June 14, 2011

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: **CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE PCE SITE**
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 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 April 26, 2011. The text has been modified to reflect agreements made in meetings between NDEP, Mr. Tim Swickard, Esq. and Tetra Tech on May 25 and 27, 2011. This report is being provided to BCA in both hard copy and electronic Adobe Acrobat format on this date, June 14, 2011.

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

Robert L. Manriquez, PG
Program Manager

Enclosure(s) Corrective Action Plan for Groundwater

Dist: 1/Addressee
2/NDEP, Carson City, NV
Attn: Ms. Mary Siders
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CORRECTIVE ACTION PLAN FOR GROUNDWATER
MARYLAND SQUARE PCE SITE
3661 SOUTH MARYLAND PARKWAY
LAS VEGAS, NEVADA

SUBMITTED TO
NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
BUREAU OF CORRECTIVE ACTIONS
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PREPARED FOR
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June 14, 2011

SIGNATURE PAGE

CORRECTIVE ACTION PLAN FOR GROUNDWATER
MARYLAND SQUARE PCE SITE
3661 SOUTH MARYLAND PARKWAY
LAS VEGAS, NEVADA

For the services provided and described in this document, the following language is from NAC 459:

> ***I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulations and ordinances.***

June 14, 2011

Tamara Pelham
Project Manager
Nevada Certified Environmental Manager
CEM # 1537, Exp. September 11, 2012

June 14, 2001

Robert L. Manriquez, PG
Program Manager

EXECUTIVE SUMMARY

This Corrective Action Plan (CAP) develops and evaluates potential remedies to clean up shallow groundwater contaminated with tetrachloroethene (PCE), also known as perchloroethene. The PCE contamination forms a dissolved-phase plume extending from the Maryland Square Shopping Center (the Property) to a residential neighborhood that lies downgradient. The extent of the PCE plume in shallow groundwater defines the site (Site).

The primary purpose of the Corrective Action Plan (CAP) is to establish a process, schedule and criteria by which a remedy for shallow groundwater will be evaluated and proposed for selection. The overall process is consistent with the National Oil and Hazardous Substances Contingency Plan (NCP). A secondary purpose of the CAP is to propose additional data collection, analysis and reporting needed to complete remedy selection and start design. Therefore, the objectives of the CAP are to:

1. Identify and screen general remedial actions (GRA), technology types, and process options to remediate PCE-contaminated groundwater.
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).
3. Identify Corrective Action Alternatives, or specific components thereof, for further evaluation using bench-scale and pilot testing.

Further, the CAP is intended to ensure that appropriate corrective action alternatives are developed and an appropriate corrective action is selected.

A Human Health Risk Assessment (HHRA) predicting and quantifying risk to human health will be presented in the Corrective Action Report scheduled to be completed after additional data is obtained from (1) subsequent bench-scale tests and pilot studies recommended in this draft CAP, and (2) indoor air and PCE plume delineation data are obtained and compiled as prescribed in the *Final Work Plan for Mitigation of Indoor Air and Well Water* (Tetra Tech pending).

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 the HHRA and when a final corrective action is selected in a Proposed Plan and record of decision (ROD).

Preliminary CAOs, consistent with NAC and Adopted Regulation R189-08, are:

1. Protect human health by reducing inhalation exposure to PCE and daughter products emanating from groundwater containing PCE concentrations above the remediation standard.

2. Remediate shallow groundwater where PCE concentrations exceed the remediation standard for groundwater.

The preliminary numerical remediation standard for shallow groundwater is 5.0 micrograms per liter (µg/L), the maximum contaminant level (MCL) promulgated under the Safe Drinking Water Act. The preliminary numerical remediation standard for the concentration of PCE in indoor air is the value equivalent to a 10^{-6} carcinogenic risk level. The Environmental Protection Agency's (EPA) Region IX Regional Screening Level (RSL) for residential exposure to indoor air associated with a 10^{-6} level of risk is currently 0.41 microgram per cubic meter (µg/m^3), but subject to change.

Although CAOs apply to the overall corrective action, immediate intervention to address health risk concerns in the residential area is a priority and relevant *objective* of the corrective action. For this reason, an interim corrective action is planned that will focus on the interruption of PCE migration and on remediation of groundwater beneath the downgradient residential area and the area of higher concentrations on the west side of the Boulevard Mall. Thus, "*target areas"* for the interim corrective action have been identified as the area east of the Boulevard Mall immediately upgradient of the residential area and along the east and west sides of the Boulevard Mall west parking garage.

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 all 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 Oxidation of Target Areas, Institutional Controls (IC), Subslab Depressurization (SSD) Systems, and Long-Term Monitoring (LTM)
- Alternative 2B - In Situ Chemical Oxidation of the Entire Plume, ICs, SSD Systems, and LTM
- Alternative 3 - Permeable Reactive Barrier (PRB) Upgradient of the Residential Area, ICs, SSD Systems, and LTM
- Alternative 4 – Sparge Curtain Upgradient of the Residential Area, ICs, SSD Systems, and LTM
- Alternative 5 – Groundwater Extraction and Treatment, ICs, SSD Systems, and LTM
- Alternative 6 - In Situ Enhanced Bioremediation of Target Areas, ICs, SSD Systems, and LTM.

All of these alternatives incorporate ICs and SSD systems as well as LTM to monitor decreasing PCE concentrations due to plume attenuation following implementation of the primary technology for remediation of groundwater. Based on the NCP criteria, the most promising technologies include in-situ chemical oxidation and the sparge curtain. Given the concentrations of PCE in groundwater at the site and the subsurface conditions (in particular the heterogeneity of the subsurface), an integrated approach to remediation or a combination of general response actions may be required. If in-situ chemical oxidation or a sparge curtain is proven insufficient during testing, corrective actions integrating extraction and treatment will be further evaluated. If extraction and treatment options fail, more challenging technologic applications such as a zero-valent iron (ZVI) PRB, and/or enhanced bioremediation will be reconsidered; however, given Site conditions, these technologies may have limited applicability. Until a better understanding of the field conditions and characteristics in the remediation target areas can be determined through aquifer, 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 of the existing data, additional data are needed for selection and design of the corrective action (A *Work Plan For Bench And Pilot Tests* is included as Appendix C providing details on the testing required and information to be gained):

- Aquifer testing including constant rate pumping tests, step-drawdown pumping tests and downhole resistivity testing will be conducted in the target area. Aquifer characteristics such as hydraulic conductivity, transmissivity, and ion and mineral chemistry, is required to profile relevant subsurface features within the target areas. This data will support design of in situ

chemical oxidation, sparging, and extraction and treatment systems, as well as influence considerations associated with other treatment techniques.

- Vertical delineation using FloVision® and downhole resistivity surveys in conjunction with previously collected passive bag diffusion sampling results will be used to evaluate contaminant mass migration through the subsurface in the target areas. This data will support design of in situ chemical oxidation, sparging, and extraction and treatment systems, as well as influence considerations associated with other treatment techniques.

- A bench scale test will be conducted to assess the in situ efficacy of the chemical oxidant, sodium persulfate, and determine soil oxidant demand, optimum activator, and metals mobility. If effective, a subsequent pilot test for chemical oxidant injection will be conducted.

- Pilot testing for in situ chemical oxidation with sodium persulfate, air sparging with soil vapor extraction, and ozone sparging with hydrogen peroxide will also be conducted to determine effectiveness and design parameters, including ROI, migration pathways, relative dosing requirements, mass removal rates and rate-of-reaction.

- Soil properties have not been well characterized for the target areas. Data are required for soil properties such as moisture content, porosity, grain size, horizontal and vertical permeability and contaminant distribution data; this data will be useful during well installation for aquifer testing and other pilot testing.

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1.0 INTRODUCTION

The Maryland Square Tetrachloroethene (PCE) Site (the Site) is located near downtown Las Vegas, Nevada. The Site contains a dissolved PCE plume that extends from the location of the former Al Phillips the Cleaners (APTC), in the former Maryland Square Shopping Center (the Property) at 3661 South Maryland Parkway, to more than 4,000 ft east (downgradient) (Figure 1). The historical release of PCE was initially reported to the Nevada Division of Environmental Protection (NDEP) in a spill report dated November 29, 2000, by Converse Consultants (Converse) based on a groundwater sample collected during an Environmental Site Assessment at the Property. PCE-contaminated soils are present in the source area at the former APTC facility (Converse 2002; URS 2005, 2007b).

1.1 Purpose and Organization of the Report

This Corrective Action Plan (CAP) identifies and provides an initial evaluation of technologies to remediate shallow groundwater and to prevent PCE vapors from entering soil gas, thereby protecting indoor air quality in homes in the residential neighborhood overlying the PCE plume. The CAP describes existing information for the Site and presents a scope and schedule for remediation of PCE-contaminated groundwater.

The CAP summarizes past land uses across the Site and the results of previous investigations (Section 1), the physical setting (Section 2), the nature and extent of contamination (Section 3), and the fate and transport characteristics of the primary contaminant (PCE) and its breakdown products (Section 4). Section 5 references the need for a risk assessment. Preliminary remediation standards are described (Section 6), followed by a screening of possible general remedial actions (GRA) (Section 7). Section 8 is a detailed evaluation of seven alternatives for the remediation of shallow groundwater. Section 9 includes: a discussion of the need for aquifer testing, vertical delineation, and bench and pilot-scale testing to further assess the corrective action alternatives and a proposed schedule.

The primary purpose of the Corrective Action Plan (CAP) is to establish a process, schedule and criteria by which a remedy for shallow groundwater will be evaluated and proposed for selection. The overall process is consistent with the National Oil and Hazardous Substances Contingency Plan (NCP). A secondary purpose of the CAP is to propose additional data collection, analysis and reporting needed to complete remedy selection and start design. Therefore, the objectives of the CAP are to:

1. Identify and screen GRAs, technology types, and process options to remediate PCE-contaminated groundwater and mitigate indoor air during groundwater remediation.
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).
3. Identify Corrective Action Alternatives, or specific components thereof, for further evaluation using bench-scale and pilot testing.

Corrective Action Alternatives are identified and preliminarily evaluated to ensure that an appropriate corrective action is selected. Given the heterogeneity of soil at the site, the groundwater's geochemistry, and the issues with vapor intrusion into residences, this CAP establishes a preliminary set of viable corrective action alternatives for further evaluation through bench-scale and pilot-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 corrective action system implementation.

In conjunction with this effort, a *draft Work Plan for the Mitigation of Indoor Air and Well Water* (IA/WW Work Plan) has been submitted to NDEP (Tetra Tech 2011b). When finalized, this work plan is intended to:

- develop and document strategies and protocols for routine sampling of indoor air in homes overlying groundwater exhibiting PCE concentrations at or above 100 micrograms per liter (µg/L);

- establish a program for the design, installation, and optimization of subslab depressurization systems as needed in response to current or future site conditions;
- delineate the PCE groundwater plume in the downgradient (eastern) direction to a concentration of 5 µg/L; and,
- identify domestic wells within the described plume boundaries and define and execute appropriate action to ensure PCE and associated degradation products are not exceeded in water supply wells.

The work described in the IA/WW Work Plan is to be performed concurrent with the tasks and activities prescribed in the Groundwater CAP, and it is expected that data collected for the two plans will be mutually considered, where relevant or appropriate, for the benefit of the overall remediation.

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. The former APTC facility is on the west side of South Maryland Parkway, approximately 400 ft north of Twain Avenue, across the street from The Boulevard Mall (Figure 2).

The former APTC facility has been identified by NDEP as the source of PCE contamination that forms the Maryland Square PCE plume in the shallow groundwater (Figure 3). This dissolved-phase PCE plume extends downgradient of the former APTC facility, beneath the Boulevard Mall, residential properties, and a golf course. Several golf course irrigation wells are located in the downgradient area of the PCE plume at distances ranging from approximately 3,500 to 5,600 ft east of the former APTC location. An investigation is planned for the summer of 2011 to delineate the downgradient extent of the plume to 5 µg/L PCE (Tetra Tech, pending).

1.2.1 Site Description

The Site is located in the Las Vegas Valley (Valley) approximately 1.6 miles northeast of Las Vegas McCarran International Airport. The surface topography at the Site gently slopes to the east (Figure 4). Current uses of the Site are commercial/industrial and residential. Residential properties are generally single-family homes.

APTC operated a dry cleaner facility in the Maryland Square Shopping Center at 3661 South Maryland Parkway, Las Vegas, Nevada from 1969 to 2000. The former APTC facility is on the west side of South Maryland Parkway, approximately 400 ft north of Twain Avenue, across the street from The Boulevard Mall (Figure 2).

The data for samples of soil and groundwater identify the former APTC facility as a source of PCE contamination that forms the Maryland Square PCE plume in the shallow groundwater (Figure 3). This dissolved-phase PCE plume extends downgradient of the former APTC facility, beneath the Boulevard Mall, residential properties, and a golf course. Several golf course irrigation wells are located in the downgradient area of the PCE plume at distances ranging from approximately 3,500 to 5,100 ft east of the former APTC location. An investigation is planned for the summer of 2011 to delineate the downgradient extent of the plume to 5 µg/L PCE, that will be outlined in a *Final Work Plan for Mitigation of Indoor Air and Well Water* (IA/WW Work Plan) (Tetra Tech pending).

1.2.1 Site Description

The Site is located in the Las Vegas Valley (Valley) approximately 1.6 miles northeast of Las Vegas McCarran International Airport. The surface topography at the Site gently slopes to the east. 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 at the Property. APTC took over operation of the facility later that same year from the original operator, and continued to operate the dry cleaning facility until 2000. The Property was owned by the Maryland Square Shopping Center, LLC until the Clark County School District (CCSD) purchased the Property in 2002. During a Phase II Environmental Site Assessment conducted in 2000 as part of the property transaction, PCE was detected in the groundwater at the southeast corner of the APTC facility (Converse 2000). A follow-up investigation identified PCE in soils beneath the operation area of the former APTC facility (Converse 2002). In 2004, National Dry Cleaner, Inc. (the owner of APTC) accepted financial responsibility for the investigation and remediation of PCE.

Maryland Square, LLC purchased the property from CCSD in June 2005, and demolished the former shopping center, including the concrete floor and foundation, in summer 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 adjacent property use is commercial/industrial, with residential use (apartments) several hundred feet to the northwest, and an elementary school located about 450 ft upgradient to the west.

In July 2008, National Dry Cleaners, Inc. (the owner of APTC) filed for bankruptcy, and the financial responsibility for remediating the PCE defaulted to Maryland Square Shopping Center, LLC.

Boulevard Mall

The Boulevard Mall opened in 1968 and is the oldest enclosed Mall in the Valley, currently housing approximately 140 commercial occupants. During expansion of the Mall circa 1993, several structures located on the east side of Maryland Parkway were demolished. A three-level parking garage is currently located on the east side of the Mall next to JCPenney. A three-level parking garage is also located on the west side of the Mall adjacent to Macys.

Residential Areas

Construction of the residential neighborhoods to the east (downgradient) of the Boulevard Mall began in the early 1960s. Based on a review of historical aerial photos, the Property was undeveloped prior to construction of the residential neighborhoods. Traditional slab-on-grade homes are typical for the area. Water for the residences is provided by the Las Vegas Valley Water District and 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. There may be homes and acreage properties east of Eastern Avenue which have, or have had, domestic wells. An investigation is planned for the summer of 2011 to delineate the downgradient extent of the plume to 5 µg/L PCE, and identify any domestic water supply wells that exist within the 5 µg/L contour of the PCE plume as detailed in the IA/WW Work Plan (Tetra Tec, pending).

Las Vegas National Golf Course

The Las Vegas National Golf Course was constructed in 1961, and was originally called the Stardust Country Club. The golf course has three deep water wells (PW-1, PW-2 and PW-3) located on the property for irrigation (Figure 3). According to golf course management, more than 8 million gallons of fresh water are pumped from well PW-1 per week in the summer months. The golf course management

has sampled Well PW-1 and has detected PCE at concentrations ranging from 130 µg/L in 2002 to 4.9 µg/L in 2006; the PCE detections were reported to NDEP in a letter dated May 12, 2004. NDEP wrote a letter to DCI Management Group Ltd., the owner of APTC on February 27, 2007, acknowledging their 2004 letter reporting the detection of PCE in the golf course well (NDEP 2007). PW-1 is screened from 500 to 750 ft bgs in the deep aquifer. The irrigation well has an annular seal from the ground surface to 130 ft bgs. No details are known on the sampling procedures (such as duration of pumping prior to sampling) used by the Golf Course's environmental consultant. Additional plume delineation will be performed in the area during summer 2011 as part of the IA/WW Work Plan (Tetra Tech pending)

1.2.3 Previous Investigations

A series of environmental investigations have been conducted across the Site since 2000 to assess PCE migration. PCE contamination in soil has only been found in investigations at the Property. The extent of PCE in soil at the former APTC facility was investigated and reported in 2005 and 2007 (URS 2005; URS 2007b). Several investigations have also been conducted to assess PCE in groundwater at and downgradient of APTC. In addition, a study of PCE vapors in soil gas was conducted at Boulevard Mall and in the residential neighborhood (URS 2007d). Several CAPs were also developed during this time; however, none proceeded beyond the initial investigation. Investigations were conducted by Converse Consultants from 2002 through 2004, and from 2008 to 2010, and by URS from 2005 through 2008. Table 1-1 shows a summary of the information collected in previous investigations. 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 2005.* February 6, 2005.
- URS. Quarterly Groundwater Sampling and Additional Monitoring Well Installations. March 2006. April 25, 2006.
- URS. *Quarterly Groundwater Sampling. June 2006*. July 31, 2006.
- URS. *Quarterly Groundwater Sampling. 3rd Quarter 2006*. November 14, 2006.
- URS. *Quarterly Groundwater Sampling. 4th Quarter 2006*, January 5, 2007.
- NDEP. *Groundwater Data from Golf Course Well PW-1,* February 2007.
- URS. *Source Area Soil Assessment*. February 23, 2007.
- URS. *Quarterly Groundwater Sampling, 1st Quarter 2007,* April 2, 2007.
- URS. *Off-Site Soil Vapor Assessment Report*. April 13, 2007.
- URS. *Quarterly Groundwater Sampling , 2nd Quarter 2007,* July 25, 2007.
- URS. *Installation of Downgradient Groundwater Monitoring Wells,* November 26, 2007.
- URS. *Quarterly Groundwater Sampling , 3rd Quarter 2007,* December 6, 2007.
- URS. *Quarterly Groundwater Sampling , Fourth Quarter 2007,* January 16, 2008.
- URS. Installation of Additional Downgradient Groundwater Monitoring Wells, Letter Report, March 24. 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.
- Tetra Tech. *Quarterly Groundwater Monitoring Report 3rd Quarter 2010,* October 22, 2010.
- Tetra Tech. *Quarterly Groundwater Monitoring Report 4th Quarter 2010,* January 21, 2011
- Tetra Tech. *Quarterly Groundwater Monitoring Report 1st Quarter 2011,* April 20, 2011

Quarterly groundwater monitoring has been conducted by various consultants at and downgradient of the Property since late 2005 to assess the extent of PCE contamination in groundwater. Most of the data consist of analytical data for groundwater samples collected from monitoring wells to define the distribution and extent of the dissolved-phase PCE plume in the shallow groundwater.

Data characterizing aquifer properties and soil gas for the Site are contained in three reports: an investigation by Converse (2004) and two investigations by URS (2005, 2007d). During the Converse 2004 investigation, slug tests were performed in six wells at the Site, along with some limited soil property tests on two soil samples (i.e., soil moisture, grain-size distribution, bulk density, and porosity).

The report for the Off-Site Soil Vapor Assessment (URS 2007d) provided analytical data for soil gas collected from multiple depths in 16 boreholes, along with soil geotechnical data for six soil samples. Table 6-1 in this 2007 report describes soil types ranging from clayey silt to sandy gravel. Analytical data for 32 soil vapor samples (plus four duplicate vapor samples) are presented in Table 6-2 of this 2007 report. Concentrations of PCE in these vapor samples ranged from below the analytical reporting limit to 170,000 micrograms per cubic meter (·g/m^3).

TABLE 1-1
SUMMARY OF EXISTING DATA

Data Type	Parameters/Number of Locations	Frequency / Study
Chlorinated Volatile Organic Compounds (CVOCs) in Groundwater	Method 8260B analytical data for groundwater samples from 32 wells (assuming MW-4 out of service; MW-11 sampled annually)	Annual to quarterly data
CVOCs in Soil	77 samples from 29 borings in source area	Converse, 2003; URS, 2007
Field Parameters	Dissolved oxygen (DO), oxidation-reduction potential (ORP), temperature, pH, conductivity, total dissolved solids (TDS), turbidity, water level at 32 wells	Annual to quarterly data, 160 or more samples
Inorganic parameters	Total iron, dissolved manganese, chloride, nitrate (NO_3 as Nitrogen), sulfate (SO_4), alkalinity	Irregular, 32 or more samples
Bacterial	*Dehalococcoides* (DHC) bacteria, two wells (MW-12, MW-13)	URS, 2005
Geotechnical	Soil moisture, grain-size distribution, bulk density, porosity	Converse, 2004; URS, 2007d
Aquifer tests	Slug tests	6 wells; Converse, 2004
Tracer tests	None	
Total Organic Carbon	32 wells	Irregular, 32 or more samples
Ambient Air	1 sample, summa canister with TO-15	BAI, March 2010
Soil Gas	32 samples from 16 borings	URS, 2007
Indoor Air	97 homes, 2 schools, summa canister with TO-15	Two phases, plus additional indoor hair for mitigated homes (subslab depressurization systems installed)

Source: NDEP 2011. Draft Corrective Action Plan for Groundwater, Maryland Square Shopping Center. Letter and attachments to Mr. Irwin Kishner and Mr. Tim Swickard. April 26

2.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The Valley covers roughly 1,600 square miles in southern Nevada, with the eastern edge extending to 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 ft above mean sea level (amsl) to the west. The Valley floor elevation ranges from about 3,000 ft in the west to 1,500 ft amsl in the east. (Zikmund 1996).

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 (Shevenell 1996). Mountains surrounding the basin may receive as much as 20 inches of precipitation per year, usually as snowfall. Surface water flows in the Valley are tributary to Lake Mead through Las Vegas Wash (Brothers and Katzer 1988).

2.1 Regional Hydrogeology

The Valley lies within the Basin and Range Province of the northern Mojave Desert, and is a structural basin filled with 3,000 to 15,000 ft of sediments (Langenheim and others 1998). Groundwater generally flows southeast from recharge areas in the Spring Mountains in the west and the Sheep Range in the north, toward the Las Vegas Wash and Lake Mead (Figure 4) (Leising 2004).

In the western portion of the basin, alluvial fan deposits consist of coarse-grained sand and gravel. In the lowland central and eastern portion of the basin, coarser-grained sediments interfinger with finer-grained lacustrine and playa deposits (Plume 1989, Leising 2004). In the east central area of the Valley, which includes the Site, coarser-grained deposits interfinger with layers and lenses of sandy silt, silty sand, clayey sand, sandy clay, and caliche (Plume 1989, Leising 2004). Coarser-grained deposits generally serve as aquifers, whereas silts, clays, and caliche may act as confining layers (Zikmund 1996).

The hydrostratigraphic units of the Valley are presented here as defined by Leising (2004) and illustrated on Figures 5 and 6. The upper unit consisting of a heterogeneous package of sand, silt, and clay sediments in the central and eastern areas of the Valley is termed the Las Vegas Wash Aquitard. Based on well logs on file with Nevada Division of Water Resources (NDWR), this unit may be 100 ft thick in the area of the Site. The Maryland Square PCE plume lies within the Las Vegas Wash Aquitard, but has been studied only within the upper 30 to 50 ft across the Site.

The Las Vegas Springs Aquifer underlies the Las Vegas Wash Aquitard and is subdivided into an upper unit (Las Vegas Creek Aquifer), a middle unit (Twin Lakes Aquitard), and a lower unit (La Madre Mountain Aquifer). The Las Vegas Creek Aquifer serves as the primary supply to domestic wells, and the La Madre Mountain Aquifer serves as the primary source for municipal supply wells. Based on well logs on file with NDWR, the depths to the upper and lower units of the Las Vegas Springs Aquifer within a few miles of the Site are estimated to be 100 to 200 ft bgs for the Las Vegas Creek Aquifer, and 550 to at least 750 ft bgs for the La Madre Mountain Aquifer. The Duck Creek Aquifer underlies the Las Vegas Springs Aquifer.

Recharge to the shallow groundwater system (i.e., the Las Vegas Wash Aquitard) is attributed to: (1) upward vertical flow from the Las Vegas Springs Aquifer, (2) surface infiltration of runoff, and (3) 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 downward, and in some cases, shallow groundwater may be pumped and blended with groundwater from the deeper aquifer for irrigation and industrial uses (Zikmund 1996).

2.2 Site Geology

The geology of the Site consists of interbedded layers and lenses of sand, sandy silt, sandy clay, and silty clay, along with discontinuous zones of caliche and gravel scattered throughout. Lithologic data are available for borehole logs from 33 monitoring wells installed at the Site between 2000 and 2008. The

borehole logs and well construction diagrams for all monitoring wells at the Site are provided in Appendix A. Additional lithologic information was obtained from 29 soil borings drilled for characterization of source area soils (URS 2007b), and from borings installed for active soil-gas sampling in and adjacent to the residential neighborhood (URS 2007d). The depths for monitoring wells at the Site range between 20 to 50 ft, although most wells are completed at depths between 30 and 35 ft.

Cross sections show that sediments along Algonquin Drive consist of gravelly sand and grade into silt with depth to the east (URS, 2007d). Within the neighborhood, groundwater is hosted in predominantly silty and clayey layers, with the amount of clay increasing in the eastern portion (Figure 8). Lower permeability clays and silts (silty clay, sandy clay, clayey silt, and sandy silt) dominate the saturated zone of the shallow groundwater system across most of the Site; however, the upper few feet of this zone consists of sands and silty sands in the source area and extending eastward across the Boulevard Mall property, and into the western portion of the neighborhood. This mainly sandy zone may represent portions of a paleochannel within the alluvial deposits.

Borehole logs for irrigation wells PW-1 (DWR #5675) and PW-2 (DWR #16296) at the Las Vegas National Golf Course are driller's logs, and, therefore, fairly generalized. The lithology in PW-1 is described as mainly clay/shale deposits (reddish color) with some sand and gravel "streaks" from 0 to 706 ft, and the main water-bearing gravel layer from 706 to 746 ft bgs. The well seal extends from the ground surface to 130 ft, with a screened interval from about 500 to 746 ft. The lithologic description for PW-2 notes a greater occurrence of caliche zones throughout much of the boring (total depth of 620 ft), but in particular above about 250 ft depth. Red clay and sandstone are listed as the dominant lithologies on the driller's borelog, along with a screened interval from 220 to 620 ft.

2.3 Hydraulic Properties of the Shallow Groundwater System

Depth to groundwater generally ranges between 9 to 28 ft bgs across the Site, but varies annually in each well. Based on water level data obtained in June 2010, shallow groundwater flows east with a gradient that ranges from 0.0124 to 0.0132 ft/foot (Figure 9) (Tetra Tech 2010a). Historical groundwater elevations indicate the water table has fluctuated by several feet over the monitoring period from 2000 to 2011, as illustrated on Figure 10. Data for wells adjacent to the golf course show seasonal fluctuations in water levels of approximately six feet (Figure 10). However, it is unclear whether these fluctuations represent drawdown or mounding or some degree of both.

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) representative of the Site. Calculated K values developed using the Bouwer-Rice Method (Bouwer and Rice 1976) ranged from 1.9 to 17 ft/day, whereas K values calculated using the Hvorslev Method (Hvorslev 1951) ranged from 0.8 to 6.4 ft/day.

Converse (2004) also measured total porosity and bulk density for two samples of sandy clay, yielding results of 49 to 57% for porosity, and 1.14 to 1.49 grams/cubic centimeter (g/cc) for bulk density. URS (2007d) conducted bulk density and grain size analyses for soil samples collected from three borings (SVB-5 at depths of 5.5 and 10 ft bgs, SVB-9 at depths of 3 and 8 ft bgs, and SVB-13 at depths of 8.5 and 18.5 ft bgs). Grain size ranged from clayey silt to sandy gravel, and bulk density ranged from 99.6 to 119 pounds per cubic foot or 1.6 to 1.91 g/cc.

Zikmund (1996) reported results from a study by Western Technologies (1991) to characterize basic hydraulic parameters for the shallow groundwater system in the Valley. Western Technologies tested 2- and 4-inch-diameter wells completed to depths of 25 to 30 ft bgs in downtown Las Vegas. The results of this study (summarized below) show hydraulic characteristics of the shallow groundwater system in the downtown area (near the intersection of U.S. 95 and Interstate 15), approximately 3 miles north-northwest from the former APTC site:

- 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)

Groundwater likely exhibits a range of flow velocities within the generally unconsolidated and heterogeneous geologic deposits that host the shallow groundwater at the Site. Higher rates of flow occur through the coarser grained layers (sands and gravels) and lower rates of flow through the finer grained layers (silty sands, silts, and clays). Data from two wells, USGS 43 and USGS 5 (Leising 2004) indicate that shallow groundwater northwest and southeast of the Site may best be characterized as a calcium-magnesium sulfate water, as discussed below in Section 2.4.

2.4 Geochemistry of the Shallow Groundwater System.

Groundwater in the Las Vegas Wash Aquitard is generally brackish and non-potable. Water quality in the Las Vegas Wash Aquitard generally degrades in an easterly, downgradient direction with increasing concentrations of TDS, sulfate, and sodium. The salinity of shallow groundwater is the result of evapotranspiration, dissolution of saline minerals in soils and rocks, and infiltration of irrigation water (Zikmund 1996). Groundwater in the Las Vegas Wash Aquitard in the area of the Site is a calcium-magnesium-sulfate water with a lesser bicarbonate component (Leising 2004). Some parts of the flow system also exhibit elevated concentrations of boron and nitrate (Zikmund 1996). Due to irrigation with chlorinated water from the local water system, chloroform and trihalomethanes may also be found in the shallow groundwater (Leising 2004).

Groundwater samples collected from 12 wells were analyzed for concentrations of major anions (i.e., nitrate, sulfate, chloride, bicarbonate alkalinity), total iron, dissolved manganese, total organic carbon, and dissolved oxygen (URS 2008a). Results generally agree with the regional geochemical characterization provided by Leising (2004). Sulfate is the dominant anion and ranged from 1,500 to 3,700 milligram per liter (mg/L) (URS 2008), with lesser concentrations of bicarbonate and chloride. Nitrate generally ranges from 4.5 to 23.9 mg/L in the shallow groundwater (URS 2008a), and is attributed to the heavy use of fertilizers across the Valley (Leising 2004). Total organic carbon (TOC) in shallow groundwater at the Site ranges from 1.2 to 6.0 mg/L, with one outlier of 24 mg/L in a data set of 49 samples (URS 2008a).

Field parameters (pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation-reduction potential [ORP]) are routinely measured during quarterly groundwater monitoring. The concentrations of total dissolved solids (TDS) range from 900 to 4,300 mg/L in monitoring wells installed across the Site. URS (2008a) reports detectable iron ranging from 1.2 to 38 mg/L and detectable manganese ranging from 0.0053 to 0.69 mg/L; however, turbidity is highly variable and can range from non-detectable to >999 Nephelometric Turbidity Units (NTU) due to the abundance of silt and clay in the saturated zone. Elevated concentrations of metals reported during prior investigations likely reflect the amount of turbidity (i.e., sediment) in the sample. Reported ranges and selected summary statistics for the field parameters are presented in Table 2-1.

TABLE 2-1
STATISTICAL SUMMARY OF FIELD PARAMETERS

	pH	Temp °C	SC mS/cm	Turbidity ntu	DO mg/L	TDS g/L	ORP mV
Arithmetic Mean	6.66	24.5	4.03	153	4.11	2.5	188
Standard Deviation	0.47	1.95	4.33	211	2.08	0.51	166
Median	6.8	24.45	3.68	37	4.12	2.4	170
Minimum	4.67	18.8	1.32	0	0.54	0.9	-321
Maximum	7.41	32.5	69.4	999	9.84	4.3	634
Count (n)	217	240	240	166	225	200	223

Notes:
DO - Dissolved oxygen
g/L - gram per liter
mg/L - milligram per liter
mS/cm - microSiemen per centimeter
mV - millivolts
ntu - Nephelometric Turbidity Units
ORP -oxidation-reduction potential
SC - specific conductance
TDS - total dissolved solids
Temp - Temperature

Source: NDEP 2011. Draft Corrective Action Plan for Groundwater, Maryland Square Shopping Center. Letter and attachments to Mr. Irwin Kishner and Mr. Tim Swickard. April 26

Geochemical data from the Site and the regional characterization presented by Leising (2004) indicate the geochemistry of the shallow groundwater system of the Las Vegas Wash Aquitard is an aerobic environment that likely inhibits the growth of Dehalococcoides (DHC) bacteria. In the URS 2005 investigation, the presence of DHC bacteria was investigated and reported for two wells (MW-12 and MW-13); the results were below reportable counts. The relatively high concentration of sulfate in groundwater, combined with elevated concentrations of nitrate and iron, suggest it would be difficult to induce reducing conditions that create the anaerobic geochemical environment needed to enhance either biodegradation or reductive dehalogenation of PCE and TCE.

Groundwater conditions at monitoring well MW-10 consistently exhibit a negative ORP that ranges from -140 to -330 mV. Negative ORP readings have also been observed periodically in MW-9 and MW-16, indicating the presence of isolated areas where reducing conditions may persist. However, these wells contain non-detect to low concentrations of contaminants as measured in 4th quarter 2010 (Tetra Tech 2011a). Several additional well locations typically exhibit relatively low ORP values, in the range of 50 to 210 mV, therefore, it may be possible to use additives such as EHC® (a controlled-release, integrated carbon and soluble iron product) to achieve remediation at localized areas of the Site. However, the highly oxidizing conditions across most of the site do not favor enhanced biotreatment or reductive dechlorination for remediation of PCE. To confirm the efficacy or viability of this treatment technology for limited applications, bench-scale testing or pilot testing would be necessary.

3.0 NATURE AND EXTENT OF CONTAMINATION

This section summarizes the distribution of contaminants in groundwater, soil, soil gas, and indoor air relevant to the objectives of this CAP.

3.1 Shallow Groundwater

The investigation of groundwater began in August 2000, with a limited Phase II Environmental Site Assessment of the Property (Converse, 2000a). Following the discovery of PCE in groundwater at the Property, an offsite investigation began to delineate the extent of the PCE plume, with the installation of five wells downgradient of the property (Converse, 2000b). Since that time, additional wells have been installed in a phased approach to further define the plume. Regularly scheduled monitoring of groundwater has been conducted across the Site since May 2005. Currently, 33 monitoring wells are installed at the Site, 32 of which are part of the monitoring program (Figure 3). Eleven wells in the residential area of the plume are sampled quarterly. Eleven wells in the area of the former APTC facility, the Boulevard Mall, and the southwestern residential area are sampled semi-annually. All 32 wells in the program are sampled during the 4th quarter monitoring event, and water-level measurements are collected quarterly from all 32 wells.

The PCE plume extends at least 4,000 ft east from the APTC source to the east side of the National Golf Course (Figure 3) and will be fully delineated as part of the IA/WW Work Plan (Tetra Tech pending). Approximately 700 feet east of Algonquin Drive, the width of the PCE plume increases, with expansion observed along the northern edge of the plume.(Figure 3). The width of the plume is estimated to be approximately 1,100 ft near Spencer Street. Determining the downgradient extent of the plume is the subject of the IA/WW Work Plan (Tetra Tech, pending).

Based on the rate of dissolved PCE migration across 4,000 ft in approximately 30 to 40 years, the average migration rate of the leading edge of dissolved PCE is estimated to be 100 to 130 ft/year, assuming PCE releases began in 1969 at APTC. The plume has moved with normal groundwater flow, but is attenuated to roughly half the rate of groundwater flow. The plume likely only came within the capture zone of irrigation well PW-1 after 18 to 20 years of migration. PCE was initially reported in a sample collected from PW-1 at 8.1 g/L in 1990.

The plume migration initially would have been through the fine sands and gravels as a preferential flowpath because of the higher hydraulic conductivity. Assuming a gradient of 0.013 ft/foot (Tetra Tech 2010a), an assumed average hydraulic conductivity of 15 ft/day (based on reported values provided in Section 2.3), and a porosity of 0.30, an annual, average groundwater flow rate of 237 ft/year for the shallow groundwater is derived. If the plume moved 100 to 130 ft/year, the PCE is attenuated at a factor of 1.8 to 2.4, which is within the expected range for PCE migration in a low degradation environment.

$$v = K*(dh/dl)/n*t$$
$$v = 15 \text{ ft/day} * (0.013 \text{ ft/ft})/.3 * 365 \text{ days/yr}$$
$$v = 237.25 \text{ ft/yr}$$

$$R_f = (\text{velocity of water})/(\text{velocity of contaminant})$$
$$R_f = 237/130 = 1.8$$
$$R_f = 237/100 = 2.4$$

The analytical data for PCE daughter products indicate limited, if any, degradation of PCE at the Site. Low levels of TCE and cis-1,2-dichloroethene (DCE) have been detected in wells MW-2, MW-5, and MW-6 (concentrations of about 0.5% of the PCE concentration). This is roughly the percentage that TCE occurs as a trace contaminant in industrial grade PCE. The highest concentrations of daughter products have been detected in samples from MW-6 (maximum TCE of 41 g/L; maximum cis-1,2-DCE of 23 ·g/L).

3.2 Soil Gas

In 2007, URS collected soil gas samples from multiple depths in the central residential area along north-south transects along Spencer Street and along the eastern edge of the Boulevard Mall. Soil borings were advanced to 10 and 20 ft bgs at six locations along Spencer Street (Figure 12), at six locations in the eastern parking lot of the Boulevard Mall property, and at four locations along Ottawa Drive at Algonquin Drive (Figure 13). Borings were continuously cored, and then soil gas rods were inserted with upper sections of the hole grouted so that short-term-duration soil gas samples could be collected. A tracer gas (1,1-difluoroethane) was used to detect leaks in the sampling equipment.

The highest concentration of PCE found in soil gas within the residential neighborhood was in a sample collected along Spencer Street. This sample collected from 5 feet bgs at location SVB-03 contained 46,000 micrograms per cubic meter ($\mu g/m^3$) (Figure 12). The highest PCE concentration in a soil gas sample collected near the Boulevard Mall was 170,000 $\mu g/m^3$ from 20 ft bgs at SVB-14 (Figure 13). A total of 39 samples of soil gas were collected and analyzed; seven samples contained no detectable PCE. Of the 32 samples that contained detectable concentrations of PCE, significant amounts of the tracer gas were found in four samples, indicating leakage from the atmosphere, thereby invalidating the results for these four samples.

3.3 Indoor Air

The NDEP conducted neighborhood sampling events between fall 2007 and winter 2007-2008. Between September 2007 and March 2008, the NDEP collected indoor air samples from 97 homes and two schools (Broadbent & Associates [BAI] 2008). Samples were collected in 6-liter Summa canisters over a 24-hour sampling period and then shipped to the laboratory for analyses of PCE, TCE and vinyl chloride using USEPA Analytical Method TO-15 GC/MS. Samples from fifteen of the homes contained concentrations of PCE that exceeded the NDEP's interim action level of 32 $\mu g/m^3$ for PCE in residential air (BAI 2010). The data for the indoor air samples and the BAI reports are being kept confidential by NDEP in order to respect the privacy of the homeowners. The data is available to attorneys (and their consultants) upon signing a confidentiality agreement.

Subslab depressurization (SSD) systems were installed at 14 homes, which were subsequently retested to assure that the systems successfully mitigated indoor air PCE concentrations. If indoor air PCE concentrations still exceeded the NDEP interim action level, the SSD systems were performance-tested (e.g., test the in-home pressure differential) and were modified to achieve PCE concentrations less than 32 $\mu g/m^3$ in indoor air. Subsequent sampling confirmed that homes with the SSD systems, after required modifications, exhibited PCE concentrations less than 32 $\mu g/m^3$ in indoor air (BAI 2010).

4.0 CONTAMINANT FATE AND TRANSPORT

Source Area

PCE was used in dry cleaning operations at the APTC facility from 1969 to 2000. Floor drains collected spills at the facility, 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 Property sewer line drained to the City sewer installed along the east margin of South Maryland Parkway, which drains north toward East Desert Inn Road. PCE may have migrated east of Maryland Parkway via the sewer line, with releases potentially occurring from leaks at the junction of the Property's line to the city sewer lines.

Site data from source area investigations supported the contention that PCE had been released though the concrete floor drain, because the highest PCE concentrations were found adjacent to the sump (B-10 at 120 mg/kg; B-24 at 56 mg/L) (URS 2005 and 2007b). A total of 77 soil samples from 29 soil borings delineate the extent of PCE in unsaturated soils beneath the former APTC facility (Converse, 2002, URS, 2007b). Soil sample results indicate that PCE-laden water seeped through the concrete drain and floor, continuing to migrate down through the soil until reaching groundwater. Maryland Square, LLC demolished the buildings of the former shopping center, including the concrete floor and foundation, in summer 2006.

In 2002, an additional investigation of PCE distribution in soil and groundwater provided analytical data for source area soils and groundwater (Converse, 2002). Groundwater samples collected from 12 monitoring wells showed that PCE had migrated due east from the source area, not southeast as originally thought: PCE was not detected in groundwater samples from wells MW-10 and MW-11 (Converse, 2002).

PCE concentrations up to 3,500 µg/L were detected in source area groundwater (see results for May 2005 sample from MW-1 (URS 2006a). As of 2010, PCE in groundwater in the source area had decreased to concentrations of 430 µg/L (MW-1) or less (MW-7, MW-8, MW-9, MW-12, MW-17) (Tetra Tech 2011a).

Extent of the PCE Plume in Shallow Groundwater

By mid-2005, a total of 25 wells had been installed in the APTC source area, the western and eastern parking lots at the Boulevard Mall, and into the residential neighborhood to evaluate the extent of PCE in shallow groundwater. The dissolved-phase PCE plume was found to have dispersed laterally (north-south) to a width of 300 ft at the eastern edge of the Property, and to a width of approximately 600 ft on the Mall just east of the western parking garage and in the eastern parking lot. (Converse, 2001, 2003a, 2004 and URS 2005). The URS 2005 report demonstrated that the PCE plume extended beneath the residential neighborhood, with concentrations of PCE exceeding 1,600 µg/L.

Subsequent investigations (URS 2006a, 2007f, and 2008b) established the extent of the plume to the middle of the National Golf Course (Figure 3). The width of the plume is estimated to be approximately 800 feet along Spencer Street approximately 3,000 ft from the APTC source. The downgradient extent of the plume to 5 µg/L will be delineated under work proposed in the IA/WW Work Plan (Tetra Tech pending). As of late 2010, PCE concentrations in the shallow groundwater along the centerline of the plume were estimated to be 2,500 to 3,000 µg/L near the Boulevard Mall, 1,500 to 2,000 µg/L near MW-18 and MW-23, and about 1,000 µg/L between MW-26 and MW-32. The PCE concentrations decrease quickly north and south of the centerline of the plume to below 5 µg/L within 300 to 400 ft.

Deep Groundwater

The golf course operates three irrigation wells, PW-1, PW-2 and PW-3. The golf course management has sampled well PW-1 and has detected PCE at concentrations ranging from 130 µg/L in 2002 to 4.9 µg/L in 2006; the PCE detections were reported to NDEP in a letter dated May 12, 2004. NDEP wrote a letter to DCI Management Group Ltd., the owner of APTC on February 27, 2007 informing them that their 2004 letter reporting a detection of PCE in golf course well PW-1 had been inadvertently filed in the case file for a different golf course, and this had delayed the NDEP's response (NDEP 2007).

Well PW-1 is screened from 500 to 750 ft bgs in the deep aquifer, although the filter pack extends to 130 ft bgs. The grout seal extends from 130 ft bgs to the surface. According to the property management, more than 8 million gallons of fresh water are pumped from well PW-1 per week in the summer months. The path of the PCE to the production zone of the well is unknown; it could be through a failure of the well seal or through vertical migration below the 130-foot depth of the seal. Investigation of the golf course well and the interaction of shallow and deep groundwater are proposed in the IA/WW Work Plan (Tetra Tech pending).

Migration and Retention of PCE

As presented in Section 3.1, the shallow groundwater flow across the site is from west to east at an estimated average annual flow rate of approximately 237 ft/yr. Based on the dissolved PCE plume migrating about 4,000 ft in 30 to 40 years, the average migration rate of the leading edge of the PCE plume is estimated to be 100 to 130 ft/year, with an attenuation factor of 1.8 to 2.4.

Interbedded sands and silty to sandy gravels likely provide a preferential flow path that has allowed migration of the plume at a rate faster than the "average" flow rate for the aquitard. These sands and silty to sandy gravels would allow migration at the required rates to produce the plume dimensions observed by 2008, and as indicated by the PCE detected at PW-1 in 1990.

As previously discussed, the aquitard at the Site is a heterogeneous package of alluvial deposits, consisting of interbedded layers and lenses of clay, silt, sand, and gravel (e.g., silty clay, sandy clay, silty sand, clayey sand, and sandy gravel). PCE in silt and clay beds and lenses may be retained and act as a secondary source as the more transmissive zones are cleaned up more quickly. In other words, rebound of PCE into groundwater may occur from the diffusion of PCE that is retained in these finer grained sediments, after the application of corrective action treatment technologies.

Biodegradation and Treatment of PCE

Biodegradation of PCE occurs under anaerobic (i.e., reducing) conditions. An evaluation of groundwater monitoring data suggests very little, if any, degradation of PCE occurs within the shallow groundwater system. Concentrations of PCE have likely persisted for at least 40 years at the Site, during which time daughter products TCE and *cis*-1,2-DCE have been detected only at low concentrations that are within the range of concentrations of impurities in industrial grade PCE used in dry cleaner operations.

The site chemistry is strongly aerobic across most of the site, although there may be pockets of anaerobic zones, as exemplified by conditions near well MW-10 that exhibits a negative ORP range of -140 to -330 mV. However, MW-10 has a low to below the analytical reporting limit concentration of PCE. Two groundwater samples were analyzed to ascertain the population of DHC bacteria; however, DHC bacteria were not found at measurable quantities (URS, 2005). Aerobic conditions inhibit the growth of DHC bacteria, so the results are consistent with the lack of reducing conditions in the shallow groundwater system. Sulfate is present in the groundwater at relatively high concentrations (1,500 to 3,700 mg/L, URS 2008c), so artificially inducing reducing conditions would require infusion of many moles of electron donors, which likely would produce high concentrations of sulfide, which inhibits the growth of DHC bacteria. Therefore, inducing reducing conditions by injecting only electron donors (such as HRC®) is not likely to be effective. However, induced reductive dehalogenation using a product such as EHC® may be

possible where PCE occurs in areas that have low or negative ORP readings (i.e. in limited areas of the Site). This may be cost-effective in areas where the ORP is no higher than 200 mV. Bench-scale and pilot-scale testing would be necessary to evaluate the feasibility of this treatment option. As of the date of this report, ORP measured within the PCE plume indicates oxidizing conditions that would inhibit the growth of DHC bacteria.

5.0 HUMAN HEALTH RISK ASSESSMENT

A screening level risk evaluation (SRE) was completed by the NDEP (NDEP 2008); mitigation measures taken at the residences were based on this SRE and an identified indoor air interim remediation standard of 32 $\mu g/m^3$ risk level of corresponding to10^{-4}. The HHRA will be developed with existing historical data and data collected in the upcoming sampling events for groundwater, indoor air and well water (Tetra Tech pending). The HHRA will be utilized to evaluate final remedies and be presented in the Corrective Action Report.

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 chemicals of concern (COC), affected media, and potential exposure pathways.

The following preliminary CAOs address potential risks to human health and the environment, and are consistent with NAC and Adopted Regulation R189-08:

1. Protect human health by reducing inhalation exposure to PCE and daughter products emanating from groundwater containing PCE concentrations above the remediation standard.

2. Remediate shallow groundwater where PCE concentrations exceed the remediation standard for groundwater.

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.

Although CAOs apply to the overall corrective action, immediate intervention to relieve health risk concerns in the residential area is a priority and relevant *objective* of the corrective action. For this reason, preliminary corrective actions will focus on the interruption of PCE migration and remediation of groundwater quality beneath the downgradient residential area and the area of higher concentrations on the west side of the Boulevard Mall. These preliminary "*target areas"* for remediation are defined as the area east of the Boulevard Mall, immediately upgradient of the residential area, and along the east and west sides of the Boulevard Mall west parking garage.

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, (and adopted by reference at NAC 445A.22735(1)(b)), 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," at the point of end use. A drinking water standard, like the MCL, may not be appropriate for the shallow groundwater at the Site if naturally occurring groundwater quality is so poor it is not likely to serve as a potential source of drinking water. Furthermore, Section 14 of Revised

Proposed [and adopted] Regulation R189-08, issued by the NDEP Bureau of Corrective Actions, prescribes the criteria required to conclude corrective action activity, that relies, in part, on source control; interruption to, or remediation of, exposure pathways; and the likely use of groundwater based on quality characteristics. However, groundwater is "waters of the state," (NRS 445A.415) and NDEP asserts that regulations require "no degradation" of waters of the state (NDEP 2011a). No promulgated numerical standards apply to concentrations of PCE in indoor residential air.

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 corresponding to a cancer risk level of 10^{-4}. A risk-based concentration of PCE in indoor air that is not expected to cause an increased incidence of cancer greater than 10^{-6} is considered protective for long-term exposure. This value is also considered the point-of-departure dictating corrective action, and is established by the EPA Region IX Regional Screening Level (RSL) for residential exposure. Currently, the RSL for residential indoor air is 0.41 $\mu g/m^3$, however, this value is subject to update and revision biennially.

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 can be as low as 0.03 $\mu g/m^3$ using the Environmental Protection Agency Method (EPA) Method Toxic Organic-15 (TO-15) for the determination of volatile organic compounds in ambient air and employing quadrapole mass spectrometry for select ion monitoring (SIM). TO-15 analyses employing less sophisticated detection methods commonly achieve PQLs of 0.3 $\mu g/m^3$ (TO-15 low level) or 1.4 $\mu g/m^3$ (standard TO-15). Laboratory PQLs are low enough to detect PCE concentrations in indoor air of associated with a risk level of 10^{-6}.

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.

Because commonly available analytical methods can accurately detect concentrations below the 10^{-6} risk level, the RSL associated with the 10^{-6} cancer risk level is designated as the preliminary remediation standard for purposes of designing and implementing corrective action. If the RSL value decreases below analytical PQLs, the PQL will supersede the RSL as the preliminary remediation standard. In addition, these preliminary values are expected to be refined after completion of a human health risk assessment, which will be presented in the Corrective Action Report. Numerical remediation standards will become final when the corrective action is selected in a Record of Decision.

7.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents GRAs, remedial technologies, and process options to address shallow groundwater above the remediation standard. In general, the same or similar GRAs, remedial technologies, and process options are applicable in the source area, Boulevard Mall, and residential areas; therefore, these areas have been combined for evaluation. However, considerations like safety issues, noise, and property access, among other factors, limit options in the residential neighborhood. Remedial technologies and process options are developed and screened based on implementability, effectiveness, and cost (United States Environmental Protection Agency [EPA] 1988). After the remedial technologies are evaluated, they are combined into corrective action alternatives.

Soil in the source area is being addressed as part of the CAP for Source Area Soil (Tetra Tech 2010). The CAP for Source Area Soil recommends excavation of soil containing concentrations of PCE in excess of the residential EPA Region IX Residential Regional Screening Level (RSL) of 550 micrograms per kilogram (µg/kg) for residential soil; disposal of the soil in a permitted off-site hazardous waste landfill; and addition of a chemical oxidant to the footprint of the excavation. After soil excavation (to groundwater, which is found at approximately 18 ft bgs) and disposal, the open excavation provides an opportunity for additional treatment of PCE using chemical oxidation in soil and groundwater below the excavation. Data obtained from corrective action in the source area can be subsequently used to evaluate effectiveness of chemical oxidation as part of remedy selection for groundwater.

7.1 General Response Actions

GRAs were derived from engineering judgment and experience with corrective actions proven successful for remediation of dissolved phase PCE in groundwater. 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, diffusion, dilution, or adsorption. LTM can be utilized in conjunction with MNA to monitor decrease in contaminant concentrations due to plume attenuation.
- 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 and/or LTM, (5) treatment, and (6) containment. Process options strictly 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. Given the concentrations of PCE in groundwater at the Site, the subsurface conditions, it is likely that an integrated approach to remediation or a combination of general response actions will be required.

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.

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 without implementing 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 is not 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 executed 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 source of drinking water due to poor water quality; however, groundwater is considered “waters of the state,” and regulations require “no degradation” of waters of the state. Domestic water supply wells at the Site are not permitted by the Department of Conservation and Natural Resources, Division of Water Resources. However, some residents or businesses may continue to pump and use shallow groundwater without regulatory or municipal authorization (existing wells are to be abandoned when the business or residence is connected to the municipal water supply). ICs may mitigate unauthorized use and exposure to shallow groundwater by virtue of education and awareness; however, this type of groundwater use cannot be reasonably precluded through ICs or other administrative or engineering controls. Individual domestic water supply wells are being addressed in the IA/WW Work Plan (Tetra Tech pending).

When used properly and as intended, ICs are effective, implementable, and low cost. Therefore, ICs were 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 or subslab vapor barrier 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 was retained. Subslab vapor barriers could be effective for future construction; therefore, this process option also was retained. Because (1) the location and status of unauthorized groundwater wells is unclear and (2) shallow groundwater is not a designated source of drinking water, engineering controls (e.g. individual wellhead treatment units) addressing individual groundwater wells were not considered. Individual domestic water supply wells are being addressed in the IA/WW Work Plan (Tetra Tech pending).

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.
		Subslab Vapor Barrier	An impermeable vapor barrier is placed below the building's foundation before construction.	Moderate	Easy - Moderate	Low – Moderate	Potentially applicable for new buildings/residences. Important to ensure material is compatible with contaminant. 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 biodegradation; 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. High sulfate concentration in groundwater may reduce effectiveness. May be difficult to implement in situ; nutrients and other amendments are difficult to deliver. Aquifer shows no signs of ongoing biodegradation.
		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	Typically a source control technology used for gross mass reduction. 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.
		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
Treatment (continued)	In Situ Chemical Treatment	In Situ Chemical Oxidation	Chemicals (such as ozone, potassium permanganate, or sodium persulfate) 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.
		Ozone Sparging	Inject ozone into the saturated subsurface to treat organic contaminants in groundwater.	Moderate – High	Moderate	Moderate – High	Potentially applicable. Design and effectiveness of system depends on geology, depth of contaminants, and dispersion of ozone; operations and maintenance (O&M) intensive.
Removal/ Containment/ Treatment	Ex Situ Physical/Chemical Treatment	Extraction and Treatment	Contaminated groundwater is removed by pumping, and contaminants are removed or destroyed 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 chemicals of concern (COC) 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 require additional treatment prior to 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.

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 corrective action 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 described in Section 4, very little if any degradation of PCE occurs within the shallow groundwater system. As such, any natural attenuation of contaminant concentrations would likely be due to processes other than biological degradation. Because it may be physically impossible to actively treat all areas of the plume to completion, LTM may be utilized to monitor the reduction of contaminant concentrations as the concentrations approach and drop below corrective action goals. Therefore, LTM was retained as part of a groundwater treatment train, in conjunction with a more aggressive primary 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 oxidation, sparge curtain (air sparging in conjunction with soil vapor extraction (SVE) or ozone sparging), PRB using in situ chemical dechlorination, and enhanced bioremediation. Groundwater 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 both in the laboratory and in the field. 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 can effectively treat PCE, and the costs are expected to be moderate to high. Chemical oxidation is implementable; however, success implementing the technology depends on site geology because it influences the ability to distribute the oxidant within the treatment zone. Chemical oxidant is typically injected via direct push; however, given the presence of caliche at the site, permanent injection wells may 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) achievable under injection. A contingency plan to detail precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted.

If injection were to proceed in the residential area, consideration should be given to safety issues and disruptions to residents. Careful planning and control is needed when injecting near residences or underground utilities that could provide preferential pathways; however, given that the depth to groundwater in most cases is more than 17 ft bgs, preferential pathways via utility corridors are not likely. It should be noted that groundwater has been measured at less than 9 feet bgs in MW-8, which is located in the western part of the residential neighborhood in May 2005 (NDEP 2011b). It may be difficult to inject oxidant in the residential area and achieve an adequate ROI, assuming that injection would only occur in the public right of ways and that overhead utilities must be avoided. Injection via direct push or a hollow stem auger drill rig is noisy and can be disruptive to traffic if done in roadways. Given the size of and concentrations in the plume, multiple injections are likely.

In Situ Chemical Reduction

Implementation of in situ chemical reduction is similar to in situ chemical oxidation. Chemicals are injected into groundwater to degrade PCE abiotically through reductive dechlorination. Typically zero-valent iron (ZVI) or ZVI combined with a carrier (e.g., clay or granular activated carbon [GAC]) are employed.

Although in situ chemical reduction can effectively treat PCE; the costs are expected to be moderate to high. Chemical reduction is implementable; however, success implementing the technology depends on site geology because it influences the ability to distribute the chemical within the treatment zone. Elevated sulfate concentrations in groundwater may influence the cost and performance of this technology. While some have suggested that ZVI can directly reduce sulfate to sulfide, it is more commonly noted that reduction of sulfate is biologically mediated (Environmental Technologies, Inc. [ETI] 2007). Introducing ZVI into groundwater would produce reducing conditions that would allow anaerobic bacteria to thrive. If sulfate reducing bacteria are present, they would reduce dissolved sulfate to sulfide, which would in turn react with ZVI and potentially result in some passivation of the ZVI surface. In such cases, it becomes necessary to provide more ZVI to compensate for this loss of reactive surface. Consequently, sulfate is an important anion and must be carefully considered when present at such elevated concentrations. However, elevated concentrations of dissolved sulfate do not automatically disqualify ZVI as a potential treatment option. Studies have shown that ZVI can still effectively treat chlorinated ethenes such as PCE in the presence of elevated sulfate concentrations. ETI has performed column tests on groundwater from various sites containing up to 6,000 mg/L of sulfate with little or no interference from sulfate (ETI 2007).

Reducing agent is typically injected via direct push, but given the presence of caliche at the site, a drill rig would be required. If field application is to be further considered, bench-scale and pilot tests should be conducted to determine the effectiveness of chemical reduction, the influence of site-specific geochemistry, the effects of sulfate and electron acceptor concentrations on cost, and the ROI for injection

If injection were to proceed in the residential area, consideration should be given to safety issues and disruptions to residents. Careful planning and control is needed when injecting near residences or underground utilities that could provide preferential pathways; however, given that the depth to groundwater in most cases is below 17 ft bgs, preferential pathways via utility corridors are not likely. It should be noted that groundwater has been measured at less than 9 feet bgs in MW-8 located in the western part of the residential neighborhood in May 2005. (NDEP 2011b). It may be difficult to inject in the residential area and achieve an adequate ROI, assuming that injection would only occur in the public right of ways and that overhead utilities must be avoided. Injection via direct push or a hollow stem auger drill rig is noisy and can be disruptive to traffic if done in roadways.

Sparge Curtain

Air sparging (AS) combined with soil vapor extraction (SVE) is often used 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, and partitions chlorinated solvents from the geologic media and groundwater into the vapor phase. The function of the SVE system is to capture and extract VOCs migrating into and through 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 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, implementation in residential areas should consider if SVE can effectively capture vapors produced by sparging and prevent their migration into indoor air.

Ozone sparging is similar to air sparging in that ozone is injected into the saturated zone below or within the chemical plume through a system of injection wells. However, the primary remedial mechanism is in-situ reaction and not physical removal of contaminants. The ozone dissolves in the groundwater and oxidizes dissolved contaminants, ultimately producing carbon dioxide and water.

Sparging technologies may be applicable in source areas, areas of higher PCE concentrations, or as a curtain east of the Boulevard Mall to intersect and treat the plume before it flows under the residential neighborhood. Pilot tests should be conducted to determine the effectiveness of sparging, ozone treatment, and/or SVE and associated ROIs.

Installation and operation of air sparging and/or AS/SVE in the residential area would be challenging. The design would need to be overly conservative to ensure that vapors were captured and not infiltrating into homes. Installation would be challenging with wells likely required on both private property and the public right of way. The installation and operation of the system might be considered a nuisance by residents due to the presence of work crews, noise, etc.

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 flow 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 (however, a biologically active wall could be utilized as well). 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 install a PRB.

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 (treatment efficiency) may diminish. Bench-scale treatability testing would be 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. Additional information on chemical reduction through use of ZVI is presented above.

Enhanced Bioremediation

In situ bioremediation involves microbial degradation of contaminants in groundwater. As described in Sections 2 and 4, bioremediation is not likely occurring at an appreciable rate at the Site. 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 are designed to stimulate the biodegradation of chlorinated solvents by manipulating these conditions or requirements in the subsurface (biostimulation). Some systems further augment biodegradation by adding naturally occurring or engineered microorganisms particularly suited for the breakdown of certain chemicals (bioaugmentation).

Enhanced in situ bioremediation systems for groundwater use various delivery mechanisms, degradation mechanisms, and nutrient/biological amendments that depend on site-specific characteristics. DHC bacteria have not been found at the Site; therefore, bioaugmentation would likely be required. The absence of DHC is likely due to the predominantly aerobic conditions in the aquifer. However, given that the ORP of groundwater in many of the wells is generally in the range of 50 to 210 mV, it should be cost-effective to artificially create reducing conditions. In addition, because sulfate is present in the groundwater at high concentrations, sulfate reducing bacteria will produce high concentrations of sulfide,

which might inhibit DHC. Therefore, biostimulation through injection of electron donors alone is not likely to be effective. This is evident in the poor performance of HRC® that has been used as a biostimulant at sites in the Las Vegas area (NDEP 2009). However, electron donors combined with ferrous gluconate have had some success in high sulfate groundwater. This may be because dissolved sulfide concentrations are reduced through reaction with dissolved iron. This suggests that reductive dechlorination using iron containing product such as EHC® or an alternate electron donor combined with ferrous gluconate might be possible. Should an integrated corrective action approach involve the use of enhanced bioremediation, bench-scale testing is required to determine the most effective form of enhancement and/or augmentation.

Containment, Removal and Treatment

Groundwater Extraction and Treatment

Extraction and treatment of groundwater is an ex situ remediation technology whereby groundwater is removed from the subsurface through a network of extraction wells. Extracted groundwater is pumped to a treatment facility where the dissolved contaminants are removed. Air stripping and GAC are typical removal strategies for chlorinated solvents.

The geology of the Site consists of interbedded layers and lenses of sand, sandy silt, sandy clay, and silty clay, along with discontinuous zones of caliche and gravel scattered throughout. As presented in Section 2.2, the upper few feet of this zone consists of sands and silty sands in the source area and extending eastward across the Boulevard Mall property, and into the western portion of the neighborhood. This mainly sandy zone may represent portions of a paleochannel within the alluvial deposits. The geology of the well borings indicates that the sand intervals have limited lateral extent as typical of stream channel deposits. The change in facies from sand to silt and clay along the margin of the channel deposits create hydraulic boundaries which limit the extent of the production or capture zone of wells.

Soil samples collected from the Site indicate the sand intervals frequently contain appreciable silt or clay (as much as 30 to 40%). Hydraulic tests at the site and in nearby areas of the City of Las Vegas indicate hydraulic conductivities likely range from 0.8 to 20 ft/day or 6 to 150 gpd/ft^2. Assuming saturated intervals of 25 ft and 20 ft of available drawdown, the yields of individual wells may range from 1 to 20 gpm, with sandy zones at the higher rates and silts at the lower rates. However, considering the numerous hydraulic barriers and limited unit thicknesses created by the heterogeneous conditions, and superposition effects from the influence of adjacent extraction wells, steady state production rates can be expected to be significantly lower-in the range of 0.2 to 8 gpm. The sand zones will likely be depleted relatively quickly, with the capture zone of the well field likely being dewatered. The use of injection wells to return treated water to the groundwater system can help minimize the potential negative effects of a remedial production well field. Although greater production rates can be achieved by installing the wells to depths of 50 to 60 ft bgs in the Las Vegas Wash Aquitard, such well construction may only lead to greater dewatering of the shallow groundwater system. The well system would likely operate intermittently. Saturated clays at the Site would likely dewater and may shrink. Production tests should be conducted within several silt, sand and gravel units at the Site to evaluate whether pump and treat is a viable alternative for remediation of groundwater at the Site.

Furthermore, treatment by air stripping or GAC will generate a secondary waste stream, and high TDS concentrations in the treated wastewater discharge may present complications due to water quality standards. If TDS must be removed from treated water before surface discharge, disposal, or reinjection, costs will be high. As with sparging and AS/SVE, installation and operation of a extraction system in the residential area might be considered a nuisance by residents due to the presence of work crews, noise, etc. Despite these practical constraints, extraction and treatment may also be effective as a hydraulic control; therefore, the technology was retained for further consideration.

8.0 DEVELOPMENT AND DETAILED ANALYSIS OF ALTERNATIVES

Preliminary CAOs and numerical remediation standards were identified in Section 6 of the draft CAP. Corrective action alternatives were developed and evaluated based on the CAOs and numerical remediation standards. Additional data acquisition is necessary to evaluate current site conditions (delineation of the 5 µg/L plume and geophysical parameters), evaluate risks, and more fully assess the viability of the cleanup applications (bench-scale and pilot scale testing and groundwater modeling to assess the efficacy of extraction and treatment). These sampling data 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 Target Areas, ICs, SSD Systems, and LTM
- Alternative 2B – In Situ Chemical Treatment of the Entire Plume, ICs, SSD Systems, and LTM
- Alternative 3 – Permeable Reactive Barrier Upgradient of the Residential Area, ICs, SSD Systems, and LTM
- Alternative 4 - Sparge Curtain Upgradient of the Residential Area, ICs, SSD Systems, and LTM
- Alternative 5 – Extraction and Treatment, ICs, SSD Systems, and LTM
- Alternative 6 – In Situ Enhanced Bioremediation of Target Areas, ICs, SSD Systems, and LTM.

The following sections describe the evaluation criteria (Section 8.1), describe and evaluate the corrective action alternatives for groundwater (Section 8.2), and provide a comparative analysis of the alternatives based on the evaluation criteria (Section 8.3). General assumptions made in developing cost estimates for the alternatives are presented in Appendix B.

8.1 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. Each corrective action alternative was developed and evaluated according to seven evaluation criteria. After additional data are obtained, 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 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 current knowledge of the site parameters and hydrologic and engineering judgment has been used to assume remediation timeframes for each of the alternatives. Bench-scale and pilot testing will be conducted to confirm site-specific conditions, and the remedial design will be based on

physical data. Groundwater modeling that interprets field measurements and observations, and enhances understanding of site-specific parameters and remediation scenarios will be conducted for the site when adequate data are obtained. Modeling and bench-scale and pilot studies will refine projected 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 within 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. Costs were estimated for 30 years even if the alternative was projected to take longer.

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

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. A present value analysis of each alternative is presented in Appendix B of this document.

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 among alternatives, but the cost estimates are not intended for use in detailed budgetary planning. Costs for each alternative are compiled in Appendix B. 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. NDEP has indicated its concern with the viability of in situ reductive treatment and enhanced bioremediation, given the Site's geochemistry (NDEP 2011a). The Site's geochemistry, in particular high TDS and sulfate concentrations, may make implementation of in situ reductive treatment and enhanced bioremediation challenging; however, it is not considered a fatal flaw. The viability of these technologies with respect to site-specific conditions including the geochemistry will be further evaluated in this document.

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; the current risks would remain. The on-site community may be exposed to additional risks from groundwater if higher concentrations migrated under the residential neighborhood and increased the number of residences with indoor air above the interim action level.
- 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 as PCE mass flows off site. Groundwater modeling with site-specific parameters could predict the timeframe associated with this process. For purposes of this assessment, groundwater and air monitoring were considered to continue for 30 years, the typical maximum timeframe for cost estimate purposes, although contamination would likely remain onsite for significantly longer.

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 Oxidation of Target Areas, Institutional Controls, Subslab Depressurization Systems, and Long-Term Monitoring

Alternative 2A combines in situ chemical oxidation of the target areas (the plume with concentrations above 1,000 µg/L near the Boulevard Mall western parking lot and upgradient of the residential area), ICs, the SSD systems, and LTM. Under this alternative, a chemical oxidant is injected into the subsurface in the target areas of the plume 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. LTM would measure attenuation of the plume occurring as a residual effect of treatment and subsurface alteration further reducing 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 sodium persulfate; however, bench-scale testing may determine that a different oxidant is preferable based on site-specific conditions. Sodium persulfate 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 for several months; does not decrease permeability in the subsurface; and is the most effective for the site contaminants. The assumptions made for the purposes of this CAP and costing are detailed in Appendix B.

Injection would occur over the top 20 ft of the shallow aquifer in the area near the Boulevard Mall with concentrations of PCE greater than 1,000 µg/L and upgradient of the residential area and in a line perpendicular to the plume (in the Boulevard Mall eastern parking lot). The injection wells in the in the area near the Boulevard Mall with concentrations of PCE greater than 1,000 µg/L would likely require four rounds of injection of sodium persulfate, and 10 years of annual injections uppgradient of the residential area. However, additional injection may be required based on the rate of PCE desorption from the soil matrix. The assumptions made for the purposes of this CAP and costing are detailed in Appendix B.

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; however, bench-scale testing conducted at the source area has shown a fairly low soil oxidant demand. If bench-scale testing is successful, pilot studies could 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 of those 14 properties from risk caused by vapor intrusions of PCE into indoor air. If new SSD systems are required in other properties 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, LTM will track further reduction of residual PCE concentrations due to plume attenuation. Upon completion of data gathering and pilot testing, groundwater modeling could be used to more accurately predict the timeframe in which 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 established through subsequent risk assessment to be protective of indoor air.

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

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 remediated using in situ chemical oxidation. The injection of a 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 oxidation. 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 oxidation 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 in commercial areas. 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. Injections would not occur in close proximity to residences, and given that the depth to groundwater in most cases is below 17 ft bgs, preferential pathways via utility corridors are unlikely. A contingency plan to detail precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted.
- 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 could be minimized through bench-scale and pilot testing, engineering controls, and proper design. While initial injection of chemical oxidant may release sorbed PCE into the aquifer, this PCE would subsequently be destroyed after reacting with the oxidant. The oxidation of trivalent chromium to hexavalent chromium and its consequent mobilization is not anticipated at this Site; however, as is common with chemical oxidation, even if hexavalent chromium is formed, it will return to its trivalent state as soon as it migrates out of the treatment zone. Oxidation and mobility of metals will be evaluated during bench-scale testing. Chemical treatment may increase TDS in the aquifer, and oxidants like permanganate can reduce permeability over time due to precipitation of manganese dioxide.
- The corrective action is estimated to take 30 years with four rounds of injections in the plume in the area near the Boulevard mall with concentrations of PCE greater than 1,000 µg/L and 10 rounds upgradient of the residences. For cost estimating purposes, it was assumed that the SSD systems could be turned off after 10 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 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. The lithology and contaminant distribution in the target areas needs additional delineation, 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 ft per day) may cause the chemical to wash out of the system too quickly. 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 bench-scale and pilot study and may affect the implementability and effectiveness of chemical treatment. Problems with site access or drilling issues could impact the schedule.

- The 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 chemical oxidant 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 $4,060,000. The total present value cost for Alternative 2A would be $7,100,000.

State Acceptance

This criterion will be further evaluated after comments on this CAP have been received from NDEP and subsequent to pilot testing. However, the NDEP has indicated that a contingency plan will be required (NDEP 2011a).

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 Oxidation of the Entire Plume, Institutional Controls, Subslab Depressurization Systems, and LTM

Alternative 2B combines in situ chemical oxidation of the entire plume (as practical), ICs, the SSD systems, and LTM. Under this alternative, a chemical oxidant 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, abiotic MNA would be relied on to further decrease PCE concentrations.

In situ chemical oxidation (by sodium persulfate) 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. Given the depth to groundwater, injectate migration via utility corridors is not expected; however, careful planning would accommodate conservative safety requirements. It was assumed that all injection wells would require three rounds of injection of sodium persulfate. However, additional injection may be necessary depending on the rate of PCE desorption from the soil matrix. 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 B. 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 LTM 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 employed to ensure continued operation of SSD systems. After chemical treatment, LTM would be relied on to monitor decreasing residual PCE concentrations due to attenuation of the plume. 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 B.

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 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 low-level risks to the community because the corrective action would be applied in situ in all areas of the Site. PCE sorbed to soil may be released and require treatment. 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. Drilling and injection in the public right of ways in the residential area may be considered a nuisance to residents due to noise and traffic issues. Careful planning should be used when injecting near residences or underground utilities that could provide preferential pathways; given the depth to groundwater is in most cases below 17 ft bgs, preferential pathways via utility corridors are unlikely. It should be noted that groundwater has been measured at less

than 9 feet bgs in MW-8 located in the western part of the residential neighborhood in May 2005. (NDEP 2011b), A contingency plan detailing precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted.

- 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 could be minimized through bench-scale and pilot testing, engineering controls, and proper design. Displacement of contaminated groundwater by site-wide injections may be problematic and increase the target area. While initial injection of chemical oxidant may release sorbed PCE into the aquifer, this PCE would subsequently be destroyed after reacting with the oxidant. The oxidation of trivalent chromium to hexavalent chromium is not anticipated at this Site; however as is common with chemical oxidation, even if hexavalent chromium is formed, it will return to its trivalent state as soon as it migrates out of the treatment zone. Bench-scale and/or pilot tests should additionally evaluate the potential to displace groundwater containing dissolved PCE and provide a basis to specify proper engineering controls to mitigate this ramification. Chemical treatment may increase TDS in the aquifer, and oxidants like permanganate can reduce permeability over time due to precipitation of manganese dioxide.
- The first phase of the corrective action is estimated to take 2 years with three rounds of injections. An additional 5 years of LTM 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. Access to injection locations may be an issue. 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 ft per day) may cause the chemical to wash out of the system too quickly. 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 oxidant 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 $18,550,000. The total present value cost for Alternative 2B would be $23,210,000.

State Acceptance

This criterion will be further evaluated after comments on this CAP have been received from NDEP. However, NDEP has indicated that widespread injection especially in the residential area is unacceptable due to safety concerns (NDEP 2011a).

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 Upgradient of the Residential Area, Institutional Controls, Subslab Depressurization Systems, and LTM

Alternative 3 combines a PRB, ICs, the SSD systems, and LTM. Under this alternative, a ZVI PRB would be installed upgradient of the residential area to treat contaminated groundwater as it flows into the residential area. LTM would monitor the further reduction of concentrations of PCE in groundwater due to plume attenuation. 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 20 ft below the top of the shallow saturated zone. Given the estimated installation depth, trenching may be challenging. The PRB could also be installed via hydraulic fracturing and injection if this method is 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 at 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 B.

Bench-scale and pilot testing would determine the effectiveness, dosing rates, and any geochemical interference at the Site. High sulfate concentrations at the Site may impact barrier performance. If sulfate is reduced to sulfide it would react with the ZVI and reduce the available reactive surface. Additional ZVI may have to be provided to compensate for this. When sulfate reduction occurs in PRBs, it is generally observed in the first few inches of the barrier. Precipitation of iron sulfides (FeS and FeS_2) would reduce permeability of the barrier over time. If bench-scale testing reveals the possibility for such precipitation, other treatment media could be used upgradient of the PRB to remove sulfate. If bench-scale testing is successful, pilot studies would be conducted in the area before full-scale implementation to verify applicability of bench-scale results to field conditions. These tests would also allow for refinement of costs. The costing purposes installation of a replacement PRB was assumed after 30 years.

SSD systems, ICs, groundwater and indoor air monitoring, and LTM 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, LTM would be utilized to observe decreases in PCE concentrations due to plume attenuation. For cost estimating purposes, it was assumed that groundwater monitoring would be necessary for 30 years. Indoor air sampling would be maintained until groundwater concentrations in the residential area decrease to levels protective of indoor air (assumed to be 10 years).

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

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 downgradient of the PRB 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 PCE 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 (replacement was assumed after 30 years of life, but it could be 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 30 years. For cost estimating purposes it was assumed that the SSD systems could be turned off after 10 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; however, Site conditions (e.g. high sulfate concentrations) may make its application challenging. 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 ft 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. Potential loss of permeability and sulfate reduction 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 $2,800,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $5,340,000. The total present value cost or Alternative 3 would be $8,140,000.

State Acceptance

This criterion will be further evaluated after comments on this CAP have been received from NDEP. However, NDEP has indicated that this technology does not seem viable given sulfate conditions at the Site (NDEP 2011a). While high sulfate and electron acceptor concentrations at the Site would require the addition of more ZVI, chemical reducing agents have been utilized effectively at sites with high sulfate. The feasibility of this alternative and the effect of sulfates can be determined through bench-scale testing.

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: Sparge Curtain Upgradient of the Residential Area, Institutional Controls, Subslab Depressurization Systems, and LTM

Alternative 4 combines sparging wells upgradient of the residential area (in a sparge curtain), ICs, the SSD systems, and LTM. This alternative could be implemented in two different ways, the use of ozone sparging for in situ treatment or AS/SVE. Data obtained during pilot scale testing would provide additional information necessary to help choose the more effective and efficient sparging method. For consideration on this alternative, it was assumed that 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 PCE-laden sparged air as it migrates upwards into the vadose zone. Clean water would flow from the downgradient edge of the sparge curtain. With the source area cut off, LTM would be utilized to measure concentrations of PCE in groundwater due to plume attenuation downgradient of the curtain. 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 ft 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 PCE-laden sparged air.

The treatment system would conceivably be installed under the eastern mall parking lot (and the system could be expanded to treat other areas with high PCE concentrations). 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 GAC units in series before discharge to the atmosphere; however, another form of treatment may be used if found economically preferable. An air permit would be required for the SVE system. Also, an assumed 30 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 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. In addition the potential for groundwater mounding could be initially assessed during pilot testing. These tests would also allow for refinement of costs. The assumptions made for the purposes of this CAP and costing are detailed in Appendix B. If implementation proves favorable, additional system expansion to reduce remedial timeframes may be considered.

SSD systems, ICs, groundwater and indoor air monitoring, and LTM are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. In addition to the AS/SVE treatment, LTM would monitor decreases in PCE concentrations due to plume attenuation. For cost estimating purposes, it was assumed that groundwater monitoring would be necessary for 30 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 B.

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. Sparing would reduce concentrations of PCE in groundwater in the residential area 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. Groundwater monitoring would be conducted to determine that the concentrations of PCE 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. Groundwater level monitoring would be conducted after system startup to ensure that sparging was not causing groundwater mounding; varying sparging regimes (pulsing, etc) can be evaluated for their effects on groundwater mounding as part of optimization procedures.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes removal of VOCs in groundwater and subsequent treatment. Sparging 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 SVE 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 30 years. For cost estimating purposes it was assumed that the SSD systems could be turned off after 10 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 versus ozone sparge wells, the impact of site-specific conditions, and the ROI and well spacing of the 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 sparging 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 $6,030,000. The total present value cost for Alternative 4 would be $6,800,000.

State Acceptance

This criterion will be further 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 LTM

Alternative 5 combines groundwater extraction and treatment, ICs, the SSD systems, and LTM. Under this alternative, groundwater would be removed from the subsurface and treated; LTM would be utilized to monitor post-treatment activity and additional reductions of PCE concentrations in groundwater due to plume attenuation. ICs and SSD systems would protect residents from PCE in indoor air until groundwater is treated to protective levels.

Groundwater would be extracted from within the plume, treated to remove PCE, and then re-injected. Extraction and injection wells would be installed where possible and would cover the entire plume. An estimated 14 extraction wells and 15 injection wells would be needed. Two treatment systems (one located in the mall parking lot and the other on the golf course property) would be considered. Treated water would be delivered to injection wells surrounding the PCE plume. It is expected that wells in

residential areas would be installed in right of ways. The wells would be screened in the top 20 ft 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 extracted groundwater could be reinjected after treatment to remove PCE but without treatment to reduce TDS. Some or all treated water may also be discharged to the sewer or supplied for irrigation if these options are later found to be more cost-effective. The assumptions made for the purposes of this CAP and costing are detailed in Appendix B.

Pumping tests, as well as bench-scale and pilot tests, would be required to determine the effectiveness of the alternative, aquifer characteristics, design criteria, and best suited water treatment techniques. These tests would also allow for refinement of costs. Given the geology at the Site, there will likely be localized dewatering of the formation at each extraction well. The sorbed PCE in the dewatered zone could re-contaminate groundwater when pumping stops. To reduce the impact of this phenomenon, it is expected that pumping will be pulsed rather than continuous. This aquifer has exhibited slow recharge of groundwater, indicating low hydraulic conductivity, which may make this technology difficult to implement and lead to a long remedial timeframe. The remedial duration is calculated at more than 40 years based on basic equilibrium partitioning and required pore volume exchanges. However, it is expected that the actual remedial duration will be much longer because of aquifer material heterogeneity and the tendency for fine-grained materials to be cleaned up slowly. Groundwater modeling should be completed to determine well placement. These tests would also allow for refinement of costs.

Discharge or reinjection of treated groundwater may be problematic due to elevated concentrations of TDS in extracted groundwater. Residents may find the installation of wells and the piping system in the right of way in neighborhood to be a nuisance.

SSD systems, ICs, groundwater and indoor air monitoring, and LTM are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. In addition to extraction and treatment, LTM would be relied on to monitor decreasing residual PCE concentrations due to plume attenuation. For cost estimating purposes, it was assumed that groundwater monitoring would be necessary for 30 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 B.

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 LTM would monitor concentrations of PCE in groundwater to below the preliminary remediation standards as they decreased due to plume attenuation. However, as noted, this is expected to take over 40 years. 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.

Reduction in Toxicity, Mobility, and Volume through Treatment

This alternative includes removal of PCE in groundwater and subsequent treatment. It would reduce the toxicity and volume 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 to moderate risks to the community. Drilling and trenching equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures. There would be a high level of drilling and trenching, which would disrupt surface activities in the area and would lead to physical hazards. The noise and construction during installation in the residential area may be considered a nuisance by residents. Groundwater would be extracted from the subsurface and pumped through piping to a target area; appropriate security, signs, and warnings could protect the community from accidental contact with the contaminated water.
- On-site workers may be exposed to physical and chemical risks while installing the wells, piping, electrical system, treatment plant, system operation and maintenance, 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 and would include potential increases to Site TDS if reinjection is used.
- For cost estimating purposes, a lifetime of 30 years was assumed; it was also assumed that the SSD systems could be turned off after 10 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. Dewatering is likely. Hydrogeology between the existing monitoring wells is not well defined in the target area, 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. 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 Groundwater Discharge Permit for re-injection or a National Pollutant Discharge Elimination System (NDPES) permit for surface discharge of treated groundwater would be required. Regulatory limitations applicable to the discharge of TDS mass to surface water or groundwater may adversely affect the permissibility or permit options associated with this treatment strategy such that this alternative becomes inhibited.

Cost

The capital cost of Alternative 5 would be $1,740,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $8,710,000. The total present value cost for Alternative 5 would be $10,450,000.

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 of the Target Areas, Institutional Controls, Subslab Depressurization Systems, and LTM

Alternative 6 combines enhanced in situ bioremediation, ICs, the SSD systems, and LTM. Under this alternative, enhanced bioremediation would be employed in areas of the plume in the target area to treat groundwater. (This design was for conceptual purposes, and it should be noted that this does not necessarily coincide with the areas where the aquifer conditions are amenable to reductive dechlorination as described in Section 4). ICs and SSDs would protect residents from PCE in indoor air until groundwater is treated to protective levels. LTM would monitor decreasing concentrations of remaining contamination found in groundwater due to plume attenuation.

Enhanced bioremediation would be applied through injection of substrates or microbes in the plume hot spot where practicable based on preferable ORP values and where logistically practicable, including at the Property and in streets, public right of ways, and parking lots in the Boulevard Mall. For the purposes of this study it was assumed biostimulaltion and bioaugmentation would be required (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. Amendments would be injected into the top 20 ft of aquifer at the site. The assumptions made for the purposes of this CAP and costing are detailed in Appendix B.

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. Based on the aquifer characteristics, very few biostimulants have potential to be effective.

SSD systems, ICs, groundwater and indoor air monitoring, and LTM are similar to the descriptions detailed in Alternative 2A in Section 8.2.2. In conjunction with bioremediation, LTM would be utilized to monitor decreasing residual PCE concentrations due to plume attenuation. For cost estimating purposes it was assumed that groundwater monitoring would be necessary for 30 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 B.

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 30 years with two injections in the in the area near the Boulevard mall with concentrations of PCE greater than 1,000 µg/L and three injection rounds upgradient of the residences. For cost estimating purposes it was assumed that the SSD systems could be turned off after 10 years.

Implementability

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

- The alternative is considered technically challenging, and there are several considerations. Much of the Site is not conducive to bioremediation. 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; given sulfate concentrations at the Site, EHC is likely one of the few substrates that will be effective. Potential transformation of chemicals and residual breakdown products would be monitored during the pilot study and may affect implementability and effectiveness of the alternative. 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 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 $1,240,000. The present value of O&M costs, including groundwater and indoor air monitoring, would be $15,090,000. The total present value cost for Alternative 6 would be $16,330,000.

State Acceptance

This criterion will be further evaluated after comments on this CAP have been received from NDEP. However, NDEP has indicated that high sulfate concentrations at the Site may make this alternative unviable (NDEP 2011a). While high sulfate and electron acceptor concentrations at the Site would require the addition of more EHC, this alternative may be viable in certain areas of the Site with favorable ORP values. The feasibility of this alternative and the effect of sulfates can be determined through bench-scale testing.

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 acceptance is based on comments received to date (NDEP 2011a), 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:

- Aquifer testing and vertical delineation are conducted in the target area.
- Additional data for effectiveness and design are gathered from bench scale and pilot testing.
- The risk assessment is complete.
- 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 8-2 provides a simplified table of additional data requirements for each technology.

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.	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 but increased risk if PCE concentrations in groundwater and indoor air increase. It is assumed monitoring would be required for 30 years.	Easy − This alternative is technically implementable,	Capital Costs: None O&M Costs: $3,840,000	The no action is unacceptable to NDEP.	Low − The no action alternative would likely be unacceptable to the community.
2A	In Situ Chemical Oxidation of Target Areas, Institutional Controls, SSD Systems, and LTM	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 in the area near the Boulevard mall with concentrations of PCE greater than 1,000 µg/L 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. It is assumed the SSD systems could be turned off after 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: $1,070,000 O&M Costs: $6,030,000 Total: $7,100,000	The NDEP has indicated a contingency plan will be required (NDEP 2011a).	This criterion would be evaluated after comments on the proposed plan have been received from the community.
2B	In Situ Chemical Oxidation of the Entire Plume, Institutional Controls, SSD Systems, and LTM	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.	Moderate − Minimal risk as the corrective action is applied in situ; however, injection in the residential area public right of ways may be considered a nuisance by residents. Precautions can be taken to prevent exposure of workers and the community during implementation. Environmental impacts are expected to be low to moderate. It is assumed the remediation goal would be reached in approximately 5 years.	Moderately Difficult to 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. It may be difficult given structures and utilities to inject chemical oxidant into the entire plume. This alternative is administratively feasible. An underground injection permit would be required for chemical application.	Capital Costs: $4,660,000 O&M Costs: $18,550,000 Total: $23,210,000	NDEP is concerned with the safety of injecting in the residential neighborhood (NDEP 2011a).	This criterion would be evaluated after comments on the proposed plan have been received from the community.
3	Permeable Reactive Barrier Upgradient of the Residential Area, ICs, SSD, Systems, and LTM	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 to moderate; however this alternative may increase TDS in the aquifer. It is assumed the SSD systems could be turned off after approximately 10 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: $2,800,000 O&M Costs: $5,340,000 Total: $8,140,000	NDEP has expressed concerns regarding the viability of this treatment technology due to high sulfate concentrations (NDEP 2011a).	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	Sparge Curtain Upgradient of the Residential Area,, ICs, SSD Systems, and LTM	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 sparging. Sparging 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 SSD systems could be turned off after approximately 10 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: $770,000 O&M Costs: $6,030,000 Total: $6,800,000		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 LTM	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 − 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 over 40 years, and SSD systems could be turned off after approximately 10 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. Dewatering is likely 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: $1,740,000 O&M Costs: $8,710,000 Total: $10,450,000	NDEP has expressed interest in use of extraction and treatment (NDEP 2011a).	This criterion would be evaluated after comments on the proposed plan have been received from the community.
6	In Situ Enhanced Bioremediation of Target Areas, ICs, SSD Systems, and LTM	High − Residents are protected from PCE in indoor air until groundwater concentrations are decreased by bioremediation. Treatment would decrease concentrations in the plume in the area of higher concentrations at the Boulevard mall (concentrations of PCE greater than 1,000 µg/L 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 SSD systems could be turned off after approximately 10 years.	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: $1,240,000 O&M Costs: $15,090,000 Total: $16,330,000	NDEP has expressed concerns regarding the viability of this treatment technology due to high sulfate concentrations and high ORP found across the Site.	This criterion would be evaluated after comments on the proposed plan have been received from the community.

Notes:
AS Air sparge
NDEP Nevada Division of Environmental Protection
PCE Tetrachloroethene
TDS Total dissolved solids
CAP Corrective action plan
NPDES National Pollutant Discharge Elimination System
PRB Permeable reactive barrier
GAC Granular activated carbon
O&M Operation and maintenance
SSD Subslab Depressurization
LTM Long-term monitoring
ORP Oxidation reduction potential
SVE Soil vapor extraction

TABLE 8-2
SUMMARY OF TECHNOLOGY ADVANTAGES AND DISADVANTAGES

Technology	Current Data and Use for Evaluation	Data Needed
In Situ Chemical Oxidation	• PCE concentrations in groundwater (concentrations are within the treatment range of in situ chemical oxidation). • Metals concentrations in soil and groundwater (concentrations are low enough that metals mobility should not be an issue, but additional testing required) • Lithologic logging, soil type, and groundwater velocity (current boreholes in target area, however, more contiguous vertical delineation is needed).	• Aquifer pump tests. • Vertical delineation of lithology and tetrachloroethene (PCE) distribution in target areas . • Bench scale testing including soil oxidant demand, dosing requirements, optimal activator, and metals mobility testing. • Geotechnical testing to determine porosity, grain size distribution, soil type. • Pilot testing for effectiveness, radius of influence (ROI), preferential pathways, injection method.
Sparging,	• PCE concentrations in groundwater (concentrations are within the treatment range of sparging). • Lithologic logging (current boreholes in target area, however, more contiguous vertical delineation is needed).	• Aquifer pump tests. • Vertical delineation of lithology and PCE distribution in target areas. • Geotechnical testing to determine porosity, grain size distribution, and soil type. • Pilot testing for effectiveness, ROI, air permeability, flow rates, and vapor capture.
Extraction and Treatment,	• PCE concentrations in groundwater (concentrations are within the treatment range of chemical reduction). • Total dissolved solids data (elevated concentrations may make system operation challenging). • Lithologic logging (current boreholes in target area, however, more contiguous vertical delineation is needed).	• Aquifer pump tests. • Vertical delineation of lithology and PCE distribution in target areas. • Geotechnical testing to determine porosity, grain size distribution, and soil type. • Pilot testing for ROI and treatability of groundwater.
ZVI Permeable Reactive Barrier,	• PCE concentrations in groundwater (concentrations are within the treatment range of chemical reduction). • Anion concentrations (high sulfate concentrations make implementation challenging). • Lithologic logging (current boreholes in target area, however, more contiguous vertical delineation is needed).	• Aquifer pump tests. • Vertical delineation of lithology and PCE distribution in target areas. • Bench scale testing including dosing required and fouling potential. • Geotechnical testing to determine porosity, grain size distribution, and soil type. • Pilot testing for effectiveness and preferred installation method.
In Situ Enhanced Bioremediation,	• PCE concentrations in groundwater (concentrations are within the treatment range of chemical reduction) and presence of PCE-daughter products (daughter products not present at concentrations that would indicate degradation is occurring) • Presence of anaerobic conditions (negative oxidation reduction potential (ORP) values at limited locations across Site that are not associated with target areas) • Limited microbial speciation data indicates relative absence of specific degraders and hindered ability to introduce cultured bacteria and/or enhancing substrates (no DHC bacteria present at Site)	• Vertical delineation of lithology and PCE distribution in target areas. • Bacterial analysis. • Bench-scale testing to assess inoculation and amendment effectiveness • Pilot testing to determine effectiveness of application and treatment.

9.0 RECOMMENDATIONS

This section (1) recommends the preferred corrective action alternatives based on the NCP evaluation criteria; (2) provides a list of field activities for obtaining data to evaluate and implement a corrective action, and (3) provides a schedule for bench-scale and pilot testing and submittal of the Corrective Action Report.

9.1 Recommended Corrective Action Alternative

Given the concentrations of PCE in groundwater at the site and the subsurface conditions (in particular the heterogeneity of the subsurface), an integrated approach to remediation or a combination of general response actions may be required. In 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 the NCP criteria, the most promising technologies include:

- in-situ chemical oxidation; and,
- a sparge curtain

If in-situ chemical oxidation or a sparge curtain, or a combination of both, is proven insufficient or problematic during field testing, corrective actions integrating the remedial effects of extraction and treatment will be further evaluated. If extraction and treatment options fail, more challenging technologic applications, such as a zero-valent iron (ZVI) PRB, and/or enhanced bioremediation, will be reconsidered; however, given Site conditions, these technologies may have limited applicability. Until an a better understanding of field conditions and characteristics in the remediation target areas can be determined through aquifer, bench-scale, and pilot testing, the practical application or effectiveness of a particular Corrective Action Alternative to meet CAOs and preliminary remediation standards cannot be confirmed.

9.2 Additional Testing

Based on preliminary evaluations of alternatives for the Site, bench-scale or pilot tests should be conducted to provide site-specific application data and to refine the evaluations of the alternatives. Based on a review of the existing data, the following tests and additional data collection are recommended:

- Aquifer testing including constant rate pumping tests and step-drawdown pumping tests will be conducted in the target area. Aquifer characteristics such as hydraulic conductivity, transmissivity, and ion and mineral chemistry, is required to profile relevant subsurface features within the target areas. This data will support design of in situ chemical oxidation, sparging, and extraction and treatment systems, as well as influence considerations associated with other treatment techniques.

- Vertical delineation using FloVision® and downhole resistivity surveys in conjunction with previously collected passive bag diffusion sampling results (Appendix E) will be used to evaluate contaminant mass migration through the subsurface in the target areas. This data will support design of in situ chemical oxidation, sparging, and extraction and treatment systems, as well as influence considerations associated with other treatment techniques.

- A bench scale test will be conducted to assess the in situ efficacy of the chemical oxidant, sodium persulfate, and determine soil oxidant demand, optimum activator, and metals mobility. If effective, a subsequent pilot test for chemical oxidant injection will be conducted.

- Pilot testing for in situ chemical oxidation with sodium persulfate, air sparging with soil vapor extraction, and ozone sparging with hydrogen peroxide will also be conducted to determine effectiveness and design parameters, including ROI, migration pathways, relative dosing requirements, mass removal rates and rate-of-reaction.

- Soil properties have not been well characterized for the target areas. Data are required for soil properties such as moisture content, porosity, grain size, horizontal and vertical permeability and contaminant distribution data; this data will be useful during well installation for aquifer testing and other pilot testing.

A *Work Plan For Bench And Pilot Tests* is included as Appendix C providing details on the testing required and information to be gained.

9.3 Schedule

The planned schedule for implementation of the recommended tests and additional data collection efforts is:

Task	Timeline
Obtain treated water discharge permits for aquifer testing	Within 3 weeks of work plan approval
Solicit bids for well installation and aquifer testing equipment	Within 3 weeks of work plan approval
Collect soil samples for persulfate bench-scale testing	Within 2 weeks of work plan approval
Complete persulfate bench-scale testing	Within 2 weeks of collecting soil samples
Award work for well installation and pumping tests	Within 2 weeks of soliciting bids
Obtain underground injection control (UIC) permit for pilot tests	Within 7 weeks of completing persulfate bench-scale test
Install new wells, start aquifer tests and collect baseline soil samples from pilot test areas	Within 3 weeks of bid award
Complete aquifer tests and sample collection	Within 2 weeks of starting pumping tests
Solicit bids for pilot testing equipment/services	Within 4 weeks of completing bench-scale tests
Award subcontract for pilot tests	Within 1 week of obtaining UIC permits
Start pilot tests	Within 1 week of awarding subcontracts
Complete pilot tests	Within 8 weeks of starting pilot tests
Complete pilot tests data analysis	Within 2 weeks of completing pilot tests
Complete Corrective Action Report	Within 180 days of work plan approval.

1 - The schedule is dependent upon work plan approval by NDEP, client execution, ability to gain access to the Site, and the timely issuance of permits.

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FIGURES

0 500 1,000 Feet

Approximate Scale in Feet

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

FIGURE 1
Location Map

TETRA TECH

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Source: Clark County Assessors Web Site

Scale: 0Feet 200 Feet

N

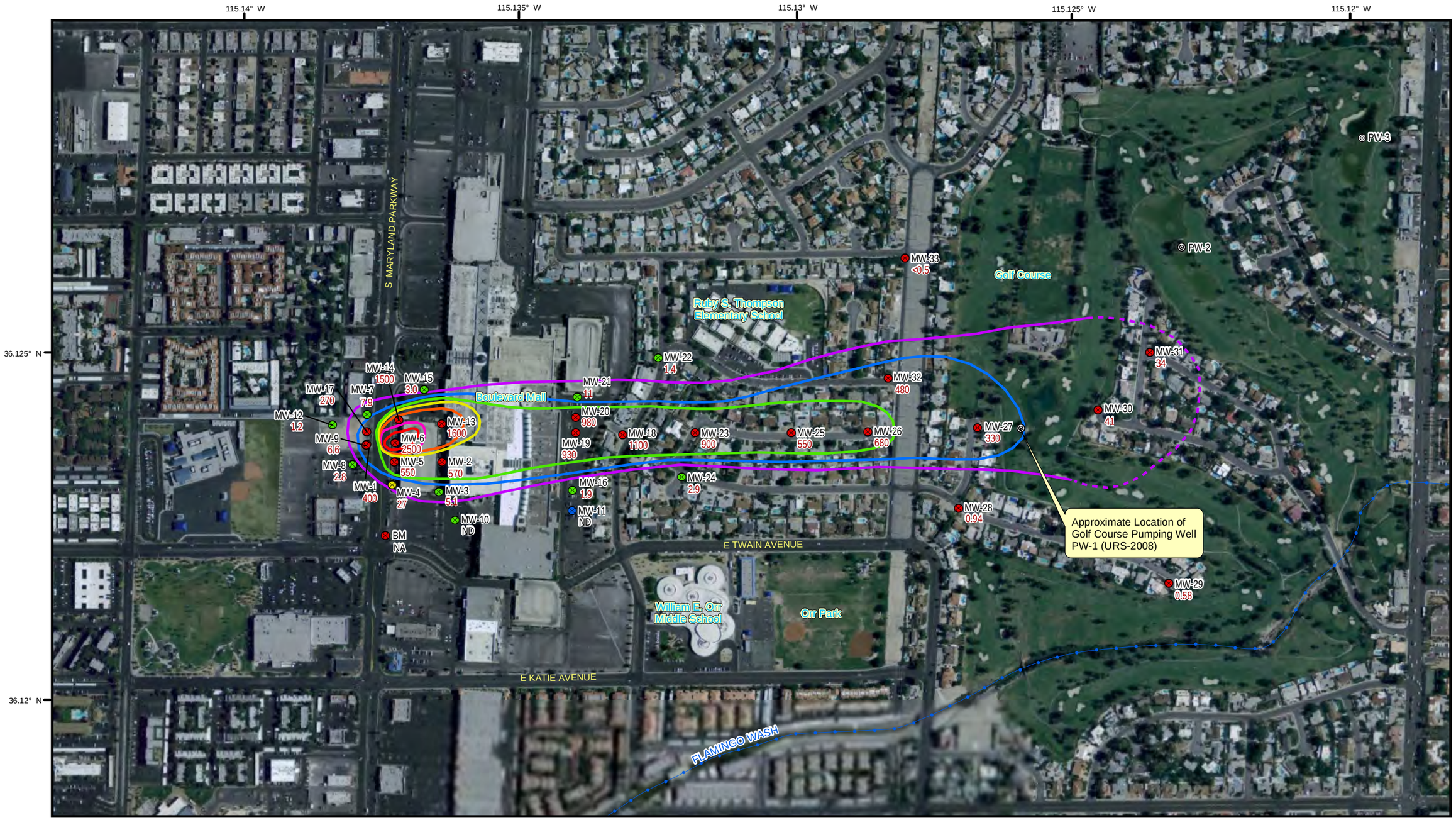
MARYLAND SQUARE SHOPPING CENTER
3661 South Maryland Parkway
Las Vegas, NV

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)
- Pumping Well Location

- 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)

PCE Tetrachloroethylene
PQL Practical Quantitation Limit
URS URS Corporation
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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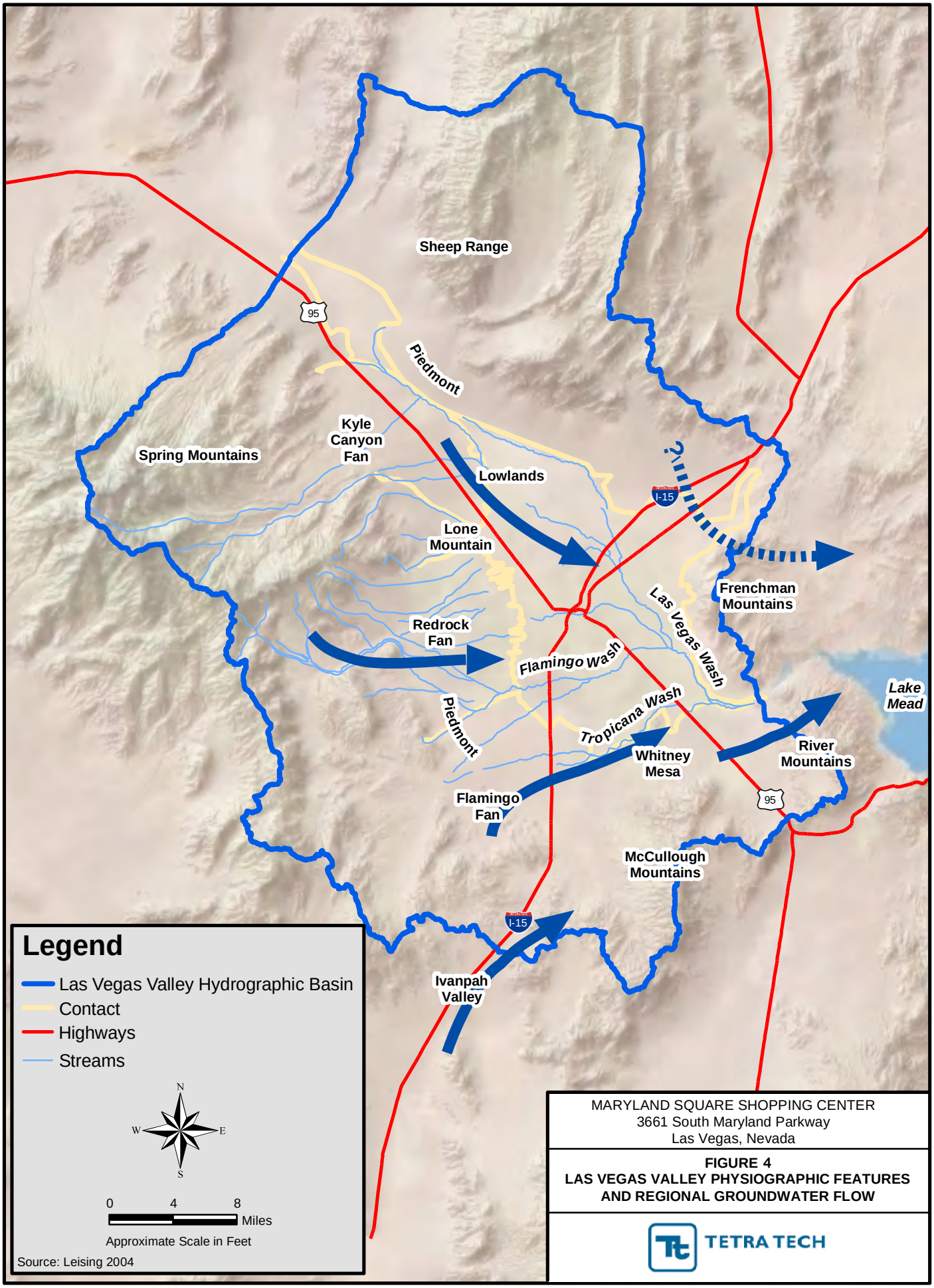

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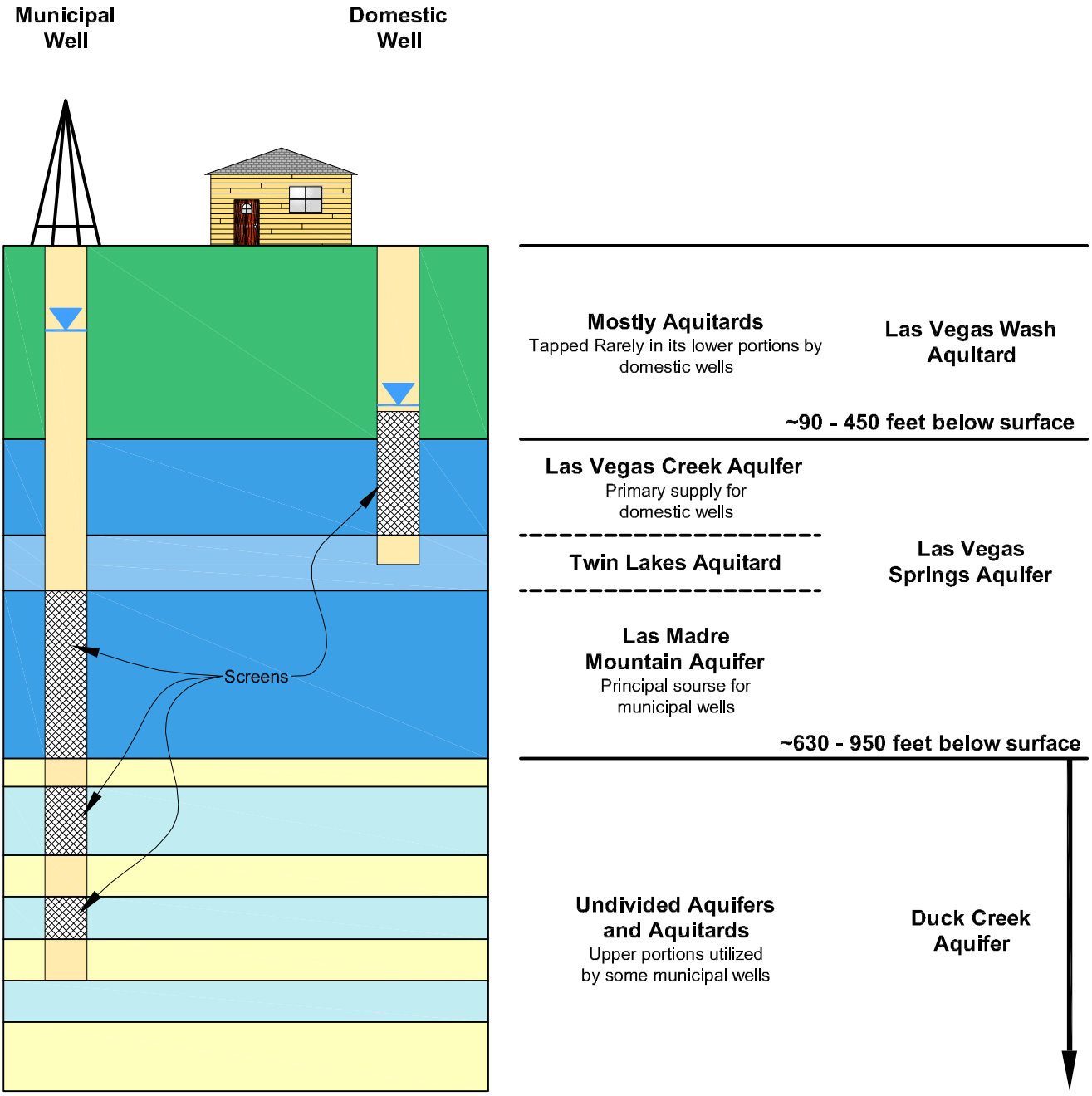
Las Vegas, Nevada

FIGURE 4
LAS VEGAS VALLEY PHYSIOGRAPHIC FEATURES AND REGIONAL GROUNDWATER FLOW

TETRA TECH



Not to Scale

MARYLAND SQUARE SHOPPING CENTER
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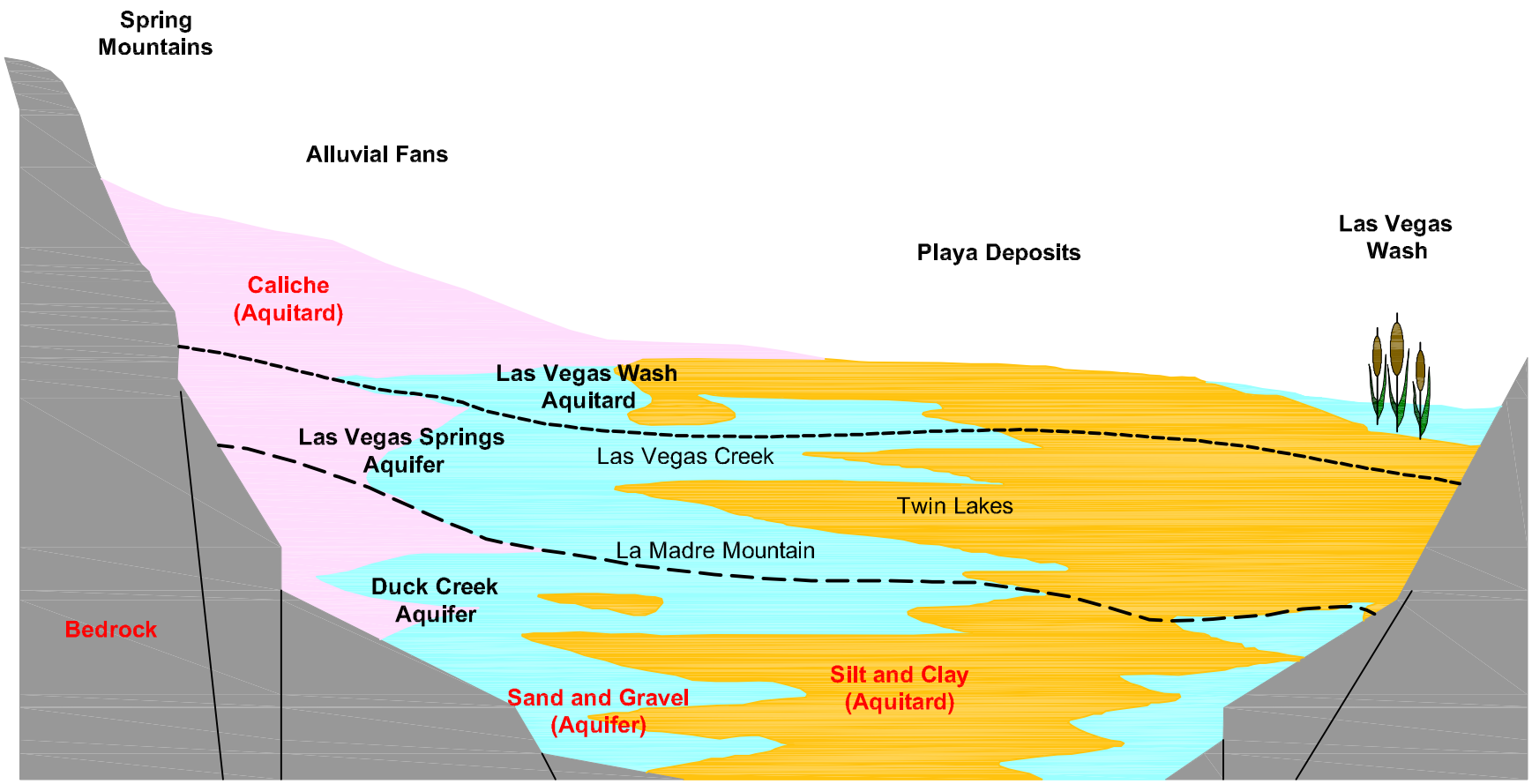
Las Vegas, Nevada

FIGURE 5
HYDROGEOLOGIC UNITS OF THE LAS VEGAS VALLEY

TETRA TECH

Source: Modified from Leising 2004



Not to Scale

MARYLAND SQUARE SHOPPING CENTER
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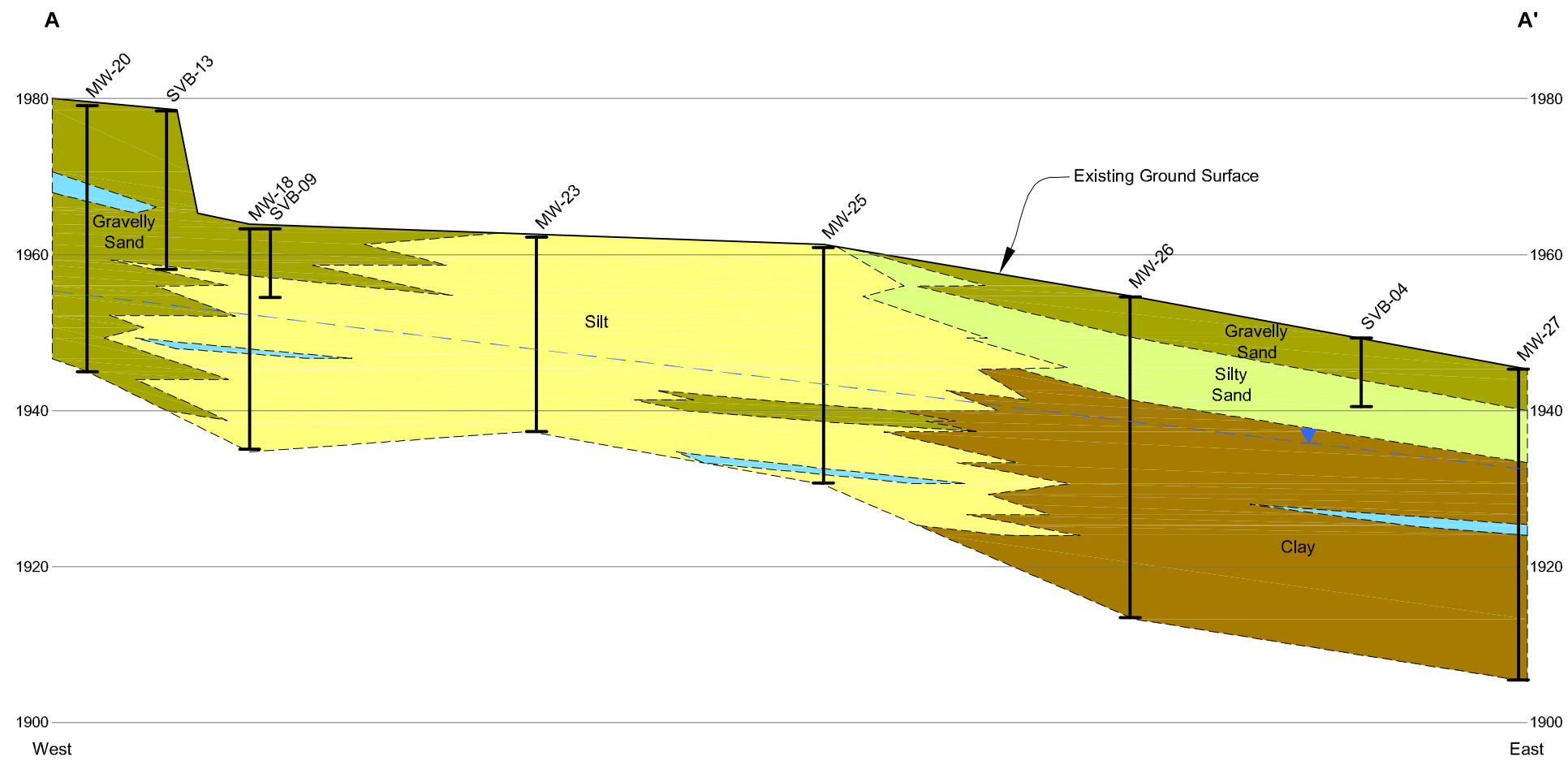
Las Vegas, Nevada

FIGURE 6
GENERALIZED CROSS SECTION OF THE LAS VEGAS VALLEY

TETRA TECH

Source: Leising 2004



Legend

- Approximate April 2007 Groundwater Surface
- Gravelly Sand
- Caliche
- Silty Sand
- Silt
- Clay

0 100 200
Horizontal Scale in Feet

0 10 20
Vertical Scale in Feet

Source: URS 2007

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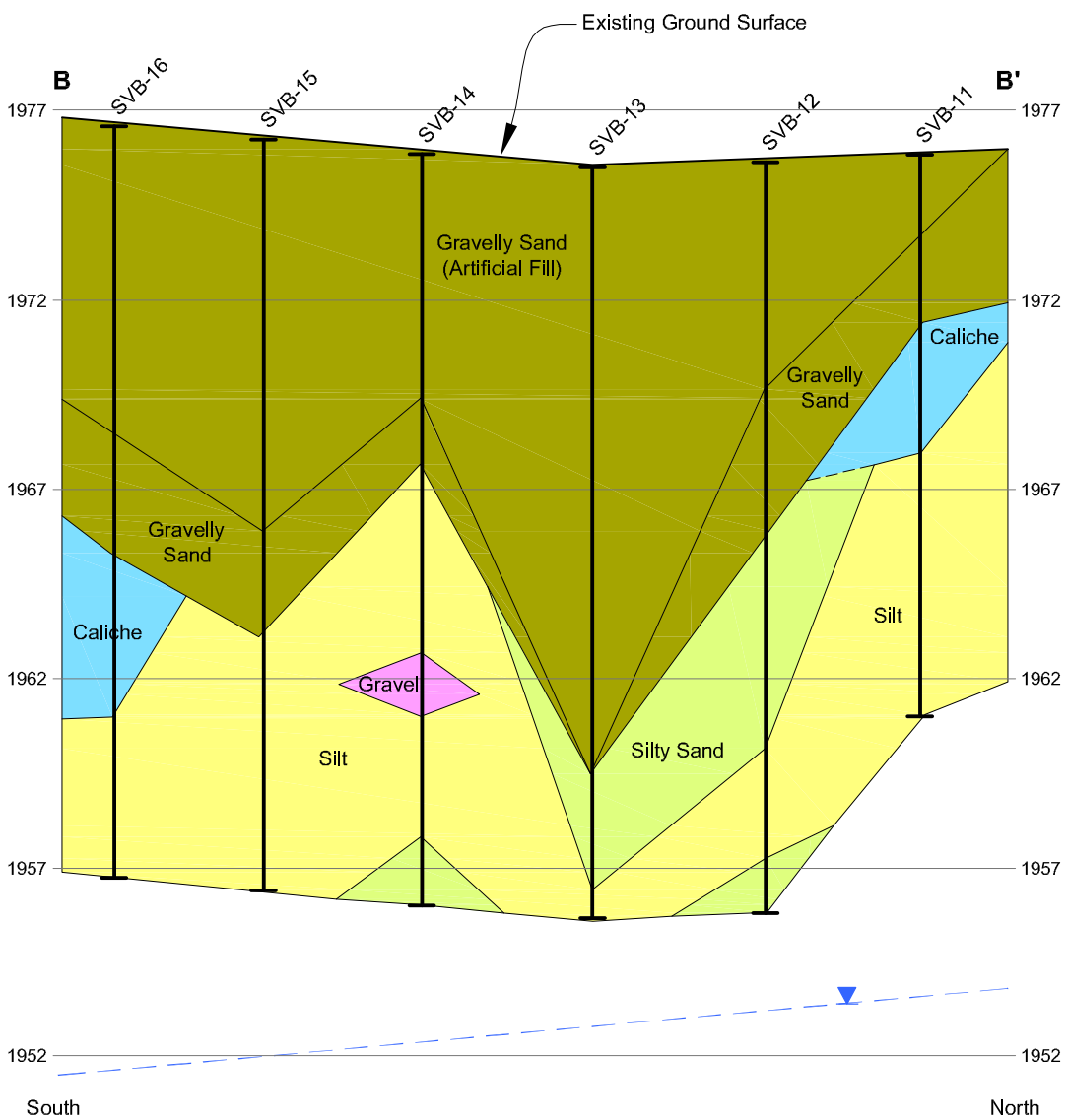
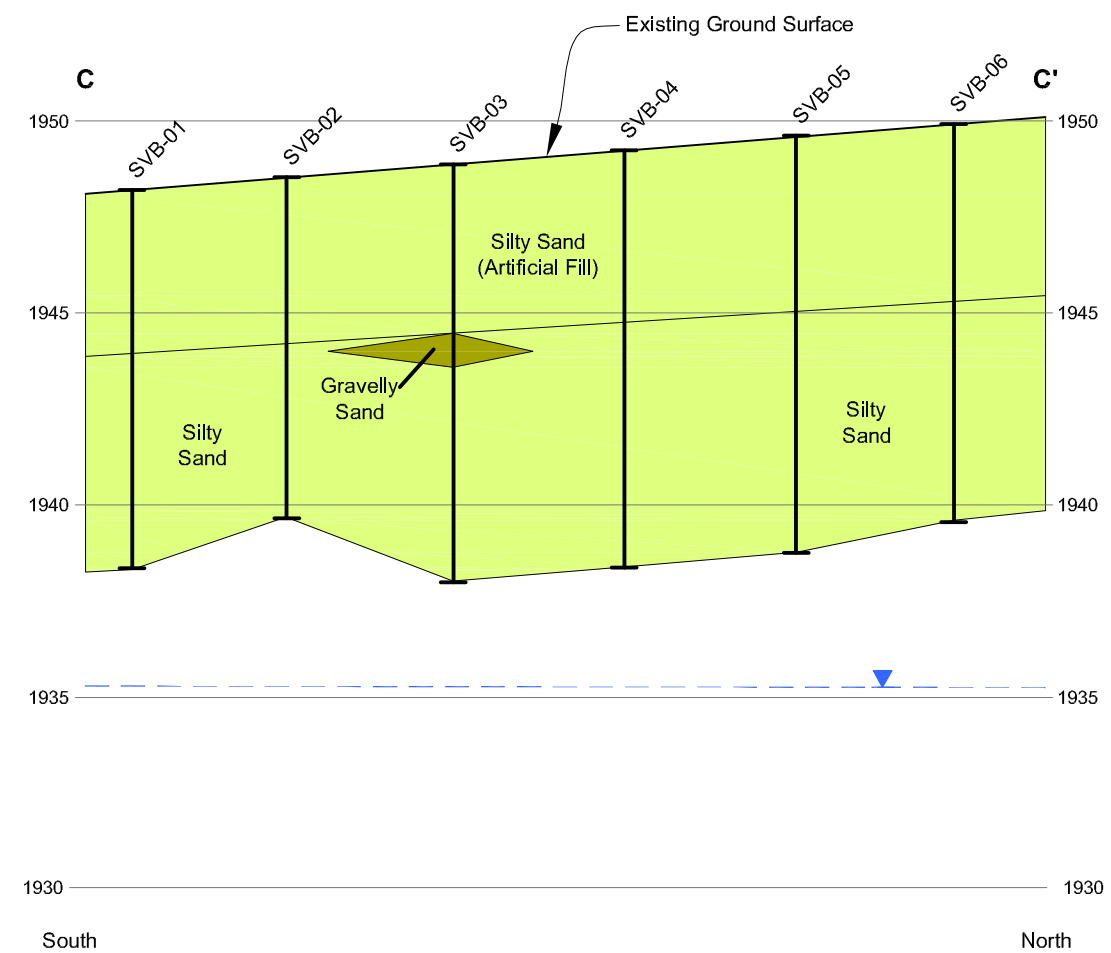
FIGURE 7
GEOLOGIC CROSS SECTION A - A'

TETRA TECH





Legend

- Approximate April 2007 Groundwater Surface
- Gravelly Sand
- Caliche
- Silty Sand
- Silt
- Gravel

0 35 70
Horizontal Scale in Feet

0 2.5 5
Vertical Scale in Feet

Source: URS 2007

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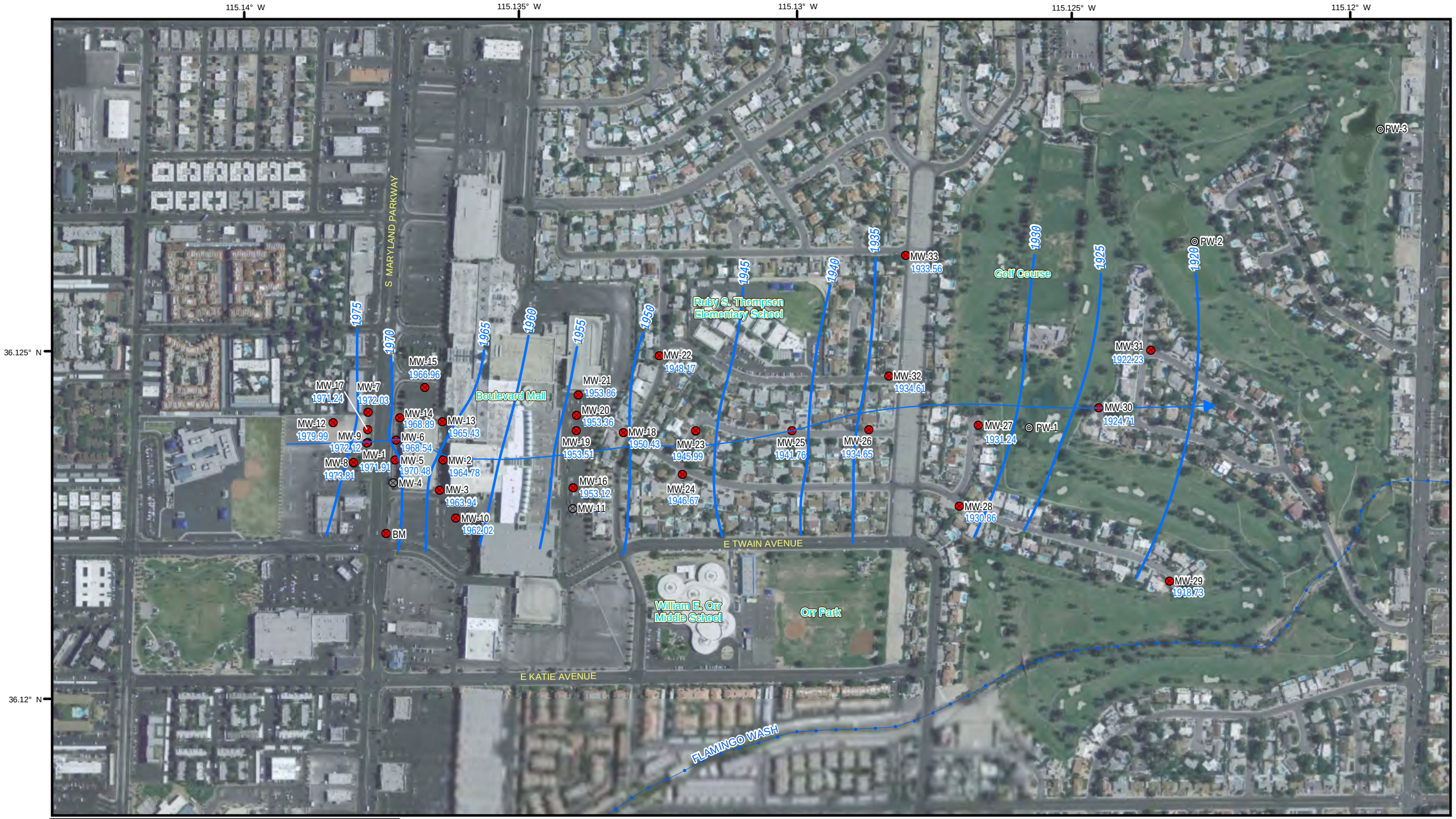
FIGURE 8
GEOLOGIC CROSS SECTIONS B - B' AND C - C'

TETRA TECH



Legend

- Monitoring Well Location
- Pumping Well Location
- Groundwater Elevation Contour (5 ft Intervals)
- Direction of Groundwater Flow
- 1971.91 Groundwater Elevation (ft amsl)
- NM Not Measured
- ft amsl Feet Above Mean Sea Level

Elevations measured February 28th - March 2nd of 2011.

N
W E
S

0 250 500 Feet

Approximate Scale in Feet

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Las Vegas, Nevada

FIGURE 9
GROUNDWATER POTENTIOMETRIC MAP WITH CONTOURS

TETRA TECH

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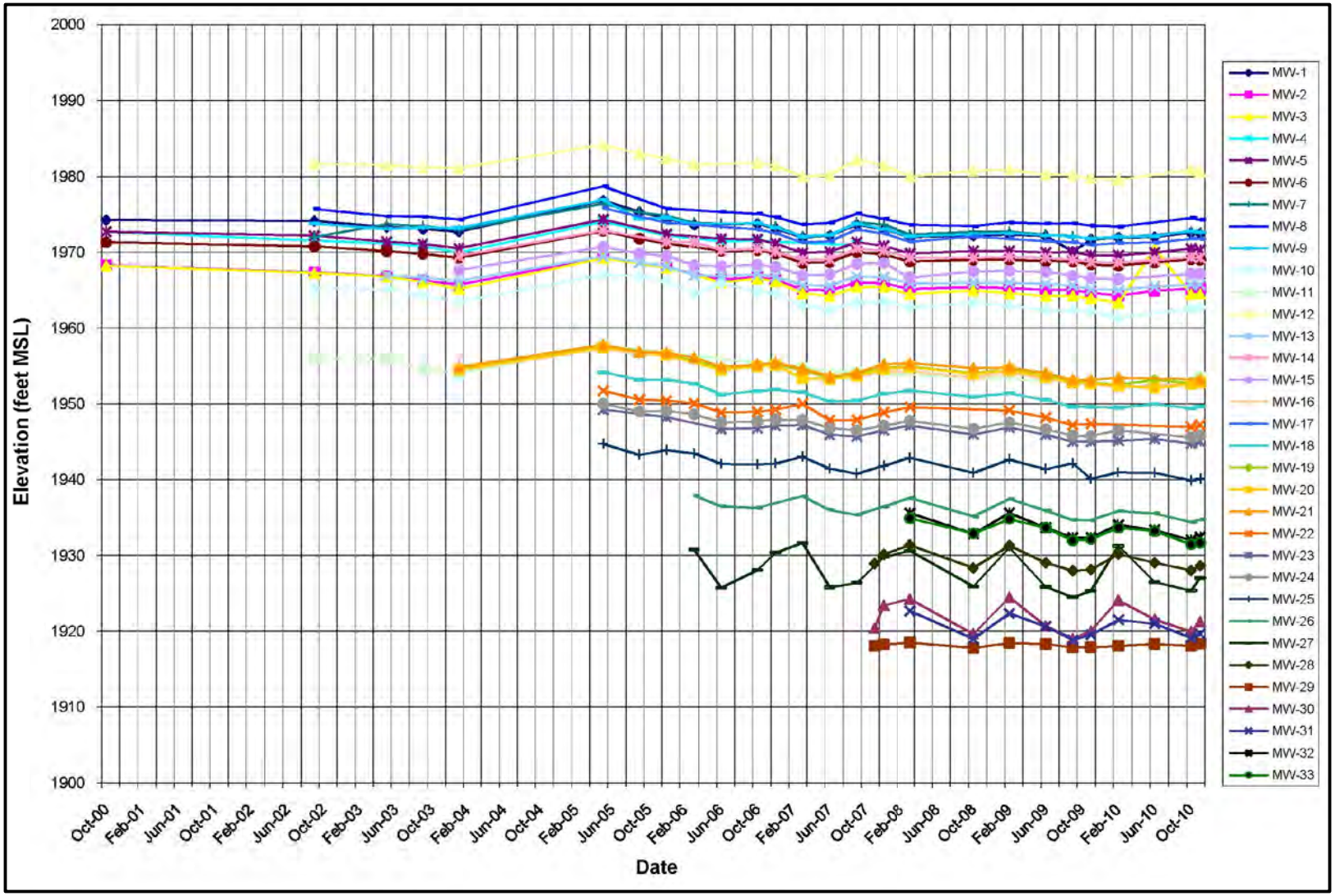

MARYLAND SQUARE SHOPPING CENTER
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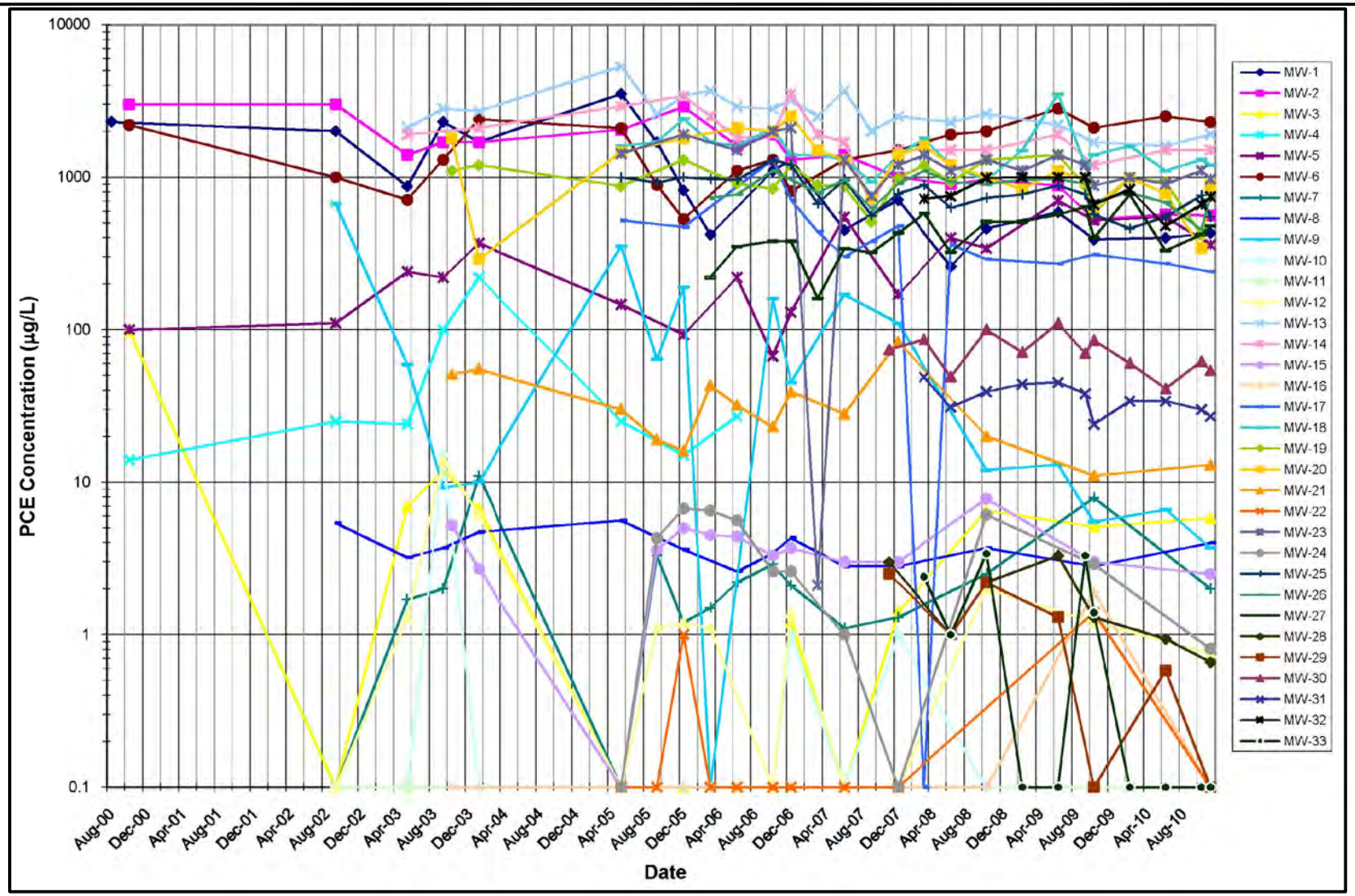
Las Vegas, Nevada

FIGURE 10
GROUNDWATER ELEVATION OVER TIME

TETRA TECH

Source: Modified from URS 2008



Note: Nondetected results are shown in the chart by a concentration of 0.1 ug/L.

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Las Vegas, Nevada

FIGURE 11
GROUNDWATER PCE CONTAMINATIONS OVER TIME

TETRA TECH

Summary of PCE Soil Vapor Concentrations

Sample Number	Sample Depth(1)	Soil Type	Soil Vapor Concentrations µg/L	µg/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

Legend

- Approximate Location of Monitoring Well Installed by URS Showing Concentration (µg/L) of PCE in Groundwater. Analytical Data from October and December 2006.
- Approximate Location of Soil Vapor Sampling Borehole Showing Concentration (µg/m(3) and ppbv) of PCE in Soil Vapor Collected from Shallow and Deeper Soil Above Groundwater.
- Approximate Concentration Contour of PCE in Groundwater

PCE tetrachloroethene

ND Analyte not detected at or above the reporting limit

µg/L Micrograms per liter

µg/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 sample SVB-05-08

N
W E
S

0 50 100 Feet

Approximate Scale in Feet

MARYLAND SQUARE SHOPPING CENTER
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Las Vegas, Nevada

FIGURE 12
SOIL VAPOR PCE CONCENTRATIONS ALONG SPENCER STREET

TETRA TECH

Sources: Clark County Assessors Web Site, URS 2007

S:\Projects Directory\Private Sector - Other Offices\Maryland Square\Groundwater Cap\Figure 14.mxd troy.fegter

Summary of PCE Soil Vapor Concentrations

Sample Number	Sample Depth[1]	Soil Type	Soil Vapor Concentrations ug/L	ug/m[3]	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-16-05	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

Legend

- Approximate Location of Monitoring Well Installed by Converse Showing Concentration (ug/L) of PCE in Groundwater. ND is Non-detect, NS is Not Sampled. Analytical Data from December 2006.
- Approximate Location of Monitoring Well Installed by URS Showing Concentration (ug/L) of PCE in Groundwater. Analytical Data from October and December 2006.
- Approximate Location of Soil Vapor Sampling Borehole Showing Concentration (ug/m3 and ppbv) of PCE in Soil Vapor Collected from Shallow and Deeper Soil Above Groundwater.
- Approximate Concentration Contour of PCE in Groundwater

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

N
W E
S

0 50 100 Feet

Approximate Scale in Feet

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

FIGURE 13
SOIL VAPOR PCE CONCENTRATIONS ALONG OTTAWA DRIVE AND THE BOULEVARD MALL

TETRA TECH

Sources: Clark County Assessors Web Site, URS 2007

S:\Projects Directory\Private Sector - Other Offices\Maryland Square\Groundwater Cap\Figure 3.mxd troy.fegter

APPENDIX A

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						

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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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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
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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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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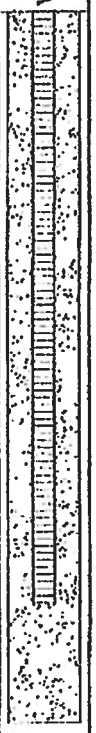
Log No. MW-3

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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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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Log No. MW-4

Date of Drilling: 10/02/01
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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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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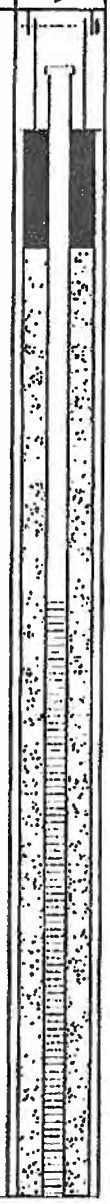
Log No. MW-5

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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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						

End of Exploration at 32.0'

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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
0		ASPHALT Type II Fill				
2		CLAY w/Silt; dry, medium brown				
4						
6						
8						
		slightly moist, light brown				
10						
		CLAY w/Silt; slightly moist, white/brown				
12						
14		CLAY w/Silt; hard, light brown				
16						
18		CALICHE; hard				
20						

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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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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						
		CALICHE; dry, white				
12						
		SAND; dry, light brown				
14						
		CALICHE; dry, white				
16		SAND; dry, white				
18						
20						

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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						

End of Exploration at 30.0'

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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:

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; dry, white				
4						
6		SAND; dry, light brown				
8		CALICHE; dry, white				
10						
12		CALICHE; dry, white				
14		SAND w/Silt; dry, light brown				
16		SAND w/Silt; dry, white and grey				
18						
20						

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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				
		CLAY w/Silt; wet, brown				
24						
		CLAY; wet, brown				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 30.0'

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Project No.
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Drawing No.

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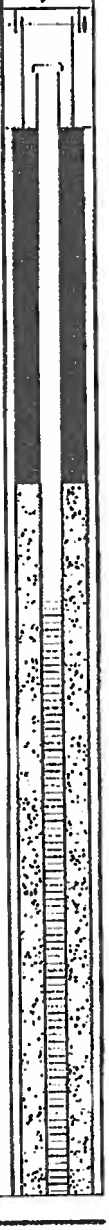
Log No. MW-9

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				
2		SAND; dry, brown				
4						
6		CALICHE; dry, white				
8		SAND w/Silt; dry, white				
10		CALICHE; hard				
12		SAND w/Silt; dry, white				
14						
16						
18						
20		CALICHE; dry, white				



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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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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	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		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.				
42						
44						
46						
48						
50						
52						
54						
56						
58						
60						

End of Exploration at 50.0'

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Drawing No.

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Log No. MW-10

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				
		SAND; dry, grey				
2						
4		CALICHE; dry, white				
		SAND; dry, brownish grey				
6						
8						
10						
12						
14						
16						
18						
20						

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Drawing No.

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Log No. MW-10

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
		SILTY CLAY; wet, brown				
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 30.0'

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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				
		SAND; dry, brown				
2						
4						
6						
8		SAND; dry, brownish grey				
10						
		SAND; dry, light brown				
12						
14		FINE SAND; dry, white				
16						
18						
20						

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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
22						
24		SAND; dry, brown				
		SILTY CLAY; wet, brown				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 33.5'

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-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						

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-12

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

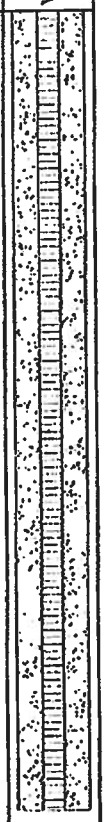
Location:
Borehole Diameter:
Groundwater Depth (ft):

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

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						
24		SANDY SILT; dry, brown				
		SAND; dry, brown				
26						
28						
30						
32						
34						
36						
38						
40						



End of Exploration at 33.5'

APPROVED BY OK

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

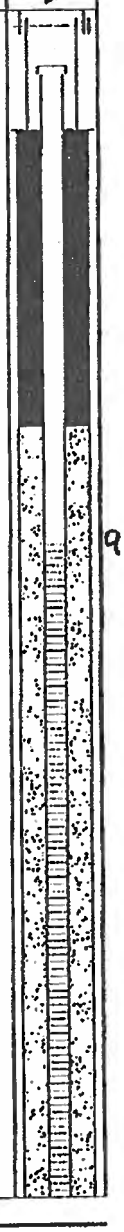
Log No. MW-13

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
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				



9'

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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
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Environmental Sciences

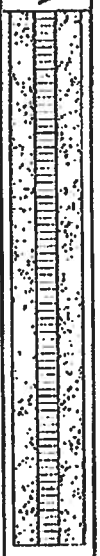
Log No. MW-13

Date of Drilling: 05/06/03
Driller: Converse
Logged By: AL.M

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	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
		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.				
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						



End of Exploration at 29.0'

APPROVED BY: O.N.

Maryland Square
3661 South Maryland Parkway
Las Vegas, NV

Project No.
00-43367-05

Drawing No.

Converse Consultants

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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

Kishnor/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:

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'

TRANSFERRED BY: [illegible]

APPROVED BY: [illegible]

Kishnor/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-15

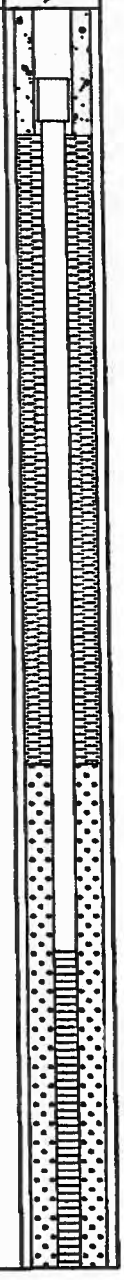
Date of Drilling:
Driller: Elite
Logged By: JJ

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

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

DRAFTED BY ESB

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		Type II fill				
		Sand				
4						
6						
8						
		Silty Sand				
10						
12						
14						
16						
18						
20						



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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-15

15

Date of Drilling:
Driller: Elite
Logged By: JI

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

Ground Surface Elevation (ft):
Equipment: Mogile B-57
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
22		Caliche				
24		Sandy Clay				
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 30.5'

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

Project No.
00-43367-06

Converse Consultants

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Environmental Sciences

Drawing No.

LOG NO. MW-10

16

Date of Drilling:
Driller: Hilti
Logged By: U

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

Ground Surface Elevation (ft):
Equipment: Mobile B-57
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	Description	Blow Count	PID/OVA Reading (ppm)	Hydrocarbon Odor/Staining	Well Design
0		Asphalt				
		Sand and Gravel Type II, loose:				
2		Sand with gravel; light brown				
4						
6						
		Gravel with sand and clay				
8		...little gravel				
10		Sandy clay; light brown				
12						
14		Clayey sand; light brown, slightly moist				
16		Gravel; loose				
		Clayey sand; light brown, slightly moist				
18						
20		Caliche				

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

Project No.
00-43367-06

Drawing No.

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Environmental Sciences

Log No. MW-16 16

Date of Drilling:
Driller: Elite
Logged By: JI

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						

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. B-17

Date of Drilling: 11/12/03
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/ Aggerate base				
		Clayey sand; light brown, slightly moist				
2						
4						
		Caliche				
6		...few gravel				
8						
		Clayey sand; light brown, slightly moist				
10						
12						
14						
16						
18						
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. B-17

Date of Drilling: 11/12/03
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

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 lean clay; reddish brown, moist				
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

Drawing No.

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

URS

BOREHOLE LOG
MW-17

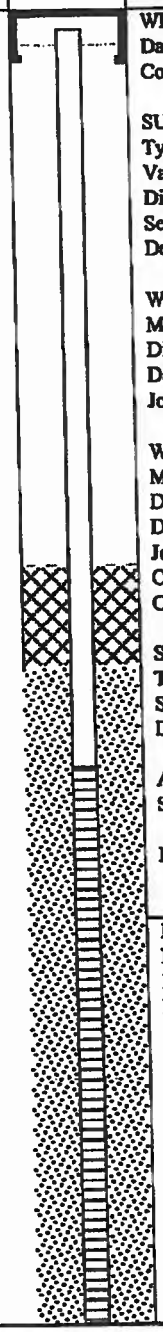
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/14/05
Date Completed:	3/14/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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
0	0930							Asphalt
1								
2								
3						ML		0'-7' Gravely SILT: lt cream, sl. moist
4								
5								
6								
7								
8						SP		7'-11' SAND: lt. Tan, poorly sorted, fine grained, moist
9								
10								
11								
12								
13								
14								
15								
16								
17								
18						ML		11' –37' Sandy SILT: lt. tan to creamy, sl. moist to v. moist
19								
20								
21								
22								
23								
24								
25								

Well: MW-17
Elev.: 1,990.92



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/14/05
Comp. Rep: S. Ball

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-15'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 15'-30'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 13'-37'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 11'-13'
Borehole: concrete
Depth: 0'-11'

REMARKS
No sampling was performed
Borehole was drilled an a
Monitor well was installed.

URS

BOREHOLE LOG
MW-17

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

Project No. 2698724.00005

Date Started:	3/14/05
Date Completed:	3/14/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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-17 Elev.: 1,990.92	Remarks/Well Information
26										
27										
28										
29										
30										
31						ML		Same as above.		
32										
33										
34										
35										
36	1125									
37								Bottom of borehole @ 37' bgs. Groundwater encountered at approximately 20' bgs.		
38										
39										
40										
41										
42										
43										
44										REMARKS
45										
46										
47										
48										
49										
50										
51										

Log No. B-18

Date of Drilling: 11/12/03
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/Agregate Type II				
2		Clayey sand; light brown, slightly moist				
4						
6						
8						
10		Silty sand; few gravels, dark brown, slightly moist				
12		Poorly graded sand with silt; light brown, slightly moist				
14						
16						
18						
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. B-16

Date of Drilling: 11/12/03
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
22						
24						
26						
		Sandy lean clay; light brown, moist				
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-18

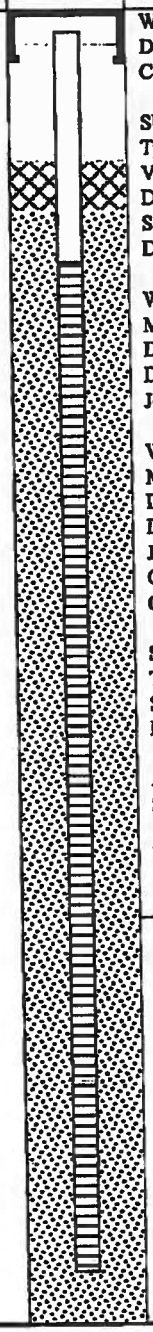
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/10/05
Date Completed:	3/10/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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
0	0834							Asphalt
1								0'-3' Gravely SILT: lt. tan
2								3'-7' color change to lt. brn
3						ML		
4								
5								
6								
7								
8								
9								
10						ML		7'-15' Sandy SILT: lt. tan, sl. moist to v. moist
11								
12								
13								
14								
15						Cali che		15'-16' CALICHE: wht, tan, v. hard, v. moist
16								
17								
18								
19								
20								
21						ML		16'-27' SILT: brn, v. moist
22								
23								
24								
25								

Well: MW-18
Elev.: 1,962.87



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/14/05
Comp. Rep: S. Ball

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-5'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 5'-25'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 4'-27'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 3'-4'
Borehole: concrete
Depth: 0'-3'

REMARKS
No sampling was performed
Borehole was drilled an a
Monitor well was installed.

URS

BOREHOLE LOG
MW-18

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

Project No. 2698724.00005

Date Started:	3/10/05
Date Completed:	3/10/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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-18 Elev.: 1,962.87	Remarks/Well Information
26	118					ML		same as above		
27								Bottom of borehole @ 27' bgs. Groundwater encountered at Approximately 9' bgs.		
28										
29										
30										
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										REMARKS
45										
46										
47										
48										
49										
50										
51										

Log No. MW-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	Description	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

Drawing No.

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

Log No. MW-19 14

Date of Drilling: 11/13/03
Driller: Hile
Logged By: H

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

Ground Surface Elevation (ft):
Equipment: Mobile B-57
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	Description	Blow Count	PID/OVA Readings (ppm)	Hydrocarbon Odor Smelled	Well Detail
22		Sandy lean clay; reddish brown, very moist				
24						
26						
28						
30						
32						
34		Caliche				
36						
38						
40						

End of Exploration at 35.0'

PREPARED BY: OK
APPROVED BY:

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 | Location: | Ground Surface Elevation (ft):
Driller: Elite | Borehole Diameter: 8.25" | Equipment: Mobile B-57
Logged By: JJ | Groundwater Depth (ft): | 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		Clayey sand with gravel; tan, slightly moist				
14						
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: Ellis
Logged By: JD

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

Ground Surface Elevation (ft):
Equipment: Mobile B-57
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/Stability	Well Design
22						
24						
26						
28						
30						
32						
34						
36						
38						
40						

End of Exploration at 35.0'

DRAWN BY: JB
APPROVED BY: JC

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

Date of Drilling: 11/1/03
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

APPROVED BY: DC

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	Description	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						

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):

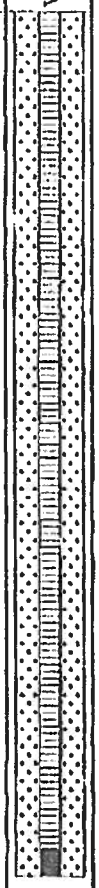
Ground Surface Elevation (ft):
Equipment: Mobile B-57
Driving Wt. and Drop:

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						



End of Exploration at 35.0'

APPROVED BY ON

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

Project No.
00-43367-06

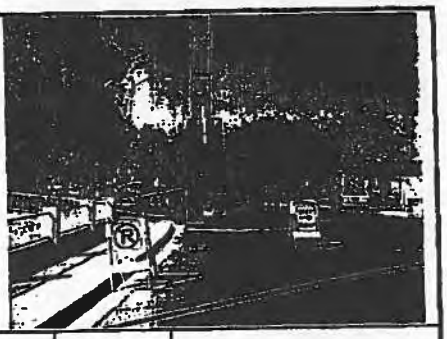
Drawing No.

Converse Consultants

Over 50 Years of Dedication in Engineering and Environmental Sciences

URS

BOREHOLE LOG
MW-22



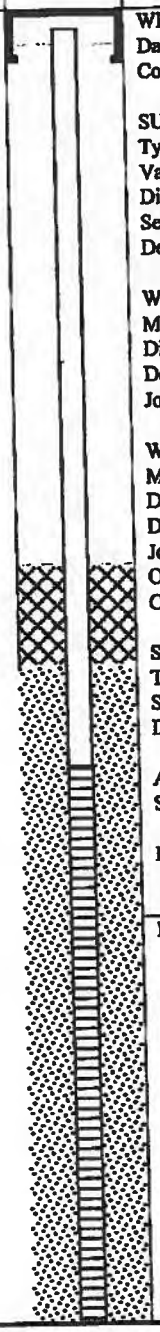
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/10/05
Date Completed:	3/10/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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
0	1310							Asphalt
1								
2						ML		0'-5' SILT: lt tan, dry, hard
3								
4								
5						Cali che		5'-7' CALICHE: wht., v. hard, moist
6								
7								
8								
9								
10								
11								
12								
13								
14								
15						ML		7'-37' Gravely SILT: lt. tan to lt. brn, sl. moist to moist
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								

Well: MW-22
Elev.: 1,974.76



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/10/05
Comp. Rep: S. Ball

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-15'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 15'-35'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

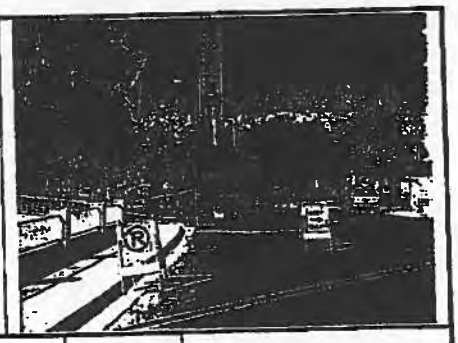
SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 13'-37'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 11'-13'
Borehole: concrete
Depth: 0'-11'

REMARKS

URS

BOREHOLE LOG
MW-22



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

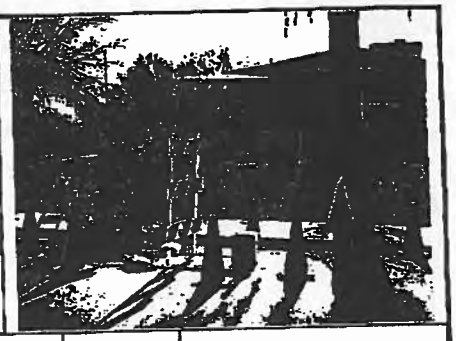
Project No. 2698724.00005

Date Started:	3/10/05
Date Completed:	3/10/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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-22 Elev.: 1,974.76	Remarks/Well Information
26										
27										
28										
29										
30										
31						ML		same as above.		
32										
33										
34										
35										
36	1600									
37								Bottom of borehole @ 37' bgs Groundwater encountered at approximately 22' bgs.		
38										
39										
40										
41										
42										
43										
44										REMARKS
45										
46										
47										
48										
49										
50										
51										

URS

BOREHOLE LOG
MW-23



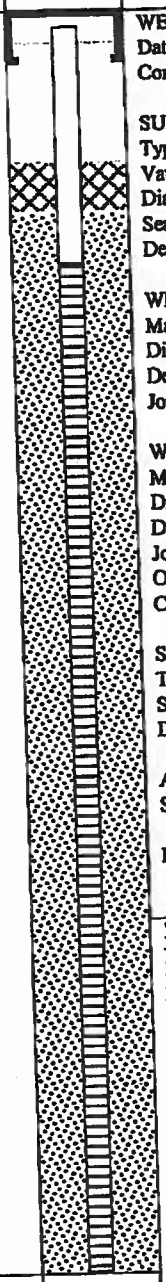
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/9/05
Date Completed:	3/9/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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
0	1310							Asphalt
1						SM		0'-2' Gravely silty SAND: dry
2								
3						ML		2'-5' SILT: brn, some gravel, moist
4								
5								
6								
7								
8								
9								
10								
11								
12								
13						ML		5'-25' Sandy SILT: lt. brn, dry to v. moist
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								Bottom of borehole @ 25 ft. bgs Groundwater encountered approx. 9' bgs

Well: MW-23
Elev.: 1,962.32



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/9/05
Comp. Rep: S. Ball

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-5'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 5'-25'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type: Montgomery
Size: 3
Depth: 4'-25'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 3'-4'
Borehole: concrete
Depth: 0'-3'

REMARKS
No sampling was performed
Borehole was drilled an a
Monitor well was installed.

URS

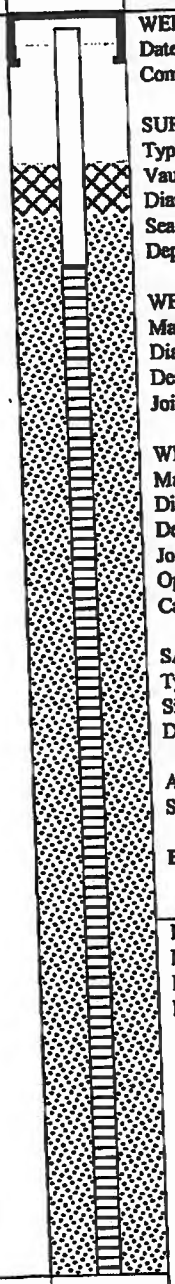
BOREHOLE LOG
MW-24

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

Project No. 2698724.00005

Date Started:	3/9/05
Date Completed:	3/9/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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
0	1222							Asphalt
1								
2								
3								
4								
5								
6								
7								
8						SM		0'-16' Fine SAND: lt. brn, dry to v. moist, find grained sand
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20						ML		16'-25'Sandy SILT: brn to lt. brn, v. moist, fine grained sand
21								
22								
23								
24		1350						
25								Bottom of borehole @ 25 ft. bgs Groundwater encountered approx. 9' bgs



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/9/05
Comp. Rep: S. Ball

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-5'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 5'-25'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 4'-25'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 3'-4'
Borehole: concrete
Depth: 0'-3'

REMARKS
No sampling was performed
Borehole was drilled an a
Monitor well was installed.

P:\AlPhillips\Maryland Square\MS June 2005 Report\MS B Log MW-24.doc

URS

BOREHOLE LOG
MW-25

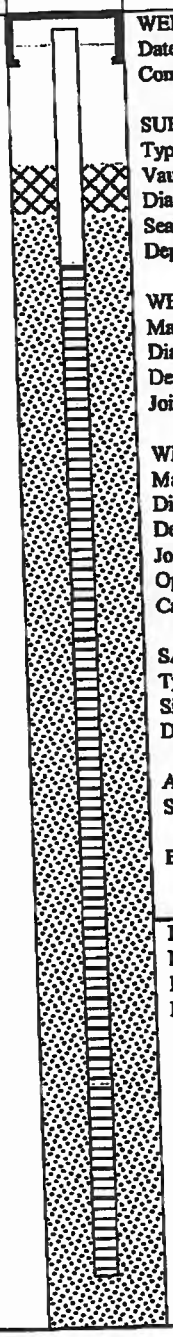
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

Project No. 2698724.00005

Date Started:	3/11/05
Date Completed:	3/11/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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
0	1028							Asphalt
1								
2								
3								
4						ML		0'-10' Sandy SILT: brn, dry to sl. moist
5								
6								
7								
8								
9								
10						GW		10'-13' Silty Gravel
11								
12								
13								
14								
15								
16								
17								
18						ML		13'-27' Sandy SILT: brn, v. moist, coarse sand
19								
20								
21								
22								
23								
24								
25								

Well: MW-25
Elev.: 1,960.74



Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 3/11/05
Comp. Rep: S. Ball

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-5'
Joints: flush

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 5'-25'
Joints: flush
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Montgomery
Size: 3
Depth: 4'-30'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 3'-4'
Borehole: concrete
Depth: 0'-3'

REMARKS
No sampling was performed
Borehole was drilled an a
Monitor well was installed.

URS

BOREHOLE LOG
MW-25

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

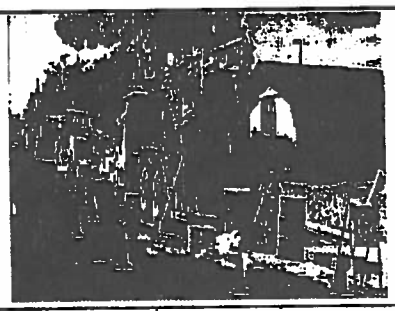
Project No. 2698724.00005

Date Started:	3/11/05
Date Completed:	3/11/05
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
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						ML		Same as above.		
27						Cali che		27'-28' CALICHE		
28						ML		28'-30' SILT		
29										
30								Bottom of borehole @ 30 ft. bgs Groundwater encountered at Approximately 10' bgs.		
31										
32										
33										
34										
35										
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

URS

BOREHOLE LOG
MW-26



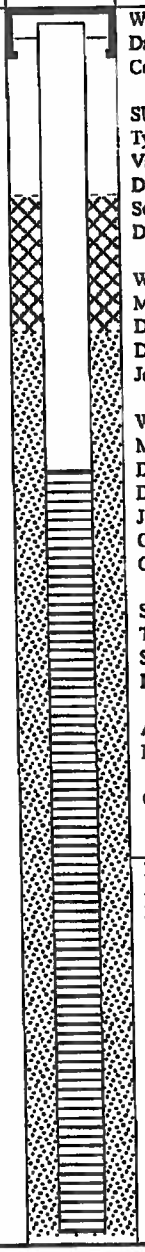
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

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						CL		24'-40' Silty CLAY, brn, v. wet		
34										
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

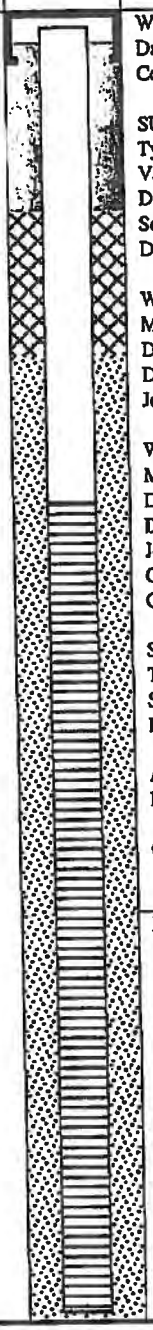
Al Phillips The Cleaner
Maryland Square Shopping Center
Subsurface Investigation
Las Vegas, Nevada

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 Maryland Square Shopping Center Subsurface Investigation Las Vegas, Nevada Project No. 2698724.00005	Date Started: Date Completed: Drilling Company: Drilling Method: Sampling Method: Logged By:	3/22/06 3/23/06 WDC Exploration Hollow Stem Auger Cuttings Inspection 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-28

Al Phillips The Cleaner
Maryland Square Shopping Center
Groundwater Monitoring Well Installation
Las Vegas, Nevada
Project No. 2698724

Date Started:	10/25/2007
Date Completed:	10/25/2007
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
Logged By:	Holly Woodward

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION
0	0915							ASPHALT
						GW		6"-1' GRAVEL
1								
2								
3						Af		1'-6' Silty SAND: fine-grain, lt. brown, sl. moist, med. dense., poorly graded w. sl. plasticity, Artificial fill
4								
5								
6								
7								
8						SM		6'-12' silty SAND: brown, sl. moist
9								
10								
11								
12								
13						SM		12'-15' silty SAND: brown, sl. moist, some pea gravel and gravel
14								
15								15'-35' silty SAND: brown
16								
17	1020							17'-17.5' encountered some gravel
18								
19								
20						SM		
21								
22								
23								
24								
25								

Well: MW-28
Elev.:

Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 10/25/2007
Comp. Rep: H. Woodward

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-15'
Joints: 5', 25'

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 15'-35'
Joints: 15', 25'
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Monterey
Size: 3
Depth: 12'-35'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 9'-12'
Borehole: concrete
Depth: 0'-9'

REMARKS
No sampling was performed
Borehole was drilled and a Monitor well was installed.

BOREHOLE LOG
MW-28

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:	10/25/2007 10/25/2007 WDC Exploration Hollow Stem Auger None Holly Woodward	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-28 Elev.:	Remarks/Well Information
26										
27										
28										
29										
30						SM		Same as above		
31										
32										
33										
34										
35								Bottom of borehole @ 35 ft. bgs Groundwater encountered at Approximately 15'-16' bgs		
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

BOREHOLE LOG
MW-29

Al Phillips The Cleaner
Maryland Square Shopping Center
Groundwater Monitoring Well Installation
Las Vegas, Nevada
Project No. 2698724

Date Started:	10/24/2007
Date Completed:	10/25/2007
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
Logged By:	Holly Woodward

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION
0	1255							ASPHALT
1						Af		6"-1.5' silty SAND: brown, sl. moist, Med. dense, some gravel, Artificial fill
2						ML		1.5'-4' sandy SILT: lt. brown, roots in soil
3								
4								
5								
6								
7								
8								
9								
10								
11						SM		4'-19' silty SAND: brown, sl. moist, some gravel
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22						CL		19'-35' CLAY: brown, wet, some pea gravel and sand
23								
24								
25								

Well: MW-29
Elev.:

Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 10/25/2007
Comp. Rep: H. Woodward

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-15'
Joints: 5', 15'

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 15'-35'
Joints: 15', 25'
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Monterey
Size: 3
Depth: 12'-35'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 9'-12'
Borehole: concrete
Depth: 0'-9'

REMARKS
No sampling was performed
Borehole was drilled and a Monitor well was installed.

BOREHOLE LOG
MW-29

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:	10/24/2007 10/25/2007 WDC Exploration Hollow Stem Auger None Holly Woodward

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-29 Elev.:	Remarks/Well Information
26										
27										
28										
29										
30						CL		Same as above		
31										
32										
33										
34										
35								Bottom of borehole @ 35 ft bgs Groundwater encountered at Approximately 18.5' bgs		
36										
37										
38										
39										
40										
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										

BOREHOLE LOG
MW-30

Al Phillips The Cleaner
Maryland Square Shopping Center
Groundwater Monitoring Well Installation
Las Vegas, Nevada
Project No. 2698724

Date Started:	10/26/2007
Date Completed:	10/26/2007
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
Logged By:	Holly Woodward

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION
0	0900							Asphalt
1						Af		6"-2' Silty SAND: brown, sl. moist, Med. dense, some gravel, Artificial fill
2								
3						ML		2'-5' Sandy SILT: brown, some pea gravel and gravel
4								
5								
6								
7								
8						ML		5'-13' sandy SILT: brown, some pea gravel, gravel, and clay
9								
10								
11								
12								
13						SM		13'-14' Silty SAND: brown with some pea gravel
14								
15								
16								
17								
18								
19						GC		14'-28' Sandy, silty GRAVEL: poorly graded
20								
21								
22								
23								
24	0945							
25								

Well: MW-30
Elev.:

Remarks/Well Information

WELL CONSTRUCTION
Date Compl.: 10/26/2007
Comp. Rep: H. Woodward

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

WELL CASING
Material: PVC
Diameter: 4"
Depth: 0'-20'
Joints: 10', 20'

WELL SCREEN
Material: PVC
Diameter: 4"
Depth: 20'-40'
Joints: 20', 30'
Opening: 0.02" slotted
Cap: expanding

SAND FILTER PACK
Type : Monterey
Size: 3
Depth: 17'-40'

ANNULUS SEAL
Sand Pack: bentonite
Depth: 14'-17'
Borehole: concrete
Depth: 0'-14'

REMARKS
No sampling was performed
Borehole was drilled and a Monitor well was installed.

BOREHOLE LOG
MW-30

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:	10/26/2007 10/26/2007 WDC Exploration Hollow Stem Auger None Holly Woodward	

Depth In Feet	Time (0100 hrs)	Sample	Well Material Log	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: MW-30 Elev.:	Remarks/Well Information
26						GC		Same as above		
27										
28						SM		28'-33' Silty SAND: brown, wet, some pea gravel		
29										
30										
31										
32										
33						CL		33'-40' Sandy, silty CLAY: hard, wet		
34										
35										
36										
37										
38										
39										
40	1020							Bottom of borehole @ 40 ft bgs Groundwater encountered at Approximately 24' 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										

URS

BOREHOLE LOG
MW-31

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 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
0								0-4" ASPHALT		WELL CONSTRUCTION Date Compl.: 3/5/2008 Comp. Rep: L. Lowe
1						Af		4"-1.5' gravelly SAND: brown, sl. moist with up to 1.5" diameter angular rocks		
2								1.5'-9' silty SAND: tan, sl. moist, well sorted, fine grained, some plasticity with some pea gravel		SURFACE COMPLETION Type: Flush Mount Vault: Traffic Diameter: 12" Seal: Concrete Depth: 0'-2'
3								3'-4' same except lt. brown		
4								4'-9' silty SAND: tan, sl. moist, well sorted, fine grained, no plasticity		
5										WELL CASING Material: PVC Diameter: 4" Depth: 0'-13.5' Joints: 3.5', 13.5'
6								6'-6.5' some caliche nodules		
7										
8										WELL SCREEN Material: PVC Diameter: 4" Depth: 13.5'-33.5' Joints: 13.5', 23.5' Opening: 0.02" slotted Cap: expanding
9						SM		9'-13' silty SAND: lt. brown, sl. moist, well sorted, sl. plasticity with some pea gravel		
10										
11										
12										SAND FILTER PACK Type : Colorado Size: 812 Depth: 11'-45'
13								13'-22' silty SAND, lt. brown, moist, sl. plasticity, poorly sorted, fine grain with some pea gravel		
14										
15										ANNULUS SEAL Bentonite Depth: 2'-11'
16								@16' same except sand more coarse		
17										
18										REMARKS No sampling was performed Borehole was drilled and a Monitor well was installed.
19								@19' same except wet		
20										
21										
22								22'-30' gravelly SAND: lt. brown, wet, poorly sorted with some silt and pea gravel		
23						SW				
24										
25										

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. *0' to 25' was logged during The drilling of B-T on 10/24/2007 by Holly Woodward
19										
20										
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										
30						ML				
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:	3/5/2008
Date Completed:	3/6/2008
Drilling Company:	WDC Exploration
Drilling Method:	Hollow Stem Auger
Sampling Method:	None
Logged By:	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										
30						ML				
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						CL				REMARKS
19	1210	W			B-T2					
20								Bottom of borehole @ 20'bgs Encountered Groundwater at approx. 18'		
21										
22										
23										
24										
25										

BOREHOLE LOG
B-T

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:	10/24/2007 10/25/2007 WDC Explorations Hollow-Stem Auger Grab/Temporary PVC casing Holly Woodward	

Depth In Feet	Time (0100 hrs)	Sample	Blow Count (ft)	PID/FID (ppm)	Sample Number	USCS/Other	Graphic Log	SOIL DESCRIPTION	Well: B-T Elev.:	Remarks/Well Information
0								0-4.5" ASPHALT		WELL CONSTRUCTION Date Compl.: 10/24/2007 Comp. Rep: H. Woodward
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: NA Vault: NA
3										Diameter: NA Seal: NA Depth: NA
4						ML		3'-6' sandy SILT: lt. brown, sl. moist		
5										WELL CASING Material: PVC Diameter: 1.25" Depth: 0-22' Joints: flush
6										
7										
8										WELL SCREEN Material: PVC Diameter: 1.25" Depth: 22-25' Joints: flush Opening: 0.02" Slotted Cap: Expanding
9						SM		6'-15' silty SAND: brown, sl. moist, poorly graded, some gravel		
10										
11										
12										SAND FILTER PACK Type : Monterey Size: 3 Depth: 19-25'
13										
14										
15								15'-17.5' CLAY: brown, sl. moist, med. dense, poorly graded, some sand and gravel		ANNULUS SEAL Sand Pack: NA Depth: NA Borehole: NA Depth: NA
16										
17								@17.5' same as above but very moist		
18						CL				REMARKS
19										
20										
21										
22										
23										
24										
25								Bottom of borehole @ 25'bgs Encountered Groundwater at approx. 22'		

APPENDIX B

Summary of Remedial Action Alternatives Costs for Groundwater

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-1

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		

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-2

Alternative 2A: In Situ Chemical Treatment of Hotspots and Residential Area, Institutional Controls (IC), Sub-Slab Depressurization (SSD) Systems, and Monitored Natural Attenuation (MNA)

Cost Item	Quantity	Unit	Cost/Unit	Item Cost	Comment/Source
Capital Costs					
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					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Reagent injection in Hotspot	25	tons	$3,552	$88,792	Vendor Quote
Reagent Injection Labor	240	hrs	$50	$12,000	Vendor Quote
Reagent Injection Equipment	5%	Reagent	$88,792	$4,440	Engineer's Estimate
			Annual Cost (Subtotal)	***$110,000***	
			Contingency (20%)	*$22,000*	
			Annual Cost + Contingency	*$132,000*	
			4-Year Present Worth Factor at 5.0% discount factor	*3.55*	
			Net Present Worth of 4 Years of Hotspot Injection Costs	***$470,000***	
Operation, Maintenance and Monitoring Costs − Upgradient Reagent					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Reagent Injection Upgradient of Residences	17	tons	$3,552	$59,194	Vendor Quote
Reagent Injection Labor	240	hrs	$50	$12,000	Vendor Quote
Reagent Injection Equipment	5%	Reagent	$59,194	$2,960	Engineer's Estimate
			Annual Cost (Subtotal)	***$80,000***	
			Contingency (20%)	*$16,000*	
			Annual Cost + Contingency	*$96,000*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of Upgradient Area Injection Costs	***$740,000***	
Operation, Maintenance and Monitoring Costs − GW Monitoring and IC					
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*	
			30-Year Present Worth Factor at 5.0% discount factor	*15.37*	
			Net Present Worth of 30 Years of GW and IC Monitoring Costs	***$3,690,000***	
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*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of SSD Monitoring Costs	***$1,110,000***	
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***	
			30-Year Present Worth Factor at 5.0% discount factor	*0.23*	
			Net Present Worth of Close-out Costs	***$20,000***	
			Alternative 2A Total Cost	***$7,100,000***	***Rounded***

TABLE B-2 (Continued)

Alternative 2A: In Situ Chemical Treatment of Hotspots and Residential Area, Institutional Controls (IC), Sub-Slab Depressurization (SSD) Systems, and Monitored Natural Attenuation (MNA)

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars See Table B-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

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-3

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	1383	tons	$3,552	$4,913,065	Vendor Quote
Reagent Injection Labor	1089	hrs	$50	$54,450	Vendor quote
Reagent Injection Equipment	5%	Reagent	$4,913,065	$245,653	Engineer's Estimate
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$5,340,000***	
			Contingency (20%)	*$1,068,000*	
			Annual Cost + Contingency	*$6,408,000*	
			3-Year Present Worth Factor at 5.0% discount factor	*2.72*	
			Net Present Worth of 3 Years of Operation and Maintenance Costs	***$17,450,000***	
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*	
			5-Year Present Worth Factor at 5.0% discount factor	*4.33*	
			Net Present Worth of 5 Years of Operation, Maintenance and Monitoring Costs	***$1,040,000***	
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***	
			5-Year Present Worth Factor at 5.0% discount factor	*0.78*	
			Net Present Worth of Close-out Costs	***$60,000***	
			Alternative 2B Total Cost	***$23,210,000***	***Rounded***

Assumptions

- All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
- All values are in 2010 Dollars — See Table B-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

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-4

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 and Bench-Scale Tests	1	LS	$75,000	$75,000	Vendor Quote
Excavation	400	BCY	$50	$20,000	China Lake FS
Spoil Disposal	200	BCY	$200	$40,000	China Lake FS
Zero-valent Iron for 18-38' BGS	844	tons	$800	$675,200	Vendor Quote
PRB Installation	844	tons	$592	$500,000	Vendor Quote
Borrow	107	CY	$10	$1,070	Engineer's Estimate
Fill in Lifts	360	CY	$10	$3,600	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	***$1,642,790***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$246,419*	
			Design (10% or $10,000 minimum)	*$164,279*	
			Construction management (15% or $10,000 minimum)	*$246,419*	
			Administrative/Legal (5% or $10,000 minimum)	*$82,140*	
			Contingency (25%)	*$410,698*	
			Total capital Costs	***$2,800,000***	
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*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of SSD Monitoring Costs	***$1,110,000***	
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*	
			30-Year Present Worth Factor at 5.0% discount factor	*15.37*	
			Net Present Worth of 30 Years of Operation, Maintenance and Monitoring Costs	***$3,690,000***	
Maintain PRB					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Replace barrier	1	LS	$1,369,770	$1,369,770	China Lake FS
			(Subtotal)	***$1,370,000***	
			20-Year Present Worth Factor at 5.0% discount factor	*0.38*	
			Net Present Worth of PRB Replacement Costs	***$520,000***	
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***	
			30-Year Present Worth Factor at 5.0% discount factor	*0.23*	
			Net Present Worth of Close-out Costs	***$20,000***	
			Alternative 3 Total Cost	***$8,140,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars See Table B-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

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-5

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 – AS/SVE and SSD					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
AS/SVE O&M	1	annual	$82,000	$82,000	Previous MD Sq
Annual Air Monitoring	1	annual	$43,000	$43,000	Previous MD Sq
Sub-slab and Residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
			Annual Cost (Subtotal)	***$250,000***	
			Contingency (20%)	*$50,000*	
			Annual Cost + Contingency	*$300,000*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of AS/SVE and SSD Monitoring Costs	***$2,320,000***	
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	China Lake FS
			Annual Cost (Subtotal)	***$200,000***	
			Contingency (20%)	*$40,000*	
			Annual Cost + Contingency	*$240,000*	
			30-Year Present Worth Factor at 5.0% discount factor	*15.37*	
			Net Present Worth of 30 Years of Operation, Maintenance and Monitoring Costs	***$3,690,000***	
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***	
			30-Year Present Worth Factor at 5.0% discount factor	*0.23*	
			Net Present Worth of Close-out Costs	***$20,000***	
			Alternative 4 Total Cost	***$6,800,000***	***Rounded***

Assumptions

- All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
- All values are in 2010 Dollars — See Table B-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

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-6

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 (29 at 40')	560	LF	$200	$112,000	China Lake FS
Submersible Pumps	14	EA	$5,000	$70,000	Engineer's Estimate
Well Electrical Connections	29	EA	$7,500	$217,500	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
Underground Injection Control Permit	1	LS	$15,000	$15,000	Engineer's Estimate
Equipment Installation (2 WWTPs)	1	LS	$75,000	$75,000	Vendor Quote
Site Electrical	1	LS	$50,000	$50,000	Engineer's Estimate
Trenching and Backfilling (2' wide, 4' deep, medium soil)	14,300	LF	$3.58	$51,123	Engineer's Estimate
Yard Piping (2" PVC)	19800	LF	$3.59	$71,033	Engineer's Estimate
Replace Pavement (6" thick, concrete)	28600	SF	$3.23	$92,235	Engineer's Estimate
Implementation of ICs	1	LS	$50,000	$50,000	China Lake FS
			Subtotal	***$1,019,890***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$152,984*	
			Design (10% or $10,000 minimum)	*$101,989*	
			Construction management (15% or $10,000 minimum)	*$152,984*	
			Aministrative/Legal (5% or $10,000 minimum)	*$50,995*	
			Contingency (25%)	*$254,973*	
			Total capital Costs	***$1,740,000***	
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*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of SSD Monitoring Costs	***$1,110,000***	
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 (2 WWTPs)	13.0	28-day Cycles	$6,396	$83,148	Vendor Quote
Rent Space for WWTP on Golf Course (50' x 25')	12.0	month	$1,250	$15,000	Engineer's Estimate
Electrical Power	12.0	Horsepower	$1,005	$12,057	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	$1,740,000	$17,400	Engineer's Estimate
Annual reporting and IC Implementation	1	annual	$67,000	$67,000	Previous MD Sq
			Annual Cost (Subtotal)	***$410,000***	
			Contingency (20%)	*$82,000*	
			Annual Cost + Contingency	*$492,000*	
			30-Year Present Worth Factor at 5.0% discount factor	*15.37*	
			Net Present Worth of 30 Years of Operation, Maintenance and Monitoring Costs	***$7,560,000***	
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	$7,806	$7,806	Vendor Quote
Site Restoration	1	LS	$50,000	$50,000	Engineer's Estimate
			(Subtotal)	***$130,000***	
			30-Year Present Worth Factor at 5.0% discount factor	*0.23*	
			Net Present Worth of Close-out Costs	***$40,000***	
			Alternative 5 Total Cost	***$10,450,000***	***Rounded***

TABLE B-6 (Continued)
Alternative 5: Groundwater Extraction and Treatment, ICs, SSD Systems, and MNA
Assumptions
All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars. See Table B-1 for abbreviations and acronyms
All values are in 2010 Dollars Net present worth discount rate is 5.0%
Peak flow is 55 gpm (3.9 gpm/well from 14 extraction wells)
Treated water will be re-injected.
14 new wells will be installed.
Assume $0.10 per KWH and 65% wire-to-water efficiency for motors
Wells will be screened from about 20-40 bgs.
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
Wells will be directly in roadways or right-of-ways. No land acquisition or purchase costs are included
One wastewater treatment system will be on the golf course property. Rental rate for open space assumed at $1/sf/month.
Electrical power connection points 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

Appendix B

Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site

Summary of Corrective Action Alternatives Costs

TABLE B-7

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(80 at 40')	3200	LF	$180	$576,000	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	***$728,000***	
			Mobe/ Demobe/ Well Abandonment (15%)	*$109,200*	
			Design (10% or $10,000 minimum)	*$72,800*	
			Construction management (15% or $10,000 minimum)	*$109,200*	
			Administrative/Legal (5% or $10,000 minimum)	*$36,400*	
			Contingency (25%)	*$182,000*	
			Total capital Costs	***$1,240,000***	
Operation, Maintenance, and Monitoring Costs − Hotspot Reagent					
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
			Annual Cost (Subtotal)	***$1,100,000***	
			Contingency (20%)	*$220,000*	
			Annual Cost + Contingency	*$1,320,000*	
			3-Event Present Worth Factor at 5.0% discount factor	*2.72*	
			Net Present Worth of 3 Years of Operation and Maintenance Costs	***$3,590,000***	
Operation, Maintenance, and Monitoring Costs − Upgradient Reagent, GW Monitoring, SSD and ICs (Year 1 - 10)					
Cost Item	**Quantity**	**Unit**	**Cost/Unit**	**Item Cost**	**Comment/Source**
Vegetable Oil Reagent	32	Wells Annually	$18,945	$606,252	Vendor Quote
Reagent Injection	1	LS	$121,000	$121,000	Vendor Quote
Quarterly GW Monitoring	4	quarters/year	$31,250	$125,000	Previous MD Sq
Sub-slab and residential Monitoring	1	annual	$118,000	$118,000	Previous MD Sq
Annual reporting and IC Implementation	1	annual	$67,000	$67,000	China Lake FS
			Annual Cost (Subtotal)	***$1,040,000***	
			Contingency (20%)	*$208,000*	
			Annual Cost + Contingency	*$1,248,000*	
			10-Year Present Worth Factor at 5.0% discount factor	*7.72*	
			Net Present Worth of 10 Years of Operation, Maintenance and Monitoring Costs	***$9,640,000***	
Operation, Maintenance, and Monitoring Costs − GW Monitoring and ICs (Year 11 - 30)					
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	China Lake FS
			Annual Cost (Subtotal)	***$200,000***	
			Contingency (20%)	*$40,000*	
			Annual Cost + Contingency	*$240,000*	
			Year-10 to Year-30 Present Worth Factor at 5.0% discount factor	*7.65*	
			Net Present Worth of 20 Years of Operation, Maintenance and Monitoring Costs	***$1,840,000***	
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***	
			30-Year Present Worth Factor at 5.0% discount factor	*0.23*	
			Net Present Worth of Close-out Costs	***$20,000***	
			Alternative 6 Total Cost	***$16,330,000***	***Rounded***

Assumptions

All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in 2010 Dollars — See Table B-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

Appendix B
Draft Corrective Action Plan for Groundwater - Maryland Square PCE Site
Summary of Corrective Action Alternatives Costs

TABLE B-8
Summary

Alternative	*Capital Costs*	*Future Costs*	*Total Cost*	Total Cost Rank (0=Lowest)
	$0	*$3,840,000*	*$3,840,000*	**0**
Alternative 2A: 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*	*$6,030,000*	*$7,100,000*	**1**
Alternative 2B: Alternative 2B: In Situ Chemical Treatment, ICs, SSD Systems, and MNA	*$4,660,000*	*$18,550,000*	*$23,210,000*	6
Alternative 3: Alternative 3: Permeable Reactive Barrier (PRB), ICs, SSD Systems, and MNA	*$2,800,000*	*$5,340,000*	*$8,140,000*	3
Alternative 4: Alternative 4: Air Sparge/ Soil Vapor Extraction (AS/SVE), ICs, SSD Systems, and MNA	*$770,000*	*$6,030,000*	*$6,800,000*	**2**
Alternative 5: Alternative 5: Groundwater Extraction and Treatment, ICs, SSD Systems, and MNA	*$1,740,000*	*$8,710,000*	*$10,450,000*	5
Alternative 6: Alternative 6: In-situ Enhanced Bioremediation, ICs, SSD Systems, and MNA	*$1,240,000*	*$15,090,000*	*$16,330,000*	4
Minimum (except for No Action)	*$770,000*	*$5,340,000*	*$6,800,000*	
Median (except for No Action)	*$1,490,000*	*$7,370,000*	*$9,295,000*	
Average (except for No Action)	*$2,046,667*	*$9,958,333*	*$12,010,000*	
Maximum	*$4,660,000*	*$18,550,000*	*$23,210,000*	

Assumptions
All dollar amounts in Subtotals and Totals to nearest ten-thousand dollars
All values are in present worth 2010 Dollars

See Table B-1 for abbreviations and acronyms

APPENDIX C

Work Plan For Bench and Pilot Tests

APPENDIX C
MARYLAND SQUARE PCE SITE - CORRECTIVE ACTION PLAN FOR GROUNDWATER
WORK PLAN FOR BENCH AND PILOT TESTS

1.0 INTRODUCTION

This document describes testing to further evaluate the feasibility of select technologies for treatment of groundwater at the Maryland Square PCE Site (Site). Figure C-1 shows the site location. Testing will include bench-scale and pilot testing, aquifer hydraulic properties testing, and aquifer profiling to determine vertical distribution of tetrachloroethene (perchloroethene, PCE) in groundwater.

2.0 OXIDANT BENCH-SCALE TEST

There are already plans to evaluate the effectiveness of potassium permanganate under the soil corrective action (Tetra Tech 2010). Because the Nevada Division of Environmental Protection (NDEP) has some concerns regarding porosity occlusion, sodium persulfate has been chosen for testing as an alternative to permanganate. Like potassium permanganate, it can be injected using direct-push technology and is known to degrade PCE. However, sodium persulfate will not occlude porosity because it does not leave behind a solid residue when it has been reduced.

Soil samples for bench-scale testing will be collected when new wells are installed for aquifer testing. One (1) to 2 kilograms of representative soil samples and a small amount of groundwater will be collected and sent to the persulfate technology vendor for bench-scale testing. The bench-scale test will measure oxidant demand and evaluate various activators. If the measured oxidant demand is low to moderate, the results of the bench test will be used to plan a persulfate pilot test. If the oxidant demand is high, the technology will be cost prohibitive and will not be evaluated further.

3.0 AQUIFER TESTING

Aquifer testing will include conducting constant rate pumping tests in the two areas of the PCE plume where hydraulic control is most likely to be considered as part of the remedial alternatives. These tests are also intended to assist, where possible or applicable, the design and optimal implementation of other remedial strategies. The proposed areas for aquifer tests are adjacent to the locations of wells: 1) MW-14 and MW-6; 2) MW-19 and MW-20; and 3) MW-13, MW-18, MW-27, MW-30 and MW-32.

Characterization of aquifer hydraulic properties will be conducted using the following tests:

1. Constant Rate Pumping Tests
2. Step-Drawdown Pumping Tests
3. FloVision® Survey and Downhole Resistivity Surveys

Constant rate pumping tests will be conducted using production wells installed in each of the two areas 1) MW-14 and MW-6; 2) MW-19 and MW-20. Installation of the production wells will include (a) soil sampling at various depths to characterize soil properties of the vadose and saturated zones; and (b) downhole resistivity surveys of the open boreholes boreholes, if multiple permeable zones are found during lithologic characterization. Once the wells are installed and developed step-drawdown tests will be conducted in each of the production wells. The step-drawdown tests will allow establishing an optimum pumping rate for the long-term constant rate tests. If a borehole resistivity survey is conducted, a FloVision® survey will also be conducted within the screened interval to help confirm the presence or absence of preferential flow.

As part of the aquifer testing activities, step-drawdown pumping tests also will be performed in wells MW-13, MW-18, MW-27, MW-30 and MW-32. Prior to these tests each well will be subjected to FloVision® and downhole resistivity surveys within the screened intervals.

The specific procedures associated with well installation, sampling, and testing are discussed below and detailed in Attachment C-1.

Legend

- Monitoring Well Location
- 1100 PCE Concentration (ug/L)
- NS Not Sampled
- ND Non-detect
- ug/L Micrograms per Liter

Note: 1. PCE data is from the November 2010 monitoring event.

N W E S

0 160 320 Feet

Approximate Scale in Feet

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

FIGURE C-1
PILOT AND AQUIFER TEST LOCATIONS

TETRA TECH

Path: S:\Projects Directory\Private Sector - Other Offices\Maryland Square\Work Plan\Figure C-1.mxd Date: 6/13/2011

3.1 Constant Rate Pumping Tests

General steps for constant rate pumping tests include:

1. Install two new production wells near existing monitoring wells to be used for drawdown observations.
2. Develop new production wells, wait 48 hours, then conduct baseline groundwater monitoring for PCE.
3. Perform step drawdown tests to determine appropriate pumping rates.
4. Perform constant rate pumping tests for up to 5 days to obtain delayed yield data.
5. After tests begin, collect groundwater samples for PCE analysis at 4 hours, 24 hours, 48 hours, and 72 or 96 hours.
6. Treat and dispose of extracted groundwater appropriately.

Preliminary groundwater production calculations developed using the Theim equation for unconfined groundwater conditions (Theim 1906) and using the results of the slug tests performed by Converse (2004) indicate steady state flows may range from 3 to 7 gallons per minute (gpm), with lower permeable units potential producing as low as 0.5 gpm. The limiting factor for the well flow capacities are the shallow depth of the wells (partial penetration of the saturated zone). Therefore, installation of new production wells is proposed for performing the aquifer tests, with use of the existing monitoring wells as observation wells.

The two new production wells will be installed 15-25 feet from wells MW-14 and MW-20 (between wells MW-6 and MW-19, respectively). The wells will be completed to a depth of 52 feet at MW-14 and to a depth of 57 feet at MW-20. The observation well array for the production well near MW-14 will include wells MW-14, MW-6, MW-17, MW-13, MW-15 and MW-5. The observation well array for the production well near well MW-20 will include wells MW-19, MW-21, and potentially wells MW-18 and MW-16. The well installation and development will be conducted as described in Attachment C-1.

The new production wells will be sampled for PCE no sooner than 48 hours after development prior to start of the pumping tests. If multiple permeable zones are found during lithologic characterization of the borehole, downhole resistivity and FloVision® surveys will be conducted. In addition, groundwater samples will be collected from each permeable interval (up to 3 intervals) using low-flow sampling techniques in accordance with the approved site monitoring plan, after initial purging at least 4 gallons (at a purge rate of 0.5 gallons per minute [gpm]) from the sample intervals.

The constant rate test will be conducted for up to 5 days to allow collection of delayed yield data to allow determination of the specific yield capacity of the unconfined saturated zone. The constant pumping rate for the test will be selected to provide 16 to 20 feet of drawdown in the production well. Data will be collected from the pumping well and the observation wells using pressure data logger transducers along with supporting manual water level measurements. Manual measurements will also be collected from the second nearest monitoring/observation well. The data logger transducers will be allowed to equilibrate with the groundwater at least 10 hours prior to starting the constant rate test. A barometric data logger will also be used to monitor changes in barometric pressure during the test, and manual water level measurements will be collected in a monitoring well located no closer than 300 feet of the production well to track diurnal and barometric effects on the groundwater level during the test. The water level data will be collected on a logarithmic time interval in accordance with standard practice. Upon completion of the pumping period, recovery data will be collected for 12 hours or until the groundwater level recovers to at least 95 percent of the original water level. The water level data will be monitored and evaluated to determine when sufficient data have been collected for evaluation of the delayed yield effects. The pumping test may be terminated prior to 5 days if sufficient delayed yield data has been collected.

Groundwater produced during the pumping test will be treated onsite and discharged in compliance with applicable permits. If it is infeasible to obtain a permit for discharge to the sewer, a temporary National Pollutant Discharge Elimination System (NPDES) permit may be obtained.

3.2 Step-Drawdown Pumping Tests

Step-drawdown pumping tests in wells 13, 18, 27, 30 and 32 will provide an estimate of the hydraulic parameters of the different geologic units across the site. The materials screened by each well are as follows:

i. MW-13: Sandy clay
ii. MW-18: Sand with silt
iii. MW-27: Silty clay with a 1-foot caliche interval
iv. MW-30: Sandy silty gravel
v. MW-32 : Clay and clayey silt

Each test is expected to take up to 4 hours to complete. The discharge from the pumping well will be increased in a stepwise fashion from an initially low constant flow rate to progressively higher constant flow rates. In each step of the test, the drawdown in the pumping well will be allowed to stabilize. Each step will be of equal duration, lasting from approximately 30 minutes to 2 hours (and long enough to establish that the effects of well storage have dissipated). In addition to estimates of hydraulic parameters, the step-drawdown tests will provide a range of specific capacities for the well. The specific capacity of the pumped well will be calculated for each step test by dividing the flow rate (in gpm) by the measured drawdown at the end of each step.

A pressure transducer with a data logger will be used to collect the water level data in the pumping well. Extracted groundwater will be treated and disposed of appropriately.

3.3 FloVision® Survey And Downhole Resistivity Survey

FloVision® and downhole resistivity surveys of select monitoring wells will be conducted to determine whether the saturated zone consists of massive beds or if there are more permeable intervals within the units. These tasks will be conducted in conjunction with activities under the Indoor Air and Well Water Work Plan (Tetra Tech pending). The results of these surveys and the results of previous Passive Diffusion Bag (PDB) sampling (Converse 2010, Appendix E of the CAP) will be evaluated to determine whether additional PDB sampling is necessary. If deemed necessary, PDB sampling will be conducted to further assess vertical distribution of PCE in select wells.

The production and monitoring wells are expected to be screened across different units of the Las Vegas Wash Aquitard, with some units potentially contributing more flow to wells. Therefore, a resistivity survey and a spinner-type survey will be conducted in wells with the highest PCE concentrations (MW-5, MW-6, MW-14) and wells located along the central line of the PCE plume in groundwater (MW-13, MW-18, MW-19, MW-23, MW-25, MW-26, MW-27, MW-30, and MW-32). A FloVision® tool will be used in some wells instead of the more commonly used spinner tool because of anticipated low flow rates.

The spinner/FloVision® tools measure the vertical water flow velocity in the well in a manner that allows measurement of flow contributions from each layer across the screened interval. When the FloVision® tool is used, a video log will accompany the data readings. The survey can be run during static or pumping (dynamic) conditions.

3.4 Data Evaluation And Reporting

The constant rate pump test data will be evaluated by methods suitable for unconfined conditions (Neuman 1974, 1975; Boulton 1963) and semi-confined (or leaky confined) conditions (Walton 1970; Hantush and Jacob 1955) or other methods available in AQTESOLV™. The step-drawdown data will be evaluated for estimates of the hydraulic parameters using the Theis method for confined conditions and Hantush-Jacob method for leaky aquifers (Hantush and Jacob 1955; Bear 1979).

The aquifer testing report will characterize the various units encountered on site within the Las Vegas Wash Aquitard. The report will provide hydrogeologic parameters that will be used to further evaluate the feasibility of corrective action alternatives as well as design a remedy after an alternative has been selected.

4.0 PILOT TESTS

The overall purpose of these pilot tests is to determine whether potentially viable technologies will perform well in the field under the conditions encountered at this site. The pilot tests will be designed to: (a) determine destruction or removal rates of PCE, (b) gauge the ability to distribute treatment chemicals or carrier fluids into site soils, and (c) obtain useful design parameters in case the technology is selected for full-scale application.

Technologies that have been selected for pilot testing include:

1. Air Sparge/Soil Vapor Extraction (AS/SVE)
2. Ozone Sparge with Peroxide
3. In Situ Chemical Oxidation (ISCO) with Persulfate

In order to reasonably compare performance, the pilot tests must be performed in parts of the plume with similar PCE concentrations. Given this objective, the parking lot east of the mall appears to be a suitable location for these pilot tests. Figure C-1 shows the proposed location. It offers unimpeded access and a sufficiently large area to conduct all three tests side by side with minimal variance in PCE concentration.

The three proposed tests will likely be set up side by side (north to south) perpendicular to groundwater flow, in the vicinity of monitoring wells MW-19 and MW-20. Individual test areas will be located to ensure that their treatment zones do not overlap.

4.1 Baseline Monitoring

The following tasks will be performed before conducting any the pilot tests:

- Groundwater in the pilot test area will be sampled and analyzed for PCE, trichloroethene (TCE), cis- and trans-1,2-dichloroethene (DCE), vinyl chloride (VC), dissolved metals (including ferrous ion) and major anions. In addition, field parameters including water levels, temperature, DO, CO_2, Eh, pH and conductivity will be measured. Three to six existing and new monitoring or observation wells may be sampled.
- Soil from the proposed treatment zone in the pilot test area will be sampled and analyzed for PCE, TCE, DCE, and VC. The concentration of PCE in soil will help estimate an empirical PCE soil-groundwater partition coefficient which can later be used in PCE destruction calculations.
- Representative samples of aquifer soils encountered while drilling new wells will be collected and tested for various physical parameters including moisture content, bulk density, porosity, grain size and total organic carbon.
- Soil gas wells in the pilot test area will be monitored using a photo ionization detector (PID)

4.2 Air Sparge/Soil Vapor Extraction

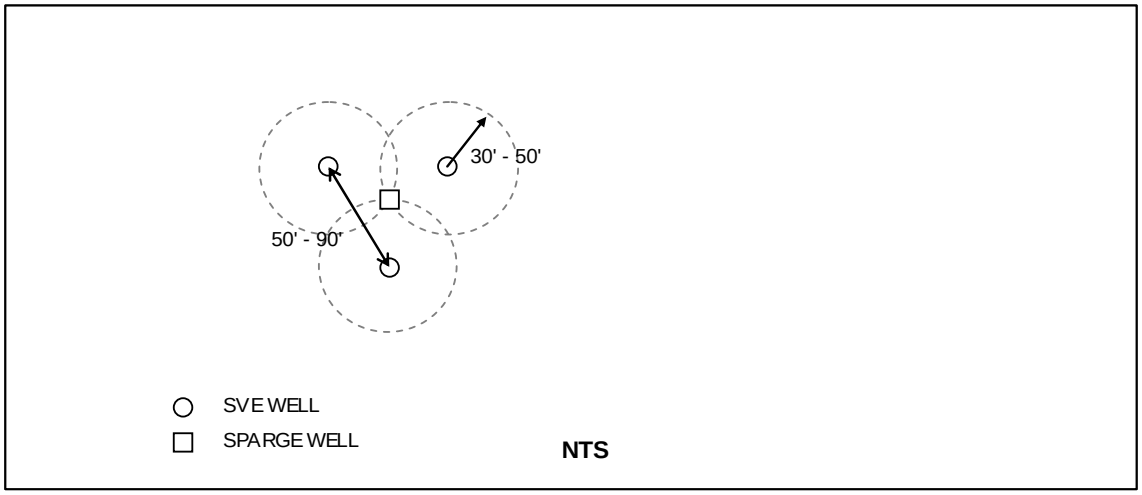
The objective of the AS/SVE pilot test is to measure achievable ROI and calculate PCE mass removal rates. This information will be used to evaluate the feasibility of the technology.

The decision to perform an AS/SVE test will be made after baseline groundwater monitoring and aquifer testing are complete. If the intrinsic permeability in the majority of the planned test area is less than 10^{-10} square centimeters (cm^2), an AS/SVE pilot will not be performed. Similarly, if the dissolved iron concentration is greater than 10 milligrams per liter (mg/L), an AS/SVE pilot will not be performed. It

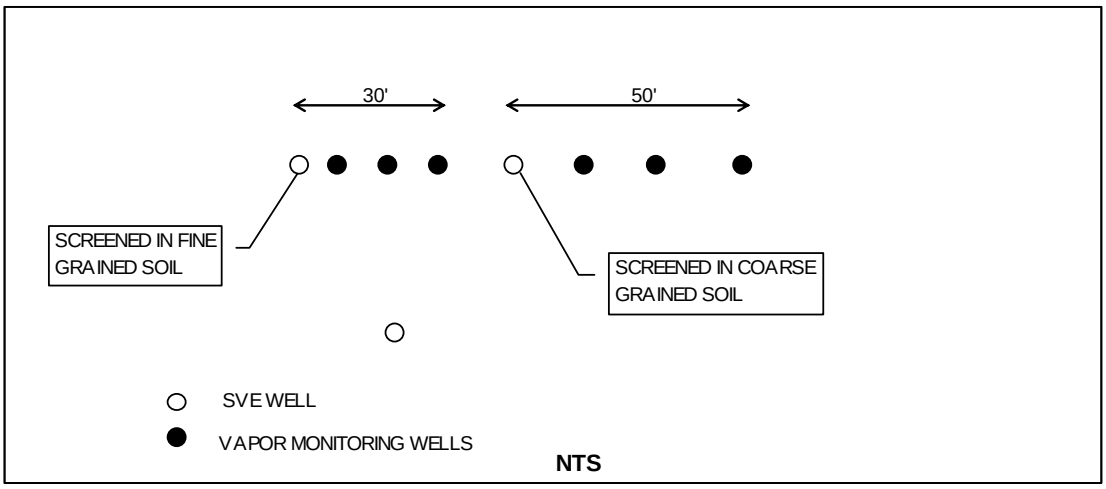
should be noted that total iron concentrations in wells MW-18 and MW-19 were less than 10 mg/L in the fourth quarter of 2006.

The AS/SVE pilot test will require at least one sparge well, three SVE wells, three to six vapor monitoring wells, and three to six groundwater monitoring wells. New observation and production wells installed as part of aquifer testing may be used.

Three SVE wells will be installed in a triangular arrangement at approximately 50 feet on centers. (This equates to a 30-ft ROI). A single sparge well will be installed at the center of the three SVE wells.



The SVE wells will be screened at least 1 foot above the water table and the well screen will be up to 5 feet long. One SVE well will be screened in a coarse grained soil and another in a fine grained soil. The third SVE well may be installed in either soil type. There will be three vapor monitoring wells in coarse grained soil, equally spaced over a distance of at least 50 feet from the SVE well. There will be three vapor monitoring wells in fine grained soil, equally spaced over a distance not exceeding 30 feet.

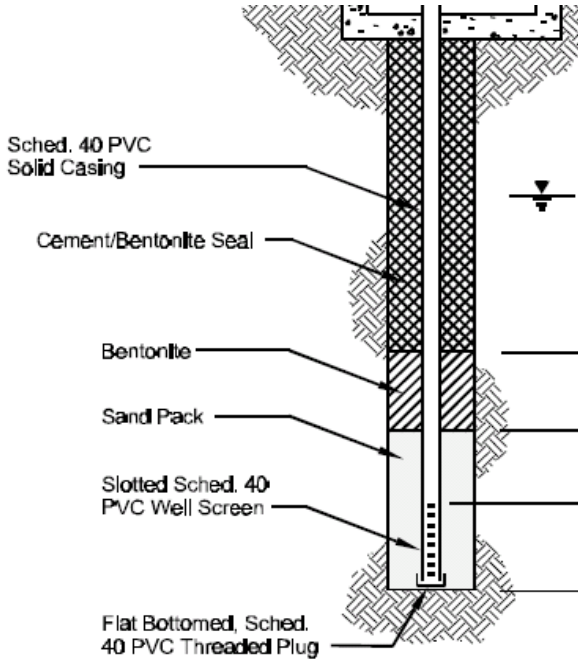


The two SVE wells representing coarse and fine grained soils will be individually tested. Testing will involve connecting one SVE well at a time to a skid-mounted SVE system. Vacuum and flow rate will be varied in steps and radius of influence will be estimated by measuring vacuum at the vapor monitoring points. A sample of the exhaust gas will be collected at each flow rate and analyzed for PCE. This will

provide the baseline concentration of PCE in soil vapor when there is no air sparging. The SVE tests are expected to take one day to complete.

A cluster of two or more sparge wells will be installed at the same location. Each well will be screened at a different depth below the water table. The top of screens may vary from 10 to 20 feet below the water table and the screen length will be 1 to 2 feet.

TYPICAL SPARGE WELL



SOURCE: EPA 2004

There will be three groundwater monitoring wells equally spaced from the sparge well over a distance of approximately 30 feet.

Air sparging tests will start the day after SVE tests are complete. SVE wells will be operated during air sparging.

The sparge well will be connected to a skid-mounted air sparge system and air will be injected into groundwater. Helium gas may be added as a tracer to help determine ROI. Injection pressure and flow rate will be varied in steps for each injection depth. Water levels and field parameters including water levels, temperature, dissolved oxygen (DO), redox potential (Eh), pH and conductivity will be monitored in the surrounding wells screened below the water table. Injection pressures and injection flow rates will be monitored. SVE exhaust gas pressure and flow rate will also be monitored. For each air sparge injection pressure and flow rate, the SVE exhaust will be sampled upstream and downstream of the moisture knockout tank and analyzed for PCE.

Water level, DO data, and helium vapor concentrations in temporary groundwater monitoring wells will be used to estimate ROI. Flow rate and PCE concentrations in exhaust gas will be used to calculate mass removal rates.

Once effectiveness is established, information from the pilot test will be used to estimate the cost of full-scale AS/SVE implementation. The estimated cost will be compared to the cost of implementing other tested technologies. Selection for full-scale remediation will be based on observed effectiveness, implementability, and cost.

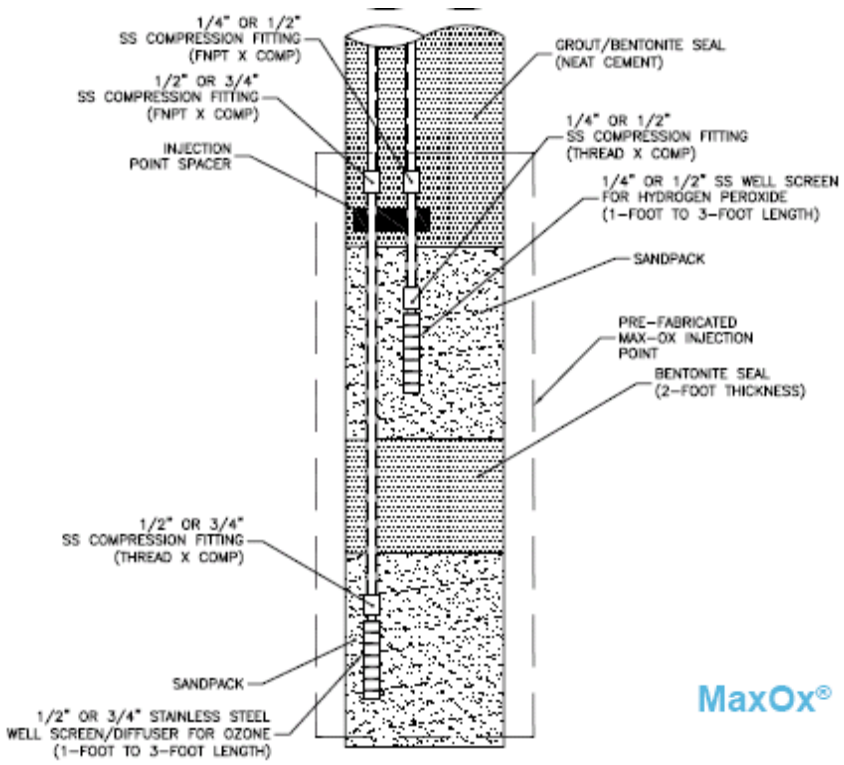
4.3 Ozone Sparge With Peroxide

The objective of the peroxide-ozone pilot test is to determine injection ROI and measure PCE destruction rates. This information will be used to evaluate the feasibility of the technology.

The test will be performed using a single injection well. ROI usually varies from 8 to 25 feet. Therefore, temporary groundwater monitoring wells will be installed at 8 feet, 16 feet and 25 feet from the injection well. If multiple soil types are encountered, nested monitoring wells will be installed so that each soil type has a separate screen.

A dual-phase injection well will be constructed. The well will have a 1- to 3-foot long screen located in the upper 10 feet of the aquifer. This screen will be used for hydrogen peroxide injection. Another 1- to 3-foot long screen located below it will be used to sparge in a mixture of ozone, oxygen and air. A typical injection well detail is shown below.

TYPICAL PEROXIDE-OZONE INJECTION WELL



SOURCE: APT WATER

The injection well will be connected to a trailer-mounted peroxide-ozone injection system. During startup, injection pressures will be optimized for maximum distribution without off gassing. It should be noted that sparging will occur at a very low flow rate compared to a typical air sparge system. This is because sparging in this case is intended for complete gaseous dissolution rather than contaminant stripping.

Because dissolved ozone would be removed through reaction, off gassing into the vadose zone is not expected. If it does occur, it should be detected in the injection well box during startup. A portable ozone monitor will be used to test for ozone at the injection well during startup. If ozone is detected, injection pressures or ozone concentrations in the carrier gas (air) will be reduced until the off-gassing stops.

Injection will be fully automated and will follow a pulsed technique. Sparging and hydrogen peroxide injection will alternate. Sparging will occur every hour for a duration not exceeding 30 minutes. Hydrogen peroxide injection will occur every hour for 2 to 5 minutes. In general, the injections will maintain a 2 to 1 molar ratio of ozone to hydrogen peroxide in the dissolved phase.
Within the first one to two weeks following the start of the pilot test, PCE concentrations in groundwater may increase. This usually happens due to desorption of PCE from the soil. Therefore, the pilot test may have to continue for 2 to 4 weeks in order to observe decreasing groundwater concentrations.

The temporary monitoring wells will be monitored weekly for PCE, TCE, DCE, VC, dissolved metals and field parameters. Field parameters will include water levels, temperature, DO, CO_2, Eh, pH and conductivity. Soil gas will be monitored weekly with a PID. After injection stops, soil samples will be collected adjacent to the pre-test baseline sampling locations and will be analyzed for PCE, TCE, DCE and VC.

Eh, DO and PCE concentration results will be used to estimate ROI. Pre- and post-treatment PCE concentrations will be used to estimate destruction rates. Soil gas data will be used to determine whether treatment is causing migration of contaminants to the vadose zone.

After injection stops, the farthest temporary monitoring well will be monitored weekly for field parameters, and once every two weeks for dissolved metals. If Eh and dissolved metals concentrations do not decrease over time, a new temporary monitoring well will be installed downgradient of the treatment zone to observe whether metals are being mobilized outside the treatment zone.

4.4 In Situ Chemical Oxidation With Persulfate

This test will be performed only if the bench-scale test indicates a low to moderate soil oxidant demand. The objective of the persulfate pilot test is to determine injection ROI and measure PCE destruction rates. This information will be used to evaluate the feasibility of the technology.

The test will be performed using a single injection well. ROI can vary from 10 to 30 feet. Therefore, temporary groundwater monitoring wells will be installed at 10 feet, 20 feet and 30 feet from the injection well. If multiple soil types are encountered, nested monitoring wells will be installed so that each soil type has a separate screen.

Persulfate will be injected using direct push technology (DPT). If necessary, hollow-stem auger drilling will be used to penetrate the caliche layer. Further drilling and injection will then proceed using DPT. This method of injection allows delivery of oxidant to the entire targeted vertical interval through focused injections into smaller 1 to 2 feet long consecutive vertical intervals. This overcomes the problem of preferential flow of oxidant to more permeable zones which can leaves less permeable zones untreated.

An experienced subcontractor will provide injection services. The subcontractor's injection rig will have all the necessary equipment to prepare the injectate, injection tooling to isolate injection intervals, and high pressure pumps to deliver the injectate into the subsurface.

The exact volume of injectate, required mass of sodium persulfate, and required mass of activator are not yet known. These quantities will be estimated after completion of the bench-scale test. However, the pilot test will be designed such that the injectate volume does not exceed 30 percent the pore volume of the targeted treatment zone. An inert dye that has been approved by NDEP may be mixed into the injectate. Alternately, a separate test may be conducted injecting only dye without persulfate to determine the injection ROI.

After the required quantity of injectate has been delivered to the subsurface, continuous soil cores will be collected from varying distances around the injection point. The cores will be examined for coloration resulting from the dye. The presence or absence of color in soil cores will help establish the radius of influence. Alternately, discrete groundwater samples may be collected from varying distances around the injection point and examined for the presence of dye. An investigative borehole will be drilled adjacent to the injection point to log lithology. All field work associated with the pilot test (excluding post-injection monitoring) should take approximately 2 days to complete.

On day 7, day 15, and day 30, the temporary monitoring wells will be sampled and analyzed for PCE, TCE, DCE, VC, persulfate, sulfate, and dissolved metals. Field parameters including water level, temperature, DO, CO_2, Eh, pH and conductivity will be measured on day 2, day 7, and weekly thereafter for one month. Depending on the sorbed mass of PCE, with this technology, one month may prove

insufficient to observe a significant decrease in PCE concentrations. If that becomes apparent, monitoring may continue on a reduced frequency for up to 2 months.

Soil gas will be monitored weekly with a PID for one month. One month after persulfate injection, soil samples will be collected adjacent to the pre-test baseline sampling locations and will be analyzed for PCE, TCE, DCE and VC.

The results of visual inspection of soil cores or discrete groundwater samples for the presence of dye will be used to estimate radius of influence. Pre- and post-treatment PCE concentrations will be used to estimate destruction rates and destruction efficiency. Soil gas data will be used to determine whether treatment is causing migration of contaminants to the vadose zone.

After the first month following injection, the farthest temporary monitoring well will be monitored for field parameters and dissolved metals on a monthly frequency for up to 3 months. If Eh and dissolved metals concentrations do not decrease over time, a new temporary monitoring well will be installed downgradient of the treatment zone to observe whether metals are being mobilized outside the treatment zone.

4.5 Analysis Of Pilot Test Results

For a technology to be considered effective: (1) it must significantly reduce PCE concentrations without causing accumulation of daughter products; (2) it must not cause a significant increase in VOC concentrations in soil gas; and (3) if the concentrations of dissolved metals are found to increase during treatment, they must decrease over time after treatment is complete. Once effectiveness is established, information from the pilot test will be used to estimate the cost of full-scale implementation of ISCO. The estimated cost will then be compared to the cost of implementing other tested technologies. Selection for full-scale remediation will be based on observed effectiveness, implementability, and cost.

5.0 SCHEDULE

The table below presents the proposed schedule.

Task	Timeline
Obtain treated water discharge permits for aquifer testing	Within 3 weeks of work plan approval
Solicit bids for well installation and aquifer testing equipment	Within 3 weeks of work plan approval
Collect soil samples for persulfate bench-scale testing	Within 2 weeks of work plan approval
Complete persulfate bench-scale testing	Within 2 weeks of collecting soil samples
Award work for well installation and pumping tests	Within 2 weeks of soliciting bids
Obtain underground injection control (UIC) permit for pilot tests	Within 7 weeks of completing persulfate bench-scale test
Install new wells, start aquifer tests and collect baseline soil samples from pilot test areas	Within 3 weeks of bid award
Complete aquifer tests and sample collection	Within 2 weeks of starting pumping tests
Solicit bids for pilot testing equipment/services	Within 4 weeks of completing bench-scale tests
Award subcontract for pilot tests	Within 1 week of obtaining UIC permits
Start pilot tests	Within 1 week of awarding subcontracts
Complete pilot tests	Within 8 weeks of starting pilot tests
Complete pilot tests data analysis	Within 2 weeks of completing pilot tests
Complete Corrective Action Report	Within 180 days of work plan approval.

Notes:

The schedule depends on work plan approval by NDEP, client execution, ability to gain access to the Site, and the timely issuance of permits.

6.0 REFERENCES

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ATTACHMENT C-1 – WELL INSTALLATION PROCEDURES

New 4-inch diameter PVC wells will be installed 15 to 25 feet from wells MW-14 and MW-20 (between wells MW-6 and MW-19, respectively). The wells will be completed to a depth of 52 feet at MW-14 and to a depth of 57 feet at MW-20. The borings will be advanced using sonic drilling and will be continuously cored to allow a detailed description of the lithology. Three samples from each boring will be collected for moisture content, bulk density, porosity, grain size, horizontal and vertical permeability, hydraulic conductivity, total organic carbon and contaminant distribution data.

The wells will be constructed of 4-inch diameter schedule 40 PVC casing with 0.010-inch slotted screen 20 to 25 feet long and will have a 2-foot sump. Sand packs will consist of clean # 1/20 sand and will extend to 2 feet above the top of the well screen. After placement of the sand, the wells will be pre-developed by gently surging across the screen interval. After settlement of the sand, additional sand is to be added to restore the sand pack to the dimensions stated previously.

At least 2-feet of hydrated bentonite pellets or bentonite grout will be placed atop the filter pack to form a seal. Each well will be pressure grouted with bentonite/cement slurry grout from the top of the filter pack to within 4 feet of the ground surface. The grout will be placed using a side discharge tremie pipe. The tremie pipe will be worked around the hole to make sure that the annular space is free of voids. The grout will be allowed to set for at least 24 hours before any further work is done on the well. The wells will be completed below grade using a bolted access cover. If the wells are later used for hydraulic control as part of an implemented remedy, the completions will be converted to well vaults to provide the space for pump controls.

The wells will be developed using a surge block and bailing, followed by pumping until turbidity is 100 NTUs or less. If multiple permeable zones are found during characterization of the borehole, groundwater samples will be collected from each permeable interval (up to 3 intervals) using low-flow sampling techniques in accordance with the approved site monitoring plan, after initial purging at least 4 gallons (at a purge rate of 0.5 gallons per minute [gpm]) from the sample intervals. The groundwater samples will be collected no sooner than 48 hours after completion of well development.

Following well installation and development, the location and elevation of each new well (ground surface and top of casing) will be surveyed to the nearest 0.01 foot by a licensed professional surveyor. Horizontal coordinates will be measured relative to the NAD 83 in the Nevada State Plane Coordinate System, East Zone. Elevation will be measured relative to NAVD 88.

APPENDIX D: TABLE D-1- RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011

The table below contains the responses to comments received from the NDEP on the "Draft Corrective Action Plan for Groundwater, Maryland Square Shopping Center, the former Al Phillips the Cleaner. The comments addressed below were received from NDEP on April 26, 2011.

Comments provided from Mary Siders, Ph.D., Bureau of Corrective Actions, Nevada Division of Environmental Protection.

Comment No.	Section / Page	Comment	Response
GENERAL COMMENTS			
		The NDEP noted some of the same issues with this version of the draft CAP for Groundwater (February 28, 2011) as for the previous version of the draft CAP (October 11, 2010). Primary concern focuses on several deficiencies, including **(1)** an inadequate evaluation of the existing data, **(2)** failure to specify data needs for each proposed alternative and provide a comparison with existing data to determine data gaps, **(3)** no conduct of a human health risk assessment (HHRA) using existing data.	1. Existing data has been evaluated. Additional tables summarizing data have been inserted in the text of the document. 2. A table summarizing the technologies selected for evaluation coupled with a derivation of data gaps for those technologies considered potentially useful has been included in Section 8. 3. Tetra Tech is relying on the conclusions of the risk evaluation conducted by the Nevada Division of Environmental Protection Bureau of Corrective Action (NDEP BCA) for purposes of developing the draft Groundwater Corrective Action Plan (CAP). A formal HHRA will be completed and the results will be presented and used to support the remedial action and selected remedy presented in the Corrective Action Report.
1.		The CAP <u>is a plan to provide a plan</u>. The CAP proposes to submit a work plan to collect additional data in a sequential schedule that does not allow adequate time for evaluation of all viable technologies within 180 days of CAP approval. Necessary data for all viable technologies should be collected concurrently, not sequentially.	Accepted. A work plan for aquifer testing, and chemical oxidant and sparging pilot testing will be included as an appendix to the CAP and submitted by June 14, 2011.
2a.		There is a large data set for volatile organic compounds (VOCs) analyzed by Method 8260B for groundwater samples collected over several years from 33 wells.	Comment noted.
2b.		There is a large data set for field parameters, with more than 250 records for 31 wells.	Comment noted.
2c.		There is a moderately large data set for inorganic constituent in groundwater, based on numerous samples collected from 12 monitoring wells. As reported in Table 4 in the groundwater monitoring report for first quarter 2008 (URS, 2008).	Comment noted.
2d.		There are indoor air data for 97 residences; with laboratory quality control (QC) data for validation of these data, which can then be used to perform an HHRA.	Comment noted.
2e.		The utility of subslab data is questionable (see Section 9.1 in the CAP); studies have shown extreme variability (orders of magnitude) across the slab. Additionally, there is an attenuation factor must be assumed if using subslab data to estimate "potential" risk. In contrast, a time-averaged sample of indoor air provides information on actual exposure. Care must be taken to avoid interference from background sources of VOCs in the home, but this is usually possible by conducting a home survey.	Accepted. Subslab sampling is no longer recommended in this document.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
3.	There are analytical data for samples of groundwater, soil, soil gas, and indoor air for the Site. Unless data are rejected, they are usable. It is unclear why these data are deemed "insufficient" in terms of quantity and quality to conduct a HHRA. The laboratory QC data are available to conduct validation of the indoor air data. The HHRA may be updated after additional data are collected and before remedy implementation.		Agreed. Available data substantiated by acceptable quality control data will be used for the HHRA. Additional data collected as prescribed by the *Final Work Plan for Mitigation of Indoor Air and Well Water* (Tetra Tech pending) will be considered during the evaluation and assignment of risk due to exposure to concentrations of PCE.
	As noted in the NDEP's letter of January 11, 2011, the remediation standard for PCE in groundwater should be the maximum contaminant level (MCL) or a level such that associated concentration of PCE in indoor air approaches a 10^{-6} risk level. The remediation standard for indoor air has not yet been determined.		Accepted. The preliminary remediation standard has been revised to correspond to the 10^{-6} risk level.
Specific Comments			
PART A: REQUIRED CRITICAL COMMENTS			
Executive Summary			
1.	Executive Summary, ES-1.	The Nevada Division of Environmental Protection (NDEP) notes that the primary purpose of the Corrective Action Plan (CAP) is to establish a **process, schedule and criteria** by which a remedy for shallow groundwater will be evaluated and proposed for selection by the NDEP. A secondary purpose of the CAP is to propose **additional data collection, analysis and reporting** needed to complete remedy selection and start design. A relatively mature conceptual site mode (CSM) exists for the site, and should be included in discussions of human health risk.	Accepted. The text has been revised.
2.	Executive Summary, ES-1.	The text states that *"A baseline risk assessment predicting and quantifying potential human health risk will be presented in the final CAP after adequate data are obtained."* As noted previously by the NDEP, it is unclear what aspects of the existing data are not adequate. The existing data appear adequate to conduct a draft risk assessment in this document. A screening-level risk assessment can then be used to determine what specific additional data, if any, are needed to complete the risk assessment.	Comment noted. Available data substantiated by acceptable quality control data will be used for the HHRA. Additional data collected as prescribed by the *Final Work Plan for Mitigation of Indoor Air and Well Water* (Tetra Tech pending) will be considered during the evaluation and assignment of risk due to exposure to concentrations of PCE. A formal HHRA will be completed and the results will be presented and used to support the remedial action and selected remedy presented in the Corrective Action Report.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
3.	Executive Summary. ES-1.	The preliminary corrective action objectives (CAOs) are listed here as: 1 *Prevent inhalation exposure of current residents to concentrations of PCE that exceed the remediation standard for residential indoor air.* 2 *Prevent use of shallow groundwater as a source of drinking water and remediate shallow groundwater where PCE concentrations exceed the remediation standard for groundwater.* Please revise to indicate that CAOs are to protect human health by reducing inhalation exposure to solvent vapors emanating from groundwater, and to protect and restore shallow groundwater in accordance with Nevada Administrative Code (NAC) 445A.22725.	Accepted: The text has been revised as agreed upon in a meeting between NDEP, Mr. Tim Swickard, and Tetra Tech on May 27, 2011.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
4.	Executive Summary, ES-1.	The text states that *"General response action (GRA) were identified using these preliminary CAOs and numerical remediation standards ..."* The CAP should also develop working definitions of the specific areas and volume of groundwater targeted for cleanup and relate this to any other areas and timing for potential interim abatement for domestic well protection and additional mitigation of indoor air (refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***). The CAP should use the concept of preliminary remediation goals (PRGs) or regional screening levels (RSLs) for purposes of analysis and incorporate applicable concepts from the April 22, 1991 (U.S. Environmental Protection Agency [USEPA] Role of Baseline Risk Assessment (Office of Solid Waste and Emergency Response [OSWER] Directive 93SS.0-30) and the August 1997 Guidance Rules of Thumb for Superfund Remedy Selection (OSWER Directive 93SS .0-69). The NDEP notes that, in the absence of applicable or relevant and appropriate requirements (ARARs) for chemicals that pose carcinogenic risks, PRGs generally should be established at concentrations that achieve 10^{-6} excess cancer risk, modifying as appropriate based on exposure, uncertainty, and technical feasibility factors. Initial PRGs are developed early in the remedial investigation and feasibility study (RI/FS) process and are based on ARARs and other readily available information, such as concentrations associated with 10^{-6} cancer risk or a hazard quotient equal to one for noncarcinogens calculated from USEPA toxicity information. Initial PRGs may also be modified based on exposure, uncertainty, and technical feasibility factors. As data are gathered during the baseline risk assessment and RI/FS, PRGs are refined into final contaminant-specific cleanup levels. Based on consideration of factors during the nine criteria analysis and using the PRG as a point of departure, the final cleanup level may reflect a different risk level within the acceptable risk range (10^{-4} to 10^{-6} for carcinogens) than the originally identified PRGs. The final cleanup levels, not PRGs, are documented in the record of decision (ROD).	Accepted. Areas of remedial priority, generally corresponding to those locations where risk of PCE exposure is known to exist and/or exceed interim remediation standards, are identified and described (Section 4).
5.	Executive Summary, ES-2.	Text refers to *"MNA as a polishing step;"* however, the attenuation currently observed in the plume appears to be almost solely the result of sorption and dispersion. The data indicate little in the way of dechlorination and degradation.	Agreed.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
6.	Executive Summary, ES-2.	Text states that *"If in-situ chemical oxidation or a sparge curtain is proven insufficient during testing, a zero-valent iron (ZVI) PRB, extraction and treatment, and/or enhanced bioremediation will be further evaluated"* and *"Until an adequate understanding of the environmental conditions and characteristics can be determined through bench-scale and pilot testing."* The NDEP does not concur with sequential bench-scale and pilot-scale testing; the schedule should be revised so that tests for viable alternatives should be conducted concurrently, so as not to further delay progress toward implementing a remedy. Describe what data are needed for an "adequate understanding" and describe how that additional data will inform decisions regarding technology selection or remedial design.	Accepted. Aquifer testing, bench-scale and pilot testing for the technologies recommended, i.e., in-situ chemical oxidation and air sparing will be conducted simultaneously. Data collected during these evaluations will also be useful for the implementation of alternative technologies in the event these technologies prove ineffective. Aquifer testing conducted during bench-scale and pilot tests will be generally applicable to a wide range of potential remedial applications.
7.	Executive Summary, ES-2.	*"Based on a review of the existing data, additional data are needed for adequate description and understanding as follows: (I) Indoor air data are needed to evaluate current residential conditions and evaluate the efficacy of mitigation systems previously installed by the Nevada Department of Environmental Protection (NDEP) ...* The NDEP notes there are indoor air data for 97 homes, along with multiple samples (before and after mitigation and system optimization) from homes where subslab depressurization (SSD) systems were installed. Annual sampling of indoor air of requesting homeowners within the plume area is required in the Permanent Injunction. (2010). Unless the existing data are invalid, there is no reason that these data cannot be used for a risk assessment. The risk assessment should be done using existing data, then updated as additional data are collected. Also, it is the Nevada Division of Environmental Protection (NDEP).	Agreed. Indoor air data will be collected and compiled as prescribed in a *Final Work Plan for Mitigation of Indoor Air and Well Water* (Tetra Tech pending). Available data substantiated by acceptable quality control data will be used for the HHRA. Should additional data become necessary after the execution of pending Indoor Air and vapor sampling, additional documentation will be supplied for review and concurrence.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
8.	Executive Summary, ES-2.	(2) *Soil properties have not been well characterized/or the unsaturated and saturated heterogeneous soils across the Site. Insufficient physical, f1ow, and contaminant distribution data have been collected in the unsaturated and saturated zones beneath the Site."* The NDEP notes that **soil properties and contaminant distribution data** for the **unsaturated zone** in the source area **are well characterized** (29 borings and 77 soil samples analyzed). The NDEP notes that **detailed delineation** of the **lithology** and **vertical distribution of tetrachloroethylene (PCE)** in groundwater will be needed **in the area(s) where a remedy will likely be installed**. However, because of the size of the site and the known heterogeneity of the alluvial deposits, detailed characterization of lithology across every location on site is not likely to be practical, except in the treatment area(s) and at any new borings or wells that are installed. Inferences by experienced geologists/hydrologists will be needed. The document provides overly generic descriptions of data gaps. The document also fails to explain how exactly the data proposed to be collected will be used to make additional decisions regarding technology selection or remedy design for this specific site. NDEP provides additional comments on Section 9 below. The NDEP request further definition of what is meant by "physical data." The NDEP assumes that "flow data" refers to hydraulic characteristics of areas targeted for remediation, which the NDEP agrees are needed. In terms of contaminant distribution data for groundwater, the NDEP notes that the **lateral boundaries of the PCE plume are well delineated to the west, north and south of the plume**, at least as far east as Spencer St. PCE was not detected (or generally detected at < 5 micrograms per liter (•g/L) in wells MW-7, MW-S, MW-9, MW-10, MW-11, MW-12, MW-1S, MW-16, MW-22, MW-24, MW-2S, MW-29, and MW-33. The NDEP notes that the PCE plume in groundwater needs to be delineated downgradient, all the way to the 5 •g/L concentration boundary in the area east of Spencer St. Cite the *Draft Work Plan for Mitigation of Indoor Air and Well Water,* which should provide a description of what actions will be taken to delineate the downgradient extent of the plume	Comment noted. Priority target areas have been identified in the text, and reference to physical soil properties has been revised to clarify soil property characteristics. The downgradient delineation of PCE in groundwater is specifically addressed by the *Final Work Plan for Mitigation of Indoor Air and Well Water* (Tetra Tech pending).

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 1, Introduction			
9.	Section 1.1, Page 1	This section contains a bulleted list of three objectives of the CAP. The NDEP notes that the primary purpose of the CAP is to establish a process, schedule and criteria by which a remedy for shallow groundwater will be evaluated and selected. NDEP also notes that the overall process should not be inconsistent with the National Oil and Hazardous Substances Contingency Plan (NCP). A secondary purpose of the CAP is to propose additional data collection, analysis and reporting needed to complete remedy selection and start design. Provide specific references to the objective and schedule for the ***Draft Work Plan for Mitigation of Indoor Air and Well Water*** and how actions in that document relate to this CAP document.	Accepted. The text has been revised.
10.	Section 1.2, Page 2	The text states that *"A golf course irrigation well is located **near the distal end of the PCE plume** at a distance of approximately 3,200 ft east of the former APTC location."* The downgradient extent of the PCE has not yet been delineated. If the maximum contaminant level (MCL) of 5 ▪g/l is used to *define* the plume, the *"distal* end" may be well beyond the golf course. Please rephrase without the text shown here *in* red font, and also refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***, which describes the plan for plume delineation (and *indoor air testing* and mitigation).	Accepted. The text has been revised.
11.	Figure 4	See NDEP comment 12 in NDEP letter January 11, 2011, which asked: *"Why does Figure* 4 *include the area west and north of the Maryland Square PCE plume? The view should be shifted* to *the south and east* to *show the plume all the way to the golf course and Flamingo Wash (the largest nearby drainage). The left-hand third of the image can be eliminated as unnecessary, as can al/ of the area north of Desert Inn Road."* Why does the same *figure* appear unchanged *in* the second draft CAP for Groundwater? What is the purpose of this figure? Please *explain.*	Comment noted. The figure has been deleted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
12.	Section 1.2.2, Page 2	Boulevard Mall. Text states that *"The Boulevard Mall opened in* 1968 *and is the oldest enclosed Mall in the Valley, currently housing approximately 1-10 commercial occupants. During expansion of the Mall circa* 1993, *several structures located on the east side of Maryland Parkway and downgradient of the APTC facility were demolished. A three-level parking garage is currently located on the east side of the Mall next to JC Penney. A three-level parking garage is also located on the west side of the Mall adjacent to Macys."* Please rewrite *to indicate* that the locations of these "structures" were south of (i.e., side-gradient to*)* the PCE plume, and that groundwater samples *from* monitoring wells (MW-10, MW-11, and MW-16) *in* the vicinity *of,* or directly downgradient *from,* these former structures have generally *yielded nondetections for* PCE. The *locations* of these former structures, along *with* the nondetections for PCE *in* downgradient wells, clearly indicate that these former structures have no relationship to the Maryland Square PCE plume.	Comment noted. The text has been deleted.
13.	Section 1.2.2, Page 2.	The second paragraph of the Boulevard Mall discussion states *"Subsurface investigation efforts have included the installation of several monitoring wells across the Boulevard Mall property that are currently sampled and tested for PCE on a quarterly basis. The maximum PCE concentration reported in groundwater on the Boulevard Mall property was 5,310 •g/L at MW-13 in May 2005. The geologic profile logged during monitoring well installation(s) is generally characterized as sand)' silt or clayey sand extending to approximately 19 feet bgs and sandy clay from 19 to* 29 *feet bgs within the saturated zone. Groundwater elevations fluctuate by as much as 15 or more feet across the site, which is demonstrated in the November 2010 groundwater monitoring results, wherein the groundwater elevation at monitoring well MW-6 was 1969.01 ft above mean seal level (amsl) and the groundwater elevation at monitoring well MW-19 was 1953.00 ft amsl."* Please **delete this paragraph in its entirety**; it is not appropriate for this section. Details of the geology and information from previous site investigations are discussed in Sections 2 and 3 of the CAP.	Accepted. The text has been deleted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
14.	Section 1.2.2. Residential Areas, Page 3	Text states that *"Residences are on City of Las Vegas water that comes primarily from Lake Mead, although some City water (approximately 10 percent) is supplied from deep groundwater wells located in the northern portion of Las Vegas. "* Please verify and rephrase to state that homes in the residential neighborhood (Paradise Palms) are served by the Las Vegas Valley Water District (see: http://www.lvvwd.com/about/wr.html); however, there are homes and acreage properties east of Eastern Avenue; some of which have, or have had, domestic wells (refer again to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***).	Accepted. The text has been revised.
15.	Section 1.2.2, Page 3	Please be more specific regarding the reference, "NDEP 2007." The golf course sampled the irrigation wells and provided the analytical data to the NDEP in a letter dated May 12, 2004. The NDEP summarized these data in a letter to DCI, the parent company of the former dry cleaners, on February 27, 2007. See: http://ndep.nv.gov/pce/record/2007-02-27.pdf.	Accepted. The text has been revised.
16.	Section 1.2.3, Previous Investigations.	Previous Investigations. states that *"A series of environmental investigations have been conducted across the Site since 2000 to assess groundwater, subsurface soils, and soil vapor migration"* Please rewrite to clarify that soil contamination is found only in the source area. Since the initial (historical) release was reported in November, 2000, investigations have been conducted to assess the extent of PCE contamination in the source area soils, as well as in groundwater at and downgradient of the source area. In addition, a study of PCE vapors in soil gas was conducted at Boulevard Mall and in the residential neighborhood (URS, 2007).	Accepted. The text has been revised.
17.	Section 1.2.3. Pages 3 and 4	This section concludes *"Based on a review of historical documents, data gaps that remain are identified and discussed in Section 9.0."* Yet, it is not clear what review has been done, because there are no tables summarizing the existing data from the historical documents. This review does not mention the samples of indoor air that were collected from 97 homes and two schools; although these data are not released to the public record, Tetra Tech has access to this information per the confidentiality agreement signed on behalf of the Hermann Kishner Trust (Trust). These data can, however, be discussed in a general way, without reference to specific addresses.	Accepted. The text has been deleted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 2, Physical Characteristics of the Study Area			
18.	Section 2.1 Pages 5 & 6	Incorrect name; it is the Nevada Division of Water Resources	Accepted. The text has been revised.
19.	Section 2.2, Site Geology, Page 6	Geological terminology, a as well as other words, are misused in this section. See Comments 110, 112 -115, and 118 in Part B of this Attachment for details.	Accepted. The text has been revised.
20.	Page 6, Section 2.3, 4th paragraph.	Text states that results from aquifer tests conducted in 1991 *"are considered representative of shallow groundwater characteristics in the downtown area ... "* Are there no data more recent than 20 year-old data cited in the CAP? Characteristics of shallow groundwater likely have changed appreciably over 20 years of population growth in the Las Vegas area. Also, please specify ***why*** and ***how*** these data are considered representative. There are also data from a 1999 pumping test conducted for a U.S. Department of Energy (DOE) facility in North Las Vegas (Bechtel 2000) that may be worth reviewing.	Comment noted. Aquifer tests results do not become invalid with age. Although the groundwater chemistry may have changed due to development and recharge impacts, the hydraulic characteristics of the saturated intervals are still the same. The results of aquifer tests performed in 1991 should still be representative of the hydraulic properties for the shallow groundwater interval in the downtown area. Tetra Tech is not familiar with and does not have a copy of the 1999 DOE facility aquifer test. Provided the aquifer test was conducted in saturated media that is equivalent to the shallow saturated zones found in the area of Maryland Parkway, Spencer Street and Eastern Avenue, the results of the DOE pumping test may be suitable evaluating and simulating groundwater flow and contaminant transport at the Maryland Square PCE site
21.	Page 7,1st paragraph.	Again, improper and incorrect terminology is used to describe geological conditions and groundwater geochemistry. See Comments 110, 112 -115, and 118 in Part B of this Attachment for details.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
22.	Section 2.4, Geochemistry of the Shallow Groundwater	States: *Groundwater samples were collected from **eight wells** and analyzed for concentrations of major anions (i.e., nitrate, sulfate, chloride, bicarbonate alkalinity), total iron, dissolved manganese, total organic carbon, and dissolved oxygen (**URS 2005**). Results generally agree with the regional geochemical characterization provided by Leising (2004). Sulfate is the dominant anion, with lesser concentrations of bicarbonate and chloride. Nitrate generally ranges from 4.5 to 7.3 mg/L in the shallow groundwater (URS 2005), and is attributed to the heavy use of fertilizers across the Valley (Leising 2004). Total organic carbon (TOC) in shallow groundwater at the Site ranges from 1.2 to 6.0 mg/L (URS 2005).* Please see **Comments 6 and 18** in the NDEP's previous set of review comments (January 11, 2011) on the first attempted draft CAP for Groundwater. As noted by the NDEP "T*here is a moderately large data set for inorganic constituent in groundwater, based on numerous samples collected from **12 monitoring wells**. As reported in Table 4 in the groundwater monitoring report for first quarter 2008 (URS, 2008), **data for 48 samples of groundwater** show...*" The NDEP notes that sulfate concentrations reported in URS (2008) range from 1,500 to 3,700 milligrams per liter (mg/L). The text needs revision to include accurate descriptions of available data.	Accepted. The text has been revised.
23.	Section 2.4, Geochemistry of the Shallow Groundwater	States: *"Field parameters (PH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation-reduction potential [ORP]) are routinely measured during quarterly groundwater monitoring. Most TDS measurements from across the Site are between 2,100 and 2,700 mg/L. URS (2005) reports detectable iron ranging from 1.2 to 38 mg/L and detectable manganese ranging from 0.0053 to 0.69 mg/L; however, turbidity is highly variable and can range from non-detectable to >999 Nephlometric Turbidity Units (NTU) due to the abundance of silt and clay in the saturated =one. Elevated concentrations of metals reported during prior investigations likely reflect the amount of turbidity (i.e. , sediment) in the sample. Reported ranges of the field parameters are ..."* The NDEP notes that it would be more useful to report median values and perhaps a few other statistics, in addition to just the range, which may just reflect outliers. The NDEP notes that URS (2008) reports data that range from 900 to 4,300 mg/L for total dissolved solids (TDS), with a median of 2,400 mg/L (n=200). It is unclear why an older report with fewer data (Le., URS 2005) is used; particularly because the NDEP has previously provided a statistical summary table of the data in a January 11, 2011 comment letter (table shown again below). [*See comment letter for table.*]	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
24.	Page 8, 1st paragraph.	Page 8, 1st paragraph notes that: *" The relatively high concentration of sulfate in groundwater, with gypsum crystals in the subsurface soils, combined with elevated concentrations of nitrate and iron, suggest* ***it would be difficult to induce reducing conditions*** *that create the anaerobic geochemical environment needed to enhance either biodegradation or reductive dehalogenation of PCE and TCE."* The NDEP agrees it would be difficult. A lack of PCE degradation reflects the condition of the plume across most (if not all) of the site, as evidenced by the (only) trace amounts of PCE degradation products, primarily trichloroethylene (TCE) and cis-l,2-dichloroethylene (DCE), which have been detected inconsistently at low concentrations in some wells.	Agreed.
Comment No.	**Section / Page**	**Comment**	**Response**
25.	Page 8, 1st paragraph..	Page 8, 1st paragraph continues, stating: *"However, groundwater conditions at monitoring well MW-IO consistently exhibit a negative ORP that ranges from -1-10 to -330 m V. Negative ORP readings have also been observed periodically in MW-9 and MW-16, indicating the presence of localized areas where reducing conditions may persist.* The NDEP notes that the wells listed here (MW-9, MW-10, and MW-16) contain nondetect to low concentrations of contaminants (as measured in 4th quarter 2010). The groundwater sample from well MW-9 contained 3.7 ·g/L PCE. <0.5 ·g/L TCE, and <0.5 ·g/L 1.**2-DCE**; all contaminant were nondetect <0.5 ·g/L in **MW-10** and **MW-16**. In addition, well MW·16 lies just north of well MW-11, which contained weathered gasoline. The degradation of gasoline typically drives the oxidation-reduction potential (ORP) lower in the immediate area of the fuel. Please note that average **ORP readings are higher than 100 millivolts (mV) in all the wells that actually contain significant concentrations of PCE**. The NDEP also notes that, as a check of the validity of the ORP measurements, consider dissolved oxygen (DO) and pH measurements taken at the same time: • In general, ORP values and concentrations of DO should be positively correlated (i.e., high ORP values should correspond to high concentrations of DO; low ORP values should correspond to low concentrations of DO). • The maximum (saturated) solubility of oxygen at the site (about 1920 feet to 1970 feet above mean sea level [amsl)) is approximately 8 mg/L DO for waters in equilibrium with atmospheric oxygen. Groundwater can be expected to contain	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
		lesser amounts of DO; therefore any DO measurements greater than 8 mg/L are highly suspect. • At the average pH (6.8) of the Site, ORP could possibly range from about -400 to 830 mV; measurements outside this range are highly suspect. • Any pH measurements of 6.0 or less are considered highly anomalous and suspect.	
26.	Page 8, 1st paragraph.	*Given that groundwater at several additional well locations typically exhibits relatively low ORP values, in the range of 50 to 210 mV, it may be possible to use additives such as EHC® (a controlled-release, integrated carbon and soluble iron product) to achieve remediation o/targeted areas o/the Site. To confirm the efficacy or viability o/this treatment technology, bench-scale testing or pilot testing would be necessary."* Median concentrations for important naturally occurring electron acceptors in site groundwater include 3 mg/L iron; 4.5 mg/L nitrate; 1,700 mg/L sulfate; and 3.5 mg/L DO. Full dechlorination is unlikely until these electron acceptors have been reduced. The optimal Eh range for reductive dechlorination is approximately -220 to -240 mV. The NDEP also notes that main problem with in situ chemical oxidation (ISCO) or in situ reduction is **effective distribution** of the injected materials. The heterogeneity of the unconsolidated alluvial deposits across the Site is less than ideal for distribution of any injectate. This needs to be acknowledged in the document and testing needs to indicate how this problem will be evaluated on a site-specific basis. As noted in a technical guidance document prepared by the Indiana Department of Environmental Management (IDEM) (2009), *"The most serious problem... is getting enough oxidant [or reductant] in contact with the contamination."* The USEPA (2004) notes that *"Chemical oxidants may not be able to penetrate low permeability homogeneous soils* or *horizons in heterogeneous soils that contain the bulk of petroleum contaminant mass."* Inhomogeneous layers are also difficult, as the injected oxidants (or reductants) will follow the most permeable layer, and little will penetrate the tighter material. Finally, the Interstate Technology and Regulatory Council (ITRC) (2005) notes that *"Typical ROIs (radius of influence) for injections range from* 2.5 *feet for tight clays to* 25 *feet in permeable saturated soils."* The NDEP notes that if laboratory (bench-scale) tests fail, there is certainly no need to go to field pilot tests; however, "successful" bench-scale tests cannot predict success at the field scale.	Comment noted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 3, Nature and Extent of Contamination			
27.	Section 3.1	See Comments 110, 112 -115, and 118 in Part B of this Attachment for details.	Accepted. The text has been revised.
28.	Section 3.1, Page 9, first paragraph	States that *"The investigation of groundwater began in August 2000. Additional wells have been installed several times since 2000 to evaluate the extent of dissolved PCE in groundwater. Regularly scheduled monitoring of groundwater has been conducted since May 2005. Currently,* 33 *monitoring wells are installed at the Site,* 31 *of which are part of the monitoring program (Figure* 3). *Eleven wells in the residential area of the plume are monitored quarterly. Eleven wells in the area of the former APTC facility, the Boulevard Mall, and the southwestern residential area are monitored semi-annually. All* 33 *wells in the program are monitored during the 4th quarter monitoring event."* As written, this states that each additional well has been installed several times. To convey the correct meaning, the text should state, "Since discovery of PCE-contaminated groundwater at the site of the former dry cleaner, additional wells have been installed across the site to evaluate the extent ...." The number of wells is incorrect; 32 wells (i.e., all 33 except MW-4) are part of the monitoring program. The NDEP has requested several times, that well **MW-11 be sampled annually**.	Accepted. The text has been revised.
29.	Section 3.1, Page 9, second paragraph	States that *"The PCE plume extends approximately* .J, *000 ft east from the APTC source to the east side of the National Golf Course (Figure* 3)." Actually, the length of the plume, if defined by the 5 ▪g/L contour, may well extend beyond 4,000 ft from the source area. Suggest rewriting to state that "the plume is at least 4,000 feet in length, but has not been fully delineated to the east at the 5 ▪g/L contour." Reference the ***Draft Work Plan for Mitigation of Indoor Air and Well Water,*** which provides the plan for downgradient delineation of the PCE plume.	The text and Figure 3 have been revised to include the correct locations of the irrigation wells and describe the potential influence of the three golf course irrigation wells on migration of the plume.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
30.	Section 3.1, Page 9, , second paragraph	States that '*The plume extends due east from the source, under the Boulevard Mall, then slightly curves to the north under the neighborhood between Cherokee Lane and Seneca Lane toward irrigation well PW-I, located within the Las Vegas National Golf Course. The plume east of PW-1 is estimated to extend 1200 ft. The center line of the plume is estimated to extend through MW-6, between MW-19 and MW-20, just north of MW-23 and MW-25, and approximately midway between MW-26 and MW-32 toward PW-1. PCE concentrations in the shallow groundwater along the centerline are estimated to be 2,500 to 3,000 •g near the Boulevard Mall, 1,500 to 2,000 •g/L near MW-18 and MW-23, and approximately 1,000 •g between MW-26 and MW-32."* The NDEP notes that this description of the plume geometry is described incorrect in the CAP, possibly biased by the fact that **the golf course irrigation well is incorrectly located** (Figure 3 in CAP). As noted in the NDEP's comments on the first draft CAP for Groundwater, irrigation well PW-1 is located approximately 250 feet **due east** of monitoring well MW-27. The NDEP notes that the plume shows no "curve to the north." but rather, shows a slight widening to the north along Spencer when the groundwater plume encounters a shallower gradient in the area of the golf course (potentially due to a slight mounding resulting from irrigation of the golf course). If one looks at recent (2008 -2010) averages of concentrations for each monitoring well, it is clear that the plume centerline runs almost directly down Seneca Lane. Therefore, from the source to the east side of the golf course, the plume trajectory appears to be about 1 or 2 degrees north of due east. Please describe what analysis was made to obtain the estimate of "1200 feet east of PW-1" as the extent of the plume.	Accepted. The text has been revised.
31.	Section 3.1, Page 9	Page 9, Section 3.1, paragraph 3 states that "*Assuming a gradient of 0.013 ft/foot (Tetra Tech 2010a), an assumed average hydraulic conductivity of 15 ft/day (based on reported values provided in Section 2.3), and a porosity of 0.30, an annual, average groundwater flow rate of 237 ft/year for the shallow groundwater is derived. If the plume moved 100 to 130 ft/year, the PCE is attenuated at a factor of 1.8 to 2.4, which is within the expected range for PCE migration in a low degradation environment.*" Why not use the Bioplume or Biochlor model to demonstrate this and provide graphic output? Also, explain more clearly how the 100 to 130 ft/year movement of the plume was determined (i.e., by the leading edge of dissolved phase PCE at 5 ugµ/l [which has not been defined for the site] or other means).	The text has been revised. Tetra Tech believes a better estimate can be developed through an analytical solution using real site data - monitoring results with gradient determinations from water level data and hydraulic conductivities determined using data from aquifer tests conducted in the nearby area. Bioplume or Biochlor results can be too easily manipulated through adjusting source volumes and dispersion coefficients

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
32.	Section 3.1, Page 9	Page 9, Section 3.1, fourth paragraph states that "*The plume migration initially would have been through the mixtures of fine sands and gravels as a preferential flowpath because of the higher hydraulic conductivity. The dissolved PCE then would have migrated into the silts and clays by diffusion and along soil partings (secondary porosity from differential stress cracks and desiccation partings that do not reseal due to the calcic water that minimizes clay swelling). Therefore, preferential flow paths likely allowed the leading edge of the plume to migrate 100 to 130 ft/year, while movement into and through the clay and silt units likely occurred at 1 to 20 ft/year. The plume at the Site is expected to be stable at its lateral extent, with remnants of later releases (such as periodic flushing/cleanout of the sump and drain lines) likely still moving through the plume as slugs (mobile hot spots of higher PCE concentration).*" It seems that the writer is attempting to describe groundwater flow through preferential pathways in lithologically heterogeneous alluvial deposits. Please note that models using a **dual-domain** mass transfer approach for solute transport in heterogeneous aquifers may be applicable at this site (see, for example: Feehley et al 2000). Discuss contaminant migration in this context. Again, incorrect terminology is used to describe the geology, geochemistry, and hydrogeology. See Comments 110, 112 - 115, and 118 in Part B of this Attachment for details. What is the derivation for the concept of "**mobile hot spots**" of dissolved PCE migrating as slugs? "Hot spot" is typically used informally to describe areas of exceptionally high concentrations of contaminants in soil. The NDEP is unfamiliar with usage of "**mobile hot spot**" to describe groundwater contamination. The hypothesis espoused here, of "slugs" of PCE released suddenly to groundwater and now moving as "mobile hot spots" seems contrived. What evidence or literature support can be provided to support this concept?	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
33.	Pages 9 and 10, the last/first paragraph	Pages 9 and 10, the last/first paragraph states that "*The PCE concentrations in the groundwater have fluctuated over time, with many wells exhibiting apparent decreases (Figure 12). In the upgradient portion of the plume, changes likely are due to movement of PCE slugs. For example, the concentration of dissolved PCE in MW-1 varied between 870 and 3,500 µg/L during 2000 to 2005, but decreased to below 1,000 µg/L by June 2007. The concentration of PCE in groundwater in MW-2 was at 3,000 µg/L in 2000 to 2002, and decreased to below 1,000 µg/L by June 2008. PCE concentrations in MW-6 decreased in late 2005, then increased over the next 4 years and are currently near 2,500 µg/L. The groundwater in MW-13 had the highest PCE concentration ever reported (5,310 µg/L) in May 2005; since that time, the PCE concentrations have decreased to below 3,000 in 2007, and below 2,000 in 2010. MW-14 and MW-18 previously also had groundwater with PCE above 3,000 µg/L. PCE concentrations in groundwater at MW-14 were below 1,000 µg/L as of 2007, and in MW-18 have been below 2,000 µg/L since December 2006. PCE concentrations in groundwater in MW-23 have been below 2,000 µg/L since June 2007. PCE concentrations in wells MW-19, MW-20, MW-23, MW-25, MW-26, and MW-32 have all decreased to below 1000 µg/L. In the downgradient area of the plume, these decreases are likely due to lateral spreading of the plume by diffusion into the finer grained silts and clays*". **Please rewrite this paragraph, with data summarized in tables or on readable graphs**. Use statistical trend tests to evaluate trends in concentration at each well, if trends are discussed. Analytical data and statistical test results should be summarized in a table for discussion. The NDEP notes that the graph shown as **Figure 12b** (there is no 12 or 12a) shows data from all 33 site wells and is difficult to read. Breaking the data into logical subgroups (e.g., source area wells, west mall wells, east mall wells, etc.) could provide useful information on the behavior of the PCE plume. Results of **duplicate samples** collected during fourth quarter of 2010 suggest that there is potentially significant vertical heterogeneity in contaminant distribution. The "apparent decreases" may reflect minor changes in the sampling protocols used and the depth from which samples were collected. **Duplicate samples for MW-19, MW-26, and MW-30** show relative percent differences of **15.5%, 11.3%, and 12.2%.** Vertical distribution of contaminant concentrations in groundwater (and the need to evaluate such distribution) is not discussed in the CAP, but should be.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
34.	Section 3.2, Page 10	Page 10, Section 3.2, last sentence states that "*Of the 32 samples that contained detectable concentrations of PCE, significant amounts of the tracer gas were found in four samples, indicating leakage from the atmosphere and invalidating the results.*" Please add to the end of this sentence "***for these four samples***."	Accepted. The text has been revised.
35.	Section 3.3, First paragraph	The first paragraph of Section 3.3 states that "*The NDEP conducted neighborhood sampling events between fall 2007 and winter 2007-2008. During these events, 97 homes and two schools 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/m3 (Broadbent & Associates [Broadbent] 2010).*" As written, the period of sampling is unclear. Please rewrite to indicate that, "*between September 2007 through March 2008, the NDEP collected indoor air samples from 97 homes and two schools (Broadbent & Associates [BAI] 2008). Samples were collected in 6L Summa canisters over a 24-sampling period, then shipped to the laboratory for analysis of PCE, TCE, and vinyl chloride using USEPA Analytical Method TO-15 GC/MS. Samples from fifteen of the homes contained concentrations of PCE that exceeded the NDEP's interim action level of 32 µg/m3 for PCE in residential indoor air (BAI 2010).*" Also, please specify that the data for indoor air samples and the BAI reports are being kept confidential, in order to respect the privacy of the homeowners. These data are released to attorneys (and their consultants) upon signing of a confidentiality agreement.	Comment noted.
Section 4, Contaminant Fate and Transport			
36.	Section 4, first paragraph	Section 4, first paragraph notes that "*PCE may have migrated east of Maryland Parkway via the sewer line, with releases potentially occurring from leaks at the connection to city sewer lines.*" The NDEP notes that soil beneath the sewer-line junction of the lateral from the former dry cleaners and the main line underlying Maryland Parkway has never been sampled. However, releases at this junction could lead to high concentrations immediately east of Maryland Parkway, such as seen in well MW-6.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
37.	Section 4, third paragraph	Section 4, third paragraph states that "*The lateral spread may have been due to the influence of the **utility lines** along the South Maryland Parkway.*" The NDEP notes that the depth to groundwater in this area is about 18 ft below ground surface (bgs), whereas utility lines are typically 8 ft bgs or less. It therefore seems unlikely that utility lines would have had much, if any, influence on the lateral migration of PCE. If "utility lines" is used here to mean "sewer lines," then the latter should be used instead, and the next paragraph applies. If "utility lines" refers to sewer lines, then yes, the intersection of the sewer lateral from the dry cleaners to the sewer main could be a point of additional leakage. The width of the plume at this point is approximately 400 to 500 feet. The sewer flows north up S. Maryland Pkwy, then east on Desert Inn Rd. Once in the main sewer line, the PCE does not appear to have leaked to the north of the lateral junction with the main sewer, because there is a lack of detectable PCE in wells a short distance north of the plume (see data for MW-15 and the "Gap" well for Boulevard Mall). Also, there would have been no flow to the south in the sewer main, yet the plume appears to be symmetrical north and south of the source location, and. Therefore, the data do not appear to support the suggestion that "*The lateral spread may have been due to the influence of the **utility lines** along the South Maryland Parkway.* If "utility lines" refers to the storm drain line, this line flows south toward Flamingo Wash. However, the same comments about plume symmetry apply.	Accepted. The text has been revised.
38.	Page 11, fourth paragraph	Page 11, fourth paragraph states that additional wells "*...established the extent of the plume to the east side of the National Golf Course, an approximate distance of 4,000 ft from the source area.*" Please note that the downgradient extent of the plume is **not yet defined to the 5 µg/L** contour. Please restate and also refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water*** (which provides a plan for delineation) and the NDEP's comments on this work plan.	Accepted. The sentence has been deleted.
39.	Page 11, fourth paragraph	Page 11, fourth paragraph states that "*The plume at the Site is assumed to be stable at its eastern extent.*" Any such statement regarding plume stability should be tested, not assumed. Please apply a statistical trend test to evaluate stability at confidence levels of 80% and 90%.	Accepted. The sentence has been deleted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
40.	Page 11, fourth paragraph	Page 11, fourth paragraph states that "*Slugs with higher concentration of PCE from releases in the late 1990s (such as from flushing /cleanout of the sump and drain lines) are likely still moving through the central area of the plume.*" The CAP presents no data, evidence, or evaluation to support the statement that "slugs" of PCE were released in the "late 1990s." What is the basis of this statement? Any releases on the ground surface, from floor drains, or from sewers, would still need to migrate down through the soil until reaching groundwater (about 20 ft bgs). Movement through the soil column would be attenuated, so it is difficult to reconcile this with PCE released as "slugs" to the groundwater. Please provide evidence, data, or literature references supporting this suggestion. A better explanation for the apparent distribution of PCE in the shallow groundwater is that the heterogeneity of the interbedded clay, silt, sand and gravel deposits controls a vertically and horizontally complex plume distribution. The existing monitoring well network may not be capable of completely defining internal PCE distribution at the actual scale of the 500 µg/l and 1,000 µg/l PCE isoconcentration contours across the Site. It will be important to better define vertical plume distribution and hydrogeologic characteristics and connectivity in the areas proposed for the shallow groundwater remedy.	Accepted. The text has been revised...
41.	Figure 3	The NDEP notes, again, that the golf course irrigation well, PW-1, is incorrectly located on Figure 3.	Accepted. The figures have been revised to show the correct locations of the three golf course irrigation wells.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
42.	Page 12, fifth paragraph	Page 12, fifth paragraph states that "*The site chemistry is strongly aerobic across most of the site, although there may be* ***pockets of anaerobic zones****, as exemplified by conditions near well MW-10 that exhibits a negative ORP range of -140 to -330 mV.*" It is true that **MW-10** has shown low ORP; however, this well also shows low to nondetect levels of PCE. The NDEP notes that there are only two wells that have average ORP values less than 0 mV; MW-10 and MW-11, and only two other wells (MW-9 and MW-16) with ORP median values less than 100 mV. **Three of these four wells never contained significant concentrations of PCE**, and MW-9 was screened deeper as an "intermediate well". The lack of reducing conditions (i.e., median ORP values >100 mV) in the other 29 of the 33 wells suggests that **the four wells with lower median values for ORP are atypical for the Site**. The median values for each well plotted on normal probability plots (see below) support this observation, showing a marked inflection point between the line defining the low ORP wells and the rest of the site wells. The NDEP notes that the optimal ORP for complete reductive dechlorination is -220 to -240 mV.	Accepted. The text has been revised...

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
43.	Page 12, fifth paragraph	Page 12, fifth paragraph continues, stating that "*Biodegradation Biodegradation of PCE occurs under anaerobic conditions through the bioactivity. URS (2005) submitted two groundwater samples to ascertain the population of DHC bacteria; however, the presence of DHC bacteria was not evident. Aerobic conditions inhibit the growth of DHC bacteria. In addition, as sulfate is present in the groundwater at relatively high concentrations, artificially inducing reducing conditions will produce high concentrations of sulfide that will also inhibit DHC bacteria. Therefore, inducing reducing conditions by injecting only electron donors (such as HRC®) is not likely to be effective. However, electron donors combined with zero-valent iron (ZVI)* ***have had some success in high sulfate groundwater****. This suggests that induced reductive dehalogenation using a product such as EHC® may be possible. This may be cost-effective in areas where the ORP is no higher than 200 mV. Bench-scale and pilot-scale testing would be necessary to evaluate the feasibility of this treatment option.* **Please provide references** for the statement that "*electron donors combined with zero-valent iron (ZVI)* ***have had some success in high sulfate groundwater.****"* If the only reference is from tests performed by the vendor, then this is considered experimental and not representative of actual successful application. **Calculations should be conducted before any testing**; using the maximum and median concentrations of electron acceptors in the shallow groundwater system. Median values include 3.5 mg/L DO, 5.9 mg/L nitrate, 1700 mg/L sulfate, 220 mg/L alkalinity, along with concentrations of iron and manganese. Also, the NDEP notes that **partial degradation of PCE is unacceptable**, because TCE, 1,2-DCE and vinyl chloride also pose vapor intrusion concerns	Comment noted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 5, Human Health Risk Assessment			
44.	Section 5	Section 5 of the draft CAP is unacceptable. Existing data should be used to conduct a human health risk assessment (HHRA). Existing data have laboratory quality control (QC) data to allow for a Level IV validation. A proper evaluation of the existing data, along with a listing of the data needed, should have been conducted to identify data gaps. The draft CAP fails to provide any of these.	Comment noted. As decided in the meeting between NDEP, Mr. Tim Swickard, and Tetra Tech on May 25, 2011, the HHRA will be developed on past data and data collected in the upcoming sampling events for groundwater monitoring and indoor air and well water. Any additional sampling required will be presented to NDEP in a letter. The HHRA will be utilized to evaluate final remedies and be presented in the Corrective Action Report.
45.	Section 5,Page 13	Section 5, page 13 states that *" 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 are obtained."* As the NDEP has previously stated (see Comment 2, below, from NDEP letter dated January 11, 2011), there are data already available for indoor air samples collected from 97 homes. The CAP gives no reason why these data cannot be used to perform a HHRA now. This HHRA can be updated periodically, as new data are collected. *"There are analytical data f or samples of groundwater, soil, soil gas, and indoor air for the Site. It is unclear why these data are deemed "insufficient" in terms of quantity and quality, or what would be defined as "sufficient." The NDEP notes that the issue is data usability, and it appears that the available analytical data have not been reviewed* to *assist in preparation of the CAP, let alone assessed for usability. Please review the laboratory results and quality control (QC) data for usability (see U.S. Environmental Protection Agency [USEPAJ S40-R-08-01, 2008). Unless data are rejected, they are usable. Please specify explicitly."* (NDEP letter, January 11, 2011).	Comment noted. See response to comment 44.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 6, Identification of Preliminary Corrective Action Objectives			
46.	Section 6, Page 15	First complete paragraph states that *"... 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 µg/m^3. NDEP 's indoor air sampling program achieved an average detection limit for PCE in indoor air of* 5.6 *µg/m3 (NDEP 2011). Laboratory PQLs are not low enough to detect PCE concentrations in indoor air of 0.32 µg/m^3.* The NDEP used Method TO-l5 because the detection limit was sufficient for the purpose of the testing (method detection limit [MDL 3.4 micrograms per cubic meter [µg/m^3 for PCE). The purpose of NDEP's testing was to evaluate whether any homes contained PCE vapors at concentrations exceeding the NDEP's interim-action level of 32 ug/m3. However, Method TO-l5 SIM is capable of much lower detection limits. Air Toxics Laboratories using selective ion mode (SIM) achieves detection limits of less than 1 µg/m^3 (see study for the Maryland Department of the Environment [DEP], 2007): http://www.mde.state.md.us/ assets/ document/ Glenn%20Heights%20ASI%20Report%20-%20Final.pdf The appropriate analytical method must be used to achieve detection limits that are less than the remediation standard selected for residential indoor air. For example, if a remediation standard of 3.2 µg/m^3 were to be selected (10^{-5} risk level), TO-l5 SIM would be needed, rather than TO-l5. Please also reference the *Draft Work Plan for Mitigation of Indoor Air and Well Water.*	Accepted. The text has been revised

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
47.	Section 6, Page 15	First complete paragraph states that *"The numbers generated in the previous three steps for PCE in indoor air were NDEP's interim action level (a risk-based concentration of 32 µg/m^3 associated with a risk factor of 10^{-4}), a risk-based concentration correlating to the 10^{-6} risk level (0.32 µg/m^3) and the laboratory PQL."* As noted in the NDEP's comment above, the reporting limit for TO-I5 SIM is generally less than 1 µg/m^3. The Maryland study cited above shows laboratory analytical reports, with reporting limits of 0.16 to 0.36 µg/m^3 for PCE, and 0.13 to 0.14 µg/m^3 for TCE. The numbers discussed for the laboratory reporting limits should include a summary of such limits for the different analytical methods, so that the appropriate method is selected to provide the data necessary to address the specific needs of the study. Moreover, the MDL is defined the USEPA in 40 CFR part 136, Appendix B (49 FR 43234 dated October 26, 1984), as *"the lowest concentration that can be measured and reported with 99% confidence that the concentration is greater than zero."* The sample quantitation limit (SQL) is the sample-specific MDL, which takes into account the specifics of the sample and sample analysis (e.g., matrix, dilution, etc.) Although the precision (i.e., reproducibility) of measured concentrations near the MDL may be poor, all such "estimated" data should be used *"as is"* in any statistical analysis of the data.	Accepted. The text has been revised.
Section 7, Identification of Screening Technologies			
48.	Section 7, Page 16, First Paragraph	Page 16, first paragraph states that "In general, the same or similar GRAs, remedial technologies, and process options are applicable in the source area, Boulevard Mall, and residential areas ... " The NDEP does not necessarily agree that the same options are applicable to the residential neighborhood, as in the commercially zoned areas. Safety issues, noise, and property access, among other factors, limit options in the residential neighborhood.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
49.	Section 7.2, Page 16	Page 16, last paragraph states that *" This section analyzes the technology types and process options/or each GRA in terms o/three broad screening evaluation criteria: effectiveness, implementability, and cost (EPA* /988). *Potentially applicable GRAs identified/or groundwater consist 0/(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 o/implementation and ineffectiveness. The jive remaining GRAs are discussed in this section. Given the concentrations of PCE in groundwater at the Site, the subsurface conditions, and the various receptor pathways, it is likely that an integrated approach to remediation or a combination of general response actions will be required."* The NDEP notes that hydraulic containment (extraction wells) with pulsed pumping, above-ground treatment and reinjection (to reduce zones of stagnation) combines containment and remediation. In contrast, a slurry wall alone would be classified as containment. Please list *"the various receptor pathways"* being referred to here. Page 17, fourth paragraph states that *"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."* Please review and cite the relevant water regulations governing water use.	Accepted - The text has been revised.
50.	Section 7.2, Page 17	Page 17. last paragraph states that *"Because (1) the location and status of unauthorized groundwater wells is unclear and* (2) *shallow groundwater is not a designated source of drinking water, engineering controls (e.g. individual wellhead treatment units) addressing individual unauthorized groundwater wells were not considered."* See previous comment. Also, the NDEP notes that domestic water supply wells are to be addressed in the *Draft Work Plan for Mitigation of Indoor Air and Well Water* (document dated February 28, 2011). Refer the reader to this work plan.	Accepted - The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
51.	Section 7.2, Page 20	MNA. Page 20. second paragraph states that *"abiotic MNA may further reduce the concentrations of contaminants to complete the attainment of corrective action goals. Therefore, MNA was retained as part of a groundwater treatment train. .. "* Please note that the data suggest attenuation by sorption and dispersion only; there does not appear to be degradation of the PCE, even after the estimated time of 40 years and 4,000+ ft of plume migration.	Accepted - The text has been revised.
52.	Section 7.2, Page 20	In Situ Chemical Oxidation. Page 20. fourth paragraph states that *"Chemical oxidation is implementable; however, success implementing the technology depends on site geology because it influences the ability to distribute the oxidant within the treatment one... . Chemical oxidation has been shown to destroy PCE and its breakdown products both in the laboratory and in the field."* The NDEP notes that distribution of the oxidant throughout the contaminated area may be the main challenge for this alternative. Flow through the heterogeneous lithology of the alluvial deposits is likely best described as "dual-domain" flow (Gillham et al, 1984). Even if the oxidant successfully destroys the solvent in the coarser grained materials, contaminated fine -grained materials may remain unremediated, and act as a secondary (long-term) source. This remedy (as well as many other possible remedies) needs to be discussed in the context of dual-domain flow. Please provide references of successful application of ISCO under similar conditions and for a plume of the magnitude of the Maryland Square PCE plume.	Comment noted. The application of potassium permanganate was very successful in reducing concentrations of PCE at the Tartan Textiles Services Site in Odessa Texas (from 80,000 µg/l to less than 0.25 µg/L in the well with the highest concentration and 99% reduction in concentration in 14 of 18 wells).

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
53.	Section 7.2, Page 20	In Situ Chemical Oxidation. Page 20, last paragraph states that *"In addition, careful planning and control is needed when injecting near residences or underground utilities that could provide preferential pathways; however, given that the depth to groundwater in most cases is below 17 ft bgs, preferential pathways via utility corridors are not likely. A contingency plan to detail precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted."* The NDEP notes that groundwater has been measured at less than 9 feet bgs in the western part of the residential neighborhood. (MW-18, May 2005). Potential safety issues will need to be addressed as part of obtaining a permit from the NDEP for injections of high concentrations of oxidizing chemicals within the residential neighborhood, because there is no certain way to control the migration of these chemicals. It is not possible to guarantee that the oxidants, or the oxidation byproducts, would behave the same as the PCE plume, or migrate along the same pathways. Each oxidant type has specific drawbacks such as potential permeability issues associated with $Mn0_2$ precipitation with permanganate, or potential volatilization from the exothermic reactions associated with either persulfate or Fenton's reagent, any of which can create safety concerns. Please provide references of successful application of ISCO under similar conditions and for a plume of the magnitude of the Maryland Square PCE plume.	Comment noted. Tetra Tech does not recommend ISCO in the residential neighborhood. The text has been revised to reference the 2005 groundwater level measured in MW-18. The extent of the exothermic reaction associated with persulfate is dependent on the activation mechanism.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
54.	Section 7.2, Page 21	In Situ Chemical Reduction. Page 21, second paragraph states that *"Although ill situ chemical reduction can effectively treat PCE; the costs are expected to be moderate to high. Chemical reduction is implementable; however, success implementing the technology depends on site geology because it influences the ability to distribute the chemical within the treatment zone. Elevated sulfate concentrations in groundwater may influence the cost and performance of this technology. While some have suggested that ZVI can directly reduce sulfate to sulfide, it is more commonly noted that reduction of sulfate is biologically mediated (Environmental Technologies, Inc. fETI) 2007)."* It is the abundance of electron acceptors, not just the high concentration of sulfate (as much as 3,700 mg/L), that needs to be considered. Please provide references for sites where sulfate reduction to sulfide in a permeable reactive barrier (PRB) has been observed and described. The NDEP notes that distribution of the reductant throughout the contaminated area is also a challenge for this alternative. Even if the reductant successfully destroys the solvent in the coarser grained materials, contaminated fine-grained materials may remain unremediated, and act as a secondary (long-term) source. This remedy also needs to be discussed in the context of dual-domain flow and mass transfer. The elevated concentrations of sulfate (average 1,700 mg/L, maximum 3,700 mg/L) present at the site are problematic for achieving complete dechlorination. Sulfate reduction (Eh about -220 mV to -240 mV) would be required to get the PCE to fully dechlorinate to ethene, during reductive dechlorination. Moreover, sulfate reduction produces sulfide, which is toxic to the dechlorinating bacteria. Elevated sulfate/sulfide could result in partial dechlorination of PCE, resulting in a "stall" of the process and the buildup of TCE, cis-1,2-DCE and/or vinyl chloride. Vapor intrusion risks exist for all of these daughter products.	Comment noted. This treatment technology is not recommended.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
55.	Section 7.2, Page 21	In Situ Chemical Reduction. Page 21, second paragraph states that *"However, elevated concentrations of dissolved sulfate do not automatically disqualify ZVI as a potential treatment option. Studies have shown that ZVI can still effectively treat chlorinated ethenes such as PCE in the presence of elevated sulfate concentrations. ETI has performed column tests on groundwater from various sites containing up to 6,000 mg/L of sulfate with little or no interference from sulfate (ETI 2007) ."* Please provide references of successful application of reductant under similar geochemical and geological conditions, and for a plume of the magnitude of the Maryland Square PCE plume. The NDEP was unable to locate the ETI (2007) report referenced here.	Comment noted. The ETI 2007 report was provided to Ms. Mary Siders on May 26, 2011. This treatment technology is not recommended.
56.	Section 7.2, Page 21	In Situ Chemical Reduction. Page 21, third paragraph states that *"the effects of sulfate and electron acceptor concentrations on cost"* will need to be evaluated. Calculations and a rough estimate of the amount of zero-valent iron (ZVI) should have been presented in the CAP. Based on some assumptions and a sulfate concentration of 3,000 mg/L, the NDEP used the Regenesis on-line calculator and calculated that approximately 1 million pounds of HRC-X would be needed to reduce sulfate and other electron acceptors at the site. That equates to about $8.7 million worth of HRC-X.	Comment noted. The amount of ZVI was calculated for cost estimating purposed. This treatment technology is not recommended.
57.	Section 7.2, Page 21	Sparging. Page 21 states that *"Sparging technologies may be applicable in source areas, areas of higher PCE concentrations, or as a curtain east of the Boulevard Mall to intersect and treat the plume before it flows under the residential neighborhood. Pilot tests should be conducted to determine the effectiveness of sparging, o=one treatment, and/or SVE and associated ROIs."* Designing an in-situ sparging system would require that the vertical and cross-sectional profile of the PCE plume be well defined for optimum placement of the sparge points. Pilot testing would need to be conducted to determine the effective radius of influence of a sparge point and to define the initial and design operational parameters (Le., number of sparge points, operating pressures and flow rates, etc.). The NDEP agrees that soil-gas-permeability testing should be performed to design an SVE system that will capture the vapors created by the sparging action.	Agreed.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
58.	Permeable Reactive Barrier. Page 22	Permeable Reactive Barrier. Page 22 states that *"Subsurface geology can influence the performance and longevity of P RBs. If carbonate or other solid phase precipitates form within the P RB, hydraulic conductivity and reactivity (treatment efficiency) may diminish. Bench-scale treatability testing would be 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."* The ZVI-based PRB technology is susceptible to premature passivation (Le., loss of its catalytic properties) by high alkalinity, TDS, and sulfate. The groundwater at the Maryland Square site has been characterized with an alkalinity near 300 mg/L, TDS levels ranging from 900 to 4,300 mg/L, and sulfate concentrations averaging 1,700 mg/L, with a maximum measured at 3,700 mg/L range (URS 2007, see Tables 2 and 4). These concentrations are in the ranges where these constituents are known to impact the longevity of ZVI-based PRBs due to mineral precipitation and/or other surface coating reactions (ITRC,2005). Sulfate has the potential to enhance the growth of sulfate-reducing bacteria that feed off of the hydrogen released during iron corrosion. Excessive growth of sulfate reducers can cause biofouling, which in turn can cause preferential flow through the barrier and reduce the hydraulic residence time. Depending on the severity of clogging problems, groundwater flow may eventually bypass the PRB all together. Please provide examples of sites with similar geochemistry and geology that have had success with a PRB applied to a solvent plume of similar magnitude.	Comment noted. This treatment technology is not recommended.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
59.	Section 7.2, Page 22	Enhanced Bioremediation. Page 22 states that *"DHC bacteria have not been found at the Site; therefore, bioaugmentation would likely be required. The absence of DHC is likely due to the predominantly aerobic conditions in the aquifer. However, given that the ORP of groundwater in many of the wells is generally in the range of 50 to 210m V. it should be cost effective to artificially) create reducing conditions. In addition, because sulfate is present in the groundwater at high concentrations, sulfate reducing bacteria will produce high concentrations of sulfide, which might inhibit DHC. Therefore, biostimulation through injection of electron donors alone is not likely to be effective. This is evident in the poor performance of HRC that has been used as a biostimulant at sites in the Las Vegas area (NDEP 2009). However, electron donors combined with ferrous gluconate have had some success in high sulfate groundwater. This may be because dissolved sulfide concentrations are reduced through reaction with dissolved iron. This suggests that reductive dechlorination using iron containing product such as EHC® or an alternate electron donor combined with ferrous gluconate might be possible. Should an integrated remedial approach involve the use of enhanced bioremediation, bench scale testing is required to determine the most effective form of enhancement and/or augmentation."* PCE degrades under anaerobic conditions, which would require creating reducing conditions (-220 to- 240 mV is the optimal range for reductive dechlorination) in the aquifer and maintaining the conditions where dechlorinating microorganisms could survive. It is most likely that an exogenous culture would be required to avoid long lag periods before such microbial populations developed to the level required to reductively dechlorinate the PCE. Because of the geochemical conditions, a significant amount of reductant would be required to reduce the aquifer, the flux of oxygenated groundwater into the reduced zone would rapidly deplete the "stored" reducing power, and (as noted in the CAP) the sulfate could cause issues with sulfide generation. Calculations *should be* performed to estimate the amount (and cost) of the reagent necessary to artificially create a reducing environment, *before* conducting bench-scale tests. *Continued…*	Comment noted. This treatment technology is not recommended.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
59 (cont)	Section 7.2, Page 22	Bioreactors would have to deal with the sulfide toxicity issue, as well as the potential for offensive odors. Techniques to overcome the sulfide toxicity issues through the addition of ferrous or mineral forms of iron are would add costs to the project. Biological approaches for treating PCE in groundwater may not result in complete treatment, thereby creating the potential for vapor intrusion of chlorinated daughter products. Please provide references documenting success, re: the statement that *"electron donors combined with ferrous gluconate have had some success in high sulfate groundwater."*	
60	Extraction and Treatment. Page 23, Second Paragraph	Extraction and Treatment. Page 23, second paragraph Again, improper and incorrect terminology is used to describe geological conditions and groundwater geochemistry. See Comments 110, 112 – 115, and 118 in Part B of this Attachment for details.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
61	Extraction and Treatment. Page 23, Third Paragraph	Extraction and Treatment. Page 23, third paragraph states that *"Soil samples collected from the Site indicate the sand intervals frequently contain appreciable silt or clay (as much as 30 to ./0%) Hydraulic tests at the site and in nearby areas of the City of Las Vegas indicate hydraulic conductivities likely range from 0.8 to 20 ft/day or* 6 *to 150 gpd/ft2. Assuming saturated intervals of* 25 *ft and 20ft of available drawdown, the yields of individual wells may range from I to 20 gpm, with sandy zones at the higher rates and silts at the lower rates. However, considering the numerous hydraulic barriers and limited unit thicknesses created by the heterogeneous conditions, and superposition effects from the influence of adjacent extraction wells, steady state production rates can be expected to be significantly lower-in the range of 0.2 to* 8 *gpm. The sand zones will likely be depleted relatively quickly, with the capture zone of the well field likely being dewatered. The use of injection wells to return treated water to the groundwater system can help minimize the potential negative effects of a remedial production wellfield. Although greater production rates can be achieved by installing the wells to depths of 50 to 60ft bgs in the Las Vegas Wash Aquitard, such well construction may only lead to greater dewatering of the shallow groundwater system. The well system would likely operate intermittently. Saturated clays at the Site would likely de water and may shrink, potentially resulting ill subsidence in the residential and Boulevard Mall area.* See Comments 110, 112 - 115, and 118 in Part B of this Attachment for more details. The specter of subsidence as a result of groundwater extraction at this site seems inappropriate. Please provide references documenting (1) the presence of dominantly 2:1 clays in the geologic deposits at the site, (2) other sites, with similar geologic deposits, similar proposed rates of extraction, and similar infrastructure, where subsidence has been documented. The NDEP notes that subsidence as a result of groundwater pumping is documented in cases of water-supply wells mining groundwater over a long period of time. The NDEP is not familiar with any documented case of subsidence resulting from a pump and treat system used for site remediation . Again, dual-domain flow should be part of the discussion here	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
62.	Section 7.2, Page 23	Extraction and Treatment. Page 23, paragraph 4 states that *"Production tests should be conducted within several silt, sand and gravel units at the Site to evaluate whether pump and treat is a viable alternative for remediation of groundwater at the Site. Current data indicate that Site conditions are not conducive to this option as the primary remedial approach.* The unconsolidated geologic deposits at the site generally range from silty clay to silty sands, with some layers and lenses of silty/sandy gravel. Based on this knowledge, the hydraulic conductivities that may generally be expected at the site would range from 10^{-6} to 10^{-3} centimeters per second (cm/sec) or 0.0028 to 2.8 ft/day. A detailed profiling of the lithology and the vertical distribution of PCE concentrations at the treatment area(s) would be needed.	Agreed.
63.	Section 7.2, Page 23	Extraction and Treatment. Page 23, paragraph 5 states that *"Furthermore, treatment by air stripping or GAC will generate a secondary waste stream, and high TDS concentrations in the treated wastewater discharge may present complications due to water quality standards and policies imposed by the Colorado River Basin Salinity Forum. If TDS must be removed from treated water before surface discharge, disposal, or reinjection, costs will be high. Despite these practical constraints, extraction and treatment may be effective as a hydraulic control; therefore, the technology was retained for further consideration.* The NDEP notes that, as long as the treated water is reinjected back into the plume and degradation is not an issue (Le., no further degradation), then this is allowed under UIC regulations and a permit may be issued. The NDEP views capture/containment of the mass of dissolved-phase PCE that lies upgradient of the neighborhood, treatment, and reinjection downgradient of the point of extraction as a viable option.	Comment noted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 8, Development and Detailed Analysis of Alternatives			
64.	Section 8	64. The introductory text in this section states that *"The alternatives were developed and screened based on the requirements of NAC -l45A.227J; 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 - Sparge Curtain, ICs, SSD Systems, and MNA* *Alternative 5 - Extraction and Treatment, ICs, SSD Systems, and MNA* *Altemative 6 - In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA.* The NDEP notes that the **data needs for each alternative should have been provided.** along with an analysis of the existing data. This would have allowed identification of data gaps. This type of analysis is missing from the CAP.	Accepted. The information has been provided in Table 8.2.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
65.		Page 27. NDEP Acceptance states that *"NDEP has indicated its concern with the viability of in situ reductive treatment and enhanced bioremediation, given the Site 's geochemistry (NDEP 2011). The Site's geochemistry. in particular high TDS and sulfate concentrations, may make implementation of in situ reductive treatment and enhanced bioremediation challenging,' however, it is not considered a fatal flaw. The viability of these technologies with respect to site-specific conditions including the geochemistry will be further evaluated in this document and through subsequent bench-scale and pilot testing as appropriate*. Please perform some basic calculations regarding complete reduction of electron acceptors. Concentrations of sulfate have been measured as high as 3,700 mg/l; each mole of sulfate consumes four moles of H2 in the reaction: The optimal ORP range for reductive dechlorination is -220 to -240 mV. To achieve this, all oxygen, nitrate, ferric iron, manganese, and sulfate must be reduced. Then, there is the matter of sulfide precipitation occluding porosity, as well as the biotoxicity issues with sulfide. The NDEP is concerned about the viability of reductive treatment to completely dechlorinate PCE in this setting.	Comment noted. The amount of ZVI was calculated for cost estimating purposes. The text has been revised. These treatment technologies are not recommended.
66.	Section 8.2.1, Page 28	Page 28. Section 8.2.1 (**Alternative** 1- No Action) states that Alternative 1 (no action) presumably would not be acceptable to the NDEP (or the community). This is a correct presumption.	Agreed.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
67.	Section 8.2.2, Page 29	Page 29. Section 8.2.2 **(Alternative 2A** - ISCO at plume hotspot and the plume upgradient of the residential area. ICs. SSD systems. and MNA) The CAP defines the term *"hotspot,"* as areas of the plume where PCE concentrations exceed 1,000 ug/l. There are areas of the plume within the neighborhood that fall under this definition. Please provide references for other sites in similar geologic settings (heterogeneous alluvial deposits) with similar geochemistry and similarly sized PCE plumes where use of oxidants has been successful in the complete oxidation of PCE (i.e., no buildup of other toxic volatile organic compounds [VOCs]). Also, please provide specific sites where project team members have successfully implemented chemical oxidation on this scale. The NDEP concurs with maintenance of existing SSD systems and installation of additional systems if the concentrations of PCE in indoor air are found to exceed the interim action level of 32 $\mu g/m^3$ in any other homes. Reference the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***.	Accepted. The text has been revised.
68.	Section 8.2.3, Page 29	Page 26, 1st paragraph states that "*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..."* and *"Abiotic MNA occurring as a residual effect of treatment and subsurface alteration could further reduce concentrations of PCE in groundwater."* The NDEP agrees with the concept of injections that are NOT in the residential neighborhood. Permitting issues should be addressed at the onset of investigating any alternative requiring injections. The Bureau of Water Pollution Control (BWPC) handles underground injection control (UIC) permitting. See: http://ndep.nv.gov/bwpc/uic_overview04.htm	Agreed.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
69.	Section 8.2.2, Page 31	Page 31, 1st bullet states that "*Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence injection.*" Please define "well defined." The NDEP notes that the **main characteristic** of the unconsolidated alluvial deposits across the site is **heterogeneity**. It is not practical (or feasible, cost-wise) to precisely define the hydrogeology for every point across the site. Inferences must be made by experienced geologists/hydrologists. However, a more detailed study of the lithology and contaminant distribution is advisable for the treatment area(s). The main challenge encountered with ISCO (or injection of reductants) is achieving effective distribution of the injected material. Field tests are required to evaluate whether the interbedded silts and clays (along with caliche lenses) can be effectively treated in situ.	Accepted. The text has been revised.
70	Page 31, State Acceptance	Page 31, State Acceptance states that "*However, the NDEP has expressed initial reservations regarding the environmental impacts of this alternative and indicated that it will require a contingency plan (NDEP 2011).*" The NDEP is concerned with safety issues regarding the use of any oxidant. A contingency plan will be needed. The NDEP also notes that there is no way to control (or know) the migration routes of the injected materials. **Tracer tests** should be considered to evaluate possible migration pathways.	Comment noted.
71	Section 8.2.3, Pages 31 and 32	Pages 31-32, Section 8.2.3 (**Alternative 2B** - ISCO, ICs, SSD Systems, MNA). The CAP also notes that "*Given the depth to groundwater, injectate migration via utility corridors is not expected; however, careful planning would accommodate conservative safety requirements. It was assumed that all injection wells would require three rounds of injection of potassium permanganate.*" Under this alternative, oxidant would be injected across the areal extent of the plume, everywhere concentrations in groundwater exceed 100 µg/L. The NDEP notes that this alternative proposes injections of oxidant within the residential neighborhood, with an estimate of three injections over time. Unanticipated migration of injected solutions argues against the safe use of oxidants within a residential neighborhood. There are explosion hazards associated with hydrogen peroxide (including Fenton's reagent) and persulfate solutions. Also, infrastructure in the neighborhood and a shallow water table (8 to 19 ft bgs) in the neighborhood, raise additional safety concerns with this alternative.	Comment noted. However, the extent of the exothermic reaction and "explosion hazard" associated with persulfate is dependent on the activation mechanism. This alternative is not recommended.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
72	8.2.3, Page 32	Text for Alternative 2B, Page 32 continues, "*Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed to be 2 years).*" Considering the concentrations in groundwater (as much as 3,500 µg/L measured in MW-18 within the residential neighborhood), has the equilibrium partitioning of PCE into soil gas and sorbed onto soil been considered? Vadose zone soils may act as both sink and source over time. Has this been considered in the estimate of 2 years to achieve the remediation standard for indoor air other than simply stating that "*PCE sorbed to soil may be released and require treatment.*"? Concentrations of PCE in soil gas at equilibrium with groundwater can be calculated. PCE in groundwater at 1000 µg/L was calculated to have an equilibrium concentration of 600,000 µg/m3 in soil gas at the interface (See: http://www.handpmg.com/lustline28-downward-migration.htm).	Comment noted.
73	Section 8.2.3, Pages 32 and 33	Pages 32-33, bullet at bottom/top of page states that "*Alternative 2B would present low-level risks to the community because the corrective action would be applied in situ in all areas of the Site... 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. Careful planning should be used when injecting near residences or underground utilities that could provide preferential pathways; given the depth to groundwater is in most cases below 17 ft bgs, preferential pathways via utility corridors are unlikely. A contingency plan detailing precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted.*" This alternative has serious safety issues and an optimistic estimate of how quickly the remediation standard for indoor air would be met. Check UIC permitting requirements and conduct some rough calculations on amount of oxidant needed. Also, the ROI for such injections seems unlikely to extend across a residential lot, assuming injection in the street right-of-way.	Agreed. Calculations for the amount of oxidant needed were performed as part of cost estimating. This alternative is not recommended.
74	Section 8.2.4, Page 34	Page 34, Section 8.2.4 (**Alternative 3** - ZVI PRB, IC, SSD Systems, and MNA) states that "*Abiotic MNA would further reduce concentrations of PCE in groundwater and would be monitored.*" Abiotic monitored natural attenuation (MNA) seems unrealistic, considering that there is little evidence of degradation of PCE after 40 years (assuming releases from the start of dry cleaning operations at the former APTC in the former Maryland Square Shopping Center).	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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75.	Section 8.2.4, Page 34	Page 34, Section 8.2.4 (**Alternative 3** - ZVI PRB, IC, SSD Systems, and MNA) "*Bench-scale and pilot testing would determine the effectiveness, dosing rates, and any geochemical interference at the Site. High sulfate concentrations at the Site may impact barrier performance. If sulfate is reduced to sulfide it would react with the ZVI and reduce the available reactive surface. Additional ZVI may have to be provided to compensate for this. When sulfate reduction occurs in PRBs, it is generally observed in the first few inches of the barrier. Precipitation of iron sulfides (FeS and FeS2) would reduce permeability of the barrier over time. If bench-scale testing reveals the possibility for such precipitation, other treatment media could be used upgradient of the PRB to remove sulfate. If bench-scale testing is successful, pilot studies would be conducted in the area before full-scale implementation to verify applicability of bench-scale results to field conditions. These tests would also allow for refinement of costs. The costing purposes installation of a replacement PRB was assumed after 30 years.*" High concentrations of sulfate in groundwater can severely affect the reactivity and permeability of, and flow through, ZVI PRBs. Please provide references to case studies where PRBs have proven to be successful when sulfate concentrations are 2,000 to 4,000 mg/L, alkalinity is high (200 to 300 mg/L), and concentrations of TDS are also elevated. Unanticipated issues related to high concentrations of sulfate upgradient of the barrier, with reduction of sulfate to sulfide and then to FeS. Precipitation resulted in long-term impact on barrier reactivity and permeability. See http://www.frtr.gov/pdf/meetings/k--ghosh_09jun04.pdf	Comment noted. This alterative is not recommended.
76.	Section 8.2.4, Page 36	Page 36, State Acceptance states "*However, NDEP has indicated that this technology does not seem viable given sulfate conditions at the Site (NDEP 2011). While high sulfate and electron acceptor concentrations at the Site would require the addition of more ZVI, chemical reducing agents have been utilized effectively at sites with high sulfate. The feasibility of this alternative and the effect of sulfates can quickly be determined through bench-scale testing.*" The NDEP has performed calculations regarding the use of another reductant (HRC-X). Prior to any testing, please provide **calculations, along with references** on the successful implementation of a ZVI PRB under similar geologic, hydrological, and geochemical conditions. Please provide references for case studies where "*chemical reducing agents have been utilized effectively at sites with high sulfate.*"	Comment noted. Calculations were performed on the amount of ZVI required as part of cost estimating. This alterative is not recommended

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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77	Page 36, Section 8.2.5 (Alternative 4 - Sparge Curtain, ICs, SSD Systems, and MNA).	*For consideration on this alternative, it was assumed that 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 PCE-laden sparged air as it migrates upwards into the vadose zone. Clean water would flow from the downgradient edge of the sparge curtain.* Groundwater mounding formed as a result of sparging can affect groundwater flow. Such mounding has the potential to significantly modify the flow regime to the extent that the system design is rendered inadequate. (See more discussion at http://epppublications.com/Documents/14-02-22.pdf). Please provide a discussion of how the possible diversion of the contaminant plume due to groundwater mounding would be monitored and prevented. Also provide references and information on successful use of sparge curtains for sites with plumes of similar magnitude.	Comment noted. The text has been changed to provide the requested discussion. Monitoring points will be used during pilot testing activities, and sparging operations can be optimized to incorporate pulsing to manage groundwater movement in undesirable directions. The ARCO underground storage tank release remediation that occurred in 1998/1999 in Reno, Washoe County, Nevada is an example of the successful use of a sparge curtain. The release occurred approximately 0.5-mile from the then Sierra Pacific Power Company (SPPCo) municipal water supply well near Mill Street and Kietzke Street (now Truckee Meadows Water Authority). Broadbent and Associates employed a sparge curtain around the wellhead to protect the wellhead from the rapid approach of methyl tert-butyl ether (MTBE).
78.	Page 39, Section 8.2.6, (Alternative 5 - Extraction and Treatment, ICs, SSD Systems, and MNA)	The second paragraph of this section states that "*Groundwater would be extracted from within the plume, treated to remove PCE, then re-injected outside the plume. Extraction and injection wells would be installed where possible and would cover the entire plume. An estimated 14 extraction wells and 15 injection wells would be needed. Two treatment systems (one located in the mall parking lot and the other on the golf course property) would be considered. Treated water would be delivered to injection wells surrounding the PCE plume. It is expected that wells in residential areas would be installed in right of ways.*" The NDEP envisioned a transect of pumping wells just upgradient of the residential neighborhood, with reinjection within the plume just downgradient of the extraction wells to: (1) help reduce stagnant zones; and (2) help flush out contaminated groundwater under the neighborhood. Re-injection of poor-quality water back into the same "aquifer" is acceptable to the NDEP BWPC, upon issuance of a UIC permit. This configuration of pumping wells would serve both as **containment and remediation,** and would prevent the greatest mass of PCE (currently west of and underneath the mall) from migrating into the residential neighborhood.	Comment noted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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79.	Page 39, Fourth Paragraph	Page 39, Fourth Paragraph states that "*Given the geology at the Site, there will likely be localized dewatering of the formation at each extraction well. The sorbed PCE in the dewatered zone could recontaminate groundwater when pumping stops. To reduce the impact of this phenomenon, it is expected that pumping will be pulsed rather than continuous. This aquifer has exhibited slow recharge of groundwater, indicating low hydraulic conductivity, which may make this technology difficult to implement and lead to a long remedial timeframe.*" The NDEP assumes that pumping tests and a detailed profiling of lithology and contaminant distribution will be necessary for all remedial alternatives (except the no-action alternative). "Smart pump and treat" should be evaluated for implementation at this site (see Hoffman, 1993). Extraction and ex situ treatment for chlorinated solvents has been used successfully at other sites in Nevada (see NDEP Facility ID D-000084, D-000544 for examples), although the Maryland Square PCE plume is of greater magnitude than these other sites.	Comment noted.
80.	Page 39, Fourth Paragraph	Page 39, Fourth Paragraph states that "*The remedial duration is calculated at more than 40 years based on basic equilibrium partitioning and required pore volume exchanges. However, it is expected that the actual remedial duration will be much longer because of* ***aquifer material heterogeneity*** *and the* ***tendency for fine-grained materials to be cleaned up slowly****.*" The NDEP notes that the heterogeneity of the alluvial deposits and tendency of fine-grained materials to be slower to clean up are issues that **affect all the alternatives** discussed in the CAP.	Agreed, but it should be noted that this heterogeneity affects the treatment alternatives to varying degrees.
81.	Page 39, Fifth Paragraph	Page 39, fifth paragraph states that "*The potential for dewatering to compromise the geotechnical stability of subsurface clay and silt lithologic zones will also require careful evaluation to ensure protection of surface structures and infrastructure.*" The NDEP is unfamiliar with any remediation site in the Las Vegas Valley that has suffered subsidence as a result of groundwater extraction for treatment. Please provide references and information to document such a response. Also, provide information documenting the presence of 2:1 clays in the shallow groundwater system at the Site.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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82.	Page 39, Fifth Paragraph	Page 39, fifth paragraph states that "*Discharge or reinjection of treated groundwater may be problematic due to elevated concentrations of TDS in extracted groundwater. Re-injecting groundwater containing elevated TDS (even if from the same groundwater source) or conducting surface discharge is limited by regulation and may not be permitted.*" Treatment of water for TDS (or other natural condition) is not needed as long as the water is reinjected into the same water-bearing unit (NDEP BWPC)	Comment noted, with clarification from Mary Siders, electronic mail dated May 26, 2011 indicating Underground Injection Control permit requirements dismissing treatment for TDS if reinjection occurs within the plume area.
83.	Page 41, First Paragraph	states that "*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.*" The NDEP notes that geologic heterogeneity and groundwater geochemistry (high concentrations of sulfate, alkalinity, TDS, etc.) may adversely affect many of the remedial technologies discussed in the CAP for Groundwater.	Comment noted.
84.	Page 41, Section 8.2.7 (Alternative 6: In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA)	Page 41, Section 8.2.7 (**Alternative 6:** In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA)states that "*enhanced bioremediation would be employed in areas of the plume hotspot and upgradient of the residential area to treat groundwater as it flows into the residential area (where the aquifer conditions are amenable to reductive dechlorination as described in Section 4).*" Re: Section 4; **see NDEP comment 39**: The NDEP notes that there are **only two wells** that have average ORP values less than 0 mV; **MW-10** and **MW-11**. MW-11 contained petroleum product (weathered gasoline), which is an electron donor during aerobic degradation and which typically reduces ORP in the area surrounding the product. The NDEP notes that 29 of the 33 monitoring wells have median values of ORP greater than 100 mV.	Comment noted. This alternative is not recommended.
85.	Page 41, Last Paragraph	Page 41, last paragraph states that "Enhanced bioremediation would be applied through injection of substrates or microbes in the plume hot spot where practicable based on preferable ORP values and where logistically practicable, including at the Property and in streets, public right of ways, and parking lots in the Boulevard Mall." For this alternative, as for the earlier discussions of alternatives involving in situ oxidation and reduction, the difficulty of effectively distributing the injectate into a highly heterogeneous package of unconsolidated geologic deposits is perhaps the greatest challenge for any in situ treatment that relies upon injection of substances. Injections would require UIC permitting.	Comment noted. This alternative is not recommended.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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86.	Page 42, First Full Paragraph	Page 42, first full paragraph Page 42, first full paragraph notes that "*The high sulfate concentration found at the site would increase the amount of substrate required.*" The NDEP notes that it is not just the sulfate. Considering the median values for DO (3.5 mg/L), nitrate (5.9 mg/L), alkalinity (220 mg/L), and sulfate (1,700 mg/L), there is an abundance of naturally occurring electron acceptors that must be satisfied before redox conditions for complete reductive dechlorination (approximately -220 to -240 mV) are attained.	Comment noted. This alternative is not recommended.
87.	Section 8, Page 43, Fourth Complete Bullet	Section 8, Page 43, Fourth Complete Bullet states that "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; given sulfate concentrations at the Site, EHC is likely one of the few substrates that will be effective." Please provide references and information on EHC and why it may be effective. Provide calculations on the amount of substrate needed to overcome median concentrations of electron receptors at the site, as well as the mass required to remediate the dissolved-phase PCE.	Comment noted. This technology is not recommended.
88.	Table 8-1, Comparison of Alternatives Summary	Although this table summarizes the evaluation criteria for each alternative, neither this table nor Table 7-1 provide a list of the data needs for each alternative. The data needs must be listed, then reviewed against the data that are currently available, in order to determine "data gaps." Under the column, "state acceptance," please specify the nature of NDEP's concerns, not just "NDEP expressed concerns regarding the feasibility of this alternative." For example, under Alternative 3, the cause for NDEP's concern should be specified (e.g., high concentrations of sulfate and other electron acceptors; formation and precipitation of sulfides that may compromise permeability of the PRB; passivation, failure to achieve complete reductive dechlorination, resulting in breakthrough of chlorinated degradation products, etc.)	Comment noted. Table 8-2 has been revised to reflect an inventory of the technologies evaluated and associated data needs.
89.	Table 8-2	Summary of Technology Advantages and Disadvantages. Please do not simply list "preferred by NDEP" or "NDEP does not support this technology at the site." Describe the reasons that cause concern for the NDEP; for example, for ISB to be effective, all electron acceptors must be satisfied in order to attain anaerobic conditions suitable for complete reductive dechlorination of PCE and its chlorinated degradation products.	Comment noted. Table 8-2 has been revised and the references regarding regulatory disposition are no longer pertinent.

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Section 9, Recommendations			
90.	Page 48, Section 9, Recommendations, First Paragraph	Page 48, **Section 9**, Recommendations, first paragraph states that "*This section provides a list of data needs and field activities recommended for obtaining needed data. These data gaps* ***disallow a sufficient understanding of the Site conditions pertinent to****: (1) development of a human health risk assessment, (2) a complete evaluation of remedial alternatives, and (3)* ***confirmation of site parameters*** *essential for development of a final remedial design.*" Continued "*These data gaps disallow a sufficient understanding of the Site conditions pertinent to...*" What does this statement mean? The "understanding" of exposure due to inhalation of PCE vapors entering homes as a result of vapor intrusion is well established at this site (i.e., there is a mature CSM for this site). Please describe, *explicitly*, what a "sufficient understanding of the Site conditions" is envisioned to be. The existing data clearly document PCE concentrations in indoor air at a level exceeding a 10^{-4} risk level (and as much as 110 µg/m3) in some homes. Additional studies of subslab vapors, soil gas, and groundwater are not needed to perform a HHRA now. (1) As previously noted by the NDEP, there are indoor air data for 97 homes, some data for soil gas and quarterly data for groundwater. No reason is provided as to why these data cannot be used for an initial risk assessment. This risk assessment should be updated as new data are collected, but must not be postponed until then. (2) Here, the NDEP agrees that additional hydrologic and lithologic data are needed in order to more fully evaluate all remedial alternatives. Particular studies, such as tracer studies, deployment of passive diffusion bags (PDBs) or other method to evaluate PCE stratification within wells, separate discrete-depth vertical sampling, aquifer pumping tests, evaluation of ROIs, etc. should be described in the CAP (or at least as an appendix to the CAP or in a summary table providing some details). (3) It is unclear what is meant by "confirmation of site parameters;" the NDEP notes that aquifer tests (pumping tests) and a detailed analysis of lithology and contaminant distribution in the treatment area are likely needed. The NDEP also notes that there is a large data set for field parameters (pH, ORP, DO, etc.) and a large set of analytical data for groundwater chemistry. Please ***specifically*** and ***explicitly*** describe what is meant by "confirmation of site parameters" and how that information will be used to make recommendations and inform decisions.	Accepted. This section has been revised. Work plans to conduct include aquifer tests and bench-scale and pilot tests for in-situ chemical oxidation and air sparging are include with the CAP and will be submitted by June 14, 2011.

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91.	Page 48, Second Paragraph	Page 48, second paragraph states that "*The **extent of groundwater contamination and how it impacts soil gas and indoor air are not fully defined** in the downgradient areas of the plume, **north of Cherokee Lane** in the residential neighborhood and across the golf course.* The NDEP notes that, the extent of the PCE plume from the source area to at least as far as the golf course, the **extent of groundwater contamination** is well-defined on the north, west, and south by site monitoring wells. Data from other monitoring wells and borings that were installed for other sites located to the north and south of the plume, further assist in constraining the lateral boundaries of the Maryland Square PCE plume by showing nondetections for PCE[1]. **The northern boundary of the plume is constrained**, using data from several wells and one boring (grab sample). Please describe what "not fully defined" means in this context. The extreme heterogeneity of PCE vapors in the vadose zone, combined with building-specific characteristics, **precludes using PCE concentrations in groundwater to accurately predict PCE vapors in the vadose zone at any given location or PCE concentrations in the indoor air of any specific house**. There is no evidence that PCE contamination in groundwater extends farther north than currently delineated as nondetected (or very low detections, less than the drinking water standard of 5 µg/L) in wells MW-22 and MW-33, so please explain why "north of Cherokee Lane" is specifically identified here as a "data need." A March 24, 2008 report (URS) also included analytical data for a boring that was installed about mid-way between monitoring wells MW-32 and MW-33, along Spencer St. A grab groundwater sample from boring B-T2 contained 130 µg/L PCE. See Figure 2 in URS (2008) showing the location of boring B-T2 and the correct location of the golf course irrigation well, PW-1. [1]Other sites providing such data include (1) the Sears UST site; (2) the former Dr. Clean, H-000511; (3) Boulevard Mall, H-000240; and (4) the "GAP" wells on the west side of Boulevard Mall. Refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***, for proposed locations of additional groundwater monitoring wells. If by asking the question "*how does the PCE in groundwater **impact soil gas**?*" is meant "*WHERE does the soil gas contain PCE vapors*?," that may prove to be an extensive research project to define the distribution of the "patchy fog" of vapors in the lithologically heterogeneous unsaturated zone and in utility corridors across the site. The data for indoor air and	Accepted. This section has been revised. References to indoor air sampling or samples that may be required for the HHRA are deferred to the *Final Work Plan to Mitigate Indoor Air and Well Water* (Tetra Tech pending).

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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		groundwater show that the highest concentrations of PCE in groundwater do not directly coincide with the highest concentrations of PCE in indoor air. The NDEP collected soil gas data to (1) determine if PCE was volatilizing and accumulating in the vadose zone, and (2) estimate the possible indoor air concentrations using the USEPA's version of the Johnson-Ettinger model. Using the maximum concentration detected in the neighborhood (46,000 µg/m3), along with site-specific and some default parameters, the model very accurately predicted the maximum concentration of PCE found in indoor air. The USEPA (2002) recommends that the potential for vapor intrusion be considered for structures lying within 100 feet of the boundary of the groundwater plume. Limited additional sampling of soil gas in some areas may be proposed, but the only way to know whether the ***indoor air*** of any given home is affected by vapor intrusion is to sample the indoor air. The unique characteristics of each home, along with behaviors and habits of the inhabitants, can lead to significant vapor intrusion effects to one home and none in an adjacent home. Wertz (2011) put it most simply when he stated: "I sample houses because that's where the people are." Across the site, groundwater gradients and the PCE plume head nearly due east from the source area to the golf course. The role of golf course irrigation and how this may affect the flow of groundwater, the migration of the PCE plume, and migration of soil gas should be considered, however. The downgradient extent of the plume to the 5 µg/L boundary will be evaluated per the ***Draft Work Plan for Mitigation of Indoor Air and Well Water.***	
92.	Page 48, second paragraph	states that "*The pathways of potential concern* ***relate to***[a] *volatilization of PCE from groundwater to soil gas and its transport to indoor air in homes and businesses. A work plan is being developed for an investigation to* ***determine the extent of PCE in groundwater***[b] *and* ***better understand the volatilization of PCE from groundwater into soil gas and its migration***[c] *and* ***transport into indoor air***[d]***.*** *Data expected to be obtained via that effort* ***are needed to prepare the risk assessment***[e] *and* ***develop mitigation measures***[f] *for residential indoor air.*" a. The NDEP notes that **the exposure pathway is inhalation** of PCE vapors that have intruded into a particular building. The use of "relate to" in describing this pathway is unnecessarily vague. b. The Permanent Injunction (December 27, 2010) requires that a work plan to "*define the* ***downgradient extent*** *of the Site groundwater plume containing more than 5 µg/L of PCE*" be provided to the NDEP	Accepted. This section has been revised

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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		(and the Court). This delineation will likely require the installation of additional borings and monitoring wells near Eastern Blvd, on the eastern extent of the golf course, and perhaps farther east. Please reference the *Draft Work Plan for Mitigation of Indoor Air and Well Water.* The apparent widening of the PCE plume in groundwater along the western edge of the golf course may best be explained by the seasonal irrigation (effects of which are easily seen in the annual water table fluctuations in wells MW-33, MW-27, MW-30, and other wells near the golf course). The infiltration of irrigation water may create local mounding or otherwise perturb the hydrologic flow in the immediate vicinity of the golf course. Nondetections for PCE in wells MW-22 and MW-33 constrain the northern boundary of the plume, whereas nondetections in wells MW-10, MW-16, MW-11, MW-28, and MW-29 constrain the southern boundary of the plume. c. A "better understanding" of **volatilization of PCE from groundwater and into the vapor phase** can be obtained via calculations using Henry's Law, and the knowledge that diffusion-driven migration of vapor phase may lead to a vapor distribution that does not necessarily follow the concentrations in the groundwater (i.e., the "patchy fog" model). As for the migration of vapors; once liberated from groundwater, the PCE vapors will follow preferential pathways, unconstrained by the hydraulic gradient to which groundwater must attend. Movement of contaminant vapors via gaseous diffusion can be described by Fick's first law. There are many publications that describe volatilization and subsequent transport of the vapor phase; please **describe how and why additional data on this matter are needed to remediate groundwater at the site**. d. The **transport of soil gas into buildings** is unique to the characteristics of a particular structure (e.g., HVAC system, cracks in slab, etc), along with the behavior of the inhabitants (e.g., leaving windows open or closed, etc.). Two adjacent homes can exhibit very different impacts from vapor intrusion as a result of building characteristics and inhabitant behaviors; that is, it is not possible to accurately predict which homes will have what concentration of PCE vapors in indoor air. (See "VI Assessment and Mitigation Decisions: Panel Discussion" USEPA Workshop, March 15, 2011).	

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

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		e. Wertz (2011) stresses that "*The goal of a vapor intrusion assessment strategy is not to learn all there is to know about the VI pathway at the site, only to develop enough knowledge to properly manage risks.*" The NDEP notes that there are indoor air data for 97 homes; please explain why these data cannot be used to perform a risk assessment, and why detailed research is needed to "*understand the volatilization of PCE from groundwater into soil gas and its migration and transport into indoor air*," instead of focusing on managing risk within each home across the site and remediating groundwater. Additional data for samples of indoor air may, however, be used to update the HHRA. f. Mitigation measures for residential indoor air generally consist of installing an SSD system (also known as a radon mitigation system). There is standard guidance available from the USEPA, American Society for Testing and Materials (ASTM), and others. It is not clear what aspect of the data proposed here for collection, will be used to "develop mitigation measures for residential indoor air." **Please specifically describe how a "better understanding of volatilization" will be used to "develop mitigation measures for indoor air.**" As previously noted, the only way to know the extent of vapor intrusion effects in any given home is to test the indoor air in that home, while carefully evaluating the potential for background sources (i.e., consumer products containing PCE or other VOCs) within the home.	
93.	Page 48, Second Paragraph	Page 48, second paragraph states that "*Additional data representing hydraulic flow parameters for the diverse range of soil types at the Site are needed for evaluation of the remedial alternatives and development of the remedial design.*" The NDEP agrees that the collection of aquifer test data (e.g., pumping tests, etc.), along with detailed lithologic and contaminant distribution data in the treatment area(s), is needed for development of the remedial design. However, aquifer tests, tracer tests, etc. should be proposed in the CAP and detailed as individual work plans in an appendix to the CAP.	Accepted. A pilot study work plan has been included as part of the CAP.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
94.	Page 48, First Bullet	Page 48, first bullet states that "*Indoor air data are needed to* ***evaluate current residential conditions***[a] *and* ***evaluate the efficacy of mitigation systems previously installed by NDEP***" The currently available data for indoor air may be used to conduct a risk assessment now; additional data to be collected "at least annually" (per Section III.A.1.a. of the Permanent Injunction), may be used to assess current conditions and update the risk assessment. The NDEP collected post-mitigation samples of indoor air to assess the efficacy of the SSD systems; systems that were not achieving sufficient reductions in PCE vapors in the indoor air were performance-tested, optimized, and retested (BAI, 2010). Re-sampling of all homes (with consent of the home owner) overlying the plume is required "at least annually." As data are collected, conditions may be re-evaluated, along with the continued efficacy of the SSD systems. The NDEP notes that a HHRA can be conducted using the currently available data. The Permanent Injunction requires indoor air sampling, at least annually. These data can be used to update the HHRA performed using the existing data.	Accepted. The text has been revised. As decided in the meeting between NDEP, Mr. Tim Swickard, and Tetra Tech on May 25, 2011, the HHRA will be developed on past data and data collected in the upcoming sampling events for groundwater monitoring and indoor air and well water. Any additional sampling required will be presented to NDEP in a letter. The HHRA will be utilized to evaluate final remedies and be presented in the Corrective Action Report.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
95.	Page 48, First Secondary Bullet	Page 48, first secondary bullet states that "*Indoor air sampling and **subslab sampling** in the residential area **are needed to verify results from previous investigations**, re-assess how well previous data represent current conditions at the Site, and establish a baseline for monitoring remedial progress.*" Verification of existing data is not needed in order to conduct a HHRA. The existing data for indoor air should be used to conduct a HHRA now. Subslab data are not needed to conduct a HHRA. The NDEP notes that there is considerable debate regarding the utility of subslab samples. The spatial variability of vapor concentrations across the slab has been shown to be several orders of magnitude. Unlike indoor air (which is generally well mixed), vapors in subsurface soils show a large amount of spatial variability (Johnson 2001). McHugh (2007) highlighted as a key point, that the spatial variability in subsurface media is much higher than the temporal variability in indoor or ambient air. Given such spatial variability in the subsurface, McHugh (2007) noted that "*lots of sample locations are required to understand VOC concentration in subsurface*," but that, for indoor air, a "*single sample can accurately characterize well-mixed space.*" Ekland and Simon (2007) noted that "*The soil-gas and subslab soil gas data at the site indicate a surprisingly large degree of spatial variability.*" Siegel (2009) noted that "*subslab results have been found to vary significantly under the same structure, even beneath small individual residences.*" The issue of background sources contributing to concentrations of PCE in indoor air needs to be considered, using in-home surveys, discussing with the homeowner that importance of not using certain products during the sampling period, and checking for VOCs using a mini-Rae part per billion (ppb) photoionization detector (PID) before and after sampling. In some cases, perhaps a subslab sample may be collected, but the NDEP does not consider it necessary in order to conduct a HHRA. Additional samples of indoor air can be used to augment the existing data and update the HHRA prepared using the existing data.	Comment noted. The text has been revised. Comment noted. As decided in the meeting between NDEP, Mr. Tim Swickard, and Tetra Tech on May 25, 2011, the HHRA will be developed on past data and data collected in the upcoming sampling events for groundwater monitoring and indoor air and well water. Any additional sampling required will be presented to NDEP in a letter. The HHRA will be utilized to evaluate final remedies and be presented in the Corrective Action Report.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
96.	Page 48, Second Secondary Bullet	Page 48, second secondary bullet states that "*Similar indoor air and subslab data are needed for the Boulevard Mall to determine whether engineered control systems are needed to mitigate indoor air in order to address potential risks under current conditions.*" In general, in commercial/industrial facilities, Occupational Safety and Health Administration (OSHA) standards apply and establish "allowable" concentration limits. The NDEP is focused on assuring remediation (and mitigation) on behalf of the homeowners. Subslab data are not needed to determine whether systems are needed to mitigate indoor air at the mall or in the homes, unless there is indication of in-home sources of PCE.	Comment noted.
97.	Page 48, Second Primary Bullet	Page 48, second primary bullet states that "*Soil properties have not been well characterized for the unsaturated and saturated heterogeneous soils across the Site. Insufficient physical, flow, and contaminant distribution data have been obtained in the unsaturated and saturated zones beneath the Site.*" The NDEP notes that unsaturated soils in the **source area** have been well-characterized with respect to lithology, as well as the distribution of PCE. Elsewhere across the site, lithologic data are available only at monitoring wells and soil borings. The NDEP agrees that a detailed determination of contaminant distribution and lithology will likely be needed in the treatment area(s). Additional hydraulic data, such as obtained by pumping tests, are also needed.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
98.	Page 48, Last Bullet	Page 48, last bullet states that "*Additional soil testing (standard measurements of porosity, grain size distribution, organic carbon, and bacterial analyses) is needed to better understand the geotechnical properties and lithologic conditions of the heterogeneous subsurface soils* ***as related to flow dynamics, contaminant transport, and vapor migration;*** *this information* ***is necessary*** *to assist in evaluating remedy selection and development and implementation of the remedial design*. The NDEP notes that it likely will not be possible to collect enough data to *completely* characterize vapor migration in the subsurface at the site, nor is this information needed to evaluate and design a remedy for groundwater. Vapors are not constrained by hydraulic gradients like groundwater, and may instead follow utility corridors and other preferential pathways, mainly by diffusion, but advection (especially in the zone of building influences) may also occur. The spatial variability of vapor concentrations in the subsurface is expected to be extreme, both laterally and vertically. So much so that **defining the distribution of subsurface vapors is only practical in a very general way, and it should not be listed as "necessary" for evaluating, developing, and implementing a remedy for groundwater**.	Accepted. The text has been revised.
99.	Page 48, Last Paragraph	Page 48, last paragraph states that "*Given the concentrations of PCE in groundwater at the site, the subsurface conditions, and the* ***various receptor pathways****, an integrated approach to remediation or a combination of general response actions likely will be required.*" Please explain what "various pathways" are being referred to here. The **known receptor pathway** is "inhalation of chlorinated solvent vapors" that have intruded into indoor air of homes overlying the Maryland Square PCE plume. A **possible receptor pathway** is ingestion of PCE-contaminated groundwater obtained from shallow domestic wells, which may be present at some properties east of Eastern Blvd; that topic is being addressed in a separate work plan (Provide reference to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water)***. The NDEP does agree, however, that a combination of response actions may be required.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
100.	Page 48, Last Paragraph	Page 48, last paragraph states that "*...bench-scale **or pilot tests** should be conducted to evaluate the potential of a corrective action to meet project needs. Tests for air permeability, ROI, and groundwater production are needed. Production tests are necessary to understand the flow capacity and area of influence in the variety of soil types that exist at the Site, and to predict the locations and effects of the complex flow boundary conditions for developing the remedial design for a groundwater remedy.*" The NDEP notes that because distribution in the subsurface is the primary challenge for any injection (ISCO or reductants), field-scale tests will likely be needed. Laboratory tests alone cannot predict if the distribution issues can be overcome. A tracer test may be useful at the field scale.	Agreed. Tetra Tech does not feel that a tracer test is necessary at this time.
101.	Page 49, First Full Paragraph	Page 49, first full paragraph states that "*If testing for chemical oxidation and sparging technologies proves unsuccessful or insufficient as an overall strategy for treatment of the Site, additional testing for a ZVI PRB, extraction and treatment, and enhanced bioremediation will be considered.*" The NDEP suggests doing some calculations to estimate how much material (whether HRC, EHC, or ZVI) would be needed to (1) overcome all the electron acceptors, and (2) completely dehalogenate the PCE. The NDEP used the Regenesis calculator on-line and, with site-specific chemistry and some general assumptions, received an estimate of nearly 1 million pounds ($8.7 million) of HRC-X would be required...All testing should be done concurrently, rather than sequentially, in order to not further delay remedy selection and implementation.	Comment noted. This technology is not recommended.
102.	Page 49, Section 9.3	Page 49, Section 9.3 provides a proposed schedule for the listed tasks. However, the NDEP does not see pumping tests, tracer tests, geotechnical testing or other such testing listed here. Also, it seems that one month may be an inadequate amount of time for field pilot testing, particularly for injection followed by testing to verify distribution and efficacy of the injections.	Accepted. The schedule has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Other Critical Comments			
103.		The NDEP notes that the draft CAP does not propose evaluation of the relationship between the shallow groundwater system and the deeper aquifer. Nested wells or piezometers could be installed in the vicinity of the golf course irrigation well, PW-1. Additionally, a video survey of well PW-1 could be performed to evaluate the integrity of the well casing. Understanding the relationship between the shallow and deep groundwater system may be important is addressing groundwater contamination, and should be considered in the CAP.	
PART B: CORRECTIONS AND SUGGESTED REVISIONS			
Executive Summary			
104.	Executive Summary	No minor comments on this section.	Comment noted.
Section, Introduction			
105.	Section 1, Page 1	Page 1, first paragraph. Text states that "*PCE-contaminated groundwater was initially reported to the Nevada Department of Environmental Protection (NDEP) in a spill report dated November 29, 2000, by Converse Consultants (Converse).*" Please specify that the historical release of PCE was reported upon discovery by Converse, and was based on a groundwater sample collected during an ESA **at the source area** (i.e., former APTC at the former Maryland Square Shopping Center).	Accepted. The text has been revised.
106.	Section1.2, Page 1	Section 1.2, page 1. The text states that "*The former APTC facility has been identified **by NDEP** as the source of PCE contamination that forms the Maryland Square PCE plume in the shallow groundwater (Figure 3).*" The data, not the NDEP, identify the source area. Revise this sentence to state "The **analytical data for soil and groundwater indicate** the former APTC facility as the source of the Maryland Square PCE plume."	Comment noted.
107.	Section 1.2.2, Page 2	Section 1.2.2, page 2. Text states that "*the **facility** was owned by the Maryland Square Shopping Center, LLC until the Clark County School District (CCSD) purchased the property in 2002.*" Here, "facility" should be replaced with "Property."	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 2, Physical Characteristics of the Study Area			
108.	Section 2.1	Section 2.1. Incorrect name; it is the Nevada Division of Water Resources	Accepted. The text has been revised.
109.	Section 2.2, Site Geology, Page 6	Section 2.2, Site Geology, page 6. Geologic terms, as well as other words, are misused in this section (shown in red font below). The current text states: "*The geology of the Site consists of interbedded sequences of sand, sandy silt, sandy clay, and silty clay with frequent zones of caliche and intermixed gravel scattered throughout. Lithologic data are available in borehole logs from 33 monitoring wells installed at the Site between 2000 and 2008. The borehole logs and well construction diagrams for all monitoring wells at the Site are provided in Appendix A. Additional lithologic information was obtained from 29 soil borings drilled for subsurface characterization of the former APTC area, and from borings installed for active soil-gas sampling in and adjacent to the residential neighborhood. Figures 8 and 9 show cross sections prepared by URS (2007d) representing the downgradient area east of Algonquin Drive. Figure 8 shows that sediments along Algonquin Drive consist of gravelly sand and grade into silt in the area of wells MW-23 and MW-25, and then to clay at approximately 10 ft bgs in the area of wells MW-26 and MW-27. Figure 9 shows gravelly sand in the upper 5 to 10 ft along Algonquin Drive and silty sand in the upper 10 to 12 ft along Seneca Drive.* *Total depth of monitoring wells at the Site vary from 20 to 50 ft, although most wells are completed at depths between 30 and 35 ft. Heterogeneous mixtures of lower permeability clays and silts (silty clay, sandy clay, clayey silt, and sandy silt) dominate the saturated intervals across most of the site. An apparent, alluvial stream-channel sand meanders through the area of the former APTC facility and portions of the Boulevard Mall in the upper 1 to 5 ft of the saturated zone, as evidenced in the borehole logs of wells MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14, MW-15, MW-20, MW-23 and MW-25. Sands exist in the lower portions of wells MW-12, MW-14, MW-20, MW-23, MW-25, MW-28, MW-30, and MW-31, as shown in the corresponding borehole logs. The borehole logs for wells PT-1 and PT-2 at the National Golf Course indicate that below 80 ft bgs, the geology consists of interbedded red clay, sand, gravel, and caliche to at least 750 ft bgs.* Continued…	Accepted. The text has been revised."

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
109 Continued		"**Sequence**" has specific meaning in geology and is incorrectly used here. "**Frequent**" and "**vary**" are improperly used to mean "common" and "range." "**Mixtures**" is not a proper geologic description. It is unclear what "saturated ***intervals***" are being specified here. An "***apparent alluvial stream channel sand meanders***..." should be described as sandy deposits of a possible paleochannel. Unconsolidated deposits along Algonquin are described by URS (2007) as **gravelly, silty sand** grading into silt and sandy silt. "Caliche" is <u>not listed</u> in the borehole log for PW-1; rather, the dominant lithology is clay/shale (reddish color) with some sand and gravel from 0 to 706 ft, and the main water-bearing gravel layer from 706 to 746 ft bgs. Suggested rewrite follows: *Lithologic data are available for borehole logs from 33 monitoring wells (installed at the Site between 2000 and 2008), as well as 16 borings installed for collection of soil vapor samples (URS 2007x) and 29 borings drilled to characterize the source area (URS 2007x). The geologic deposits at the Site consist mainly of interbedded sands, sandy silts, sandy clay, and silty clay, along with some discontinuous zones of caliche and gravely sands. Gravels are less common in the aquitard than in the deeper aquifer. The borehole logs and well construction diagrams for all monitoring wells at the Site are provided in Appendix A.* *URS (2007x) provided geologic cross sections that show deposits underlying the area along Algonquin Drive consist mainly of gravelly to silty sand that grades into sandy silt in the area of wells MW-23 and MW-25 (Figure 8). Farther downgradient, in the area of wells MW-26 and MW-27, these deposits grade into silty clays below the water table (approximately 10 to 12 ft bgs). Cross sections drawn perpendicular to the longitudinal axis of the PCE plume show gravelly to silty sands in the upper 5 to 10 ft along Algonquin Drive and predominantly silty sands in the upper 10 to 12 ft along Spencer Street (Figure 9).* *Total depth of monitoring wells at the Site ranges from 20 to 50 ft, although most wells are completed at depths between 30 and 35 ft. Lower permeability clays and silts (silty clay, sandy clay, clayey silt, and sandy silt) dominate the saturated zone of the shallow groundwater system across most of the Site; however, the upper few feet of this zone consists of sands and silty sands in the source area and extending eastward across the Boulevard Mall property, and into the western portion of the neighborhood. This mainly sandy zone may represent portions of a paleochannel within the alluvial deposits.* Continued…	

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
109 Continued		*Borehole logs for irrigation wells PW-1 (DWR #5675) and PW-2 (DWR #16296) for the Las Vegas National Golf Course are driller's logs, and, therefore, fairly generalized. The lithology in PW-1 is described as mainly clay/shale deposits (reddish color) with some sand and gravel "streaks" from 0 to 706 ft, and the main water-bearing gravel layer from 706 to 746 ft bgs. The well seal extends from the ground surface to 130 ft, with a screened interval from about 500 to 746 ft. The lithologic description for PW-2 notes a greater occurrence of caliche zones throughout much of the boring (total depth = 620 ft), but in particular above about 250 ft depth. Red clay and sandstone are listed as the dominant lithologies on the driller's borelog, along with a screened interval from 220 to 620 ft.*	
110.	Section 2.3	Section 2.3, Hydraulic Properties of the Shallow Groundwater System. Depth to groundwater generally ***ranges*** from 9 to 28 feet across the site, but ***varies*** annually within each well.	Accepted. The text has been revised.
111.	Page 7, 1st Paragraph States	Page 7, 1st paragraph states: "*With the complex geology, the rate of groundwater flow within the shallow saturated zone varies, with preferentially higher flow rates within the gravelly sands and lower flow rates within silty to sandy clays. However, due to the frequent occurrence of scattered pea gravel and caliche within the mixed clays and silts, in combination with calcic water (which minimizes swelling of the clays), hydraulic conductivities within silty clay intervals may be relatively high (within the range of 0.01 to 1.0 ft/day) along predominant flow paths occurring along soil partings.*" Please eliminate incorrect word usage and nonstandard terminology, such as "soil partings" which is a seldom-used term in pedology to describe voids that forms in soil horizons as peds form (aggregations of soil particles). "Soil partings" has nothing to do with flow of groundwater through the saturated unconsolidated alluvial deposits. Why is this (and other) inappropriate geologic terminology repeated throughout discussion of groundwater flow in this CAP? An experienced geologist should revise this discussion so that appropriate technical terminology is used. The NDEP suggests the following rewrite: *Groundwater likely exhibits a range of flow velocities within the generally unconsolidated and heterogeneous geologic deposits that host the shallow groundwater at the Site. Higher rates of flow occur through the coarser grained layers (sands and gravels) and lower rates of flow through the finer grained layers (silty sands, silts, and clays). Data from two wells, USGS 43 and USGS 5 (Leising 2004) indicate that shallow groundwater northwest and southeast of the Site may best be characterized as a calcium-magnesium sulfate water, as discussed below in Section 2.4.*	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
Section 3, Nature and Extent of Contamination			
112.	Section 3.1	**Section 3.1 needs to be rewritten** <u>**using known facts**</u> and <u>**standard geologic terminology**</u>. "**Soil partings**" and "**desiccation partings**" and "**differential stress cracks**" are nonstandard terms that do not apply to groundwater flow systems. "Soil partings" is a term used (rarely) in pedology in discussing the structure of soil (specifically, the pore voids that develop around soil peds). None of these terms are commonly used in discussing groundwater flow. Geologists do not typically refer to "mixtures" of sand and gravel, so it is difficult to determine if the writer meant to say "interbedded sands and gravels" or "layers and lenses of sandy gravel." The chemical type of groundwater is "calcium-magnesium-sulfate" water; the term "**calcic water**" is not commonly used in the Unites States to describe the chemistry of groundwater. Regarding swelling clays: Is there documentation of 2:1 clays in the alluvial deposits at the Site?	Accepted. The text has been revised.
Section 4, Contaminant Fate and Transport			
113.	Page 12, Third Paragraph	<u>Page 12, third paragraph</u> states "*The PCE plume is believed to have initially migrated through the preferential path of the sand and gravel portions of the Las Vegas Wash Aquitard (the shallow groundwater system). Although these intervals are poorly sorted, with up to 30% silt or clay present, these sand/gravel facies are the higher permeable portions of the aquitard and would allow migration at the required rates to produce the plume dimensions observed by 2008, and as indicated by the PCE detected at PW-1 in 1990.*" Please rewrite this paragraph, using proper geologic terminology and correct word usage. Interbedded sands and silty to sandy gravels likely provide a preferential flow path that has allowed migration of the plume at a rate faster than the "average" flow rate for the aquitard. This type of flow system (**dual domain**) has been described in the literature, and should at least be mentioned here. "Higher permeable portions"? Please state correctly.	Accepted. The text has been revised.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Comment No.	Section / Page	Comment	Response
114.	Page 12, Third Paragraph	Page 12, third paragraph states "*However, a large amount of the aquitard at the Site also consists of heterogeneous clays and silts (silty clay, sandy clay, silty sand, and clayey sand). Dissolved PCE in groundwater will move by advective transport and diffusion into the portions of these facies that have greater silt and sand content and where secondary porosity has developed along **soil partings** from **differential stress cracks** and **seasonal desiccation**. This inflow into the finer grained units may occur at rates of 1 to 20 ft or more each year. PCE in these silt and clay units may be retained for a very long time, as little degradation is evident from the monitoring data. Rebound of PCE into groundwater may occur from the diffusion of PCE that is **entrained** in these finer grained sediments after the application of many available remedial treatment technologies.*" Please **rewrite this paragraph using standard geologic terminology**: "soil partings" is a (rarely used) term to describe the voids formed when peds form in a soil horizon. This term is not used in discussions of groundwater flow; "**differential stress cracks**" is a mechanical term generally used in materials science; "**seasonal desiccation**" is a term used to describe the condition of surface soils, not groundwater at 18 ft bgs. "Entrained" is used incorrectly and this sentence incorrectly states that this "entrainment" occurs "after the application of remedial treatment." This is probably not the meaning intended.	Accepted. The text has been revised.
Section 5, Human Health Risk Assessment			
115	Section 5	Section 5 of the draft CAP is unacceptable.	Comment noted. As decided in the meeting between NDEP, Mr. Tim Swickard, and Tetra Tech on May 25, 2011, the HHRA will be developed on past data and data collected in the upcoming sampling events for groundwater monitoring and indoor air and well water. Any additional sampling required will be presented to NDEP in a letter. The HHRA will be utilized to evaluate final remedies and be presented in the Corrective Action Report.
Section 6, Identification of Preliminary Corrective Action Objectives and Remediation Standards			
116	Section 6	No minor comments on this section.	Comment noted.

TABLE D-1: RESPONSES TO COMMENTS FROM THE STATE OF NEVADA DIVISION OF ENVIRONMENTAL PROTECTION ON THE DRAFT CORRECTIVE ACTION PLAN FOR GROUNDWATER, MARYLAND SQUARE SHOPPING CENTER, DATED FEBRUARY 28, 2011(CONTINUED)

Section 7, Identification of Screening Technologies			
117	Section 7	**Extraction and Treatment.** Page 23, second paragraph states that "*The geology of the Site consists of interbedded **sequences** of sand, sandy silt, sandy clay, and silty clay with **frequent** zones of caliche and **intermixed** gravel **scattered throughout**. Heterogeneous **mixtures** of lower permeability clays and silts dominate the saturated **intervals** across most of the site. As presented in Section 2.2, **an alluvial stream-channel sand meanders** through the area of the former APTC facility and portions of the Boulevard Mall in the upper 1 to 5 ft of the saturated zone. In the central area of the site along the path of the plume, **sands exist** in the saturated lower portion of intervals screened by the wells. The geology of the well borings indicates that the sand intervals have limited lateral extent as typical of stream channel deposits. The change in facies from sand to silt and clay along the margin of the channel deposits create hydraulic boundaries **which limit the extent of the production or capture zone of wells**."* As previously stated (Sections 2.2 and 3.1), **please rewrite this description** using geologically correct terminology and precise language. "Sequence" has specific geologic meaning, not as used here; "mixtures" is not a technically correct description; etc.	Accepted. The text has been revised.
Section 8, Development and Detailed Analysis of Alternatives			
118.		No minor comments on Section 8.	Comment noted.
Section 9, Recommendations			
119		No minor comments on Section 9.	Comment noted.

APPENDIX D

Response to NDEP Comments

APPENDIX E

Results of Passive Bag Diffuser Sampling

Converse 2010

Converse Consultants
Geotechnical Engineering, Environmental & Groundwater Science, Inspection & Testing Services

May 12, 2010 00-43367-08

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

Subject: **Results of Passive Diffusion Bag Sampling**
Maryland Square Shopping Center
3661 South Maryland Parkway
Las Vegas, Nevada
Facility ID #H-000086

Dear Mr. Vandenburg:

In addition to recently providing the results of the 1st quarter 2010 groundwater sampling event, Converse Consultants (Converse) is pleased to present the results of our passive diffusion bag (PDB) sampling completed at the subject property (Property). This work was conducted as requested by previous representatives of the Trust.

Site Description/Background

The Property is located at 3661 South Maryland Parkway at the northwest corner of Maryland Parkway and Twain Avenue in Las Vegas, Nevada. It is located in the Southeast ¼ of the Northeast ¼ of Section 15, Township 21 South, Range 61 East. The Property was previously developed as a strip shopping center. A dry cleaning facility [Al Phillips the Cleaner (APTC)] was previously located in the shopping center. Please refer to Plate No. 1 for the Site location.

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In August 2000, as the result of a property transaction, the subsurface soil and groundwater conditions were investigated. Groundwater samples collected from one well revealed perchloroethene (PCE) concentrations that exceeded the United States Environmental Protection Agency (EPA) maximum contamination level (MCL) for PCE in drinking water of 5.0 micrograms per liter (ug/l) or parts per billion (ppb).

Over time, multiple phases of assessment have been conducted for various parties. This work was conducted under the oversight of the Nevada Division of Environmental Protection (NDEP). At this time, there are 33 monitoring wells that are a part of the ongoing groundwater monitoring and sampling program associated with the Property. Certain wells are located onsite (at the former APTC) while others are located on downgradient properties (Boulevard Mall and residential neighborhood). The furthest downgradient wells are located approximately 4,000 feet east of the Property. Select wells are sampled on a quarterly basis and all of the wells (if possible) are sampled annually. The sampling method currently employed at the site is low flow sampling. This sampling method was first employed in September 2008. Previously, sampling was conducted using traditional sampling methods involving the removal of three to five well volumes of water prior to collection of a groundwater sample. Low flow purging and sampling results in minimal drawdown. Advantages of low flow purging and sampling include increased sample quality, reduced disturbance to well and formation, reduction in investigation derived waste, increased well life, and reduced costs.

Purpose and Sampling Method

The purpose of this sampling effort was to evaluate vertical distribution of contaminants in select wells to assess if any trends appeared evident and to allow for consideration of more "zone specific" remediation efforts (i.e., does a certain lithologic unit or depth within the saturated zone appear to be where remedial efforts should be focused). In order to facilitate this

evaluation, vertical profiling of select wells was conducted. This consists of the collection of formation water along the screened interval of the wells and is done using either a low-flow or passive sampling method.

For this effort, a passive sampling method was selected. Passive sampling involves the collection of a groundwater sample without expending external energy. This typically involves placing a collection device into the well and then having diffusion across a concentration gradient occur which results in collection of a sample in the screened interval. For this effort, passive diffusion bags (PDBs) were utilized. Diffusion samplers are constructed of a semi-permeable material that allows groundwater to diffuse into the sampler until the concentration gradient equilibrates between the water in the formation and the sampler. The PDBs are made of polyethylene and are considered an effective tool in collecting samples for analysis of chlorinated VOCs as these compounds can diffuse into the sampler. The polyethylene bags are filled with deionized and contaminant free water and then suspended at predetermined depths in the wells. Contaminants diffuse through the bag into the previously contaminant-free water until the bag water and well water reach equilibrium (usually a minimum of two weeks is recommended).

Several factors can affect the performance of PDBs. These include the target analyte (these are considered effective for chlorinated VOCs), the exposure period (manufacturer for specific PDBs used recommends a minimum of two weeks), and well construction (good hydraulic connection between well and borehole is needed which is typically achieved through proper well development). An additional factor that can affect vertical profiling of a well is the assumption that groundwater flows horizontally through the well. Vertical hydraulic gradients in an aquifer can result in ambient vertical flow in the well. To date, no evaluation of potential for vertical hydraulic gradients has been conducted at this site.

Vertical profiling was not conducted on all 33 wells associated with this project. Wells were selected for inclusion in this effort based primarily on two factors. These were 1) samples collected from these wells have historically contained PCE concentrations in excess of 500 micrograms per liter (ug/L), and 2) the wells had enough water column to facilitate collection of a minimum of two samples to allow for an evaluation of vertical distribution of contaminants. Two exceptions to this were wells MW-11 and MW-17. Well MW-11 was included to evaluate a well that had not been sampled in some time and that had historically not contained PCE. Well MW-17 was sampled in order to include a well located on the site of the former dry cleaners that had historic PCE concentrations.

Groundwater Monitoring and Sampling Procedures

On February 23, 2010, groundwater levels were measured and PDBs were placed in wells MW-2, MW-5, MW-11, MW-13, MW-14, MW-17, MW- 18, MW-23, MW-26, MW-27 and MW-32 (see Plate 1 for well locations). As stated, the wells were sampled using diffusion bag samplers that were hung in the wells. Each bag was filled with deionized water prior to placement. The bag manufacturer recommends the bags be placed a minimum of two weeks prior to sampling. On March 15, 2010, samples were retrieved from the PDBs and collected in laboratory provided sterilized 40-ml glass vials that were capped with Teflon lined lids, labeled, and placed in an insulated container with ice.

As discussed, during this sampling event, multiple bags were placed in each well sampled to assess the vertical profile of PCE in groundwater. The bags are placed at predetermined intervals in each well. According to the manufacturer of the sample bags, Eon Products, Inc., each sampler covers five feet of water column. Converse provided Eon Products with the total water column in each well and they subsequently provided pre-constructed rope and sample bags for placement in the wells. Tables showing the information used to determine bag placement

in these wells is included herein. Note, that in select wells, a shorter 4-foot separation of bags was used to allow for inclusion of these wells in the sampling effort.

Groundwater Sampling Results

The local groundwater gradient at the subject site is generally towards the east as shown in Plate 2. Groundwater elevations have been separately provided in the Groundwater Monitoring and Sampling Report – 1st Quarter 2010.

Groundwater samples were submitted to Veritas Laboratories of Las Vegas, Nevada for analysis. Each sample was analyzed for volatile organic compounds using EPA Method 8260B. Analytical results for this sampling event are summarized in Table 1. A copy of the laboratory analytical report is attached.

Table 1: Groundwater Analytical Results, March 15, 2010

Sample I.D.	Approximate Sample Depth	PCE (ug/L)	% Difference	PCE Result from Low-Flow Sampling Event (Date Sampled)	TCE (ug/L)	Lithology
MW-2A	22.07	790		530	3.5	Clay
MW-2B	27.07	840	5.95	Nov. 09	3.1	Clay
MW-5A	21.59	540		520	3.8	Clay with silt
MW-5B	26.59	860	37.21	Nov. 09	5.1	Clay with silt
MW-11A	27.13	<0.50		<0.50	<0.50	Silty Clay
MW-11B	31.00	<0.50	N/A	Feb. 10	<0.50	Silty Clay
MW-13A	20.05	1,900		1,700	5.1	Sandy Clay
MW-13B	23.42	2,000	5.00	Nov. 09	5.3	Sandy Clay
MW-14A	24.04	330		1,200	<0.50	Sandy Lean Clay/Silty Sand
MW-14B	29.04	390	15.38	Nov. 09	<0.50	Silty Sand
MW-17A	22.50	240	37.50	310	<0.50	Sandy Silt
MW-17B	27.50	150		Nov. 09	<0.50	Sandy Silt
MW-18A	14.13	1,800	27.78	1,600	5.2	Sandy Silt/Caliche
MW-18B	18.13	1,300		Feb. 10	5.9	Silt
MW-23A	18.31	1,100		1,000	4.8	Sandy Silt
MW-23B	22.50	1,100	0.00	Feb. 10	4.7	Sandy Silt
MW-26A	22.50	870	29.89	790	1.7	Silty Clay
MW-26B	27.50	740		Feb. 10	1.5	Silty Clay
MW-26C	32.50	610			1.5	Silty Clay
MW-27A	22.50	400	32.50	770	2.5	Caliche/Silty Clay
MW-27B	27.50	270		Feb. 10	3.2	Silty Clay
MW-27C	32.50	270			2.7	Silty Clay
MW-32A	21.44	360		830	4.4	Clay
MW-32B	25.50	400		Feb. 10	4.0	Clayey Silt
MW-32C	30.50	410	12.20		5.9	Clayey Silt

% Difference represents difference between highest and lowest concentration between PDB bags in that well.

Sample depth is to the center point of the PDB from ground surface.

The analytical results presented in Table 1 show that PCE was detected in each monitoring well sampled, except for MW-11. Maximum PCE concentrations were noted at a depth of approximately 23.42 feet bgs in monitoring wells MW-13.

Discussion

Wells with the lowest percent difference in concentration versus depth had maximum PCE concentrations of 1,100 ug/L (MW-23, 0.00% diff), 2,000 ug/L (MW-13, 5.00% diff.), and 840 ug/L (MW-2, 5.95% diff.). Wells with the greatest percent difference in concentration versus depth had maximum concentrations of 240 ug/L (MW-17, 37.50% diff.), 860 ug/L (MW-5, 37.21% diff.), and 400 ug/L (MW-27, 32.50% diff.).

The percent difference between the high and low PCE concentrations between PDBs in each well, in general, appear to be less as overall well concentrations increased. However, there were instances where this was not the case. For example, the maximum PCE concentration in MW-2 and MW-5 were similar, yet these wells exhibited a relatively low and relatively high percent difference in concentration versus depth 5.95% and 37.21%, respectively.

Concentrations appear to show a minor trend when compared with lithology versus depth within each well. In most wells, the lithology was consistent throughout the sampled area. Wells where there were differences in lithology versus depth were MW14, MW-18, MW-27, and MW-32. In well MW-32, the highest PCE concentration was noted within a clayey silt and the low within a clay. In well MW-14, the highest PCE concentration was noted within a silty sand and the low within a sandy lean clay. Such differences could be attributable to the differences in the hydraulic conductivity of the differing lithologies; however, the differences in concentrations in these wells versus depth were only 390 ug/L versus 330 ug/L (MW-14 and 410 ug/L versus 360 ug/L (MW-32). Further, these lithologies are not likely continuous at depth throughout the area as alluvial depositional systems can be complex and vary greatly both laterally and with depth.

The concentrations noted using the PDBs were generally similar to those documented during the low-flow sampling events. Some of the more distinct differences (MW-14, 1,200 ug/L using low-flow: 390 ug/L using PDB) could be attributed to the fact that the low-flow sampling for this well was conducted four months prior (drd quarter 2009) to the PDB sample being collected from this well. However, in two instances, MW-27 and MW-32, PCE concentrations were lower using the PDB method, and the sampling events were conducted approximately one month apart. This could be attributed to the different sampling methods.

Summary/Conclusions

Passive diffusion sampling methods, consisting of the use of PDBs, was conducted at the subject property in an effort to evaluate vertical distribution of contaminants in select wells to assess if any trends were evident and to allow for consideration of more "zone specific" remediation efforts. Results of this sampling effort did not indicate any significant trends that would demonstrate specific depths or lithologic variability such that a selected remedial method should be focused on a specific zone (depth or lithologic unit). It is likely that vertical movement of contaminants is in part controlled by stringers of more permeable material throughout the subsurface that are not readily identifiable while logging using certain drilling methods. Such stringers have been observed throughout the Las Vegas Valley when continuous coring of soil borings has been conducted.

Limitations

The conclusions presented in this report are professional opinions based on the data described in this report. They are intended only for the purpose, site location and project indicated. The conclusions presented in this report are based on the assumption that conditions do not deviate from those observed during our study, as described in this report. No other warranty is either expressed or implied.

Conclusions presented in this report are based on the sampling and testing completed for the stated scope of work. Sampling and testing locations are intended to confirm the presence or absence of target contaminants at selected locations. Contaminant levels observed may not be the highest levels present at the site. It is not the intent of this study to perform exploration to detect other contaminants. Observed contaminants may change with relation to time, on-site activities, and adjacent site activities. This report represents information only to the specific time in which it was collected.

Certified Environmental Manager (CEM) Statement

For the services provided and described in this document, the following language is from NAC 459.

> *I hereby certify that I am responsible for the services described in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state, and local statutes, regulations, and ordinances.*

Thank you for the opportunity to be of service. Should you have any questions or comments, please call our office at your convenience.

Respectfully submitted,

CONVERSE CONSULTANTS

Robert J. Gegenheimer, CEM
Senior Project Manager
Nevada CEM 1228 (Exp. 01/04/11)
Dated 4/28/10

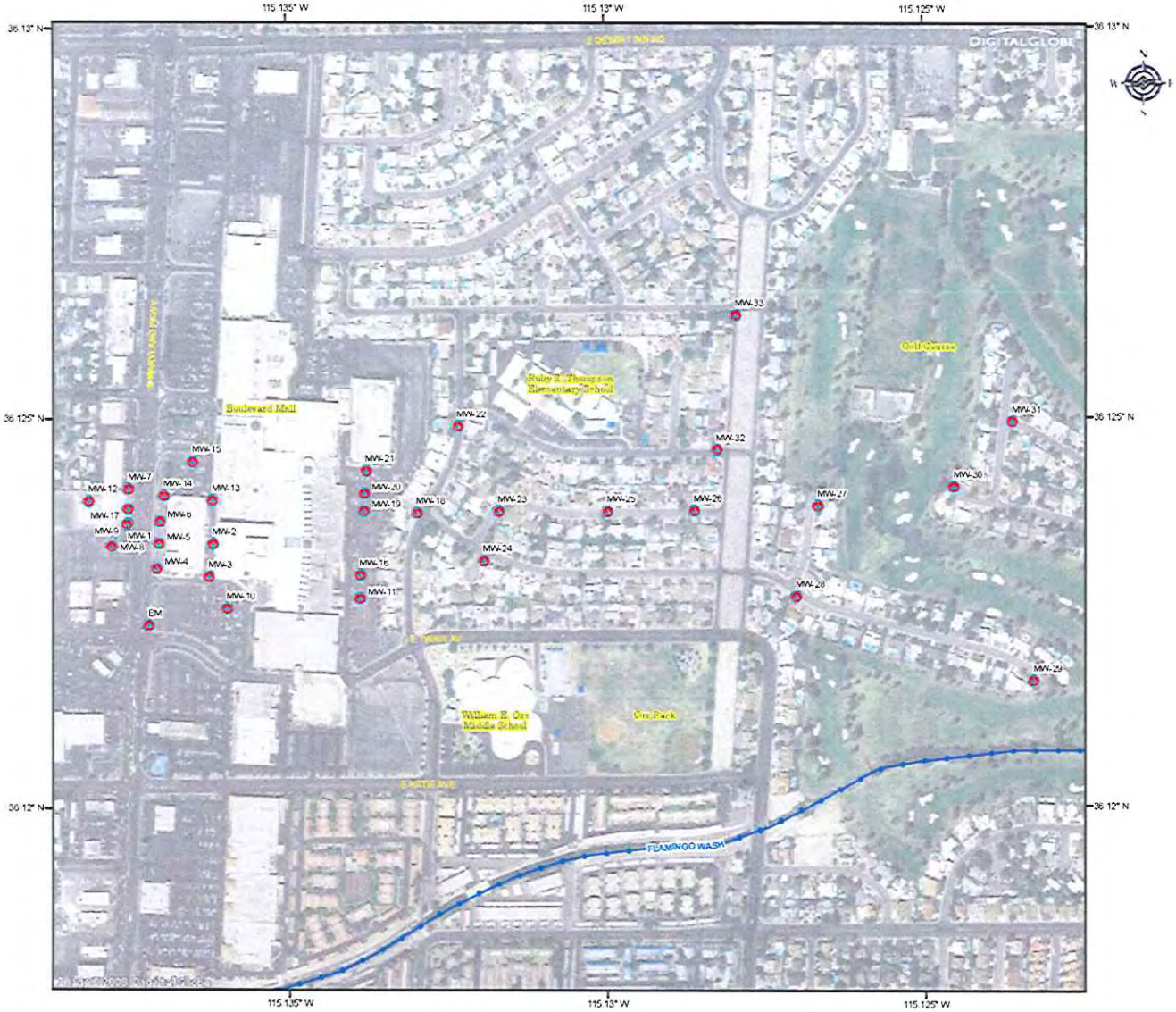
Reviewed and approved by,

Kurt A. Goebel, PG, CEM
Senior Vice President

KAG:RJG:ls

Encl: Plate 1—Vicinity Map
Plate 2—Potentiometric Surface Map
Boring Logs/Well Construction Diagrams

Dist: 1/Addressee
1/Mr. Jason Gerber, Marquis & Aurbach



1 inch = 500 feet

0 500 1,000 1,500 2,000 Feet

Maryland_Site_Map.mxd

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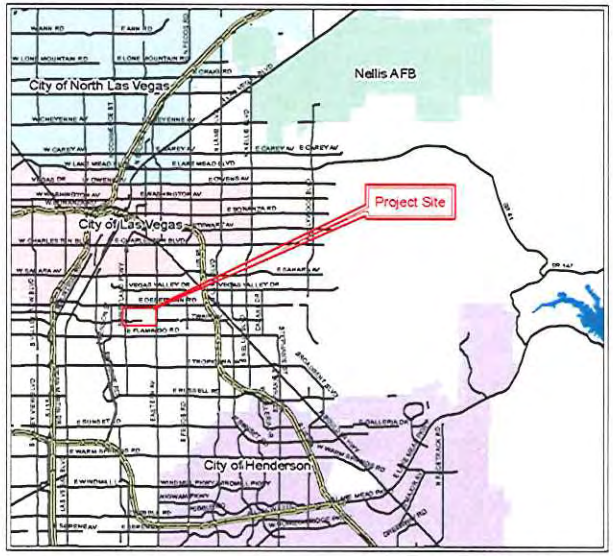


1 inch = 4 miles

Legend

Monitoring Well Locations

SITE MAP

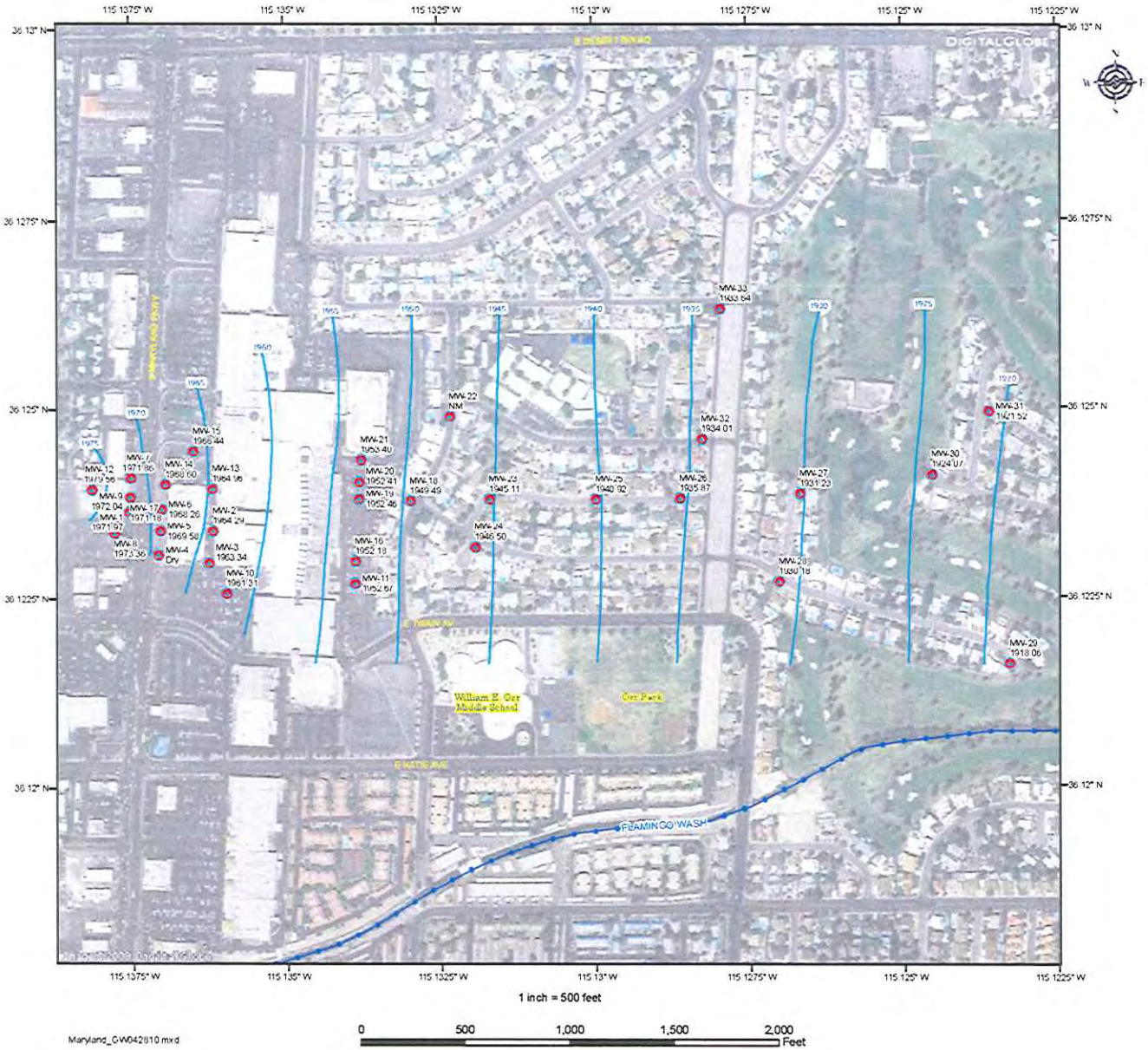
MARYLAND SQUARE SHOPPING CENTER

3661 South Maryland Parkway
Las Vegas, Nevada

Plate 1

Date Created: 04/28/10

Project No: 00-43367-09



1 inch = 500 feet

0 500 1,000 1,500 2,000 Feet

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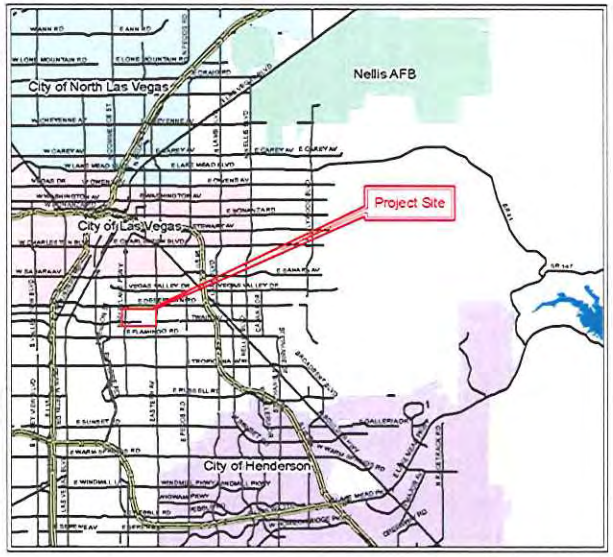

Note: NM = Not Measured

1 inch = 4 miles

Legend

- Monitoring Well Locations
- Groundwater Contours

Groundwater Gradient

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

Plate 2

Date Created: 04/28/10 Project No: 00-43367-09

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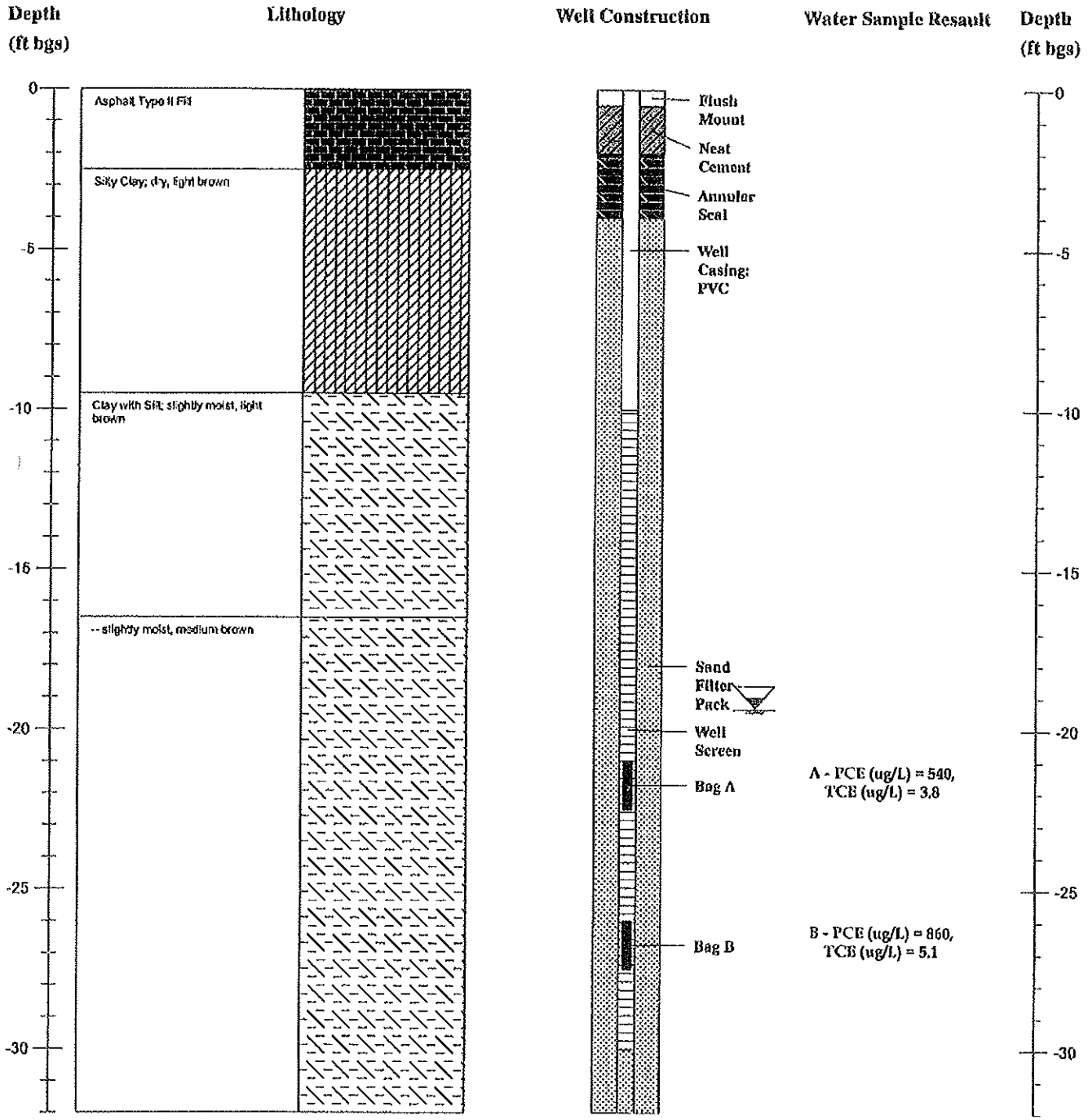
Well Name:	MW-5
Northing:	2676843.40
Easting:	787963.04
Surface Elevation:	1,989.19'
Log Depth:	32'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Square

Las Vegas, Nevada



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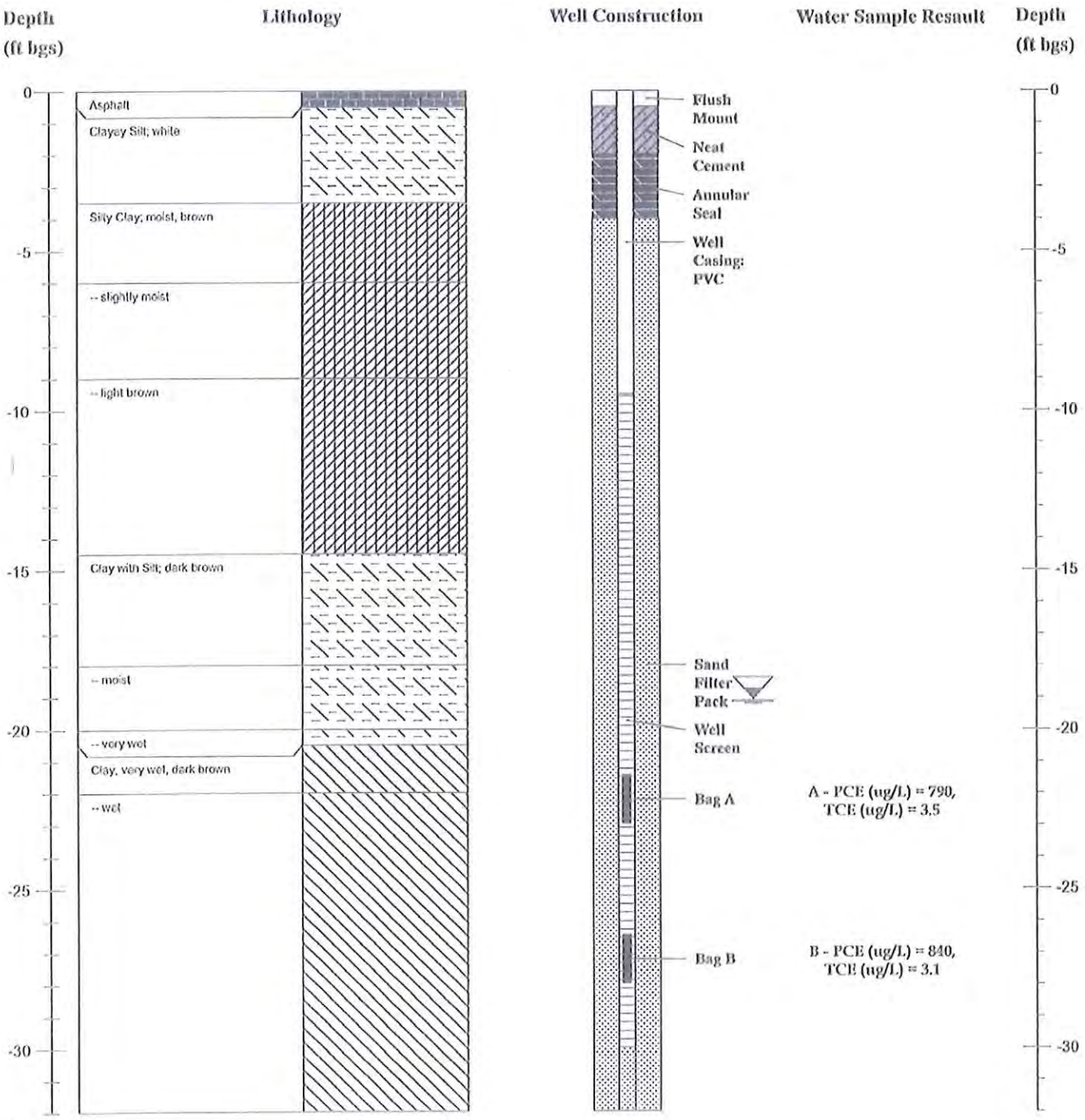
Converse Consultants

Well Name:	MW-2
Northing:	2674583.05
Easting:	788213.52
Surface Elevation:	1,583.97'
Log Depth:	32'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



S:\LasVegas\00-43367-09 Maryland Square\rockbrooks\MW-2

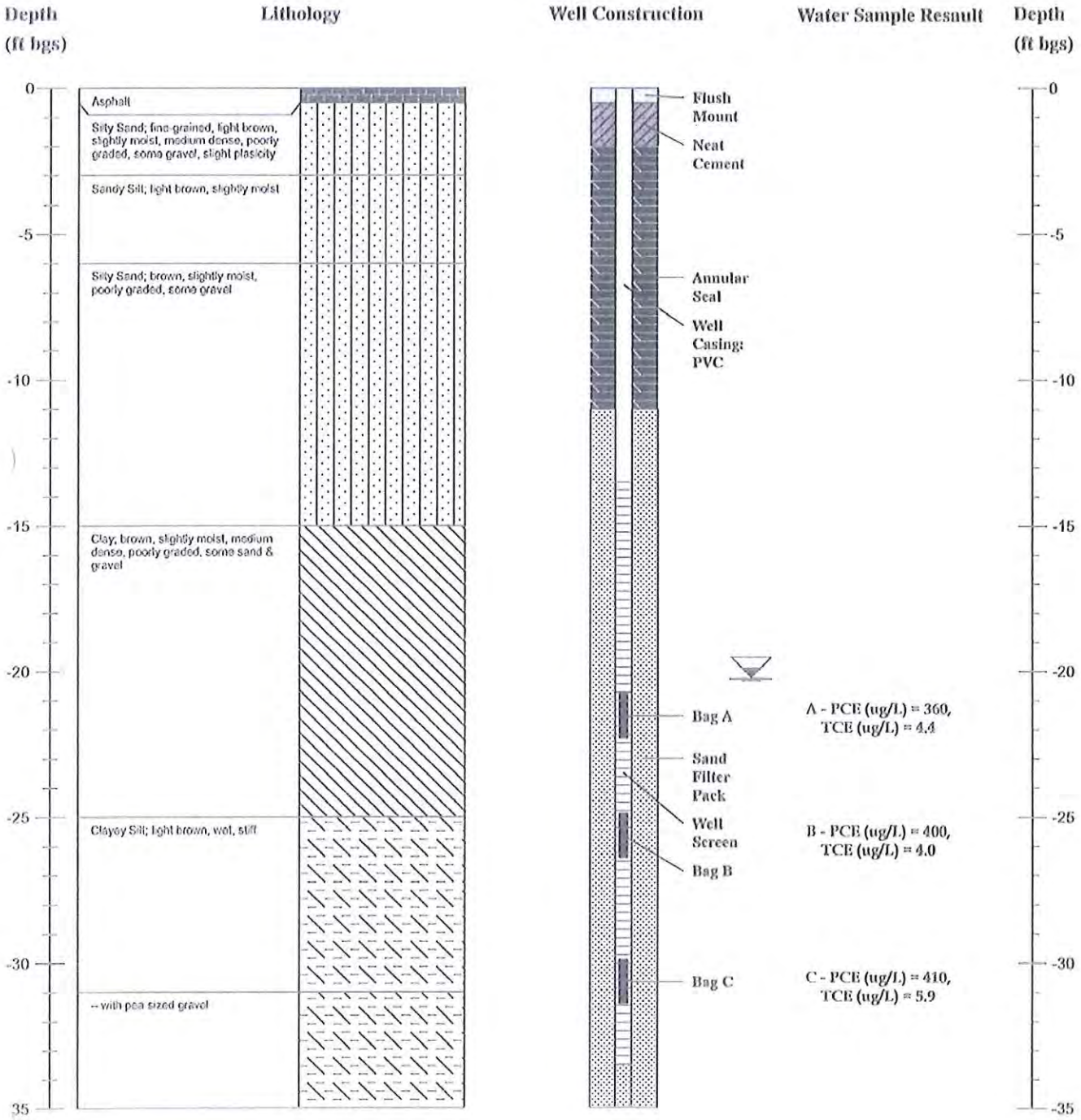
Converse Consultants

Well Name:	MW-32
Northing:	26747285.59
Easting:	750555.06
Surface Elevation:	1,952.52'
Log Depth:	35'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



S:\LasVegas\00-43367-09 Maryland Square\welcomed\MW-32

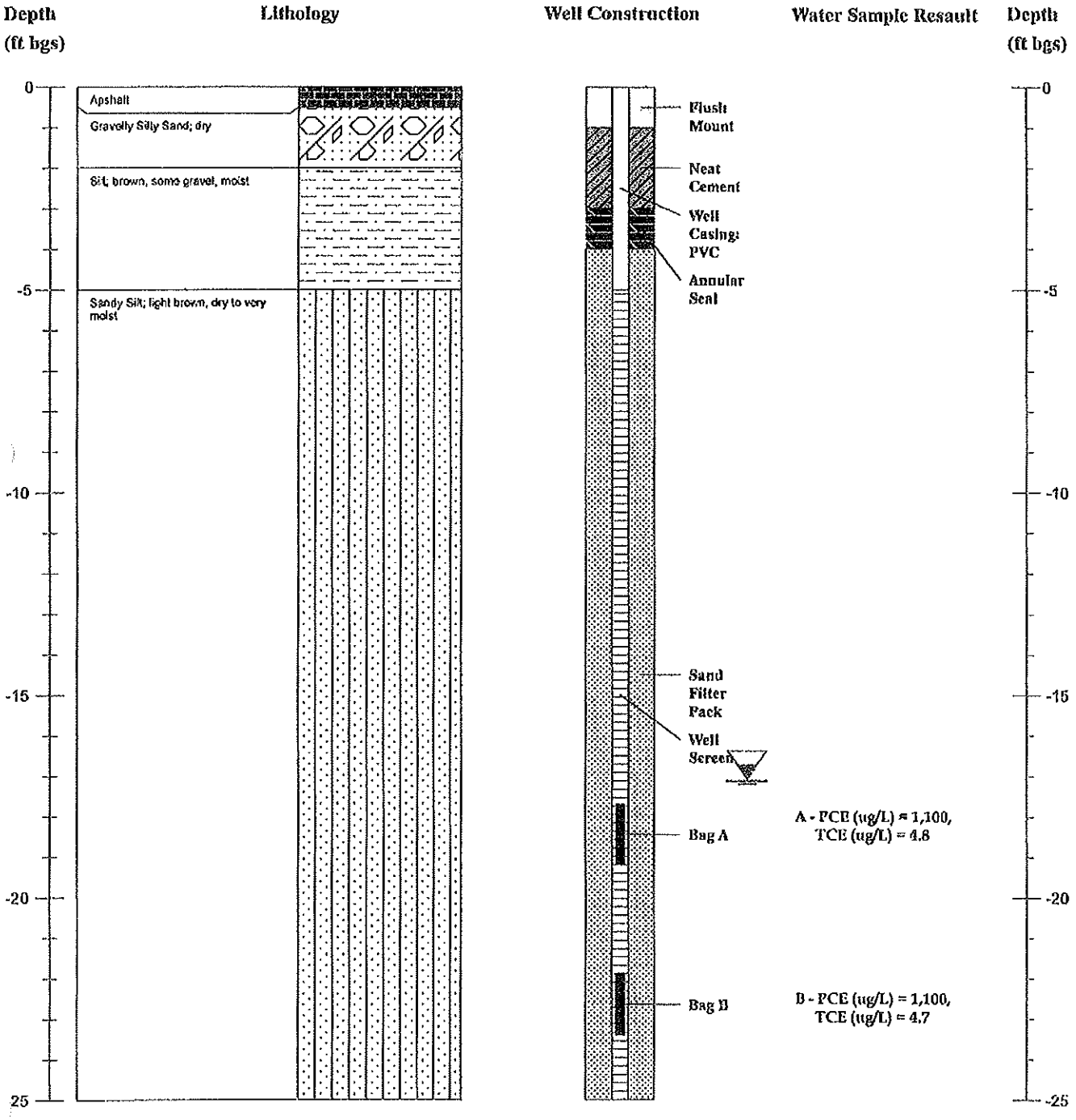
Converse Consultants

Well Name:	MW-23
Northing:	26746996.75
Easting:	789541.32
Surface Elevation:	1,962.29'
Log Depth:	25'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



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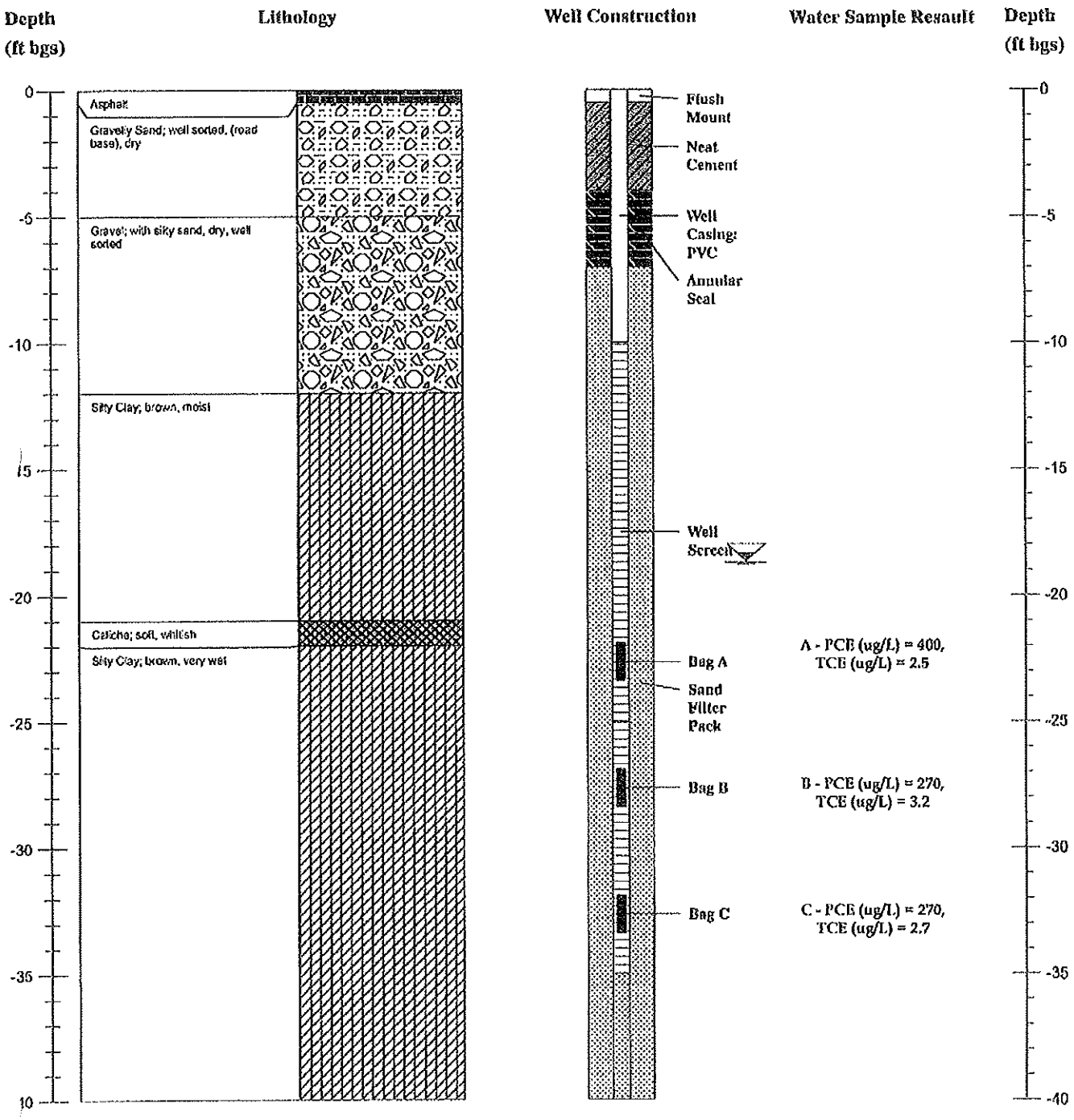
Converse Consultants

Well Name:	MW-27
Northing:	26747015.60
Easting:	791026.29
Surface Elevation:	1,944.23'
Log Depth:	40'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Marlyand Parkway

Las Vegas, Nevada



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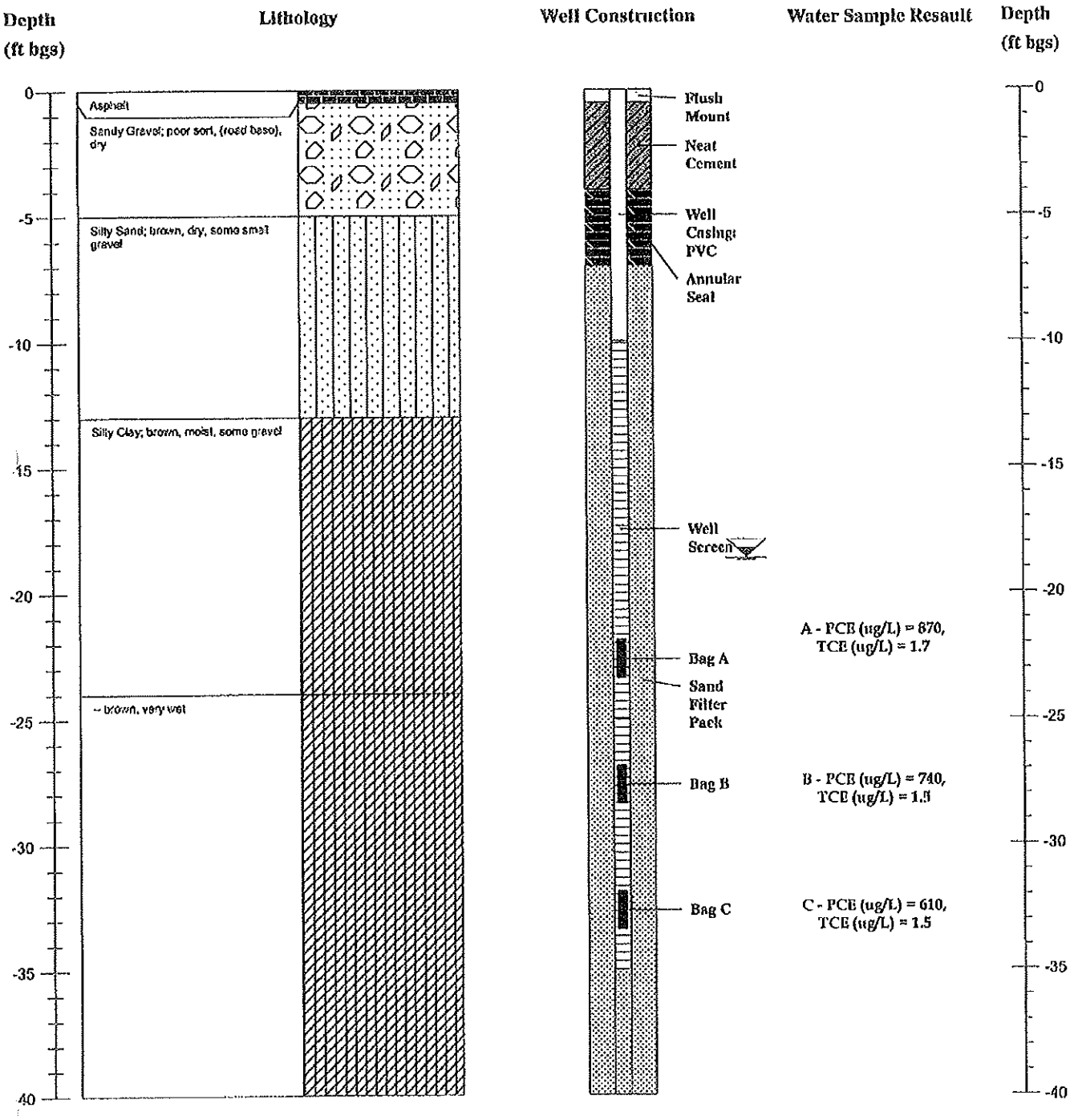
Converse Consultants

Well Name:	MW-26
Northing:	26747602.74
Easting:	790449.03
Surface Elevation:	1,953.48'
Log Depth:	40'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



S:\Las Vegas\00-43367-09 Maryland Square\xlworks\MW-26

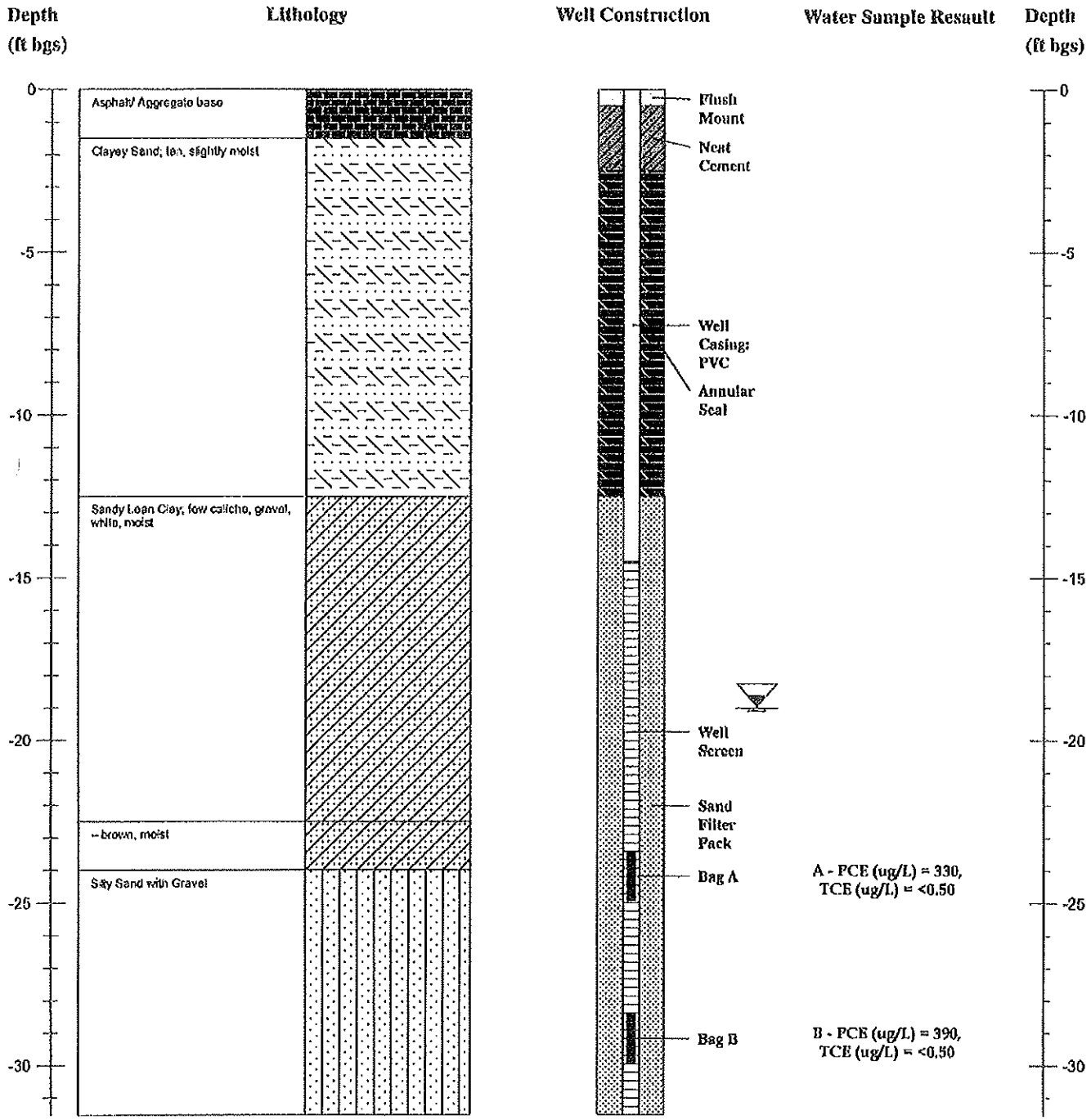
Converse Consultants

Well Name:	MW-14
Northing:	26747065.67
Easting:	767987.08
Surface Elevation:	1,987.86'
Log Depth:	31.54'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



S:\LasVegas\00-43367-09 Maryland Square\rockwork\MW-14

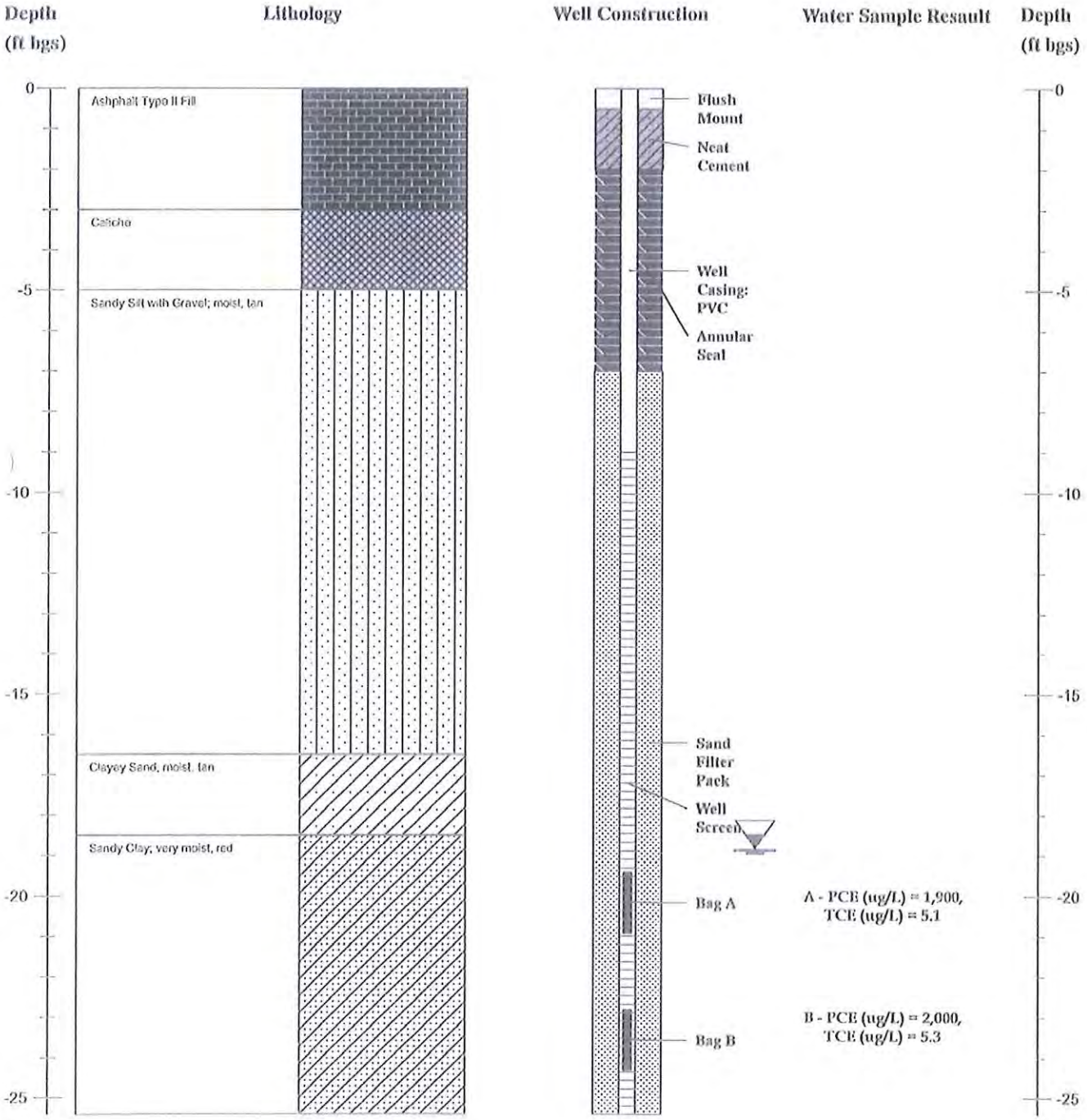
Converse Consultants

Well Name:	MW-13
Northing:	26747039.80
Easting:	788211.81
Surface Elevation:	1,984.18'
Log Depth:	25.42'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



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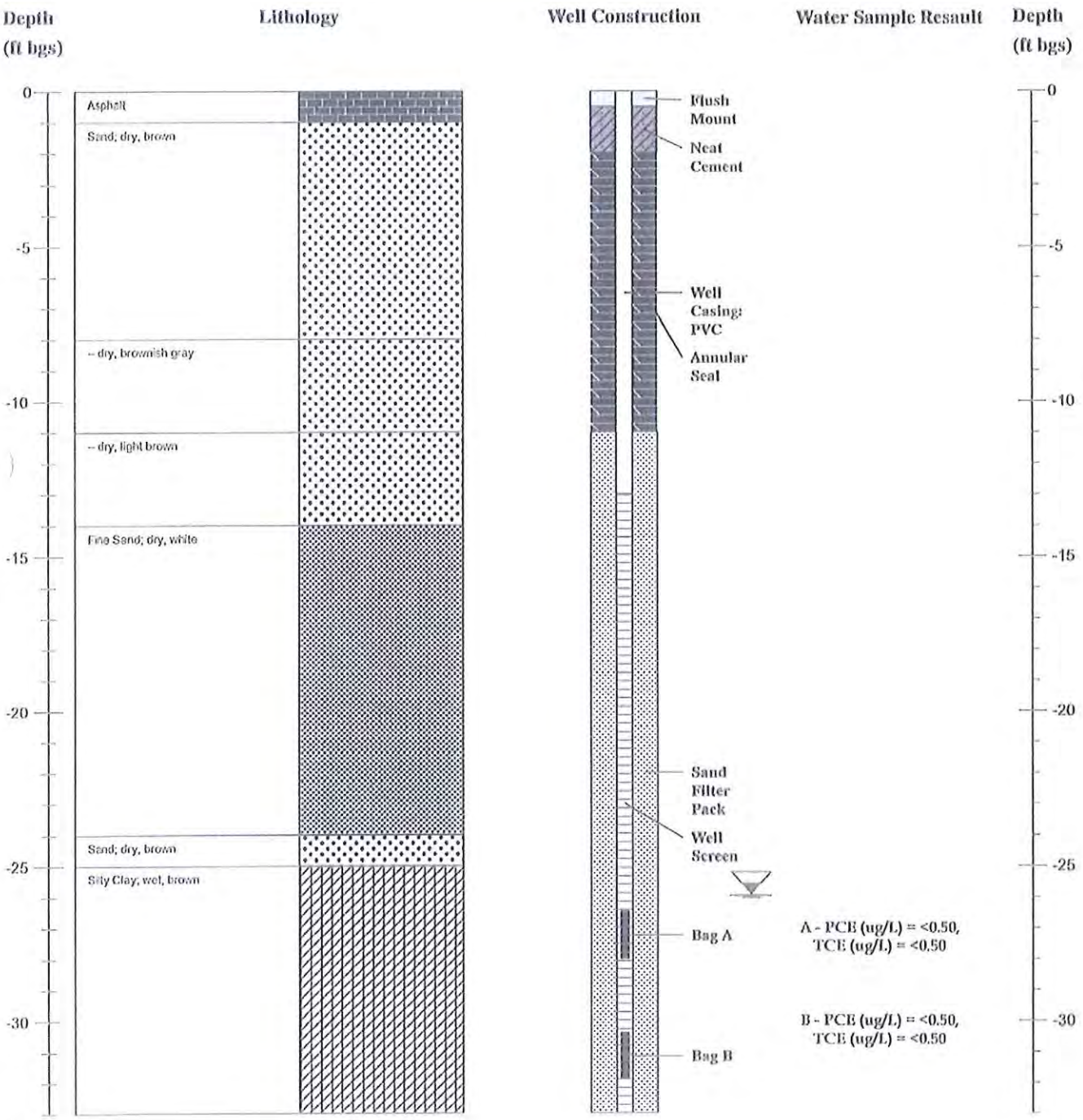
Converse Consultants

Well Name:	MW-11
Northing:	26746590.69
Easting:	788896.84
Surface Elevation:	1,980.21'
Log Depth:	33'
Project Number:	00-43367-03

MARYLAND SQUARE

3611 South Maryland Square

Las Vegas, Nevada



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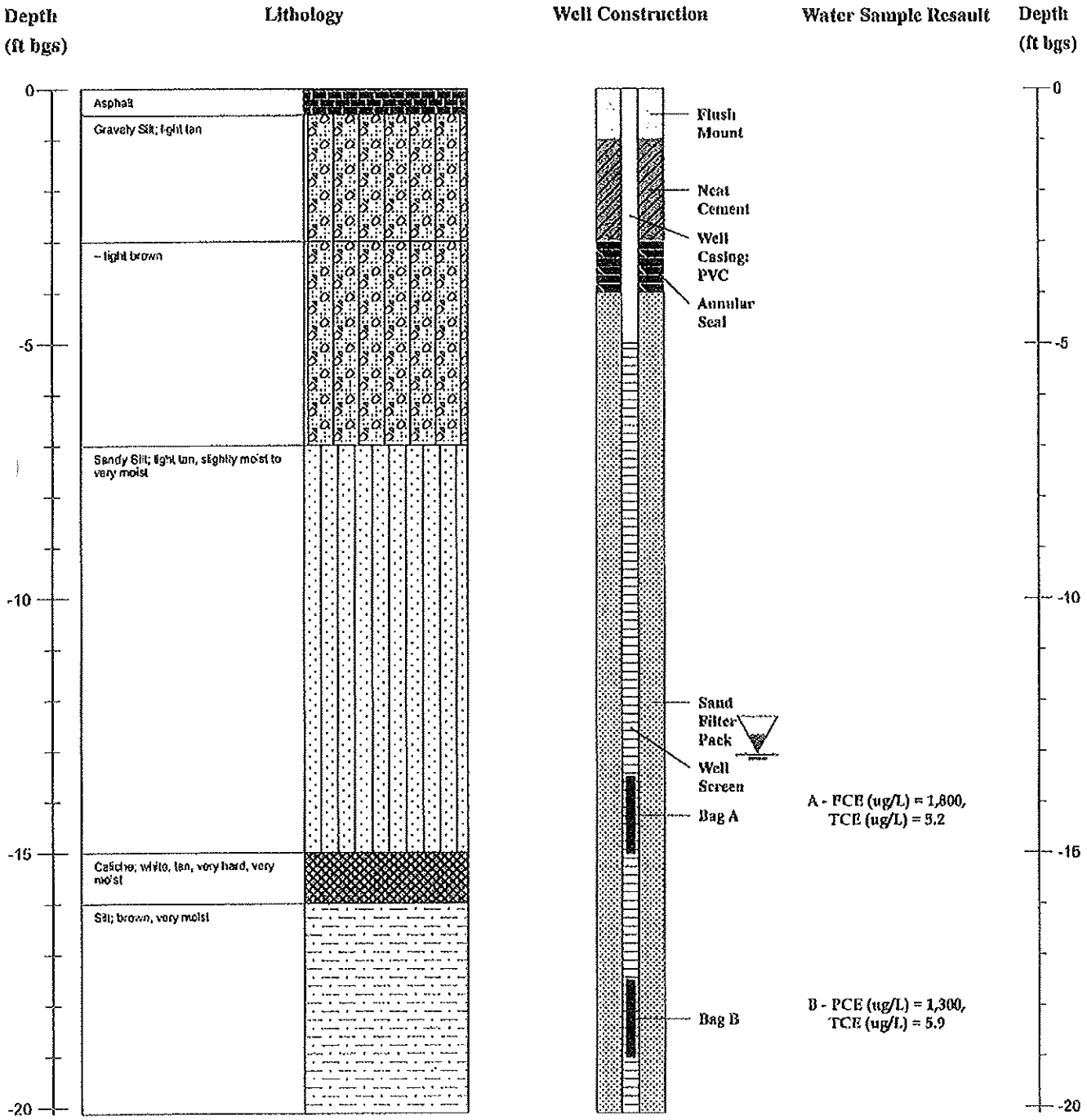
Converse Consultants

Well Name:	MW-18
Northing:	26746988.82
Easting:	769161.40
Surface Elevation:	1,962.86'
Log Depth:	20.13'
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Square

Las Vegas, Nevada



S:\Las Vegas\00-43367-09 Maryland Square\rockwork\MW-18

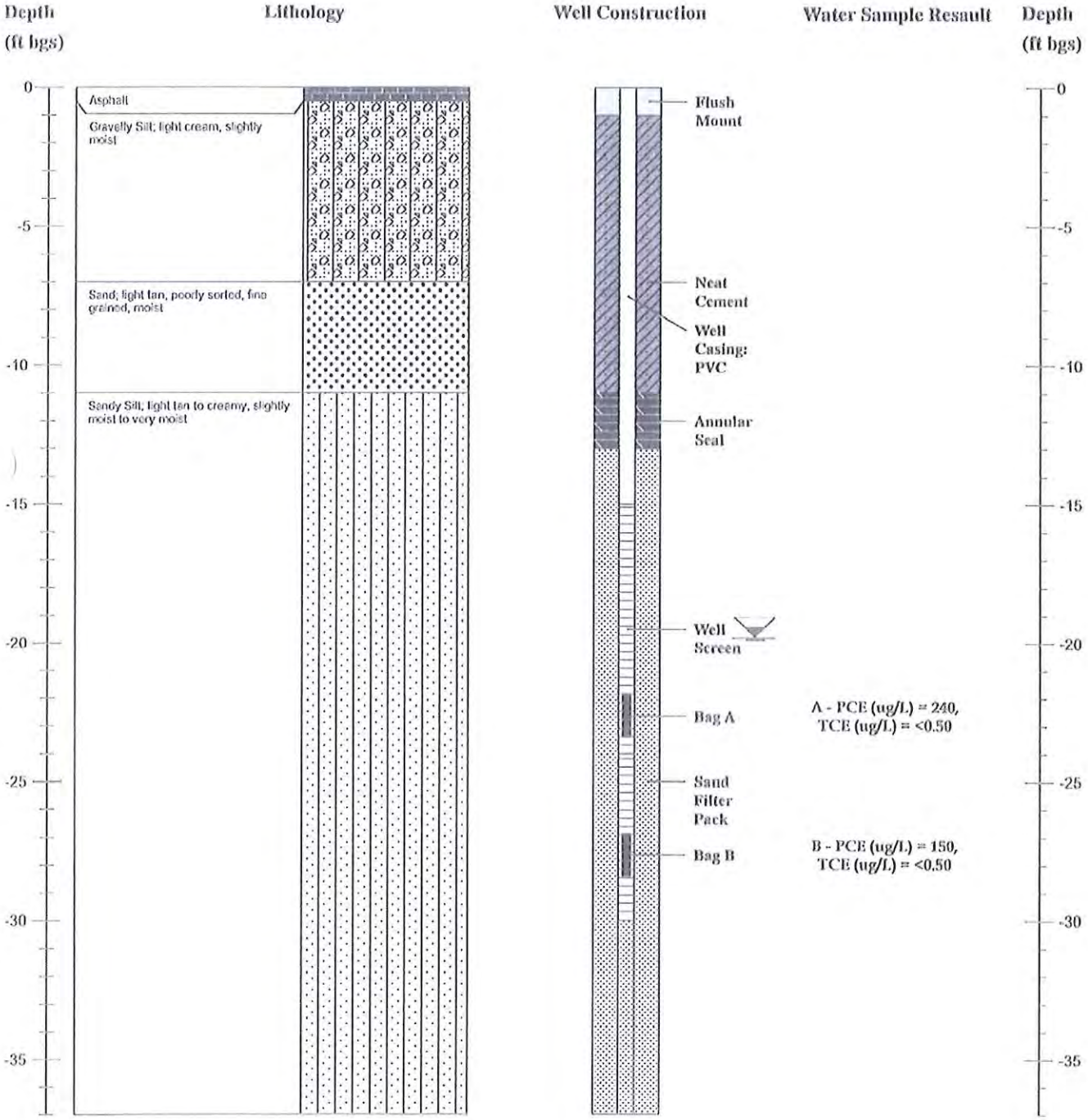
Converse Consultants

Well Name:	MW-17
Northing:	26747003.44
Easting:	767818.82
Surface Elevation:	1,990.89'
Log Depth:	37
Project Number:	00-43367-09

MARYLAND SQUARE

3661 South Maryland Parkway

Las Vegas, Nevada



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8. POLYETHYLENE DIFFUSION BAG (PDB) SAMPLERS

8.1 Description and Application

The Polyethylene Diffusion Bag (PDB) sampler was developed in the late 1990's and has become a widely accepted technique for determining concentrations of VOCs in groundwater monitoring wells. PDBs are installed in groundwater monitoring wells, at one or more intervals below the water surface in the well screen, and left in place under natural flow conditions. After sufficient residence-time the PDBs are removed and the contents discharged directly into analysis vials for standard volatile analysis. Because pumping and purging field time are eliminated and waste water disposal is reduced to a few milliliters, the technique results in significant cost savings over purge and pump techniques. The technique also provides depth specific profiling for compound and concentrations. PDBs are also used in saturated sediments in and around surface water to approximate VOC discharge to the surface.

The PDBs' ability to reflect dissolved VOC concentrations in the adjacent aquifer allows determination of stratification and vertical concentration gradients of VOC contaminants. Generally, each two-foot-long PDB sampler represents not more than five feet of the well screen. Interval VOC concentrations may be measured at specific well screen depths by hanging PDB samplers in series (Figure 8-1). In addition to gaining information about the well's hydrogeological attributes, correct positioning of a future single PDB sampler may be determined.

Figure 8-1. Deployment of PDB samplers to vertically profile well

8.1.1 Physical Characteristics

PDB samplers are made of low density polyethylene (typically 4mils thick) film which serves as a semi-permeable membrane. The membrane is formed into the shape of a tube to create a sample chamber which is filled with de-ionized water and sealed. Various configurations are commercially available either pre-filled and sealed at both ends at the factory, or with a fill port and plug for filling at the factory, in the field, or at the user's lab. PDB samplers are typically 18 to 24 inches long and 1.25 to 1.75 inches in diameter to fit into a 2-inch diameter and larger monitoring wells (Figure 8-2). These dimensions provide 200 to 350 ml of sample for multiple VOA samples and duplicates. Other diameters and lengths are available to fit smaller diameter wells or to provide specific sample volumes. PDBs are available with an exterior polyethylene mesh that protects against abrasion (Figure 8-3). Figure 8-4 displays a protective canister available for deployment of PDBs in sediments.

Figure 8-2. Typical passive diffusion bag sampler with protective mesh sleeve, weight, and deployment supplies

Figure 8-3. EON diffusion bag sampler and supplies

Figure 8-4. Protective screen canister for PDB deployment in sediments

PDBs operate using the principles of molecular diffusion across the semi-permeable polyethylene membrane. VOCs in the aquifer are transported into the well through the screen by natural flow and by diffusion. The deionized water in the PDB contains no organic compounds

Chlorobenzene 1,2-Dichloroethane Toluene

Favorable laboratory diffusion testing results
Carbon tetrachloride 1,1-Dichloroethene 1,1,1-Trichloroethane
Chloroethane *cis*-1,2-Dichloroethene 1,1,2-Trichloroethane
Chloroform *trans*-1,2-Dichloroethene Trichloroethene (TCE)
Chloromethane 1,2-Dichloropropane Trichlorofluoromethane
2-Chlorovinylether *cis*-Dichloropropene 1,2,3-Trichloropropane
Dibromochloromethane 1,2-Dibromoethane Vinyl chloride
Dibromomethane *trans*-1,3-Dichloropropene Xylenes (total)
1,2-Dichlorobenzene Ethyl benzene
Unfavorable laboratory diffusion testing results
Acetone Methyl *tert*-butyl ether
Methyl *iso*-butyl ketone Styrene

Table 8-2. Field experience sampling VOCs with PDBs (Parsons 2004)

Data suggest that PDB sampling may be useful for these target compounds (see text)
Benzene 1,2-Dichlorobenzene 1,1,2,2-Tetrachloroethane*
Bromobenzene* 1,3-Dichlorobenzene Tetrachloroethene
Bromochloromethane* 1,4-Dichlorobenzene Toluene
n-Butylbenzene Dichlorodifluoromethane 1,2,3-Trichlorobenzene*
sec-Butylbenzene 1,1-Dichloroethane 1,2,4-Trichlorobenzene*
tert-Butylbenzene 1,2-Dichloroethane 1,1,1-Trichloroethane
Carbon disulfide 1,1-Dichloroethene 1,1,2-Trichloroethane
Carbon tetrachloride *cis*-1,2-Dichloroethene Trichloroethene
Chlorobenzene *trans*-1,2-Dichloroethene Trichlorofluoromethane
Chloroethane 1,2-Dichloropropane 1,1,2-Trichloro-1,2,2-trifluoroethane
Chloromethane Ethylbenzene Vinyl chloride
Dibromochloromethane Hexachlorobutadiene* *m,p*-Xylene
1,2-Dibromoethane* *p*-Isopropyltoluene *o*-Xylene
Dibromomethane* 1-Methylethylbenzene Xylenes, total
Data suggest that PDB sampling may be problematic for these target compounds (see reference)
tert-Amyl methyl ether* Naphthalene 1,2,4-Trimethylbenzene
Bromoform* *n*-Propylbenzene 1,3,5-Trimethylbenzene
*The data set for this compound was relatively small (fewer than five instances of comparison), so the power of the classification (i.e., acceptable or unacceptable) is fairly low.

8.1.4 Sample Volume

Volume varies with the diameter and length of the PDB. Standard PDBs are sized to fit in 2-inch wells (1.25-inch OD by 18-24-inches long). The standard PDB sampler holds 220-350 mL of water. PDB samplers can be custom fabricated in varying lengths and diameters for specific volume requirements. Generally, PDBs have been made to obtain a sample volume of 250 to 350 mL.

8.2 State of the Art

8.2.1 Lab Testing

Laboratory testing for chemical parameters has shown excellent correlation for those compounds tested.

8.2.2 Field Testing

Numerous studies have been performed to demonstrate the appropriateness of the use of PDB and allowed it to be recognized as a valid groundwater sampling technique. The Air Force Center

Transfer of water from the PDB to sample containers is required before shipping samples to the laboratory.

8.4 Unanswered Questions

[None]

8.5 Selected References

ITRC, 2004. Technical and Regulatory Guidance for Using Polyethylene Diffusion Bag Samplers to Monitor Volatile Organic Compounds in Groundwater.

Parsons. 2004. Final Comprehensive Results Report for the Passive Diffusion Bag Sampler Demonstration.

Vroblesky, D. A. 2001. User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compounds Concentrations in Wells, Part 1 and 2. US Geological Survey Water Resources Investigation Reports 01-4060 and 01-4061.

ITRC, Diffusion Sampler Information Center (DSIC), http://diffusionsampler.itrcweb.org/common/default.asp

NJDEP, August 2005, Field Sampling Procedures Manual, Chapters 5 and 6. http://www.state.nj.us/dep/srp/guidance/fspm/