

Overall Protection of Human Health

Alternative 3 protects human health and the environment because groundwater that poses an unacceptable risk to human health would be treated by reductive dechlorination by ZVI within the PRB. The PRB would reduce concentrations of PCE in groundwater to below the preliminary remediation standards. While the level of contaminants decreases in groundwater, residents would be protected from the risk of PCE in indoor air by the previously installed SSD systems, which would be operated until groundwater concentrations decrease to levels protective of indoor air.

Long-Term Effectiveness and Permanence

PCE in groundwater would be permanently treated in situ. Groundwater monitoring would be conducted to confirm that concentrations of VOCs are reduced to below preliminary remediation standards and would not pose a long-term risk to human health. PRBs tend to be low maintenance, but depending on site characteristics, some PRBs require replacement (typically after approximately 20 years of life, or earlier if precipitation is an issue). Bench-scale testing should provide adequate information regarding the expected life of the PRB.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes treatment of the VOCs in groundwater. The PRB would reduce the toxicity and volume of contamination in the groundwater.

Short-Term Effectiveness

Four factors considered as part of the short-term effectiveness criteria are assessed below for Alternative 3:

- Alternative 3 would present minimal risks to the community because the corrective action would be applied in situ. Excavation or drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures.
- On-site workers may be exposed to risks while emplacing the PRB, handling the ZVI, or sampling contaminated groundwater. These risks would be minimized by proper handling and housekeeping and use of appropriate personal protective equipment. Remediation activities would be carried out under a health and safety program designed to minimize worker exposure.
- Environmental impacts of the PRB would be minimal because the remediation is in situ.

- The corrective action is estimated to take 20 years. For cost estimating purposes it was assumed that the SSD systems could be turned off after 2 years. Site-specific testing and groundwater modeling would refine these estimates of remediation time.

Implementability

Three factors considered as part of the implementability criteria are assessed below for Alternative 3:

- The alternative is considered technically feasible. PRB installation, groundwater and indoor air monitoring, and SSD system installation are fairly routine activities. Given the estimated installation depth of approximately 18 to 38 feet bgs, trenching may be challenging. The PRB could also be installed via hydraulic fracturing and injection if this method would be found preferable (pilot testing would be required to determine the ROI and effectiveness of hydraulic fracturing and injection in the formation). Bench-scale and pilot testing would be required to assess the effectiveness of the technology and the impact of site-specific conditions. High TDS may be problematic and cause precipitate formation. Potential loss of permeability, mobilization of metals, or transformation of chemicals would be monitored during the pilot study, and may affect implementability and effectiveness. Problems installing the PRB could impact the schedule.

- Materials required for the PRB and any additional SSD system installations are readily available. Services for PRB installation, groundwater and indoor air monitoring, and SSD system installation are also readily available.

- The alternative is considered administratively feasible. If the wall is installed by injection, a permit would be required.

Cost

The capital cost of Alternative 3 would be $3,520,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $3,290,000. The total present value cost or Alternative 3 would be $6,810,000.

State Acceptance

This criterion will be evaluated after comments on this CAP have been received from NDEP.

Community Acceptance

This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.2.5 Alternative 4: Air Sparge/ Soil Vapor Extraction (AS/SVE) Institutional Controls, Subslab Depressurization Systems, and MNA

Alternative 4 combines AS/SVE wells upgradient of the residential area, ICs, the SSD systems, and MNA. Under this alternative, air would be injected into the groundwater in a line of AS wells perpendicular to the plume, creating a sparge curtain to strip PCE in groundwater as it flows into the residential area. SVE wells would be utilized to extract the soil gas containing vapor-phase PCE. MNA would be relied on to further reduce concentrations of PCE in groundwater. ICs and SSDs would protect residents from PCE in indoor air until groundwater is treated to protective levels.

Sparging, injection of air into the aquifer, would occur over the top 20 feet of the shallow aquifer. AS wells would be placed perpendicular to groundwater flow west of the residential area (in the eastern Boulevard Mall parking lot) to treat groundwater flowing into the residential area. The sparge curtain would stretch across the plume and treat concentrations of PCE currently greater than 5 µg/L. SVE wells would be utilized to capture the soil gas with PCE. The treatment would occur under the eastern mall parking lot. The parking lot would help trap vapors in the subsurface for capture. For cost estimating purposes it was assumed that PCE in the effluent gas would be removed by two vapor-phase granulated activated carbon (GAC) units in series before discharge to the atmosphere; however, another form of treatment may be found economically preferable. An air permit would be required for the SVE system. Also, an assumed 15 years of treatment would be required as contaminated groundwater flows toward the residences. O&M of the system would include weekly air monitoring to assure attainment of discharge standards associated with an air quality permit.

A pilot scale test should be considered to better determine AS/SVE design parameters including the ROI of the AS and SVE wells, stripping effectiveness based on site geology, vapor capture effectiveness, and likely influent concentrations. These tests would also allow for refinement of costs. The assumptions made for the purposes of this CAP and costing are detailed in Appendix C.

SSD systems, ICs, groundwater and indoor air monitoring, and MNA are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. In addition to the AS/SVE treatment, MNA be relied on to decrease residual PCE concentrations below the remediation standard. For cost estimating purposes it was assumed that groundwater monitoring would be necessary for 20 years. Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed at 3 years).

More specific assumptions made for costing the alternatives are listed in Appendix C.

Overall Protection of Human Health

Alternative 4 protects human health and the environment because PCE that poses an unacceptable risk to human health would be removed from groundwater and treated. AS/SVE would reduce concentrations of PCE in groundwater to below the preliminary remediation standards. While the level of contaminants decrease in groundwater (occurring fairly quickly in the residential area), residents would be protected from the risk of PCE in indoor air by the previously installed SSD systems, which would be operated until groundwater concentrations decrease to levels protective of indoor air.

Long-Term Effectiveness and Permanence

PCE would be removed from groundwater, captured from the air stream, and treated if GAC would be utilized, or just treated if another form of treatment would be selected. Groundwater monitoring would be conducted to determine that the concentrations of VOCs are reduced to below the preliminary remediation standards and would not pose a long-term risk to human health. Air monitoring of the SVE treatment system discharge would be conducted to ensure PCE would not be released at unacceptable levels to the atmosphere. No long-term activities would be required to maintain the effectiveness of this alternative.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes removal of VOCs in groundwater and subsequent treatment. AS/SVE would reduce the toxicity, volume, and mobility of contamination.

Short-Term Effectiveness

Four factors considered as part of the short-term effectiveness criteria are assessed below for Alternative 4:

- Alternative 4 would present minimal risks to the community. Soil gas monitoring should be conducted to verify that the SVE system is capturing soil gas with elevated concentrations of PCE. Drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures.
- On-site workers may be exposed to risks while installing AS and AVE wells, or sampling contaminated groundwater; these risks would be minimized by safety procedures and use of appropriate personal protective equipment. Remediation activities would be carried out under a health and safety program designed to minimize worker exposure.
- Environmental impacts would be minimal.
- The corrective action is estimated to take 20 years. For cost estimating purposes it was assumed that the SSD systems could be turned off after 3 years of AS/SVE operation.

Implementability

Three factors considered as part of the implementability criteria are assessed below for Alternative 4:

- The alternative is considered technically feasible; however there are several considerations. AS/SVE well installation, and groundwater, soil gas, and indoor air monitoring are fairly routine activities. Pilot testing would be required to assess the effectiveness of AS/SVE, the impact of site-specific conditions, and the ROI and well spacing of the AS/SVE wells. Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence sparging and capture. Careful planning should be used when sparging near residences or underground utilities that would provide preferential pathways. Problems with site access or drilling issues could impact the schedule.

- Materials required for implementation of AS/SVE and any additional SSD system installation are readily available. Services for well installation and for groundwater, soil gas, and indoor air monitoring are also readily available.

- The alternative is considered administratively feasible. An air permit for the SVE system would be required. Site-specific testing and groundwater modeling would refine these estimates of remediation time.

Cost

The capital cost of Alternative 4 would be $770,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $5,210,000. The total present value cost for Alternative 4 would be $5,980,000.

State Acceptance

This criterion will be evaluated after comments on this CAP have been received from NDEP.

Community Acceptance

This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.2.6 Alternative 5: Extraction and Treatment, Institutional Controls, Subslab Depressurization Systems, and MNA

Alternative 5 combines groundwater extraction and treatment, ICs, the SSD systems, and MNA. Under this alternative, groundwater would be removed from the subsurface and treated; MNA would be relied on to further reduce concentrations of PCE in groundwater. ICs and SSD systems would protect residents from PCE in indoor air until groundwater is treated to protective levels.

Extraction wells would be applied where practicable at the site, including: at the Property; in streets, public right of ways, and parking lots in the Boulevard Mall; and in streets, public right of ways residential areas. The wells would be screened in the top 20 feet of the shallow aquifer. A number of applicable treatment trains for the extracted groundwater include but are not limited to aqueous GAC units, ultraviolet (UV) oxidation, and air stripping followed by vapor-phase GAC units. For this CAP, it was assumed that GAC would be utilized to treat the extracted groundwater. It was also assumed that TDS in the extracted groundwater would not require treatment and that water could be disposed of through the municipal sewer system. Consideration should be given to use of the water for irrigation purposes. The high TDS may lead to precipitate formation and fouling of the extraction and treatment equipment. An additional step (like a resin bed) may need to be added to the treatment train to remove hardness and reduce precipitation in the treatment system. The assumptions made for the purposes of this CAP and costing are detailed in Appendix C.

Pump and pilot testing would be required to determine the effectiveness of the alternative, aquifer characteristics, design criteria, and the likelihood of precipitate formation. Groundwater modeling should be completed to determine well placement. These tests would also allow for refinement of costs.

SSD systems, ICs, groundwater and indoor air monitoring, and MNA are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. In addition to extraction and treatment, MNA would be relied on to decrease residual PCE concentrations below the remediation standard. For cost estimating purposes it was assumed that groundwater monitoring would be necessary for 20 years. Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed at 10 years).

More specific assumptions made for costing the alternatives are listed in Appendix C.

Overall Protection of Human Health

Alternative 5 protects human health and the environment because groundwater that poses an unacceptable risk to human health would be extracted from the aquifer and treated. Extraction and treatment and MNA would be expected to reduce concentrations of PCE in groundwater to below the preliminary remediation standards. While the level of contaminants decrease in groundwater, residents would be protected from the risk of PCE in indoor air by the previously installed SSD systems, which would be operated until groundwater concentrations decrease to levels protective of indoor air.

Long-Term Effectiveness and Permanence

PCE would be removed with groundwater and treated. Groundwater monitoring would be conducted to determine that the concentrations of VOCs are reduced to below the preliminary remediation standards and would not pose a long-term risk to human health. Besides the implementation and monitoring, no long-term activities would be required to maintain the effectiveness of this alternative.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes removal of VOCs in groundwater and subsequent treatment. It would reduce the toxicity, volume, and mobility of contamination.

Short-Term Effectiveness

Four factors considered as part of the short-term effectiveness criteria are assessed below for Alternative 5:

- Alternative 5 would present minimal risks to the community. Drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures. Groundwater would be extracted from the subsurface and pumped through piping to a treatment area; appropriate security, signs, and warnings could protect the community from accidental contact with the contaminated water.
- On-site workers may be exposed to risks while installing the wells, operating the treatment plant, or sampling contaminated groundwater; these risks would be minimized by safety procedures and use of appropriate personal protective equipment. Remediation activities would be carried out under a health and safety program designed to minimize worker exposure.
- Environmental impacts would be minimal.
- The corrective action is estimated to take 20 years. For cost estimating purposes it was assumed that the SSD systems could be turned off after 15 years of operation. Site-specific testing and groundwater modeling would refine these estimates of remediation time.

Implementability

Three factors considered as part of the implementability criteria are assessed below for Alternative 5:

- The alternative is considered technically feasible. Well installation, treatment of PCE-contaminated water, and groundwater and indoor air monitoring are fairly routine activities. Pilot and pump testing and subsequent groundwater modeling would be required to assess site-specific conditions and determine spacing of the extraction wells. Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence hydraulic capture. The high TDS may lead to precipitate formation and fouling of the extraction and treatment equipment, which can be costly. It was assumed that TDS would not be removed from the treated groundwater; if TDS removal is required, reverse osmosis (RO) is one of the few treatments available. RO is expensive and would produce brine that would require costly disposal. Problems with site access or drilling issues could impact the schedule.

- Materials required for implementation of the extraction and treatment system and for any additional SSD system installation are readily available. Services for well installation and for groundwater and indoor air monitoring are also readily available.

- The alternative is considered administratively feasible. A National Pollutant Discharge Elimination System (NDPES) permit for the groundwater treatment system would be required.

Cost

The capital cost of Alternative 5 would be $2,120,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $7,070,000. The total present value cost for Alternative 5 would be $9,190,000.

State Acceptance

This criterion will be evaluated after comments on this CAP have been received from NDEP.

Community Acceptance

This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.2.7 Alternative 6: In Situ Enhanced Bioremediation, Institutional Controls, Subslab Depressurization Systems, and MNA

Alternative 6 combines enhanced in situ bioremediation, ICs, the SSD systems, and MNA. Under this alternative, enhanced bioremediation would be utilized in the plume hotspot and upgradient of the residential area to treat groundwater as it flows into the residential area. ICs and SSDs would protect residents from PCE in indoor air until groundwater is treated to protective levels. MNA would be relied on to further decrease concentrations of remaining contamination found in groundwater.

Enhanced bioremediation would be applied through injection of substrates or microbes in the plume hot spot where practicable, including at the Property and in streets, public right of ways, and parking lots in the Boulevard Mall. For the purposes of this CAP, it is assumed that biostimulation would be adequate; however, biostimulation in conjunction with bioaugmentation may be required given the lack of degradation occurring in the aquifer (bench-scale testing would determine the level of enhancement required). Biostimulation would also be conducted upgradient of the residences in the Boulevard Mall's eastern parking lot. It was assumed that vegetable oil would be injected into the top 20 feet of aquifer at the site. The assumptions made for the purposes of this CAP and costing are detailed in Appendix C.

Bench-scale testing would be required to determine the technology's effectiveness, including substrate requirements, need for bioaugmentation, dosing rates, and potential geochemical interference at the Site. The high sulfate concentration found at the site would increase the amount of substrate required. If bench-scale testing is successful, pilot studies would be conducted in the area before full-scale implementation to establish the effective dosage rates, ROI, the optimal well spacing, breakdown products, and potential for degradation to stall. These tests would also allow for refinement of costs. The bench-scale and pilot studies would also evaluate any potential increase in TDS or loss of permeability in the subsurface. It should be noted that hydrogen release compound (HRC) (lactic acid), a form of biostimulant utilized for anaerobic degradation, has been ineffective in the Las Vegas area due to high sulfate concentrations (NDEP 2009).

SSD systems, ICs, groundwater and indoor air monitoring, and MNA are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. In conjunction with bioremediation, MNA would be relied on to decrease residual PCE concentrations below the remediation standard. For cost estimating purposes it was assumed that groundwater monitoring would be necessary for 10 years. Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed at 3 years).

More specific assumptions made for costing the alternatives are listed in Appendix C.

Overall Protection of Human Health

Alternative 6 protects human health and the environment because groundwater that poses an unacceptable risk to human health would be treated through enhanced bioremediation. Biodegradation would reduce concentrations of PCE in groundwater to below the preliminary remediation standards. While the level of contaminants decrease in groundwater, residents would be protected from the risk of PCE in indoor air by the previously installed SSD systems, which would be operated until groundwater concentrations decrease to levels protective of indoor air.

Long-Term Effectiveness and Permanence

PCE in groundwater would be permanently treated in situ. Groundwater monitoring would be conducted to determine that the concentrations of VOCs are reduced to below the preliminary remediation standards and would not pose a long-term risk to human health. No long-term activities would be required to maintain the effectiveness of this alternative.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes treatment of the VOCs in groundwater. Enhanced bioremediation would reduce the toxicity and volume of contamination in the groundwater.

Short-Term Effectiveness

Four factors considered as part of the short-term effectiveness criteria are assessed below for Alternative 6:

- Alternative 6 would present minimal risks to the community because the corrective action would be applied in situ. Drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures. Initially, concentrations of PCE breakdown products would increase as microbial degradation occurs. Proper design would minimize the likelihood of the degradation stalling before complete breakdown of the compounds.
- On-site workers may be exposed to risks while installing injection or monitoring wells, handling the substrate for injection, or sampling contaminated groundwater; these risks would be minimized by proper handling and housekeeping and use of appropriate personal protective equipment. Remediation activities would be carried out under a health and safety program designed to minimize worker exposure.
- Environmental impacts in the injection areas would be minimal because the remediation is in situ. However, the biostimulation may increase TDS in the aquifer. Site-specific testing and groundwater modeling would refine these estimates of remediation time.
- The corrective action is estimated to take 10 years with two injections in the plume hotspot and three injection rounds upgradient of the residences. For cost estimating purposes it was assumed that the SSD systems could be turned off after 3 years.

Implementability

Three factors considered as part of the implementability criteria are assessed below for Alternative 6:

- The alternative is considered technically feasible; however there are several considerations. Well installation, injection, groundwater and indoor air monitoring, and installation of SSD systems are fairly routine activities. Bench-scale and pilot testing would be required to assess the effectiveness of the treatment technologies, need for bioaugmentation, and impact of site-specific conditions on the dosage, the ROI, and well spacing. Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence the injection. High sulfates may be problematic and require additional substrate. Potential transformation of chemicals and residual breakdown products would be monitored during the pilot study and may affect implementability and effectiveness of the alterative. Problems with site access or drilling issues could impact the schedule.

- Materials required for implementation of enhanced bioremediation and any additional SSD system installation are readily available. Services for well installation, injection, groundwater and indoor air monitoring, and SSD system installation are also readily available.

- The alternative is considered administratively feasible. A permit for injection of the substrates or microbes would be required.

Cost

The capital cost of Alternative 6 would be $1,190,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $5,850,000. The total present value cost for Alternative 6 would be $7,040,000.

State Acceptance

This criterion will be evaluated after comments on this CAP have been received from NDEP.

Community Acceptance

This criterion will be evaluated after comments on the proposed plan have been received from the community. Community comments and concerns will be considered before final decisions are made on the corrective actions.

8.3 Comparison of Corrective Action Alternatives

This section compares the groundwater corrective action alternatives using the seven criteria to assess relative performances of the alternatives. State and community acceptance will be evaluated after comments on this CAP have been received from NDEP and comments on the proposed plan have been received from the community. The preferred alternative for soil and groundwater will be selected in the proposed plan after:

- Data gaps are filled.
- The risk assessment is complete.
- The CAP is finalized.
- Bench- and pilot-scale testing have been completed.
- A corrective action alternative is recommended in the Corrective Action Report.

Table 8-1 presents a comparative summary of the alternatives and evaluation criteria.

TABLE 8-1

COMPARISON OF ALTERNATIVES SUMMARY

Alternative	Description	Overall Protection of Human Health	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Cost	State Acceptance	Community Acceptance
1	No Action	Low − The no action alternative is not protective of human health.	Low − The no action alternative is not effective in preventing exposure to soil above the PCAG.	Low − The no action alternative does not reduce the toxicity, mobility, or volume of contaminants.	Low - Minimal risk to the residents as there is no implementation. It is assumed monitoring would be required for 30 years.	Easy − This alternative is technically implementable,	Capital Costs: None O&M Costs: $xxx,xxx	Low − The no action alternative would likely be unacceptable to NDEP and the community.	Low − The no action alternative would likely be unacceptable to the community.
2A	In Situ Chemical Treatment of Hotspots and Residential Area, Institutional Controls, SSD Systems, and MNA	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by in situ chemical treatment. Treatment would rapidly decrease concentrations in the plume hotspot and in the residential area.	High − PCE will be destroyed through in situ chemical treatment. Several injections of chemical are likely.	High − The toxicity and volume of contaminants would be reduced through chemical treatment.	High − Minimal risk as the corrective action is applied in situ. Precautions can be taken to prevent exposure of workers and the community during implementation. Environmental impacts are expected to be low; however, this alternative may increase TDS in the aquifer. It is assumed the remediation goal would be reached in approximately 10 years.	Moderately Difficult − This alternative is considered technically feasible, and materials required are readily available. A bench-scale and pilot test should be conducted to better determine efficacy, geochemical interferences, and design parameters. The higher flow rate in sand and gravel channels may cause problems. This alternative is administratively feasible. An underground injection permit would be required for chemical application.	Capital Costs: $xxx,xxx O&M Costs: $xxx,xxx Total: $xxx,xxx	This criterion would be evaluated after comments on this CAP have been received from NDEP.	This criterion would be evaluated after comments on the proposed plan have been received from the community.
2B	In Situ Chemical Treatment, Institutional Controls, SSD Systems, and MNA	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by in situ chemical treatment. Treatment would rapidly decrease concentrations in the plume.	High − PCE will be destroyed through in situ chemical treatment. Several injections of chemical are likely.	High − The toxicity and volume of contaminants would be reduced through chemical treatment.	High − Minimal risk as the corrective action is applied in situ. Precautions can be taken to prevent exposure of workers and the community during implementation. Environmental impacts are expected to be low; however this alternative may increase TDS in the aquifer. It is assumed the remediation goal would be reached in approximately 2 years.	Moderately Difficult − This alternative is considered technically feasible, and materials required are readily available. A bench-scale and pilot test should be conducted to better determine efficacy, geochemical interferences, and design parameters. The higher flow rate in sand and gravel channels may cause problems. This alternative is administratively feasible. An underground injection permit would be required for chemical application.	Capital Costs: $xxx,xxx O&M Costs: $xxx,xxx Total: $xxx,xxx	This criterion would be evaluated after comments on this CAP have been received from NDEP.	This criterion would be evaluated after comments on the proposed plan have been received from the community.
3	Permeable Reactive Barrier, ICs, SSD, Systems, and MNA	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by reductive dechlorination. Treatment would rapidly decrease concentrations in the residential area.	High − PCE will be destroyed through reductive dechlorination. Once installed, the PRB should last for the lifetime of the project.	High − The toxicity and volume of contaminants would be reduced through reductive dechlorination.	High − Minimal risk as the corrective action is applied in situ. Precautions can be taken to prevent exposure of workers and the community during implementation. Environmental impacts are expected to be low; however this alternative may increase TDS in the aquifer. It is assumed the remediation goal would be reached in approximately 20 years.	Moderately Difficult to Difficult − This alternative is considered technically feasible, and materials required are readily available. The depth to groundwater makes conventional trenching more challenging. A bench-scale and pilot test should be conducted to better determine efficacy, geochemical interferences, precipitate formation, and design parameters. The high TDS may lead to precipitate formation. This alternative is administratively feasible. A permit may be required if the PRB is injected.	Capital Costs: $xxx,xxx O&M Costs: $xxx,xxx Total: $xxx,xxx	This criterion would be evaluated after comments on this CAP have been received from NDEP.	This criterion would be evaluated after comments on the proposed plan have been received from the community.

TABLE 8-1

COMPARISON OF ALTERNATIVES SUMMARY (CONTINUED)

Alternative	Description	Overall Protection of Human Health	Long-Term Effectiveness and Permanence	Reduction in Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Cost	State Acceptance	Community Acceptance
4	AS/SVE ICs, SSD Systems, and MNA	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by chemical treatment. Treatment would rapidly decrease concentrations in the residential area.	Moderate to High − PCE will be removed through AS/SVE. AS/SVE systems tend to be O&M intensive. Air from the SVE will require treatment to remove PCE.	High − The toxicity, volume, and possibly mobility of contaminants would be reduced through removal and treatment .	Moderate to High − Air contaminated with PCE would be brought above ground; however, precautions can be taken to prevent exposure of workers and the community during implementation. Design would need to ensure PCE vapors are captured and do not enter the residential area. Environmental impacts are expected to be low. It is assumed the remediation goal would be reached in approximately 20 years.	Moderately Difficult − This alternative is considered technically feasible, and materials required are readily available. A pilot test should be conducted to better determine design parameters and ensure PCE vapor capture by the SVE system. This alternative is administratively feasible. An air quality permit would be required.	Capital Costs: $xxx,xxx O&M Costs: $xxx,xxx Total: $xxx,xxx	This criterion would be evaluated after comments on this CAP have been received from NDEP.	This criterion would be evaluated after comments on the proposed plan have been received from the community. (It should be noted that AS/SVE systems tend to create noise, which may be objectionable to some residents.)
5	Extraction and Treatment, ICs, SSD Systems, and MNA	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by extraction and treatment. Treatment would decrease concentrations in the plume over time.	Moderate to High − PCE will be removed from the aquifer. Extraction and treatment tends to require an extended timeframe to remove contaminants.	High − The toxicity, volume, and mobility of contaminants would be reduced through removal and treatment.	High − Groundwater contaminated with PCE would be brought above ground; however, precautions can be taken to prevent exposure of workers and the community during implementation. Environmental impacts are expected to be low. It is assumed the remediation goal would be reached in approximately 20 years.	Moderately Difficult to Difficult − This alternative is considered technically feasible, and materials required are readily available. Groundwater capture can be challenging and the aquifer may dewater in areas with a tight formation; groundwater modeling would be required. The high TDS may lead to fouling of the extraction and treatment equipment. Pump and soil tests should be conducted to better determine effectiveness, well placement, and design parameters. Discharge of water with TDS may also be an issue. This alternative is administratively feasible. A NPDES permit would be required.	Capital Costs: $xxx,xxx O&M Costs: $xxx,xxx Total: $xxx,xxx	This criterion would be evaluated after comments on this CAP have been received from NDEP.	This criterion would be evaluated after comments on the proposed plan have been received from the community.
6	In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by bioremediation. Treatment would decrease concentrations in the plume hotspot and in the residential area.	High − PCE will be destroyed through microbial degradation. Multiple injections of microorganisms (bioaugmentation) or substrates (biostimulation) may be required.	The toxicity and volume of contaminants would be reduced through microbial degradation.	High − Precautions can be taken to prevent exposure of workers and the community during implementation. Concentrations of PCE breakdown products would initially increase. Environmental impacts are expected to be low; however this alternative may increase TDS in the aquifer. It is assumed the remediation goal would be reached in approximately 10 years.	Moderately Difficult to Difficult − This alternative is considered technically feasible. Bioremediation can be more sensitive to environmental conditions than other technologies. Materials required are readily available. A bench-scale and pilot test should be conducted to determine the effectiveness of the microbial degradation process, geochemical interferences, and design parameters. The high sulfate conditions at the site may be an issue. This alternative is administratively feasible. An underground injection permit would be required for substrate and/or microbe application.	Capital Costs: $xxx,xxx O&M Costs: $xxx,xxx Total: $xxx,xxx	This criterion would be evaluated after comments on this CAP have been received from NDEP.	This criterion would be evaluated after comments on the proposed plan have been received from the community.

Notes:

AS Air sparge
GAC Granular activated carbon
NDEP Nevada Department of Environmental Protection
O&M Operation and maintenance
PRB Permeable reactive barrier
SVE Soil vapor extraction
TDS Total dissolved solids
CAP Corrective action plan
MNA Monitored natural attenuation
NPDES National Pollutant Discharge Elimination System
PCE Tetrachloroethene
SSD Subslab Depressurization

9.0 RECOMMENDATIONS

The comparison of Corrective Action Alternatives suggests that Alternatives 2A, 3, 4, and 6 have the greatest potential to satisfy CAOs and abate PCE concentrations in groundwater, soil vapor, and indoor air. However, it is clear that Site conditions and environmental characteristics are not well adequately understood, given the current data population, to reliably or confidently perform a baseline risk assessment, groundwater modeling, and select a final Corrective Action Alternative. An effort to comprehensively fill data gaps and simultaneously obtain an inventory of representative environmental samples for subsequent or coincident bench-scale testing must be executed as a priority in advance of scaled pilot testing and final remedy selection.

9.1 Additional Data Needs

This section identifies additional data needs and studies required to quantify risks associated with PCE contamination present in shallow groundwater at the Site to support preparation of the Baseline Risk Assessment. Filling these data needs is also essential to refining an approach for cleanup and to support development of the remedial design.

The nature and extent of soil and groundwater contamination that could directly impact residences and other receptors are not clearly defined particularly on the Boulevard Mall, the Golf Course, and in down gradient areas. At present the primary pathways of potential concern relate to the volatilization of PCE in groundwater to soil and ultimately to indoor air in homes and businesses present at the Site. With approval by NDEP, work plans will be developed to conduct the data gap investigations needed to allow the subsequent risk assessment and remedial design.

Based on a review of the historical documents, identified data gaps and additional data collection activities are identified as follows:

- Groundwater production tests have not been performed in the shallow aquifer beneath the Site.
    - Provide the hydraulic data needed to perform predictive modeling to better assess shallow aquifer conditions and assist in the evaluation and design of remedial alternatives.
- Insufficient geologic information is available for much of the Site; the current understanding indicates geology is heterogeneous and consists of a mixture of silt and clay intervals, and poorly sorted sands and gravels. Previous investigations have focused primarily on delineating the nature and extent of contamination in soil and shallow groundwater related to releases from the site. Results from these investigations suggest that geologic conditions are highly variable and may control the nature of exposure pathways and subsequently dictate the design of potential remedies.
    - Soil physical testing needs to be performed to better understand subsurface conditions that control heterogenieties affecting flow dynamics, contaminant transport and vapor migration.
- Insufficient soil gas data are available across the site from above the shallow aquifer. At present only limited soil gas data has been collected using active soil gas sampling methods and temporary probes. The available data are restricted to areas west and east of the majority of residential properties impacted by the shallow PCE plume. Soil gas data are not available from beneath the former APTC facility, the Boulevard Mall, or the Golf Course.

- o Collect additional soil gas data that is needed to provide a better understanding and allow predictive determinations of potential risk created by soil gas. This will include corollary ground water samples.

- o Small gauge nested vapor probes and geologic core samples for physical property testing and air and water permeability testing are needed across the site to further narrow the areas where vapor intrusion is an issue. The factors that control the potential for vapor intrusion to be an issue at the Site will need to be further evaluated so this information can be used to predict when and where application of remedial strategies will be the most effective and where remediation is not necessary.

- o To better predict the potential for vapor intrusion, the distribution of contamination near the interface between the saturated and unsaturated zone will need to be better defined using nested wells. Preliminary results indicate that distributions of PCE contamination may be similar in the top 20 feet of water present in the shallow water zone.

- Soil properties have not been well characterized. Insufficient physical property, flow, and contaminant distribution data have been collected in the unsaturated and saturated zones beneath the Site.

  - o An evaluation of the physical properties controlling contaminant flow is needed to estimate the rates of PCE migration through shallow groundwater and the attenuation of vapors caused by geologic formations. A greater understanding of the physical properties of the subsurface is also needed to support the design of proposed remedial systems.

  - o In addition to standard measurements of porosity, grain size distribution, sorting, organic carbon, and bacterial analyses, various types of flow tests are needed for the evaluation and remedial design processes. These tests would include air permeability and radius of influence tests, as well as water flow and production rate evaluations. Shallow groundwater draw down tests are also needed to evaluate the affects on the PCE plume caused by pumping at the Golf Course.

- The distribution of PCE and associated degradation products in the shallow groundwater have not been well defined in the downgradient area of the golf course.

  - o Collect data from the golf course irrigation well, including pump testing, as required to determine hydraulic conductivity.

  - o Conduct groundwater modeling to understand capture zone and influences of golf course pumping on aquifer conditions.

  - o Groundwater modeling results and related predictive tools are needed to optimize well locations for well installations and flow testing.

  - o Spatial information on the distribution of the plume, particularly in the distal end of the plume will need to be collected.

- Indoor air data is necessary to evaluate current residential conditions and evaluate efficacy of mitigation systems previously installed by NDEP

  - o Indoor air sampling and subslab sampling are needed to verify results from previous investigations and how representative they are of current conditions at the Site and to establish a baseline for monitoring remedial progress.

- o Background sampling of indoor and outdoor air is needed to confirm the reliability of previous results and the representativeness of data to be collected at the Site.

Additional information is also required for the baseline risk assessment in four risk areas denoted for the site including: source (APTC), Boulevard Mall, residential, and golf course. Additional activities per area would include:

- General overall data needs: site-specific soil physical characteristic data (soil fraction organic carbon, etc.), geologic data, background chemical concentration data, and data validation
- Source area: soil gas data, and groundwater data
- Boulevard Mall: soil gas data, indoor air data, and groundwater data
- Residential Area: soil gas data, subslab data, indoor air (homes and schools) data, and groundwater data
- Golf Course: soil gas data, indoor air data (club house and maintenance building), and groundwater data (shallow and irrigation well).
    - o Data quality needs to be verified for existing data and data critical to the project validated on an as needed basis.

9.2 Bench-Scale and Pilot Testing

Section 8, alternatives were assessed for their overall protection of human health; long-term and short-term effectiveness; reduction in toxicity, mobility, and volume through treatment; implementability; and cost. Based on preliminary evaluations of alternatives for the Site, bench-scale or pilot tests should be conducted to evaluate the potential of a corrective action to meet project needs. Currently, the most promising technologies evaluated include chemical treatment, a ZVI PRB, AS/SVE, and enhanced bioremediation. Bench tests for chemical treatment and enhanced bioremediation should be conducted to determine effectiveness and feasibility. A column test simulating treatment by a ZVI PRB should also be conducted. If bench-scale tests are successful, the results should be used to aid in design of pilot studies as needed. A Pilot Study Work Plan will be developed detailing the requirements, objectives, layout, and schedules for the progression of tests to be used for further refining the selected alternative(s) for the Site. The following provides details on bench scale testing and a speculative outline of what some of these pilot tests might include.

In-Situ Chemical Treatment

In situ chemical treatment via oxidation or reduction requires bench-scale testing. In situ chemical oxidation or reduction requires bench-scale testing to determine the stochiometry for the chemical demand for the Site soil and groundwater, and the type of chemical and other additives that are suitable. If bench-scale testing is successful, pilot testing is needed to evaluate the effectiveness of the chemical for remediating the contaminant to acceptable levels, and to obtain data for full-scale implementation evaluation including ROI, degradation byproducts, and persistence in the aquifer. Data from post-pilot test monitoring will assist in determining whether periodic injections would be necessary following rebound.

Chemical Treatment - Zero-Valent Iron

Column bench-scale testing may be performed to evaluate the appropriateness of utilizing ZVI and dosing requirements. Site groundwater would be pumped through a column of ZVI (combined with sand or gravel similar to how it will be applied in the PRB). Samples of influent and effluent water would be collected to evaluate ZVI performance, and flow rates and TDS would be measured to determine if precipitation is occurring. If the bench test shows a reduction of contaminant mass without significant clogging of the ZVI, a pilot test may be considered to evaluate emplacement methods.

Air Sparging and Soil Vapor Extraction

A pilot test would determine the effectiveness of AS and the ability of an SVE system to control the induced vapor plume. The ROIs of the AS and SVE wells would be determined for full-scale implantation. In addition, the test would help predict influent PVE concentrations in order to develop appropriate air treatment strategies.

Enhanced Bioremediation

Two biotreatment approaches will be considered - these include bio-stimulation (the addition of carbon substrates) and bioaugmentation (the addition of specialized microorganisms). Various carbon substrates are available that can be injected into the aquifer including emulsified vegetable oil, CAP-18, or other patentable products. Bench-scale tests would be conducted to determine if biostimulation is feasible at the Site. Specialized microorganism products are also available that may be needed to ensure that degradation occurs or degradation does not stall at *cis*-1,2-DCE stall. Bench testing would determine if the concentrations of Site contaminants, high metals concentrations, or other site conditions (such as low pH or high sulfate) interfere with microbial dechlorination. These tests also would determine if bio-augmentation reduces the time for total destruction of the parent compound (PCE), would determine the kinetics of degradation, and would help estimate dosages and quantities required for a pilot test. If bench-scale testing is successful, pilot testing would be conducted to determine ROI and required injection frequency.

9.3 Path Forward

It is currently unclear how or whether prior schedule or scoping documents developed in collaboration with the NDEP will be relevant to the conceptual path forward anticipated in this document. However, in recognition of an outlined Scope of Work originally dated July 26, 2010, but refined and redistributed by NDEP on October 5, 2010, the perceived process to effectively and efficiently advance corrective action evaluation and implementation is:

Task	Schedule
1. Propose a plan to fill data gaps and conduct bench-scale tests.	December 15, 2010.
2. Fill data gaps, complete bench-scale testing, and conduct the baseline risk assessment.	February 28, 2011.
3. Report results of field sampling, bench-scale tests, and baseline risk assessment.	April 15, 2011.
4. Finalize the CAP for Groundwater.	May 15, 2011.
5. Propose a Draft Groundwater Pilot Study Work Plan.	May 15, 2011.
6. Finalize the Groundwater Pilot Study Work Plan.	Within 30 days of resolving comments with the NDEP.
7. Complete pilot testing; maintain operation, as applicable.	Within 120 days of approved Pilot Study Work Plan.
8. Evaluate corrective actions and propose a remedy in a Corrective Action Report based on the results of both bench-scale and pilot testing.	Within 75 days of completing pilot test(s).

9. Summarize the evaluation process and selected corrective action in the Proposed Plan, and solicit public comment.	To be determined.
10. Prepare and submit a remedial design/remedial action (RD/RA) plan.	To be determined.
11. Upon approval of the RD/RA, implement the corrective action.	To be determined.

Schedule dates are subject to change based on NDEP concurrence and subsequent project developments.

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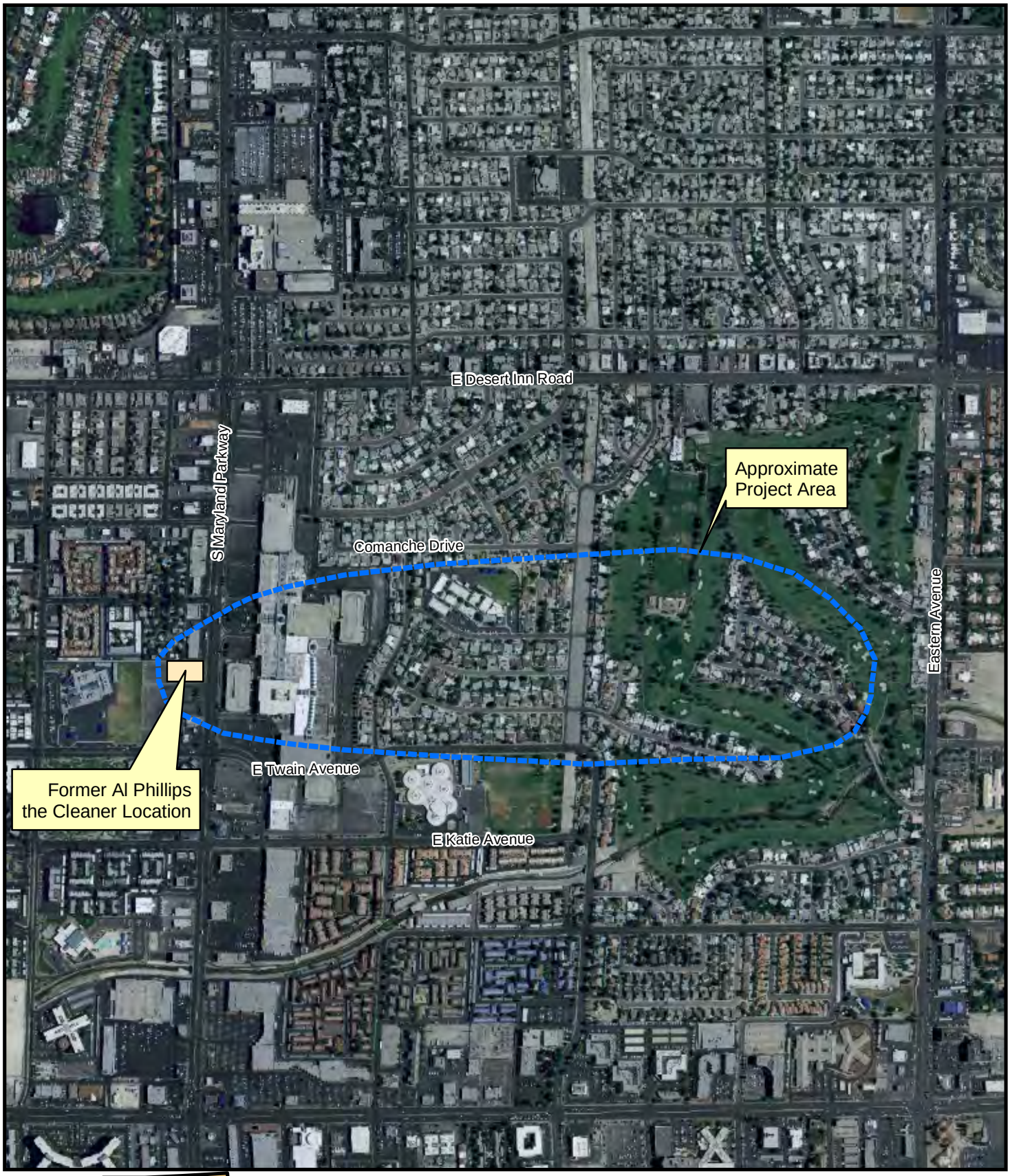
FIGURES



N
W E
S

0 500 1,000 Feet

Approximate Scale in Feet

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, Nevada

FIGURE 1
Site Map

TETRA TECH

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Source: Clark County Assessors Web Site

Scale: 0Feet 200 Feet

N

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 2

Al Philips the Cleaner
Former Facility Location

TETRA TECH

Modified from URS 2007

Legend

- Monitoring Well Location (July 2010)
- Monitoring Well Location (February 2010)
- Monitoring Well Location (November 2009)
- Monitoring Well Location (June 2006)
- 2500 ug/L PCE Contour
- 2000 ug/L PCE Contour
- 1500 ug/L PCE Contour
- 1000 ug/L PCE Contour
- 500 ug/L PCE Contour
- 100 ug/L PCE Contour
- 5 ug/L PCE Contour (Dashed Where Inferred)

ug/L Micrograms Per Liter
NA Not Analyzed
NS Not Sampled
PCE PQL = 0.5 ug/L

N W E S

0 250 500 Feet
Approximate Scale in Feet

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, Nevada

FIGURE 3
PCE CONCENTRATION MAP

TETRA TECH

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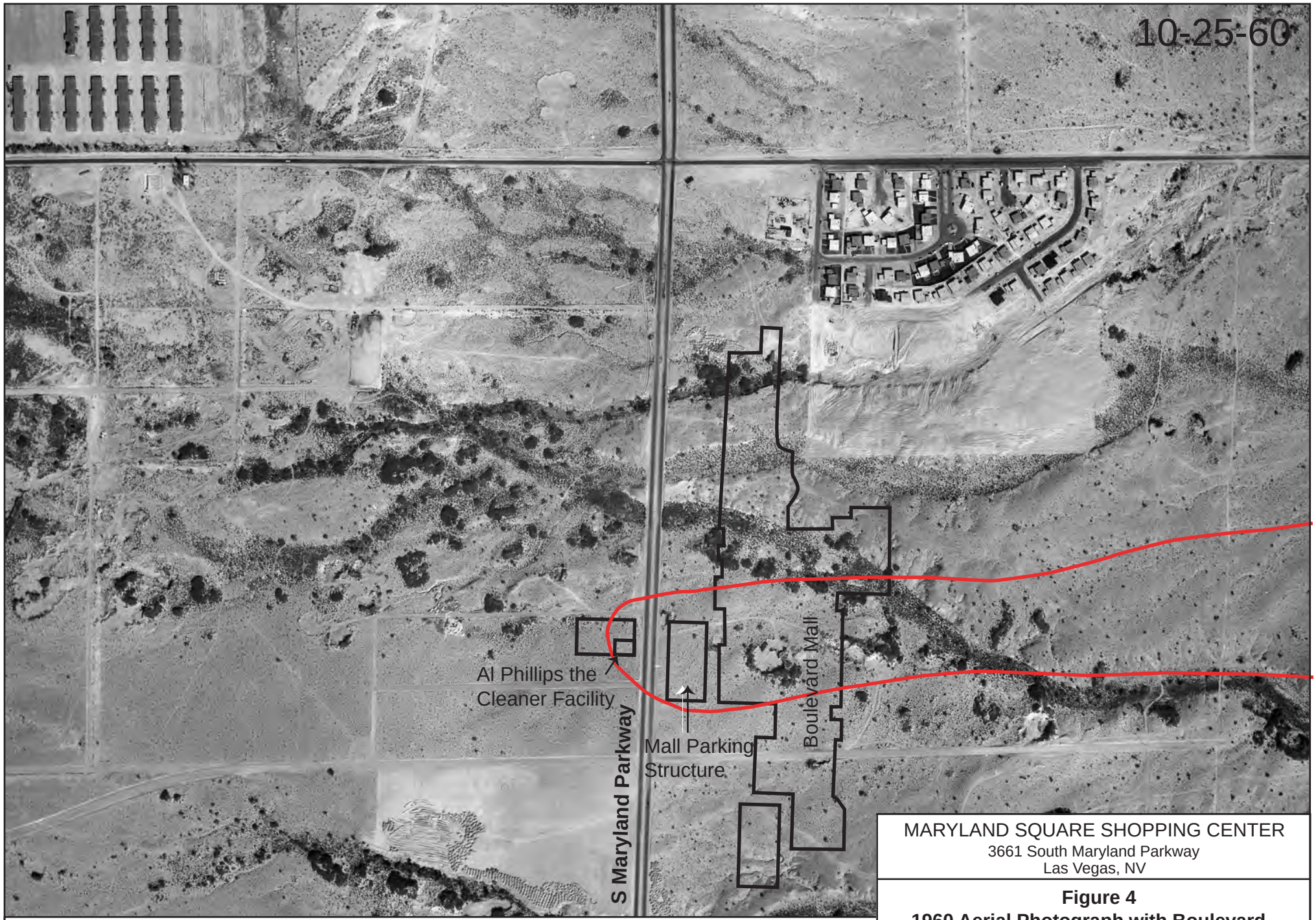


PCE Contour 5 ug/L

PCE Tetrachloroethylene

ug/L Micrograms per Liter

Photograph Courtesy of Cooper Aerial Photo

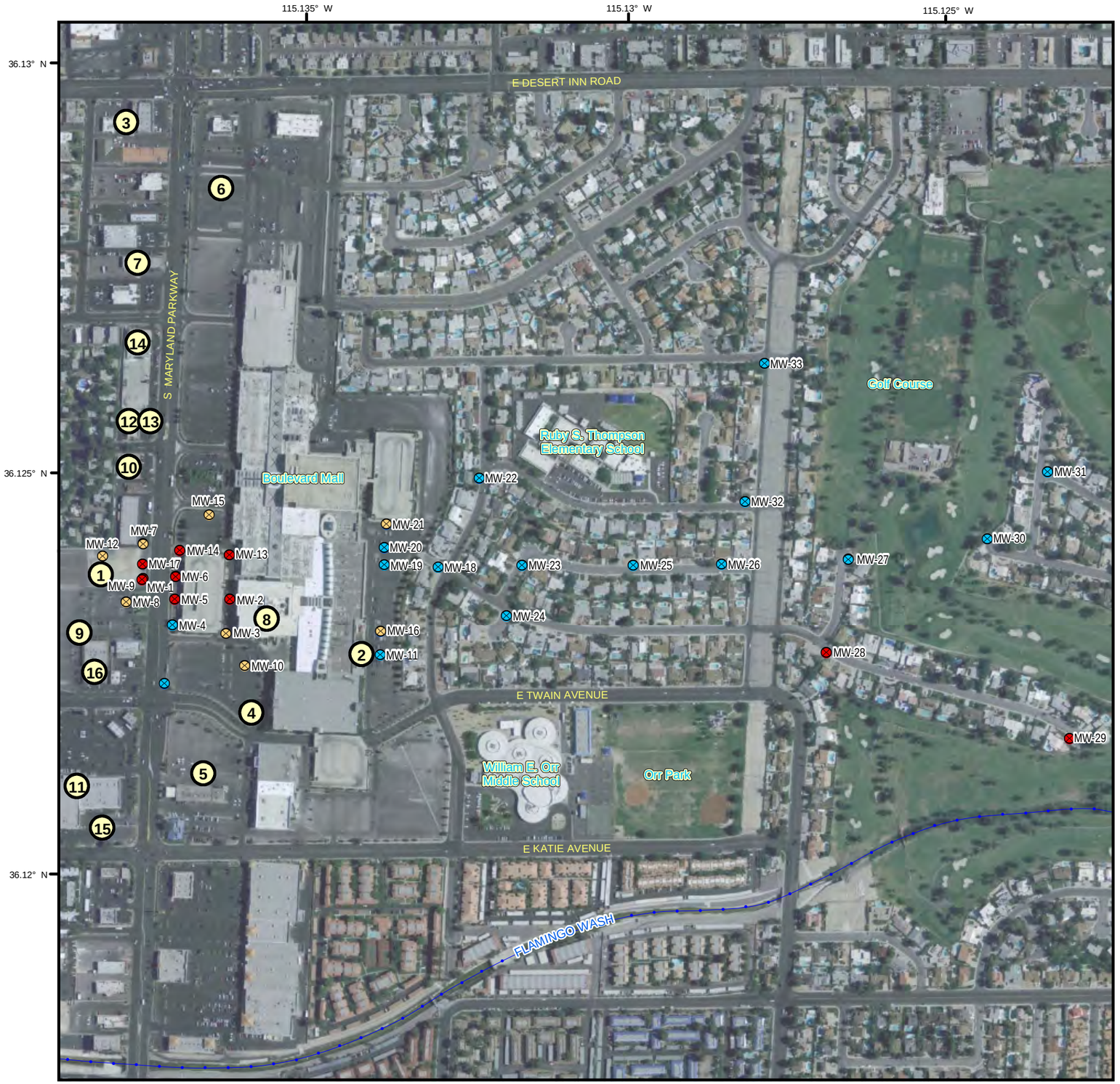
N

0 250 500
Feet

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 4
1960 Aerial Photograph with Boulevard Mall Footprint

TETRA TECH



PRP Name

1. H-000086 - Former MSSC - 3661 S. Maryland Parkway
2. H-000240 - east parking lot of Boulevard Mall site
3. H-000511 - Former Dr. Clean Dry Cleaner - 1195 E. Desert Inn Road
4. H-00600 - Goodyear Auto Center - 3682 S. Maryland Parkway
5. 8-000199 - JCPenny (Former Firestone) - 3770 S. Maryland Parkway
6. 8-000549 - Sears Automotive Center - 3450 S. Maryland Parkway
7. 8-000967 - Superior Tire - 3415 S. Maryland Parkway
8. Fidesta Auto Center - 3634 Maryland Parkway
9. Wonder World South Cleaners - 3651 Maryland Parkway
10. Las Vegas Cleaners and Laundry - 3547 Maryland Parkway
11. Safeway Fuel Facility - 1155 E. Twain Avenue
12. Evans R.E. Shell Service - 3519 Maryland Parkway
13. Prestige Stations Inc. - 5063-3519 Maryland Parkway
14. Stivers Enco Service - 3465 Maryland Parkway
15. Gardner S Lee Chevron Service - 3783 Maryland Parkway
16. Kellys Gulf/7 11 - 3685 Maryland Parkway

Legend

- Monitoring Well Sampled 2nd Quarter 2009
- Monitoring Well Sampled 3rd Quarter 2009
- Monitoring Well Sampled 4th Quarter 2009

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, Nevada

FIGURE 5
Previous or Existing Commercial Operations in Site Vicinity

TETRA TECH

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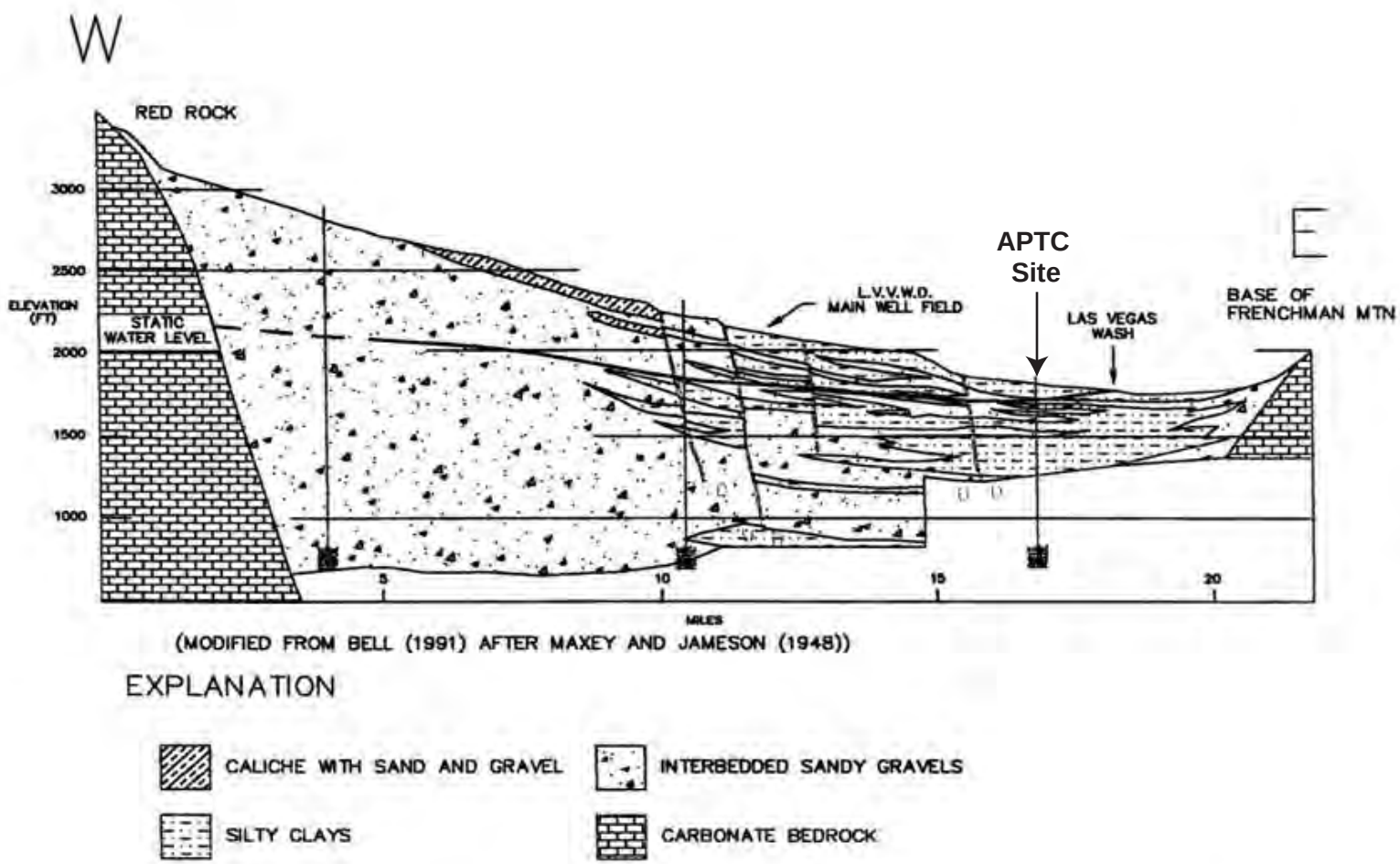
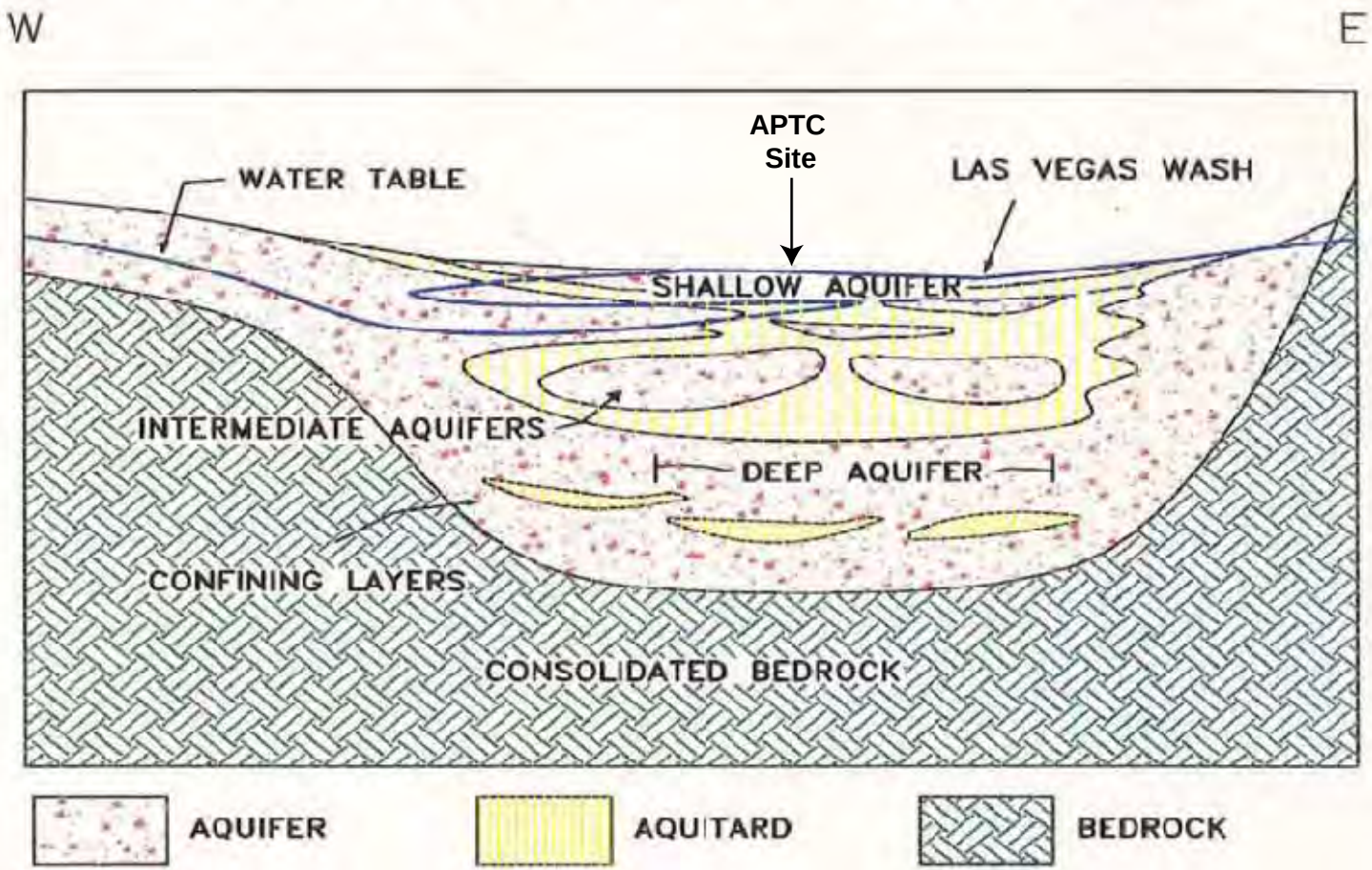


MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 6
Generalized Geologic Cross Section of the Las Vegas Valley

TETRA TECH

Source: http://www.lasvegasgmp.com/html/pubs_tech_papers.html

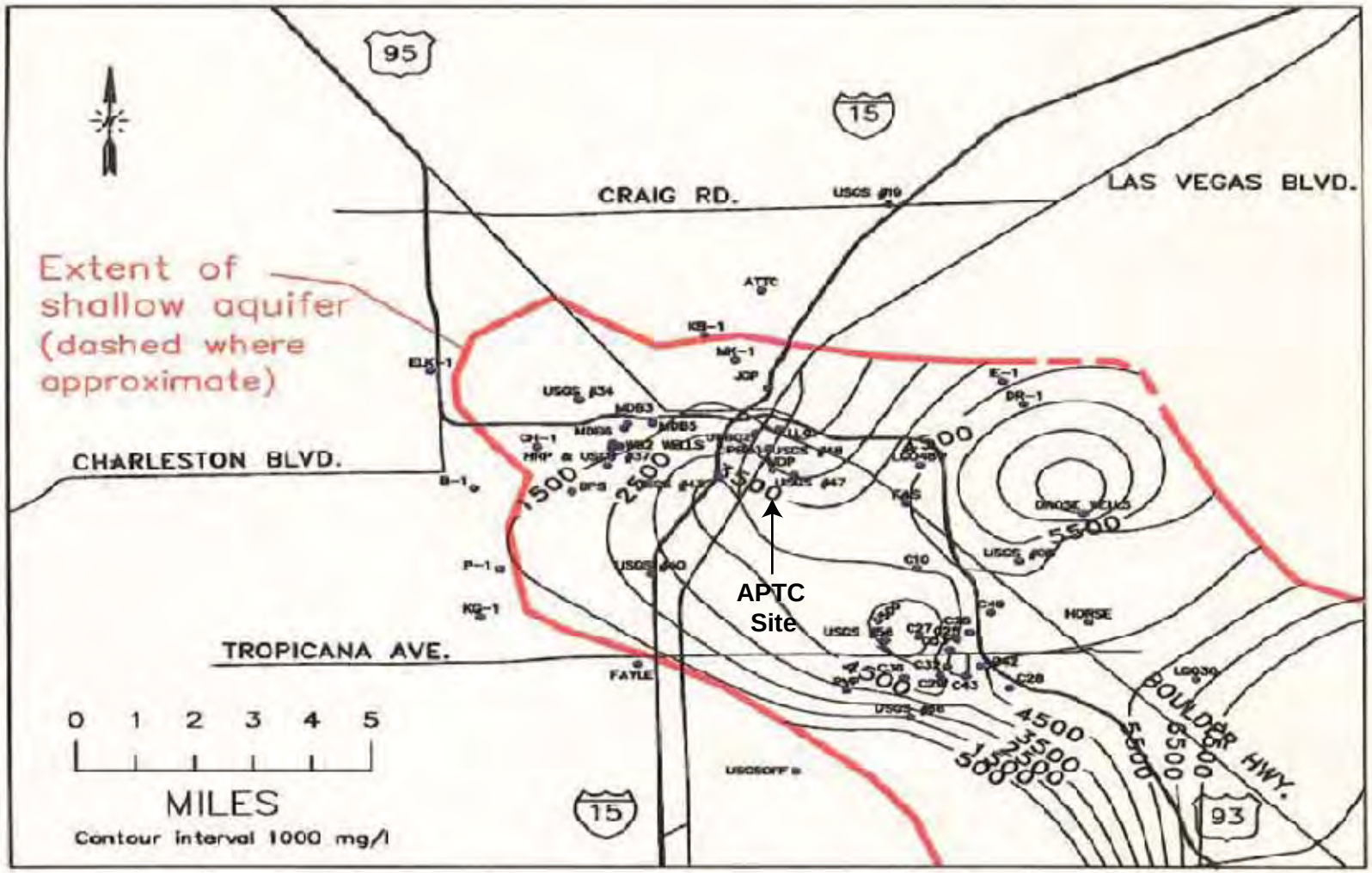


(Modified from Hines et al, 1993)

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 7
Schematic of Aquifer Systems in the Las Vegas Valley

TETRA TECH



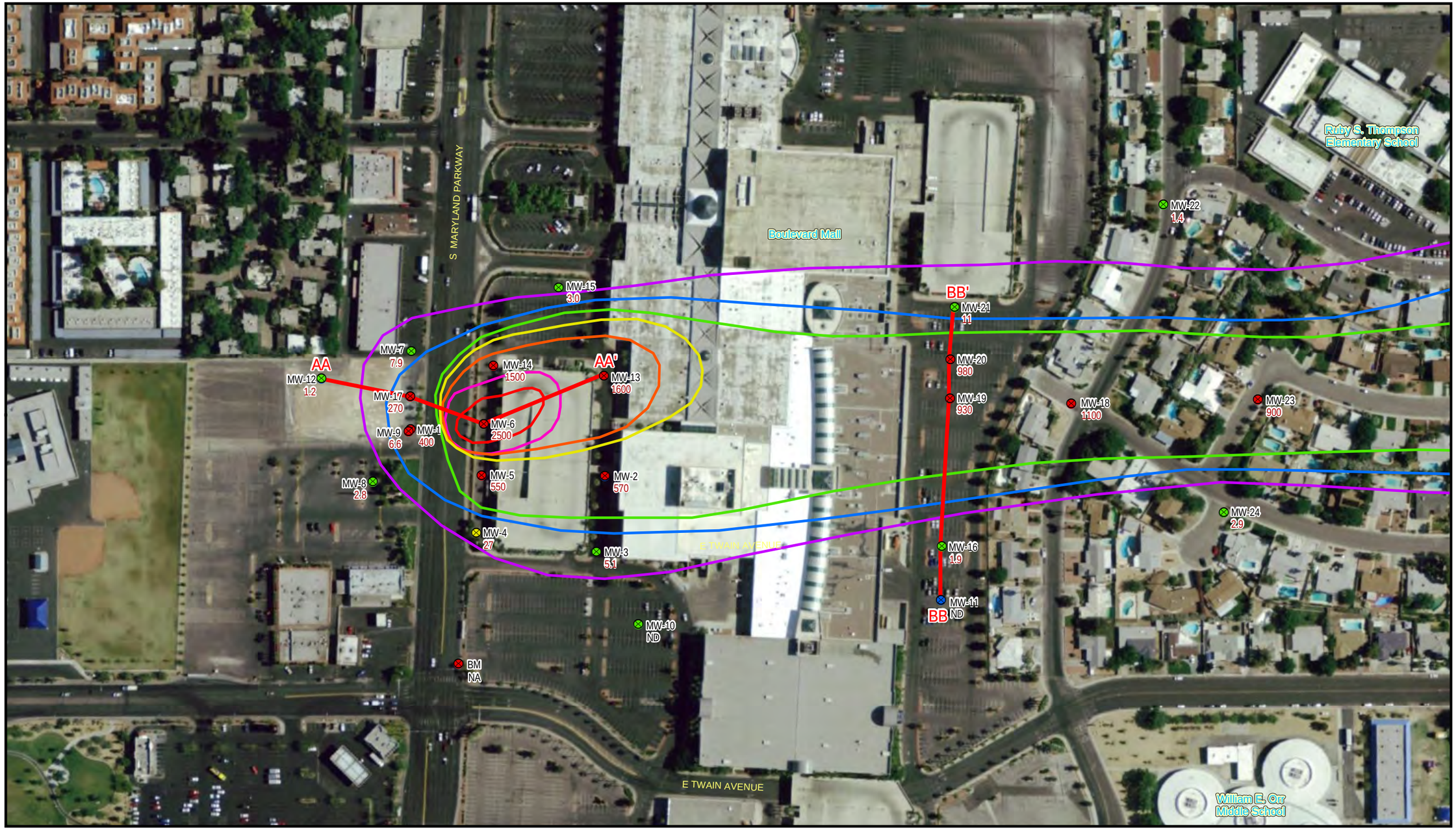
TDS In Shallow Groundwater (After Zikmund,1996)

TDS Total Dissolved Solids

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 8
Total Dissolved Solids in the Shallow Groundwater Aquifer of Las Vegas Valley

TETRA TECH



Legend

- Monitoring Well Location (July 2010)
- Monitoring Well Location (February 2010)
- Monitoring Well Location (November 2009)
- Monitoring Well Location (June 2006)
- 2500 ug/L PCE Contour
- 2000 ug/L PCE Contour
- 1500 ug/L PCE Contour
- 1000 ug/L PCE Contour
- 500 ug/L PCE Contour
- 100 ug/L PCE Contour
- 5 ug/L PCE Contour
- AA — AA' Cross Section Location
- ug/L Micrograms Per Liter
- NA Not Analyzed
- ND Not Detected
- PCE PQL = 0.5 ug/L

PCE Tetrachloroethylene
PQL Practical Quantitation Limit

N W E S

0 100 200 Feet

Approximate Scale in Feet

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, Nevada

FIGURE 9
CROSS SECTIONS AA-AA' & BB-BB'

TETRA TECH

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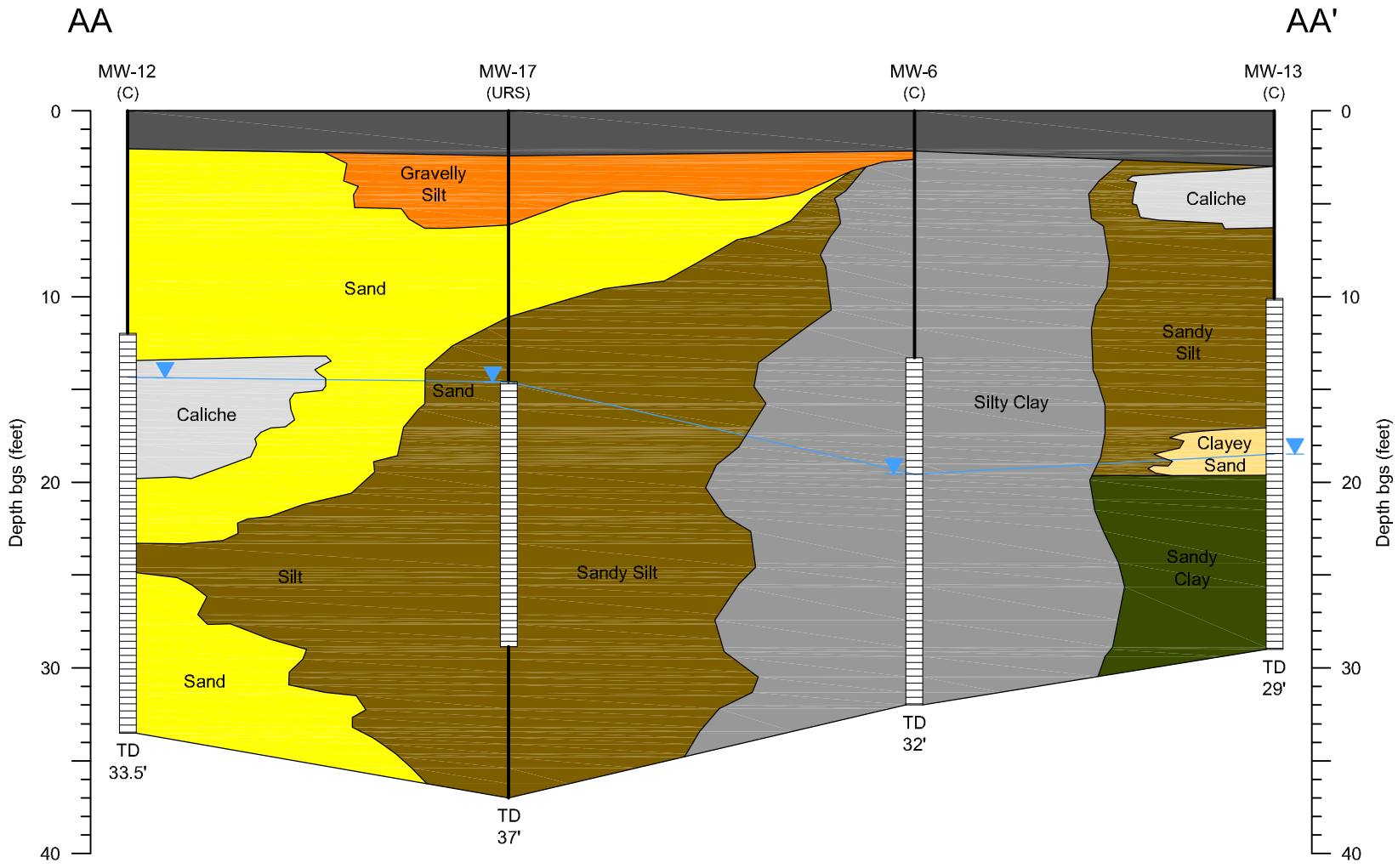


APTC to Boulevard Mall Geologic and Hydrogeologic CSM

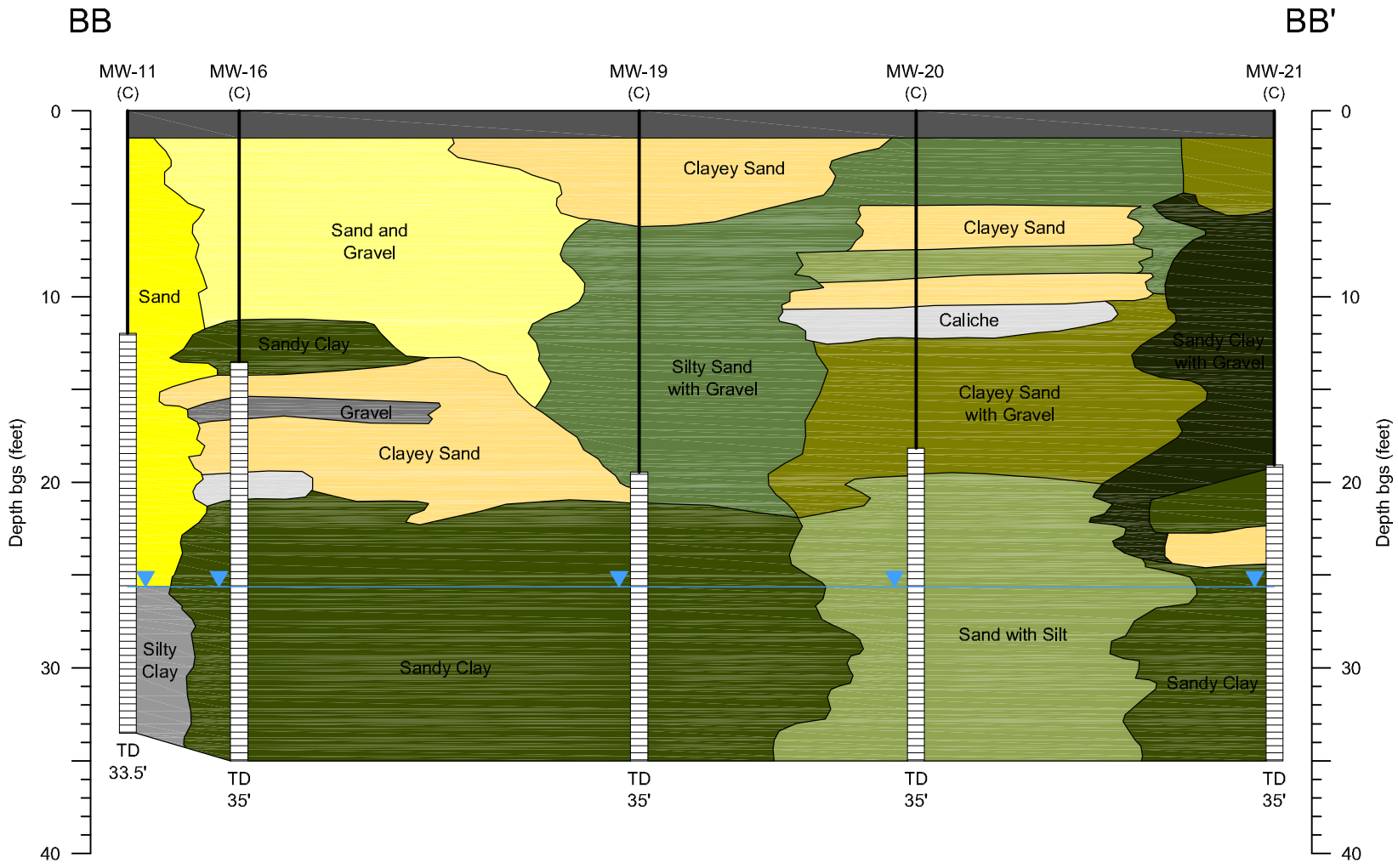
Not to Scale

ASPHALT	SILTY CLAY	TD	TOTAL DEPTH		SCREENED INTERVAL
GRAVELLY SILT	CALICHE	(C)	CONVERSE WELL		WATER LEVEL
FINE SAND TO SAND	CLAYEY SAND	(URS)	URS WELL		GROUNDWATER TABLE
SANDY SILT TO SILT	SANDY CLAY	bgs	BELOW GROUND SURFACE		

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 10
Geologic Cross Section AA - AA'

TETRA TECH



Boulevard Mall East Geologic and Hydrogeologic CSM

Not to Scale

ASPHALT	SILTY SAND WITH GRAVEL	CLAYEY SAND WITH GRAVEL	TD TOTAL DEPTH
GRAVEL	CALICHE	SILTY CLAY	SCREENED INTERVAL
FINE SAND TO SAND	CLAYEY SAND	(C) CONVERSE WELL	WATER LEVEL
SAND AND GRAVEL	SANDY CLAY	bgs BELOW GROUND SURFACE	GROUNDWATER TABLE

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 11
Geologic Cross Section BB - BB'

TETRA TECH

Source: Clark County Assessors Web Site

Scale: 0Feet 200 Feet

N

Legend:

- Monitoring Wells installed by URS
- Monitoring Wells installed by Converse Consulting
- Approximate Location of Soil Vapor Sampling Borehole

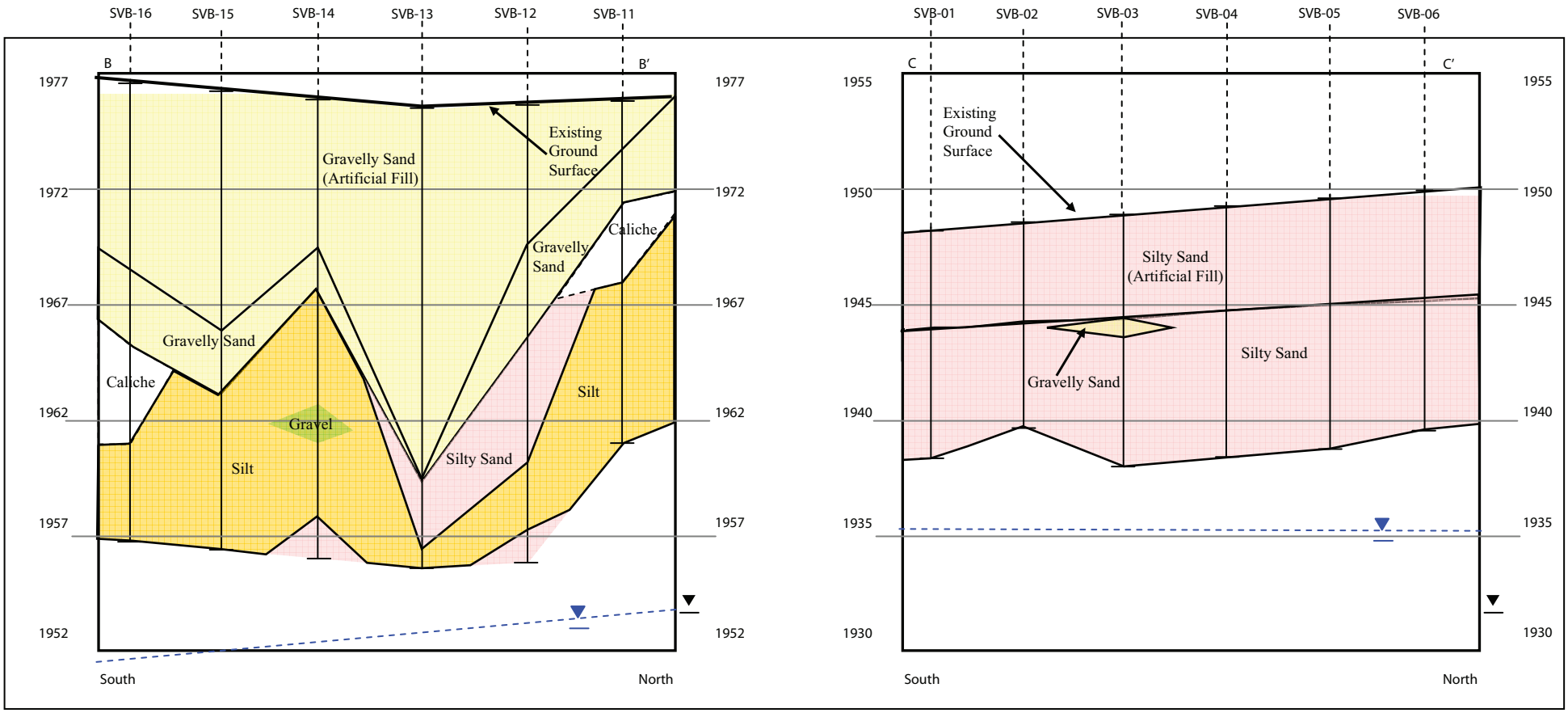
MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 12
Geologic Cross Section Map
A-A', B-B' and C-C'

TETRA TECH

Modified from URS 2007

CROSS SECTIONS B – B′ AND C – C′



Horizontal Scale: 0 — 70 feet

Vertical Scale: 0 — 5 feet

Legend:

Approximate March 2007 Groundwater Surface

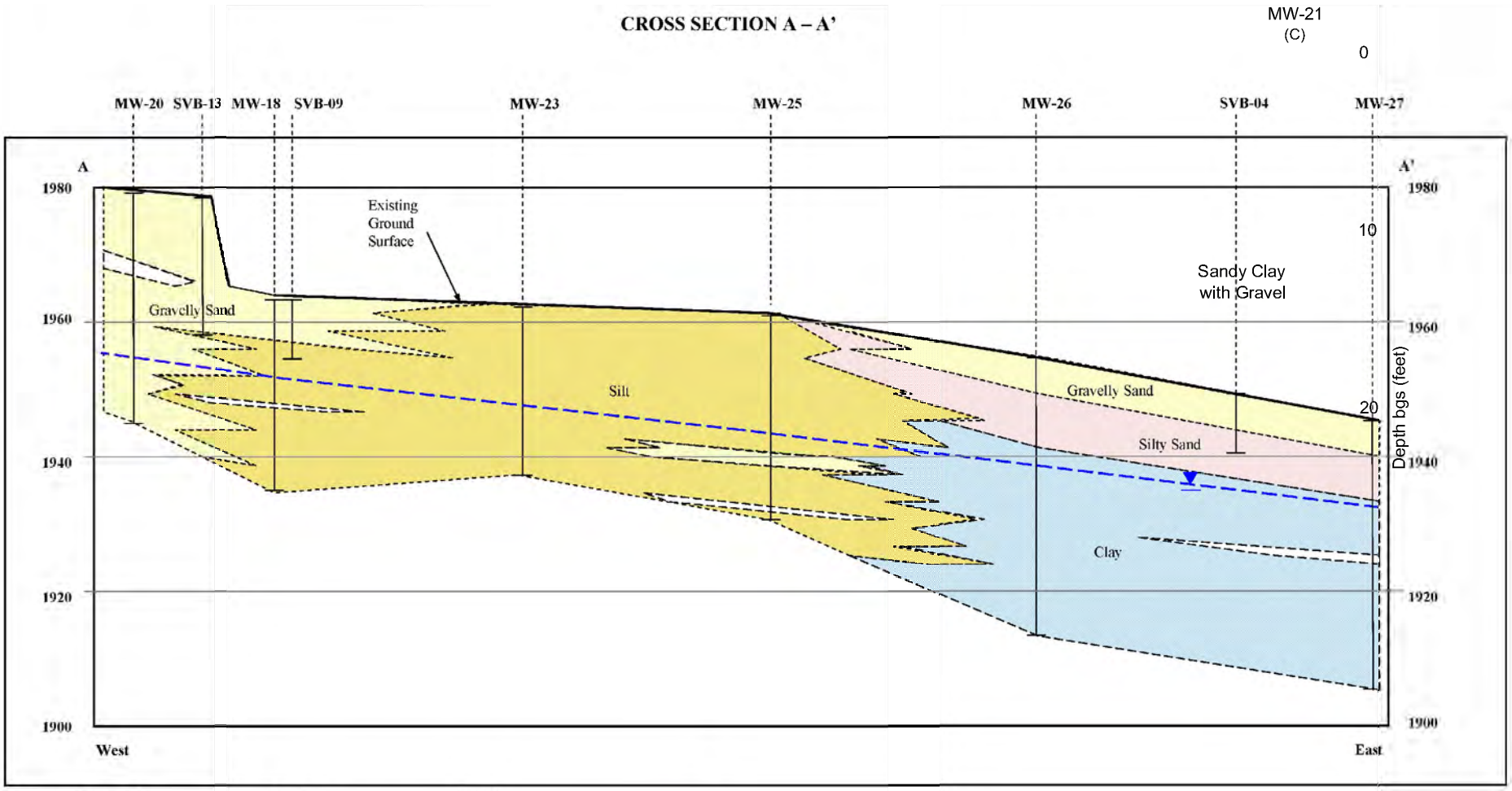
- Gravel
- Gravelly Sand
- Caliche
- Silty Sand
- Silt

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 13
Geologic Cross Section B-B' & C-C'

TETRA TECH

Modified from URS 2007



Horizontal Scale: 0 — 200 feet

Vertical Scale: 0 — 20 feet

Note:

Legend:

Approximate April 2007 Groundwater Surface

- Gravelly Sand
- Caliche
- Silty Sand
- Silt
- Clay

Not to Scale

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 14
Geologic Cross Section A - A'

TETRA TECH

Modified from URS 2007

Legend

- Monitoring Well Location
- Groundwater Elevation Contour (5 ft Intervals)
- Direction of Groundwater Flow
- 1965.46 Groundwater Elevation (ft amsl)
- NM Not Measured

N
W E
S

0 250 500 Feet

Approximate Scale in Feet

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, Nevada

FIGURE 14
Groundwater Potentiometric Map with Contours

TETRA TECH

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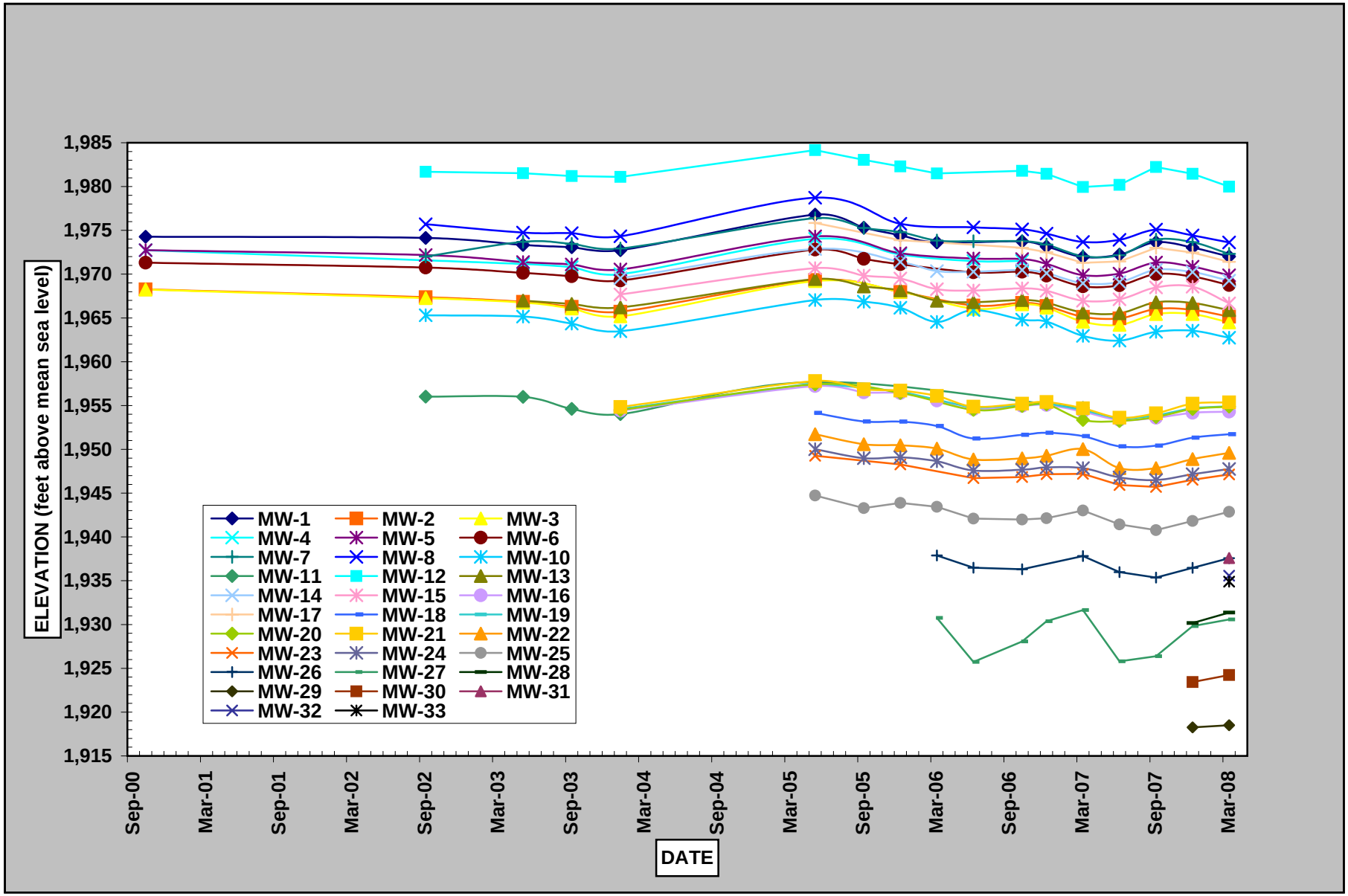
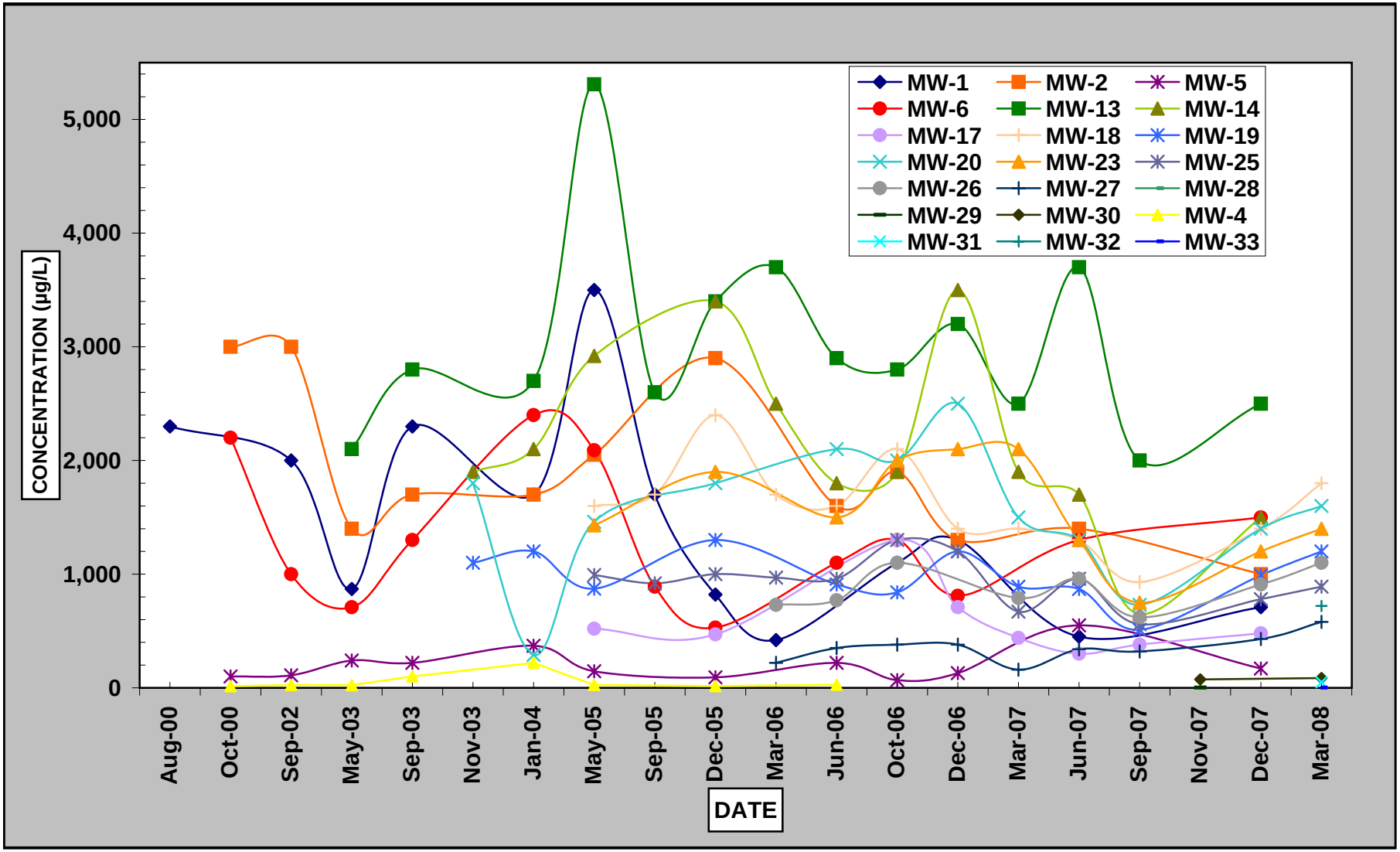


MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 16
Groundwater Elevation Over Time

TETRA TECH

Modified from URS 2008



MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 17
Groundwater PCE Contaminations Over Time

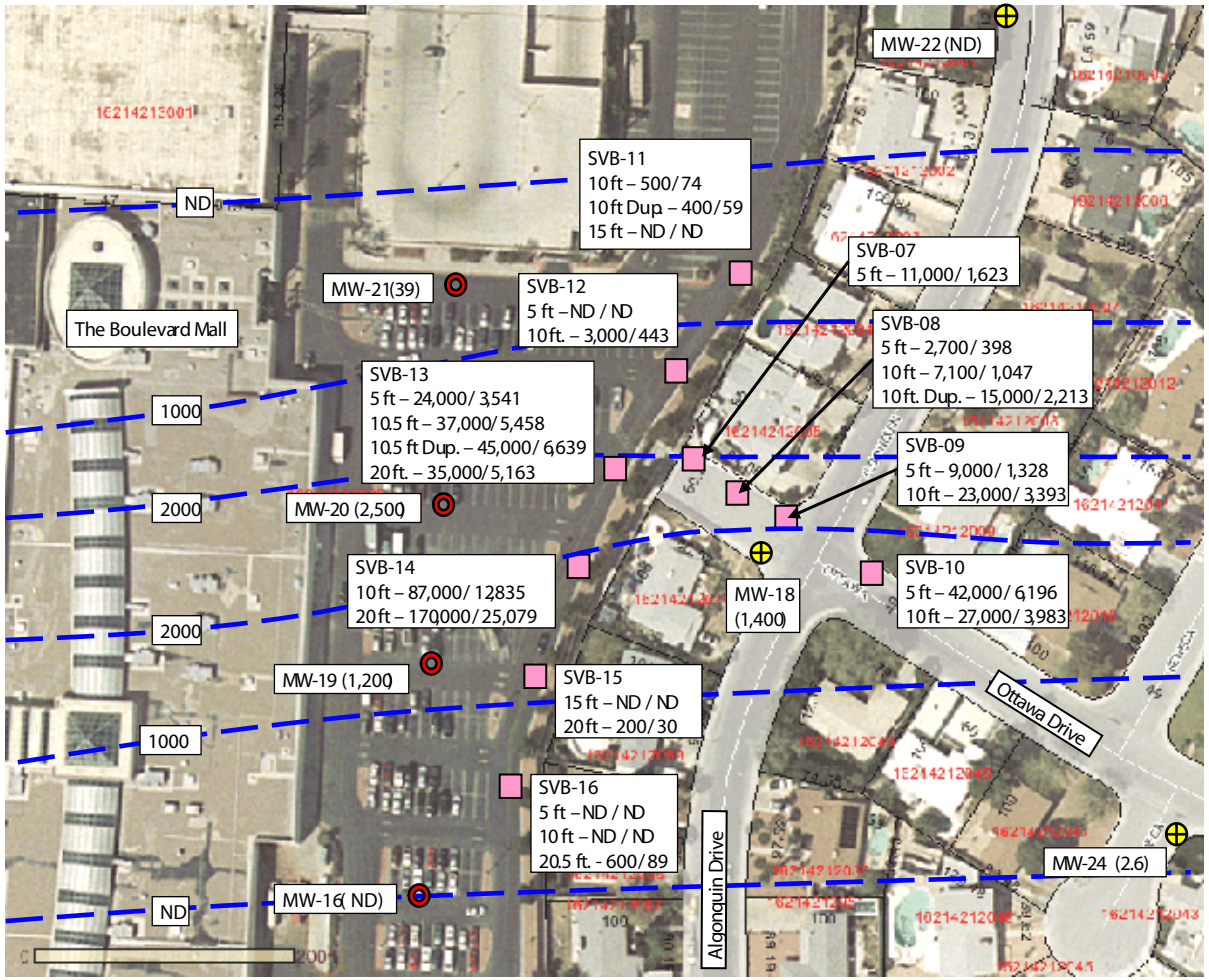
TETRA TECH

Modified from URS 2008

Summary of PCE Soil Vapor Concentrations

Sample Number	Sample Depth [1]	Soil Type	Soil Vapor Concentrations ug/L	ug/m³	ppbv
SVB-07-05	5	Silty Sand (Af)	11	11,000	1,623
SVB-08-05	5	Silty Sand (Af)	2.7	2,700	398
SVB-08-10	10	Silty Sand	7.1	7,100	1,047
SVB-08-910[2]	10	Silty Sand	15	15,000	2,213
SVB-09-05	5	Silty Sand (Af)	9.0	9,000	1,328
SVB-09-10	10	Gravelly Sand	23	23,000	3,393
SVB-10-05	5	Sand	42	42,000	6,196
SVB-10-10	10	Sand	27	27,000	3,983
SVB-11-10	10	Sandy Silt	0.5	500	74
SVB-11-910[2]	10	Sandy Silt	0.4	400	59
SVB-11-15	15	Sandy Silt	ND	ND	ND
SVB-12-05	5	Gravelly Sand (Af)	ND	ND	ND
SVB-12-10	10	Gravelly Sand	3.0	3,000	433
SVB-13-05	5	Gravelly Sand (Af)	24	24,000	3,541
SVB-13-10.5	10.5	Gravelly Sand (Af)	37	37,000	5,458
SVB-13-910.5[2]	10.5	Gravelly Sand (Af)	45	45,000	6,639
SVB-13-20	20	Sandy Silt	35	35,000	5,163
SVB-14-10	10	Silt	87	87,000	12,835
SVB-14-20	20	Silty Sand	170	170,000	25,079
SVB-15-15	15	Silt	ND	ND	ND
SVB-15-20	20	Silt	0.2	200	30
SVB-16-5	5	Gravelly Sand (Af)	ND	ND	ND
SVB-16-10	10	Gravelly Sand	ND	ND	ND
SVB-16-20.5	20.5	Silt	0.6	600	89

Notes: PCE = tetrachloroethene, ND = Analyte not detected at or above the reporting limit, ug/L = Micrograms per liter, ug/m³ = Micrograms per cubic meter, ppbv = Parts per billion by volume, [1] Depth in feet (ft.) below ground surface, [2] Soil samples SVB-08-910, SVB-11-910, and SVB-13-910.5 are duplicates for samples SVB-08-10, SVB-11-10, and SVB-13-10.5 respectively.



Source: Clark County Assessors Web Site

Scale: 0 Feet — 200 Feet

N

Legend:

- Monitoring Wells installed by URS
- Monitoring Wells installed by Converse Consulting
- Approximate Location of Soil Vapor Sampling Borehole
- Approximate Concentration Contour of PCE in Groundwater

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 18
Soil Vapor and Groundwater PCE Results
(Western Residential Area)

TETRA TECH

Modified from URS 2007

Summary of PCE Soil Vapor Concentrations

Sample Number	Sample Depth [1]	Soil Type	Soil Vapor Concentrations ug/L	ug/m^3	ppbv
SVB-01-05	5	Silty Sand (Af)	2.5	2,500	369
SVB-02-04	4	Silty Sand (Af)	3.0	3,000	443
SVB-02-10	10	Silty Sand	ND	ND	ND
SVB-03-05	5	Silty Sand (Af)	46	46,000	6,786
SVB-03-12	12	Silty Sand	0.8	800	118
SVB-04-05	5	Sand (Af)	0.4	400	59
SVB-04-12	12	Silty Sand	1.0	1,000	148
SVB-05-08	8	Silty Sand	25	25,000	3,688
SVB-05-98[2]	8	Silty Sand	17	17,000	2,508
SVB-05-13	13	Silty Sand	1.1	1,100	162
SVB-06-08	8	Silty Sand	ND	ND	ND
SVB-06-12	12	Silty Sand	12	12,000	1,770

Notes:

PCE = tetrachloroethene

ND = Analyte not detected at or above the reporting limit

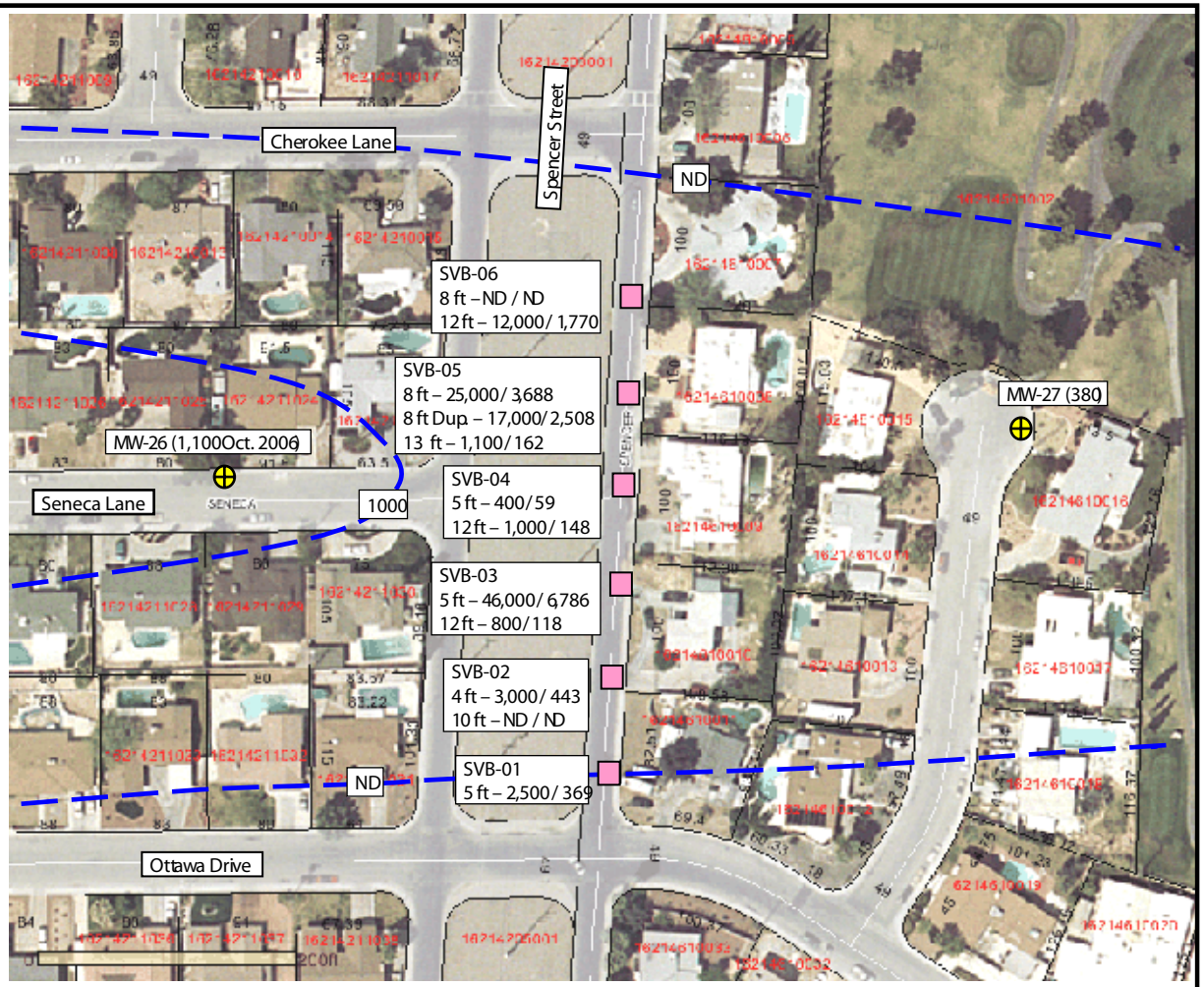
ug/L = Micrograms per liter

ug/m^3 = Micrograms per cubic meter

ppbv = Parts per billion by volume

(1) Depth in feet (ft.) below ground surface

(2) Soil sample SVB-05-98 is a duplicate for samples SVB-05-08.



Source: Clark County Assessors Web Site

Scale: 0 Feet — 200 Feet

N

Monitoring Wells installed by URS

Approximate Location of Soil Vapor Sampling Borehole

Approximate Concentration Contour of PCE in Groundwater

MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

Figure 19
Soil Vapor and Groundwater PCE Results
(Eastern Residential Area)

TETRA TECH

Modified from URS 2007

TABLES

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-1	Aug 00	2,300	ND	ND	ND
	Oct 00	NS	NS	NS	NS
	Sept 02	2,000	ND	ND	ND
	May 03	870	ND	ND	ND
	Sept 03	2,300	ND	ND	ND
	Jan 04	1,700	ND	ND	ND
	May 05	3,500	ND	ND	ND
	Sept 05	1,700	ND	ND	ND
	Dec 05	820	ND	ND	ND
	Mar 06	420	ND	ND	ND
	June 06	NS	NS	NS	NS
	Oct 06	1,100	ND	ND	ND
	Dec 06	1,300	ND	ND	ND
	June 07	450	ND	ND	ND
	Dec 07	710	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	260	ND	ND	ND
	Oct 08	460	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	590	ND	ND	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	390	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	400	ND	ND	ND
MW-2	Oct 00	3,000	18	18	ND
	Sept 02	3,000	13	13	ND
	May 03	1,400	ND	ND	ND
	Sept 03	1,700	ND	ND	ND
	Jan 04	1,700	ND	ND	ND
	May 05	2,050	17	9.7	ND
	Dec 05	2,900	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	1,600	ND	ND	ND
	Oct 06	1,900	ND	ND	ND
	Dec 06	1,300	ND	ND	ND
	June 07	1,400	ND	ND	ND
	Dec 07	1,000	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	900	ND	ND	ND
	Oct 08	960	3.4	1.2	ND
	Feb 09	NS	NS	NS	NS
	June 09	880	3.2	1.1	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	530	2.4	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	570	2.1	0.77	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-3	Oct 00	98	ND	ND	ND
	Sept 02	ND	ND	ND	ND
	May 03	6.9	ND	ND	ND
	Sept 03	12	ND	ND	ND
	Jan 04	6.7	ND	ND	ND
	May 05	ND	ND	ND	ND
	Dec 05	ND	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	ND	ND	ND	ND
	Oct 06	ND	ND	ND	ND
	Dec 06	1.2	ND	ND	ND
	June 07	ND	ND	ND	ND
	Dec 07	1.4	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	6.5	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	5.1	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS
MW-4	Oct 00	14	ND	ND	ND
	Sept 02	25	ND	ND	ND
	May 03	24	ND	ND	ND
	Sept 03	100	ND	ND	ND
	Jan 04	220	ND	ND	ND
	May 05	25	ND	ND	ND
	Dec 05	15	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	27	ND	ND	ND
	Oct 06	NS	NS	NS	NS
	Dec 06	NS	NS	NS	NS
	June 07	NS	NS	NS	NS
	Dec 07	NS	NS	NS	NS
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	NS	NS	NS	NS
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	NS	NS	NS	NS
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-5	Oct 00	100	ND	ND	ND
	Sept 02	110	ND	ND	ND
	May 03	240	ND	ND	ND
	Sept 03	220	ND	ND	ND
	Jan 04	370	ND	ND	ND
	May 05	146	ND	ND	ND
	Dec 05	93	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	220	ND	ND	ND
	Oct 06	67	ND	ND	ND
	Dec 06	130	ND	ND	ND
	June 07	550	ND	ND	ND
	Dec 07	170	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	400	ND	ND	ND
	Oct 08	340	2.7	1.2	ND
	Feb 09	NS	NS	NS	NS
	June 09	700	4.6	1.3	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	520	3.9	1.4	ND
	Feb 10	NS	NS	NS	NS
	June 10	550	2.9	1.3	ND
MW-6	Oct 00	2,200	13	8.1	ND
	Sept 02	1,000	41	14	ND
	May 03	710	22	ND	ND
	Sept 03	1,300	ND	ND	ND
	Jan 04	2,400	ND	ND	ND
	May 05	2,090	13	11	ND
	Sept 05	890	13	23	ND
	Dec 05	530	41	21	ND
	Mar 06	NS	NS	NS	NS
	June 06	1,100	ND	ND	ND
	Oct 06	1,300	ND	ND	ND
	Dec 06	810	9.9	8.9	ND
	June 07	1,300	ND	ND	ND
	Dec 07	1,500	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	1,900	ND	ND	ND
	Oct 08	2,000	13	3.9	ND
	Feb 09	NS	NS	NS	NS
	June 09	2,800	14	4.1	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	2,100	14	6.4	ND
	Feb 10	NS	NS	NS	NS
	June 10	2,500	13	6.2	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-7	Sept 02	ND	ND	ND	ND
	May 03	1.7	ND	ND	ND
	Sept 03	2.0	ND	ND	ND
	Jan 04	11	ND	ND	ND
	May 05	ND	ND	ND	ND
	Sept 05	3.3	ND	ND	ND
	Dec 05	1.2	ND	ND	ND
	Mar 06	1.5	ND	ND	ND
	June 06	2.2	ND	ND	ND
	Oct 06	2.9	ND	ND	ND
	Dec 06	2.1	ND	ND	ND
	June 07	1.1	ND	ND	ND
	Dec 07	1.3	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	2.5	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	7.9	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS
MW-8	Sept 02	5.4	ND	ND	ND
	May 03	3.2	ND	ND	ND
	Sept 03	3.7	ND	ND	ND
	Jan 04	4.7	ND	ND	ND
	May 05	5.6	5.6	ND	ND
	Dec 05	3.6	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	2.6	ND	ND	ND
	Oct 06	3.4	ND	ND	ND
	Dec 06	4.3	ND	ND	ND
	June 07	2.8	ND	ND	ND
	Dec 07	2.8	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	3.7	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	2.8	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-9	Sept 02	670	ND	ND	ND
	May 03	59	ND	ND	ND
	Sept 03	9.2	ND	ND	ND
	Jan 04	10	ND	ND	ND
	May 05	353	ND	ND	ND
	Sept 05	64	ND	ND	ND
	Dec 05	190	ND	ND	ND
	Mar 06	ND	ND	ND	ND
	June 06	NS	NS	NS	NS
	Oct 06	160	ND	ND	ND
	Dec 06	45	ND	ND	ND
	June 07	170	ND	ND	ND
	Dec 07	110	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	12	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	13	ND	ND	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	5.5	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	6.6	ND	ND	ND
MW-10	Sept 02	ND	ND	ND	ND
	May 03	ND	ND	ND	ND
	Sept 03	15	ND	ND	ND
	Jan 04	ND	ND	ND	ND
	May 05	ND	ND	ND	ND
	Sept 05	ND	ND	ND	ND
	Dec 05	ND	ND	ND	ND
	Mar 06	ND	ND	ND	ND
	June 06	ND	ND	ND	ND
	Oct 06	ND	ND	ND	ND
	Dec 06	1.0	ND	ND	ND
	June 07	ND	ND	ND	ND
	Dec 07	1.0	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	ND	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	ND	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-11	Sept 02	ND	ND	ND	ND
	May 03	ND	ND	ND	ND
	Sept 03	NS	NS	NS	NS
	Nov 03	NS	NS	NS	NS
	Jan 04	NS	NS	NS	NS
	May 05	NS	NS	NS	NS
	Dec 05	NS	NS	NS	NS
	Mar 06	NS	NS	NS	NS
	June 06	NS	NS	NS	NS
	Oct 06	NS	NS	NS	NS
	Dec 06	NS	NS	NS	NS
	June 07	NS	NS	NS	NS
	Dec 07	NS	NS	NS	NS
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	NS	NS	NS	NS
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	NS	NS	NS	NS
	Feb 10	ND	ND	ND	ND
	June 10	NS	NS	NS	NS
MW-12	Sept 02	ND	ND	ND	ND
	May 03	1.3	ND	ND	ND
	Sept 03	14	ND	ND	ND
	Jan 04	6.1	ND	ND	ND
	May 05	ND	ND	ND	ND
	Sept 05	1.1	ND	ND	ND
	Dec 05	1.2	ND	ND	ND
	Mar 06	1.1	ND	ND	ND
	June 06	NS	NS	NS	NS
	Oct 06	ND	ND	ND	ND
	Dec 06	1.4	ND	ND	ND
	June 07	ND	ND	ND	ND
	Dec 07	ND	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	2.0	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	1.2	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-13	May 03	2,100	ND	ND	ND
	Sept 03	2,800	ND	ND	ND
	Jan 04	2,700	ND	ND	ND
	May 05	5,310	ND	ND	ND
	Sept 05	2,600	ND	ND	ND
	Dec 05	3,400	ND	ND	ND
	Mar 06	3,700	ND	ND	ND
	June 06	2,900	NS	NS	NS
	Oct 06	2,800	ND	ND	ND
	Dec 06	3,200	ND	ND	ND
	Mar 07	2,500	ND	ND	ND
	June 07	3,700	ND	ND	ND
	Sept 07	2,000	ND	ND	ND
	Dec 07	2,500	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	2,300	ND	ND	ND
	Oct 08	2,600	5.3	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	2,200	2.9	ND	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	1,700	3.7	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	1,600	3.2	ND	ND
MW-14	Nov 03	1,900	ND	ND	ND
	Jan 04	2,100	ND	ND	ND
	May 05	2,920	5.5	ND	ND
	Dec 05	3,400	ND	ND	ND
	Mar 06	2,500	ND	ND	ND
	June 06	1,800	NS	NS	NS
	Oct 06	1,900	ND	ND	ND
	Dec 06	3,500	ND	ND	ND
	Mar 07	1,900	ND	ND	ND
	June 07	1,700	ND	ND	ND
	Sept 07	650	ND	ND	ND
	Dec 07	1,500	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	1,500	ND	ND	ND
	Oct 08	1,500	2.9	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	1,900	4.4	ND	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	1,200	2.1	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	1,500	2.4	ND	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-15	Nov 03	5.2	ND	ND	ND
	Jan 04	2.7	ND	ND	ND
	May 05	ND	ND	ND	ND
	Sept 05	3.6	ND	ND	ND
	Dec 05	5.0	ND	ND	ND
	Mar 06	4.5	ND	ND	ND
	June 06	4.4	NS	NS	NS
	Oct 06	3.3	ND	ND	ND
	Dec 06	3.7	ND	ND	ND
	June 07	3.0	ND	ND	ND
	Dec 07	3.0	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	7.8	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	3.0	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS
MW-16	Nov 03	ND	ND	ND	ND
	Jan 04	ND	ND	ND	ND
	May 05	ND	ND	ND	ND
	Sept 05	ND	ND	ND	ND
	Dec 05	ND	ND	ND	ND
	Mar 06	ND	ND	ND	ND
	June 06	ND	ND	ND	ND
	Oct 06	ND	ND	ND	ND
	Dec 06	ND	ND	ND	ND
	June 07	ND	ND	ND	ND
	Dec 07	ND	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	ND	2.8	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	1.9	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-17	May 05	520	ND	ND	ND
	Dec 05	470	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	NS	NS	NS	NS
	Oct 06	1,300	ND	ND	ND
	Dec 06	710	ND	ND	ND
	Mar 07	440	ND	ND	ND
	June 07	300	ND	ND	ND
	Sept 07	380	ND	ND	ND
	Dec 07	480	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	360	ND	ND	ND
	Oct 08	290	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	270	ND	ND	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	310	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	270	ND	ND	ND
MW-18	May 05	1,600	ND	ND	ND
	Sept 05	1,700	ND	ND	ND
	Dec 05	2,400	ND	ND	ND
	Mar 06	1,700	NS	NS	NS
	June 06	1,600	NS	NS	NS
	Oct 06	2,100	ND	ND	ND
	Dec 06	1,400	ND	ND	ND
	Mar 07	1,400	ND	ND	ND
	June 07	1,300	ND	ND	ND
	Sept 07	930	ND	ND	ND
	Dec 07	1,400	ND	ND	ND
	Mar 08	1,800	ND	ND	ND
	June 08	1,200	ND	ND	ND
	Oct 08	950	3.7	ND	ND
	Feb 09	1,500	5.2	ND	ND
	June 09	3,500	5.1	ND	ND
	Sept 09	1,200	ND	ND	ND
	Nov 09	1,400	4.1	ND	ND
	Feb 10	1,600	4.8	ND	ND
	June 10	1,100	3.5	ND	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-19	Nov 03	1,100	ND	ND	ND
	Jan 04	1,200	ND	ND	ND
	May 05	873	ND	ND	ND
	Dec 05	1,300	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	910	ND	ND	ND
	Oct 06	840	ND	ND	ND
	Dec 06	1,200	ND	ND	ND
	Mar 07	890	ND	ND	ND
	June 07	870	ND	ND	ND
	Sept 07	510	ND	ND	ND
	Dec 07	990	ND	ND	ND
	Mar 08	1,200	NS	NS	NS
	June 08	930	ND	ND	ND
	Oct 08	1,300	5.7	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	1,400	6.1	ND	ND
	Sept 09	880	ND	ND	ND
	Nov 09	580	3.7	ND	ND
	Feb 10	990	5.5	ND	ND
	June 10	930	4.2	ND	ND
MW-20	Nov 03	1,800	ND	ND	ND
	Jan 04	290	2.8	ND	ND
	May 05	1,460	ND	ND	ND
	Dec 05	1,800	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	2,100	ND	ND	ND
	Oct 06	2,000	ND	ND	ND
	Dec 06	2,500	ND	ND	ND
	Mar 07	1,500	ND	ND	ND
	June 07	1,300	ND	ND	ND
	Sept 07	730	ND	ND	ND
	Dec 07	1,400	ND	ND	ND
	Mar 08	1,600	NS	NS	NS
	June 08	1,200	ND	ND	ND
	Oct 08	1,000	3.5	ND	ND
	Feb 09	830	ND	ND	ND
	June 09	1,100	3.3	ND	ND
	Sept 09	940	ND	ND	ND
	Nov 09	640	2.2	ND	ND
	Feb 10	990	3.3	ND	ND
	June 10	780	2.4	ND	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
MW-21	Nov 03	51	ND	ND	ND
	Jan 04	55	ND	ND	ND
	May 05	30	ND	ND	ND
	Sept 05	19	2.4	1.5	ND
	Dec 05	16	1.8	1.3	ND
	Mar 06	43	ND	ND	ND
	June 06	32	ND	ND	ND
	Oct 06	23	ND	ND	ND
	Dec 06	39	ND	ND	ND
	June 07	28	ND	ND	ND
	Dec 07	83	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	20	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	11	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS
MW-22	May 05	ND	ND	ND	ND
	Sept 05	ND	ND	ND	ND
	Dec 05	1.0	ND	ND	ND
	Mar 06	ND	ND	ND	ND
	June 06	ND	ND	ND	ND
	Oct 06	ND	ND	ND	ND
	Dec 06	ND	ND	ND	ND
	June 07	ND	ND	ND	ND
	Dec 07	ND	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	NS	NS	NS	NS
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	1.4	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS
MW-23	May 05	1,430	ND	ND	ND
	Dec 05	1,900	ND	ND	ND
	Mar 06	NS	NS	NS	NS
	June 06	1,500	ND	ND	ND
	Oct 06	2,000	ND	ND	ND
	Dec 06	2,100	ND	ND	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
	Mar 07	2.100	ND	ND	ND
	June 07	1,300	ND	ND	ND
	Sept 07	750	ND	ND	ND
	Dec 07	1,200	ND	ND	ND
	Mar 08	1,400	ND	ND	ND
	June 08	1,100	ND	ND	ND
	Oct 08	1,300	4.4	ND	ND
	Feb 09	1,100	ND	ND	ND
	June 09	1,400	4.6	ND	ND
	Sept 09	1,200	ND	ND	ND
	Nov 09	880	3.2	ND	ND
	Feb 10	1,000	3.8	ND	ND
	June 10	900	2.6	ND	ND
MW-24	May 05	ND	ND	ND	ND
	Sept 05	4.3	ND	ND	ND
	Dec 05	6.7	ND	ND	ND
	Mar 06	6.5	ND	ND	ND
	June 06	5.6	ND	ND	ND
	Oct 06	2.6	ND	ND	ND
	Dec 06	2.6	ND	ND	ND
	June 07	1.0	ND	ND	ND
	Dec 07	ND	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	NS	NS	NS	NS
	Oct 08	6.1	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	NS	NS	NS	NS
	Sept 09	NS	NS	NS	NS
	Nov 09	2.9	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	NS	NS	NS	NS
MW-25	May 05	993	ND	ND	ND
	Sept 05	920	ND	ND	ND
	Dec 05	1,000	ND	ND	ND
	Mar 06	970	ND	ND	ND
	June 06	960	ND	ND	ND
	Oct 06	1,300	ND	ND	ND
	Dec 06	1,200	ND	ND	ND
	Mar 07	670	ND	ND	ND
	June 07	960	ND	ND	ND
	Sept 07	560	ND	ND	ND
	Dec 07	780	ND	ND	ND
	Mar 08	890	ND	ND	ND
	June 08	630	ND	ND	ND
	Oct 08	730	1.5	ND	ND
	Feb 09	770	ND	ND	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
	June 09	880	2.0	ND	ND
	Sept 09	770	ND	ND	ND
	Nov 09	570	1.3	ND	ND
	Feb 10	460	2.3	ND	ND
	June 10	550	0.93	ND	ND
MW-26	Mar 06	730	ND	ND	ND
	June 06	770	ND	ND	ND
	Oct 06	1,100	ND	ND	ND
	Dec 06	NS	NS	NS	NS
	Mar 07	790	ND	ND	ND
	June 07	960	ND	ND	ND
	Sept 07	620	ND	ND	ND
	Dec 07	910	ND	ND	ND
	Mar 08	1,100	ND	ND	ND
	June 08	930	ND	ND	ND
	Oct 08	900	1.4	ND	ND
	Feb 09	960	ND	ND	ND
	June 09	970	1.5	ND	ND
	Sept 09	910	ND	ND	ND
	Nov 09	690	ND	ND	ND
	Feb 10	790	1.8	ND	ND
	June 10	680	0.74	ND	ND
MW-27	Mar 06	220	ND	ND	ND
	June 06	350	ND	ND	ND
	Oct 06	380	ND	ND	ND
	Dec 06	380	ND	ND	ND
	Mar 07	160	ND	ND	ND
	June 07	340	ND	ND	ND
	Sept 07	320	ND	ND	ND
	Dec 07	430	ND	ND	ND
	Mar 08	580	ND	ND	ND
	June 08	320	ND	ND	ND
	Oct 08	510	2.6	ND	ND
	Feb 09	510	ND	ND	ND
	June 09	570	3.3	ND	ND
	Sept 09	640	ND	ND	ND
	Nov 09	400	2.0	ND	ND
	Feb 10	770	3.5	ND	ND
	June 10	330	1.4	ND	ND
MW-28	Nov 07	3.0	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	1.0	ND	ND	ND
	Oct 08	2.2	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	3.3	ND	ND	ND
	Sept 09	NS	NS	NS	NS

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
	Nov 09	1.3	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	0.94	ND	ND	ND
MW-29	Nov 07	2.5	ND	ND	ND
	Mar 08	NS	NS	NS	NS
	June 08	1.0	ND	ND	ND
	Oct 08	2.2	ND	ND	ND
	Feb 09	NS	NS	NS	NS
	June 09	1.3	ND	ND	ND
	Sept 09	NS	NS	NS	NS
	Nov 09	ND	ND	ND	ND
	Feb 10	NS	NS	NS	NS
	June 10	0.58	ND	ND	ND
MW-30	Nov 07	74	ND	ND	ND
	Mar 08	86	ND	ND	ND
	June 08	49	ND	ND	ND
	Oct 08	100	1.8	ND	ND
	Feb 09	71	ND	ND	ND
	June 09	110	2.0	ND	ND
	Sept 09	70	1.1	ND	ND
	Nov 09	85	1.4	ND	ND
	Feb 10	60	ND	ND	ND
	June 10	41	ND	ND	ND
MW-31	Mar 08	49	ND	ND	ND
	June 08	31	ND	ND	ND
	Oct 08	39	ND	ND	ND
	Feb 09	44	ND	ND	ND
	June 09	45	ND	ND	ND
	Sept 09	38	ND	ND	ND
	Nov 09	24	ND	ND	ND
	Feb 10	34	1.2	ND	ND
	June 10	34	ND	ND	ND
MW-32	Mar 08	720	ND	ND	ND
	June 08	750	ND	ND	ND
	Oct 08	990	6.1	ND	ND
	Feb 09	1,000	7.2	ND	ND
	June 09	1,000	5.3	ND	ND
	Sept 09	1,000	ND	ND	ND
	Nov 09	660	3.7	ND	ND
	Feb 10	830	5.4	ND	ND
	June 10	480	2.6	ND	ND
MW-33	Mar 08	2.4	ND	ND	ND
	June 08	1.0	ND	ND	ND
	Oct 08	3.4	ND	ND	ND
	Feb 09	ND	ND	ND	ND
	June 09	ND	ND	ND	ND

Table 3-1:
Historical Groundwater Analytical Results
Maryland Square Shopping Center

Well ID	Date	PCE (µg/l)	TCE (µg/l)	cis-1,2-Dichloroethane (µg/l)	Vinyl Chloride (µg/l)
	Sept 09	3.3	ND	ND	ND
	Nov 09	1.4	ND	ND	ND
	Feb 10	ND	ND	ND	ND
	June 10	ND	ND	ND	ND

Notes:

ND = Non-Detect
NS = Not Sample
PCE = Tetrachloroethylene
TCE = Trichloroethene
µg/l = micrograms per liter

APPENDIX A

Auxiliary Tables

A-1: Summary of Field Water Quality Measurements in Monitoring Wells (Table 4, URS 20054)

A-2: Laboratory Analysis for Soil Samples collected on October 31, 1997 (Fluor Daniel GTI)

A-3 Major Ion Chemistry for Selected Shallow Wells in Las Vegas Valley, Nevada

TABLE 4

SUMMARY OF FIELD WATER QUALITY MEASUREMENTS IN MONITORING WELLS

Maryland Square Shopping Center

Well ID	Sample Date	pH	Temperature (°C)	Specific Conductance (uS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	Turbidity (ntu)
SHALLOW WELLS							
MW-1	Jan-04	6.97	22.5	3.48	0.93	NM	NM
	May-05	7.02	26.0	3.98	5.43	110	441
MW-2	Jan-04	7.05	23.2	3.10	1.13	NM	NM
	May-05	6.93	23.4	3.47	4.82	193	698
MW-3	Jan-04	6.87	22.4	2.91	0.97	NM	NM
	May-05	6.99	26.0	2.88	2.54	149	**
MW-4	Jan-04	6.95	22.0	2.71	1.23	NM	NM
	May-05	6.83	24.2	3.73	3.68	160	664
MW-5	Jan-04	6.72	22.3	2.61	1.20	NM	NM
	May-05	7.09	25.4	2.59	4.56	184	**
MW-6	Jan-04	6.97	22.4	2.31	1.19	NM	NM
	May-05	6.91	25.9	2.35	3	123	**
MW-7	Jan-04	7.00	22.4	2.23	0.93	NM	NM
	May-05	7.10	24.8	1.79	4.03	129	**
MW-8	Jan-04	6.99	22.0	2.16	1.04	NM	NM
	May-05	7.03	27.7	1.75	3.64	107	**
MW-10	Jan-04	7.00	24.4	3.13	1.03	NM	NM
	May-05	6.82	28.1	3.20	1.46	-253	25
MW-11	Jan-04	NM	NM	NM	NM	NM	NM
	May-05	NM	NM	NM	NM	NM	NM
MW-12	Jan-04	6.99	22.4	2.15	NM	NM	NM
	May-05	6.76	24.9	2.58	3.22	219	**
MW-13	Jan-04	6.61	22.2	3.29	1.07	NM	NM
	May-05	6.97	24.5	2.06	4.16	118	>999
MW-14	Jan-04	6.99	22.3	2.27	1.30	NM	NM
	May-05	6.95	24.7	3.23	NM	140	NM
MW-15	Jan-04	6.35	22.4	2.20	1.00	NM	NM
	May-05	6.99	25.1	2.33	2.85	164	**
MW-16	Jan-04	6.97	22.4	2.31	0.68	NM	NM
	May-05	7.12	25.2	2.88	1.10	-4	**
MW-17*	May-05	6.92	24.1	3.49	5.94	181	22
MW-18*	May-05	7.10	24.3	3.86	5.56	139	>999
MW-19	Jan-04	6.99	22.4	1.90	1.02	NM	NM

TABLE 4
SUMMARY OF FIELD WATER QUALITY MEASUREMENTS IN MONITORING WELLS
Maryland Square Shopping Center

Well ID	Sample Date	pH	Temperature (°C)	Specific Conductance (uS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	Turbidity (ntu)
MW-19	May-05	7.13	25.0	1.86	5.76	130	**
MW-20	Jan-04	6.94	22.6	2.07	1.11	NM	NM
	May-05	7.16	23.6	1.32	4.97	131	**
MW-21	Jan-04	6.91	22.3	2.04	1.08	NM	NM
	May-05	7.07	24.6	2.82	2.88	131	**
MW-22*	May-05	6.79	24.1	3.89	1.68	46	474
MW-23*	May-05	7.00	24.5	3.63	2.56	121	**
MW-24*	May-05	6.97	23.1	3.56	1.48	76	>999
MW-25*	May-05	7.03	23.6	4.00	4.34	141	>999
Average		6.95	23.9	2.75	2.54	115	387
INTERMEDIATE WELLS							
MW-9	Jan-04	6.99	22.6	2.50	1.18	NM	NM
	May-05	7.14	26.1	2.68	7.56	130	296
Average		7.07	24.4	2.59	4.37	130	296

NOTES: * = wells installed in Apr 2005 by URS. ** = instrument failure
Monitoring well MW-11 not sampled due to detection of floating hydrocarbons in the well.
°C = degrees Celsius. uS = microsiemens (equivalent to umhos). mg/L = milligrams per liter.
mV = millivolts. Ntu = Nephelometric Turbidity Units

TABLE 1
Laboratory Analyses for Soil Samples Collected on October 31,1997
(All Results Expressed as Milligrams per Kilogram Unless Otherwise Noted)

Sears Store 1328
Las Vegas, Nevada

Boring	Sample ID	Depth (feet)	PID Readings	TPH as Gas	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE	Methylene Chloride
PP-1	PP-1-5	5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	16
	PP-1-11	11	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	15
	PP-1-15	15	N/A	<10	<5.0	<5.0	<5.0	<5.0	<5.0	21
PP-2	PP-2-5	5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	20
	PP-2-11.5	11.5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	32
PP-3	PP-3-5	5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	13
	PP-3-11	11	62	<10	<5.0	<5.0	<5.0	<5.0	<5.0	15
	PP-3-14	14	0	N/A	<5.0	<5.0	<5.0	<5.0	<5.0	17
PP-4	PP-4-5	5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	20
	PP-4-11	11	51	<10	<5.0	<5.0	<5.0	<5.0	<5.0	21
PP-5	PP-5-5	5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<10
	PP-5-11	11	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<10
PP-6	PP-6-5	5	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<10
	PP-6-11	11	0	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<10
	PP-6-13.5	13.5	N/A	<10	<5.0	<5.0	<5.0	<5.0	<5.0	<10

Notes:
Total Petroleum Hydrocarbons (TPH) as gasoline reported in milligrams per kilogram.
Sample PP-3-14 was not analyzed for TPH as gasoline.

TABLE 2
Laboratory Analyses for Groundwater Samples Collected on October 31, 1997
(All Results Expressed as Micrograms per Liter Unless Otherwise Noted)

Sears Store 1328
Las Vegas, NV

Sample Location	TPH as Gas	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE	1,3,5 Trimethyl-benzene	1,2,4 Trimethyl-benzene	Naphthalene
PP-1	<100	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
PP-2	<100	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
PP-3	<100	<5.0	<5.0	<5.0	132	<5.0	34	33	5.8
PP-4	<100	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
PP-5	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S	N/S
PP-6	190	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0

Notes:
Total Petroleum Hydrocarbons (TPH) as gasoline by EPA Method Modified 8015
NS: Not Sampled due to insufficient volume

TABLE 3
Laboratory Analyses for Groundwater Samples collected on April 16, 1998
(All Results Expressed as Micrograms per Liter Unless Otherwise Noted)

Sears Store 1328
Las Vegas, NV

Sample Location	TPH as Gas	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE	Chloroform
GP-1-11.4	<50	<2.0	<2.0	<2.0	<2.0	<5.0	5.5
GP-2-10.9	<50	<2.0	<2.0	<2.0	<2.0	<5.0	<2.0
GP-3E-10.9	<50	<2.0	<2.0	<2.0	<2.0	<5.0	3.3

Notes:
Total Petroleum Hydrocarbons (TPH) as gasoline by EPA Method Modified 8015, with purge and trap extraction
Volatile Organic Compounds by EPA Method 8260A

Table 1
Major Ion Chemistry for Selected Shallow Wells in
Las Vegas Valley, Nevada

	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{2-}	B	NO3 - N	Source
SITE											
C25	4940*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Wild, 1990
C27	6340	456	610	405	41.0	275	249	3890	3.50	2.88	LVVWD database
C28	4930	464	274	610	31.0	308	733	2360	2.00	2.56	LVVWD database
C29	5530	518	390	460	52.9	205	500	3050	3.30	4.02	LVVWD database
C32	4650	420	380	317	19.6	176	248	2780	5.00	7.93	LVVWD database
C33	3770*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Bashor, 1994
C36	4750*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Bashor, 1994
C42	4380	513	265	335	34.5	254	351	2390	3.00	8.40	LVVWD database
C43	3550*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Bashor, 1994
C49	3120	314	202	286	22.0	258	270	1640	1.70	6.72	LVVWD database
DROSE	3750	338	250	336	35.3	270	286	2030	1.56	1.78	LVVWD database
DROSE10G	7240	437	553	756	154	306	646	3960	3.11	13.6	LVVWD database
DROSE11G	4500	424	251	421	138	314	360	2380	1.58	7.21	LVVWD database
DROSE13T	4280	364	299	364	92.3	262	308	2410	1.43	7.04	LVVWD database
DROSEPS	5380	371	428	512	58.3	256	466	2900	1.77	17.6	LVVWD database
JGP	756	100	70	55	17.0	410	252	120	0.28	2.00	Brothers & Katzer, 1988
LGO48	4580	324	400	379	61.7	274	421	2540	1.30	0.81	Wild, 1990

Modified from

Table 1 (Continued)
Major Ion Chemistry for Selected Shallow Wells in
Las Vegas Valley, Nevada

	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^{2-}	B	NO3 - N	Source
MDB3	548	132	0.3	33.7	8.7	n.a.	40	214	n.a.	0.01	Wild, 1990
MDB5	1185	255	21	33.2	39.0	58	14	747	n.a.	0.22	Wild, 1990
MDB6	728	185	0.2	55	22.4	n.a.	63	178	n.a.	0.38	Wild, 1990
PVP	3230	394	203	225	17.2	201	238	1750	0.90	8.29	Wild, 1990
USGS #5	4940	513	320	446	67.2	321	487	2650	2.60	4.67	Wild, 1990
USGS #34	990	143	100	41	5.3	265	132	429	0.10	5.53	LVVWD database
USGS #37	1855	175	165	145	22.4	563	172	739	0.30	13.6	LVVWD database
USGS #40	3070	327	211	238	18.5	250	246	1570	1.10	8.16	LVVWD database
USGS #43	4830	433	423	222	38.5	373	208	2760	1.90	8.54	Wild, 1990
USGS #47	2360	218	211	141	14.9	255	166	1240	n.a.	1.20	Wild, 1990
USGS #48	1840*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Bashor, 1994
USGS #56	5400	610	410	340	20.0	183	650	2900	n.a.	n.a.	Wild, 1990
USGS #68	1720*	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	Wild, 1990

n.a. = data not available
* = TDS values calculated from EC where EC * 66% = TDS
NOTE: Above values are the most recent values listed in the reference material.
All concentrations in mg/l.

Modified from

APPENDIX B

Boring Logs and Well Construction Diagrams

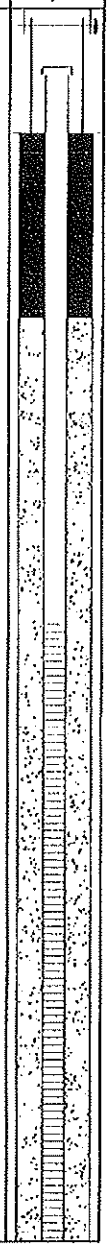
Log No. MW-1

Date of Drilling: 08/09/00
Driller: Converse
Logged By: ALM

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
		SILTY SAND; dry, tan				
2						
4						
6						
8						
10						
12						
14						
16						
18						
20						



APPROVED BY ON

Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

Over 60 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-1

Date of Drilling: 08/09/00
Driller: Converse
Logged By: ALM

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22		SANDY CLAY; very moist, light brown				
24						
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 30.0'

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Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

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Log No. MW-2

Date of Drilling: 10/02/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
		CLAYEY SILT; white				
2						
4		SILTY CLAY; moist, brown				
6		...slightly moist				
8		...light brown				
10						
12						
14						
		CLAY w/Silt; dark brown				
16						
18		...moist				
20		...very wet				

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Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

Over 60 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-2

Date of Drilling: 10/02/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		CLAY; very wet, dark brown				
22		...wet				
24						
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 32.0'

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Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

Over 60 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-3

Date of Drilling: 10/02/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
		SILTY CLAY; dry, light brown				
2						
4						
		CLAY w/Silt; slightly moist, medium brown				
6						
8						
		SILTY CLAY; slightly moist, light brown				
10						
12						
		... medium brown				
14						
16						
18		...moist, dark brown				
20						

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Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

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Log No. MW-3

Date of Drilling: 10/02/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		CLAY w/Silt; moist, dark brown				
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 32.0'

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Las Vegas, NV

Project No.
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Drawing No.

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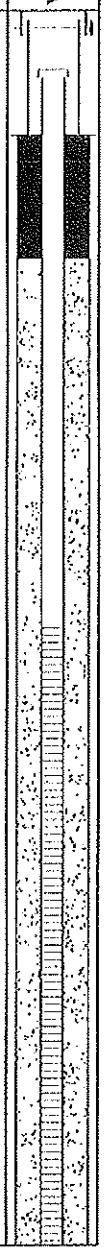
Log No. MW-4

Date of Drilling: 10/02/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT Type II Fill				
2		SILTY CLAY; dry, light brown				
4						
6						
8						
10						
12						
14		CLAY w/Silt; slightly moist, medium brown				
16						
18						
20						



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Drawing No.

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Log No. MW-4

Date of Drilling: 10/02/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		CLAY w/Silt; slightly moist, medium brown				
22						
24						
		...very moist				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 32.0'

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Project No.
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Drawing No.

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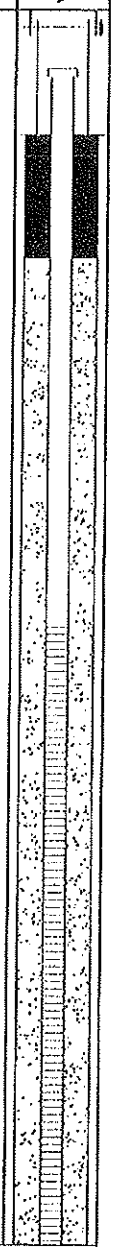
Log No. MW-5

Date of Drilling: 10/03/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT Type II Fill				
2						
		SILTY CLAY; dry, light brown				
4						
6						
8						
10		CLAY w/Silt; slightly moist, light brown				
12						
14						
16						
		CLAY w/Silt; slightly moist, medium brown				
18						
20						



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Drawing No.

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Log No. MW-5

Date of Drilling: 10/03/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

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End of Exploration at 32.0'

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Project No.
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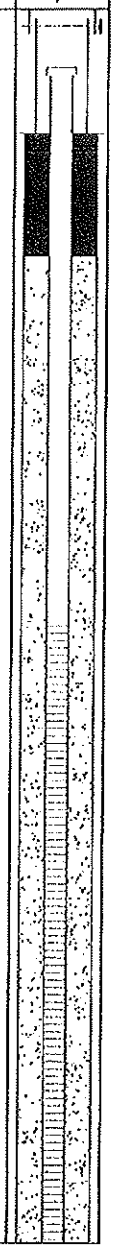
Log No. MW-6

Date of Drilling: 10/03/00 | Location: | Ground Surface Elevation (ft):
Driller: Converse | Borehole Diameter: | Equipment: Air Rotary
Logged By: JMW | Groundwater Depth (ft): | Driving Wt. and Drop:

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT Type II Fill				
2		CLAY w/Silt; dry, medium brown				
4						
6						
8						
10		slightly moist, light brown				
12		CLAY w/Silt; slightly moist, white/brown				
14		CLAY w/Silt; hard, light brown				
16						
18		CALICHE; hard				
20						



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Project No.
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Drawing No.

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Log No. MW-6

Date of Drilling: 10/03/00
Driller: Converse
Logged By: JMW

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		CLAY w/Silt; slightly moist, light brown				
22						
24		....wet				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 32.0'

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Drawing No.

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Log No. MW-7

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
		SAND; dry, grey and brown				
2						
4						
6						
8						
10						
12		CALICHE; dry, white				
		SAND; dry, light brown				
14						
		CALICHE; dry, white				
16		SAND; dry, white				
18						
20						

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Drawing No.

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Log No. MW-7

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		SILTY CLAY; wet, brown				
22		CLAY; wet, brown				
24						
26						
28						
30						
32						
34						
36						
38						
40						

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End of Exploration at 30.0'

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Project No.
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Drawing No.

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Log No. MW-8

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
		SAND; dry, white				
2						
4						
6		SAND; dry, light brown				
8		CALICHE; dry, white				
10						
		CALICHE; dry, white				
12						
		SAND w/Silt; dry, light brown				
14						
16		SAND w/Silt; dry, white and grey				
18						
20						

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Drawing No.

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Log No. MW-8

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22		CALICHE; dry, white				
24		CLAY w/Silt; wet, brown				
26		CLAY; wet, brown				
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 30.0'

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Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

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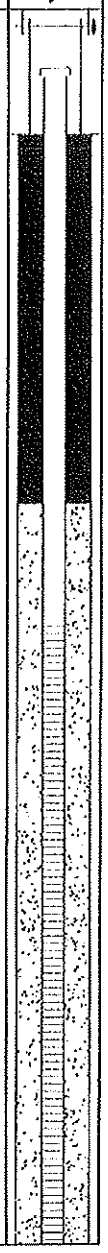
Log No. MW-9

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
		SAND; dry, brown				
2						
4						
6		CALICHE; dry, white				
8		SAND w/Silt; dry, white				
10		CALICHE; hard				
		SAND w/Silt; dry, white				
12						
14						
16						
18						
		CALICHE; dry, white				
20						



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Project No.
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Drawing No.

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Log No. MW-9

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		SANDY SILT; dry, brown				
22						
24		CLAY; wet, brown				
26						
28						
30						
32						
34						
36						
38						
40						

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Project No.
00-43367-05

Drawing No.

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Log No. MW-9

Date of Drilling: 09/19/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						

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End of Exploration at 50.0'

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Project No.
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Drawing No.

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Log No. MW-10

Date of Drilling: 09/20/02 **Location:** **Ground Surface Elevation (ft):**
Driller: Converse **Borehole Diameter:** **Equipment:** Air Rotary
Logged By: AMK **Groundwater Depth (ft):** **Driving Wt. and Drop:**

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
2		SAND; dry, grey				
4		CALICHE; dry, white				
6		SAND; dry, brownish grey				
8						
10						
12						
14						
16						
18						
20						

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Project No.
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Log No. MW-10

Date of Drilling: 09/20/02 **Location:** **Ground Surface Elevation (ft):**
Driller: Converse **Borehole Diameter:** **Equipment:** Air Rotary
Logged By: AMK **Groundwater Depth (ft):** **Driving Wt. and Drop:**

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		SILTY CLAY; wet, brown				
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

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End of Exploration at 30.0'

Maryland Square
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Project No.
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Drawing No.

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Log No. MW-11

Date of Drilling: 09/20/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
2		SAND; dry, brown				
4						
6						
8		SAND; dry, brownish grey				
10						
12		SAND; dry, light brown				
14		FINE SAND; dry, white				
16						
18						
20						

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Log No. MW-11

Date of Drilling: 09/20/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22						
24		SAND; dry, brown				
		SILTY CLAY; wet, brown				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 33.5'

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Project No.
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Drawing No.

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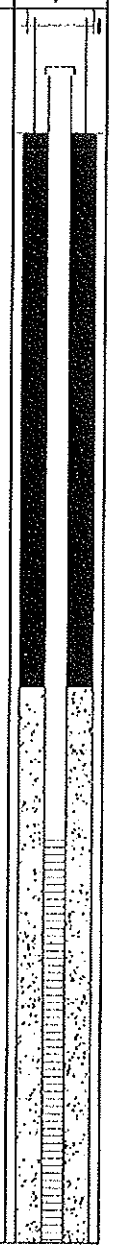
Log No. MW-12

Date of Drilling: 09/20/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT				
2		SAND; dry, brown				
4						
6		FINE SAND; dry, brown				
8						
10						
12						
14		CALICHE; dry, white				
16						
18						
20						



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Drawing No.

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Log No. MW-12

Date of Drilling: 09/20/02
Driller: Converse
Logged By: AMK

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22						
24		SANDY SILT; dry, brown				
		SAND; dry, brown				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 33.5'

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Project No.
00-43367-05

Drawing No.

Converse Consultants

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Log No. MW-13

Date of Drilling: 05/06/03
Driller: Converse
Logged By: ALM

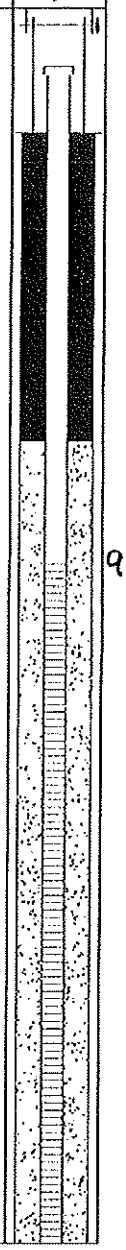
Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		ASPHALT Type II Fill				
2						
4		CALICHE				
6		SANDY SILT w/gravel; moist,tan				
8						
10						
12						
14						
16						
18		CLAYEY SAND; moist, tan				
20		SANDY CLAY; very moist, red				



APPROVED BY ON

Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

Over 60 Years of Dedication in Engineering and Environmental Sciences

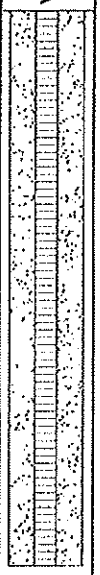
Log No. MW-13

Date of Drilling: 05/06/03
Driller: Converse
Logged By: ALM

Location:
Borehole Diameter:
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Air Rotary
Driving Wt. and Drop:

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						



End of Exploration at 29.0'

APPROVED BY ON

Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

Over 60 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-14

Date of Drilling: 11/14/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		Asphalt/Aggregate base				
2		Clayey sand; tan, slightly moist				
4						
6						
8						
10						
12						
14		Sandy lean clay; few caliche, gravel, white, moist	50/6			
16						
18						
20			13/20			

APPROVED BY ON

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Drawing No.

Log No. MW-14 14

Date of Drilling: 11/14/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		Sandy lean clay; few caliche, gravel, white, moist				
22						
		Sandy lean clay; brown, moist				
24		Silty sand with gravel				
26						
28						
		Silty sand with gravel				
30						
32						
34						
36						
38						
40						

End of Exploration at 40.0'

APPROVED BY CN

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Drawing No.

Log No. MW-15 15

Date of Drilling:
Driller: Elite
Logged By: JJ

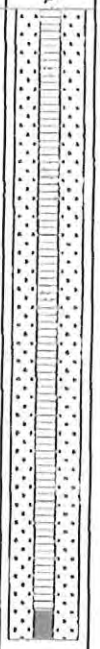
Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mogile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22						
		Caliche				
24		Sandy Clay				
26						
28						
30						
32						
34						
36						
38						
40						

APPROVED BY ON

End of Exploration at 30.5'

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication
In Engineering and
Environmental Sciences

Drawing No.

Log No. MW-16 16

Date of Drilling:
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY 11/11/03

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		Asphalt				
2		Sand and Gravel Type II, loose				
4		Sand with gravel; light brown				
6						
8		Gravel with sand and clay ...little gravel				
10						
12		Sandy clay; light brown				
14		Clayey sand; light brown, slightly moist				
16		Gravel; loose				
18		Clayey sand; light brown, slightly moist				
20		Caliche				

APPROVED BY ON

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Drawing No.

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-16 16

Date of Drilling:
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY 11/11/05

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		Sandy lean clay; reddish, slightly moist				
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

APPROVED BY ON

End of Exploration at 35.0'

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Drawing No.

Log No. MW-19

19

Date of Drilling: 11/13/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		Asphalt/Aggregate				
2		Clayey sand; light brown, slightly moist				
4						
6						
		Silty sand with gravel; dark brown, slightly moist				
8						
10		...tan				
12						
14		...brown				
16						
18						
20						

APPROVED BY ON

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Drawing No.

Log No. MW-19 19

Date of Drilling: 11/13/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25
Groundwater Depth (ft):

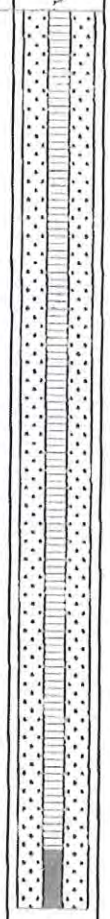
Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		Sandy lean clay; reddish brown, very moist				
22						
24						
26						
28						
30						
32						
34		Caliche				
36						
38						
40						



End of Exploration at 35.0'

APPROVED BY ON

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication
In Engineering and
Environmental Sciences

Drawing No.

Log No. MW-20

Date of Drilling: 11/13/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		Asphalt/Aggregate				
2		Silty sand with gravel; dark brown, slightly moist				
4						
6		Clayey sand; tan, slightly moist				
		Poorly graded sand with silt; light brown, slightly moist				
8		Clayey sand few gravels; tan, slightly moist				
10		Caliche				
12						
14		Clayey sand with gravel; tan, slightly moist				
16						
18						
20		Poorly graded sand with silt; light brown, slightly moist				

APPROVED BY ON

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Drawing No.

Log No. MW-20 70

Date of Drilling: 11/13/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY: KSB

Depth (ft)	Graphic Log	SUMMARY OF SUBSURFACE CONDITIONS This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

APPROVED BY: ON

End of Exploration at 35.0'

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Drawing No.

Log No. MW-21

Date of Drilling: 11/13/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		Asphalt/Aggregate				
2		Clayey sand with gravel; tan, slightly moist				
4		Sandy lean clay with gravel; tan, slightly moist				
6						
8						
10						
12						
14						
16						
18		...tan				
20						

APPROVED BY ON

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Drawing No.

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-21

21

Date of Drilling: 11/13/03
Driller: Elite
Logged By: JJ

Location:
Borehole Diameter: 8.25"
Groundwater Depth (ft):

Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

DRAFTED BY ESB

SUMMARY OF SUBSURFACE CONDITIONS

This log is part of the report prepared by Converse for this project and should be read with the report. This summary applies only at the location and time of the exploration. Subsurface conditions may differ at other locations and may change at this location with the passage of time. The data presented is a simplified model of the actual conditions encountered.

Depth (ft)	Graphic Log	Summary of Subsurface Conditions	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		Sandy lean clay; light brown, slightly moist				
22		Clayey sand; light brown, slightly moist				
24		Sandy lean clay; tan, slightly moist				
26						
28						
30						
32						
34						
36						
38						
40						

APPROVED BY ON

End of Exploration at 35.0'

Kishner/Maryland Square
3661 So. Maryland Parkway
Las Vegas, Nevada

Project No.
00-43367-06

Drawing No.

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

URS

BOREHOLE LOG
MW-26

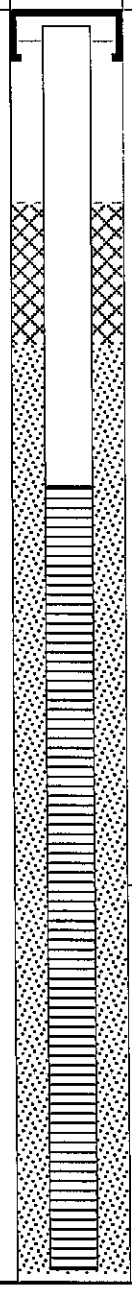
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/22/06
Date Completed:	3/22/06
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	Cuttings Inspection
Logged By:	Randy S. Kyes

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION
0	1030							Asphalt
1						GW		0'-5' Sandy GRAVEL, poor sort, (road base), dry
2								
3								
4								
5	1115					SM		5'-13' Silty SAND, brn, dry, some small gravel.
6								
7								
8								
9								
10								
11								
12								
13						CL		13'-24' Silty CLAY, brn, moist, some pea gravel.
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24						CL		24'-40' Silty CLAY, brn, v. wet
25								

Well: MW-27
Elev.:



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/22/05
Comp. Rep: R.S. Kyes

SURFACE COMPLETION
Type: Flush Mount
Vault: Traffic
Diameter: 12"
Seal: Concrete
Depth: 0'-1'

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-10'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 10'-35'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 7'-40'

ANNULUS SEAL
Bentonite
Depth: 4'-7'
Concrete
Depth: 0'-4'

REMARKS
No sampling performed, borehole was drilled and a monitor well was installed.

Soil profile characterized by inspection of drill cuttings.

URS

BOREHOLE LOG
MW-26

Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

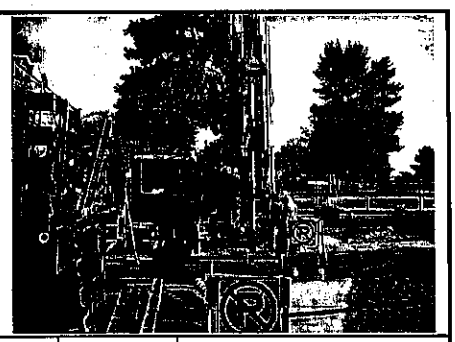
Project No. 2698724.00005

Date Started:	3/22/06
Date Completed:	3/22/06
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	Cuttings Inspection
Logged By:	Randy S. Kyes

Depth in Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-25 Elev.: 1,960.74	Remarks/Well Information
26										
27						CL		24'-40' Silty CLAY, brn, v. wet		
28										
29										
30										
31										
32										
33										
34						CL		24'-40' Silty CLAY, bm, v. wet		
35										
36										
37										
38										
39	1150									
40								Bottom of borehole @ 40 ft. bgs Groundwater encountered at Approximately 15' bgs.		
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

URS

BOREHOLE LOG
MW-27



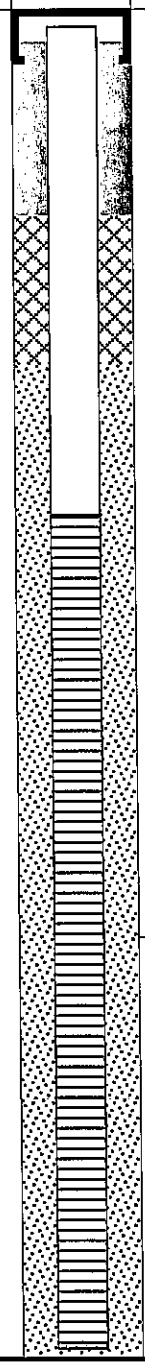
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/22/06
Date Completed:	3/23/06
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	Cuttings Inspection
Logged By:	Randy S. Kyes

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION
0	1520							Asphalt
1						SW		0'-5' Gravely SAND, well sorted, (road base), dry
2								
3								
4								
5						GM		5'-12' GRAVEL, w/ silty sand, dry, well sorted.
6								
7								
8								
9								
10								
11								
12						CL		12'-21' Silty CLAY, brn, moist,
13								
14								
15	1545 0714							
16								
17								
18								
19								
20								
21								21'-22' CALICHE, soft, whitish
22								
23								
24						CL		22'-26' Silty CLAY, brn, v. wet
25								

Well: MW-27
Elev.:



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/23/05
Comp. Rep: R.S. Kyes

SURFACE COMPLETION
Type: Flush Mount
Vault: Traffic
Diameter: 12"
Seal: Concrete
Depth: 0'-1'

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-10'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 10'-35'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 7'-40'

ANNULUS SEAL
Bentonite
Depth: 4'-7'
Concrete
Depth: 0'-4'

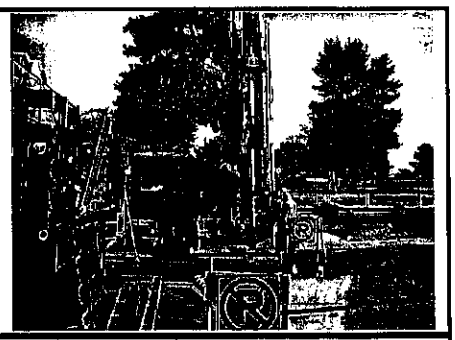
REMARKS
No sampling performed. borehole was drilled and a monitor well was installed.

Soil profile characterized by inspection of drill cuttings.

Restart @ 0714 on 03/23

URS

BOREHOLE LOG
MW-27



Al Phillips The Cleaner	Date Started:	3/22/06
Maryland Square Shopping Center	Date Completed:	3/23/06
Subsurface Investigation	Drilling Company:	WDC Exploration
Las Vegas, Nevada	Drilling Method:	Hollow Stem Auger
	Sampling Method:	Cuttings Inspection
Project No. 2698724.00005	Logged By:	Scott Ball

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-25 Elev.: 1,960.74	Remarks/Well Information
26										
27						CL		26'-40' Silty CLAY, brn, v. wet		
28										
29										
30										
31										
32										
33										
34						CL		34'-40' same as above		
35										
36										
37										
38										
39	0727									03/23/06.
40								Bottom of borehole @ 40 ft. bgs Groundwater encountered at Approximately 15' bgs.		
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

BOREHOLE LOG
MW-31

Al Phillips The Cleaner Maryland Square Shopping Center Groundwater Monitoring Well Installation Las Vegas, Nevada Project No. 2698724	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/5/2008 3/6/2008 WDC Exploration Hollow Stem Auger None Lisa Lowe	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-31 Elev.: 1937.93	Remarks/Well Information
26						SW		22'-30' gravelly SAND: lt. brown, wet, poorly sorted with some silt and pea gravel		
27										
28										
29										
30						ML		30-'-35' sandy SILT: lt. brown, wet, stiff with some pea gravel		
31										
32										
33										
34										
35						CL		35'-45' gravelly CLAY: lt. brown, wet, stiff with some sand and silt		
36										
37										
38										
39										
40										
41										
42										
43										
44										
45								Bottom of borehole @ 45 ft. bgs Groundwater encountered at Approximately 17 ft bgs. *Borehole drilled to 45 ft bgs due to gravelly SAND (22'-30') collapsing into borehole		
46										
47										
48										
49										
50										
51										

BOREHOLE LOG
MW-32

Al Phillips The Cleaner Maryland Square Shopping Center Groundwater Monitoring Well Installation Las Vegas, Nevada Project No. 26698724	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/4/2008 3/4/2008 WDC Exploration Hollow Stem Auger None Holly Woodward/Lisa Lowe	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-32 Elev.: 1952.82	Remarks/Well Information
0								0-4.5” ASPHALT		WELL CONSTRUCTION Date Compl.: 3/4/2008 Comp. Rep: L. Lowe
1						Af		@ 4.5” to 3’ silty SAND: fine-grained, lt. brown, sl. moist, med. dense, poorly graded w. sl. plasticity, some pea gravel, artificial fill		
2										SURFACE COMPLETION Type: Flush Mount Vault: Traffic Diameter: 12” Seal: Concrete Depth: 0’-2’
3						ML		3’-6’ sandy SILT: lt. brown, sl. moist		
4										
5										WELL CASING Material: PVC Diameter: 4” Depth: 0’ to 13.5’ Joints: 3.5’, 13.5’
6						SM		6’-15’ silty SAND: brown, sl. moist, poorly graded, some gravel		
7										
8										WELL SCREEN Material: PVC Diameter: 4” Depth: 13.5’ to 33.5’ Joints: 13.5’, 23.5’ Opening: 0.02” slotted Cap: expanding
9										
10										
11										
12										SAND FILTER PACK Type : Colorado Size: 812 Depth: 11’-35’
13										
14										
15						CL		15’-25’ CLAY: brown, sl. moist, med. dense, poorly graded, some sand and gravel		ANNULUS SEAL Bentonite Depth: 2’-11’
16										
17								@17.5’ same as above but very moist		
18										REMARKS No sampling was performed Borehole was drilled and a Monitor well was installed.
19										
20										*0’ to 25’ was logged during The drilling of B-T on 10/24/2007 by Holly Woodward
21										
22										
23										
24										
25						ML		25’-31’ clayey SILT, lt. brown, wet, stiff		

BOREHOLE LOG
MW-32

Al Phillips The Cleaner Maryland Square Shopping Center Groundwater Monitoring Well Installation Las Vegas, Nevada Project No. 2698724	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/4/2008 3/4/2008 WDC Exploration Hollow Stem Auger None Holly Woodward/Lisa Lowe	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-32 Elev.: 1952.82	Remarks/Well Information
26								25'-31' clayey SILT, lt. brown, wet, stiff		
27										
28										
29						ML				
30										
31								31'-35' same with pea gravel		
32										
33										
34										
35								Bottom of borehole @ 35 ft. bgs Groundwater encountered at Approximately 17.5 feet bgs.		
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

BOREHOLE LOG
MW-33

Al Phillips The Cleaner Maryland Square Shopping Center Groundwater Monitoring Well Installation Las Vegas, Nevada Project No. 26698724	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/5/2008 3/6/2008 WDC Exploration Hollow Stem Auger None Lisa Lowe	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-33 Elev.: 1950.92	Remarks/Well Information
0								0-4” ASPHALT		WELL CONSTRUCTION Date Compl.: 3/6/2008 Comp. Rep: L. Lowe
1						Af		4”-2’ SAND, lt. brown, st. moist, poorly sorted with up to 1” diameter angular Rocks, Artificial Fill		
2						SM		2’-5’ silty SAND: lt. brown, sl. moist, well sorted with up to 1.5” long gypsum crystals		SURFACE COMPLETION Type: Flush Mount Vault: Traffic Diameter: 12” Seal: Concrete Depth: 0’-2’
3										
4										
5								5’-9’ sandy SILT: brown, sl moist, stiff with some pea gravel		WELL CASING Material: PVC Diameter: 4” Depth: 0’-13.5’ Joints: 3.5’, 13.5’
6										
7										
8										WELL SCREEN Material: PVC Diameter: 4” Depth: 13.5’ to 33.5’ Joints: 13.5’, 23.5’ Opening: 0.02” slotted Cap: expanding
9								9’-16’ gravelly SILT: brown sl. moist, stiff with some fine grain sand		
10										
11										
12										SAND FILTER PACK Type : Colorado Size: 812 Depth: 11’-35’
13										
14						ML				
15										ANNULUS SEAL Bentonite Depth: 2’-11’
16								16’-25’ sandy SILT, brown, moist, stiff with some pea gravel		
17										
18										REMARKS No sampling was performed Borehole was drilled and a Monitor well was installed.
19										
20										
21										
22										
23										
24										
25								25’-34’ clayey SILT, lt. brown, wet, stiff		

BOREHOLE LOG
MW-33

Al Phillips The Cleaner Maryland Square Shopping Center Groundwater Monitoring Well Installation Las Vegas, Nevada Project No. 2698724	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/5/2008 3/6/2008 WDC Exploration Hollow Stem Auger None Lisa Lowe	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-33 Elev.: 1950.92	Remarks/Well Information
26								25'-34' clayey SILT, lt. brown, wet, stiff		
27										
28										
29						ML				
30										
31										
32										
33										
34								34'-35' silty CLAY: white, moist, stiff		
35								Bottom of borehole @ 35 ft. bgs Groundwater encountered at Approximately 16.5' bgs.		
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

BOREHOLE LOG
MW-T2

Al Phillips The Cleaner Maryland Square Shopping Center Groundwater Monitoring Well Installation Las Vegas, Nevada Project No. 26698724	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/4/2008 3/5/2008 WDC Explorations Hollow-Stem Auger Grab/Dedicated Bailer Lisa Lowe	

Depth In Feet	Time (0100 hrs)	Sample	Blow Count (ft)	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: B-T2 Elev.:	Remarks/Well Information
0								0-4" ASPHALT		WELL CONSTRUCTION Date Compl.: Comp. Rep:
						Af		4" to 1' silty SAND: lt. brown, sl. moist, poorly sorted with 1-2" diameter angular and rounded rocks		
1						SM		1'-7.5' silty SAND: tan, sl. moist, fine grained, well sorted, no plasticity, with some pea gravel and gypsum		SURFACE COMPLETION Type: Vault: Diameter: Seal: Depth:
2										
3										
4										
5										WELL CASING Material: Diameter: Depth: Joints:
6										
7										
8								7.5'-13' sandy SILT: brown, moist, sl. plasticity		WELL SCREEN Material: Diameter: Depth: Joints: Opening: Cap:
9						ML				
10										
11										
12										SAND FILTER PACK Type : Size: Depth:
13								13'-17' same except stiff		
14										
15										ANNULUS SEAL Sand Pack: Depth: Borehole: Depth:
16										
17								17'-20' same with some pea gravel		
18										REMARKS
19						CL				
	1210	W			B-T2					
20								Bottom of borehole @ 20'bgs Encountered Groundwater at approx. 18'		
21										
22										
23										
24										
25										

APPENDIX C

Summary of Remedial Action Alternatives Costs for Groundwater

Table C-1

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 1					
No Action					
Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment**
None					
			Subtotal	***$0***	
			Total capital Costs	***$0***	
Operation, Maintenance and Monitoring Costs − SSD					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment**
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$120,000***	
			30-Year Present Worth Factor at 5.0% discount factor	*15.37*	
			Net Present Worth of 30 Years of Operation, Maintenance and Monitoring Costs	***$1,840,000***	
Operation, Maintenance and Monitoring Costs − GW Monitoring					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment**
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
			Annual Cost (Subtotal)	***$130,000***	
			30-Year Present Worth Factor at 5.0% discount factor	*15.37*	
			Net Present Worth of 30 Years of Operation, Maintenance and Monitoring Costs	***$2,000,000***	
			Alternative 1 Total Cost	***$3,840,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars
Net present worth discount rate is 5.0%

Abbreviation and Acronyms

AS/SVE	Air Sparge/ Soil Vapor Extraction	MNA	Monitored Natural Attenuation
BCY	Bulk Cubic yards	Mobe	Mobilization
bgs	Below ground surface	PCE	Tetrachloroethene
China Lake FS	2005 Cost estimate for similar site (China Lake) using RACER	PRB	Permeable Reactive Barrier
cfm	Cubic feet per minute	Previous MD Sq	Previous cost estimates for Maryland Square Shopping Center Remediation
CY	Cubic yard		
Decon	Decontamination		
Demobe	Demobilization	RACER	Remedial Action Cost Engineering and Requirements System, designed for Remediation Projects
EOV	Emulsified vegetable oil		
GW	Groundwater		
gpm	Gallons per minute	SF	Square Foot
IC	Institutional Controls	Site Prep	Site Preparation
kwh	Kilowatt hour		
LF	Linear foot	SSD	Sub-slab depressurization
LS	Lump Sum	µg/L	Micrograms per liter of PCE
MG	Million gallon		

Table C-2

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 2A					
In Situ Chemical Treatment of Hotspots and Residential Area, Institutional Controls (IC), Sub-Slab Depressurization (SSD) Systems, and Monitored Natural Attenuation (MNA)					
Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Site Prep for Equipment Laydown	1	LS	$10,000	$10,000	Engineer's Estimate
Injection Wells (76 at 40')	3040	LF	$160	$486,400	China Lake FS
Bench Scale Test	1	LS	$7,000	$7,000	Vendor Quote
Pilot Study	1	LS	$25,000	$25,000	Vendor Quote
Additional SSD systems	10	Homes	$5,000	$50,000	Previous MD Sq
Implementation of ICs	1	LS	$50,000	$50,000	China Lake FS
			Subtotal	***$628,400***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$94,260*	
			Design (10% or $10,000 minimum)	*$62,840*	
			Construction management (15% or $10,000 minimum)	*$94,260*	
			Administrative/Legal (5% or $10,000 minimum)	*$31,420*	
			Contingency (25%)	*$157,100*	
			Total capital Costs	***$1,070,000***	
Operation, Maintenance and Monitoring Costs − Hotspot Reagent and SSD					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Reagent injection in Hotpot	24	tons	$3,552	$85,240	Vendor Quote
Reagent Injection Labor	240	hrs	$50	$12,000	Vendor Quote
Reagent Injection Equipment	5%	Reagent	$85,240	$4,262	Engineer's Estimate
Sub-slab and residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$220,000***	
			Contingency (20%)	*$44,000*	
			Annual Cost + Contingency	*$264,000*	
			2-Year Present Worth Factor at 5.0% discount factor	*1.86*	
			Net Present Worth of 2 Years of Operation and Maintenance Costs	***$490,000***	
Operation, Maintenance and Monitoring Costs − Upgradient Reagent, GW Monitoring and IC					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Reagent Injection Upgradient of Residences	16	tons	$3,552	$56,827	Vendor Quote
Reagent Injection Labor	240	hrs	$50	$12,000	Vendor Quote
Reagent Injection Equipment	5%	Reagent	$56,827	$2,841	Engineer's Estimate
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
Annual reporting and IC Implementation	1	annual	$67,000	$67,000	Engineer's Estimate
			Annual Cost (Subtotal)	***$270,000***	
			Contingency (20%)	*$54,000*	
			Annual Cost + Contingency	*$324,000*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of Operation, Maintenance and Monitoring Costs	***$2,500,000***	
Closeout Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Closeout Report	1	LS	$67,000	$67,000	China Lake FS
			(Subtotal)	***$70,000***	
			10-Year Present Worth Factor at 5.0% discount factor	*0.61*	
			Net Present Worth of Close-out Costs	***$50,000***	
			Alternative 2A Total Cost	***$4,110,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars See Table C-1 for abbreviations and acronyms
Net present worth discount rate is 5.0%
76 new wells will need to be installed, making a total of 80 injection wells
Injection points or wells will be at about 17-40 bgs in Years 1 through 10 GW velocity will be between 0.5-4 foot per day
Initially treating a concentration of approximately 1,000 ug/L, decreasing to 500 after Year 5
SSD systems would operate for 2 years and GW monitoring would be for 10 years
Injection will be directly in roadways or right-of-ways
Oxidant demand based on high sulfates at site

Injection well abandonment part of demobilization costs
Implementation of ICs cost based on length of time required

Table C-3

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 2B					
In Situ Chemical Treatment, ICs, SSD Systems, and MNA					
Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Site Prep for Equipment Laydown	1	LS	$10,000	$10,000	Engineer's Estimate
Site Prep for Injection Wells	121	Wells	$3,000	$363,000	Engineer's Estimate.
New Injection Wells (349 at 40')	13960	LF	$160	$2,233,600	China Lake FS
Bench Scale Test	1	LS	$7,000	$7,000	Vendor Quote
Pilot Study	1	LS	$25,000	$25,000	Vendor Quote
Additional SSD systems	10	Homes	$5,000	$50,000	Previous MD Sq
Implementation of ICs	1	LS	$50,000	$50,000	China Lake FS
			Subtotal	***$2,738,600***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$410,790*	
			Design (10% or $10,000 minimum)	*$273,860*	
			Construction management (15% or $10,000 minimum)	*$410,790*	
			Aministrative/Legal (5% or $10,000 minimum)	*$136,930*	
			Contingency (25%)	*$684,650*	
			Total capital Costs	***$4,660,000***	
Operation, Maintenance and Monitoring Costs − Reagent and SSD					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Reagent	1291	tons	$3,552	$4,585,642	Vendor Quote
Reagent Injection Labor	1089	hrs	$50	$54,450	Vendor quote
Reagent Injection Equipment	5%	Reagent	$4,585,642	$229,282	Engineer's Estimate
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$4,990,000***	
			Contingency (20%)	*$998,000*	
			Annual Cost + Contingency	*$5,988,000*	
			2-Year Present Worth Factor at 5.0% discount factor	*1.86*	
			Net Present Worth of 2 Years of Operation and Maintenance Costs	***$11,130,000***	
Operation, Maintenance and Monitoring Costs − GW Monitoring and IC					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Annual reporting and IC Implementation	1	annual	$67,000	$67,000	
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
			Annual Cost (Subtotal)	***$200,000***	
			Contingency (20%)	*$40,000*	
			Annual Cost + Contingency	*$240,000*	
			4-Year Present Worth Factor at 5.0% discount factor	*3.55*	
			Net Present Worth of 4 Years of Operation, Maintenance and Monitoring Costs	***$850,000***	
Closeout Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Closeout Report	1	LS	$67,000	$67,000	Previous MD Sq
			(Subtotal)	***$70,000***	
			4-Year Present Worth Factor at 5.0% discount factor	*0.82*	
			Net Present Worth of Close-out Costs	***$60,000***	
			Alternative 2B Total Cost	***$16,700,000***	***Rounded***

Assumptions

- All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
- All values are in 2010 Dollars — See Table C-1 for abbreviations and acronyms
- Net present worth discount rate is 5.0%
- 14 existing wells in the vicinity are available for injection
- 349 new wells will need to be installed, making a total of 363 injection wells
- Will inject equal amounts of reagent over 2 years
- Injection points or wells will be at about 17-37 bgs. GW velocity will be between 0.5-4 foot per day
- Initially treating a concentration of approximately 1,000 ug/L, decreasing to 500 after year 1
- SSD systems would operate for 2 years and GW monitoring would be for 4 years
- One-third of the wells will require some site prep. Other sites will be directly in roadways or right-of-ways
- Oxidant demand based on high sulfates at site
- Implementation of ICs cost based on length of time required

Table C-4

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 3

Permeable Reactive Barrier (PRB), ICs, SSD Systems, and MNA

Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Site Prep	1	LS	$10,000	$10,000	Engineer's Estimate
Decon Facilities	1	LS	$71,820	$71,820	China Lake FS
Waste Management	1	LS	$7,140	$7,140	China Lake FS
Stockpile	1	LS	$14,760	$14,760	China Lake FS
Pilot Study	1	LS	$25,000	$25,000	Vendor Quote
Excavation	700	BCY	$50	$35,000	China Lake FS
Spoil Disposal	350	BCY	$200	$70,000	China Lake FS
Zero-valent Iron for 18-38' BGS	1688	tons	$800	$1,350,400	Vendor Quote
PRB Installation	1688	tons	$148	$250,000	Vendor Quote
Barrow	163	CY	$10	$1,630	Engineer's Estimate
Fill in Lifts	630	CY	$10	$6,300	Engineer's Estimate
Street Repair	900	SY	$120	$108,000	Engineer's Estimate
Wells (9 at 40 ft)	36	LF	$450	$16,200	Engineer's Estimate
Additional SSD systems	10	Homes	$5,000	$50,000	Engineer's Estimate
Implementation of ICs	1	LS	$50,000	$50,000	Engineer's Estimate
			Subtotal	***$2,066,250***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$309,938*	
			Design (10% or $10,000 minimum)	*$206,625*	
			Construction management (15% or $10,000 minimum)	*$309,938*	
			Administrative/Legal (5% or $10,000 minimum)	*$103,313*	
			Contingency (25%)	*$516,563*	
			Total capital Costs	***$3,520,000***	
Operation, Maintenance and Monitoring Costs − SSD Monitoring					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$120,000***	
			Contingency (20%)	*$24,000*	
			Annual Cost + Contingency	*$144,000*	
			2-Year Present Worth Factor at 5.0% discount factor	*1.86*	
			Net Present Worth of 2 Years of SSD Monitoring Costs	***$270,000***	
Operation, Maintenance, and Monitoring Costs − GW Monitoring and ICs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
Annual Reporting and IC Implementation	1	annual	$67,000	$67,000	Engineer's Estimate
			Annual Cost (Subtotal)	***$200,000***	
			Contingency (20%)	*$40,000*	
			Annual Cost + Contingency	*$240,000*	
			20-Year Present Worth Factor at 5.0% discount factor	*12.46*	
			Net Present Worth of 20 Years of Operation, Maintenance and Monitoring Costs	***$2,990,000***	
Closeout Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Closeout Report	1	LS	$67,000	$67,000	China Lake FS
			(Subtotal)	***$70,000***	
			20-Year Present Worth Factor at 5.0% discount factor	*0.38*	
			Net Present Worth of Close-out Costs	***$30,000***	
			Alternative 3 Total Cost	***$6,810,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars — See Table C-1 for abbreviations and acronyms
Net present worth discount rate is 5.0%
The wall will be 375' long, 3' wide and extend to the bottom of the treatment zone
7 new monitoring wells will need to be installed
New wells: 1 additional upgradient monitoring well, 2 downgradient, and 6 in the wall (3 upgradient edge and 3 downgradient edge)
The treatment zone would be at about 18-38 bgs. GW velocity will be between 0.5-4 feet per day
Initially treating a concentration of approximately 1,000 ug/L, decreasing to 500 after Year 10 . The treatment would last for 20 years.
SSD systems would operate for 3 years and GW monitoring would be for 20 years
Implementation of ICs cost based on length of time required

Table C-5

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 4

Air Sparge/ Soil Vapor Extraction (AS/SVE),ICs, SSD Systems, and MNA

Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Site Characterization	1	LS	$30,000	$30,000	Previous MD Sq
Site Prep	1	LS	$20,000	$20,000	Previous MD Sq
AS/SVE Installation and startup	1	LS	$163,000	$163,000	Previous MD Sq
Air permitting	1	LS	$11,000	$11,000	Previous MD Sq
AS Wells (11 at 40')	440	LF	$160	$70,400	China Lake FS
SVE Wells (12 at 17')	204	LF	$160	$32,640	China Lake FS
Pilot Study	1	LS	$25,000	$25,000	Vendor Quote
Additional SSD systems	10	Homes	$5,000	$50,000	Engineer's Estimate
Implementation of ICs	1	LS	$50,000	$50,000	China Lake FS
			Subtotal	***$452,040***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$67,806*	
			Design (10% or $10,000 minimum)	*$45,204*	
			Construction management (15% or $10,000 minimum)	*$67,806*	
			Aministrative/Legal (5% or $10,000 minimum)	*$22,602*	
			Contingency (25%)	*$113,010*	
			Total capital Costs	***$770,000***	
Operation, Maintenance and Monitoring Costs − SSD					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$120,000***	
			Contingency (20%)	*$24,000*	
			Annual Cost + Contingency	*$144,000*	
			3-Year Present Worth Factor at 5.0% discount factor	*2.72*	
			Net Present Worth of 3 Years of SSD Monitoring Costs	***$390,000***	
Operation, Maintenance, and Monitoring Costs - SVE O&M, Air and GW Monitoring and ICs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
SVE O&M	1	annual	$82,000	$82,000	Previous MD Sq
Annual Air Monitoring	1	annual	$43,000	$43,000	Previous MD Sq
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
Annual Reporting and IC Implementation	1	annual	$67,000	$67,000	China Lake FS
			Annual Cost (Subtotal)	***$320,000***	
			Contingency (20%)	*$64,000*	
			Annual Cost + Contingency	*$384,000*	
			20-Year Present Worth Factor at 5.0% discount factor	*12.46*	
			Net Present Worth of 20 Years of Operation, Maintenance and Monitoring Costs	***$4,790,000***	
Closeout Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Closeout Report	1	LS	$67,000	$67,000	China Lake FS
			(Subtotal)	***$70,000***	
			20-Year Present Worth Factor at 5.0% discount factor	*0.38*	
			Net Present Worth of Close-out Costs	***$30,000***	
			Alternative 4 Total Cost	***$5,980,000***	***Rounded***

Assumptions

- All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
- All values are in 2010 Dollars — See Table C-1 for abbreviations and acronyms
- Net present worth discount rate is 5.0%
- 23 new wells will need to be installed, 12 for the SVE and 11 for the AS
- Each SVE well will have an air flow rate of 40 cubic feet per second
- Injection points or wells will be at about 20-40 bgs with a radius of influence (ROI) of 10'. GW velocity will be between 0.5-4 feet per day
- Initially treating a concentration of approximately 1,000 ug/L, decreasing to 500 ug/L after Year 10 .
- SSD systems would operate for 3 years and GW monitoring would be for 20 years
- Wells will be located in mall parking lot.
- Implementation of ICs cost based on length of time required

Table C-6

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 5

Groundwater Extraction and Treatment, ICs, SSD Systems, and MNA

Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment**
Site Characterization	1	LS	$30,000	$30,000	Previous MD Sq
Site Prep and Slab work	1	LS	$100,000	$100,000	Engineer's Estimate
Air permitting	1	LS	$11,000	$11,000	Previous MD Sq
New GW Wells (22 at 40')	880	LF	$200	$176,000	China Lake FS
Submersible Pumps	35	LS	$5,000	$175,000	Engineer's Estimate
Well Electrical Connections	35	LS	$7,500	$262,500	Engineer's Estimate
Pump Test	1	LS	$25,000	$25,000	Vendor Quote
Additional SSD systems	10	Homes	$5,000	$50,000	Engineer's Estimate
Storm Sewer Permit	1	LS	$15,000	$15,000	Engineer's Estimate
Equipment Installation	1	LS	$50,000	$50,000	Vendor Quote
Site Electrical	1	LS	$50,000	$50,000	Engineer's Estimate
Yard Piping	1	LS	$250,000	$250,000	Engineer's Estimate
Implementation of ICs	1	LS	$50,000	$50,000	China Lake FS
			Subtotal	***$1,244,500***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$186,675*	
			Design (10% or $10,000 minimum)	*$124,450*	
			Construction management (15% or $10,000 minimum)	*$186,675*	
			Aministrative/Legal (5% or $10,000 minimum)	*$62,225*	
			Contingency (25%)	*$311,125*	
			Total capital Costs	***$2,120,000***	
Operation, Maintenance and Monitoring Costs − SSD Monitoring					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$120,000***	
			Contingency (20%)	*$24,000*	
			Annual Cost + Contingency	*$144,000*	
			15-Year Present Worth Factor at 5.0% discount factor	*10.38*	
			Net Present Worth of 15 Years of SSD Monitoring Costs	***$1,490,000***	
Operation, Maintenance, and Monitoring Costs − System O&M, GW Monitoring and ICs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
GW Treatment System Rental	13.0	28-day Cycles	$4,264	$55,432	Vendor Quote
Electrical Power	16.0	Horsepower	$1,005	$16,075	See Below
Activated Carbon Replacement	4.0	per year	$11,975	$47,900	Vendor Quote
Inspection of Operations	52 weeks	14 hrs per week	$50	$36,400	Engineer's Estimate
Electrical, well and pump O&M	1%	Capital Cost	$2,120,000	$21,200	Engineer's Estimate
Annual reporting and IC Implementation	1	annual	$67,000	$67,000	Previous MD Sq
			Annual Cost (Subtotal)	***$370,000***	
			Contingency (20%)	*$74,000*	
			Annual Cost + Contingency	*$444,000*	
			20-Year Present Worth Factor at 5.0% discount factor	*12.46*	
			Net Present Worth of 20 Years of Operation, Maintenance and Monitoring Costs	***$5,530,000***	
Closeout Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Closeout Report	1	LS	$67,000	$67,000	China Lake FS
Equipment Removal	1	LS	$5,204	$5,204	Vendor Quote
Site Restoration	1	LS	$50,000	$50,000	Engineer's Estimate
			(Subtotal)	***$130,000***	
			20-Year Present Worth Factor at 5.0% discount factor	*0.38*	
			Net Present Worth of Close-out Costs	***$50,000***	
			Alternative 5 Total Cost	***$9,190,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars. See Table C-1 for abbreviations and acronyms
All values are in 2010 Dollars Net present worth discount rate is 5.0%
Peak flow is 120 gpm (10 gpm/well from 22 new extraction wells and 2 gpm/well from 13 existing wells − wells running at 50% of the time)
Discharge will be to storm sewer system after permitting. Clark County, NV does not allow discharge of GW to sanitary sewers
13 existing wells will be used. 22 new wells will need to be installed, making for a total of 35 wells
Assume $0.10 per KWH and 65% wire-to-water efficiency for motors
Injection points or wells will be at about 20-40 bgs with a radius of influence (ROI) of 10'. GW velocity will be between 0.5-4 feet per day
Initially treating a concentration of approximately 1,000 ug/L, decreasing to 500 ug/L after Year 7.
SSD systems would operate for 10 years and GW monitoring would be for 20 years
Sites will be directly in roadways or right-of-ways. No land acquisition or purchase costs are included
Electrical power and stormwater discharge point are near site and each extraction well. Carbon filters will be changed out every 6 months
No hardness control will be required in the treatment system, wells, and yard piping
Implementation of ICs cost based on length of time required

Table C-7

Maryland Square Shopping Center

Summary of Remedial Action Alternatives Costs for Groundwater

Alternative 6

In-situ Enhanced Bioremediation, ICs, SSD Systems, and MNA

Capital Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment**
Site Prep for Equipment Laydown	1	LS	$20,000	$20,000	Engineer's Estimate
New Injection Wells(48 at 40')	3040	LF	$180	$547,200	China Lake FS
Bench Scale Test	1	LS	$7,000	$7,000	Previous MD Sq
Pilot Study	1	LS	$25,000	$25,000	Vendor Quote
Additional SSD systems	10	Homes	$5,000	$50,000	Previous MD Sq
Implementation of ICs	1	LS	$50,000	$50,000	China Lake FS
			Subtotal	***$699,200***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$104,880*	
			Design (10% or $10,000 minimum)	*$69,920*	
			Construction management (15% or $10,000 minimum)	*$104,880*	
			Administrative/Legal (5% or $10,000 minimum)	*$34,960*	
			Contingency (25%)	*$174,800*	
			Total capital Costs	***$1,190,000***	
Operation, Maintenance, and Monitoring Costs − Hotspot Reagent and SSD					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Vegetable Oil Reagent	48	Wells Annually	$18,945	$909,378	Vendor Quote
Reagent Injection	1	LS	$182,000	$182,000	Vendor quote
Sub-slab and residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$1,210,000***	
			Contingency (20%)	*$242,000*	
			Annual Cost + Contingency	*$1,452,000*	
			3-Year Present Worth Factor at 5.0% discount factor	*2.72*	
			Net Present Worth of 3 Years of Operation and Maintenance Costs	***$3,950,000***	
Operation, Maintenance, and Monitoring Costs − Upgradient Reagent, GW Monitoring and ICs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Vegetable Oil Reagent	32	Wells Annually	$12,630	$404,168	Vendor Quote
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
Annual reporting and IC Implementation	1	annual	$67,000	$67,000	China Lake FS
			Annual Cost (Subtotal)	***$200,000***	
			Contingency (20%)	*$40,000*	
			Annual Cost + Contingency	*$240,000*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of Operation, Maintenance and Monitoring Costs	***$1,850,000***	
Closeout Costs					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Closeout Report	1	LS	$67,000	$67,000	China Lake FS
			(Subtotal)	***$70,000***	
			10-Year Present Worth Factor at 5.0% discount factor	*0.61*	
			Net Present Worth of Close-out Costs	***$50,000***	
			Alternative 6 Total Cost	***$7,040,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars — See Table C-1 for abbreviations and acronyms
Net present worth discount rate is 5.0%
76 new wells will need to be installed, making a total of 80 injection wells
10 year lifespan, injection of EVO in hotspot over 3 years and upgradient of residences for 10 years.
Injection points or wells will be at about 17-37 bgs with a ROI of 10'. GW velocity will be between 2-4 feet per day
Initially treating a concentration of approximately 1,000 ug/L, decreasing to 500 ug/L after Year 5.
SSD systems would operate for 3 years and GW monitoring would be for 10 years
Sites will be directly in roadways or right-of-ways
Reagent costs based on high sulfates concentrations.
Implementation of ICs cost based on length of time required

Table C-8
Maryland Square Shopping Center
Summary of Remedial Action Alternatives Costs for Groundwater

Summary				
Alternative	***Capital Costs***	***Future Costs***	***Total Cost***	**Total Cost Rank (0=Lowest)**
	$0	*$3,840,000*	*$3,840,000*	**0**
Alternative 2A: In Situ Chemical Treatment of Hotspots and Residential Area, Institutional Controls (IC), Sub-Slab Depressurization (SSD) Systems, and Monitored Natural	*$1,070,000*	*$3,040,000*	*$4,110,000*	**1**
Alternative 2B: In Situ Chemical Treatment, ICs, SSD Systems, and MNA	*$4,660,000*	*$12,040,000*	*$16,700,000*	6
Alternative 3: Permeable Reactive Barrier (PRB), ICs, SSD Systems, and MNA	*$3,520,000*	*$3,290,000*	*$6,810,000*	3
Alternative 4: Air Sparge/ Soil Vapor Extraction (AS/SVE),ICs, SSD Systems, and MNA	*$770,000*	*$5,210,000*	*$5,980,000*	**2**
Alternative 5: Groundwater Extraction and Treatment, ICs, SSD Systems, and MNA	*$2,120,000*	*$7,070,000*	*$9,190,000*	5
Alternative 6: In-situ Enhanced Bioremediation, ICs, SSD Systems, and MNA	*$1,190,000*	*$5,850,000*	*$7,040,000*	4
Minimum (except for No Action)	*$770,000*	*$3,040,000*	*$4,110,000*	
Median (except for No Action)	*$1,655,000*	*$5,530,000*	*$6,925,000*	
Average (except for No Action)	*$2,221,667*	*$6,083,333*	*$8,310,000*	
Maximum	*$4,660,000*	*$12,040,000*	*$16,700,000*	

Assumptions
All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in present worth 2010 Dollars
See Table C-1 for abbreviations and acronyms