Urban Environmental Partners llc

REMEDIAL INVESTIGATION / FEASIBILITY STUDY AND CLEANUP ACTION PLAN

Rainier Mall Property

4208 Rainier Avenue South, Seattle, WA 98118

King County Parcel #7950301480

July 27, 2020 **DRAFT**

Prepared for:

Rainier & Genesee, LLC and
Mount Baker Housing Association

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1.0 Introduction

On behalf of Rainier & Genesee, LLC and Mount Baker Housing Association, Urban Environmental Partners (UEP) has prepared this **DRAFT** Remedial Investigation (RI), Feasibility Study (FS), and Cleanup Action Plan (CAP) for the Rainier Mall "Site" (Voluntary Cleanup Program [VCP] ID NW3261), addressed at 4208 Rainier Avenue South in Seattle, Washington (the Property) as shown on Figures 1 and 2.

As established in the Washington Administrative Code (WAC), Chapter 173-340-200, a "Site" is defined by the full vertical and lateral extent of contamination that has resulted from the release of hazardous substances into the environment. The Rainier Mall Site is defined by the historical release of chlorinated volatile organic compounds (CVOCs) associated with former dry cleaning operations on the Property and by the use of creosote treated wood pilings to support the construction of a former grocery store. The primary CVOCs at the Site include tetrachloroethylene, also known as perchloroethylene (PCE) and it's degradation compounds trichloroethylene (TCE), cis-1,2-dichloroethylene (DCE), trans-1,2-DCE, 1,1-DCE, and Vinyl Chloride (VC). In addition, the chemical compounds at the Site associated with creosote treated wood piles are polycyclic aromatic hydrocarbons (PAHs).

This report was prepared for submittal to the Washington State Department of Ecology (Ecology) under the VCP, and was developed to meet the general requirements of an RI, FS, and CAP as defined by the Washington State Model Toxics Control Act (MTCA) Regulation in Chapters 173-340-350 through 173-340-410 of the WAC. Public review and comment of the final Draft and RI/FS/CAP will be pursuant to Prospective Purchaser Consent Decrees that Rainier & Genesee Property and Mount Baker Housing Association will enter with Ecology.

1.1 Document Purpose

1.1.1 Remedial Investigation

The purpose of the RI was to collect data necessary to adequately characterize the Site for the purposes of developing and evaluating remedial alternatives consistent with WAC 173-340-350(7). The RI components of this report present historical information regarding the former use of the Property, summarize the scope and findings of each environmental investigation that has been conducted at the Site, provide the Site data for soil, groundwater, and vapor studies from the remedial investigations, and present a Conceptual Site Model (CSM) for the contaminant release, transport, and potential exposure pathways at the Site.

1.1.2 Feasibility Study

The purpose of the FS is to utilize the data collected during the RI to develop and evaluate remedial alternatives for the Site and to select the most appropriate alternative based on the procedures in WAC 173-340-350(1) through (8), and the evaluation criteria listed below. According to MTCA, a cleanup alternative must satisfy all of the following threshold criteria as specified in WAC 173-340-360(2):

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws; and,
- Provide for compliance monitoring.

WAC 173-340-360(2)(b) also recommends that the selected cleanup action:

- Use permanent solutions to the maximum extent practicable;
- Provide for a reasonable restoration time frame; and,
- Consider public concerns on the proposed cleanup action alternative.

The FS analysis proposes the cleanup levels to be applied to the impacted media at the Site, and shows how the Site will be brought into compliance with the proposed cleanup standards.

1.1.3 Cleanup Action Plan

As provided in WAC 173-340-360 and -380, the purpose of the CAP is to present the objectives of the cleanup action, the technical components of implementing the selected cleanup method, the proposed points of compliance for the Site, and the means and methods proposed for compliance monitoring activities.

2.0 Background

The following section provides a description of the Property, a presentation of the physical settings of the Property, and a summary of environmental investigations and interim actions conducted at the Site to date.

2.1 Location, Address, and Legal Description

The Property consists of a single, irregularly-shaped King County Tax Parcel (#7950301480), comprising 2.33 acres, addressed at 4208 Rainier Avenue South in Seattle, Washington (Figures 1 and 2). The Property is accessed from the north side of South Genesee Street on the south side of the Property. The following is an abbreviated legal description of the Property as provided by the King County Department of Assessments:

SQUIRES LAKESIDE ADD & POR VAC ALLEY ADJ LESS ST
Plat Block: 9
Plat Lot: 7 THRU 38

2.2 Current Improvements, Land Use, and Occupant Information

The Property is currently improved with a 36,071 square foot (sf) vacant retail structure on the north half of the parcel, and has an associated asphalt parking lot on the south side of the Property that covers the remainder of the parcel.

2.3 Historical Land Use Summary

According to historical land use research conducted by Hahn and Associates, Inc. (Hahn) in 2000 as part of Phase I and Phase II Environmental Site Assessments (ESAs), the Property was formerly developed with up to three separate dry cleaning facilities on the southwestern portion of the Property as shown on Figure 2. These historic dry cleaners reportedly operated in three distinct locations between approximately 1930 and 1968. The buildings were removed from the Property between 1967 and 1978.

According to Hahn's Phase I ESA, the current single-story retail building was constructed on the north end of the Property around 1967 and was initially occupied by a Safeway (Store No. 441) and mixed-use retail mall. Historical building plans associated with the construction of the Safeway indicate the building was constructed on approximately 172 treated wooden piles. Wooden piles of this era were commonly treated with creosote, which contains chemical compound such as PAHs.

Safeway No. 441 ceased operations in approximately 1998 and the structure was expanded and converted into a mixed-use mall (Rainier Mall) supporting multiple retail tenants. Rainier Mall closed in August of 2016 and has remained vacant since that time.

2.4 Physical Settings

2.4.1 Topographic Characteristics

The primary topographic gradient at the Site is from west to east, with a localized depression throughout the central portion of the parking area. Elevations range from approximately 47 feet above mean sea level (AMSL) (NAVD 88 datum) near the western property boundary, to approximately 42 feet AMSL within the localized depression.

2.4.2 Groundwater Use Assessment

According to a database search of registered water wells with Ecology (Ecology 2020), there are no active water supply wells within a 0.5-mile radius of the Property. Shallow groundwater in the vicinity of the Property does not appear to serve as a source of drinking water.

Seattle Public Utilities (SPU) provides the potable water supply to the City of Seattle. SPU's main source of water is derived from surface water reservoirs located within the Cedar and South Fork Tolt River watersheds. According to King County's Interactive Map for the County's Groundwater Program, there are no designated aquifer recharge or wellhead protection areas within several miles of the Site (King County iMAP 2020).

2.5 Summary of Environmental Investigations

This report section summarizes the release discovery and subsequent environmental investigations conducted by various consulting companies at the Site. The types and locations of the historic explorations from the investigations are depicted on Figure 3, while the cumulative soil and groundwater data results from the studies are tabulated on Tables 1 through 6. The primary contaminants of concern for the Site, and those that have been the focus of the majority of these environmental investigations, are the CVOCs - PCE and its degradation products (TCE, DCE, and VC).

The CVOC data results for soil and groundwater samples from the studies are depicted by location on plan view Figures 4 and 5, respectively, as well as on cross sectional Figures 12 through 15. Laboratory analytical reports are presented in Appendix A and boring logs, if available, are presented in Appendix B.

2.5.1 Hahn and Associates, Inc. Phase I and II Environmental Site Assessments, 2000

In 2000, Hahn performed a Phase I ESA for the Property which identified the historical presence of up to three dry cleaning operations, operating in three distinct locations on the southwestern portion of the Property (Figure 2). This land use practice was identified as a Recognized Environmental Condition (REC) due to the common use, storage, and improper disposal hazardous cleaning solvents, and further environmental assessment was recommended in the Hahn report.

Hahn subsequently oversaw the advancement of eight borings (B-1 through B-8) on the Property to evaluate the environmental quality of soil and groundwater in the vicinity of these former dry cleaners. Soil samples were collected from 4 locations at depths between 4.5 and 19.5 feet below ground surface (bgs).

Groundwater was encountered in borings B-1, B-3, B-4, B-5, and B-7 at depths between 26 and 32 feet bgs. Reconnaissance groundwater samples were collected at these 5 locations by inserting a temporary screened well point in the boring, purging the wells dry with a peristaltic pump, waiting for recharge, then extracting groundwater using a disposable polyethylene bailer.

Soil and groundwater samples collected during the investigation were analyzed for volatile organic compounds (VOCs) by EPA Method 8260B.

Investigation Findings – Soil

- One soil sample, collected from boring B-1 at a depth of 19.5 bgs, contained concentrations of PCE and TCE in excess of their respective MTCA Method A Cleanup Levels.

Investigation Findings – Groundwater

- Groundwater samples collected from borings B-1 and B-4 contained concentrations of PCE, TCE, 1,1-DCE and/or VC in excess of their respective MTCA Method A Cleanup Levels.
- The groundwater sample collected from boring B-7 contained a detectable concentration of PCE, however the value was well below its MTCA Method A Cleanup Level.

The results of the investigation indicated that a significant release of CVOCs had occurred to both soil and groundwater in the vicinity of the southern dry cleaning facilities. The PCE release was reported to Ecology by the owner following Hahn's Phase II sampling.

2.5.2 SoundEarth Strategies, Inc. –Subsurface Investigation, 2017

During due diligence work between January and March of 2017, SoundEarth conducted a subsurface investigation to evaluate the nature and extent of the CVOC release identified by Hahn. The investigation consisted of the advancement of 13 borings (SB01 through SB08, and B01 through B05) across the southern portion of the Property in locations shown on Figure 3. Soil samples were collected from depths between 5 and 40 feet bgs.

One boring (B01), located in the suspected PCE source area, was completed as a 2-inch diameter groundwater monitoring well (B01/MW01) and was sampled in accordance with American Society of Testing and Materials (ASTM) Guideline D6771-02 "Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations" (ASTM low flow methodology). Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples from the SoundEarth borings/wells were analyzed for CVOCs by EPA Method 8260C.

Investigation Findings - Soil

- Soil samples collected from borings SB01, SB02, SB08, B01, B02, B03, and B04, at depths between 12.5 and 32.5 feet bgs, contained concentrations of PCE, TCE, and/or VC in excess of their respective MTCA Method A Cleanup Levels, as shown by soil data presented on Figure 4.

Investigation Findings – Groundwater

- The groundwater sample collected from monitoring well MW01 contained an elevated concentration of PCE (8,700 ug/L) in excess of its MTCA Method A Cleanup Level. TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC were not detected above their laboratory reporting limits in this early sample, however the reporting limits themselves were in excess of their respective MTCA Method A Cleanup Levels due to laboratory dilution. Groundwater data are presented on Figure 5.

2.5.3 SoundEarth Strategies, Inc. – Passive Soil Vapor Assessment, 2017

In December of 2017, SoundEarth performed a soil vapor assessment to further assess the CVOC source area and the extent of shallow soil impacts. Fifty-six passive soil vapor samplers (Gore Sorbers) were installed on the southern portion of the Property and into the adjacent sidewalk right-of-way (ROW) as shown on Figure 6.

Investigation Findings – Soil Vapor

- Only 5 of the 56 soil vapor samples contained even detectable concentrations of CVOCs. These low level soil gas results provided inconclusive data with respect to the investigation purpose as an obvious PCE source area was not found. Also, there was/is no direct correlation of the soil gas data from this study with existing soil contamination data, or with CVOC concentrations in groundwater. However, the soil gas results from the survey indicated that shallow soil (fill) on the Property is not likely impacted with PCE.

2.5.4 SoundEarth Strategies, Inc. – Subsurface Investigation, 2018

In 2018, SoundEarth conducted a multi-phase supplemental subsurface investigation to further define the extent of the CVOC release, characterize the fill material across the Property, and assess the potential for vapor intrusion into the existing retail building. The investigation consisted of the advancement of 21 borings (B06 through B18 and TB01 through TB08) across the Property and three soil gas vapor sampling points (SGO1 – SG03) in locations as shown on Figure 3. Soil samples were collected from depths between 5 and 46 feet bgs and the soil gas samples were collected at approximately 8 feet bgs.

Borings B12, B15, and B16 were drilled near the western Property boundary, at angles of approximately 46-48 degrees toward the adjacent ROW, to collect soil samples beneath known utility obstructions in the sidewalk.

Soil Borings B07, B09, B15 through B18, TB07 and TB08 were completed as 2-inch diameter groundwater monitoring wells. Monitoring wells B07/MW03, B09/MW02, B15/MW07, B16/MW06, B17/MW09, B18/MW08, TB07/MW04, and TB08/MW05 were sampled in accordance with ASTM low flow methodology. Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples were analyzed for: CVOCs by EPA Method 8260C; gasoline-range petroleum hydrocarbons (GRPH) by Northwest Method NWTPH-Gx; diesel-range petroleum hydrocarbons (DRPH) and oil-range petroleum hydrocarbons (ORPH) by Northwest Method NWTPH-Dx; MTCA 5 metals (arsenic, cadmium, chromium, lead, and mercury) by EPA Method 6020A; and/or polycyclic aromatic hydrocarbons (PAHs) by EPA Method 8270D SIM.

The soil gas samples were analyzed for CVOCs by EPA Method TO-15.

Investigation Findings – Soil

- The soil sample collected from a fill area containing debris at TB05 at a depth of 5 feet bgs contained a concentration of ORPH in excess of its MTCA Method A Cleanup Level.
- Soil samples collected from borings B06, B12, B14, B16, B18, and TB08, at depths between 10.5 and 20 feet bgs, contained concentrations of PCE and/or TCE in excess of their respective MTCA Method A Cleanup Levels.
- Select soil samples collected from borings TB01, TB03, TB04, B06, and B09 contained concentrations of metals consistent with natural background levels, which were below their respective MTCA Method A Cleanup Levels.
- Select soil samples collected from TB01, TB03, and B09 did not contain concentrations of PAHs above the laboratory detection limit and/or MTCA Method A Cleanup Levels.

Investigation Findings – Groundwater

- The groundwater samples collected from monitoring wells MW05, MW08, and MW09 contained concentrations of PCE, TCE, cis-1,2-DCE, and VC in excess of their respective MTCA Method A Cleanup Levels.
- The initial groundwater sample collected from monitoring well MW02 contained a concentration of VC slightly above its MTCA Method Cleanup Level.

- The groundwater samples collected from MW03, MW04, MW06, and MW07 contained concentrations of CVOCs below their laboratory detection limits and/or MTCA Method A Cleanup Levels.

Investigation Findings – Soil Gas

- Concentrations of PCE were detected in all three samples at concentrations between 25 to 48 micrograms per cubic meter (µg/m3), which is below the MTCA Method B screening level of 321 µg/m3.
- Remaining CVOC concentrations were below the laboratory detection limit for all three soil gas samples.

The results of this 2018 soil and groundwater sampling provided additional detail regarding the nature of the CVOC release but did not adequately define the extent of impacts, specifically in the direction to the south.

The ORPH detected in soil from TB05 has been attributed to uncontrolled fill material, or isolated debris, and does not appear to be associated with a point source release on the Property.

The results of the soil gas sampling indicate that vapor intrusion is not a concern for the existing on-Property structure to the north.

Soil gas analytical results are tabulated on Table 8.

2.5.5 Urban Environmental Partners – Subsurface Investigation, 2019

In April of 2019, subsequent to the Site's enrollment into the Voluntary Cleanup Program, UEP conducted a subsurface investigation to evaluate potential CVOC impacts beneath the southern adjacent ROW (South Genesee Street). The investigation consisted of the advancement of 2 borings (UB10 and UB11) using hollow stem auger (HSA) drilling methods within the westbound traffic lane in South Genesee Street. Soil samples were collected from depths between 10 and 28 feet bgs.

Both borings were completed as 2-inch diameter groundwater monitoring wells. Monitoring wells UB10/MW10 and UB11/MW11 were sampled in accordance with ASTM low flow methodology. Monitoring well construction details are summarized in Table 7.

Select soil and groundwater samples were analyzed for CVOCs by EPA Method 8260C.

Investigation Findings – Soil

- Two soil samples collected from UB10 in the saturated soil zone at depths of 25 and 28 feet bgs, respectively, contained concentrations of PCE and/or TCE in excess of their respective MTCA Method A Cleanup Levels.
- The soil samples collected from UB11 between 13 and 28 feet bgs did not contain detectable concentrations of CVOCs.

Investigation Findings – Groundwater

- The initial groundwater sample collected from monitoring well MW10 contained concentrations of PCE, TCE, cis-1,2-DCE, and VC in excess of their respective MTCA Method A Cleanup Levels.
- The groundwater sample collected from MW11 did not contain detectable concentrations of CVOCs.

2.5.6 Aestus – GeoTrax CSM+™ Ultra-High Resolution Site Characterization, 2019-2020

In December of 2019, Aestus, LLC (Aestus) began its GeoTrax Survey™ work and applied an electrical resistivity imaging (ERI) technology to survey the Site. The goal was to use the Aestus imaging technology in further assessing the nature and extent of the CVOC release. The imaging survey evaluates potential geologic formations, soil types, preferential flow pathways, and levels of naturally occurring bioactivity by bacteria using its electrical hydrogeology scanning technology, and imaging results are used to update the CSM with higher data density to more fully develop the Conceptual Site Model.

ERI works by imparting an electrical current into the ground, and then measuring voltage and soil resistance and conductivity at multiple locations along a straight survey line/transect. Based on these voltage conductance data, the apparent resistivity of subsurface materials is calculated using Ohm's Law. These measurements are then converted to provide measurements of model resistivity or true resistivity at regular points. Aestus uses specialty ERI methods developed specifically for the environmental industry with enough sensitivity and resolution to image NAPLs and associated aqueous phase impacts as well as to interpret hydrogeology and bioactivity at a Site.

Subsurface areas impacted with fresh or unweathered light or dense non-aqueous liquids (LNAPLs or DNAPLs, respectively) and related dissolved phase contamination, typically present as more resistive anomalous zones relative to areas that contain only non-impacted soils and pore fluids.

The presence of chloride and/or other ions in soil create lower resistivity (i.e., higher electrical conductivity) in the subsurface. The Aestus technology routinely detects bioactive zones in the subsurface which create a very electrically conductive signature (less resistive) due to shifting groundwater chemistry and the presence of nanowires between the bacteria and other organisms which may be present. Bioactivity signatures are typically the strongest electrical signal in Aestus' imagery.

Aestus performed 10 transect lines across the property in the locations shown on Figure 8. Each transect consisted of 56 stainless steel electrodes, installed in a straight line at specific intervals to a depth of approximately 12 inches. The electrodes were connected via geophysical cables and the cables were connected to Aestus' data acquisition field instruments. Once each survey line was laid out in the field, Aestus' specialized data acquisition methods gathered a significant amount of data related to the electrical properties of the subsurface in that transect area. Following field data collection, Aestus used their proprietary data processing techniques to develop a final electrical resistivity 2D image of the subsurface for each transect location. The depth of the 2D image is one-fifth of the transect line length on the ground surface, which allowed the Aestus survey to interpret soil conditions to depths of about 40 feet bgs.

Because Aestus' subsurface imaging technology is not a quantitative analytical tool, it does not immediately identify or quantify the chemical, geological, and biological (bioactivity) composition of anomalies detected in the imagery. Data integration of historical investigation work, and follow-up confirmation drilling is necessary to effectively "convert" or calibrate the Aestus electrical signatures back to the subsurface features of interest, such as physical (geology signatures), chemical (contamination presence/absence and relative concentration), and biological signatures (indicating potential presence/absence of bioactivity). The cumulative and multiple sources of data are integrated for calibration and interpretation purposes, which typically includes but is not limited to boring logs, site stratigraphy, analytical sample data, and fluid level measurements.

Investigation Findings

The Aestus GeoTrax ERI Survey™ identified several areas of interest at the Site apart from the known zones of impacts proximate to the former dry cleaners at the southwest corner of the Property illustrated on Figure 8. Specifically, these 3 areas exhibited anomalous electrically resistive or conductive properties which could be consistent with the presence of subsurface isolated contamination zones or preferential flow paths containing contaminant impacts and/or ongoing naturally occurring bioactivity.

Primary areas of interest from the Aestus survey included the following:

Area 1 – Potential Deeper Flow Path Proximate to Former Dry Cleaner at SW Corner of Site

The GeoTrax Survey™ imagery indicate an electrically anomalous, and possibly layered zone proximate to the know impacted monitoring wells in the Site's primary source area which may be consistent with a preferential flow path affecting the horizontal and vertical migration of the impacts.

Area 2 – Former Dry Cleaner Building at Northwest Corner of Site

The GeoTrax Survey™ imagery identified a high value resistor/conductor pair in the area of the northern former dry cleaner at 4234 Rainier Avenue South (Figure 2). Previous investigations in this area have not identified CVOCs at elevated concentrations; however the survey results indicated a potential secondary contaminant source in the location that needed investigation.

The general area slightly north of the former cleaner showed the highest electrical resistivity values detected by Aestus' GeoTrax Survey™ imaging, however, high electrical resistivity values can also be caused by dry or coarse grain soils and/or fill materials.

Area 3 – Potential Subsurface Channel Feature Oriented North-South

The GeoTrax Survey™ imagery identified what appears to be a channel-like subsurface feature of anomalously low resistivity (high electrical conductivity) oriented north to south within the central portion of the Property as shown on Figure 8. This anomalous zone extended vertically to approximately 25 feet bgs, and could be indicative of a geologic feature as a preferential flow path containing the presence of impacts with ongoing bio-degradation activity.

2.5.7 Urban Environmental Partners – GeoTrax Survey™ Confirmation Drilling, 2020

In March of 2020, UEP conducted a subsurface investigation to evaluate the 3 areas of concern identified during Aestus' GeoTrax Survey™. The investigation consisted of the advancement of 8 borings (UB12 through UB19) in locations shown on Figure 3 using HSA or direct push drilling methods. Soil samples were collected from depths between 4 and 46 feet bgs. The sampling depths at each location which were specifically targeted based on the Geotrax Survey™ results.

Seven of the borings were completed as 2-inch diameter groundwater monitoring wells. Wells UB12/MW12 through UB18/MW18 were sampled in accordance with ASTM low flow methodology. Reconnaissance groundwater was also sampled from boring UB19 in accordance EPA 2005 publication Groundwater Sampling and Monitoring with Direct Push Technologies. Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples were analyzed for: VOCs by EPA Method 8260D; GRPH by Northwest Method NWTPH-Gx; and/or DRPH and ORPH by Northwest Method NWTPH-Dx.

<u>Investigation Findings – Soil</u>

- The soil samples collected from UB13 at depths between 9 and 43 feet bgs contained concentrations of PCE, TCE, and/or VC in excess of their respective MTCA Method A Cleanup Levels. The sample collected from 23 feet bgs also reported a concentration of GRPH, however

- this result was flagged by the laboratory, indicating that the value consists of a chlorinated compound with elevated concentrations.
- A soil sample collected from UB15 at a depth of 6 feet contained a concentration of PCE in excess of its MTCA Method A Cleanup Level.
- The soil samples collected from the remaining borings contained CVOC concentrations below their laboratory detection limits and/or MTCA Method A Cleanup Levels.

Investigation Findings – Groundwater

- The groundwater samples collected from monitoring wells MW12, MW13, MW16, MW17, and MW18 contained concentrations of one or more CVOC in excess of their respective MTCA Method A Cleanup Levels.
- The groundwater samples collected from the remaining borings/monitoring wells contained CVOC concentrations below their laboratory detection limits and/or MTCA Method A Cleanup Levels.
- The groundwater samples collected from monitoring wells MW12, MW13, MW16, and MW18 contained detectable concentrations of GRPH, however these results were flagged by the laboratory, indicating that the values consist of chlorinated compound(s) with elevated concentrations.

The lab data findings of the confirmation drilling from the GeoTrax Survey™ targets indicate the following with respect to the 3 areas of concern:

Area 1

The CVOC concentrations detected in groundwater from monitoring wells MW12, MW13, MW16 and MW18 indicate a preferential pathway as a saturated sand unit not previously identified on the Property, which explains the southeasterly distribution of the dissolved phase contaminants. This Site feature is discussed further in Section 3.4.

Area 2

The PCE concentration detected in soil at boring UB15 may explain the GeoTrax Survey™ results in this area, however the impact does not appear to be extensive based on deeper soil test results and lack of groundwater impacts.

Area 3

The CVOC concentrations detected in groundwater from monitoring wells MW16, MW17, and MW18 indicated a groundwater flow channel not previously identified on the Property, supporting the north/south distribution of contaminants. This Site feature is discussed further in Section 3.4.

2.5.8 Urban Environmental Partners – Plume Boundary Investigation, 2020

In March and April of 2020, UEP conducted a subsurface investigation to evaluate the southern and eastern extent of groundwater impacts and southern extent of soil impacts. The investigation consisted of the advancement of 5 borings (UB20 through UB24) using HSA or direct push drilling methods to the south and east of the known plume extents. Soil samples were collected from depths between 25 and 35 feet bgs.

All five borings were completed as 1- or 2-inch diameter groundwater monitoring wells. Monitoring wells UB20/MW20 through UB24/MW24 were sampled in accordance with ASTM low flow methodology. Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples were analyzed for CVOCs by EPA Method 8260C.

Investigation Findings – Soil

- The saturated soil samples collected from UB20 at depths between 30 and 35 feet bgs contained concentrations of PCE, and/or TCE slightly exceeding their respective MTCA Method A Cleanup Levels.
- The soil samples collected from the remaining borings (UB21, UB22, and UB23) did not contain detectable concentrations of CVOCs.

Investigation Findings – Groundwater

- The groundwater sample collected from MW20, on the day after installation, contained concentrations of TCE and cis-1,2-DCE, also slightly in excess of their respective MCTA Method A Cleanup Levels. This well was resampled after proper well development and equilibration period on April 10th, 2020, which then contained no detectable concentrations of CVOCs.
- The groundwater samples collected from monitoring wells MW21 through MW24 contained no detectable concentrations of CVOCs.

The results from this investigation defined the contaminant plume boundary to the south and east of the Property as shown on Figure 5. Results from these wells identified and targeted a saturated sand layer beginning around 20-27 feet bgs on the Property, which is believed to be the primary preferential flow path for contaminants on the south end of the Property. This geologic feature is discussed further in Section 3.4.

2.5.9 Urban Environmental Partners – Groundwater Sampling Event, March and April 2020

In March and April of 2020, UEP resampled existing monitoring wells (MW01 through MW11) to assess current groundwater conditions across the Site. Many of these wells had not been sampled for several years since their initial installation. Samples were collected in accordance with ASTM low flow methodology and were analyzed for CVOCs by EPA Method 8260C

Investigation Findings

- The groundwater samples collected from MW01, MW05, MW08 in the source area, and from downgradient MW09 contained high concentrations of CVOCs in excess of their respective MTCA Method A Cleanup Levels. These results were consistent with previous sampling event(s), and indicate the primary source area of the release.
- The groundwater sample collected from MW02 contained concentrations of CVOCs below their respective laboratory reporting limits and/or MTCA Method A Cleanup Levels. The sample previously collected from MW02 contained a concentration of VC slightly above the MTCA Method A Cleanup Level.
- The groundwater samples collected from MW03, MW04, MW07, and MW11 did not contain detectable concentrations of CVOCs. These results were consistent with previous sampling event(s), and appear to bound the edges of the dissolved phase plume.
- The UEP 2020 groundwater sample collected from MW06 contained concentrations of PCE, TCE, and VC in excess of their respective MCTA Method A Cleanup Level. This well previously (2010) did not contain detectable concentrations of CVOCs.
- The latest (2020) groundwater sample collected from MW10 did not contain detectable concentrations of CVOCs. These results represented a significant reduction in contaminant concentration from the initial 2019 sampling event after well installation. To verify these results, two additional samples were collected, one with the tubing placed at the center of the well screen, and the second with the tubing placed at the bottom of the well screen. Neither sample contained detectable concentrations of CVOCs, verifying the sample results that show MW10 is not contaminated above laboratory detection limits.

2.5.10 Urban Environmental Partners – Additional Subsurface Investigation, April 2020

In April of 2020, UEP conducted an additional subsurface investigation to further evaluate the contaminant distribution and confirm the geology and primary preferential flow path on the Property. The investigation work consisted of the advancement of 2 borings (UB25 and UB26) using sonic drilling technology, which allowed for a detailed and continuous review of soil lithology to the maximum depth explored of 50 feet bgs. UB25 was positioned near the primary source area, while UB26 was positioned to the south and east of the source area, just inside the Property boundary. Continuous soil cores were observed from each boring, and select soil samples were collected from depths between 27 and 45 feet bgs.

Both borings were completed as 2-inch diameter groundwater monitoring. Wells UB25/MW25 and UB26/MW26 were sampled in accordance with ASTM low flow methodology. Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples were analyzed for CVOCs by EPA Method 8260C.

<u>Investigation Findings – Soil</u>

- Fill material was encountered in UB25 to a depth of approximately 14 feet bgs. The soil identified below the fill consisted primarily of a dense Recessional Lacustrine clay to approximately 27 feet bgs, underlain by discontinuous silty sand and sand layers to a depth of approximately 35 feet bgs. Dense glacially consolidated silt and clay was encountered between approximately 35 feet and the maximum depth explored of 50 feet bgs.
- Fill material was also encountered in UB26 to a depth of approximately 16 feet bgs. The soil identified below the fill consisted primarily of a dense Recessional Lacustrine clay to approximately 25 feet bgs, underlain by a continuous Recessional Outwash sand layer to a depth of approximately 40 feet bgs. Dense glacially consolidated silt and clay was encountered between approximately 40 feet and the maximum depth explored of 50 feet bgs.
- Soil samples collected from both borings within the saturated sand layer at depths of 30 and 35 feet bgs contained concentrations of PCE and TCE above their respective MTCA Method A Cleanup Levels.
- Soil samples collected from both borings within the dense glacially consolidated clay at or below 40 feet bgs did not contain detectable concentrations of CVOCs.

These results in consolidation with observations from other borings indicate the presence of discontinuous lenses of sand in the vicinity of the primary source area, transitioning to a more continuous sand layer to the south and east of the source area. The geologic representation of the Site stratigraphy is shown as a cross-section on Figure 10.

Based on the cumulative soil sample data set, the Site contaminants are shown not to have penetrated the dense glacially consolidated silty clay present ubiquitously at the Property at and below approximately 40 feet bgs.

<u>Investigation Findings – Groundwater</u>

- The groundwater samples collected from MW25 and MW26 contained concentrations of PCE, TCE, cis-1,2-DCE, and VC above their respective MTCA Method A Cleanup Levels.

2.5.11 Urban Environmental Partners – Northern Dry Cleaner Investigation, 2020

In April of 2020, UEP conducted a targeted subsurface investigation to evaluate the extent of soil impacts in the vicinity of UB15, where a concentration of PCE was previously detected in soil at 6 feet bgs. The investigation consisted of the advancement of 3 borings (UB27 through UB29) using direct push drilling methods. The borings were advanced approximately 12-15 feet to the northeast, southeast, and northwest from UB15. Soil samples were collected between 6 and 17 feet bgs.

Select soil samples were analyzed for CVOCs by EPA Method 8260C.

Groundwater was not sampled during this investigation, as the samples previously collected from both monitoring wells MW14 and MW15 contained no detectable concentrations of CVOCs.

<u>Investigation Findings</u>

- None of the soil samples from UB27 through UB29 contained detectable concentrations of CVOCs.

These findings confirm that the soil impacts detected in UB15 are isolated and do not represent a significant source of contaminants at the Site.

2.5.12 Urban Environmental Partners – Soil Gas and Sewer Gas Sampling, April 2020

In April of 2020, UEP conducted a soil gas and sewer gas investigation to evaluate the potential for vapor intrusion into future on-Property structures and adjacent structures through contaminant migration within sewer conduits. The investigation consisted of the advancement of 2 soil gas probes (SG04 and SG05) using direct push drilling methods adjacent or near sewer laterals within the northwest portion of the parking area, and the collection of two sewer gas samples (sewer north and sewer south) collected from manhole access ports up-stream and down-stream of the CVOC source area (Figure 7).

The soil gas probes were advanced to approximately 18-inches bgs. Rigid inert tubing was cut to length and inserted to the bottom of the borings. Sand was then poured into the holes around the tubing and hydrated granular bentonite chips were used to seal the top of the holes from the atmosphere. The existing air within the tubing was then purged prior to sample collection to avoid any external cross contamination.

The sewer gas samples were prepped for collection by lowering a section of rigid inert tubing to the approximate depth of the sewer main (~10 feet bgs).

The samples were collected utilizing 1-liter Summa canisters fitted with flow regulators calibrated to a rate of between 150 to 200-milliliters per minute (ml/min).

The gas samples were analyzed for target list VOCs by EPA Method TO-15.

Investigation Findings – Soil Gas

- Neither soil gas sample contained detectable concentrations of CVOCs.

Investigation Findings – Sewer Gas

- The sewer gas sample collected from up-stream of the source area, contained concentrations of TCE and VC above their respective MTCA Method B Screening Levels for Sub-slab Soil Gas.
- The sewer gas sample collected down-stream of the source area did not contain detectable concentrations of CVOCs.

These findings indicate that vapor intrusion is not an issue for current or future on-Property structures on the northern portion of the Property, or up-stream structures due to no evidence of contaminant migration within the sewer conduit adjacent to the Site.

These results also suggest that dry cleaner originated contaminants have been introduced into the sewer from source(s) up-stream (south) of the Property.

Soil gas and sewer gas results are tabulated on Table 8.

2.5.13 Urban Environmental Partners – Creosote Treated Pile Assessment, 2020

On April 27, 2020, UEP oversaw the excavation of a test pit/trench, on the north side of the current vacant retail structure in order to expose and evaluate whether treated wooden piles were used and still present. The trench was advanced using a track mounted mini-excavator and was approximately 3 feet wide by 15 feet long (Figure 9). The positioning of the trench was determined using historical building plans which identified the likely placement of the treated wooden piles used for the building's foundation.

The trenching successfully exposed the piles. Upon exposure of the piles, it was visually evident that they had been treated with creosote due to the dark staining of the surrounding soil which appeared to be a sand fill with discoloration next to the piles.

UEP collected soil samples at sequential intervals away from a pile to evaluate the migration distance of potential soil impacts (3-inches, 6-inches, 12-inches, and the middle between two piles [approximately 6 feet]).

On June 3, 2020, UEP oversaw the advancement of two soil borings (UB32 and UB33) in locations south and downgradient from the former retail structure using direct push drilling technology. Soil samples were collected from depths between 2 and 18 feet bgs.

Both borings were completed as 1-inch diameter monitoring wells (UB32/MW32 and UB33/MW33) which were sampled on June 8, 2020 in accordance with ASTM low flow methodology. The wells were installed to evaluate the potential for PAH leachability and mobility in groundwater at the Site. Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples from both locations were analyzed for PAHs by EPA Method 8270E SIM, and the laboratory results were evaluated using Toxicity Equivalency Methodology detailed in WAC 173-340-708(e).

Investigation Findings – Soil

- The soil sample collected from 3-inches away from a pile contained concentrations of PAHs in excess of the MTCA Method A Cleanup Level.
- The soil samples collected from 6-inches away, and from 1-foot away from a pile contained detectable concentrations of PAHs, however the calculated toxicity equivalency concentrations were below the MTCA Method A Cleanup Level.
- The soil sample collected at the approximate central location between two piles did not contain detectable concentrations of PAHs.
- The soil samples collected from UB32 and UB33 between 2 and 18 feet bgs did not contain detectable concentrations of PAHs.

Investigation Findings – Groundwater

- The groundwater samples collected from MW32 and MW33 did not contain detectable concentrations of PAHs (Table 9).

The results of this investigation indicate that the wood pilings were treated with creosote and that PAHs exceed the MTCA Method A soil Cleanup Level in the immediate vicinity of the wood piles. However, the migration of PAHs from the creosote treated wood piles is limited to soil within 3 to 6 inches from each of the piles, and results show that the presence of the treated piles is not a threat to groundwater quality.

2.5.14 Urban Environmental Partners – Subsurface Investigation, 2020

In May of 2020, UEP conducted a focused subsurface investigation to validate data previously collected at the Site. Specifically, UEP suspected that the lab results for previous soil samples collected from borings UB12 and UB13 at depths of 37 and 43 feet bgs, respectively, were anomalous data. These 2 samples were collected from within the consolidated glacial till layer beneath the Site, which has been shown in other Site areas to retard the transmission of contaminants. These 2 deeper soil samples (UB12-37 and UB13-43) were analyzed by a mobile laboratory, and the reported concentrations were suspected to result from gas chromatograph “column bleed” from previous high PCE concentrations from “hot” samples analyzed ahead of these 2 borings. Also, it was considered possible that the anomalous results may have been due to contaminant drag down from the hollow stem auger drilling methodology.

The focused investigation consisted of the advancement of 2 borings (UB30 and UB31) using sonic drilling technology, which allowed for a detailed and continuous review of lithology to the maximum depth explored. UB30 was positioned in a downgradient position close to the source area, while UB31 was positioned directly between UB12 and UB13, where the suspected samples from glacial till with anomalous data were collected. Soil samples from UB30 and UB31 were collected in these sonic borings from depths between 12 and 43 feet bgs, targeting each specific geologic feature that was encountered.

Both borings were completed as 2-inch diameter groundwater monitoring wells, and the wells UB30/MW30 through UB31/MW31 were sampled in accordance with ASTM low flow methodology. Monitoring well construction details are summarized on Table 7.

Select soil and groundwater samples were analyzed for CVOCs by EPA Method 8260C.

Investigation Findings – Soil

- Fill was encountered in UB30 to a depth of approximately 17 feet bgs. The soil identified below the fill consisted primarily of a dense Recessional Lacustrine clay with intermixed fine sand to approximately 30 feet bgs, underlain by a medium to coarse Recessional Outwash sand to a depth of approximately 36 feet bgs. Dense glacially consolidated silt and clay was encountered between approximately 36 feet and the maximum depth explored of 40 feet bgs, with results as follows:

  - Soil samples from UB30 collected from within the Recessional Lacustrine clay did not contain detectable concentrations of CVOCs.
  - Soil samples collected from within the medium coarse Recessional Outwash sand between 30 and 35 feet contained concentrations of PCE and/or TCE above their respective MTCA Method A Cleanup Levels.
  - Numerous soil samples collected from within the glacially consolidated silt and clay below 35 feet contained concentrations of CVOCs below their laboratory reporting limit and/or MTCA Method A Cleanup Level.
- Fill was encountered in UB31 to a depth of approximately 12 feet bgs. The soil identified below the fill consisted primarily of a dense Recessional Lacustrine clay to approximately 24 feet bgs, underlain by discontinuous layers of sand and sandy silt to a depth of approximately 30 feet bgs. Dense glacially consolidated silt and clay was encountered between approximately 30 feet and the maximum depth explored of 45 feet bgs with results as follows:
  - Soil samples collected from UB31 within the discontinuous layers of sand and sandy silt between 24 and 28 feet contained concentrations of PCE and TCE above their respective MTCA Method A Cleanup Levels.
  - Soil samples collected from within the glacially consolidated silt and clay below 30 feet did not contain detectable concentrations of CVOCs.

These results for the soil analysis in the targeted lithologies support the conclusion that the mobile laboratory data for samples collected from UB12 and UB13, within the glacially consolidated silt and clay, were anomalous and likely the result of laboratory error.

The data results from sonic borings UB30 and UB31 for the soil in various depths at these locations are also consistent with the previous understanding of Site geology and contaminant migration pathways, discussed in Section 3.4.

Investigation Findings – Groundwater

- The groundwater samples collected from MW30 and MW31 contained concentrations of PCE, TCE, cis-1,2-DCE, and VC in excess of their respective MTCA Method A Cleanup Levels.

2.5.15 Urban Environmental Partners – ORPH Investigation, 2020

On June 3, 2020, UEP oversaw the advancement of two borings (UB34 and UB35) using direct push drilling technology at locations near and downgradient from boring TB05, where ORPH was previously detected at concentrations exceeding the MTCA Method A Cleanup Level. The purpose of these borings was to confirm that the ORPH detection was due to variable fill material (possible asphalt) and was not the result of a point source release. Soil samples were collected between approximately 3 feet and 14 feet bgs.

Groundwater was encountered in both borings at approximately 5 feet bgs was sampled in accordance with the EPA 2005 publication Groundwater Sampling and Monitoring with Direct Push Technologies.

Soil and groundwater samples were analyzed for DRPH and ORPH by Northwest Method NWTPH-Dx.

Investigation Findings - Soil

- None of the soil samples from around boring TB05 contained concentrations of DRPH or ORPH.

Investigation Findings – Groundwater

- The groundwater sample collected from boring UB34 contained a concentration of DRPH well below the MTCA Method A Cleanup Level, however this result was flagged by the laboratory for not resembling the fuel standard used for quantitation. It is possible this result is due to organic interference.
- The groundwater sample collected from UB35 did not contain detectable concentrations of DRPH or ORPH.

The results of this investigation confirm that the ORPH detection in TB05 was the result of variable fill material, likely inclusive of asphalt debris. Based on these findings, this area does not appear to warrant further investigation or remedial action.

2.6 Subsurface Conditions

Subsurface conditions have been observed in the numerous drilled explorations performed at the Site, and by observing groundwater levels in monitoring wells that were installed in number of the drilled borings discussed above. This data and information provide the basis for understanding the movement of the contamination at the Site. Additionally, the Seattle Geologic Map (Troost, K.G., Booth, D.B., Wisher, A.P., and Shimel, S.A., 2005) was referenced and provides a basis for understanding the off-Site movement of groundwater.

It should be noted that, historically, a glacial stream has run through the Site, as indicated on the 1908 topographic map of Seattle (U.S. Geological Survery, 1955). The stream ran from north to south/southeast, eventually turning to the east near the existing Rainier Playfield and discharging to Wetmore Slough. The Wetmore Slough at the time extended southward in what is now Genesee Park and Playfields, before being filled.

2.6.1 Soil Conditions

The Seattle Geologic Map indicates the Site is underlain by fill over Recessional Lacustrine soil. Based on the Site explorations, the fill consists of a highly variable mixture of gravel, sand, clay, and silt; and wood and concrete debris have been observed in places. The thickness of the fill ranges from approximately 8 to 17 feet bgs.

Underlying the fill in some explorations, an organic-rich silty sand to sandy silt was observed, generally less than 1-foot thick. This soil is likely a recent wetland deposit associated with the former stream.

The fill and wetland deposit are underlain by Recessional Lacustrine soil. The Recessional Lacustrine soil consists of mostly a silty clay although in some areas silt is the predominate soil type. In several explorations the clay was relatively plastic. Reddish brown mottling was observed in the upper portions of the deposit, likely as a result of iron oxide staining, which indicates the movement of water through the soil. The Recessional Lacustrine deposit ranges in thickness from approximately 10 to 20 feet.

In the central portion of the PCE impacted area, a sand layer with varying amounts of silt and occasional gravel is present below the Recessional Lacustrine deposit, and likely represents Recessional Outwash. The Recessional Outwash forms a channel-like structure running from northwest to southeast as shown on Figure 10. Also shown on Figure 10, the sand channel thickens from just a couple of feet in the northwest to approximately 15 feet to the southeast, with a decrease in the silt content to the southwest area of the Site.

Underlying the Recessional deposits are glacially consolidated soils. Based on the Seattle Geologic Map and our experience in the Seattle area, these soils are likely Pre-Vashon in age. In general, these soils consist of clay and silt, with some of the silt deposits exhibiting a till-like texture. These deposits are hard to very hard.

Although it was not observed on the Site, the Seattle Geologic Map shows a bedrock outcropping approximately 2 blocks south of the Site roughly parallel to South Alaska Street.

2.6.2 Groundwater Conditions

The depth to groundwater was measured in each of the Site monitoring wells and, in general, the depth to groundwater is approximately 6 to 15 feet bgs. The depth to water measurements were converted to elevations based on the recent survey of the wells. Groundwater elevations range from approximately 32 to 37 feet AMSL across the Site.

The groundwater elevations were contoured to identify groundwater flow patterns as shown on Figure 11. The groundwater contours indicate that groundwater flows toward the primary area of soil contamination at the Site, then flows to the southeast toward monitoring well MW20. This flow pattern is a function of the sand channel observed at the Site, which provides a lower resistance to flow than the clay and silt, and serves as a preferential pathway for groundwater flow.

Based on our understanding of the local hydrology and geology, groundwater in the area then likely flows to the east following the former stream channel, eventually discharging to Lake Washington in the area of Wetmore Slough. Exposed bedrock south of Genesee Park limits groundwater flow to the south. Although the contours shown on Figure 11 are closed in the area of monitoring well MW20, this is a function of the contouring and spacing of data points.

The hydraulic gradient across the site ranges from approximately 0.1 feet per foot between monitoring wells MW05 and MW12 to 0.005 feet per foot between monitoring wells MW10 and MW20. These gradients are consistent with the soil conditions at the site, with higher resistance to flow within the silt and clay resulting in higher gradients, and lower hydraulic gradients within the sand channel.

2.6.3 Hydraulic Conductivity

Slug tests were performed in monitoring wells MW09, MW16, MW18, MW25, and MW26 on April 30 and May 1, 2020. The results of the slug testing can be used to provide a basis for estimating the hydraulic conductivity of the soil to support remedial evaluation. Additionally, the slug testing provided a method for understanding the presence of the sand layer in several wells where the sampling interval during drilling may have missed the sand.

A slug test involves displacement of water within the well and is accomplished by dropping a sealed, sand-filled PVC pipe in to the well. Introduction of the pipe causes water to rise in the well via displacement, and then fall back down to the static (original) water level; this is called the “falling head” portion of the test. Once the water level has recovered to the static level, the PVC pipe is removed, causing the water level to drop in the well and again rise to the static level; this is called the “rising head” portion of the test. Prior to each test, the static water level was checked using a water level tape. Recovery of water level back to static was measured using a pressure transducer/datalogger system set to collect water level on a 1-second interval. Following testing, the data was downloaded to a spreadsheet for evaluation. Graphs 2 through 6 show the test data for each of the wells. Depending on the rate of recovery, one to three series of tests were performed in each well.

The slug test data was analyzed using the Bouwer and Rice method (Bouwer, H., and Rice, R.C., 1976) and Bouwer (Bouwer 1989). Although the Bouwer and Rice method was developed for use when testing unconfined aquifers, the method can be used for confined aquifers as indicated in Bouwer (Bouwer 1989) and has been used successfully for numerous slug tests performed in the Seattle area.

Monitoring wells that were known to be screened within the Recessional Outwash unit (MW09, MW25, and MW26) produced mean hydraulic conductivity values ranging from 0.0008 to 0.0018. While those that appear to be screened within the Recessional Lacustrine unit (MW16 and MW18) produced slow recovery and low mean hydraulic conductivity values between 0.00019 and 0.000024, which indicate that the sand layer is likely not present in this area, or is relatively thin at these locations. This data is consistent with the relatively low levels of contamination in groundwater when compared to other wells on Site.

3.0 Conceptual Site Model

This section presents a conceptual understanding of the Site and identifies potential or suspected sources of hazardous substances, types and concentrations of hazardous substances, potentially contaminated media, potential exposure pathways and receptors, and contaminant fate and transport.

3.1 Confirmed and Suspected Source Area

The results of the RI indicate that the CVOC impacts confirmed in soil and groundwater beneath the Site are the result of dry cleaning operations between approximately 1930 and 1968 from facilities that existed on the southwest corner of the Property. A minor release may have also occurred near the northern dry cleaning operation, but this area has been shown to have minimal impacts in shallow soil, and does not appear to represent a significant source at the Site.

No ongoing chlorinated solvent releases from the former dry cleaner(s) are now occurring at the Site; however, the contaminated soil continues to act as a secondary source to soil vapor and groundwater.

A second impacted area of the Site has been identified in association with treated wood piles that presently support the former Safeway building on the north half of the Property. As shown on Figure 9, the presence of PAH compounds above cleanup levels was confirmed in soil close to each pile. The groundwater tests from monitoring wells (MW32 and MW33) downgradient from the building provide empirical evidence that groundwater is not impacted.

3.2 Contaminants of Concern

Based on the results of the RI, the primary Contaminants of Concern (COCs) for the Site include PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, and VC.

Secondary COCs identified at the Site, that are unrelated to the CVOC releasee, include PAHs in soil directly adjacent the creosote treated piles beneath the existing structure.

3.3 Media of Concern

Based on the results of the RI, soil and groundwater are the confirmed media of concern for the Site.

Indoor air will be retained as a media of concern for future on-Site structures based on CVOC concentrations detected in shallow groundwater that exceed the MTCA Method B Groundwater Screening Level for indoor air risks associated with potential vapor intrusion; however, as discussed in Section 2.5, soil gas/vapor sampling results have not indicated an elevated risk for vapor intrusion for current on-Property structures.

3.4 Contaminant Fate and Transport

3.4.1 Chlorinated Solvents

The understanding of the CVOC transport at the Site is based on soil and groundwater conditions observed as part of the exploration program and the distribution of contamination in the subsurface. Contamination appears to have moved through the fill material to the top of the native soil, which generally consists of silt and clay, then contamination has generally migrated from west to east on top of this confining layer.

Over time, the chlorinated solvents have migrated downward through the upper native silt and clay into variable lenses of sand. These sand layers have been shown to be less continuous within the source area, and then are more continuous to the south and east. In a number of explorations, the sand lens is observed at a depth ranging from approximately 20 to 35 bgs as shown on Figure 10. This sand channel provides a pathway for contaminants in groundwater to migrate horizontally downward, and downgradient to the southeast from the major area of soil contamination.

The sand channel is underlain by dense, hard glacially-consolidated till and fine-grained soil. These soils have a low hydraulic conductivity and serve to reduce the downward migration of contamination. In our opinion, the glacially consolidated soils served as the downward limit of Site contamination.

The downgradient extent of groundwater contamination is generally the south edge of the Property at the South Genesee Street boundary based on the most recent groundwater sampling events (monitoring wells MW10, MW11, and MW20).

The general absence of off-Site contamination (with the exception of very low levels within and across South Genesee Street) is likely due to anaerobic degradation that is occurring at the plume edge. Once PCE enters the subsurface, chemical processes such as hydrolysis, direct mineralization, and/or reductive dehalogenation by bacteria may facilitate a natural reduction or breakdown of the PCE into non-hazardous components. Biological attenuation processes such as reductive dechlorination and cometabolic degradation may also affect the reduction of PCE under conducive subsurface conditions. As reductive biodegradation of PCE occurs, we find the PCE degradation compounds that include TCE, cis-1,2-DCE, trans-1,2-DCE, and VC. Degradation products are found in groundwater at all source area and downgradient wells. In addition, the dissolved oxygen levels for source area and downgradient wells are very low, ranging from 0.30 mg/L (MW31) to about 0.9 mg/L (MW09, MW26, and MW10) indicating that strong biological activity is degrading the CVOCs.

In most of the monitoring wells where PCE has been detected in groundwater, these degradation products that are present include TCE, cis-1,2-DCE, and VC, demonstrating the biological degradation and possibly chemical attenuation processes are occurring at the Site.

3.4.2 Evaluation of Empirical Data for PAHs Associated with Treated Wood Piles

Under Washington Administrative Code (WAC) 173-340-747(9), Ecology allows for empirical demonstrations to show that minor cleanup level exceedances in soil have not, and will not, cause an exceedance of applicable groundwater cleanup levels and that no exposure scenarios are represented by the environmental conditions on the Property. WAC 173-340-747(9) states the following:

(b) **Requirements**. To demonstrate empirically that measured soil concentrations will not cause an exceedance of the applicable ground water cleanup levels established under WAC 173-340-720, the following shall be demonstrated:

(i) The measured ground water concentration is less than or equal to the applicable ground water cleanup level established under WAC 1733-340-720; and

(ii) The measured soil concentration will not cause an exceedance of the applicable ground water cleanup level established under WAC 173-340-720 at any time in the future. Specifically, it must be demonstrated that a sufficient amount of time has elapsed for migration of hazardous substances from soil into ground water to occur and that the characteristics of the site (e.g., depth to ground water and infiltration) are representative of future site conditions. This demonstration may also include a measurement or calculation of the attenuating capacity of soil between the source of the hazardous substance and the ground water table using site-specific data.

(c) **Evaluation criteria**. Empirical demonstrations shall be based on methods approved by the department. Those methods shall comply with WAC-173-340-702(14), (15), and (16).

As presented in Section 2.5.13 and on Figure 9, the PAH impacts in soil associated with the treated piles are present within a limited 3-inch to 6-inch radius around each timber pile, however the Site meets the empirical demonstration requirements stated in WAC 173-340-747(9) and that the PAH-impacted soil that is present adjacent to the piles has not and will not cause exceedances of the applicable groundwater cleanup levels. This scenario is shown based on the following conditions:

- Soil samples and groundwater samples collected from UB32/MW32 and UB33/MW33 installed in the downgradient direction from the treated pile assemblage, have not exhibited detectable concentrations of PAHs. These compliant soil and groundwater results for properly placed monitoring wells indicate that soil impacts associated with the creosote-treated timber piles beneath the existing building have not leached and have not caused exceedances of applicable groundwater cleanup levels.

- Since the 1968 construction of the retail structure, the Property has remained developed with the existing building and treated wood pile foundation. Property conditions have been consistent since that time, therefore the creosote-treated wood timber piles have been in place for over 52 years. This is a sufficient amount of time for the PAHs present in soil to leach into groundwater, however the data collected from monitoring wells MW32 and MW33 indicate that leaching has not occurred at the Site. Groundwater data from the sampling indicates that migration of potential contaminants associated with the treated piles from soil to groundwater has not occurred and is not likely to occur in the future.

Based on these results, the soil to groundwater pathway is incomplete and human exposure scenarios can be managed through targeted remediation efforts and engineering controls.

3.5 Distribution of Contamination in Soil

For purposes of this report, CVOC concentrations in soil can be assigned to two areas: a) the primary source area, which contains concentrations ranging from 0.049 mg/kg to 510 mg/kg and may support some, but limited areas of residual product; and b) the leading plume edge that contains detectable PCE concentrations in saturated soil ranging from 0.027 mg/kg to 2.2 mg/kg which is likely more representative of the dissolved phase plume in groundwater. This soil area is not considered a continued source to groundwater impacts.

The lateral extent of CVOC soil contamination within the source area is limited to the southwestern portion of the Property, within the parcel boundaries (Figure 4). The northern limit is defined by the absence of impacts in borings B-6, B-8, B07, B08, and UB17; the eastern limit is defined by the absence of impacts in borings B09, UB18, and UB19; the southern limit is defined by the absence of impacts in borings SB05, TB07, B-2, and B13; and the western limit is defined by the absence of impacts in the angle borings B12 and B16 at locations beneath the western adjacent ROW.

The lateral extent of CVOC soil contamination within the leading plume edge is limited to the southcentral portion of the Property, the southern adjacent ROW, and the northern portion of the south adjacent property. These impacts are bounded laterally by the lack of soil contamination within the saturated Recessional Outwash sand in borings UB21 through UB23 (Figure 4).

The vertical extent of CVOC soil contamination within the source area ranges from approximately 10 feet bgs to approximately 35 feet bgs, while the vertical extent of soil contamination within the leading plume edge ranges from approximately 25 to 35 feet bgs within the saturated Recessional Outwash sand. The vertical extent in both zones are limited by the presence of glacially consolidated silt and clay consistently encountered around 35 to 40 feet bgs (Figures 12 through 15).

The lateral extent of PAH soil contamination associated with the creosote treated pile assemblage is limited to approximately 3 to 6-inhces from the surface of each pile, with the vertical extent limited to the depth of the piles.

3.6 Distribution of Contamination in Groundwater

The lateral extent of groundwater contamination at the Site is limited to the southwestern portion of the Property, extending south beneath the adjacent ROW to the northern portion of the south adjacent property.

The northern plume boundary is defined by the absence of impacts in monitoring well MW03; the eastern leading plume edge is represented by the slight concentrations detected in MW02; the southeastern plume boundary is defined by the absence of impacts in monitoring well MW24, and the southern plume boundary is defined by the absence of impacts in monitoring wells MW21 through MW23 (Figure 5). The most recent groundwater sampling events have not detected CVOC concentrations in monitoring wells MW10 or MW20, indicating the groundwater plume may not extend far beyond the southern Property boundary, however this Site area will be considered impacted until four consecutive quarters of compliant groundwater data can be obtained.

The western plume boundary had previously been defined by the absence of CVOC contamination in the groundwater collected from MW06 and MW07. However, CVOC concentrations were recently detected in MW06 during the March 12, 2020 sampling event; the groundwater collected from MW07 contained non-detectable concentrations of CVOCs, consistent with previous sampling results. Access limitations due to utilities within the ROW of Rainier Avenue South prohibit the collection of more meaningful data (Figure 5) further to the west of MW06. Based on our understanding of the CSM, the contaminant transport mechanisms at the Site (fill depth, gradient and groundwater flow direction) do not support a westerly migration and distribution of contaminants, therefore MW06 is proposed as the western point of compliance. The minor PCE concentrations recently shown in groundwater in this area will be treated by the selected remedial approach for the Site.

3.7 Exposure Pathways

This section discusses the confirmed and potential human health and ecological exposure pathways at the Site.

3.7.1 Soil Pathway

Potential exposure pathways for soil contamination include volatilization into soil vapor and subsequent exposure through the vapor pathway discussed below, or via the direct contact pathway, which comprises direct contact via dermal contact with and/or ingestion of soil beneath the Site.

Contamination at the Site is currently capped with asphalt or concrete, however, until such time that the soil contamination is removed, remediated, or institutional controls are in place to prevent direct contact, this pathway will be considered complete.

3.7.2 Groundwater Pathway

Potential exposure pathways for groundwater contamination include volatilization into soil vapor and subsequent exposure through the vapor pathway discussed below, or via the direct contact pathway, which comprises both the dermal contact and ingestion pathways.

Dermal contact scenarios could include construction workers encountering shallow seated groundwater during remediation or utility work, therefore this exposure pathway will remain complete until contamination is remediated or institutional controls are in place to prevent direct contact.

Based on the groundwater use assessment discussed in Section 2.4.2, the risk of ingestion of contaminated groundwater at the Site is low, however it could be argued that this aquifer represents a potential future source of drinking water and cannot be deemed non-potable based on current conditions. Therefore, this exposure pathway will remain complete until contamination is remediated or institutional controls are in place to prevent potable groundwater classification and use.

3.7.3 Vapor Pathway

The air-filled pore space between soil grains in the unsaturated zone is referred to as soil gas or soil vapor. Soil vapor can become contaminated from the volatilization of contaminants adsorbed to soil mineral surfaces and/or dissolved in groundwater and can pose a human exposure risk via inhalation.

The CVOC concentrations detected in shallow groundwater exceed the MTCA Method B Groundwater Screening Level (SL) for indoor air risks associated with potential vapor intrusion, therefore this pathway will remain complete until soil and groundwater contamination no longer present a threat of volatilization or engineering controls are in place to prevent exposure.

Soil gas samples previously collected adjacent to the existing structure are too far from the primary source area to be representative of conditions in that area, where future structures may be erected.

3.8 Terrestrial Ecological Evaluation

The Terrestrial Ecological Evaluation (TEE) is required by WAC 173-340-7940 at locations where a release of a hazardous substance to soil has occurred. The regulation requires that one of the following actions be taken to assess potential risk to plants and animals that live entirely or primarily on affected land:

- Documenting a TEE exclusion using the criteria presented in WAC 173-340-7491;
- Conducting a simplified TEE in accordance with WAC 173-340-7492; or,
- Conducting a site-specific TEE in accordance with WAC 173-340-7493.

The Site appears to qualify for a TEE exclusion given that the proposed remediation would result in COC concentrations below their applicable cleanup levels at the standard points of compliance. Therefore no further consideration of ecological impacts is required under MTCA.

4.0 Feasibility Study

This section describes the development and evaluation of cleanup action alternatives to facilitate selection of a remedy for the Site using MTCA evaluation criteria.

4.1 Remedial Action Objectives

RAOs are statements of the goals that a remedial alternative should achieve in order to be retained for further consideration as part of this Focused FS. The MTCA regulation, WAC 173-340-360(2)(a) provides that a cleanup action must include the following threshold remedial action objectives (RAOs):

- Protect human health and the environment;
- Comply with cleanup standards outlined in WAC 173-340-700 through 173-340-760;
- Comply with applicable state and federal laws; and
- Provide for compliance monitoring outlined in WAC 173-340-410.

MTCA (173-340-360(2)(b) also requires that the cleanup alternative:

- Use permanent solutions to the maximum extent practicable;
- Provide for a reasonable restoration time frame; and
- Consider public concerns on the proposed cleanup action alternative.

The overall RAO for the Site is to address impacted subsurface soil and groundwater that represent potentially complete contaminant exposure pathways. The Site is to be compliant with unrestricted land use requirements, therefore, the cleanup objectives for the Site will address the following potential exposure pathways for current and future site uses:

- Direct contact with contaminated soil in the saturated and unsaturated zones;
- Groundwater for drinking water use; and,
- Soil gas (from impacted groundwater and soil) and vapor intrusion to indoor air.

Specific RAOs are also discussed within the remedial alternative assessment in Section 4.8.

4.2 Applicable or Relevant and Appropriate Requirements

Applicable or Relevant and Appropriate Requirements (ARARs) were screened to assess their applicability to the Site. Only those that were deemed appropriate and applicable were retained, those include:

- State Environmental Policy Act (Chapter 43.21C of the Revised Code of Washington [RCW 43.21C])
- Washington State Shoreline Management Act (RCW 90.58; WAC 173-18, 173- 22, and 173-27)
- The Clean Water Act (33 United States Code [USC] 1251 et seq.)
- CERCLA of 1980 (42 USC 9601 et seq. and Part 300 of Title 40 of the Code of Federal Regulations [40 CFR 300])
- The Fish and Wildlife Coordination Act
- Endangered Species Act (16 USC 1531 et seq.; 50 CFR 17, 225, and 402)
- Native American Graves Protection and Repatriation Act (25 USC 3001 through 3013; 43 CFR 10) and Washington's Indian Graves and Records Law (RCW27.44)
- Archaeological Resources Protection Act (16 USC 470aa et seq.; 43 CFR 7)
- Washington Dangerous Waste Regulations (WAC 173-303)
- Solid Waste Management Act (RCW 70.95; WAC 173-304 and 173-351)
- Water Quality Standards for Surface Waters of the State of Washington (RCW 90.48 and 90.54; WAC 173-201A)

- Department of Transportation Hazardous Materials Regulations (40 CFR Parts 100 through 185)
- Washington State Water Well Construction Act (RCW 18.104; WAC 173-160)
- City of Seattle and King County regulations, codes, and standards

4.3 Proposed Cleanup Levels

4.3.1 Soil Cleanup Levels

Cleanup levels for soil are based on MTCA Method A levels for Unrestricted Land Use. Two potential cleanup levels were compared, one for the direct contact pathway and one for protection of groundwater for drinking water beneficial use (soil leaching). The more restrictive of the two criteria was chosen, and is proposed as the Site cleanup level. Cleanup levels calculated for protection of groundwater as drinking water are also assumed to be protective of the vapor pathway. Proposed cleanup levels for COCs in soil at the Site are presented in the table below, and also shown on attached Table 1 with the cumulative soil sample data.

Contaminant of Concern	**MTCA Method A Cleanup Level** (mg/kg)	**Sources**
PCE	0.05	MTCA Method A Soil Cleanup Levels for Unrestricted Land Use; WAC 173-340-740(2)(b)(i); Table 740-1; and Method B - CLARC (2019)
TCE	0.03	
cis-1,2-DCE	160	
trans-1,2-DCE	1,600	
1,1-DCE	4000	
VC	0.67	
PAHs	0.1*	

*Total concentrations that all carcinogenic PAHs (cPAHs) must meet using the toxicity equivalency methodology.

4.3.2 Groundwater Cleanup Levels

Cleanup levels for groundwater are based on MTCA Method A Cleanup Levels (if established) or MTCA Method B Cleanup Levels (for drinking water use). Proposed cleanup levels for COCs in groundwater at the Site are presented in the table below, and are also shown on attached Table 5 with the cumulative Site groundwater data.

Contaminant of Concern	MTCA Method A or B Cleanup Level (ug/L)	Sources
PCE	5.0	MTCA Method A Groundwater Cleanup Levels for Unrestricted Land Use; WAC 173-340-740(2)(b)(i); Table 720-1; and Method B - CLARC (2019)
TCE	5.0	
cis-1,2-DCE	16.0	
trans-1,2-DCE	160.0	
1,1-DCE	400.0	
VC	0.2	
PAHs	0.1*	

*Total concentrations that all cPAHs must meet using the toxicity equivalency methodology.

4.3.3 Soil Vapor Screening Levels

Soil vapor screening levels are based on MTCA Method B calculated values considered protective of indoor air. These values are presented on Table 8 and vary based on the depth at which the vapor sample is collected.

4.4 Points of Compliance

The point of compliance is the location where the enforcement limits will be measured and cannot be exceeded.

4.4.1 Point of Compliance for Soil

The standard point of compliance for direct contact is throughout the Site, from ground surface to 15 feet bgs. This is the depth at which one would reasonably assume workers could encounter contaminated soil during construction or development activities. In situations where achieving the standard point of compliance is not practicable, conditional points of compliance may be established, or institutional controls implemented to prevent direct contact and protect human health and the environment.

UEP proposes a standard point of compliance for CVOC contamination in soil at the Site, and a conditional point of compliance for the PAH contaminated soil adjacent to the treated wood piles beneath the existing retail structure on the north end of the Property. Removal of these numerous piles to a depth of 15 feet bgs to address direct contact as required by the standard point of compliance would cause structural load abnormalities and may threaten the integrity of a future development.

In collaboration with the development team, it was determined that the upper 4 feet of piles and the associated contaminated soil could be removed without impacting the future building's structural features, and would adequately address the potential for direct contact during subsequent utility work given that this 4-foot depth is deeper than any planned grading or utility construction beneath a potential future foundation.

4.4.2 Point of Compliance for Groundwater

The standard point of compliance for groundwater is from the uppermost saturated zone extending vertically to the lowest most depth which could potentially be affected by the release at the Site. In situations where achieving the standard point of compliance is not practicable, conditional points of compliance may be established, and institutional controls implemented to prevent direct contact and protect human health and the environment.

UEP proposes a standard point of compliance for groundwater at the Site.

4.4.3 Point of Compliance for Soil Vapor

The point of compliance for soil vapor will be achieved when concentrations of COCs in soil gas and groundwater are below the vapor intrusion screening levels considered protective of indoor air, or when engineering controls are in place to prevent exposure.

4.5 Potential Remedial Technologies and Applicability

There are a number of potentially applicable remedial technologies for addressing CVOCs in soil and groundwater at the Site, including:

- Monitored Natural Attenuation;
- Soil Vapor Extraction;
- Air Sparging;
- Groundwater Pump and Treat;
- In-Situ Chemical Oxidation (ISCO);
- In-Situ Chemical Reduction (ISCR) with Enhanced Reductive Dechlorination (ERD);
- Dual-Phase (groundwater and soil gas) Extraction (DPE);
- In-Situ Permeable Reactive Barriers;
- In-Situ Thermal Treatment by Electrical Resistance Heating (ERH); and
- Soil Excavation and Off-site Disposal.

These technologies have been applied at sites with similar subsurface conditions and chemical occurrences. Detailed descriptions of these remedial technologies are presented below:

- **Monitored Natural Attenuation (MNA)**. Natural attenuation is "the demonstration that intrinsic degradation will reduce the concentrations of the contaminants before they pose unacceptable levels of risk to human health or the environment or exceed groundwater criteria at established points of compliance. Demonstration must be made using site data for CVOCs rate of degradation and migration across the Site. For the Site, groundwater monitoring data provides evidence that natural attenuation is occurring by reducing conditions (relatively low DO and ORP) and presence of degradation products (TCE, DCE and VC), but likely at a relatively slow rate. In order for MNA to be effective, the source area must be removed or eliminated.
- **Soil Vapor Extraction**. Soil vapor extraction (SVE) systems reduce concentrations of volatile constituents through direct extraction and through aerobic bio-stimulation of the saturated and vadose zones. SVE systems are generally considered more effective for extraction of compounds with vapor pressures greater than 0.5 to 1 millimeters of mercury (mmHg) at 20 degrees Celsius, Henry's Law coefficient greater than 0.01, or boiling points below 250 to 300 degrees Celsius (Suthersan, 1999; EPA, 2004).

  The primary remedial process of SVE at the Site is to recover soil gas from vadose zone soil that has been stripped from groundwater using air sparging or volatized through subsurface heating and extraction of the CVOCs from the vadose zone. Case studies have shown that SVE is an effective treatment technology for former dry cleaner sites contaminated with a number of CVOCs.
- **Air Sparging**. Air sparging is the process of injecting air directly into the Site's CVOC contaminated groundwater. Air sparging removes volatile organic compounds from groundwater by injected air stripping the contaminants as they travel vertically into the vadose zone. Air sparging technology effectiveness for dry cleaning solvents has a long history of demonstrated success, however the effectiveness of air sparging is dependent on soil lithology. In this case, the subsurface soil consists of heterogenous silt and sandy strata that will introduce challenges to effective treatment throughout the impacted groundwater zone.
- **Groundwater Pump and Treat**. Groundwater pump and treat (P/T), a conventional technology that has been applied extensively to CVOC sites, uses groundwater extraction systems (horizontal and vertical wells) to remove large volumes of water with relatively low contaminant concentrations. In instances of complex soil lithology and slow rates of contaminant desorption and dissolution, P/T requires the removal of many pore volumes of groundwater to flush out contaminants. Once the groundwater is delivered above ground, a water treatment technology

(air stripping, activated carbon) is applied to the extracted groundwater before the treated water is usually discharge to the local sanitary sewer. Conventional P/T systems are inherently inefficient for removing contaminants from the subsurface. Today, P/T technologies are usually selected for extracting total fluids (free-phase product and groundwater) as a source removal effort.

- **In-Situ Chemical Oxidation using Injection of Oxidizer**. In-situ chemical oxidation (ISCO) is effective for treating Site CVOCs in groundwater where Site conditions are conducive to remedial injection of aqueous based chemicals. Permanganate treatment solutions are widely used for chemical oxidation and several companies offer design level injection plans (formulas) for effective groundwater treatment. Permanganate has proven to be an effective chemical oxidant for the treatment of chlorinated solvents (PCE, TCE, cis-1,2-DCE, and VC) in soil and groundwater.
- **In-Situ Chemical Reduction using Injection of Electron Donor Chemicals for Enhanced Reductive Dechlorination**. In-situ chemical reduction (ISCR) is also an effective technology for the Site CVOCs when an anaerobic condition exists in groundwater, and the presence of PCE degradation products (TCE, DCE, and VC) and low dissolved oxygen levels indicate that a natural biological degradation condition exists in the dissolved-phase groundwater plume area. Several electron donor chemicals are available to promote and enhance the reductive dechlorination of the dissolved phase PCE and degradation products in the impacted groundwater area of the Site.
- **Dual-Phase (Groundwater and Soil Gas) Extraction and Treatment**. Dual-phase extraction (DPE) is a remediation technique designed to extract both groundwater and vapor from the subsurface formation. DPE can be accomplished through the use of pumps or high vacuum to lower the water table/dewater the saturated zone while simultaneously applying vacuum to recover vapor from the pore space of the formation. As the water column is evacuated, the unsaturated zone is expanded which allows removal of contaminants through the vapor phase under vacuum extraction. A DPE system typically is constructed with a series of extraction wells installed in the contaminant source areas and also in the area of a groundwater plume. DPE is a technology that is better suited to higher permeability soils and groundwater bearing zones such as sands and gravels. Operation of a successfully-designed DPE system could reduce concentrations of CVOCs in soil vapor, soil, and groundwater to their respective cleanup levels. DPE would require treatment and disposal of extracted vapors and groundwater.
- **In-Situ Permeable Reactive Barriers**. In-situ permeable reactive barriers (PRBs) can be installed to treat groundwater contamination and prevent further migration, particularly dissolved phase

contaminant plumes that are moving beyond parcel boundaries. These barriers can be constructed of zero-valent iron to treat CVOCs or using absorbent materials such as granular activated carbon (GAC) to remove petroleum hydrocarbons. Permeable barriers can achieve cleanup levels in groundwater at the location they are installed. However, they do not treat contamination in the vadose zone or in areas located hydraulically upgradient from their installed location. Rather, they are typically implemented when removal of the source is not practicable.

- **In-Situ Thermal Treatment (Electric Resistant Heating or ERH)**. In-Situ Thermal Treatment using electric resistive heating (ERH) is an aggressive and robust in-situ technology that is demonstrated to be effective for CVOCs in low permeability soils. The ERH technology applies high voltages to a network of subsurface electrodes, and the resistance to electrical conductance heats soil and groundwater in the treatment area between electrodes to close to the boiling point of water (100°C). Soil vapors containing the volatilized contaminants are then collected and treated.

  ERH is an in situ thermal treatment for soil and groundwater remediation that can reduce the time to clean up VOCs from years to months. The technology is now mature enough to provide site owners with both performance and financial certainty in their site-closure process. The ability of the technology to remediate soil and groundwater impacted by chlorinated solvents regardless of lithology proves to be beneficial over conventional in-situ technologies that are dependent on advective flow (e.g., soil vapor extraction, pump and treat). The ERH technology is very tolerant of subsurface heterogeneities, and actually performs as well in low-permeability silts and clay as in higher-permeability sands and gravels. ERH may also be combined with other, less costly treatment technologies to optimize and enhance their performance and perform a full Site cleanup.

- **Soil Excavation**. Soil excavation and off-site disposal is capable of meeting remedial objectives and doing so in a reasonable timeframe. At this Site, some areas of soil have PCE contamination at concentrations that would be considered a listed hazardous waste, which could result in very high soil disposal costs. However, in our experience at similar sites, Ecology can issue a "contained-out" determination for soil in which PCE concentrations are below the direct contact value of 14 mg/kg PCE. The majority of the Site contaminated soil is below this level, and thus will likely be disposed of as a non-hazardous waste (as Contained In Designation) at a permitted RCRA Subtitle D facility. The main limitation for soil excavation is that contaminated soils can exist below the water table, or in locations underlying structures or street ROWs, and may not be easily accessible.

4.6 Preliminary Remedial Screening

Because each potentially applicable technology has limitations, the remedial alternatives listed above were initially screened for the highest likely success at the Site in accordance with guidance in WAC 173-340-350(8)(b),with an emphasis on the important criteria of protectiveness, permanence, and the ability to be integrated with a post cleanup development use of the Property:

- MNA was retained as a viable alternative, but only for use in combination with another technology (excavation), which will eliminate the source area.
- SVE was retained for use in combination with other technologies (DPE and ERH) and is intended to be an ancillary part of the treatment system to address volatized organics.
- Air sparging has been shown to be effective in treating contaminated groundwater, and so has been retained for use in combination with other technologies. Air sparging can be applied as the primary treatment method to address the dissolved phase organics in groundwater.
- Traditional groundwater pump and treat has been rejected because it would be operationally difficult to integrate into the residential development, creating equipment access issues, odors/vapors, and disruption of normal residential activities.
- The DPE technology has been retained for consideration in use with a combination of similar technologies that are effective at addressing high concentration contaminants in groundwater.
- In-situ reactive barriers were rejected as they generally serve as a boundary treatment technology to prevent further migration of a contaminant plume.
- In-situ thermal treatment has been retained because it provides permanent, expeditious and reliable treatment of CVOCs, regardless of concentration or environmental media.
- Excavation and off-Site disposal has been retained because it is permanently effective and also reasonable expeditious, depending on the accessibility of the impacted media.
- ISCO and ISCR appeared to be viable alternatives, however little was known about whether subsurface conditions were conducive to injection of aqueous based chemicals. Based on this understanding, an injection pilot test was performed, as discussed below.

4.7 In-Situ Injection Pilot Test

Two pilot injection tests were performed on April 18, 2020, using an aqueous solution of sodium permanganate ($NaMnO_4$) , a strong oxidizer which is often used to treat groundwater at sites contaminated with chlorinated solvents. The purposes of the tests were to empirically evaluate and demonstrate the radius of influence for use of injection at the Site, and to evaluate the performance of field injection technology and methodology.

Two fifty-five gallon drums of $NaMnO_4$ were delivered on site for the pilot tests. Typically $NaMnO_4$ is mixed with potable water at a ratio of 6% to 8%. For the pilot tests, the $NaMnO_4$ was mixed with twice as much water, reducing the ratio to 3% to 4%, but providing a greater volume for the pilot tests. The $NaMnO_4$ and water were mixed in four 275-gallon plastic totes, with potable water supplied from a water truck. After the 2 totes containing permanganate were pumped into the injection well, the totes were refilled with water, and the injection point was flushed with two more tote volumes (550 gallons) to move the initial $NaMnO_4$ mixture outward from the injection point to extend the area of influence.

The first ISCO test was performed in injection well MW26 followed by injection well MW25. The $NaMnO_4$ mixture was injected into the subsurface through the injection point by using an air-compressor driven diaphragm pump. Injection pressures at the diaphragm pump were set to approximately 20 pounds per square inch (psi) for the test at injection well MW26 and 35 to 45 psi at injection well MW25. Once the permanganate mixture reached the well point, the pressure dropped as the permeability of soil was sufficiently high to not cause significant resistance to flow. The observed well pressure at injection well MW26 was approximately 6 psi and the pressure at injection well MW25 ranged from approximately 12 psi initially to 18 psi at the end of injection. Flow rates of injection were monitored using the marks on the totes (25-gallon intervals) and manually timing the change between marks. The typical flow rate ranged approximately 7 to 11 gallons per minute (gpm).

During injection at MW26, the groundwater table levels were observed at monitoring wells MW09 and MW10 using a pressure transducer and datalogger set to record at 1-minute intervals. During injection at MW25, the groundwater levels were observed at monitoring wells MW16 and MW18 using the same methodology.

The radius of influence was evaluated during injection by visually observing the breakthrough of $NaMnO_4$ at the adjacent existing monitoring wells (MW09, MW10, MW16, and MW18). $NaMnO_4$ has a distinct purple color that can readily be seen in treated groundwater at low concentrations. During injection at MW26, the presence of $NaMnO_4$ was monitored by low-flow pumping and periodic bailer sampling at monitoring wells MW09 and MW10. During injection at MW25, monitoring occurred at MW16 and MW18. Given the relatively high permeability of the sand in the target soil zone and low pumping rates with the peristaltic pump, it is our opinion that use of the peristaltic pump for observations did not have a measurable influence on the spreading of the $NaMnO_4$ in the sand channel.

For the ISCO test at injection well MW26, breakthrough was observed at monitoring well MW10 after approximately 550 gallons of the $NaMnO_4$ mixture was injected, with the water changing color from relatively clear to pink and then to purple, indicating that the $NaMnO_4$ mixture had reached monitoring well MW10 at a distance of approximately 22 feet from the injection point. The same color breakthrough was then observed at monitoring well MW09 after approximately 1,100 gallons of the $NaMnO_4$ mixture was injected, with the water changing color from relatively clear to pink, and then purple.

For the test at MW25, breakthrough was not observed at either monitoring well MW16 or MW18. This observation is not surprising given that the soil conditions at UB16 and UB18 around the injection well MW25 location consists mostly of silt and clay, with the relative hydraulic conductivity there being significantly lower than in the sand channel at monitoring well MW26. The soil conditions at the screen intervals for monitoring wells MW16 and MW18 are shown on Cross-Section Figure A-A' (Figure 13), and Cross Section Figure B-B' (Figure 15), respectively.

During injection at MW26, groundwater levels in monitoring wells MW09 and MW10 showed a relatively good correlation with the injection (Graph 1). At both wells, groundwater levels rose approximately 12 to 14 feet in response to the injection, and showed drops of 3 to 4 feet while totes were switched. This response is consistent with the relatively high hydraulic conductivity observed during slug testing at MW09 and MW26 (Section 2.6.3).

In contrast, during injection at MW25, the magnitude of changes in groundwater levels was much smaller in monitoring wells MW16 and MW18, which is consistent with relatively low hydraulic conductivity of the silts and clays at these locations (Graph 1). The groundwater level at these locations was elevated from baseline, but this a result of the soil being pressurized during injection at MW26, and slow recovery prior to injection at MW25.

These pilot test results indicate that the sand channel is conducive to the use of injection methods to remediate the dissolved chlorinated solvents in groundwater and to treat residual PCE in saturated soil. The radius of influence during injection likely ranges from approximately 15 to 25 feet, assuming injection pressures and volumes similar to those used in the pilot tests. Depending on the relative density and viscosity of the selected product used during injection, the radius of influence may vary. If the selected groundwater remedial treatment injectate selection is different than the aqueous sodium permanganate solution used during this pilot test, a second pilot should be performed to confirm the radius of influence and suitable injection pressures.

Monitoring well MW09 was also resampled after the pilot test on May 15, 2020 to evaluate the effect of the $NaMnO_4$ injection on contaminant concentrations in the downgradient location over time. The results presented in the table below indicate a likely rebound of contaminant concentrations assuming a non-detect baseline at the time of treatment. Red values indicate an exceedance of the MTCA Method A Cleanup Level for groundwater.

Boring/Well ID	Date Sampled	Analytical Results - Micrograms per Liter (µg/L)					
		PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC
MW09	4/14/2020	**350**	**460**	**370**	**2.8**	<0.5	**5**
	5/15/2020	**99**	**87**	**48**	<1	<0.5	**0.47**

To further assess oxidizer as a viable injectate, a permanganate natural oxygen demand (PNOD) test was performed by Carus Corporation, which showed a moderate consumption of oxidizer and raised the issue of injection volume needed and commensurate cost.

The conclusion of the pilot test was that in situ injection was confirmed as a viable technology for treating the dissolved phase CVOC plume in groundwater. However, a solution geared towards reductive dechlorination, as opposed to oxidation, would likely be a more successful treatment option because it enhances the naturally occurring bacterial degradation of CVOCs in the dissolved phase plume. Field and lab documentation show a significant anaerobic environment already exists in the dissolved phase CVOC plume downgradient from the source area.

Using this information, in combination with the results from the preliminary remedial screening, four remedial alternatives were developed for further evaluation. A suitable alternative may include one or combine multiple technologies to achieve remedial objectives.

4.8 Remedial Alternative Assessment

The development of remedial action alternatives considered only those remedial components that effectively treat the COCs in the affected media of concern and that were appropriate to the future Property redevelopment plan.

Current development plans for the Property include the construction of approximately 500 units of mixed market rate and affordable housing with no underground parking planned in the area of the CVOC release. With these development plans in mind, the following specific cleanup objectives were developed:

- Achieve the MTCA Method A cleanup levels for impacted soil and groundwater in a reasonable timeframe to allow the return of the Property to a constructive use;
- Select and apply a site remedy for COCs at the Site, that is consistent with redevelopment for mixed residential and commercial use, and that protects future occupants (individuals and families with children and pets) living in the building;

- Select a remedy that does not require long-term, on-going operations, like groundwater pump and treat or soil vapor extraction in-situ methods for treatment of subsurface media after occupation of the building which involve operation of an above-ground treatment unit;
- Avoid institutional controls if possible; and,
- Implement active cleanup to meet remedial goals and allow restoration and completion of development of the Property by 2022. Compliance monitoring may extend beyond this date.

Each of the four remedial alternatives also include the excavation of CVOC impacted soil in the vicinity of UB15 and the upper four feet of PAH impacted material adjacent to the treated piles. Source removal was deemed to be the most practical and cost effective approach in these areas during preliminary remedial alternative screening and did not appear to warrant a feasibility level assessment. As such, the remedial alternatives evaluated in this FS are focused on the CVOC release from the southern dry cleaning operation(s) only. Source removal in these areas was retained and carried through to the Cleanup Action Plan.

The four alternatives are compared with MTCA criteria for cleanup actions (WAC 173-340-350(8)), including disproportionate cost, technical feasibility and restoration timeframe to reach a preferred alternative.

Cost estimates generated for this assessment are feasibility-level (-30/+50%) and based on Net Present Value calculations for future costs incurred after the first year.

4.8.1 Alternative 1: Excavation and Disposal of Soil with Monitored Natural Attenuation of Groundwater

Alternative 1 objective is to permanently remove the Site's source of CVOCs in a very short timeframe, but before site development begins. Following source removal by excavation, residual groundwater impacts are managed by monitored natural attenuation in accordance with Ecology guidance.

Excavation and Off-Site Disposal of Source Soil

A source soil excavation plan requires the removal of a total of approximately 15,000 cubic yards of soil, to depths ranging between 20- to 35 bgs, as shown on Figure 16. A breakdown of the total soil excavation and handling mass consists of: 2,800 tons of F-listed waste, requiring Subtitle C disposal; 11,600 tons of problem waste (nonhaz or Contained In), requiring Subtitle D disposal; 3,000 tons of problem waste soil (nonhaz), that is eligible for disposal as a Class 2 waste; and 3,000 tons of overburden soil that would be re-used as backfill in the excavation area. To achieve depths of up to 35 feet bgs, approximately 200 linear feet of sheet pile will be installed along the west and southern sides of the excavation. The remaining excavation will be removed using a 3:1 sloped cut. For conceptual design purposes, excavation depths beyond 15 feet bgs will required limited dewatering, however any ponded and recovered water during excavation will be treated off site as a hazardous waste. Recovered groundwater and other collected water during remedial excavation will be treated on site using activated carbon and discharged to the nearest sanitary sewer under a King County discharge permit.

Monitored Natural Attenuation

The conceptual excavation plan and limits of excavation shown on Figure 16 are based on most of the soil containing CVOC concentrations that are approximately 100 times the site cleanup levels. This remedial plan will require segregation of the hazardous waste concentration soil during excavation.

Based on experience at similar sites, the estimated remediation timeframe after source removal for the groundwater to reach cleanup levels under monitored natural attenuation (MNA) conditions is 10 to 15 years. The relatively rapid timeframe is expected to be enhanced by the removal of the source area and improved subsurface soil conditions provided by the source area excavation and backfill.

This remedial alternative will also include the following elements:

- Installation of soil vapor controls in the future building, which includes vapor barrier, subslab passive venting, and a subslab gas collection layer for active gas venting, if necessary;
- Periodic indoor air monitoring of the new building; and
- Institutional Controls, such as deed restrictions for building modifications and maintenance best management practices (BMPs) for maintaining vapor controls.

The scope and cost for this alternative is not dependent on development plans, since this work will be performed either before development (excavation) or completion after construction of the building (MNA process). The vapor mitigation features will be integrated into the architectural designs for the building. The estimated cost of this alternative is approximately $6.9 million. Details of the remediation cost estimate are provided on Table 10.

4.8.2 Alternative 2: Dual Phase Extraction (DPE) with Air Sparging (AS)

Alternative 2 applies a dual-phase extraction (DPE) technology to remediate soil and groundwater. DPE uses off-the-shelf equipment and controls capable of inducing a vacuum to simultaneously extract VOC-laden soil vapor and contaminated groundwater from the subsurface. The contaminated soil and groundwater within the area treated by the system become progressively cleaner as contaminants are removed. DPE systems are utilized to remove contaminants from shallow, low permeability or heterogeneous formations. The components of this alternative include the following:

The DPE system would consist of a network of groundwater recovery wells that are connected to a centralized recovery and treatment system to facilitate contaminant extraction (Figure 17). A high vacuum blower, capable of inducing a vacuum of at least 15-inches of mercury, would be required to achieve a sufficient radius of influence and contaminant mass removal rate. Due to the limitation on vacuum lift of groundwater of approximately 30-feet bgs, submersible extraction pumps may be used in deeper wells to recover groundwater and allow for vapor recovery using a high vacuum pump. The recovery wells would include a screened section in the zone of contaminated soil and groundwater. The DPE system would operate through application of the vacuum to the recovery wells via a drop pipe and/or a dedicated submersible groundwater recovery. At this “equilibrium level”, both soil vapor and recharging fluids are simultaneously removed by the drop pipe. By extracting liquids, the DPE system lowers the water table around the well, exposing more of the formation to vapor extraction. Once conveyed above ground, the extracted vapors and groundwater are separated, collected and treated, and clean effluents are discharged either to the atmosphere or to the sanitary sewer.

Because the recovery of CVOCs by groundwater pumping alone is generally not cost-effective, this technology is often applied in conjunction with air sparging to provide additional groundwater treatment.

This alternative does not include a Monitored Natural Attention task, as the alternative assumes that DPE will continue until soil and groundwater have achieved their Cleanup Levels. Due to access issues, active DPE is not planned for impacted groundwater at the southern ROW at Genesee, however performing cleanup of the upgradient source area will enhance the attenuation in this area within the operation timeframe.

DPE is a relatively mature technology, and the use of Alternative 2 translates to a permanent removal and treatment system that provides hydraulic control of chemical migration as well as on-Site treatment. However, the rate of treatment is slow and is likely to lead to a long restoration timeframe. Once the DPE equipment is in place, development in the treatment zone cannot begin until cleanup goals are met.

Alternative 2 installation and operation costs are $4.5 million and assumes 10 years of operation. This cost does include vapor mitigation measures in the new building, but does not include the work scope to perform MNA, if needed. Details of the remediation cost estimate are provided on Table 11.

4.8.3 Alternative 3: Electrical Resistive Heating (ERH) with Soil Vapor Extraction (SVE)

Cleanup Action Alternative 3 utilizes ERH/SVE only to treat all of the Site CVOC contaminated soil and groundwater that exceeds cleanup levels. This includes the dissolved phase PCE groundwater plume south of the primary source area toward South Genesee Street.

The ERH/SVE system consists of zero valent iron (ZVI) electrodes and temperature monitoring points (TMPs) that are installed with spacing approximately 15 feet between each electrode, as shown on Figure 18. The approximately one hundred 12-inch diameter electrodes are constructed in borings advanced within the Site parcel and the impacted ROW to approximately 30 to 35 feet bgs into the saturated zone using standard drilling techniques. The estimated six electrodes located along the southern property boundary will be installed using angle-drilled borings. The ERH electrodes are comprised of a conductive and permeable backfill material with copper electrodes placed at intervals in the un-cased backfill material. A schematic of the electrode construction is provided in Appendix C. The backfill material in each electrode consists of ZVI filings and granular iron shot mixed with graphite as filler. The electrodes serve to heat the impacted soil and groundwater area for the ERH/SVE treatment. The ZVI component of each electrode also functions to promote the electrochemical abiotic reduction of chlorinated contaminants to benign, non-toxic end products (ethene and chlorine ions), as shown in the following chemical equations:

$Fe^{o} \rightarrow Fe^{2+} + 2e(-)$ and $PCE + 8e(-) + 4H(+) \rightarrow Ethene + 4\ Cl(-)$

The ZVI electrochemical treatment of dissolved phase chlorinated solvents is on-going after ERH energy is turned off, and the electrode system in the treatment area serves as a long term groundwater polishing stage to address potential solvent rebound or other potential anomalous irregularities of the ERH treatment process.

In the ERH/SVE stage of treatment, soil and groundwater is heated to an average temperature of approximately 100 degrees Celsius to convert the CVOCs to vapor phase for subsequent recovery by soil vapor extraction at the top of each electrode. During heating, the subsurface temperature is constantly monitored at TMPs located within the treatment area. As shown in the electrode diagram, steel pipes under vacuum are installed at the top of each electrode for the collection of generated soil vapor. These vacuum extraction pipes capture and convey soil vapor and steam from the subsurface treatment area to an on-site, above-ground and secure treatment building. The treatment building consists of a power control unit, steam condenser, two SVE blowers and carbon units to treat the recovered condensate and soil vapor generated by the vacuum system.

The ERH/SVE system is scheduled to operate for a period of about 5 to 6 months, with daily/weekly/monthly operations, monitoring, maintenance, and air and water discharge compliance sampling.

Following the shutdown of the ERH/SVE equipment, soil and groundwater samples will be collected in accordance with an approved Compliance Monitoring Plan.

The scope and cost for this alternative is not dependent on development plans, since this ERH is planned to be completed prior to groundbreaking for development. The implementation of this remedial alternative assumes that post cleanup site conditions will not require vapor mitigation features for the development. The estimated cost of this alternative is $5.4 million. Details of the remediation cost estimate are provided on Table 12.

4.8.4 Alternative 4: Electrical Resistive Heating (ERH)/SVE with In-Situ Chemical Treatment by Reduction/ISCR and Enhanced Reductive Dechlorination (ERD))

Remedial Alternative 4 incorporates ERH/SVE technology at the primary source area and in-situ chemical treatment by injection of electron donor reducing injectates into the dissolved phase groundwater plume outside the primary source area to enhance the enhanced biological reductive dechlorination (ERD) and degradation of the CVOCs. ISCR/ERD would be performed using the injection of electron donor chemicals into the trailing plume (e.g., downgradient of the source area) of the CVOC impacted groundwater, as shown on Figure 19. The assumed radius of influence is 20 feet as presented on Figure 19. ISCR/ERD would be performed using an aqueous solution of ZVI called sulfidated micro ZVI (sM-ZVI) combined with a bio-degradation enhancer compound called 3D micro-emulsion (3DME), which is a proprietary and patented blend of oleic acids and lactates/polylactates, which are injected as aqueous emulsions. The goal of ERH combined with ISCR/ERD is to restore the Site source soil and impacted groundwater to concentrations that are below the Site cleanup levels within a reasonable timeframe (before development construction) and not require long term monitoring (e.g., MNA) or other engineered controls (e.g., vapor barrier or subslab venting).

<u>Electrical Resistance Heating in the Primary Source Area</u>

The ERH treatment system has been designed to treat the CVOC contaminant distribution (vertical and horizontal extent and concentration gradient) in the Source Area only. The planned uniform spacing for electrodes is consist at approximately 15-feet in the full treatment area, but the electrode depths vary by treatment interval, from 10 to 35 feet bgs in the center of the primary source area – Area A on Figure 19, from 10 to 30 feet bgs in Area B, and from 10 to 20 feet bgs in Area C to the north.

The descriptions provided in Alternative 3 above for a full-scale ERH system are similar for this alternative, including installation, startup, operation, monitoring, and maintenance of the system. However, the footprint and number of electrodes and TMPs for this alternative are less than those needed for Alternative 3. In general, this ERH design requires about half the equipment and electrical power as Alternative 3, and includes approximately 60 electrodes, 10 TMPs, and a similar treatment unit consisting of electricity controllers, extraction blowers, steam condenser, and carbon cannisters to scrub or treat the recovered vapors.

The ERH/SVE system is scheduled to operate for a period of about 6 months, with daily, weekly and monthly operations, monitoring, maintenance, and air and water discharge compliance sampling. After the ERH shutdown, the soil and groundwater media of the Site area will be sampled for compliance monitoring.

In Situ Chemical Treatment for Impacted Groundwater Downgradient of the Source Area

The dissolved phase PCE groundwater plume migrating southeast from the source area, and a very small, low level PCE impact area recently showing at monitoring well MW06 (west of the source area) defines the area of the ISCR/ERD treatment. ISCR/ERD treatment will follow the completion of the ERH/SVE treatment in the source area and will take advantage of the enhanced natural biological degradation when the reducing bacteria that are already present will be stimulated by the increased water temperature at the Property from the ERH treatment.

Electrochemical Reduction by the ZVI Electrode System

As described above for Alternative 3, the estimated 54 point array of permeable ZVI electrodes installed for the ERH/SVE system will serve as a continual groundwater polishing system through the abiotic reduction process wherein ZVI reduces chlorinated solvents to ethene.

Relying on the results of the pilot test conducted by UEP, the injection well system for distribution of ISCR chemicals and the bio-degradation enhancers will be designed to deliver injectates between 20- to 35-feet bgs, and spaced at 20-feet on center, in an area approximately 6,000 square feet in the areas as shown on Figure 19. Accordingly, a mass/quantity of injectate will be designed to ensure that contact with the contaminant is achieved where COCs exceed the cleanup levels in groundwater. In this case approximately 6,000 pounds of sM-ZVI and 6,000 pounds of 3DME will be injected throughout the ISCR/ERD treatment area. Calculations for estimating the sM-ZVI/3DME injection volume are provided in Appendix E. The injection of ISCR/ERD chemicals is anticipated to occur over 1 injection period taking approximately 2 weeks. After about 2 months of contact time for the ISCR injectates, performance monitoring will be completed on select monitoring wells to evaluate whether a second injection event should be considered in any identified recalcitrant areas that would show contaminant rebound, depending on the results of the groundwater performance sampling in the ISCR area.

Other FS design assumptions for this alternative include the following:

- Permits required to operate the ERH/SVE system would include a utility permit for a power transformer installation and service upgrade, wastewater discharge permit for the discharge of treated condensate water to the sanitary sewer, and an air discharge permit (from PSCAA) to discharge scrubbed vapors to the atmosphere following treatment by GAC.

- The site would be registered with Ecology's Underground Injection Control (UIC) program prior to initiating ISCR/ERD injections; and,
- The alternative will not require any significant dewatering or treatment efforts.

The scope and cost for this alternative is not dependent on development plans, since this work will be completed before development begins. Compliance groundwater monitoring may continue during or after development of the Property. The estimated cost of this alternative is $3.3 million. Details of the remediation cost estimate are provided on Table 13.

4.9 Evaluation and Selection of Remedial Alternative

For this feasibility evaluation, four alternatives were developed and evaluated based on Ecology's criteria in WAC 173-340-350(8) and WAC 173-340-360[3][f] to address Site CVOC contamination in consideration of a future, at-grade, multistory, multifamily housing site with no subgrade parking within the contaminant plume area. The alternatives are intended to eliminate or control on Property potential exposure routes (direct contact, leaching to groundwater, and vapor generation) in a relatively short period of performance (i.e., completed prior to the planned development construction in 2022). The cleanup action alternative evaluation presented in Table 14 is based on Ecology guidance and provides a semi-quantitative assessment of seven MTCA criteria, from protectiveness to public concerns, including costs (WAC 173-340-360[3][f]). A numeric score ranging from 0 to 10 is assigned for each of the criteria within each alternative based on best professional judgment and as routinely used in evaluating remedial alternatives. A higher score represents a more favorable or effective application of the criterion for that alternative.

The criteria scores are weighted according to Ecology's Sediment Cleanup User's Manual II, Appendix H and a MTCA Composite Benefit Score (CBS) is calculated for each cleanup action alternative by summing the mathematical product of the criterion score times the weighting factor (same for each criterion), which represents a semi-quantitative measure of environmental benefit that the alternative offers. Based on Site conditions, the weighting factors for the each criteria are: Protectiveness – 30%, Permanence – 20%, Long-Term Effectiveness – 20%, Short-Term Risks – 10%, Implementability – 10%, and Public Concerns – 10% For example, the scores for each criterion for an alternative are determined to be: 10, 8, 8, 2, 2 and 3, then the resulting MTCA Composite Benefit Score is calculated as (10)(0.3) + (8)(0.2) + (8)(0.2) + (2)(0.1) + (2)(0.1) + (3)(0.1) = 6.1. A score of 6.1 represents a moderate CBS and environmental benefit on a scale of 0 (lowest environmental benefit) to 10 (highest environmental benefit).

Feasibility level costs criterion for each alternative are not given a score but are used to perform a disproportionate cost analysis (DCA).

A brief description of MTCA FS evaluation criteria is provided below.

Protectiveness. The two types of exposure risk associated with the presence of CVOCs at the Site are terrestrial ecological risk and human health risk. The Site qualifies for a TEE exclusion, therefore mitigating the potential human health risk associated with exposure to the CVOCs in indoor air, soil, and groundwater are the primary objective of any cleanup action implemented. The timeframe to reduce risk and attain cleanup standards is considered.

Alternatives 3 and 4 provide the highest level of protectiveness and shortest timeframe to reach compliance.

Alternatives 1 and 2 each provide some level of protectiveness, however the timeframe to reach compliance is estimated to be 5 years or more. More likely, Alternative 1 – Excavation and MNA timeframe is more than 10 years. Alternatives 3 and 4 will provide a predictably, much shorter restoration time frame. In addition, Alternatives 1 and 2 will likely require some mitigation features to control vapor intrusion in a future building.

Permanence. Alternatives are evaluated based on their ability to permanently reduces or eliminate the toxicity, mobility or volume of hazardous substances on the Site, including the adequacy of the alternative in destroying the contaminants.

Alternatives 3 and 4 both provide the highest level of permanence, as these technologies permanently remove or destroy CVOCs compounds in both soil and groundwater. And these technologies as applied in both alternatives target the entire impacted areas.

Alternative 1 provides the highest level of permanence by excavating and permanently removing contaminated soil from the site, however some portion of impacted groundwater will rely on MNA. Alternative 2 is designed to effectively remove (and eventually treat) CVOC compounds from the Site, however a degree of untreated zones is dependent on the hydrology and stratigraphy of the subsurface conditions. These alternatives provide a low to moderate ranking for permanence.

Effectiveness over the Long Term. Long-term effectiveness defines the degree of certainty that the alternative will effectively perform as intended and the magnitude and time frame that the remedy relies on Site controls (e.g., vapor barriers and monitoring).

Alternatives 3 and 4 provide the highest level of long-term effectiveness, as both remedies will implement a confirmation sampling program in both soil and groundwater to demonstrate attainment of cleanup levels.

Alternatives 1 and 2 rely on technologies that have some degree of uncertainty related to the subsurface geotechnical and chemical conditions of the soil and groundwater, including radius of influence, oxidation and degradation potential. These alternatives provide a low to moderate level of long term effectiveness.

Management of Short-Term Risks. The risk to human health and the environment associated with the implementation and construction of the alternative.

Each of the alternatives presents moderate to significant short-term risks because each includes high-risk activities associated with implementation, including shoring and excavation, drilling and probe installation, injection of permanganate, and operation of pressurized lines for sparing and extraction. ERH presents a high level of risk due to the use of electrical control and distribution equipment and high voltage circuits.

Technical and Administrative Implementability. The ability for an alternative to be implemented – technically feasible, availability of infrastructure and services, and complexity and size of the project, to name a few criteria.

Alternative 1 scores the highest for this criterion as soil excavation, handling and off-site disposal is regularly selected as a soil remedy. The groundwater area intended for MNA is relatively small and accessible.

Alternatives 2, 3 and 4 have a moderate level of Implementability, as these alternatives require a large number of both below- and above-ground equipment and delivery of media (soil gas and groundwater extraction, injection of oxidants, etc.). However, all of the selected technologies have a high number of instances of successful and dependable Implementability throughout the country.

Public Concerns. The criteria weigh the relative familiarity, concerns, or support for an alternative. For this Site, the public is defined as the neighborhood community, leaders, and organizations. The project is a future low-income housing project supported by the Mt. Baker Housing Association.

At this stage, there has been little to no input by the public on the project, however as soon as the Prospective Purchaser Consent Decree is initiated, a full public disclosure and comment period will be completed for the proposed remedial solution. Rainier and Genesee LLC and Mt. Baker Housing Association are in design development for their plans for constructing affordable housing at the Site, and the remedial system in the final CAP will be integrated with their plans that anticipate the future use of the Property for multifamily housing, which dictates an unrestricted land use, and protection of indoor occupants and habitants.

Cost. The relevant project cost to consider for evaluation includes the cost of design, construction, operation and maintenance and long-term monitoring. Cost estimates for treatment technologies shall describe pretreatment, analytical, labor, and waste management costs. The design life of the cleanup action shall be estimated, and the cost of replacement or repair of major elements shall be included in the cost estimate.

The total estimated life-cycle costs (e.g., design, implementation, O&M and closure) for Alternatives 1 through 4 are as follows:

- Cleanup Action Alternative 1— Excavation and Disposal of Soil with Monitored Natural Attenuation of Groundwater: $6.9 million (Table 10). This alternative represents the highest cleanup cost.
- Cleanup Action Alternative 2 – Air Sparge/Soil Vapor Extraction (AS/SVE) and Groundwater Extraction (Dual Phase Extraction): $4.5 million (Table 11). This alternative represents a relatively moderate cleanup cost.
- Cleanup Action Alternative 3— Electrical Resistive Heating (ERH): $5.4 million (Table 12). This alternative represents a relatively high cleanup cost.
- Cleanup Action Alternative 4— Electrical Resistive Heating (ERH) with In-Situ Chemical Treatment: $3.3 million (Table 13). This alternative represents the most moderate cleanup cost. The cost is significantly less than Alternative 3 due to the focusing of the ERH treatment within the primary source area and implementing a more cost effective but successful technology within the dissolved phase plume.

Alternative 1 Summary

Excavation and Monitoring Natural Attenuation is comprised to two widely different treatment technologies and approaches with varying degrees of protectiveness and permanence ratings. For example, excavation provides the highest degree of protectiveness, as the excavated soil is immediately and permanently removed from the Site (disregarding any gaps in confirmation sampling); however, MNA relies on natural rates of degradation (generally takes tens of years) and is often limited by the ability to control or influence subsurface chemical conditions.

Alternative 2 Summary

Dual Phase Extraction (soil vapor and groundwater extraction) relies on well tested, conventional remediation technologies to cleanup subsurface soil and groundwater contaminated with chlorinated solvents. If the DPE can be effectively applied throughout the contaminated zone, this technology is generally effective in capturing and removing the majority of the on-site, target chemicals. However, the certainty and predictability of complete and permanent contaminant removal will likely be hindered by the variability and channeling of sand layer occurrences. Further, the restoration time frame for DPE is difficult to predict and much longer than Alternatives 3 and 4.

Alternative 3 Summary

Electrical Resistance Heating/Soil Vapor Extraction (ERH/SVE) is considered a confirmed and robust technology with highly reliable results in treating both soil and groundwater with CVOCs The "steam stripping" technique is effective in all types of soil, including the dense silt and clays present at the Property. ERH is considered to have one of the highest degrees of protectiveness and permanence, including the shortest timeframe for completion to compliance (not including excavation). However, implementability is a concern for treating the full Site area due to the presence of contamination in the public ROWs.

Alternative 4 Summary

This alternative combines ERH/SVE within the source area and ISCR/ERD treatment within the leading edge of the dissolved phase plume southeast from the source area. Both treatment technologies are considered tested and very reliable for in-situ treatment of dry cleaning solvents and their breakdown products. The relative protectiveness of ISCR compared to ERH would be considered fairly equal, as the PCE GW plume can be described as anaerobic, stable, accessible within a relatively isolated sand channel, and already exhibiting conditions representing strong biological reductive dichlorination activity. Moreover, the presence of the ZVI components in the electrode system provides an ongoing groundwater polishing function for possible rebound in the treatment area, augmenting the sM-ZVI function of injection points. The predicted timeframe to compliance for this dual treatment system is very short, considered equal to that of Alternative 3.

4.10 Disproportionate Cost Analysis and Selected Remedial Alternative

The disproportionate cost analysis or DCA was conducted in general accordance with methodology provided by Ecology WAC 173-340-360(3)(e). Relying on the results of the MTCA evaluation of remedial alternatives (Table 14), a cost-to-benefit ratio was developed for each alternative by dividing the total FS cost estimate by the numeric CBS (and dividing by 1,000,000). The lower value equals a greater benefit per dollar spent. The results of the DCA indicate that Alternative 4 – ERH/SVE with ISCR/ERD is the preferred remedial alternative.

4.11 Preferred Remedial Alternative

The selected remedial Alternative 4 – ERH/SVE with ISCR/ERD is a combination of two applicable technologies. The application of electrical resistive heating with soil vapor extraction to the primary source area of highest soil and groundwater contamination is the use of a vigorous, robust and proven technology that will be thorough, permanent, and relatively quick. The results of the ISCO pilot test confirmed injection technology as strongly applicable to the dissolved phase contaminants in the sand aquifer that is conducive to chemical treatment. Based on the permanganate natural oxidant demand

(PNOD) score for the sand aquifer at 11.4mg/kg, considered a moderate soil oxidant demand, and the observed rebound of PCE in MW10 after the pilot test, a more applicable injection chemical system was further evaluated for application to the Site aquifer conditions. As presented in Section 2.5.6 the Aestus ERI results for Area 3 indicated the presence of high biological activity in the dissolved phase contaminant plume. A deeper analysis of monitoring well data shows the presence of PCE degradation products in all monitoring wells downgradient from the primary source area. Moreover, the dissolved oxygen (DO) content in the dissolved phase plume shows highly anaerobic conditions. Based on these factors, an in situ injection technology involving zero valent iron (sulfidated micro ZVI) to support and continue the ZVI process from the ERH electrodes, coupled with injection of 3DME micro-emulsion to enhance the biological degradation activity already present at the Site was selected for ISCR. This combined injection technology will be confirmed with a pilot test to evaluate the in situ injection distribution dynamics, and confirm the radius of influence for ISCR/ERD.

5.0 Cleanup Action Plan

This section provides a broad description of the preferred remedial Alternative 4. This Cleanup Action Plan provides the cleanup action components that will be implemented in order to implement and confirm the remediation of soil and groundwater beneath the Property containing concentrations of CVOCs exceeding the cleanup levels.

5.1 Cleanup Action Construction Activity Summary

5.4.1 Electrical Resistive Heating/Soil Vapor Extraction

The ERH/SVE system will encompass approximately 9,000 square feet and consist of 54 electrodes and 8 temperature monitoring points (TMPs) that will be installed in the approximate spacing shown on Figure 19. The electrodes will be advanced to three different soil depth intervals based on the distribution of contaminants in the source area (20 feet bgs, 30 feet bgs, and 35 feet bgs). The electrodes are comprised of a conductive, and permeable backfill material with copper wires placed at intervals in the un-cased backfill material, as shown in a schematic of the electrode construction provided in Appendix C. The backfill material in each electrode consists of ZVI filings, a granular iron shot mixed with graphite as filler. Each of the TMPs will consist of Schedule 80 PVC pipe installed in borings advanced using standard HSA drilling techniques. Pipes for the collection of recovered soil vapor will be connected to the electrodes to convey soil vapor from the treatment area by vacuum to a treatment building located on the southwestern portion of the Property. The treatment building consists of a power control unit, condenser, two SVE blowers and GAC units to treat the recovered condensate and soil vapor generated by vacuum system.

After installation of the electrodes, TMPs, and the vapor extraction mechanical and treatment equipment, the system will undergo startup and testing. After testing, electrical power will be applied to the Site continuously except during system adjustments and routine maintenance. Thermocouples in the TMPs will be monitored continuously using a Power Control Unit (PCU) and remote monitoring systems. The PCU is a variable transformer system capable of providing three simultaneous power outputs and automatically adjusting applied voltages. During operations, the heating contractor will monitor the system remotely and perform site visits every other week for visual inspection and maintenance of the ERH components of the system. Additional trips would be made as necessary to ensure that the ERH system is functioning efficiently and effectively, as designed.

The total treatment time for ERH is expected to be between 140 and 180 days to achieve the compliance goals.

5.4.2 In-Situ Chemical Reduction/Enhanced Reductive Dechlorination

ISCR/ERD is a process that involves the injection of electron donor chemicals into groundwater and/or soil for the purpose of rapid contaminant destruction, first with electrochemical reduction by ZVI contact, and then biological degradation by enhanced bacterial action. Regenesis is the supplier of sM-ZVI and 3DMEand also the anticipated vendor for injecting the treatment chemicals to accomplish ISCR/EDR.

The proposed ISCR/ERD application treatment areas are shown on Figure 19. The primary treatment area downgradient of the source area measures approximately 8,400 square feet with a treatment thickness of up to 15 feet in the saturated sand layer. A total of 6,000 pounds of sM-ZVI and 6,000 pounds of 3DME will be injected into an approximately 19 injection points/wells as shown with their overlapping radius of influence. The concentrated injectates will be mixed on site with potable water for a total injection volume of 18,000 gallons, or about 950 gallons per injection point. The product application will target an injection interval within the sand channel approximately 20 to 35 feet below ground surface, from the southern edge of the ERH treatment zone to the south property line at South Genesee Street. In addition to the downgradient groundwater plume, ISCR/ERD will be used to target several smaller areas of groundwater contamination. These include:

- Two injection points near monitoring well MW08 along Rainier Avenue South with a total injection volume of about 2,000 gallons;
- Two injection points near monitoring well MW17 in the middle of the site with a total injection volume of about 2,000 gallons; and
- Three injection points near monitoring well MW20 on the south side of South Genesee Street with a total injection volume of about 3,000 gallons.

The depth interval for injection at smaller areas will depend on the subsurface conditions observed during drilling of the injection wells, and depth of observed contamination from previous explorations.

The 19 injection point locations are anticipated to be installed using direct push drilling methods with the injection points consisting of 1-inch diameter schedule 40 PVC or stainless steel depending on their proximity to the ERH treatment area. We anticipate that the primary injection area in the sand channel would be injected into at a rate of 4 to 8 gallons per minute and at pressures between 5 to 20 psi at the wellhead. These injection parameters will be confirmed by an ISCR pilot test. During the full ISCR treatment, at least 4 injection points will be injected into simultaneously. For the other injection areas to be treated by ISCR/ERD, we anticipate the flow rates will be lower and injection pressures higher depending on the soil conditions at each location. The injection project is estimated to take up to 10 field days to complete.

Injection methodology will be similar to that used during the pilot tests, with up to 4 injections performed simultaneously to better control the distribution of sM-ZVI and 3DME in the subsurface.

Injection for the main area of ISCR/ERD within the sand channel will start at the downgradient edge of the groundwater plume along South Genesee Street, and along the east boundary, and move northward toward the center of the Site for the subsequent injection rows. The goal of this injection sequencing is to start the injection rows from the downgradient side of the plume, and proceed with injections moving in the upgradient direction, which will reduce the potential for the injection process to cause any plume migration in the downgradient direction.

The field injection will be performed using similar equipment and procedures utilized during the pilot test. Specific means and methods at each injection point will be confirmed at the time of injection.

During ISCR/ERD injection, existing monitoring wells that have not been utilized for injection will be periodically monitored to observe the progress and radius of influence of the injection, as described below.

5.4.3 PAH Contaminated Soil Remediation

As presented in the RI Section 3.4 and the Compliance Section 4.4 of the report, we have provided an empirical demonstration with soil and groundwater data that the standard direct contact point of compliance requirement of 15 feet below the ground surface is not applicable. We have proposed a conditional point of compliance of 4 feet bgs for remediation of soil contaminated with PAHs above applicable cleanup levels. The remedial cleanup of the PAH contaminated area will be conventional and implementable. After obtaining applicable permits, in order to expose the pile caps and tops of the treated wood piles for removal, the building and floor slab of the existing structure will be demolished and removed. Pile caps will be broken apart with a concrete breaker bar, and the material removed.

Once exposed and accessible, the top 4 feet of each pile (or multiple pile system) will be removed along with the associated contaminated soil. This soil cleanup will be accomplished by digging an area about 2 feet wide on all 4 sides of each pile (or system) to allow access. Once contaminated soil is removed, the piles will be cut off at the excavation grade consistent with the proposed 4 feet bgs conditional point of compliance. Treated wood piles will be removed and sawdust and other debris will be removed from the excavation hole for each pile area. Suitable backfill material will then be used to fill the excavation void. After grading the excavation area, an impermeable membrane and asphalt cap will be placed over the former building area to prevent stormwater conveyance and rainfall infiltration through the remaining treated piles left in place, to prevent leaching of the remaining PAHs in soil into the Site groundwater.

5.4.4 Engineering Controls

Although the selected remedy is intended to meet cleanup levels for unrestricted land use, compliance monitoring activities may extend into the proposed development schedule. As such, UEP proposes the installation of a sub-slab vapor barrier beneath any structure in the area of the current chlorinated solvent plume that is resistant to VOC permeability.

Additionally, the concrete slab on grade for the future building in the area of the existing former Safeway structure will act as a barrier to direct contact exposure to PAH contaminated soil left in place.

5.4.5 Cleanup Action Schedule

The overall project schedule is dependent upon a couple of key milestones that determine the start of the project, with the drivers being: 1) Ecology review and approval of the draft RI/FS-CAP, 2) the issuance of a construction permit by Seattle City Light for the electrical power drop to perform the ERH component of the remedy, and 3) the installation of the ERH electrode apparatus, and the TRS set up for power control equipment. A tentative schedule with anticipated dates is provided at Appendix F.

6.0 Compliance Monitoring

There are three types of compliance monitoring identified for remedial cleanup actions performed under MTCA (WAC 173-340-410): protection, performance, and confirmation monitoring. A paraphrased definition for each is presented below (WAC 173-340-410[1]).

- **Protection Monitoring**—To evaluate whether human health and the environment are adequately protected during construction and the operation and maintenance period of an interim action or cleanup action.
- **Performance Monitoring**—To document that the interim action or cleanup action has attained cleanup standards.

- **Confirmation Monitoring**—To evaluate the long-term effectiveness of the interim action or cleanup action once cleanup standards or other performance standards have been attained.

6.1 Protection Monitoring

A Site Specific Health and Safety Plan (HASP) will be prepared for the cleanup action that meets the minimum requirements for such a plan identified in federal (Title 29 of the Code of Federal Regulations) and state regulations (WAC 296). The HASP identifies known Site hazards and monitoring protocols to mitigate these hazards.

6.2 Performance Monitoring

Performance monitoring includes the collection of soil samples from within the ERH/ISCR Treatment Areas in representative areas to show that treatment of soil is being accomplished by the remedial methodology. Performance monitoring for soil conditions will be conducted in the primary source area during the operations of the ERH treatment period, and then within the ISCR treatment area at a period about 60 days after the conclusion of the ISCR injection events.

6.2.1 Soil Performance Monitoring

Performance monitoring for ERH treatment will be conducted throughout the treatment period by daily monitoring of the temperature probes recording the soil treatment process, and by regular testing of CVOC content in the SVE condensate. When the temperature monitors for the treatment area show that average soil temperatures have met a temperature of 88 degrees Centigrade (~ 190 degrees Fahrenheit), then 2 performance borings will be drilled within the central core area of the ERH treatment area to test soil and check ERH treatment progress. Soil samples will be collected in the 2 soil borings to depths of 30 feet in the approximate locations shown on Figure 20.

Sampling Methods

Soil sample collection will follow the TRS protocol supplied as Appendix D.

Sample Analysis

Soil samples will be submitted to an Ecology-accredited analytical laboratory for the following analytical methods:

- CVOCs by EPA Method 8260C

Concentrations will be compared to the MTCA Method A cleanup levels for soil (Table 740-1 of WAC-173-340). The laboratory detection limits will be sufficient to detect the COCs at concentrations at, or below the MTCA cleanup levels.

6.2.2 Groundwater Performance Monitoring

Pre-Treatment Monitoring Round

Prior to groundwater treatment by ERH and ISCR, all existing wells on the Property and within the Site (inclusive of MW20) will be sampled to establish pre-treatment groundwater baseline conditions.

For performance and compliance sampling, two additional monitoring wells will be installed in the ERH treatment area (MW36 and MW37, constructed with stainless steel well screens and riser pipes), and one additional monitoring well (MW38) will be installed in the ISCR area. Locations of these 3 additional monitoring wells are shown on Figure 21.

Groundwater Sampling Methods

Groundwater well purging and sampling will be performed using the TRS hot water sampling protocol as provided in Appendix D. This is to ensure that sampling methodology is consistent with those utilized during ERH operations.

The general procedures to be followed are described below:

- Connect ¼-inch Teflon sample tubing from a pre-installed valve on the head of the well, to a cooling coil and place the coil in a bucket or cooler with ice to form an ice bath.
- Connect a pump to the cooling coil and connect the cooling coil discharge tubing to a flow-through cell with calibrated meter probes/sensors securely held in the flow-through cell.
- Connect tubing from the discharge of the flow-through cell to the purge water collection bucket.
- Groundwater samples will be collected following stabilization of temperature, pH, specific conductance, turbidity, dissolved oxygen, and oxidation-reduction potential. If the monitoring well is completely dewatered during purging, samples will be collected when the groundwater in the well has recovered to at least 80 percent of the pre-purge casing volume
- Each sample container will be labeled with the date and time sampled, well identification number, project number, and preservative(s), if any. All sample collection information will be documented on a sample COC form; the sample will be placed in a cooler chilled to near 4 degrees Celsius and transported to the laboratory. The COC protocols will be maintained during sample transport and submittal to the laboratory.
- Purge water will be temporarily stored in an appropriately labeled container at the Property pending receipt of waste profiling results. An estimated volume of 10 gallons of purge and decontamination water is anticipated to be generated during each performance sampling event.

- Non-reusable sampling and health and safety supplies and equipment will be disposed of in an appropriate waste dumpster at the Property.
- The well cap and monument will be secured following sampling. Damaged or defective well caps or monuments will be noted and scheduled for replacement, if necessary.

Sample Analysis

Samples will be submitted to an Ecology-accredited analytical laboratory, on a standard turnaround time. Groundwater performance and confirmation samples will be analyzed for CVOCs by EPA Method 8260C.

Concentrations will be compared to MTCA Method A cleanup levels for groundwater (Table 720-1 of WAC-173-340) to evaluate the groundwater conditions beneath the Site.

6.3 Confirmation Monitoring

Confirmation monitoring will commence once multiple lines of evidence indicate that the ERH remediation is complete. Multiple lines of evidence include, but are not limited to, subsurface temperatures and PCE vapor extraction rates. When the compliant analytical data from the confirmation monitoring as described below have met MTCA Method A cleanup levels, the data will indicate that the remedial action objectives (MTCA Compliance) have been achieved, and the ERH treatment will cease.

6.3.1 Soil Confirmation Monitoring

Groundwater quality monitoring from monitoring wells MW25, MW31, MW36, and MW37 will be used to empirically demonstrate that soil compliance has been achieved in the ERH treatment area. The following groundwater monitoring wells will serve as compliance monitoring locations for the Rainier Mall Site: MW02, MW03, MW04, MW10, MW11, MW20, MW25, MW30, MW31, and new wells MM36, MW37, and MW38.

The groundwater quality for the Site will serve as empirical evidence that soil compliance conditions have been met.

To confirm that cleanup levels have been achieved, the concentrations of COCs will be compared to their respective cleanup levels and, if applicable, evaluated in accordance with the Ecology document *Statistical Guidance for Ecology Site Managers* (Ecology 1992). As detailed in the guidance, confirming whether the Site is clean is based on a comparison of the 95th percent upper confidence limit on the mean (UCL_{95}) with the defined cleanup level. Each sample collected will be analyzed at detection limits low enough to detect compliance with the cleanup levels. The resulting data will then be tested for conformance with distributional assumptions (normal versus lognormal) and the UCL_{95} calculated based on the methods described in Ecology's 1992 guidance document.

If the UCL_{95} for a specific chemical does not exceed the cleanup level, then the Site is considered clean; otherwise, it is still considered contaminated. The Site is considered clean when the UCL_{95} for each COC is less than its respective cleanup level. This statistical approach allows for post-sampling excavation to remove individual sample hot spots that cause exceedance of the cleanup levels and retesting to assess if the recalculated UCL_{95} exceeds the cleanup level.

6.3.2 Groundwater Conformation Monitoring

Once the performance monitoring suggests that the MTCA compliance has been met, groundwater samples will be collected on a quarterly basis from each compliance monitoring well (same wells as the Pre-Treatment monitoring round) as shown on Figure 21. During ERH treatment and then the subsequent development construction, the indicated monitoring wells will be protected, or if damaged, replaced. Monitoring well MW03 will be used as an upgradient well for compliance evaluation. Sampling and analytical methods will be the same as for the performance monitoring (Section 6.2.2).

Once four consecutive quarters of post-remediation groundwater samples with CVOC concentrations below the established cleanup levels are obtained, the groundwater beneath the Property at the Site will be considered to have met the point of compliance.

7.0 References

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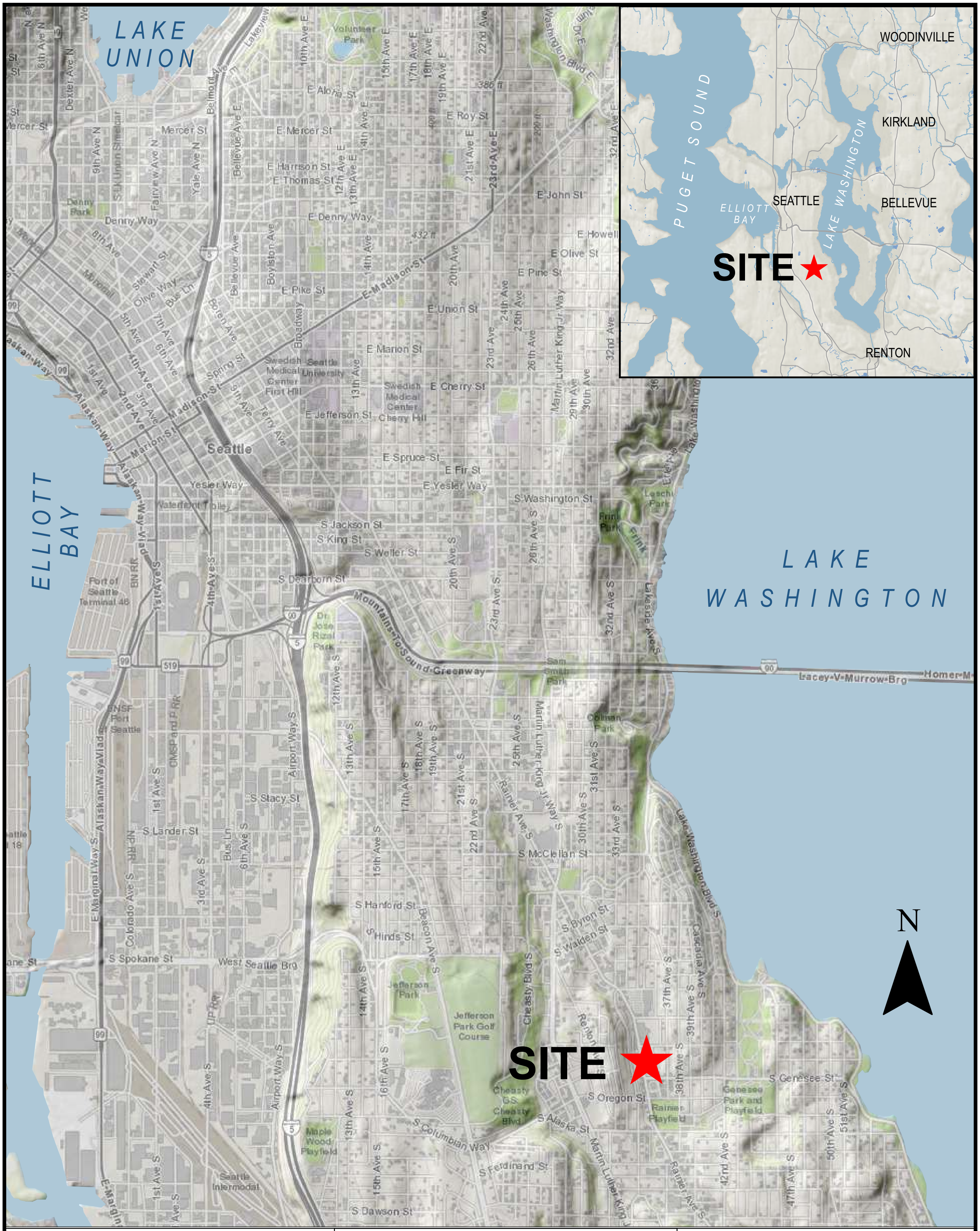
Exhibit A: Figures



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Rainier Mall Site
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Figure 1
Site Location Map

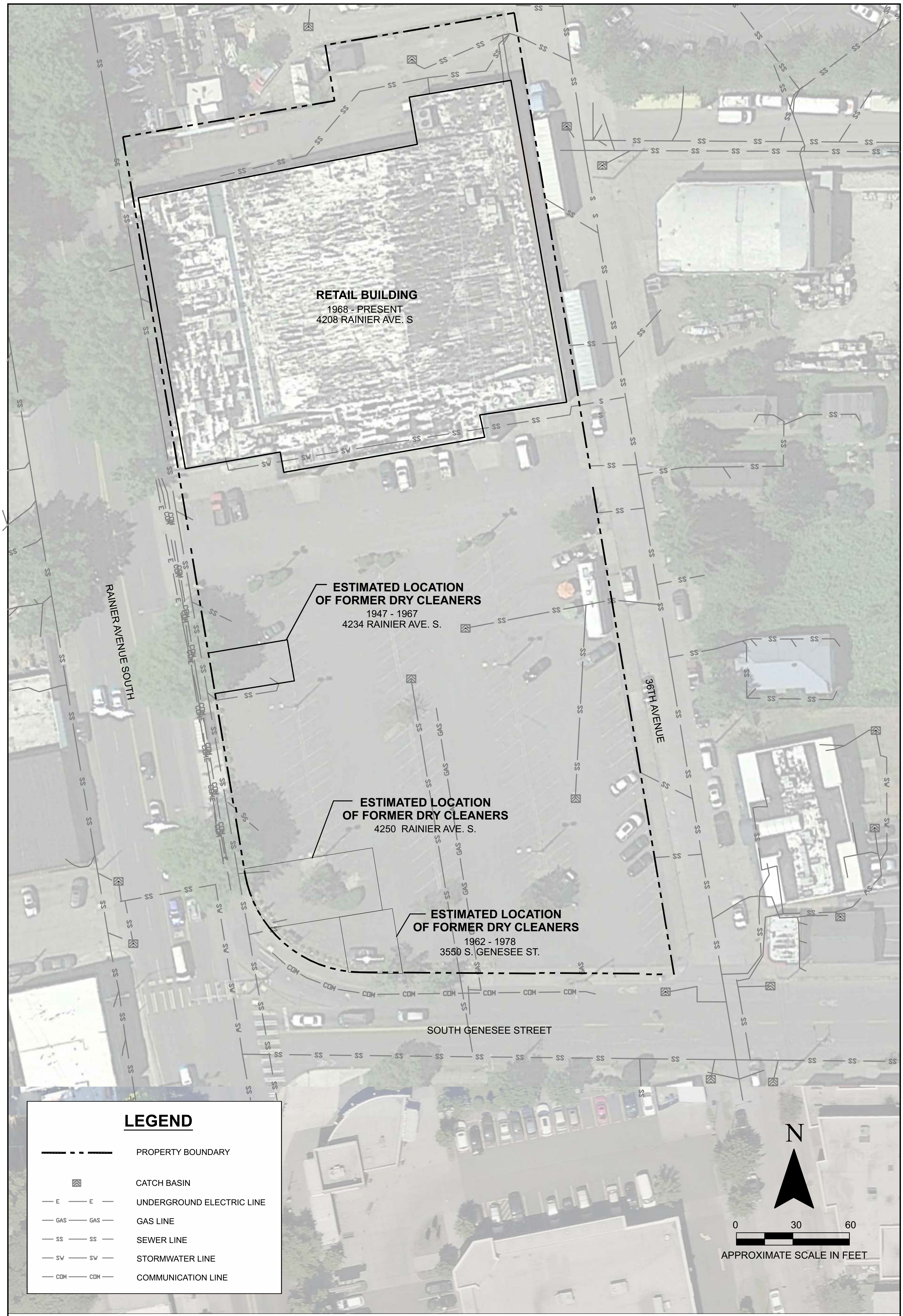

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Figure 2
Site Features

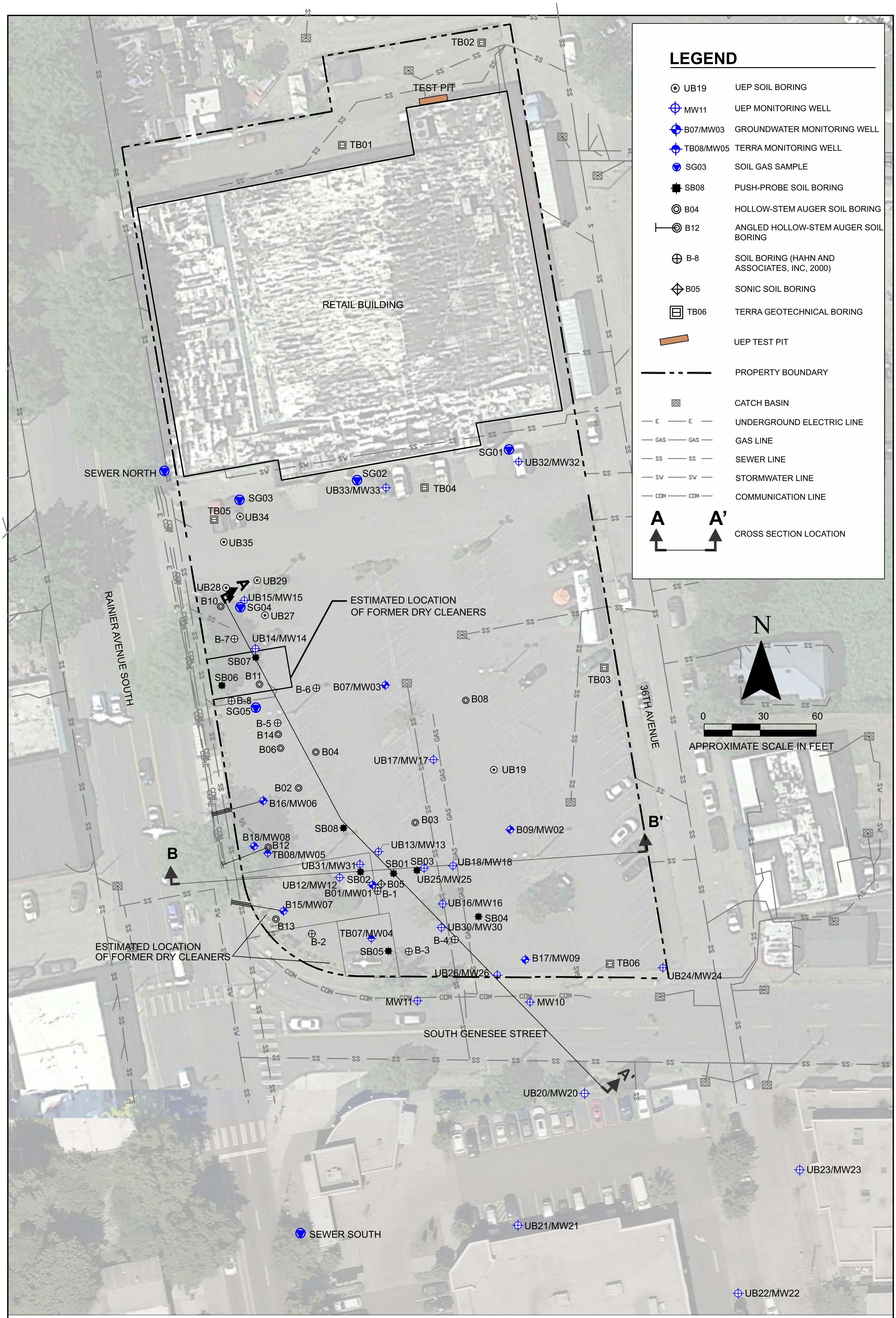

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Figure 3
Exploration Location Plan

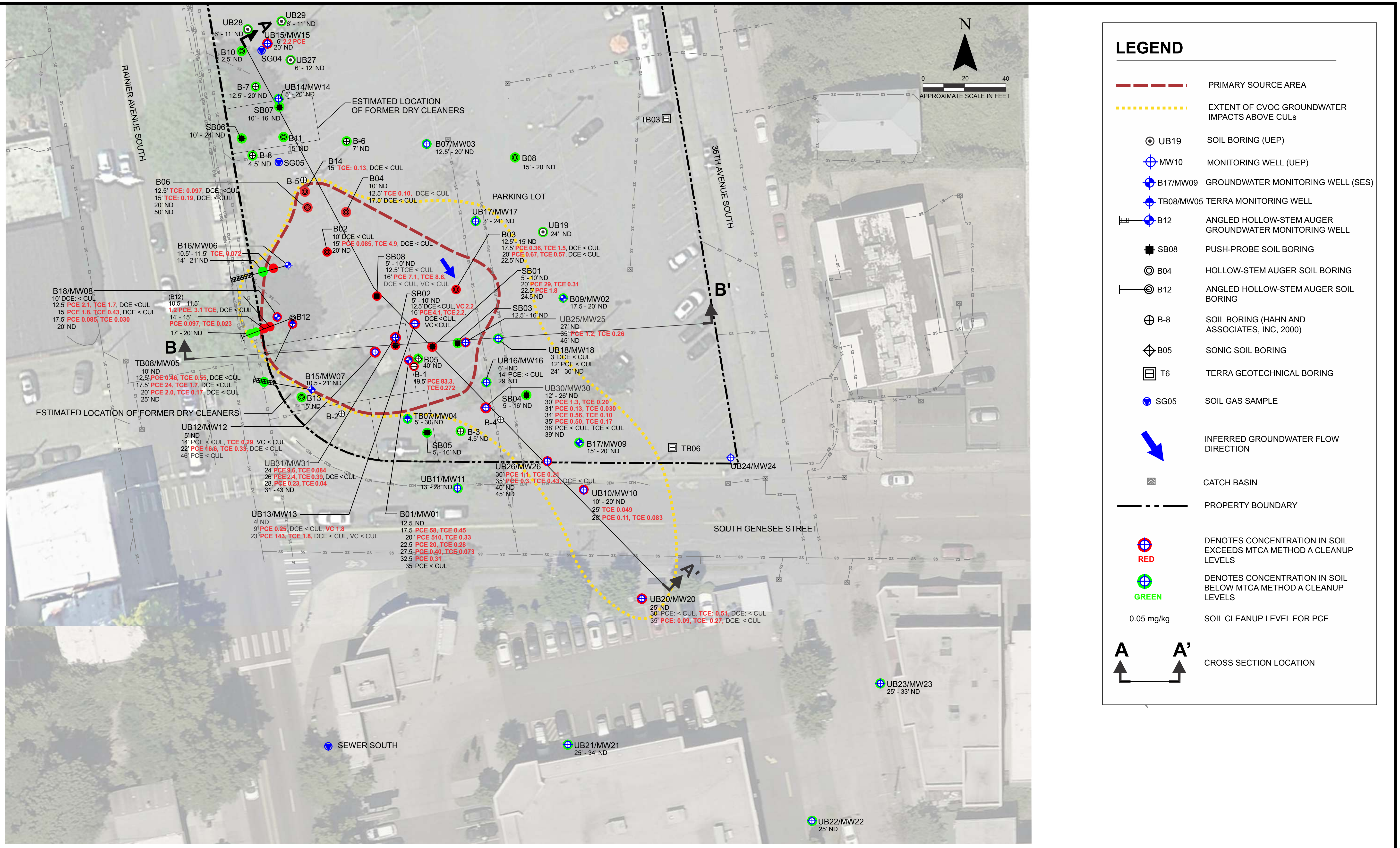

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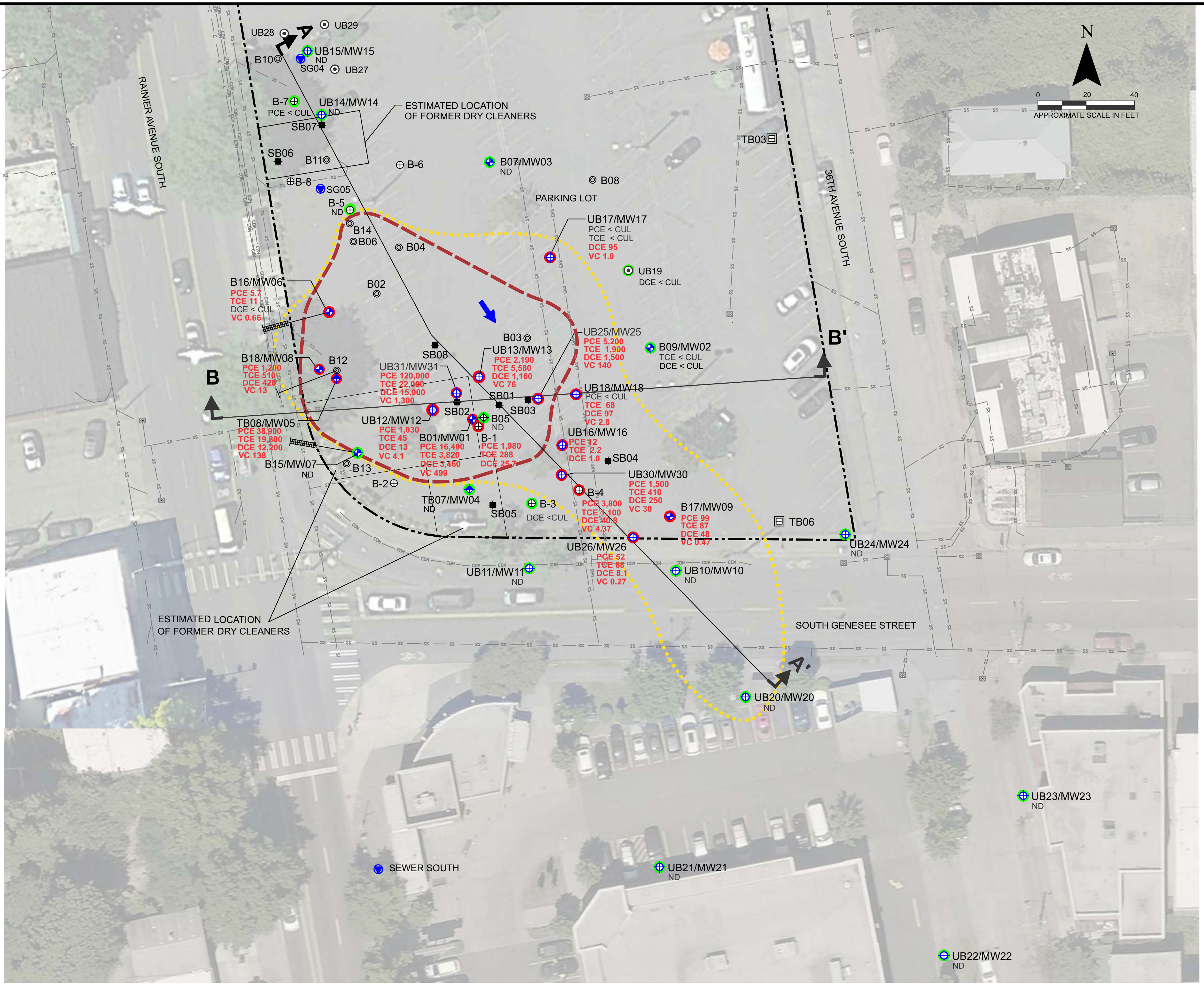
Figure 4
CVOC Concentrations in Soil



LEGEND

▬ ▬ ▬	PRIMARY SOURCE AREA
⋯⋯⋯	EXTENT OF CVOC GROUNDWATER IMPACTS ABOVE CULs
⊙ UB19	SOIL BORING (UEP)
⌖ MW10	MONITORING WELL (UEP)
⌖ B17/MW09	GROUNDWATER MONITORING WELL (SES)
⌖ TB08/MW05	TERRA MONITORING WELL
⌖ B12	ANGLED HOLLOW-STEM AUGER GROUNDWATER MONITORING WELL
■ SB08	PUSH-PROBE SOIL BORING
◎ B04	HOLLOW-STEM AUGER SOIL BORING
◎ B12	ANGLED HOLLOW-STEM AUGER SOIL BORING
⊕ B-8	SOIL BORING (HAHN AND ASSOCIATES, INC, 2000)
◈ B05	SONIC SOIL BORING
⊟ T6	TERRA GEOTECHNICAL BORING
● SG05	SOIL GAS SAMPLE
➘	INFERRED GROUNDWATER FLOW DIRECTION
▨	CATCH BASIN
▬ · ▬	PROPERTY BOUNDARY
🟥 RED	DENOTES CONCENTRATION IN GROUNDWATER EXCEEDS MTCA METHOD A CLEANUP LEVELS
🟩 GREEN	DENOTES CONCENTRATION IN GROUNDWATER BELOW MTCA METHOD A CLEANUP LEVELS

GROUNDWATER CLEANUP LEVELS

PCE	5 µg/L
TCE	5 µg/L
Cis DCE	16 µg/L
VC	0.2 µg/L

A A' CROSS SECTION LOCATION

NOTE: GROUNDWATER CONCENTRATIONS DEPICTED ON THIS FIGURE ARE FROM MOST RECENT SAMPLING EVENTS.

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Figure 5
CVOC Concentrations in Groundwater

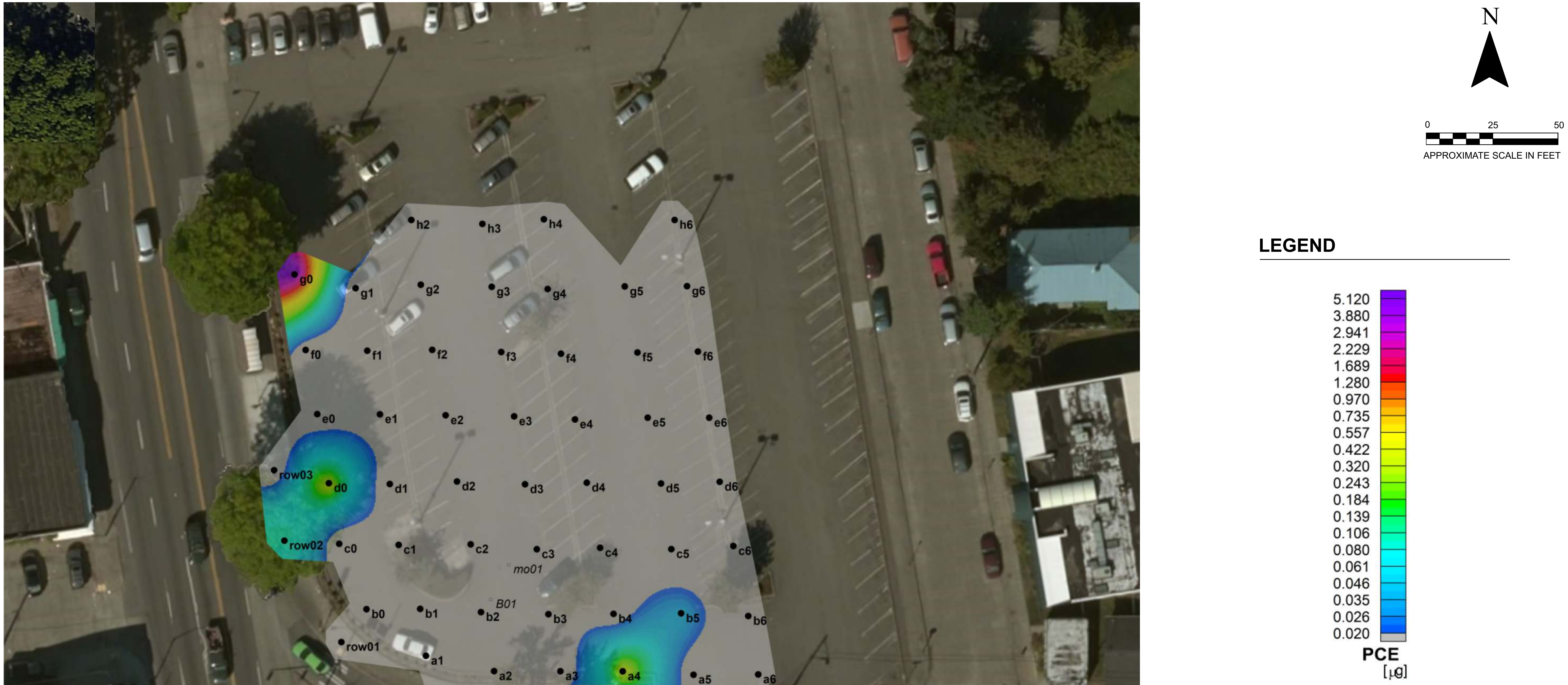

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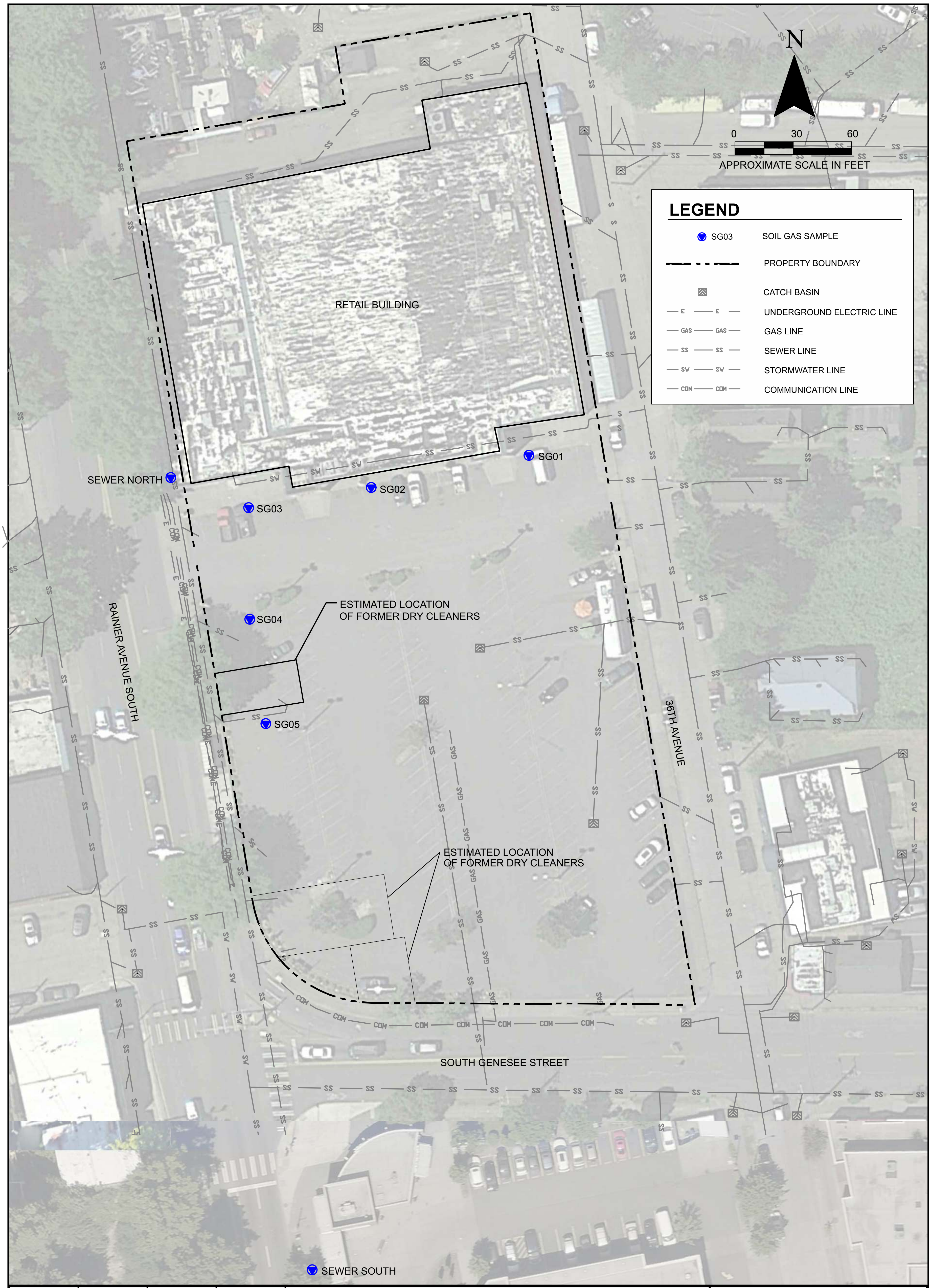
Figure 6
Passive Vapor Investigation Results



Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results - Micrograms per Cubic Meter (µg/m^3)										
				PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC	Chloroethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1,1-Trichloroethane	1,1,2-Trichloroethane
SG01	SoundEarth	1/2/2018	8	**48**	<5.4	<4	<4	<4	<2.6	<2.6	<4	<4	<5.5	<5.5
SG02	SoundEarth	1/2/2018	8	**38**	<5.4	<4	<4	<4	<2.6	<2.6	<4	<4	<5.5	<5.5
SG03	SoundEarth	1/2/2018	8	**25**	<5.4	<4	<4	<4	<2.6	<2.6	<4	<4	<5.5	<5.5
SG04	UEP	4/10/2020	1.5	<110	<4.3	<6.3	<6.3	<6.3	<4.1	<42	<6.5	<0.65	<8.7	<1.7
SG05	UEP	4/10/2020	1.5	<110	<4.3	<6.3	<6.3	<6.3	<4.1	<42	<6.5	<0.65	<8.7	<1.7
Sewer South	UEP	5/15/2020	10	**270**	**69**	**340**	**3.7**	<3	**22**	<20	<3.1	<0.31	<4.1	<0.83
Sewer North	UEP	5/15/2020	10	<54	<2.1	<3.2	<3.2	<3.2	<2	<21	<3.2	<0.32	<4.4	<0.87
Ecology MTCA Method B Screening Levels for Sub-Slab Soil Gas				**320**	**11**	**NE**	**NE**	**3,000**	**9.50**	**NE**	**52**	**3.2**	**76,000**	**5.20**
Ecology MTCA Method B Screening Levels for Deep Soil Gas				**960**	**33**	**NE**	**NE**	**9,100**	**28**	**NE**	**160**	**9.6**	**230,000**	**16.00**

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Figure 7
CVOC Concentrations in
Soil Gas and Sewer Gas

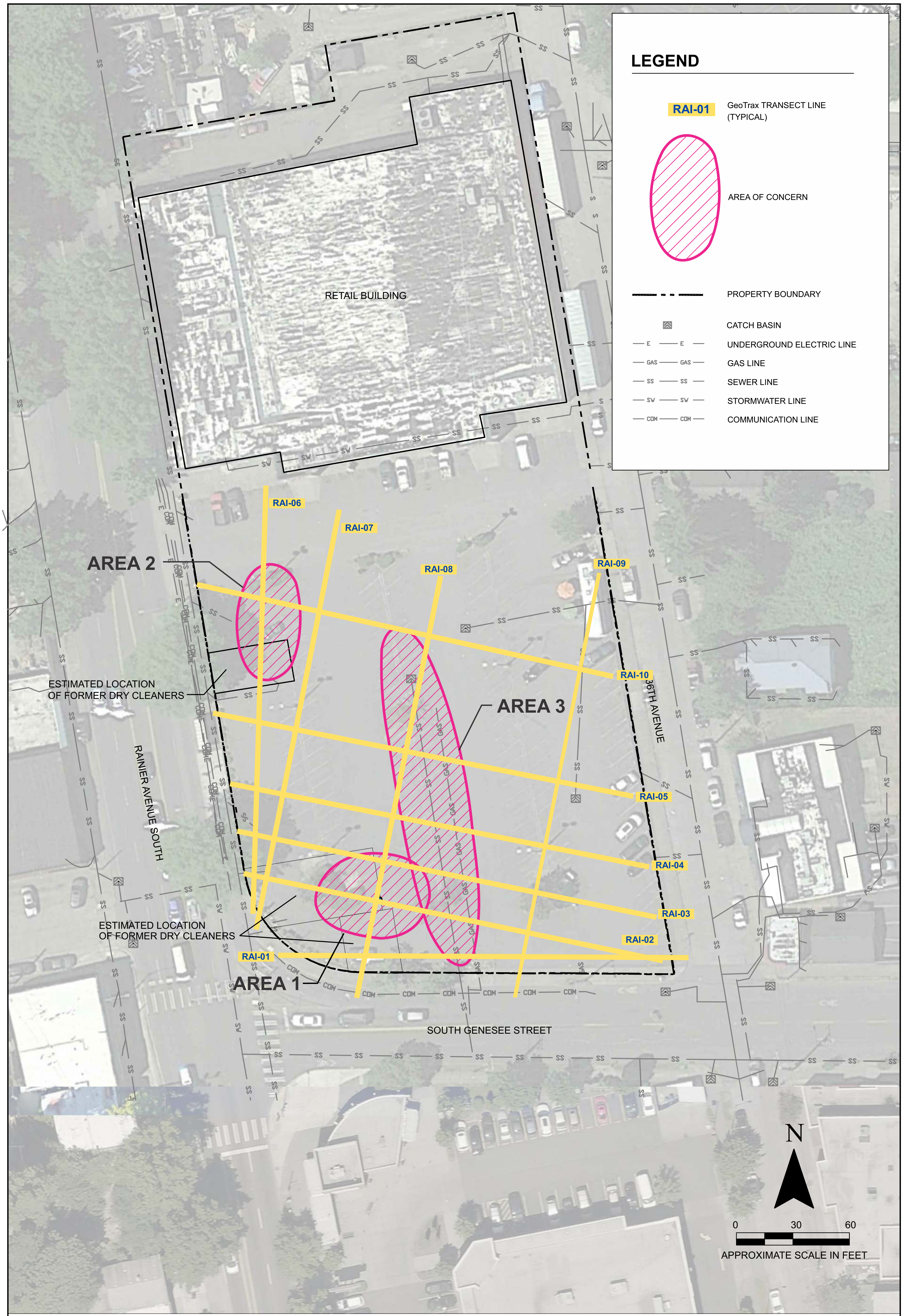

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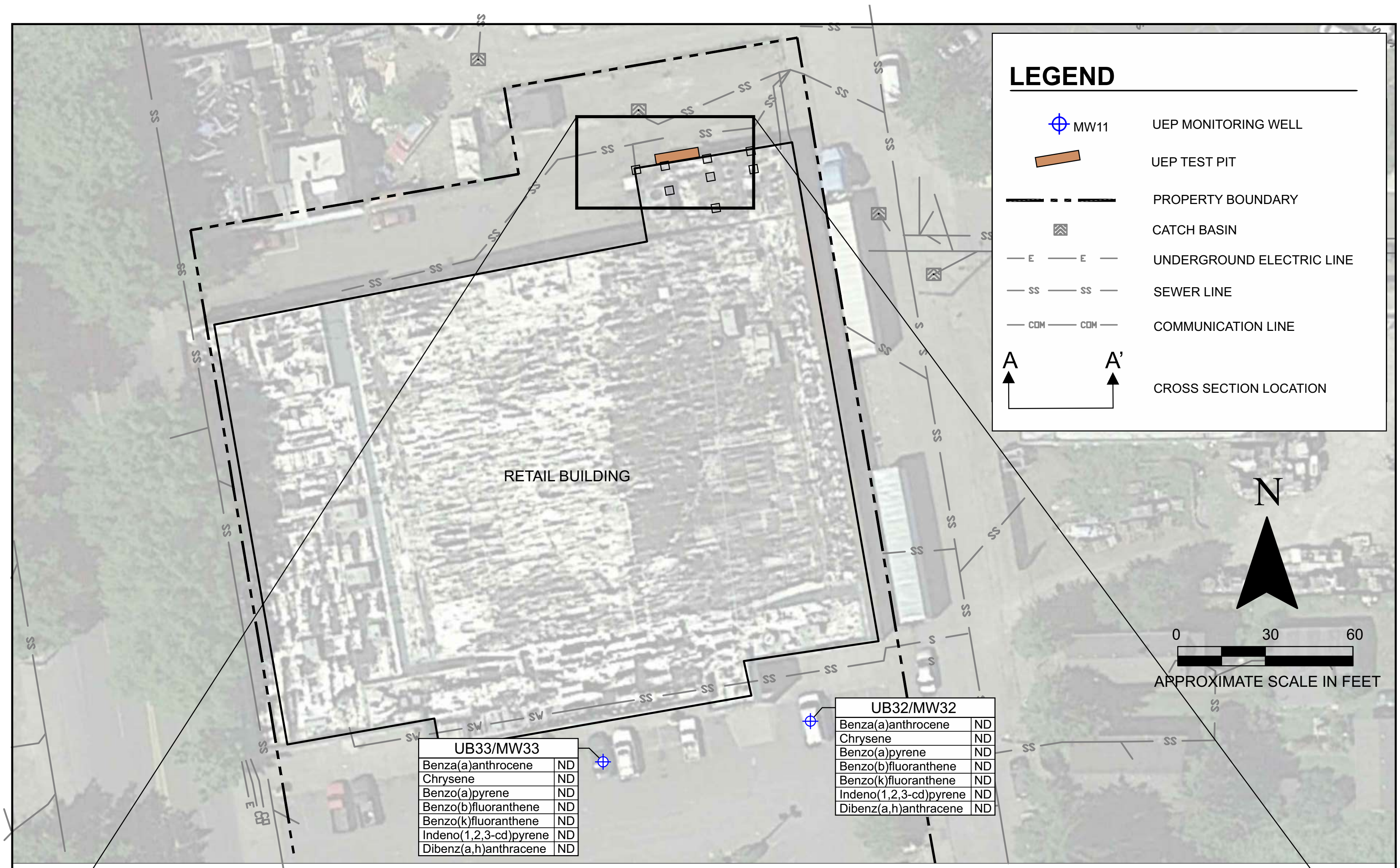
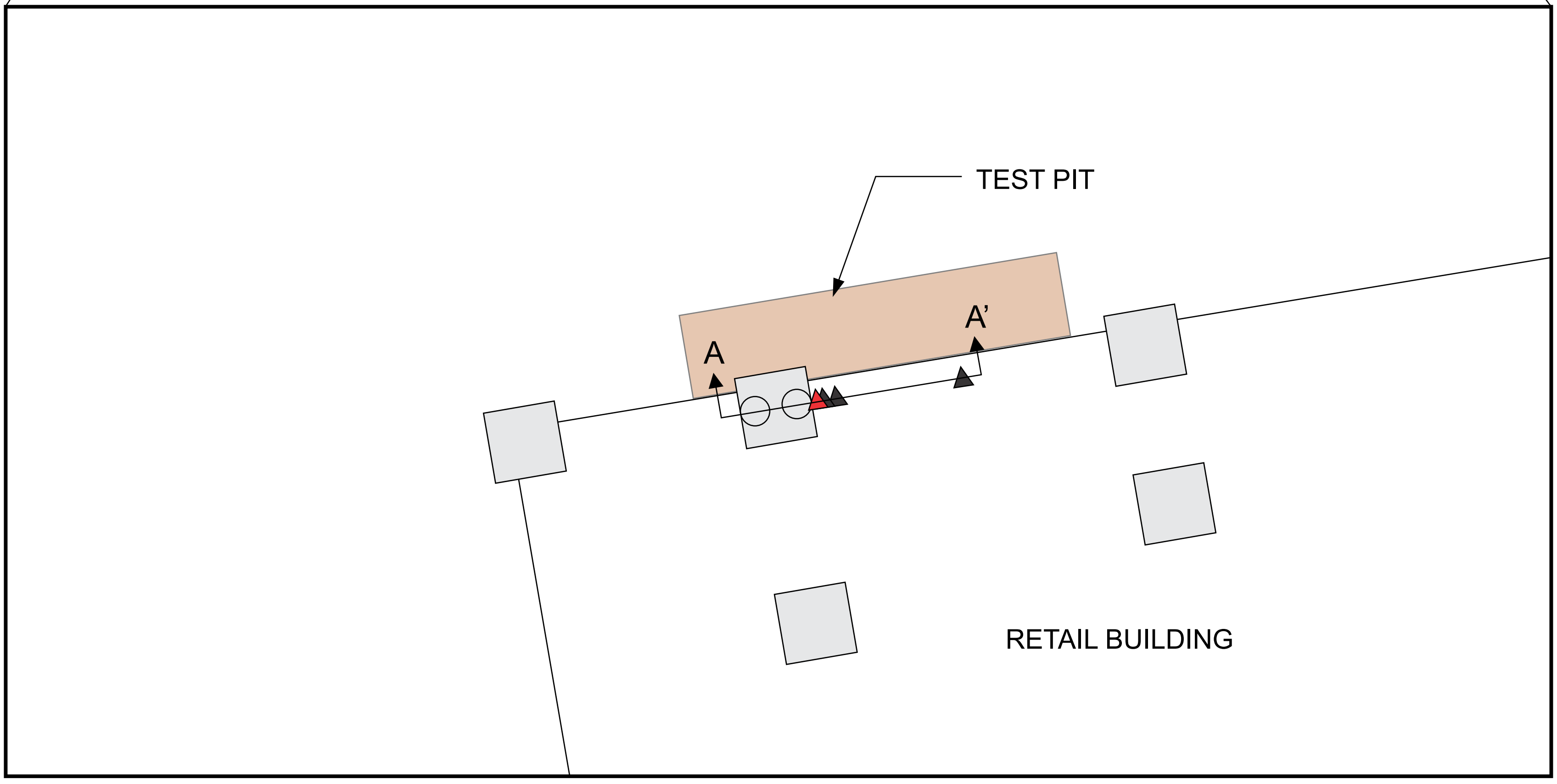
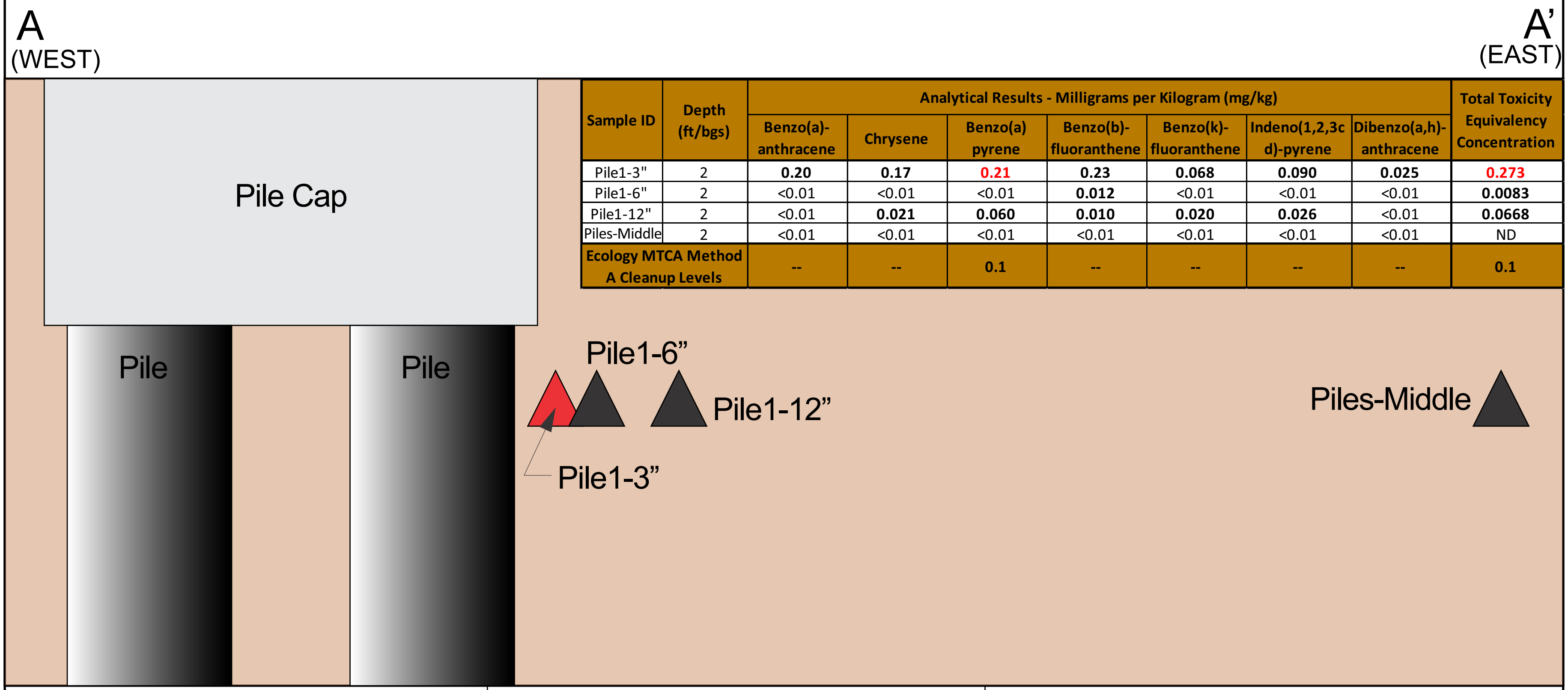
Figure 8
Geotrax Survey Results



UB33/MW33	
Benza(a)anthrocene	ND
Chrysene	ND
Benzo(a)pyrene	ND
Benzo(b)fluoranthene	ND
Benzo(k)fluoranthene	ND
Indeno(1,2,3-cd)pyrene	ND
Dibenz(a,h)anthracene	ND

UB32/MW32	
Benza(a)anthrocene	ND
Chrysene	ND
Benzo(a)pyrene	ND
Benzo(b)fluoranthene	ND
Benzo(k)fluoranthene	ND
Indeno(1,2,3-cd)pyrene	ND
Dibenz(a,h)anthracene	ND





Sample ID	Depth (ft/bgs)	Analytical Results - Milligrams per Kilogram (mg/kg)							Total Toxicity Equivalency Concentration
		Benzo(a)-anthracene	Chrysene	Benzo(a) pyrene	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Indeno(1,2,3cd)-pyrene	Dibenzo(a,h)-anthracene	
Pile1-3"	2	**0.20**	**0.17**	**0.21**	**0.23**	**0.068**	**0.090**	**0.025**	**0.273**
Pile1-6"	2	<0.01	<0.01	<0.01	**0.012**	<0.01	<0.01	<0.01	**0.0083**
Pile1-12"	2	<0.01	**0.021**	**0.060**	**0.010**	**0.020**	**0.026**	<0.01	**0.0668**
Piles-Middle	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND
Ecology MTCA Method A Cleanup Levels		--	--	0.1	--	--	--	--	0.1

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Figure 9
PAH Assessment and Empirical Data

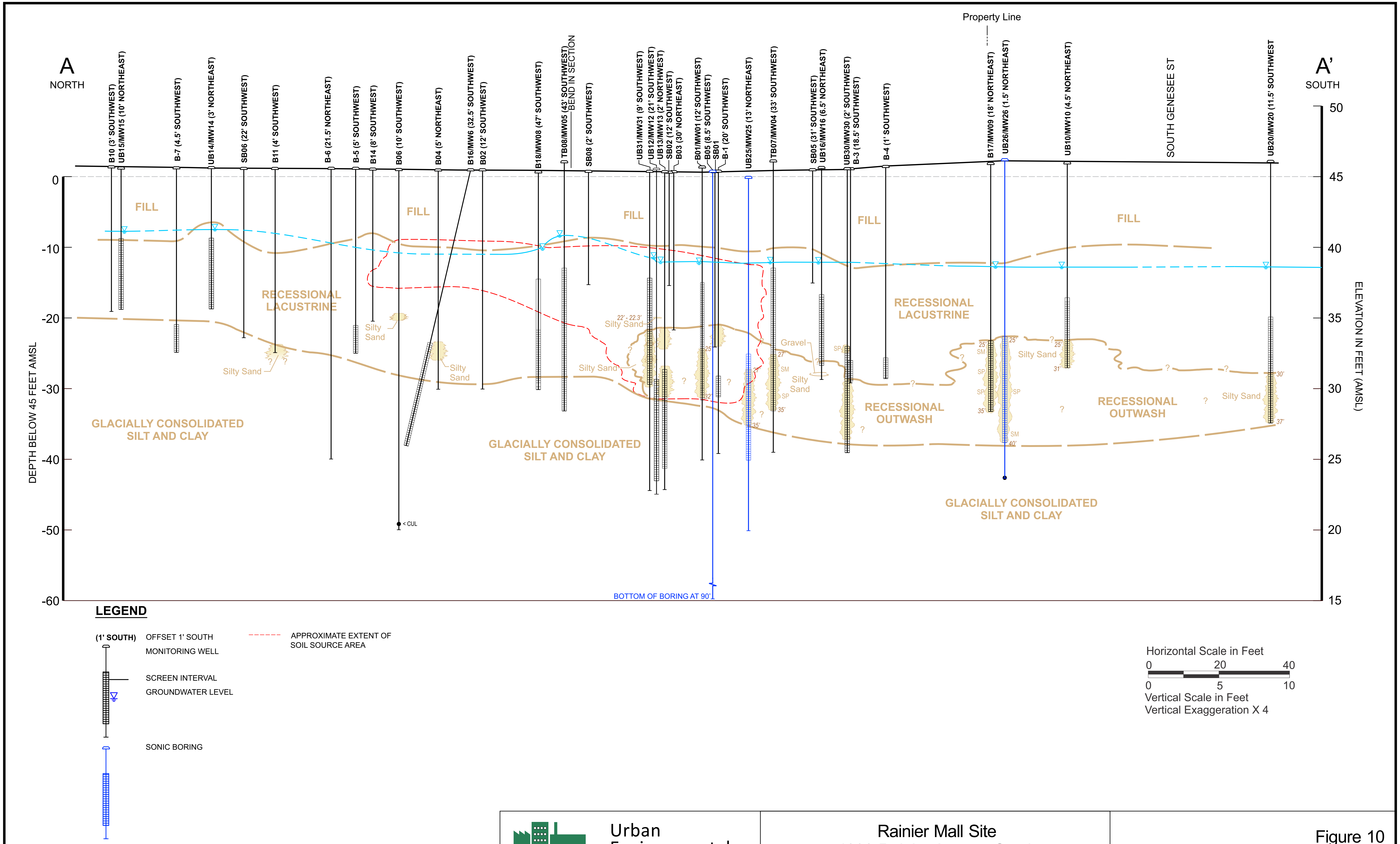

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Figure 10
Geologic Cross Section A-A'

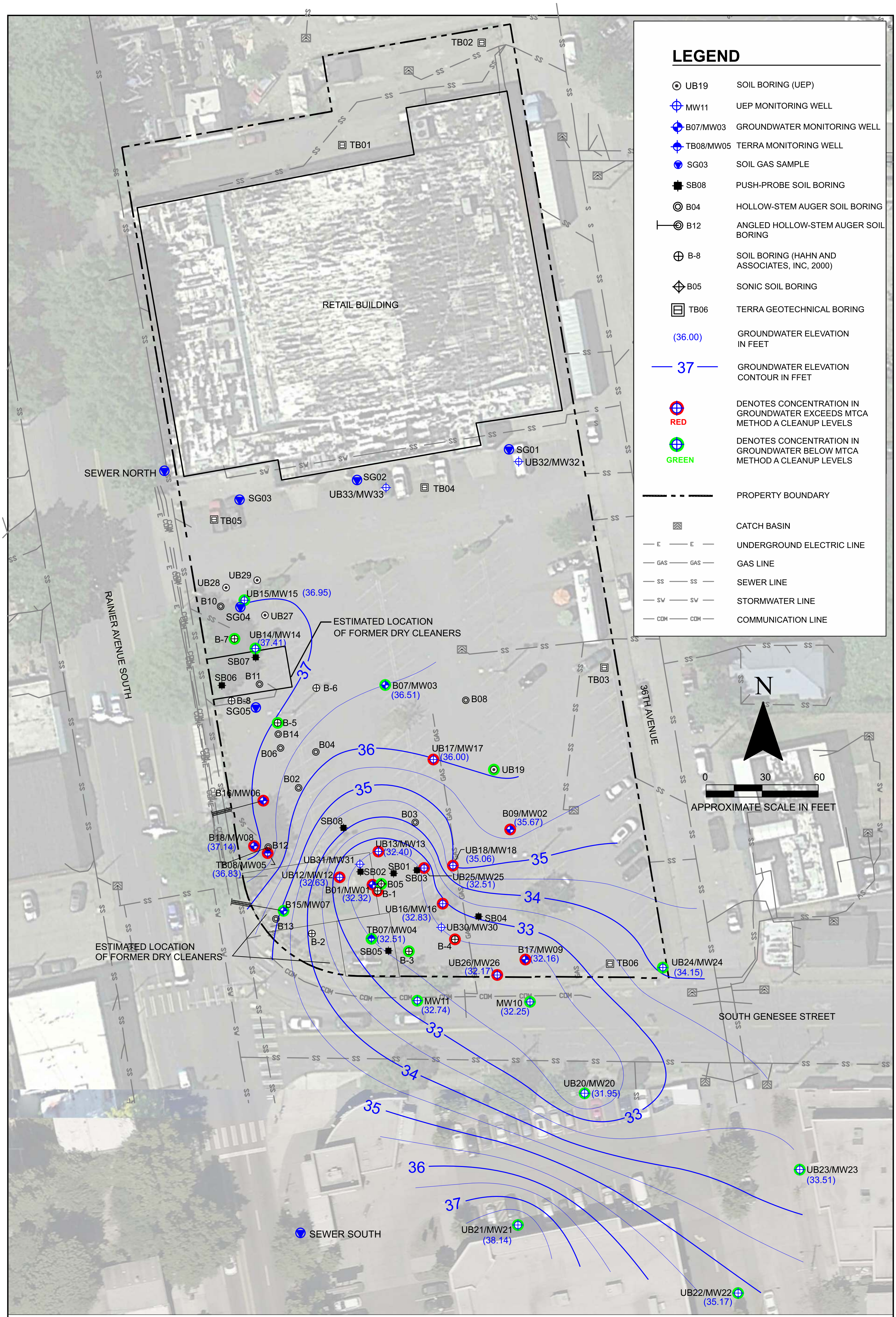

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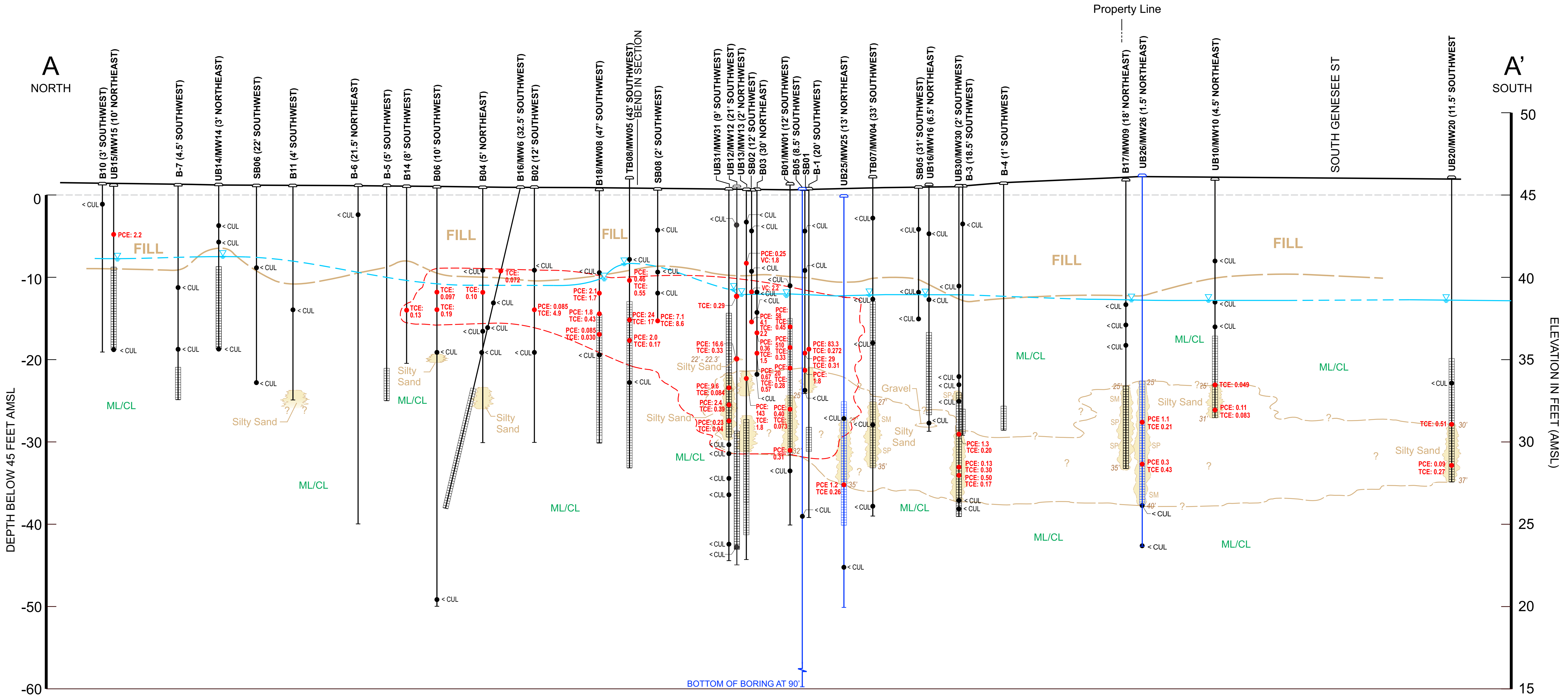
Figure 11
Groundwater Contour Map
4/14/2020



LEGEND

(1' SOUTH) OFFSET 1' SOUTH

MONITORING WELL

SCREEN INTERVAL

GROUNDWATER LEVEL

SONIC BORING

APPROXIMATE EXTENT OF SOIL SOURCE AREA

CONCENTRATIONS OF CHEMICALS OF CONCERN IN SOIL (mg/kg):

● CONCENTRATION BELOW MTCA METHOD A CLEANUP LEVEL

● CONCENTRATION ABOVE MTCA METHOD A CLEANUP LEVEL

mg/kg	MILLIGRAMS PER KILOGRAM
µg/L	MICROGRAMS PER LITER
RED	DENOTES CONCENTRATIONS EXCEEDING MTCA METHOD A CLEANUP LEVELS
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
MTCA	WASHINGTON STATE MODEL TOXICS CONTROL ACT
bgs	BELOW GROUND SURFACE
VC	VINYL CHLORIDE
< CUL	BELOW CLEANUP LEVEL PCE CUL (SOIL) = 0.05 mg/kg

Horizontal Scale in Feet
0 20 40
0 5 10
Vertical Scale in Feet
Vertical Exaggeration X 4

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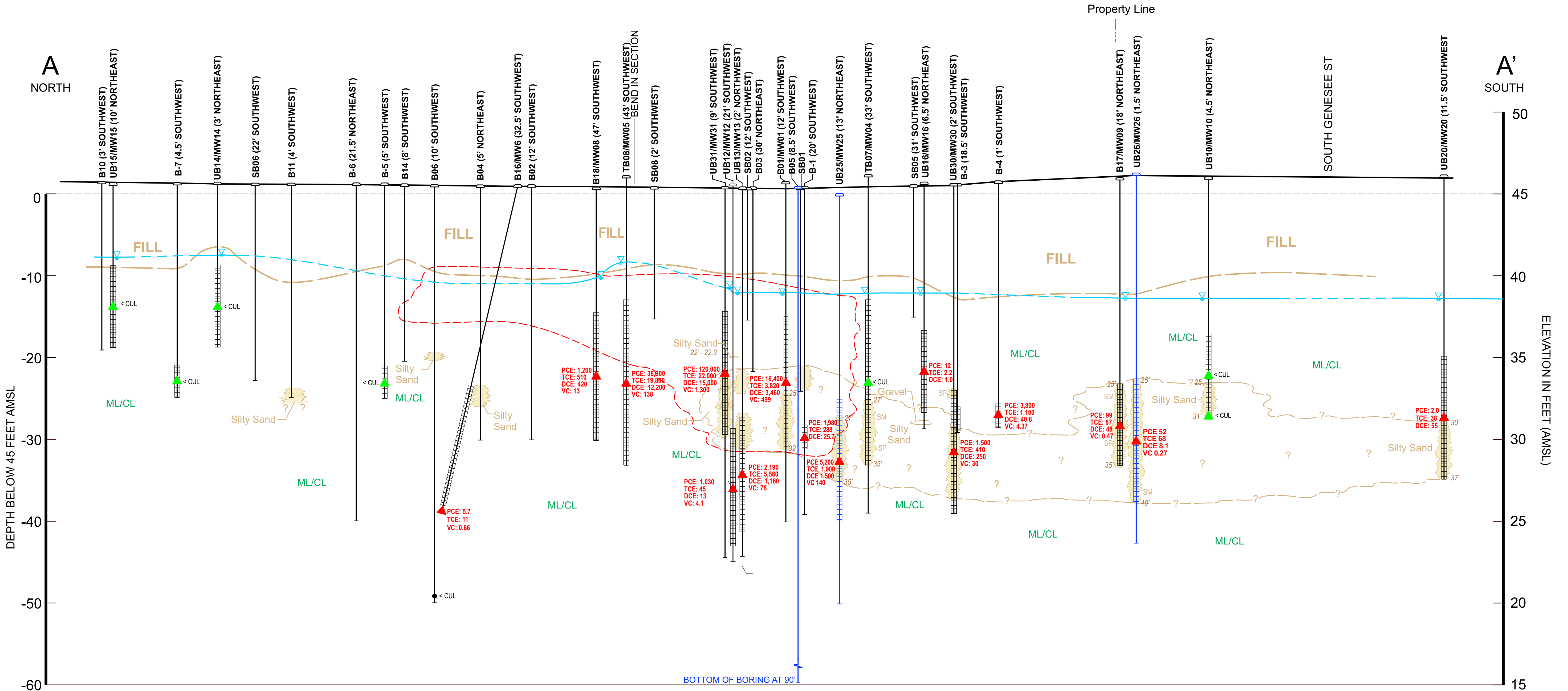
Figure 12
Cross Section A-A' with
CVOC Concentrations in Soil



LEGEND

(1' SOUTH) OFFSET 1' SOUTH

MONITORING WELL

SCREEN INTERVAL

GROUNDWATER LEVEL

SONIC BORING

APPROXIMATE EXTENT OF SOIL SOURCE AREA

CONCENTRATIONS OF CHEMICALS OF CONCERN IN PERCHED GROUNDWATER

🟩 CONCENTRATION BELOW MTCA METHOD A CLEANUP LEVEL

🟥 CONCENTRATION ABOVE MTCA METHOD A CLEANUP LEVEL

< CUL BELOW CLEANUP LEVEL
PCE CUL (GW) = 5.0 µg/L

NOTE: GROUNDWATER CONCENTRATIONS DEPICTED IN THIS FIGURE ARE FROM MOST RECENT SAMPLING EVENTS.

Horizontal Scale in Feet
0 20 40
0 5 10
Vertical Scale in Feet
Vertical Exaggeration X 4

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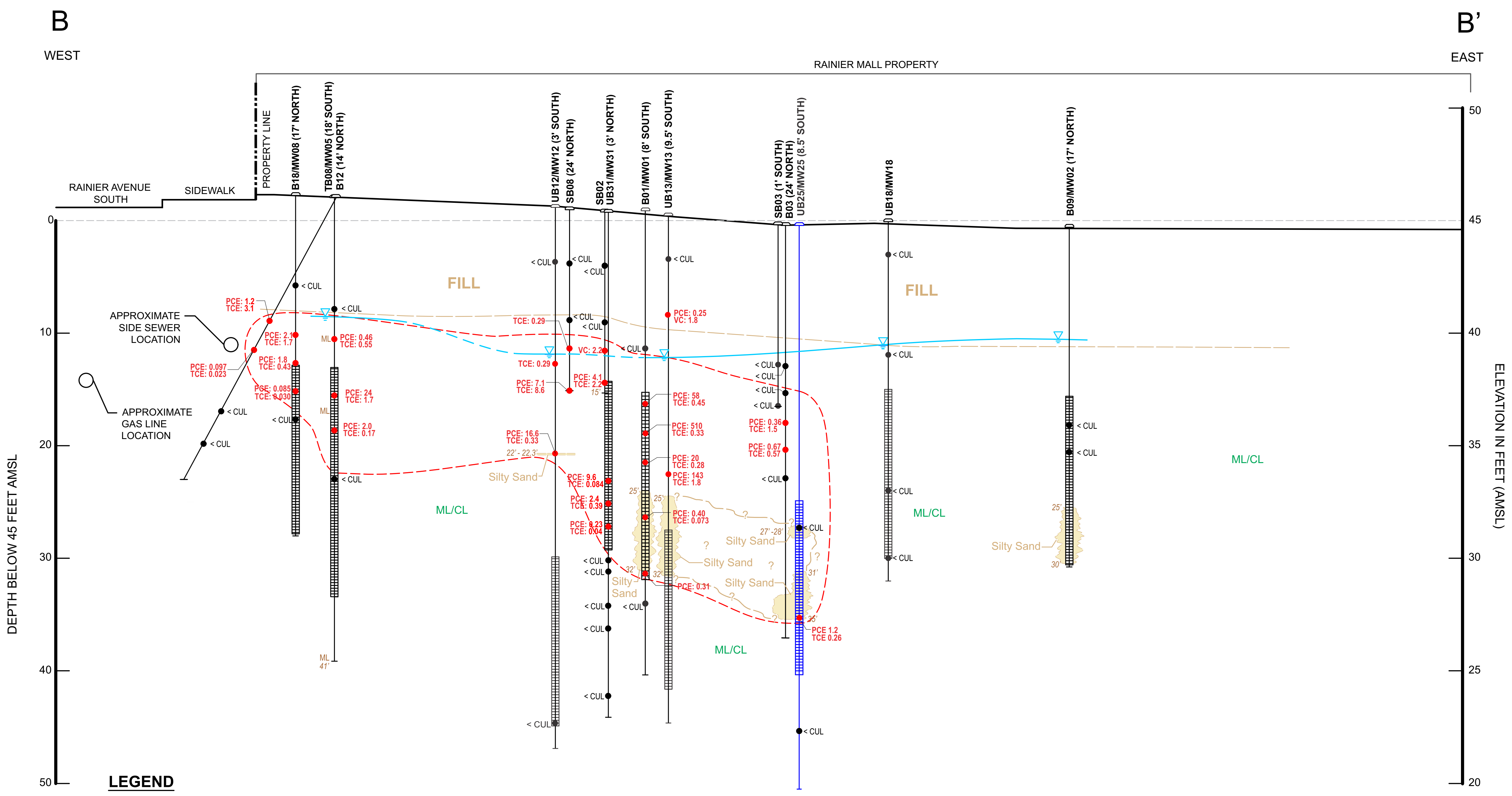
Figure 13
Cross Section A-A' with cVOC Concentrations in Groundwater



LEGEND

(1' SOUTH) OFFSET 1' SOUTH

MONITORING WELL

SCREEN INTERVAL

GROUNDWATER LEVEL

SONIC BORING

APPROXIMATE EXTENT OF SOIL SOURCE AREA

CONCENTRATIONS OF CHEMICALS OF CONCERN IN SOIL (mg/kg):

● CONCENTRATION BELOW MTCA METHOD A CLEANUP LEVEL

● CONCENTRATION ABOVE MTCA METHOD A CLEANUP LEVEL

mg/kg	MILLIGRAMS PER KILOGRAM
µg/L	MICROGRAMS PER LITER
RED	DENOTES CONCENTRATIONS EXCEEDING MTCA METHOD A CLEANUP LEVELS
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
MTCA	WASHINGTON STATE MODEL TOXICS CONTROL ACT
bgs	BELOW GROUND SURFACE
VC	VINYL CHLORIDE
< CUL	BELOW CLEANUP LEVEL PCE CUL (SOIL) = 0.05 mg/kg

Horizontal Scale in Feet
0 10 20
0 5 10
Vertical Scale in Feet
Vertical Exaggeration X 2

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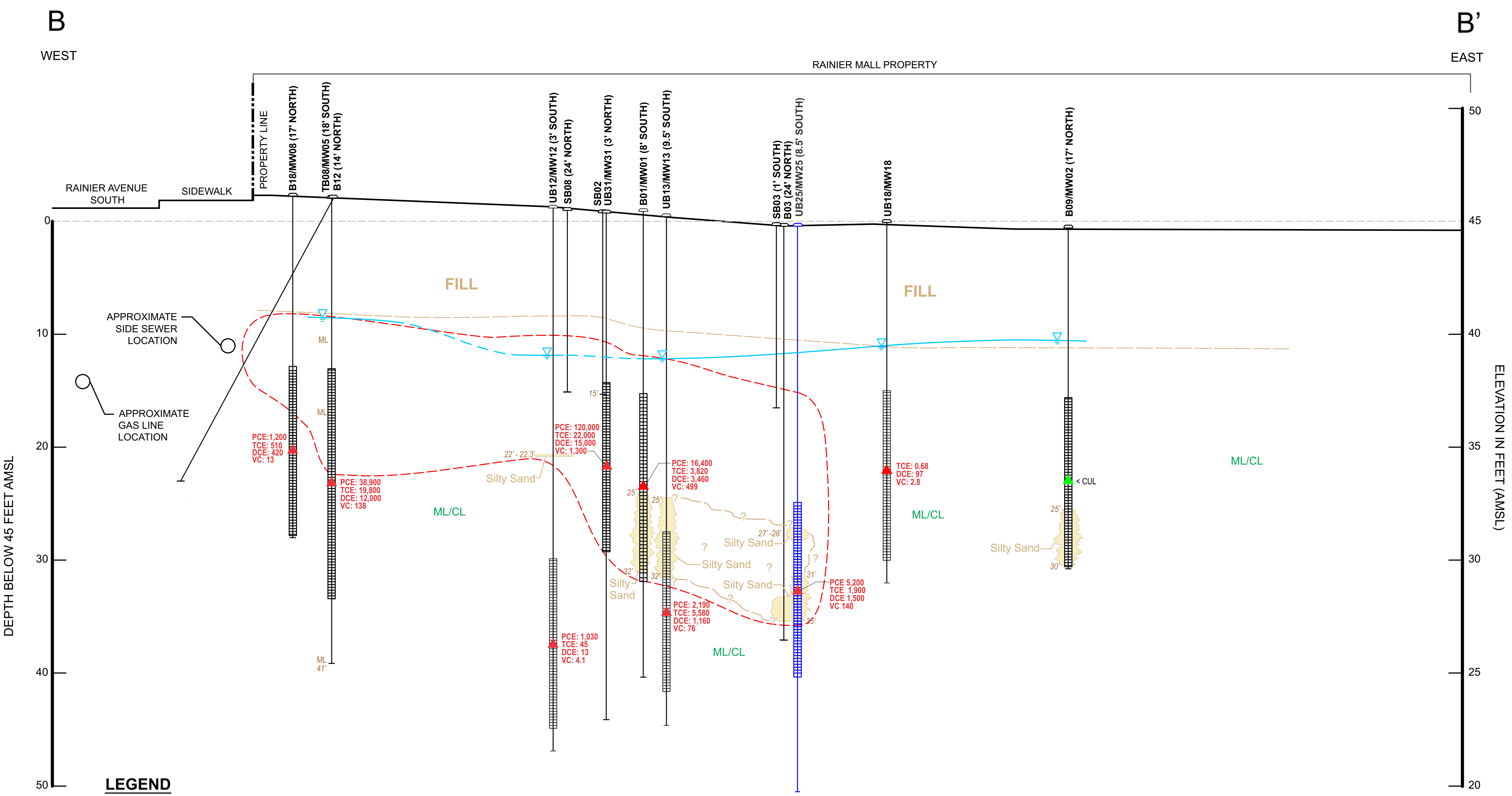
Figure 14
Cross Section B-B' with
CVOC Concentrations in Soil



LEGEND

Horizontal Scale in Feet
0 10 20
0 5 10
Vertical Scale in Feet
Vertical Exaggeration X 2

(1' SOUTH) OFFSET 1' SOUTH
MONITORING WELL
SCREEN INTERVAL
GROUNDWATER LEVEL

SONIC BORING

APPROXIMATE EXTENT OF SOIL SOURCE AREA

CONCENTRATIONS OF CHEMICALS OF CONCERN IN PERCHED GROUNDWATER

▲ CONCENTRATION BELOW MTCA METHOD A CLEANUP LEVEL

▲ CONCENTRATION ABOVE MTCA METHOD A CLEANUP LEVEL

mg/kg	MILLIGRAMS PER KILOGRAM
µg/L	MICROGRAMS PER LITER
RED	DENOTES CONCENTRATIONS EXCEEDING MTCA METHOD A CLEANUP LEVELS

PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
MTCA	WASHINGTON STATE MODEL TOXICS CONTROL ACT
bgs	BELOW GROUND SURFACE
VC	VINYL CHLORIDE
< CUL	BELOW CLEANUP LEVEL PCE CUL (GW) = 5.0 µg/L

NOTE: GROUNDWATER CONCENTRATIONS DEPICTED IN THIS FIGURE ARE FROM MOST RECENT SAMPLING EVENTS.

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Figure 15
Cross Section B-B' with CVOC
Concentrations in Groundwater

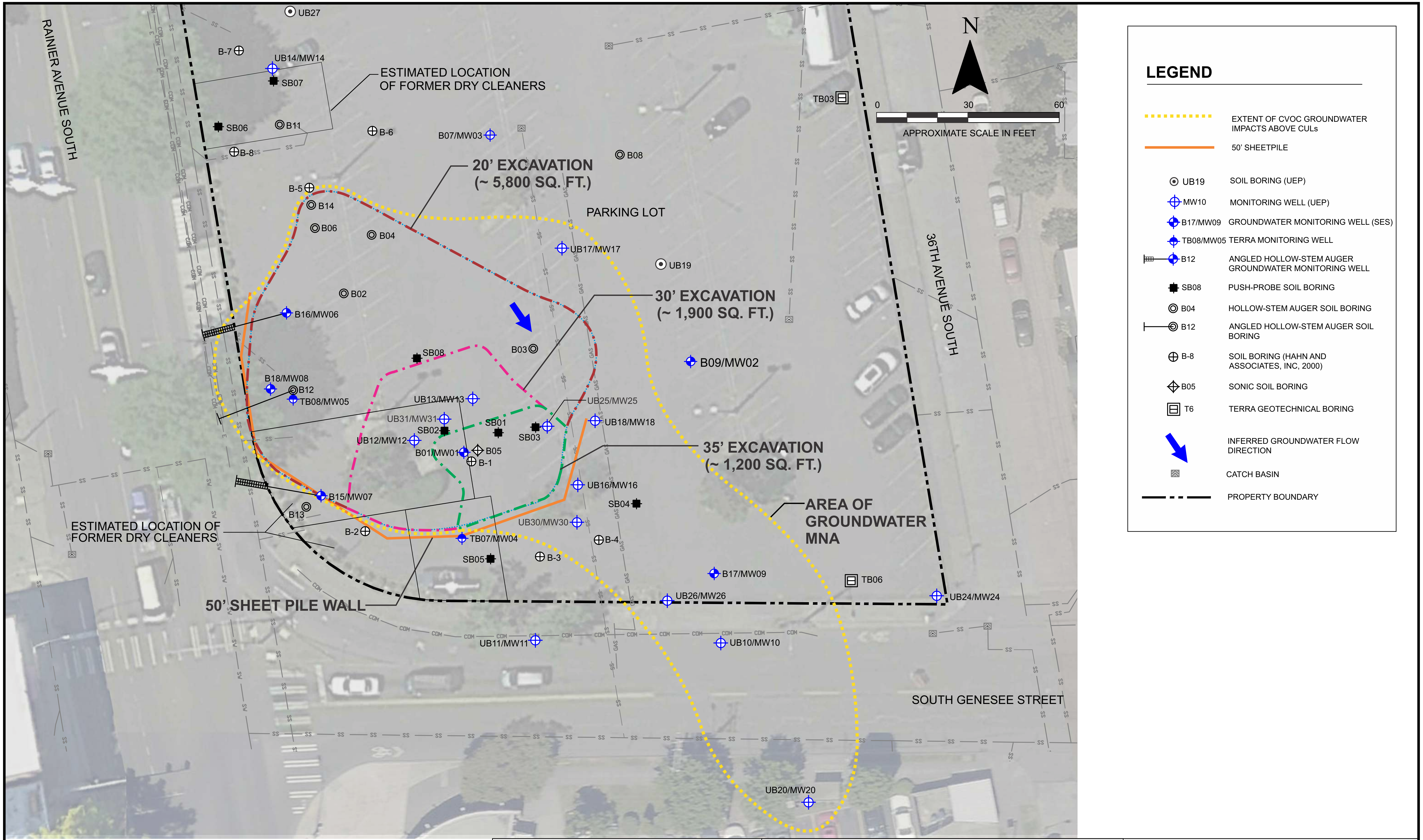

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Figure 16 - Alternative 1
Excavation of Soil with
Monitored Natural Attenuation

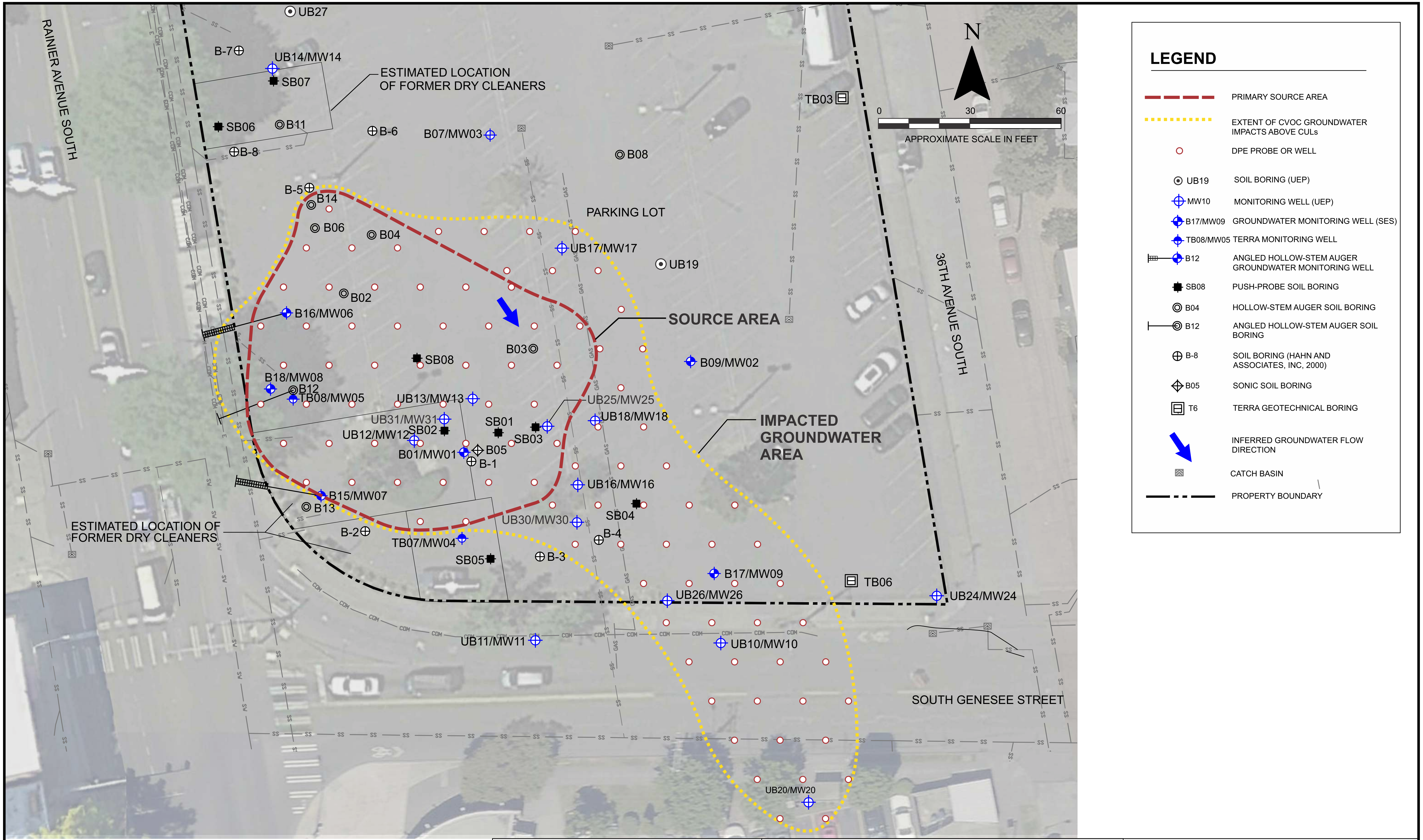

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Figure 17 - Alternative 2
DPE with Air Sparging

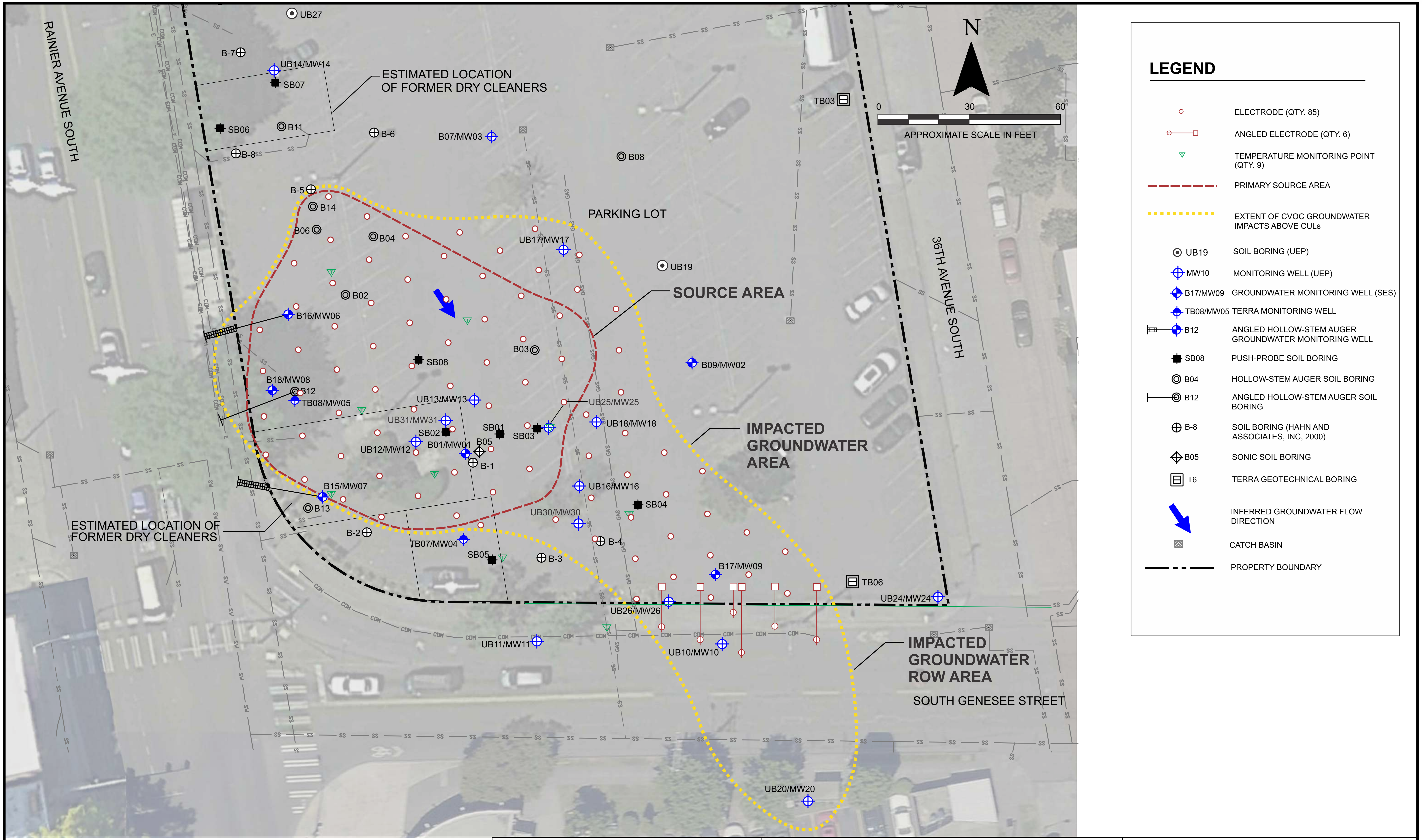

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Figure 18 - Alternative 3
Electrical Resistance Heating
with SVE

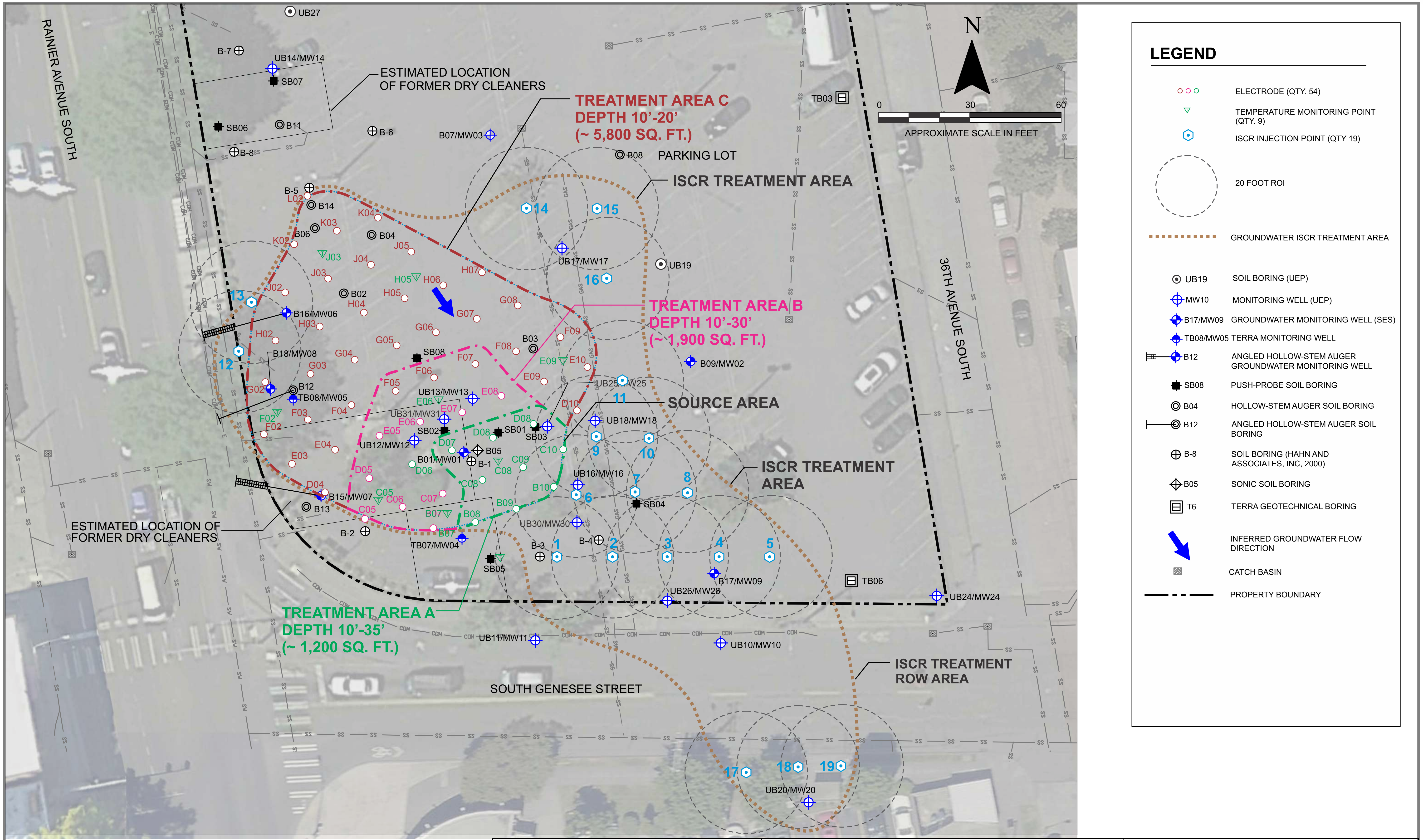

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Figure 19 - Alternative 4
ERH (Source Area) and
ISCR (Groundwater)

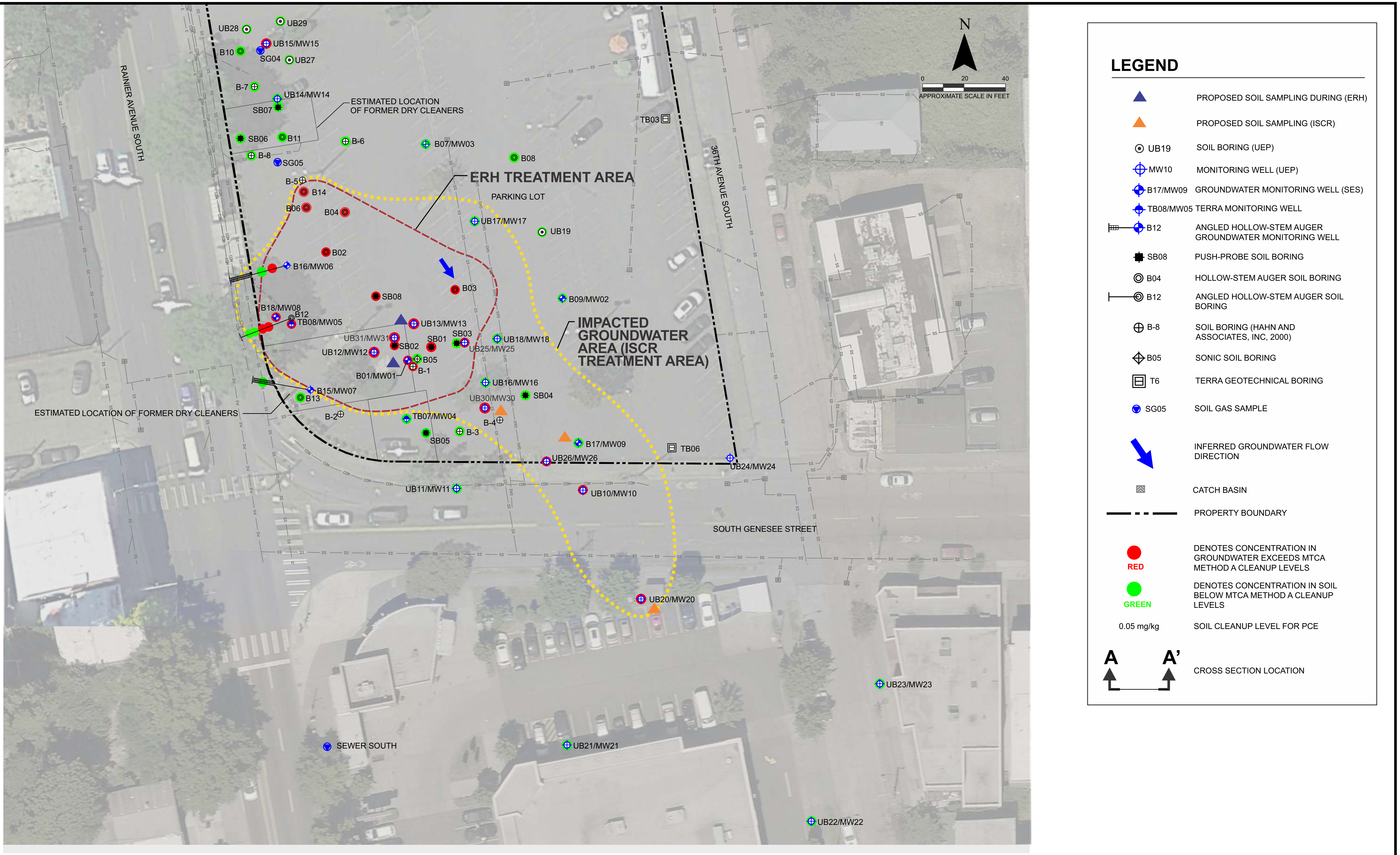

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Figure 20
Soil Performance and Compliance Monitoring

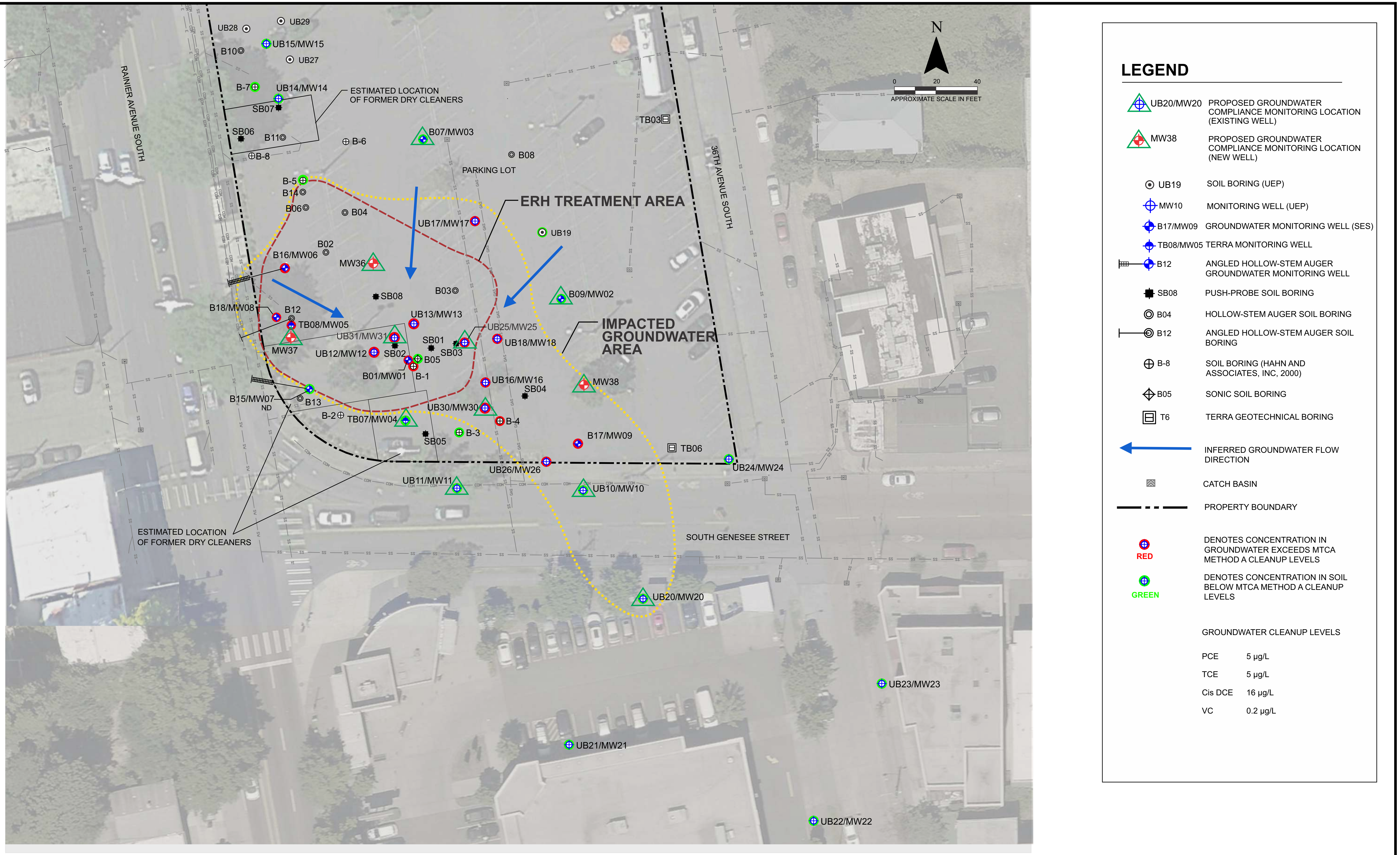

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Figure 21
Proposed Groundwater
Compliance Monitoring

Exhibit B: Tables

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Table 1
Soil Analytical Results for cVOCs
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Milligrams per Kilogram (mg/kg)					
					PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC
B-1	5015-000628-005	Hahn	6/28/2000	19.5	**83.3**	**0.272**	<0.005	--	<0.005	<0.01
B-3	5015-000628-018	Hahn	6/28/2000	4.5	<0.005	<0.005	<0.005	--	<0.005	<0.01
B-6	5015-000628-018	Hahn	6/28/2000	7	<0.005	<0.005	<0.005	--	<0.005	<0.01
B-8	5015-000629-039	Hahn	6/28/2000	4.5	<0.005	<0.005	<0.005	--	<0.005	<0.01
SB01	SB01-5.0	SoundEarth	1/18/2017	5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB01-10.0			10	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB01-20.0			20	**29**	**0.31**	<0.05	<0.05	--	<0.05
	SB01-22.5			22.5	**1.8**	<0.02	<0.05	<0.05	--	<0.05
	SB01-24.5			24.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
SB02	SB02-5.0	SoundEarth	1/18/2017	5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB02-10.0			10	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB02-12.5			12.5	<0.025	<0.02	**6.7**	**0.052**	--	**2.2**
	SB02-16			16	**4.1**	**2.2**	**1.1**	<0.05	--	**0.052**
SB03	SB03-12.5	SoundEarth	1/18/2017	12.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB03-16.0			16	<0.025	<0.02	<0.05	<0.05	--	<0.05
SB04	SB04-5.0	SoundEarth	1/18/2017	5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB04-12.5			12.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB04-16.0			16	<0.025	<0.02	<0.05	<0.05	--	<0.05
SB05	SB05-5.0	SoundEarth	1/18/2017	5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB05-12.5			12.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB05-16.0			16	<0.025	<0.02	<0.05	<0.05	--	<0.05
SB06	SB06-10.0	SoundEarth	1/18/2017	10	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB06-24.0			24	<0.025	<0.02	<0.05	<0.05	--	<0.05
SB07	SB07-10.0	SoundEarth	1/18/2017	10	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB07-16.0			16	<0.025	<0.02	<0.05	<0.05	--	<0.05
SB08	SB08-5.0	SoundEarth	1/18/2017	5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB08-10			10	<0.025	<0.02	<0.05	<0.05	--	<0.05
	SB08-12.5			12.5	<0.025	**0.029**	**1.3**	**0.086**	--	<0.05
	SB08-16.0			16	**7.1**	**8.6**	**10**	**0.056**	--	**0.24**
B01/MW01	B01-12.5	SoundEarth	2/9/2017	12.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	B01-17.5			17.5	**58**	**0.45**	<0.05	<0.05	--	<0.05
	B01-20			20	**510**	**0.33**	<0.05	<0.05	--	<0.05
	B01-22.5			22.5	**20**	**0.28**	<0.05	<0.05	--	<0.05
	B01-27.5			27.5	**0.40**ht	**0.073**ht	<0.05ht	<0.05ht	--	<0.05ht
	B01-32.5			32.5	**0.31**ht	<0.02ht	<0.05ht	<0.05ht	--	<0.05ht
	B01-35			35	**0.049**ht	<0.02ht	<0.05ht	<0.05ht	--	<0.05ht
B02	B02-10	SoundEarth	2/9/2017	10.0	<0.025	<0.02	**0.13**	<0.05	--	<0.05
	B02-15			15.0	**0.085**	**4.9**	**6.7**	**0.25**	--	0.097
	B02-20			20.0	<0.025	<0.02	<0.05	<0.05	--	<0.05
B03	B03-12.5	SoundEarth	2/9/2017	12.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
	B03-15			15.0	<0.025	<0.02	0.082	<0.05	--	<0.05
	B03-17.5			17.5	**0.36**	**1.5**	**1.1**	<0.05	--	<0.05
	B03-20			20.0	**0.67**	**0.57**	**0.41**	<0.05	--	<0.05
	B03-22.5			22.5	<0.025	<0.02	<0.05	<0.05	--	<0.05
B04	B04-10	SoundEarth	2/9/2017	10.0	<0.025	<0.02	<0.05	<0.05	--	<0.05
	B04-12.5			12.5	<0.025	**0.10**	**0.79**	**0.12**	--	<0.05
	B04-17.5			17.5	<0.025	<0.02	**0.32**	<0.05	--	<0.05
B05	B05-40	SoundEarth	3/22/2017	40.0	<0.025	<0.02	<0.05	<0.05	--	<0.05
TB01	TB01-15	SoundEarth	1/24/2018	15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
TB02	TB02-15	SoundEarth	1/24/2018	15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
TB05	TB05-05	SoundEarth	1/25/2018	5	<0.025	<0.02	--	--	<0.05	<0.05
TB07	TB07-05	SoundEarth	1/26/2018	5	<0.025	<0.02	<0.05	--	<0.05	<0.05
	TB07-15			15.0	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	TB07-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	TB07-30			30	<0.025	<0.02	<0.05	--	<0.05	<0.05

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Table 1
Soil Analytical Results for cVOCs
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Milligrams per Kilogram (mg/kg)					
					PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC
TB08	TB08-10	SoundEarth	1/26/2018	10.0	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	TB02-12.5			12.5	**0.46**	**0.55**	**0.21**	--	<0.05	<0.05
	TB08-17.5			17.5	**24**	**1.7**	**0.45**	--	<0.05	<0.05
	TB08-20			20.0	**2.0**	**0.17**	**0.06**	--	<0.05	<0.05
	TB08-25			25	<0.025	<0.02	<0.05	--	<0.05	<0.05
B06	B06-12.5	SoundEarth	1/26/2018	12.5	<0.025	**0.097**	**0.15**	--	<0.05	<0.05
	B06-15			15	<0.025	**0.19**	**0.47**	<0.05	<0.05	<0.05
	B06-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B06-50			50	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B07	B07-12.5	SoundEarth	1/25/2018	12.5	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B07-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B08	B08-15	SoundEarth	1/25/2018	15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B08-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B09	B09-17.5	SoundEarth	1/25/2018	17.5	<0.025	<0.02	<0.05	--	<0.05	<0.05
	B09-20			20	<0.025	<0.02	<0.05	--	<0.05	<0.05
B10	B10-2.5	SoundEarth	1/26/2018	2.5	<0.025	<0.02	--	--	<0.05	<0.05
B11	B11-15	SoundEarth	1/26/2018	15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B12	B12-10.5	SoundEarth	2/7/2018	10.5–11.5	**1.2**	**3.1**	**0.88**	<0.05	<0.05	<0.05
	B12-14			14–15	**0.097**	**0.023**	<0.05	<0.05	<0.05	<0.05
	B12-17			17–18	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B12-20			20–21	<0.025	<0.02	<0.05	--	<0.05	<0.05
B13	B13-15	SoundEarth	2/7/2018	15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B14	B14-15	SoundEarth	2/7/2018	15	<0.025	**0.13**	**0.40**	<0.05	<0.05	<0.05
B15	B15-11	SoundEarth	10/1/2018	10.5–11.5	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B15-14			14–15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B15-17			17–18	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B15-20			20–21	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B16	B16-11	SoundEarth	10/1/2018	10.5–11.5	<0.025	**0.072**	<0.05	<0.05	<0.05	<0.05
	B16-14			14–15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B16-17			17–18	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B16-20			20–21	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B17	B17-15	SoundEarth	10/2/2018	15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B17-17.5			17.5	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	B17-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
B18	B18-10	SoundEarth	10/2/2018	10	<0.025	<0.02	**0.51**	<0.05	<0.05	<0.05
	B18-12.5			12.5	**2.1**	**1.7**	**0.93**	<0.05	<0.05	<0.05
	B18-15			15	**1.8**	**0.43**	**0.38**	<0.05	<0.05	<0.05
	B18-17.5			17.5	**0.085**	**0.030**	<0.05	<0.05	<0.05	<0.05
	B18-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB10	UB10-10	UEP	4/20/2019	10	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB10-15			15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB10-18			18	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB10-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB10-25			25	<0.025	**0.049**	<0.05	<0.05	<0.05	<0.05
	UB10-28			28	**0.11**	**0.083**	<0.05	<0.05	<0.05	<0.05
UB11	UB11-13	UEP	4/20/2019	13	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB11-15			15	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB11-20			20	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB11-25			25	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB11-28			28	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB12 (CD02A)	UB12-5	UEP	3/4/2020	5	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB12-14			14	<0.02	**0.29**	**2.06**	<0.02	<0.05	**0.34**
	UB12-22			22	**16.6**	**0.33**	**0.17**	<0.02	<0.05	<0.02
	UB12-37			37	~~**0.16**~~	<0.02	<0.02	<0.02	<0.05	<0.02
	UB12-46			46	~~**0.028**~~	<0.02	<0.02	<0.02	<0.05	<0.02
UB13 (CD08)	UB13-4	UEP	3/5/2020	4	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB13-9			9	**0.25**	<0.02	**33**	**0.21**	<0.05	**1.8**
	UB13-23			23	**143**	**1.8**	**0.16**	<0.02	<0.05	**0.033**
	UB13-43			43	~~**0.39**~~	<0.02	<0.02	<0.02	<0.05	<0.02

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Table 1
Soil Analytical Results for cVOCs
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Milligrams per Kilogram (mg/kg)					
					PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC
UB14 (CD06)	UB14-5	UEP	3/5/2020	5	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB14-7			7	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB14-20			20	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
UB15 (CD10A)	UB15-6	UEP	3/5/2020	6	**2.2**	<0.02	<0.02	<0.02	<0.05	<0.02
	UB15-20			20	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
UB16 (CD02B)	UB16-6	UEP	3/4/2020	6	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB16-14			14	**0.028**	<0.02	<0.02	<0.02	<0.05	<0.02
	UB16-29			29	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
UB17 (CD05B)	UB17-3	UEP	3/5/2020	3	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB17-11			11	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB17-24			24	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
UB18 (CD03)	UB18-3	UEP	3/5/2020	3	<0.02	<0.02	**0.022**	<0.02	<0.05	<0.02
	UB18-12			12	**0.027**	<0.02	<0.02	<0.02	<0.05	<0.02
	UB18-24			24	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB18-30			30	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
UB19	UB19-24	UEP	3/5/2020	24	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
UB20	UB20-25	UEP	3/12/2020	25	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02
	UB20-30			30	**0.047**	**0.51**	**0.36**	<0.02	<0.05	<0.02
	UB20-35			35	**0.09**	**0.27**	**0.083**	<0.02	<0.05	<0.02
UB21	UB21-25	UEP	4/7/2020	25	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB21-30			30	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB21-34			34	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB22	UB22-25	UEP	4/7/2020	25	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB23	UB23-25	UEP	4/7/2020	25	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB23-30			30	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB23-33			33	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB25	UB25-27	UEP	4/10/2020	27	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB25-35			35	**1.2**	**0.26**	<0.05	<0.05	<0.05	<0.05
	UB25-45			45	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB26	UB26-30	UEP	4/10/2020	30	**1.1**	**0.21**	<0.05	<0.05	<0.05	<0.05
	UB26-35			35	**0.31**	**0.43**	**0.14**	<0.05	<0.05	<0.05
	UB26-40			40	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB26-45			45	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB27	UB27-6	UEP	4/10/2020	6	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB27-12			12	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB28	UB28-6	UEP	4/10/2020	6	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB28-11			11	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB29	UB29-6	UEP	4/10/2020	6	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB29-11			11	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
UB30	UB30-12	UEP	5/15/2020	12	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB30-23			23	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB30-24			24	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB30-26			26	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB30-30			30	**1.3**	**0.20**	<0.05	<0.05	<0.05	<0.05
	UB30-31			31	**0.13**	**0.030**	<0.05	<0.05	<0.05	<0.05
	UB30-34			34	**0.56**	**0.10**	<0.05	<0.05	<0.05	<0.05
	UB30-35			35	**0.50**	**0.17**	<0.05	<0.05	<0.05	<0.05
	UB30-38			38	**0.035**	**0.024**	<0.05	<0.05	<0.05	<0.05
	UB30-39			39	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05

Table 1
Soil Analytical Results for cVOCs
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Milligrams per Kilogram (mg/kg)					
					PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC
UB31	UB31-24	UEP	5/15/2020	24	**9.6**	**0.084**	<0.05	<0.05	<0.05	<0.05
	UB31-26			26	**2.4**	**0.39**	**0.073**	<0.05	<0.05	<0.05
	UB31-28			28	**0.23**	**0.04**	<0.05	<0.05	<0.05	<0.05
	UB31-31			31	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB31-32			32	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB31-35			35	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB31-37			37	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
	UB31-43			43	<0.025	<0.02	<0.05	<0.05	<0.05	<0.05
Ecology MTCA Method A Cleanup Levels[2] Unless Otherwise Specified					**0.05**	**0.03**	**160[3]**	**1,600[3]**	**4,000[3]**	**0.67[4]**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
~~0.39~~ = Sample results was determined to be anomalous.
< = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).(1) Analyzed by EPA Method 8260C or 8260D.
(2) MTCA Cleanup Regulation, Chapter 173-340 of WAC, Table 740-1 Method A Cleanup Levels for Soil, revised 2013.
(3) MTCA Cleanup Regulation, Chapter 173-340 of WAC, CLARC Soil, Method B Noncancer, Direct Contact, CLARC Website: <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>
(4) MTCA Cleanup Regulation, Chapter 173-340 of WAC, CLARC Soil, Method B Cancer, Direct Contact, CLARC Website: < https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>

-- = not analyzed/not applicable
bgs = below grade surface
UEP = Urban Environmental Partners llc
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
cVOCs: Chlorinated Volatile Organic Compounds
PCE = tetrachloroethylene
TCE = trichloroethylene
DCE = dichloroethylene
VC = Vinyl Chloride
MTCA = Washington Model Toxics Control Act.
Hahn = Hahn and Associates, Inc.
SoundEarth = SoundEarth Strategies, Inc.

Table 2
Soil Analytical Results for Petroleum Hydrocarbons and Select VOCs
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results - Milligrams per Kilogram (mg/kg)						
					GRPH	DRPH	ORPH	Benzene	Toluene	Ethylbenzene	Total Xylenes
TB01	TB01-15	SoundEarth	1/24/2018	15	**15**	**110**x	<250	--	--	--	--
TB02	TB02-15	SoundEarth	1/24/2018	15	<5	<50	<250	--	--	--	--
TB05	TB05-05	SoundEarth	1/24/2018	5	<5	**190**x	**5,100**	--	--	--	--
UB12 (CD02A)	UB12-5	UEP	3/4/2020	5	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB12-14			14	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB12-22			22	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB12-37			37	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB12-46			46	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB13 (CD08)	UB13-4	UEP	3/5/2020	4	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB13-9			9	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB13-23			23	**160***	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB13-43			43	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB14 (CD06)	UB14-5	UEP	3/5/2020	5	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB14-7			7	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB14-20			20	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB15 (CD10A)	UB15-6	UEP	3/5/2020	6	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB15-20			20	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB16 (CD02B)	UB16-6	UEP	3/4/2020	6	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB16-14			14	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB16-29			29	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB17 (CD05B)	UB17-3	UEP	3/5/2020	3	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB17-11			11	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB17-24			24	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB18 (CD03)	UB18-3	UEP	3/5/2020	3	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB18-12			12	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB18-24			24	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
	UB18-30			30	<10	<50	<250	<0.02	<0.10	<0.03	<0.15
UB34	UB43-3	UEP	6/3/2020	3	--	<50	<250	--	--	--	--
	UB34-7			7	--	<50	<250	--	--	--	--
	UB34-13			13	--	<50	<250	--	--	--	--
UB35	UB35-4	UEP	6/3/2020	4	--	<50	<250	--	--	--	--
	UB35-10			10	--	<50	<250	--	--	--	--
	UB35-14			14	--	<50	<250	--	--	--	--
Ecology MTCA Method A Cleanup Levels[1] Unless Otherwise Specified					**100/30[2,3]**	**2,000[4]**	**2,000[4]**	**0.03[5]**	**7[5]**	**6[5]**	**9[5]**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
< = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) MTCA Cleanup Regulation, Chapter 173-340 of WAC, Table 740-1 Method A Cleanup Levels for Soil, revised 2013.
(2) Analyzed by Method NWTPH-Gx or NWTPH-HCID.
(3) The GRPH CUL is 30 mg/kg when benzene is present, or 100 mg/kg without benzene
(4) Analyzed by Method NWTPH-Dx or NWTPH-HCID
(5) Analyzed by EPA Method 8021B, 8260C, or 8260D.

Laboratory Notes:
x = The sample chromatographic pattern does not resemble the fuel standard used for quantitation.
* = The gasoline range value consists of a chlorinated compound with elevated concentrations.

-- = not analyzed/not applicable
bgs = below grade surface
NWTPH = Northwest Total Petroleum Hydrocarbon
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
GRPH = Gasoline-Range Petroleum Hydrocarbons
DRPH = Diesel-Range Petroleum Hydrocarbons
ORPH = Oil-Range Petroleum Hydrocarbons
MTCA = Washington Model Toxics Control Act.
SoundEarth = SoundEarth Strategies, Inc.

Table 3
Soil Analytical Results for Total Metals
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Milligrams per Kilogram (mg/kg)							
					Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
TB01	TB01-05	SoundEarth	1/24/2018	5	2.54	--	<1	18.8	4.82	<1	--	--
TB03	TB03-05	SoundEarth	1/24/2018	5	2.39	--	<1	28.2	4.26	<1	--	--
TB04	TB04-05	SoundEarth	1/24/2018	5	1.79	--	<1	12.1	8.10	<1	--	--
B06	B06-05	SoundEarth	1/24/2018	5	6.73	--	<1	18.0	8.81	<1	--	--
B09	B09-05	SoundEarth	1/24/2018	5	3.17	--	<1	26.8	4.06	<1	--	--
Ecology MTCA Method A Cleanup Levels[2] Unless Otherwise Specified					**20**	**16,000[3]**	**2**	**2,000**	**250**	**2**	**400[3]**	**400[3]**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
< = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) Samples analyzed by EPA Method 6020A.
(2) MTCA Cleanup Regulation, Chapter 173-340 of WAC, Table 740-1 Method A Cleanup Levels for Soil, revised 2013.
(3) MTCA Cleanup Regulation, Chapter 173-340 of WAC, CLARC, Soil, Method B, Noncancer, Direct Contact, CLARC Website <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>.

-- = not analyzed/not applicable
bgs = below grade surface
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
MTCA = Washington Model Toxics Control Act.
SoundEarth = SoundEarth Strategies, Inc.

Table 4
Soil Analytical Results for Polycyclic Aromatic Hydrocarbons
4208 Rainier Ave South, Seattle

Boring ID	Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Milligrams per Kilogram (mg/kg)							Total Toxicity Equivalency Concentration[2]
					Benzo(a)-anthracene	Chrysene	Benzo(a)pyrene	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Indeno(1,2,3cd)-pyrene	Dibenzo(a,h)-anthracene	
TB01	TB01-05	SoundEarth	1/24/2018	5	<0.02	<0.02	<0.1	<0.2	<0.2	<0.2	<0.2	ND
TB03	TB03-05	SoundEarth	1/24/2018	5	<0.02	<0.02	<0.1	<0.2	<0.2	<0.2	<0.2	ND
B09	B09-05	SoundEarth	1/24/2018	5	**0.015**	**0.028**	**0.022**	**0.031**	**0.012**	<0.010	<0.010	**0.029**
NA	Pile1-3"	UEP	4/27/2020	2	**0.20**	**0.17**	**0.21**	**0.23**	**0.068**	**0.090**	**0.025**	**0.273**
NA	Pile1-6"	UEP	4/27/2020	2	<0.01	<0.01	<0.01	**0.012**	<0.01	<0.01	<0.01	**0.0083**
NA	Pile1-12"	UEP	4/27/2020	2	<0.01	**0.021**	**0.060**	**0.010**	**0.020**	**0.026**	<0.01	**0.0668**
NA	Piles-Middle	UEP	4/27/2020	2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	ND
Ecology MTCA Method A Cleanup Levels[3] Unless Otherwise Specified					--	--	**0.1**	--	--	--	--	**0.1**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
< or ND = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) Samples analyzed by GC/MS-SIM or EPA Method 8270D.
(2) Calculated Using Toxicity Equivalency Methodology in WAC 173-340-708(e)
(3) MTCA Cleanup Regulation, Chapter 173-340 of WAC, Table 740-1 Method A Cleanup Levels for Soil, revised 2013.

-- = not analyzed/not applicable
bgs = below grade surface
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
MTCA = Washington Model Toxics Control Act.
SoundEarth = SoundEarth Strategies, Inc.
UEP = Urban Environmental Partners

Table 5
Groundwater Analytical Results for
Chlorinated Volatile Organic Compounds
4208 Rainier Ave South, Seattle

Boring/Well ID	Sample ID	Sampled By	Date Sampled	Analytical Results - Micrograms per Liter (µg/L)					
				PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC
B-1	B-1 (29-32)	Hahn	6/28/2000	**1,980**	**288**	**25.7**	--	<1.0	<1.2
B-3	B-3 (27-30)	Hahn	6/28/2000	<1.0	<1.0	**1.8**	--	<1.0	<1.2
B-4	B-4 (27-30)	Hahn	6/28/2000	**3,800**	**1,100**	**40.8**	--	**2.94**	**4.37**
B-5	B-5 (23-36)	Hahn	6/29/2000	<1.0	<1.0	<1.0	--	<1.0	<1.2
B-7	B-7 (23-26)	Hahn	6/29/2000	**1.25**	<1.0	<1.0	--	<1.0	<1.2
MW01	MW01-20180102	SoundEarth	1/2/2018	**8,700**	**<500**	**<500**	**<500**	**<500**	**<100**
	MW1-20200313	UEP	3/13/2020	**16,400**	**3,820**	**3,460**	**37**	**2.4**	**499**
MW02	MW02-20180129	SoundEarth	1/29/2018	<1	<1	7.1	<1	<1	**0.33**
	MW2-20200312	UEP	3/12/2020	<1	**0.94**	**11**	<1	<0.5	<0.2
MW03	MW03-20180129	SoundEarth	1/29/2018	<1	<1	<1	<1	<1	<0.2
	MW3-20200312	UEP	3/12/2020	<1	<0.4	<1	<1	<0.5	<0.2
MW04	MW04-20180129	SoundEarth	1/29/2018	<1	<1	<1	<1	<1	<0.2
	MW4-20200312	UEP	3/12/2020	<1	<0.4	<1	<1	<0.5	<0.2
MW05	MW05-20180129	SoundEarth	1/29/2018	**35,000**	**6,600**	**2,600**	**27**	**2.9**	**240**
	MW5-20200312	UEP	3/12/2020	**38,900**	**19,800**	**12,200**	**122**	**8.0**	**138**
MW06	MW06-20181005	SoundEarth	10/5/2018	<1	2.4	3.5	<1	<1	<0.2
	MW6-20200312	UEP	3/12/2020	**5.7**	**11**	**13**	<1	<0.5	**0.66**
MW07	MW07-20181005	SoundEarth	10/5/2018	<1	<1	<1	<1	<1	<0.2
	MW7-20200312	UEP	3/12/2020	<1	<0.4	<1	<1	<0.5	<0.2
MW08	MW08-20181005	SoundEarth	10/5/2018	**560**	**320**	**390**	**2.0**	<1	**16**
	MW8-20200312	UEP	3/12/2020	**1,200**	**510**	**420**	**3.1**	<0.5	**13**
MW09	MW09-20181005	SoundEarth	10/5/2018	**20**	**59**	**36**	<1	<1	**1.7**
	MW9	UEP	4/21/2019	**38**	**110**	**93**	**1.2**	<1	**7.4**
	MW9-20200312	UEP	3/12/2020	**300**	**740**	**1,030**	**11**	<0.5	**12**
	MW9-04142020	UEP	4/14/2020	**350**	**460**	**370**	**2.8**	<0.5	**5**
	MW09-20200515	UEP	5/15/2020	**99**	**87**	**48**	<1	<0.5	**0.47**
MW10	MW10	UEP	4/21/2019	**41**	**54**	**22**	<1	<1	**0.24**
	MW10-20200312	UEP	3/12/2020	<1	<0.4	<1	<1	<0.5	<0.2
	MW10-04142020	UEP	4/14/2020	<1	<1	<1	<1	<0.5	<0.2
	MW10-04142020b	UEP	4/14/2020	<1	<1	<1	<1	<0.5	<0.2
MW11	MW11	UEP	4/21/2019	<1	<1	<1	<1	<1	<0.2
	MW11-04142020	UEP	4/14/2020	<1	<1	<1	<1	<1	<0.2
UB12 (CD02A) / MW12	MW12-20200313	UEP	3/13/2020	**1,030**	**45**	**13**	<1	<0.5	**4.1**
UB13 (CD08) / MW13	UB13W-23	UEP	3/5/2020	**25,300**	**3,180**	**1,353**	<1	<0.5	<0.2
	MW13-20200313	UEP	3/13/2020	**2,190**	**5,580**	**1,160**	**3.3**	**22**	**76**
UB14 (CD06) / MW14	MW14-20200305	UEP	3/5/2020	<1	<0.4	<1	<1	<0.5	<0.2
UB15 (CD10A) / MW15	MW15-20200312	UEP	3/12/2020	<1	<0.4	<1	<1	<0.5	<0.2
UB16 (CD02B) / MW16	MW16-20200304	UEP	3/4/2020	**4,590**	**744**	**536**	<1	<0.5	**58.6**
	MW16-20200312	UEP	3/4/2020	**12**	**2.2**	**1.0**	<1	<0.5	<0.2
UB17 (CD05B) / MW17	MW17-20200305	UEP	3/5/2020	<1	<0.4	**166**	<1	<0.5	<0.2
	MW17-20200312	UEP	3/12/2020	**1.4**	**0.47**	**95**	<1	<0.5	**1.0**
UB18 (CD03) / MW18	UB18W-24	UEP	3/5/2020	**11.2**	**17.2**	**33.4**	<1	<0.5	<0.2
	MW18-20200312	UEP	3/12/2020	**2.8**	**68**	**97**	**3.5**	**1.3**	**2.8**
UB19	UB19W-25	UEP	3/5/2020	<1	<0.4	**3.0**	<1	<0.5	<0.2
UB20/MW20	MW20-20200312*	UEP	3/13/2020	**2.0**	**38**	**55**	<1	<0.5	**0.20**
	MW20-04102020	UEP	4/10/2020	<1	<1	**3.8**	<1	<1	<0.2
UB21/MW21	MW21-04102020	UEP	4/10/2020	<1	<1	<1	<1	<1	<0.2
UB22/MW22	MW22-04102020	UEP	4/10/2020	<1	<1	<1	<1	<1	<0.2
UB23/MW23	MW23-04102020	UEP	4/10/2020	<1	<1	<1	<1	<1	<0.2
UB24/MW24	MW24-04102020	UEP	4/10/2020	<1	<1	<1	<1	<1	<0.2
UB25/MW25	MW25-04142020	UEP	4/14/2020	**5,200**	**1,900**	**1,500**	**17**	**2.7**	**140**
UB26/MW26	MW26-04142020	UEP	4/14/2020	**52**	**68**	**8.1**	<1	<1	**0.27**
UB30/MW30	MW-30	UEP	5/23/2020	**1,500**	**410**	**250**	<100	<100	**30**
UB31/MW31	MW-31	UEP	5/23/2020	**120,000**	**22,000**	**15,000**	**120**	**11**	**1,300**
Ecology MTCA Method A Cleanup Levels[2] Unless Otherwise Specified				**5**	**5**	**16[3]**	**160[3]**	**400[3]**	**0.2**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
< = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) Analyzed by EPA Method 8260C or 8260D.
(2) MTCA Cleanup Regulation, Chapter 173-340-900 of WAC, Table 720-1 Method A Cleanup Levels for Groundwater, revised November 2007.
(3) MTCA Cleanup Regulation, Chapter 173-340 of WAC, CLARC, Groundwater, Method B, Non cancer, CLARC Website <https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx>

-- = not analyzed/not applicable
bgs = below grade surface
UEP = Urban Environmental Partners llc
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
cVOCs - Chlorinated Volatile Organic Compounds
PCE = tetrachloroethylene
TCE = trichloroethylene

DCE = dichloroethylene
VC = Vinyl Chloride
MTCA = Washington Model Toxics Control Act.
Hahn = Hahn and Associates, Inc.
SoundEarth = SoundEarth Strategies, Inc.
* Labeling Error - This sample was collected on 3/13/20

Table 6
Groundwater Analytical Results for Petroleum Hydrocarbons and Select VOCs
4208 Rainier Ave South, Seattle

Boring/Well ID	Sample ID	Sampled By	Date Sampled	Analytical Results - Micrograms per Liter (µg/L)						
				GRPH[1]	DRPH[2]	ORPH[2]	Benzene[3]	Toluene[3]	Ethylbenzene[3]	Total Xylenes[3]
B-1	B-1 (29-32)	Hahn	6/28/2000	--	--	--	<1	<1	<1	<3
B-3	B-3 (27-30)	Hahn	6/28/2000	--	--	--	<1	<1	<1	<3
B-4	B-4 (27-30)	Hahn	6/28/2000	--	--	--	<1	<1	<1	<3
B-5	B-5 (23-36)	Hahn	6/29/2000	--	--	--	<1	<1	<1	<3
B-7	B-7 (23-26)	Hahn	6/29/2000	--	--	--	<1	<1	<1	<3
UB12 (CD02A) / MW12	MW12-20200313	UEP	3/13/2020	**720***	<200	<400	<1	<1	<1	<2
UB13 (CD08) / MW13	UB13W-23	UEP	3/5/2020	**25,200***	<200	<400	<10	<10	<10	<20
	MW13-20200313	UEP	3/13/2020	**8,200***	<200	<400	<1	<1	<1	<2
UB14 (CD06) / MW14	MW14-20200305	UEP	3/5/2020	<100	<200	<400	<1	<1	<1	<2
UB15 (CD10A) / MW15	MW15-20200312	UEP	3/12/2020	<100	<200	<400	<1	<1	<1	<2
UB16 (CD02B) / MW16	MW16-20200304	UEP	3/4/2020	**3,800***	<200	<400	<10	<10	<10	<20
	MW16-20200312	UEP	3/4/2020	<100	<200	<400	<1	<1	<1	<2
UB17 (CD05B) / MW17	MW17-20200305	UEP	3/5/2020	<100	<200	<400	<1	<1	<1	<2
	MW17-20200312	UEP	3/12/2020	<100	<200	<400	<1	<1	<1	<2
UB18 (CD03) / MW18	UB18W-24	UEP	3/5/2020	<100	<200	<400	<1	<1	<1	<2
	MW18-20200312	UEP	3/12/2020	**115***	<200	<400	<1	<1	<1	<2
UB34	UB34-W	UEP	6/3/2020	--	**160x**	<250	--	--	--	--
UB35	UB35-W	UEP	6/3/2020	--	<65	<320	--	--	--	--
Ecology MTCA Method A Cleanup Levels[4] Unless Otherwise Specified				**1,000/800[5]**	**500**	**500**	**5**	**1,000**	**700**	**1,000**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
< = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) Analyzed by Northwest Method NWTPH-Gx or NEPTH-HCID
(2) Analyzed by Northwest Method NWTPH-Dx or NEPTH-HCID
(3) Analyzed by EPA Method 8260C or 8260D.
(4) MTCA Cleanup Regulation, Chapter 173-340-900 of WAC, Table 720-1 Method A Cleanup Levels for Groundwater, revised November 2007.
(5) For gasoline mixtures without benzene the cleanup level is 1,000 ug/l, for gasoline mixtures with benzene the cleanup level is 800 ug/l.
* = The gasoline range value consist of chlorinated compound(s) with elevated concentrations.
x = The sample chromatographic pattern does not resemble the fuel standard used for quantitation.

-- = not analyzed/not applicable
bgs = below grade surface
UEP = Urban Environmental Partners llc
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
GRPH = Gasoline-Range Petroleum Hydrocarbons
DRPH = Diesel-Range Petroleum Hydrocarbons

MTCA = Washington Model Toxics Control Act.
Hahn = Hahn and Associates, Inc.

Table 7
Monitoring Well Constuction Details
4208 Rainier Ave South, Seattle

Boring ID	Well ID	Screened Interval	Well Diameter
B01	MW01	18-33	2-inch
B09	MW02	15-30	2-inch
B07	MW03	15-30	2-inch
TB07	MW04	15-35	2-inch
TB08	MW05	15-35	2-inch
B16	MW08	15-30	2-inch
B15	MW09	25-35	2-inch
UB10	MW10	9.5-29.5	2-inch
UB11	MW11	15-35	2-inch
UB12	MW12	31-46	2-inch
UB13	MW13	28-42	2-inch
UB14	MW14	10-20	1-inch
UB15	MW15	10-20	1-inch
UB16	MW16	18-28	2-inch
UB17	MW17	15-25	2-inch
UB18	MW18	15-30	2-inch
UB20	MW20	22-37	2-inch
UB21	MW21	15-30	1-inch
UB22	MW22	15-30	1-inch
UB23	MW23	15-30	1-inch
UB24	MW24	14-29	1-inch
UB25	MW25	25-40	2-inch
UB26	MW26	25-40	2-inch
UB30	MW30	25-40	2-inch
UB31	MW31	15-30	2-inch
UB32	MW32	5-20	1-inch
UB33	MW33	5-20	1-inch

Table 8
Soil Gas and Sewer Gas Results for cVOCs
4208 Rainier Ave South, Seattle

Sample ID	Sampled By	Date Sampled	Depth (ft/bgs)	Analytical Results[1] - Micrograms per Cubic Meter (µg/m^3)										
				PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	VC	Chloroethane	1,1-Dichloroethane	1,2-Dichloroethane	1,1,1-Trichloroethane	1,1,2-Trichloroethane
SG01	SoundEarth	1/2/2018	8	**48**	<5.4	<4	<4	<4	<2.6	<2.6	<4	<4	<5.5	<5.5
SG02	SoundEarth	1/2/2018	8	**38**	<5.4	<4	<4	<4	<2.6	<2.6	<4	<4	<5.5	<5.5
SG03	SoundEarth	1/2/2018	8	**25**	<5.4	<4	<4	<4	<2.6	<2.6	<4	<4	<5.5	<5.5
SG04	UEP	4/10/2020	1.5	<110	<4.3	<6.3	<6.3	<6.3	<4.1	<42	<6.5	<0.65	<8.7	<1.7
SG05	UEP	4/10/2020	1.5	<110	<4.3	<6.3	<6.3	<6.3	<4.1	<42	<6.5	<0.65	<8.7	<1.7
Sewer South	UEP	5/15/2020	10	**270**	**69**	**340**	**3.7**	<3	**22**	<20	<3.1	<0.31	<4.1	<0.83
Sewer North	UEP	5/15/2020	10	<54	<2.1	<3.2	<3.2	<3.2	<2	<21	<3.2	<0.32	<4.4	<0.87
Ecology MTCA Method B Screening Levels for Sub-Slab Soil Gas[2]				**320**	**11**	**NE**	**NE**	**3,000**	**9.50**	**NE**	**52**	**3.2**	**76,000**	**5.20**
Ecology MTCA Method B Screening Levels for Deep Soil Gas[3]				**960**	**33**	**NE**	**NE**	**9,100**	**28**	**NE**	**160**	**9.6**	**230,000**	**16.00**

Notes:

Red denotes concentration exceeding MTCA screening level.
< or ND = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) Samples analyzed by U.S. EPA Method TO-15
(2) Most Conservative MTCA Method B Sub-Slab Soil Gas Screening Level, CLARC Master Spreadsheet January 2020.
(3) Most Conservative MTCA Method B Deep Soil Gas Screening Level, CLARC Master CLARC Master Spreadsheet January 2020..

-- = not analyzed/not applicable
NE = Not Established
bgs = below grade surface
cVOCs: Chlorinated Volatile Organic Compounds
PCE = tetrachloroethylene
TCE = trichloroethylene
DCE = dichloroethylene
VC = Vinyl Chloride
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
MTCA = Washington Model Toxics Control Act.

Table 9
Groundwater Analytical Results for Polycyclic Aromatic Hydrocarbons
4208 Rainier Ave South, Seattle

Boring/Well ID	Sample ID	Sampled By	Date Sampled	Analytical Results[1] - Micrograms per Liter (µg/L)							Total Toxicity Equivalency Concentration[2]
				Benzo(a)-anthracene	Chrysene	Benzo(a)pyrene	Benzo(b)-fluoranthene	Benzo(k)-fluoranthene	Indeno(1,2,3cd)-pyrene	Dibenzo(a,h)-anthracene	
UB32/MW32	MW32-20200608	UEP	6/8/2020	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	ND
UB33/MW33	MW33-20200608	UEP	6/8/2020	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	ND
Ecology MTCA Method A Cleanup Levels[3] Unless Otherwise Specified				--	--	**0.1**	--	--	--	--	**0.1**

Notes:

Red denotes concentration exceeding MTCA cleanup level.
< or ND = Not Detected at a concentration exceeding the specified laboratory reporting limit (RL).
(1) Samples analyzed by EPA Method 8270E SIM.
(2) Calculated Using Toxicity Equivalency Methodology in WAC 173-340-708(e)
(3) MTCA Cleanup Regulation, Chapter 173-340 of WAC, Table 720-1 Method A Cleanup Levels for Groundwater, revised 2013.

-- = not analyzed/not applicable
bgs = below grade surface
WAC = Washington Administrative Code
EPA = U.S. Environmental Protection Agency
MTCA = Washington Model Toxics Control Act.
UEP = Urban Environmental Partners

Table 10
Feasibility Level Cost Estimate
Alternative 1 - Soil Excavation and Monitored Natural Attenuation
Rainier Mall

CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
Excavation and Site Restoration					
Mobilization / demob	1	lump sum	$ 25,000	$ 25,000	
Site preparation, security, demo	1	lump sum	$ 50,000	$ 50,000	
Sheet Piling (200' x 50' deep)	12,300	cubic feet	$ 45	$ 553,500	
Excavation and handling	15,000	cubic yard	$ 25	$ 375,000	
Soil - Subtitle C (haz) disposal	2,800	tons	$ 320	$ 896,000	
Soil - Subtitle D (nonhaz/CI) disposal	11,600	tons	$ 128	$ 1,484,800	
Soil - Class 2 overburden disposal	3,000	tons	$ 25	$ 75,000	
Soil - site soil used as backfill	3,000	tons	$ 8	$ 24,000	
Import soil backfill to original grade	11,200	tons	$ 25	$ 280,000	
Water management, SW BMPs	1	lump sum	$ 125,000	$ 125,000	
Subtotal:				***$ 3,888,300***	
Monitored Natural Attenuation					
Well network installation	12	wells	$ 3,500	$ 42,000	
Quarterly monitoring (5 years)	20	events	$ 5,000	$ 100,000	
Semiannual monitoring (2 years)	4	events	$ 5,000	$ 20,000	
Annual monitoring (8 years)	8	events	$ 5,000	$ 40,000	
Data interpretation and reporting	15	years	$ 10,000	$ 150,000	
Subtotal:				***$ 352,000***	
Engineering Controls					
Vapor Barrier and Passive Controls	20,000	square feet	$ 15	$ 300,000	
Deed Restriction recorded with KC	1	lump sum	$ 10,000	$ 10,000	
Subtotal:				***$ 310,000***	
CAPITAL CLEANUP COSTS SUBTOTAL					**$ 4,550,300**
Labor and Administration (% of construction subtotal)					
Permit and Planning	2	%	$ 4,550,000	$91,000	
Engineering Design and Bid	10	%	$ 4,550,000	$455,000	
Cleanup Oversight and Sampling	10	%	$ 4,550,000	$455,000	
Long term reporting and agency comms	5	%	$ 4,550,000	$227,500	
Subtotal:				***$ 1,228,500***	
CLEANUP ACTION SUBTOTAL					**$ 5,778,800**
Contingency for Cleanup	20	%	$ 5,780,000	**$1,156,000**	
CLEANUP ACTION TOTAL CAPITAL COST (ROUNDED)					**$ 6,900,000**

Notes:

- Hazardous soil disposal required for material removed from 35' Excavation (1,200 SF)
- Subtitle D (nonhaz) soil disposal required for all other excavated material (1,900 + 5,800 SF)
- Assume all of soil excavated from 0' to 10' bgs is reused as onsite backfill, incl slope cuts.
- Monitored Natural Attenuation will require 15 years of active monitoring.
- CI - Contained In designation for F-Listed waste suitable for Subtitle D landfill.
- Cost estimate are feasibility-study level (+50/-30)

Table 11
Feasibility Level Cost Estimate
Alternative 2 - Dual Phase Extraction (DPE) with Air Sparging
Rainier Mall

CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
DPE Installation					
Mobilization / demob	1	lump sum	$ 25,000	$ 25,000	
Site preparation, security, demo	1	lump sum	$ 50,000	$ 50,000	
DPE and AS wells installation	100	well	$ 2,500	$ 250,000	
Piping, connectors and controls	1	lump sum	$ 150,000	$ 150,000	
GW and vapor treatment equipment	1	lump sum	$ 250,000	$ 250,000	
Soil cuttings disposal	400	tons	$ 240	$ 96,000	
Groundwater treatment and disposal	1	lump sum	$ 150,000	$ 150,000	
Site restoration and security	1	lump sum	$ 75,000	$ 75,000	
Subtotal:				***$ 1,046,000***	
DPE Operation and Maintenance					
DPE and treatment system O&M	10	years	$ 100,000	$ 1,000,000	
DPE and treatment system repairs	10	years	$ 10,000	$ 100,000	
Vapor treatment oxidizer (electric)	10	years	$ 25,000	$ 250,000	
GW monitoring, data eval and report	10	years	$ 25,000	$ 250,000	
Ecology reporting and comms	10	years	$ -	$ -	
Subtotal:				***$ 1,600,000***	
Engineering Controls					
Vapor Barrier and Passive Controls	20,000	square feet	$ 15	$ 300,000	
Deed Restriction recorded with KC	1	lump sum	$ 10,000	$ 10,000	
Subtotal:				***$ 310,000***	
CAPITAL CLEANUP COSTS SUBTOTAL					**$ 2,956,000**
Labor and Administration (% of construction subtotal)					
Permit and Planning	2	%	$ 2,960,000	59,200	
Engineering Design and Bid	15	%	$ 2,960,000	444,000	
Construction Oversight and Sampling	5	%	$ 2,960,000	148,000	
Long term reporting and agency comms	5	%	$ 2,960,000	148,000	
Subtotal:				***799,200***	
CLEANUP ACTION SUBTOTAL					**$ 3,755,200**
Contingency for Cleanup	20	%	$ 3,760,000	**752,000**	
CLEANUP ACTION TOTAL CAPITAL COST (ROUNDED)					**$4,500,000**

Notes:
- Extracted groundwater treated above ground and discharged to sanitary sewer.
- Extracted soil vapors treated above ground and discharge to atmosphere.
- Assumes 10 years of O&M, groundwater monitoring and reporting.
- DPE will achieve site CULs, no MNA as a follow up.
- Cost estimate are feasibility-study level (+50/-30)

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Table 12
Feasibility Level Cost Estimate
Alternative 3 - Electrical Resistance Heating with SVE
Rainier Mall

CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
ERH and SVE Installation					
Mobilization / demob	1	lump sum	$ 25,000	$ 25,000	
Site preparation, security, demo	1	lump sum	$ 100,000	$ 100,000	
ERH, SVE and TMP (electrode) installation	150	electrodes	$ 3,000	$ 450,000	
Electrodes, piping, connectors and controls	1	lump sum	$ 600,000	$ 600,000	
Treatment system, including GAC	1	lump sum	$ 400,000	$ 400,000	
Treatment system installation by others	1	lump sum	$ 800,000	$ 800,000	
Soil cuttings disposal	100	tons	$ 320	$ 32,000	
Well and Electrode decommissioning	150	electrodes	$ 2,000	$ 300,000	
Site restoration and security	1	lump sum	$ 80,000	$ 80,000	
Subtotal:				***$ 2,787,000***	
ERH Operation and Maintenance					
ERH and SVE operations and maintenance	6	months	$ 120,000	$ 720,000	
ERH and treatment system repairs	1	lump sum	$ 100,000	$ 100,000	
Vapor treatment GAC replacement	1	lump sum	$ 20,000	$ 20,000	
Electrical power use	6	months	$ 60,000	$ 360,000	
Consulting and Project Management	12	months	$ 8,000	$ 96,000	
Subtotal:				***$ 1,296,000***	
Engineering Controls					
Vapor Barrier and Passive Controls	5,000	square feet	$ -	$ -	
Deed Restriction recorded with KC	1	lump sum	$ -	$ -	
Subtotal:				*$* -	
CAPITAL CLEANUP COSTS SUBTOTAL					**$ 4,083,000**
Labor and Administration (% of construction subtotal)					
Permit and Planning	5	%	$ 4,080,000	204,000	
Engineering Design and Bid	5	%	$ 4,080,000	204,000	
Construction Oversight and Sampling	5	%	$ 4,080,000	204,000	
Compliance Monitoring Plan	5	%	$ 4,080,000	204,000	
Long term reporting and agency comms	5	%	$ 4,080,000	204,000	
Subtotal:				***1,020,000***	
CLEANUP ACTION SUBTOTAL					**$ 5,103,000**
Contingency for Cleanup	5	%	$ 5,100,000	**255,000**	
CLEANUP ACTION TOTAL CAPITAL COST (ROUNDED)					**$5,400,000**

Notes:
- ERH design by others.
- Vapor mitigation measures not required after treatment.
- Cost estimate are feasibility-study level (+50/-30%)

Table 13
Feasibility Level Cost Estimate
Alternative 4 - Electrical Resistance Heating and ISCR with ZVI
Rainier Mall

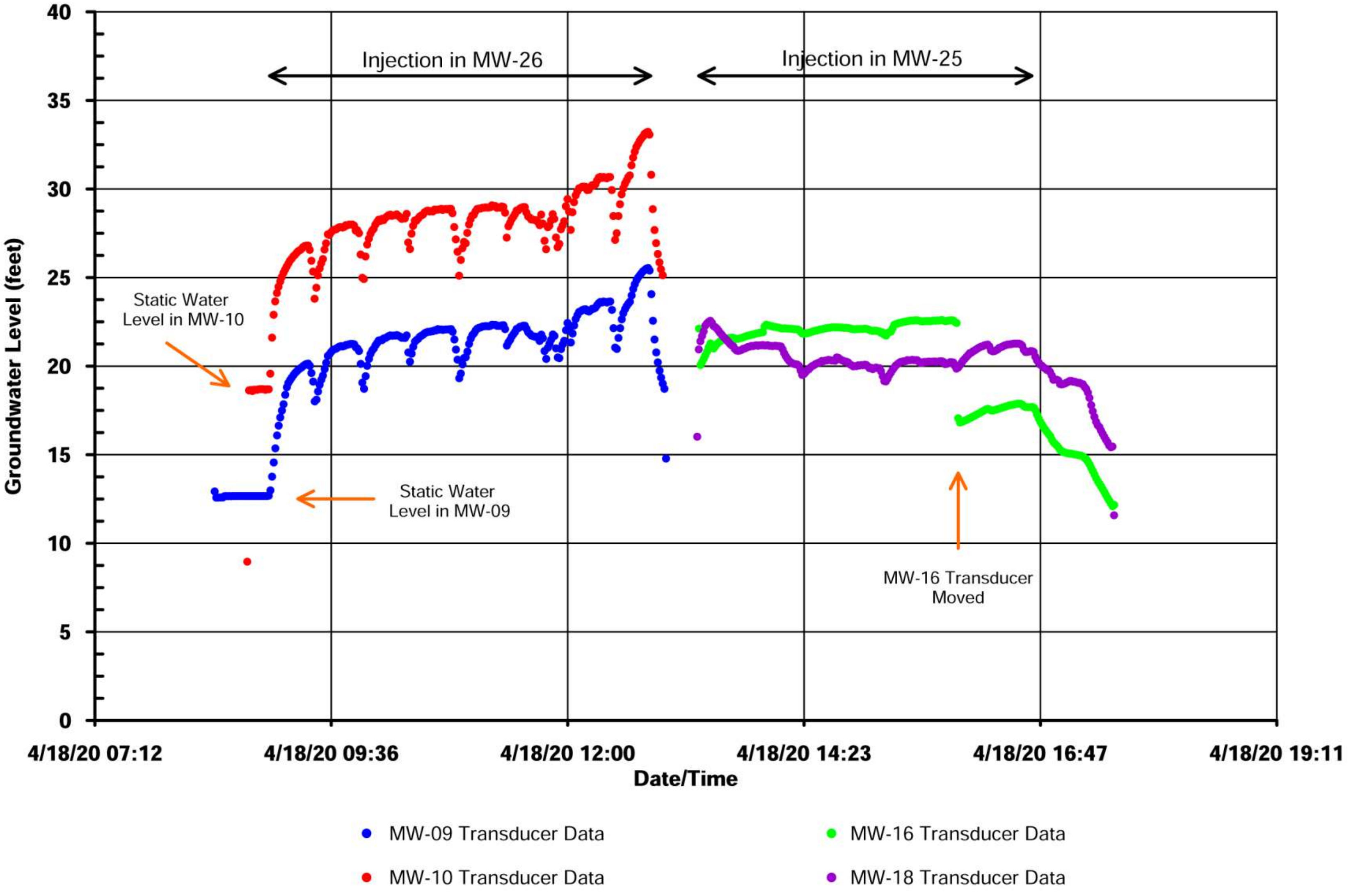
CAPITAL COST ITEM	QTY	UNIT	UNIT PRICE	COST	TOTALS
ERH and SVE Installation					
Mobilization / demob	1	lump sum	$ 25,000	$ 25,000	
Site preparation, security, demo	1	lump sum	$ 50,000	$ 50,000	
ERH, SVE and TMP (electrode) installation	70	electrode	$ 3,000	$ 210,000	
Electrodes, piping, connectors and controls	1	lump sum	$ 250,000	$ 250,000	
Treatment system, including GAC	1	lump sum	$ 200,000	$ 200,000	
Treatment system installation by others	1	lump sum	$ 400,000	$ 400,000	
Soil cuttings disposal	50	tons	$ 320	$ 16,000	
Well and electrode decommissioning	70	electrode	$ 2,000	$ 140,000	
Site restoration and security	1	lump sum	$ 50,000	$ 50,000	
Subtotal:				***$ 1,341,000***	
ERH Operation and Maintenance					
ERH and SVE operations and maintenance	6	months	$ 60,000	$ 360,000	
ERH and treatment system repairs	1	lump sum	$ 50,000	$ 50,000	
Vapor treatment GAC replacement	1	lump sum	$ 10,000	$ 10,000	
Electrical power use	6	months	$ 30,000	$ 180,000	
Consulting and Project Management	12	months	$ 8,000	$ 96,000	
Subtotal:				***$ 696,000***	
In-Situ Chemical Reduction (ISCR)					
Mobilization / demob	1	lump sum	$ 25,000	$ 25,000	
Site preparation, security, demo	1	lump sum	$ 50,000	$ 50,000	
Injection Probe well installation	30	probes	$ 3,000	$ 90,000	
ZVI/3DME Injectate Purchase	1,000	gallons	$ 40	$ 40,000	
Acgueous injection and handling	20,000	gallons	$ 5	$ 100,000	
Soil cuttings disposal (CI)	250	tons	$ 168	$ 42,000	
Subtotal:				***$ 347,000***	
Engineering Controls					
Vapor Barrier and Passive Controls	5,000	square feet	$ -	$ -	
Deed Restriction recorded with KC	1	lump sum	$ -	$ -	
Subtotal:				*$ -*	
CAPITAL CLEANUP COSTS SUBTOTAL					**$ 2,384,000**
Labor and Administration (% of construction subtotal)					
Permit and Planning	5	%	$ 2,380,000	119,000	
Engineering Design and Bid	5	%	$ 2,380,000	119,000	
Construction Oversight and Sampling	5	%	$ 2,380,000	119,000	
Compliance Monitoring Plan	5	%	$ 2,380,000	119,000	
Long term reporting and agency comms	5	%	$ 2,380,000	119,000	
Subtotal:				***595,000***	
CLEANUP ACTION SUBTOTAL					**$ 2,979,000**
Contingency for Cleanup	10	%	$ 2,980,000	**298,000**	
CLEANUP ACTION TOTAL CAPITAL COST (ROUNDED)					**$ 3,300,000**

Notes:
- ERH design by others.
- Vapor mitigation measures not required after treatment.
- Cost estimate are feasibility-study level (+50/-30%)

Table 14
Disproportionate Cost Analysis
4208 Rainier Ave South, Seattle

Alternative Name/Description	**Alt 1 - Excavation and MNA**			**Alt 2 - Dual-Phase Extraction (DPE) with Air Sparging**			**Alt 3 - Electrical Resistance Heating (ERH) with SVE**			**Alt 4 - ERH and In-Situ Chemical Reduction**		
Evaluation Criteria												
	Score	Weighting Factor	Weighted Score	Score	Weighting Factor	Weighted Score	Score	Weighting Factor	Weighted Score	Score	Weighting Factor	Weighted Score
Protectiveness	5	0.3	1.5	3	0.3	0.9	9	0.3	2.7	8	0.3	2.4
Permanence	5	0.2	1.0	4	0.2	0.8	9	0.2	1.8	9	0.2	1.8
Long Term Effectiveness	6	0.2	1.2	4	0.2	0.8	10	0.2	2.0	10	0.2	2.0
Manageability of Short Term Risk	7	0.1	0.7	5	0.1	0.5	3	0.1	0.3	2	0.1	0.2
Implementability	9	0.1	0.9	5	0.1	0.5	4	0.1	0.4	6	0.1	0.6
Consideration of Public Concerns	5	0.1	0.5	5	0.1	0.5	5	0.1	0.5	5	0.1	0.5
Comparative Benefit Score	**5.8**			**4.0**			**7.7**			**7.5**		
Estimation of Cost (in millions)	$ 6.9			$ 4.5			$ 5.4			$ 3.3		
Cost to Benefit Ratio	**1.19**			**1.13**			**0.70**			**0.44**		

Exhibit C: Graphs



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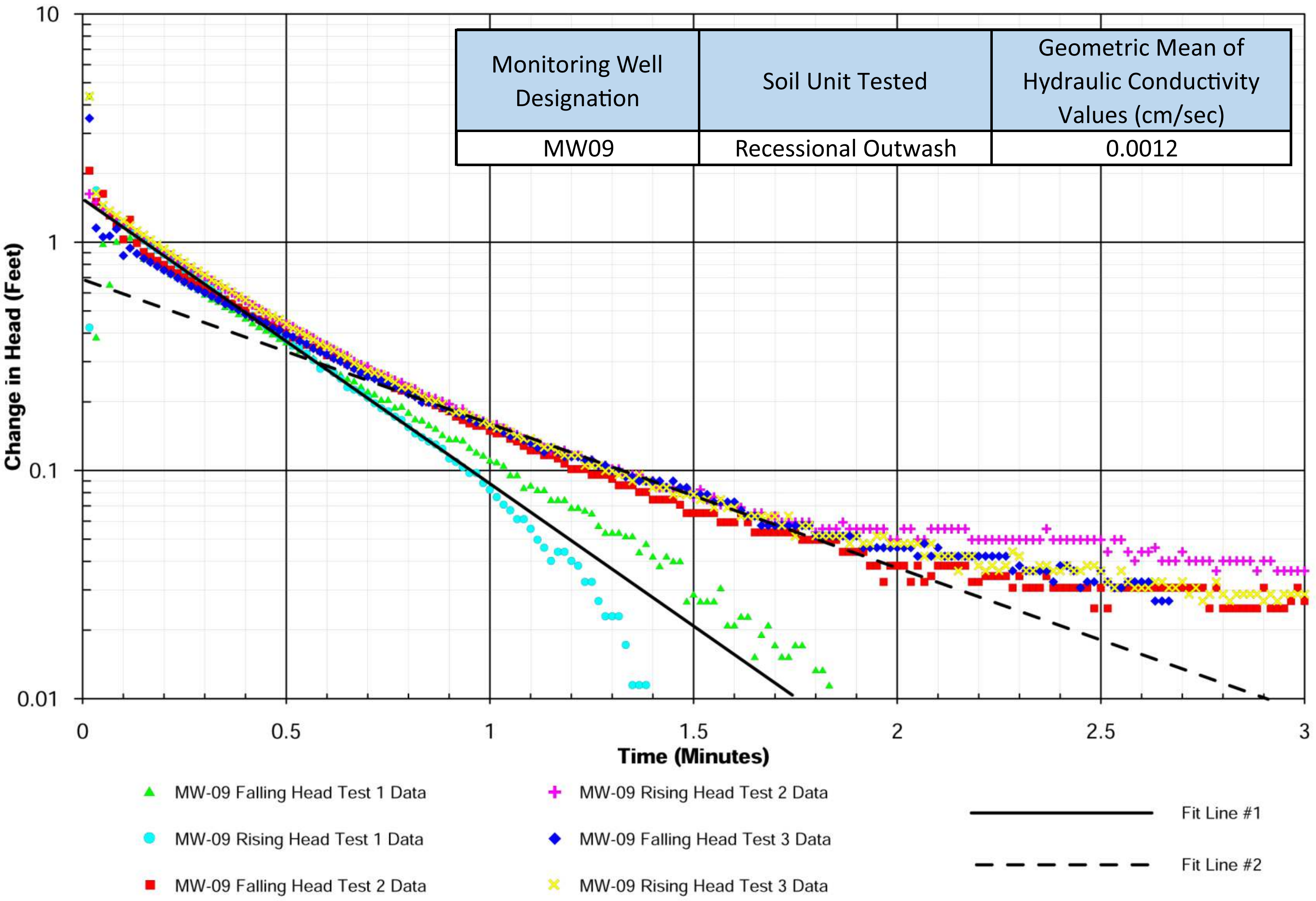
Rainier Mall Site
4208 Rainier Avenue South
Seattle, WA

Graph 1
Pilot Injection Test
Groundwater Level Data



Monitoring Well Designation	Soil Unit Tested	Geometric Mean of Hydraulic Conductivity Values (cm/sec)
MW09	Recessional Outwash	0.0012

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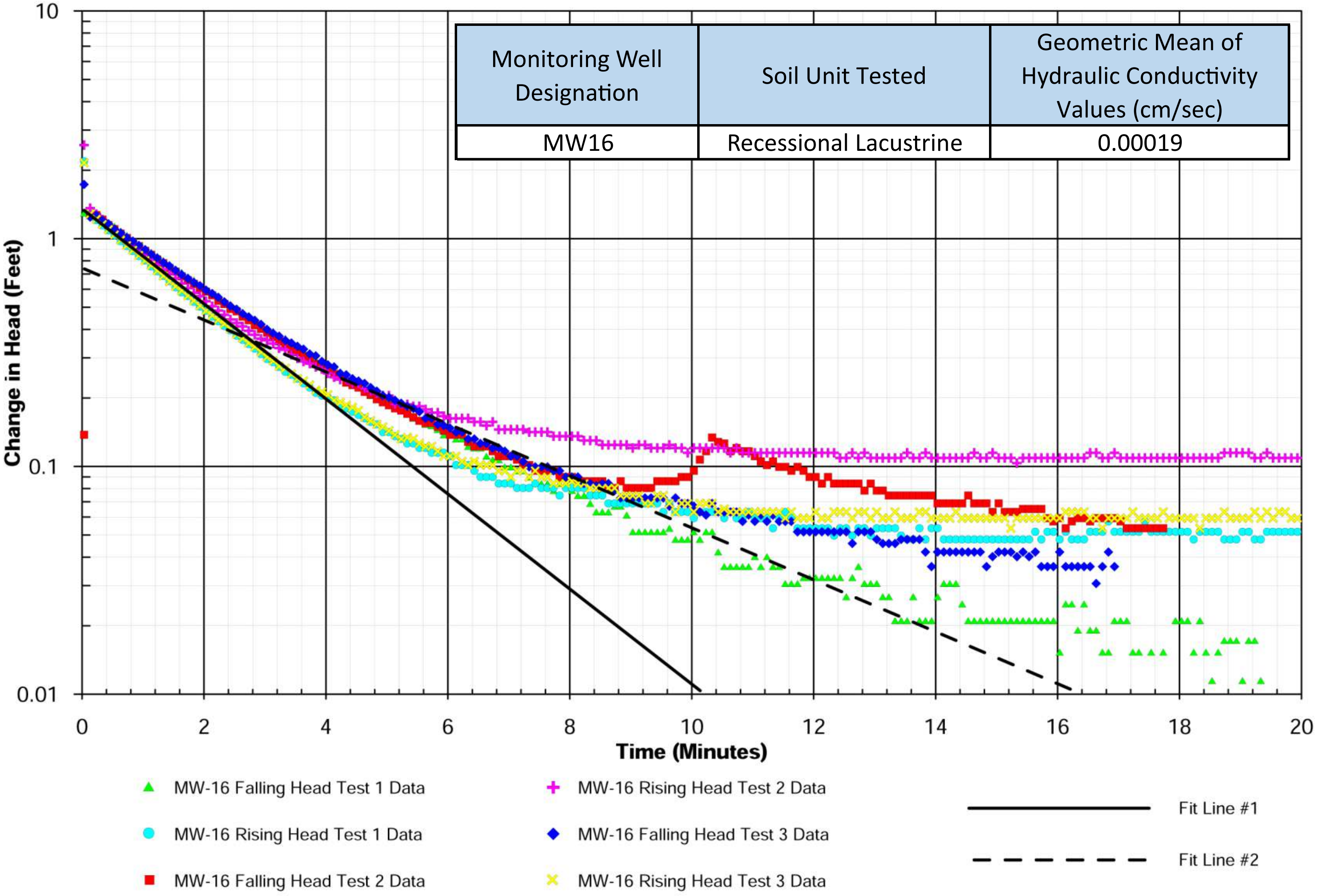
Seattle, WA

Graph 2
Monitoring Well MW09 Slug Tests



Monitoring Well Designation	Soil Unit Tested	Geometric Mean of Hydraulic Conductivity Values (cm/sec)
MW16	Recessional Lacustrine	0.00019

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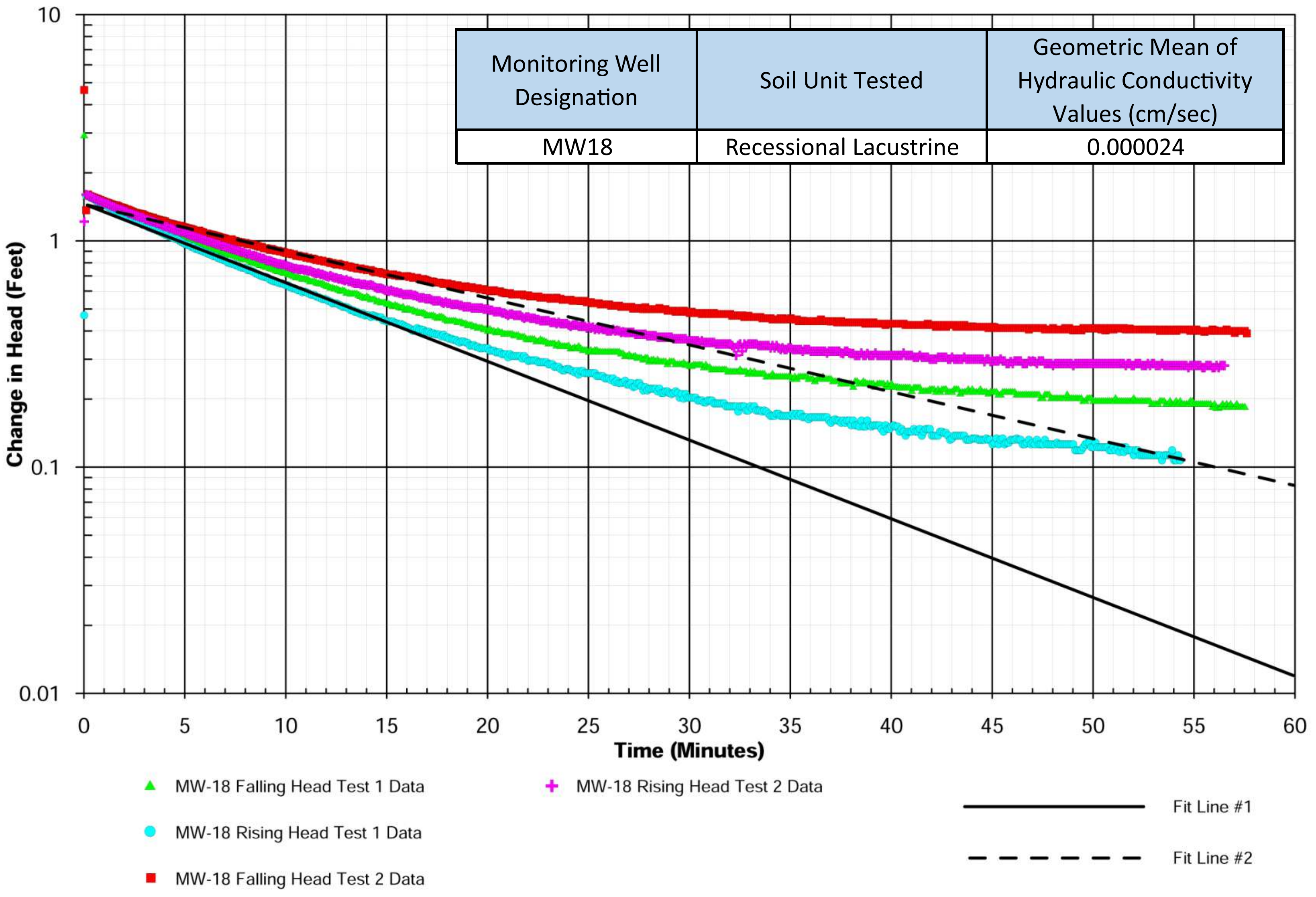
Seattle, WA

Graph 3
Monitoring Well MW16 Slug Tests



Monitoring Well Designation	Soil Unit Tested	Geometric Mean of Hydraulic Conductivity Values (cm/sec)
MW18	Recessional Lacustrine	0.000024

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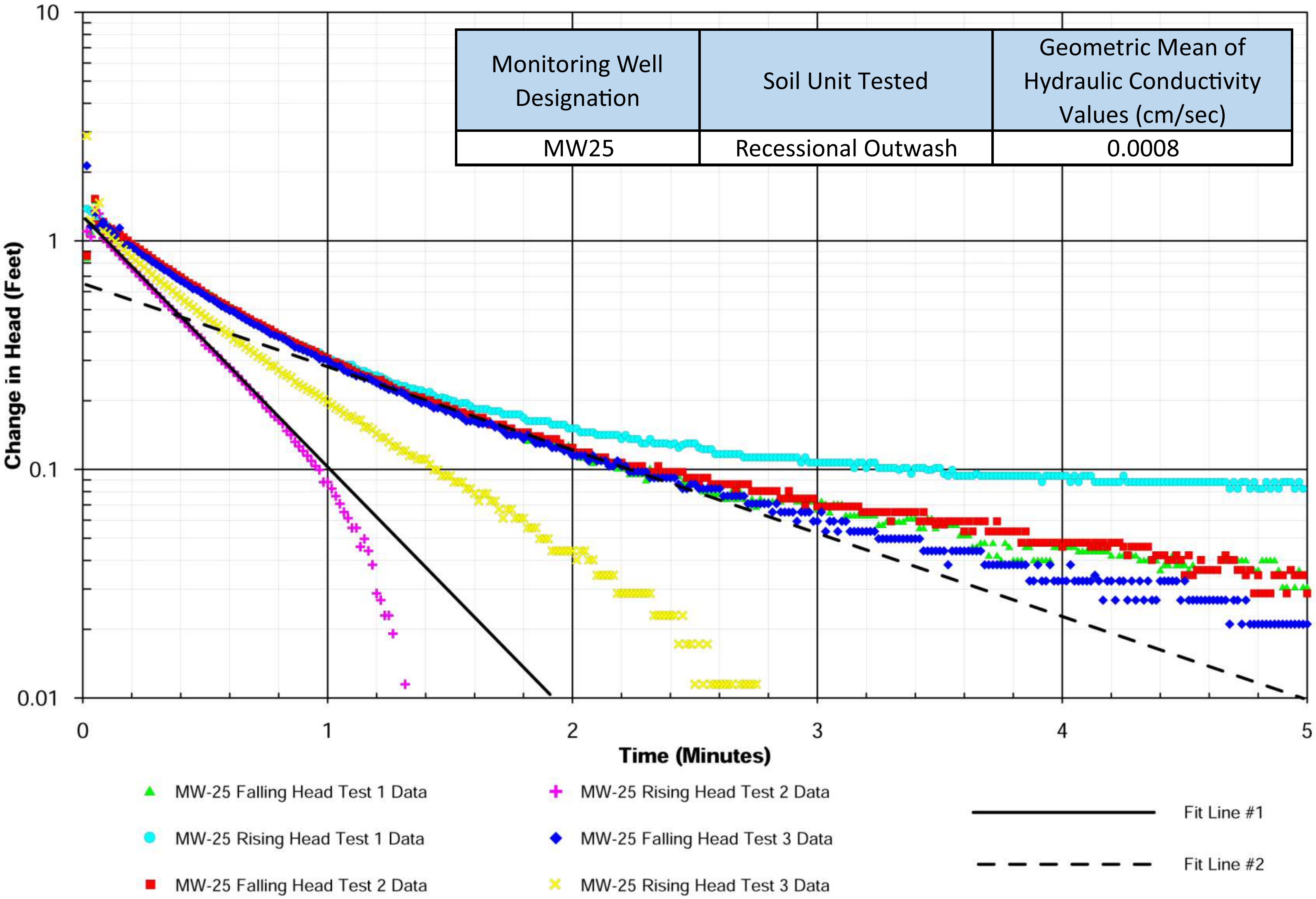
Seattle, WA

Graph 4
Monitoring Well MW18 Slug Tests



Monitoring Well Designation	Soil Unit Tested	Geometric Mean of Hydraulic Conductivity Values (cm/sec)
MW25	Recessional Outwash	0.0008

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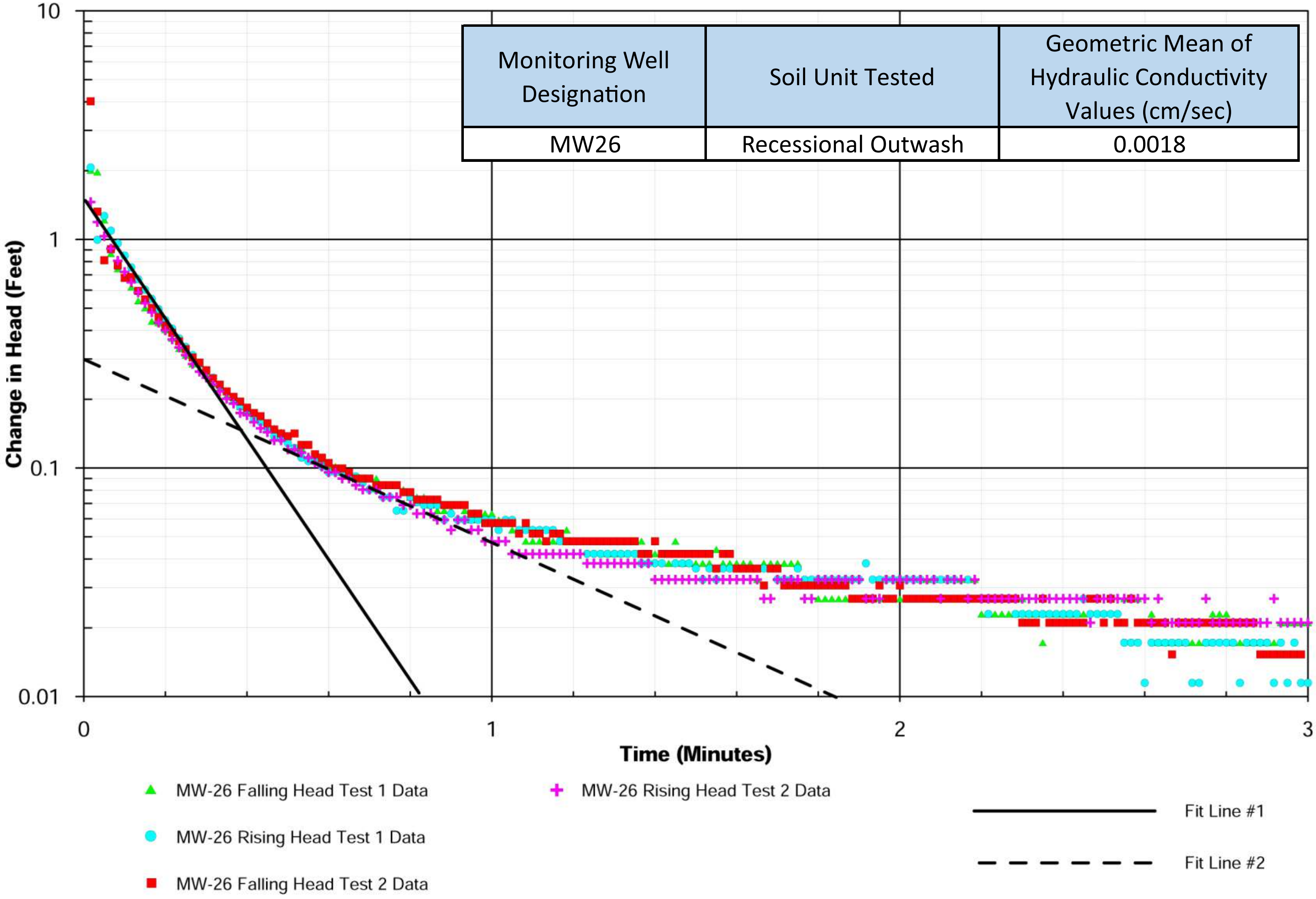
Seattle, WA

Graph 5
Monitoring Well MW25 Slug Tests



Monitoring Well Designation	Soil Unit Tested	Geometric Mean of Hydraulic Conductivity Values (cm/sec)
MW26	Recessional Outwash	0.0018

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Rainier Mall Site
4208 Rainier Avenue South
Seattle, WA

Graph 6
Monitoring Well MW26 Slug Tests

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Appendix A: Laboratory Analytical Reports

Lab Reports for the project are provided in electronic form with the original DRAFT report submittal.

Appendix B: Boring Logs

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 2/9/17
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W: See FN
Reviewed by:
Date Completed: 2/9/17

BORING LOG B01 MW-01

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: ~28 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
		8 10 15	50	0.0	B01-02.5 @0930	SM		moist, gray, silty SAND some gravel, no odors 30-50-20)	
5		3 5 10	70	0.0	B01-05 @0935			Damp, gray, silty SAND some gravel, no odors (30-55-15) Some brick fragments	
		3 2 10	80	0.0	B01-07.5 @0940			Same as previous, some brick fragments, trace organics	
10		5 50/6	60	0.0	B01-10 @0845			moist gray silty SAND, some gravel, no odors, some organics + brick (30-55-15)	
		13 5 6	10	0.0	B01-12.5 @0850			Poor recovery, Damp gray gravelly SAND, some silt no odors (20-45-35)	
15									

Drilling Co./Driller: Holocene / RJ
Drilling Equipment: Track HSA
Sampler Type: SPT
Hammer Type/Weight: Auto / 140 lbs
Total Boring Depth: 41.5 feet bgs
Total Well Depth: 33 feet bgs
State Well ID No.: BJU 248

Well/Auger Diameter: 2 / 8OD inches
Well Screened Interval: 18–33 feet bgs
Screen Slot Size: 0.10 inches
Filter Pack Used: Colorado silica SAND
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flush mount

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 2/9/17
Surface Conditions: Asphalt
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B01/MW-01

Site Address:
4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		6 4 6	0	–	~~B01-15 @0900~~			No recovery	
		0	100	40.8	B01-17.5 @0905			moist, light gray, SILT, some fine SAND, no odor (75-25-0)	
20		0 0 2	100	82.3	B01-20 @0910			Same as previous	
		2 2 5	100	15.4	B01-22.5 @0920			moist, dark gray, sandy SILT, no odor (60-40-0)	
25		5 6 15	90	1.9	B01-25 @0925			moist, dark gray, silty SAND, no odor (45-55-0)	
		13 17 23	70	0.3	B01-27.5 @0935			wet, dark speckled gray, SAND, some silt, trace gravel, no odor (20-80-0)	
30								Driller starts adding H_2O to limit heave	

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: LOS
Date Started: 2/9/17
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B01/ MW-01

Site Address: 4208 Rainier Avenue S
Seattle, Washington

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		6 10 15	70	0.9	B01-30 @0940			wet, dark gray sandy SILT to silty SAND, no odor (50-50-0).	
		7 6 3	80	5.6	B01-32.5 @0955			wet ~~Saturated~~, dark gray ~~silty~~ Sandy SILT, no odor (65-35-0).	
35		12 34 50/6"	90	0.0	B01-35 @1010			wet to moist ~~Saturated~~, dark gray, sandy SILT, no odor (65-35-0).	
		10 16 32	95	0.0	B01-37.5 @1020			wet-to moist ~~Saturated~~ dark gray, Sandy ~~Sand SILT~~ silt, no odor (70-30-0).	
40		18 36 50/6"	80	0.0	B01-40 @1035			wet to moist, dark gray ~~silty SAND~~ sandy SILT, no odor (75-25-0)	
								EOB @41.5' bgs, backfilled to 33' w/ sand + installed well MW01 w/ 15' screen.	
45									

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 3 of 3

15' up from 33

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: UDS
Date Started: 2/9/17
Surface Conditions: Asphalt
Well Location N/S: See FN
Well Location E/W:
Reviewed by:
Date Completed: 2/9/17

BORING LOG | B02/MW02

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
		11 7 12	70	0.3	B02-02.5 @1346	SM		moist, gray silty SAND w/ gravel, no odor (30-60-10) trace organics	
5		7 5 6	80	0.1	B02-05 @1345			moist, gray, silty SAND some gravel, no odor, trace organics (30-55-15).	
		18 24 14	30	0.0	B02-07.5 @1350			moist, gray silty SAND, some gravel, no odor; glass fragment (30-50-20)	
10		7 14 8	40	3.3	B02-10 @1355			moist, gray silty SAND, some gravel, no odors (40-45-15)	
		7 6 7	60	12.5	B02-12.5 @1400			moist, gray-brown, SILT some SAND, no odor (80-20-0)	
15									

Drilling Co./Driller: Holocene / RJ
Drilling Equipment: track HSA
Sampler Type: SPT
Hammer Type/Weight: Auto/140 lbs
Total Boring Depth: 31.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: 2 / 8OD inches
Well Screened Interval: — feet bgs
Screen Slot Size: ~~0.010~~ inches
Filter Pack Used: —
Surface Seal:
Annular Seal: Bentonite
Monument Type: Flush mount

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 2/9/17
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B02

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	X	5 4 6	80	72.4	B02-15 @1410			Same as previous	
	X	8 3 3	90	13.3	B02-17.5 @1415			moist, light gray brown SILT, some sand, no odor (85-15-0)	
20	X	2 1 2	80	0.0	B02-20 @1420			~~Moist~~ Moist, darker gray SILT some sand, no odor (85-15-0)	
	X	8 14 23	70	0.0	B02-22.5 @1425			~~Damp~~ moist ~~Moist~~ to wet, dark gray SILT some to w/ sand, no odor ~~85-15-0~~ (90-10-0)	
25	X	8 8 8	100	0.0	B02-25 @1430			Damp to moist, gray SILT, some sand, no odor (80-20-0).	
	X	19 30/4" 24 32	100	0.0	B02-27.5 @1440			moist, gray silt, w/ sand, no odor (85-15-0)	
30									

Drilling Co./Driller:
Drilling Equipment: See page 1
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: LDS
Date Started: 2/9/17
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B02/

Site Address: 4208 Rainier Avenue S
Seattle, Washington

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

DRAFT

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	X	18 24 28	100		B02-30 @ 1455			mo Bry, gry SILT, some SAND, no odor (85-15-0).	
								Boring terminated @ 31.5' bgs Soil conditions indicate a well would not produce GW.	
35									
40									
45									

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 3 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: CMS
Date Started: 2/10 17
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 2/10/17

BORING LOG B03

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
	☒	10 11 23	30	0.0	B03-02.5 @0815	SM		Moist, medium dense, sandy SILT w/ gravel, mixed brown-gray, with odor (60, 30, 10).	
5	☒	3 4 11	50	0.0	B03-05 @0820			Moist, loose, sandy CLAY/SILT, w/ some woody organics and glass, dark brown to black (70, 30, 10). (FILL)	
	☒	3 1 2	60	0.0	B03-07.5 @0825			Moist, loose, sandy CLAY/SILT w/ glass, woody organics, dark gray + black (80, 20, 0). (FILL)	
10	☒	0 0 3	75	0.0	B03-10 @0830			Saturated, loose, sandy CLAY, dark greenish gray, no HC odor (95, 5, 0)	
	☒	0 3 5	100	0.0	B03-12.5 @0835			Saturated, loose, sandy CLAY, dark greenish-gray, no HC odor (95, 5, 0) 14.5' 6" Saturated, loose sandy CLAY, mottled orange/gray, no HC odor (85, 15, 0)	
15									

Drilling Co./Driller: Holocene/RJ
Drilling Equipment: Limited HSA
Sampler Type: SPT
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 1/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W: see pg. 1
Reviewed by:
Date Completed:

BORING LOG B03

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	X	3 3 6	100	0.0	B03-15 @0840			Saturated, loose, sandy CLAY, mottled gray & orange (90,10,0)	
	X	0 0 1	100	0.0	B03-17.5 @0845			Saturated, loose, sandy CLAY w/ very small lenses of SAND, mottled gray & orange (90,10,0) lenses=(25,75,0)	
20	X	0 0 0	100	0.0	B03-20 @0850			Saturated, soft, sandy CLAY, dark greenish gray w/ some orange mottles (85,15,0)	
	X	2 1 1	100	0.0	B03-22.5 @0855			Saturated, soft, sandy CLAY w/ loose lenses of SAND, dark gray, no HC odor, (80,20,0)	
25	X	0 0 10	100	0.0	B03-25 @0900			Wet, soft, sandy CLAY, dark gray. no HC odor (90,10,0)	
	X	0 0 4	100	0.0	B03-27.5 @0905			Wet, soft, sandy CLAY, dark gray, no HC odor (90,10,0) 6" wet, loose, sandy SILT w/ clay, gray. no HC odor. (60,40,0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: see pg. 1 lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2/3

SoundEarth Strategies

Project: Rainier Mall Property
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see pg 1

DRAFT

BORING LOG B03

Site Address: 4208 Rainier Avenue S
Seattle, Washington

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		1 6 22	100	0.0	B03-30 @0920			Moist, sandy SILT/CLAY, gray, no HC odor (90,10,0) 3" Moist, sandy SILT, gray no HC odor (60,40,0)	
		7 12 28	100	0.0	B03-32.5 @0925			Moist, medium dense, silty medium SAND, gray, no HC odor (10,90,0)	
35		7 18 24	100	0.0	B03-35 @0950			Moist, medium dense, silty medium SAND, gray, no HC odor (10,90,0) 6" Moist, dense, sandy SILT w/ gravel, gray, no HC odor Boring terminated @ 36.5 bgs. Backfill w/ bentonite	
40									
45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see pg 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 3/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: CMS
Date Started: 2/10/17
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 2/10/17

BORING LOG B04

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
		9 10 11	50	0.0	B04-02.5 @0945			Moist, med dense, sandy SILT w/ gravel, brown and dark grey (60, 30, 10)	
5		5 12 9	75	0.0	B04-05 @1050			Moist, med. dense, silty SAND / gravel, mottled grey and orange, no HC odor (40, 55, 5)	
		4 20 15	40		B04-07.5 @1055			Moist, dense, sandy silt w/ gravel, dark grey. no HC odor (60,35,5)	
10		3 3 5	50	0.0	B04-10 @1100			Moist, loose, sandy SILT/CLAY mottled gray and orange. no HC odor (80, 20, 0)	
		2 3 6	100	0.0	B04-12.5 @1105			Moist, loose, sandy SILT/CLAY, mottled grey, and orange. no HC odor (90, 10, 0)	
15									

Drilling Co./Driller: Holocene/RJ
Drilling Equipment: Truck HSA
Sampler Type: SPT
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see pg 1

BORING LOG B04

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	X	3 3 5	100		B04-15 @1110			Moist, soft CLAY w/ sand, mottled, orange & gray. no HC odor (95,5,0)	
	X	0 0 3	100		B04-17.5 @1115			Moist, soft SILT w/ sand, brown w/ some gray & orange. no HC odor (95,5,0)	
20	X	0 2 1	100		B04-20 @1120			Moist, soft, CLAY w/ sand, dark gray, no HC odor (95,5,0)	
	X	0 0 6	100		B04-22.5 @1125			Moist, soft, sandy SILT/CLAY, gray w/ lenses of SAND no HC odor (80,20,0).	
25	X	15 20 20	100		B04-25 @1130			Wet, dense, silty medium SAND, gray. no HC odor (10,90,0).	
	X	7 15 22			B04-27.5 @1135			1" wet, SAA Moist, dense, sandy SILT, dark gray. no HC odor (80,20,0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: see pg 1 lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See pg. 1

BORING LOG B04

Site Address: 4208 Rainier Avenue S
Seattle, Washington

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	X	18 24 27	100		B04-30 @ 1145			Moist, very dense, SILT w/ sand, dark gray, no HC odor (85, 15, 0) Boring terminated @ 31.5' bgs Backfill w/ bentonite	
35									
40									
45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See pg. 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 3/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 19.5
Well Location E/W: 22 E of S lamp post
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB01

Site Address: 4208 Rainier Ave S
Seattle, Washington

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		80	0.0/0.1 0.0/0.2	SB01-2.5 (0830) SB01-5.0 (0835)	SP/GP SM		0-2" → asphalt 2"-2.5' → M. dense, dry, SAND, some gravel, some silt, lt brown, no odor (30,40,30) 2.5-4' → ~~loose~~ M. dense dry, silty SAND, trace gravel, gray, no odor, (40,55,5)	
5	5-10		50	0.0/0.4 0.0/0.2	SB01-7.5 (0836) SB01-10.0 (0840)	SM ML		0-1' → M. dense, moist, silty SAND with gravel, gray/lt brown, no odor (35,50,15) 1-2.5' → m. dense, moist, SILT with fine sand, trace gravel, gray, no odor (60,35,5)	
10	10-15		75	0.0/0.2 0.0/0.3	SB01-12.5 (0850) SB01-15.0 (0853)	ML/pt ML/CL		0-1.5' → moist, dense, SILT, little sand, with organics, dk brown, mod. organic odor, (70,30,0) 1.5-4' → moist, v. stiff SILT, ~~little~~ clay, trace sand, gray/brown, no odor (90,10,0)	
15									

Drilling Co./Driller: Holocene / Matt
Drilling Equipment: Geoprobe
Sampler Type: Sleeve
Hammer Type/Weight: — lbs
Total Boring Depth: 24.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: —/2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: asphalt
Annular Seal:
Monument Type: —

Notes/Comments:

Page: 1

SoundEarth Strategies

DRAFT

Project:
Project Number:
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W: see pg 1
Reviewed by:
Date Completed:

BORING LOG SB01

Site Address:

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	15-20		100	0.0/0.2	SB01-17.5 (0900)	CL/ML		0-5' → v. stiff, CLAY + Silt, lt brown, no odor (100,0,0)	
				0.0/0.2	SB01-20.0 (0905)	CL/ML			
20						CL/ML		0-1' → S.A.A., gray	
	15-24.5		100	1.9/1.5	SB01-22.5 (0915)	ML		1-4' → moist, v. stiff, SILT, little clay, trace fine sand, gray, no odor (90,10,0)	
				0.0/0.1	SB01-24.5 (0920)	SP		4-5' → moist, dense, F-C SAND, little gravel, trace silt, gray, no odor (10,70,20)	
25								Refusal at 24.5. GW not encountered.	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type: see pg 1
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal: see pg 1
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 2.5' of S lamp post
Well Location E/W: 14'E
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB02

Site Address: 4208 Rainier Ave S
Seattle, Washington

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		50	0.0/0.0	SB02-2.5 (0940)	SP		0-1' → Loose, dry, SAND, little silt, little gravel, lt brown, no odor (20,60,20), trace metal 1-2.5' → m. stiff, dry, fine SAND, little-some silt, gray, no odor (35,60,5)	
				0.0/0.0	SB02-5.0 (0945)	SM			
5	5-10		100	0.0/0.0	SB02-7.5 (0950)	SM		0-2.5' → S.A.A. 2.5-5.0' → moist, stiff, fine SAND with ~~fine~~ silt, trace gravel, gray, no odor (45,55,0)	
				0.0/0.0	SB02-10.0 (0955)	SM/ML			
10	10-15		100	35.1/32.0	SB02-12.5 (1000)	ML		0-1' → moist, m. dense, silt + fine sand, dk brown, some organics, no odor, (50,50,0)	
						ML/CL		1-5' → moist, v. stiff SILT, little clay, gray/lt brown, no odor (90,10,0)	
	15-16		100	7.9/3.9	SB02-16.0 (1005)	ML/CL		0-1' → S.A.A.; lt brown.	
15								Boring terminated at 16' bgs	

Drilling Co./Driller: Holocene/Mitch
Drilling Equipment: Geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 16 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: –/2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments: /

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 17' S
Well Location E/W: 45.5' E of S lamp post
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB03

Site Address: 4208 Rainier Ave S
Seattle, Washington

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		75	0.0/0.0 0.0/0.0	SB03-2.5 (1025) SB03-5.0 (1030)	SP		0-2" - asphalt 2"-2.5' → loose, dry SAND, some silt & gravel, lt brown/gray, trace wood, no odor (25, 50, 25) 2.5-4' → m. dense, dry, SAND little silt, trace gravel, brown gray, no odor (	
5	5-10		75	0.0/0.0 0.0/0.0	SB03-7.5 (1040) SB03-10.0 (1045)	SP SM		0-1.5' → S.A.A., small layers of organic-rich material 1.5-4' → m. ~~stiff~~ dense SAND with silt, trace gravel, gray brown, no odor (40, 50, 10)	
10	10-15		75	0.0/0.3	SB03-12.5 (1050)	ML		0-1' → S.A.A. 1-4' → v. stiff, dry SILT, little clay, lt brown, no odor (95, 5, 0)	
	15-16		100	0.0/0.4	SB03-16.0 (1055)	ML		0-1' → S.A.A. Terminated at 16' bgs	
15									

Drilling Co./Driller: Holocene / Antonio
Drilling Equipment: geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 16 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: ~2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments:

Page: 1

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 26' S of SE lamppost
Well Location E/W: 74' W
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB04

Site Address: 4208 Rainier Ave S
Seattle, Washington

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		75	0.0/0.0	SB04-2.5' (1100)	SP		0-2" – asphalt 2"-1.5' → loose, dry, SAND, little silt, some gravel, gray & brown, no odor (20,50,30)	
				0.0/0.0	SB04-5.0 (1105)	SM		1.5-4' → m. dense, silty SAND little gravel, gray & lt brown, no odor (35,50,15)	
5	5/10		100	0.0/0.0	SB04-7.5 (1115)	SM		0-2' → m. dense, dry, fine SAND, some silt, trace gravel, lt brown, no odor (35,60,5)	
				0.0/0.0	SB04-10.0 (1120)	SM/ML		2-5' → m. stiff, dry, SILT w/ fine sand, lt brown, no odor (60,40,0)	
10	10-15		100		SB04-12.5 (1122)	ML		0-1' → S.A.A. 1-5' → V. stiff, dry, SILT, trace clay, lt brown & gray, no odor (100,0,0)	
15	15-16		100		SB04-16.0 (1125)	ML		0-1' → S.A.A. Terminated at 16' bgs	

Drilling Co./Driller: Holocene / Matt
Drilling Equipment: Geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 16 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: ~2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments:

Page: 1

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 50' S of S lamppost
Well Location E/W: 22' E
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB05

Site Address: 4208 Rainier Ave S
Seattle, Washington

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		75	0.0/10.0 0.0/10.0	SB05-2.5 (1140) SB05-5.0 (1145)	SP SM		0-2" – asphalt 2"-1.5' → loose, dry, SAND, little silt, little gravel, dk brown, no odor (20,65,15) 1.5-4' → m. dense, silty SAND, little gravel, gray, no odor (40,50,10)	
5	5-10		75		SB05-7.5 (1150) SB05-10.0 (1152)	SM/pt SM		0-0.5' → S.A.A. 0.5-1.5' → loose, moist, SILTY SAND with organics, dk brown, organic odor, (40,55,5) 1.5-4' → m. dense, silty SAND, little gravel, lt brown/gray, no odor (40,50,10)	
10	10-15		100		SB05-12.5 (1155)	SM ML		0-1 → S.A.A. 1-5 → V. stiff, dry SILT, little fine sand, lt brown/gray, no odor (90,10,0)	
	15-16		100		SB05-16.0 (120)	ML		0-1' → V. stiff SILT, gray, no odor (100,0,0)	
15									

Drilling Co./Driller: Holocene/ Mitch
Drilling Equipment: Geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 16 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: -12 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments:

Page:

SoundEarth Strategies

DRAFT

Project: 1276-00
Project Number: Rainier Mall Property
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: Asphalt
Well Location N/S: 24' N of 2nd N lamppost
Well Location E/W: 32.5' W
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB06

Site Address: 4208 Rainier Ave S
Seattle, WA

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		50	0.0/0.0	SB06-2.5 (1215)	SP		0-2" → asphalt 2"-2.5' → loose, dry, SAND, some silt & gravel, lt brown, no odor (30,40,30)	
				0.0/0.0	SB06-5.0 (1220)	SP			
5	5-10		100	0/0	SB06-7.5 (1405)	SM		0-1' → S.A.A. 1-5' → loose, dry, SAND w/ silt, little gravel, brown, gray, & orange, no odor (40,50,10)	
				0/0	SB06-10.0 (1410)	SM			
10	10-15		100		SB06-12.5 (1415)	ML		0-5' → V. stiff SILT, dry, little fine sand, lt brown/gray mottled, no odor	(85,15,0)
					SB06-15.0 (1417)	ML			
15									

Drilling Co./Driller: Holocene / Mitch
Drilling Equipment: geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 24 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: ~2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments:

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SoundEarth Strategies

DRAFT

Project:
Project Number:
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see pg 1

BORING LOG SB06

Site Address:

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	15-20		100	0/0	CT SB06-~~[illegible]~~ 17.5 (1420)	ML		0-4' → S.A.A, thin lenses of F-C sand	
				0/0	SB06-20.0 (1425)	ML/CL		4-5' → ~~St~~ CT Stiff, moist CLAY & SILT, gray, no odor (100,0,0)	
20	20-24		100	0/0	SB06-22.5 (1430)	ML/CL		0-3' → S.A.A	
				0/0	SB06-24.0 (1435)	ML		3-4' → CT ~~Loose~~ Stiff, moist SILT, little clay, trace sand, lt brown, no odor (95,5,0)	
25								Refusal at 24' bgs. No GW encountered	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see pg 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see pg 1

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 325' N of 2nd N post
Well Location E/W: 15.5' W
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB07

Site Address: 4208 Rainier Ave S
Seattle, WA

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		50	0/0	SB07-2.5 (1450)	SP/GP		0-2.5' → loose, dry SAND GRAVEL, little silt, brown/gray, no odor (15, 45, 40)	
				0/0	SB07-5.0 (1453)				
5	5-10		50	0/0	SB07-7.5 (1455)	SP/GP SM		0-1' → S.A.A. 1-2.5' → m. dense silty SAND, little gravel, dk brown/grey, no odor (40, 50, 10)	
				0/0	SB07-10.0 (1500)				
10	10-15		100		SB07-12.5 (1505)	ML		0-5' → v. stiff SILT, little fine sand, dry, brown, no odor (90, 10, 0)	
15	15-16		100		SB07-16.0 (1510)	ML		0-1 → S.A.A. Boring terminated at 16' bgs.	

Drilling Co./Driller: Holocene/Marcu
Drilling Equipment: Geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 16 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: ~2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments:

Page: 1

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by: CJT
Date Started: 1/18/17
Surface Conditions: asphalt
Well Location N/S: 14' N of S lamppost
Well Location E/W: 14' E
Reviewed by:
Date Completed: 1/18/17

BORING LOG SB08

Site Address: 4208 Rainier Ave S
Seattle, WA

Water Depth At Time of Drilling: — feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0	0-5		100	0/0	SB08-2.5 (1520)	SP		0-2.5' → loose, dry SAND, some silt & gravel, lt brown, no odor (30,40,30)	
				0/0	SB08-5.0 (1525)	SM		2.5-5' → M. dense, dry, silty SAND, gray/dk brown, no odor (40,55,5)	
5	5-10		100	0/0	SB08-7.5 (1527)	SM		0-1' → S.A.A. 1-3' → Dense, dry silty SAND, trace gravel, gray, no odor (40,55,5)	
				0/0	SB08-10.0 (1530)	SM/ML		3-5' → v. stiff SILT + fine SAND, gray, no odor (50,50,0)	
10	10-15		100	0/0	SB08-12.5 (1535)	ML		0-3' → v. stiff SILT, little fine sand, dry, no odor, gray (55,15,0)	
						ML		3-5' → v. stiff SILT, dry, lt brown, no odor (100,0,0)	
15	15-16			4.9/4.6	SB08-16.0 (1540)			Boring terminated at 16' bgs.	

Drilling Co./Driller: Holocene / Mitch
Drilling Equipment: Geoprobe
Sampler Type: liner
Hammer Type/Weight: — lbs
Total Boring Depth: 16 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 2 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: —
Annular Seal: —
Monument Type: —

Notes/Comments: /

Page: 1

No well installed

SoundEarth Strategies

DRAFT

Mirror [illegible] (~4' ~~[illegible]~~ E of MW01)

Project: Rainier Mall
Project Number: 1276-001
Logged by: CGC
Date Started: 03/22/17
Surface Conditions: Asphalt
Well Location N/S: ~18 ft S (~18' S)
Well Location E/W: ~29 ft E (~29' E) of SW-most light pole in parking lot
Reviewed by:
Date Completed:

BORING LOG MW02

Site Address: 4208 Rainier Avenue S
Seattle, WA

perched
Water Depth At Time of Drilling: 17.5', 23', 26.5' feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			100	0.0 0.0	— —	Fill (SM)		Damp & moist, med dense, silty fine SAND w/ gravel, gray & brown, faint organic odor (30-55-15) contains wood pieces & yellow ceramic chips in upper ~2' bgs (Fill)	N/A None
5			100	0.0 0.0	— —	Fill (SM) Fill (ML)	8'	localized wet @ ~7.5 to 8' bgs Damp, dense, Sandy SILT with subr gravel. contains bits of red brick, wood pieces, & mottled broken glass. Brown & gray. No HC/solvent odor. (45-35-20) Fill	
10			100	0.0 0.8	— —	Fill (ML) ML	~11' ~12.5' ~12.5'	becomes siltier with clay & less gravel @ ~11' + (75-15-10) Fill? Moist ~~Damp~~, hard ~~dense~~, Clayey ~~Sandy~~ SILT with fine sand ~~& trace gravel~~. Mottled, orange-brown gray, no HC/solvent odor ~~(70-25-5)~~ ~~(65-30-5)~~ (90-10-0).	
15									

Drilling Co./Driller: Cascade/Zane
Drilling Equipment: Track-Mounted Sonic
Sampler Type: Core barrel
Hammer Type/Weight: — lbs
Total Boring Depth: 90.0 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:
None

Notes/Comments:
8" conductor casing used to 35' bgs. Bentonite seal placed @ ~30-35' bgs. Seal set for ~ min before drilling deeper.

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See pg 1

BORING LOG MW02

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15				0.0	—	ML		Same as above	
			100	0.0	—	ML	17.5 18'	wet, dense sandy SILT, mottled brown & gray; No HC/solvent odor (60-40-0).	∇ ~17.5'
				0.0	—	ML		Moist, hard, clayey SILT with trace fine sand, faint solvent odor @~19 to 20' bgs; Mottled brown & gray (85-15-0).	
				5.6	~~MW02-20 @1100~~ x4				
20								Moist, soft, silty CLAY, faint solvent odor. brown & gray (100-0-0)	
				@21' 11.6 ~~11.6~~	—				
			100%			ML			
				@23' 36.7		SM	23' ~~18~~	wet, dense, silty SAND, gray, faint solvent odor (30-70-0)	∇ ~23'
				@24' 82.8 @24.5' 40.6	MW02-24 @1100 x4	CL	24'	Moist, hard, ~~clayey SILT~~ silty CLAY, gray, No HC/solvent odor (100-0-0)	
25								contains 2 3-inch lenses of silty sand (30-70-0)	
			100%	0.4			26.5	wet to moist, dense fine to med SAND w/ silt & gravel, gray, faint solvent odor (10-80-10)	∇ ~26.5'
						SM-SP			
				@28' 350 @28.5' 26.5 0.3	MW02-28 @1125 x4	ML	28.5	Moist, hard, sandy SILT with clay, sl. gravel, gray, no solvent odor (30-~~50~~-20)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal: See pg 1
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2 of 6

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

Seeps!

BORING LOG MW02

Site Address: 4208 Rainier Avenue S
Seattle, Washington

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30			100	0.0	~~MW02-3~~ MW02-31 @1140 x4	ML		Damp to dry, hard, Sandy SILT with clay & fine gravel, gray, no solvent or HC odor. ~~(80-20-0)~~ (80-15-5)	
				0.0	MW02-35 @1145 x4	ML			
35			100	0.0 0.0	— —	ML		Same as above except Moist except less gravel & less sand @~37 to 38' bgs (80-10-10)	
38'				0.0	MW02-40 @1340 x4	ML	~38'	moist, dense hard, ~~Sandy~~ SILT with very fine sand, clay & fine subr. gravel, gray, no HC/Solvent odor (85-10-5) (~~5~~ 5	
40			100	0.0	—				
43'			100	0.0	~~0.0~~	ML	~43'	Damp to moist dense, SILT locally with trace very fine sand, gray, NO HC/solvent odor (95-5-0)	
45	~48'								

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Seeps!

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001-01
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See pg 1

BORING LOG MW02

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45		from 45	100		—	ML		Same as above (95-5-0)	
				0.0					
48			100	0.0	—	ML		Very dense SILT with clay ~~trdg~~ (trace fine sand, dry, gray, no HC/solvent odor (95-5-0)	
				0.0	—				
50			100	0.0	—	ML			
				0.0	—	ML		Same as above	
55			100	0.0	—	ML			
				0.0	—	ML		Same as above	
60									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

See pg 1

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001-01
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W: see pg 1
Reviewed by:
Date Completed:

BORING LOG MW02

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
60								Same as above locally [illegible] ~61 to 63 bgs Moist	
			100	0.0	—	ML			
				0.0	—	ML			
65								Same as above Damp to dry SILT with very fine sand (95-5-0)	
			100	0.0	—	ML			
				0.0	—	ML		~68' Damp to moist, dense, sandy SILT w/ gray, no Hy/solvent odor (75-25-0)	
70									
			100	0.0	—	ML			
				0.0	—	ML			
75									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal: see pg 1
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

Seeps!

BORING LOG ~~MW02~~ MW02

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0 75								Same as above (Damp to mostly dense, Sandy SILT, gray, no HC/solvent odor (75-25-0).	
			100	0.0	—	MC			
				0.0	—	MC			
5 80				0.0	—	MC			
				0.0	—	MC		Same as above (75-25-0)	
10 85				0.0	—	MC	.85'	Becomes siltier on ~~86~~ 86' bgs (80-20-0) ~~88~~ Becomes, Damp ~~Damp~~ to dry, @ 87'	
15 90				0.0	MW02-90 @1555	MC		Boring terminated @ 90 bgs	

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Seeps!

Notes/Comments:
EOB: 90 bgs
Backfilled w/ bentonite chips to grade & capped with ~~asphalt~~ Concrete.

Page: 6 of 6

SoundEarth Strategies

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 1/24/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/24/18

DRAFT

BORING LOG TB01

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~13 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								3" of asphalt	
5		8 12 12	40	0.3	TB01-05 @0938	GM		5'-6.5': Moist, med. dense silty GRAVEL w/ some sand, dark brown, occasional brick fragments, no HC odor. (25-10-65)	
10		3 4 6	80	0.0	TB01-10 @0945	ML		10'-11.5': Moist medium stiff clayey SILT w/ fine sandy layers, gray to brown, no HC odor. (90-10-0)	
15									

Drilling Co./Driller: Holocene / Rowdy
Drilling Equipment: HSA truck rig
Sampler Type: SPT
Hammer Type/Weight: AUTO/ 140 lbs
Total Boring Depth: 31.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 8" inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: Concrete
Annular Seal: Bentonite
Monument Type: —

Notes/Comments:

Page: 1/3

SoundEarth Strategies

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see page 1

BORING LOG TB01

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~13 feet bgs
Water Depth After Completion: — feet bgs

DRAFT

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	⧗	1 1 2	100	23.3	TB01-15 @0950	ML		Wet, soft clayey SILT w/ some sand, faint solvent? odor, gray to brown, (90-10-0)	
20	⧗	1 1 1	100	2.0	TB01-20 @0955	CL		Wet, soft silty CLAY, gray, no HC or solvent odor, (100-0-0)	
25	⧗	3 5 16	100	0.2		CL		Wet, ~~soft~~ ~~very~~ stiff silty CLAY, gray, no HC/solvent odor, (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see page 1

BORING LOG TB01

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~13 feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	X	3 4 6	100	0.7		CL		Wet, stiff, silty CLAY, gray, no HC/solvent odor, (100-0-0)	
								EOB @ 31.5' bgs. Boring abandoned, backfilled w/ bentonite and sealed w/ concrete flush with surface.	
35									
40									
45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:

Page: 3/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 1/24/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/24/18

BORING LOG TB02

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~15, 40 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								3" of asphalt	
5		4 6 5	20	0.0	TB02-05 @1035 (4 VOAs)	SM		med. dense Moist, silty SAND, ~~trace~~ of gravel, brown, occasional organics, no HC/solvent odor. (FILL?) (30-65-5)	
10		3 3 6	60	0.0	TB02-10 @1045	CL		stiff Moist, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
15									

Drilling Co./Driller: HOLOCENE / Rowdy
Drilling Equipment: HSA truck rig
Sampler Type: SPT
Hammer Type/Weight: AUTO / 140 lbs
Total Boring Depth: 41.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 8" inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: Concrete
Annular Seal: Bentonite
Monument Type: —

Notes/Comments:

Page: 1/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0811-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see page 1

BORING LOG TB02

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~15, 40 feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		3 5 7	80	2.4	TB02-15 @1055	CL		Wet, stiff, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
20		1 1 1	100	0.1	TB02-20 @1105	CL		Wet, soft, silty CLAY, gray to brown, no HC/solvent odor. (100-0-0)	
25		1 1 1	100	0.0		CL		~~Wet,~~ Moist, soft, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:

Page: 2/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see page 1

BORING LOG TB02

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~15, 40 feet bgs
Water Depth After Completion: —— feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30 45	⧖	3 3 4	100	0.1		CL		Moist, med. stiff, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
35 50	⧖	33 36 49	100	0.1		SM		Moist, very dense silty med. to coarse SAND w/ some gravel, gray, no HC/solvent odor. (25-60-15)	
40 55	⧖	7 15 20	100	0.0		SP		Wet, dense, medium to coarse SAND, trace of silt, gray, no HC/solvent odor. (5-90-0)	
								EOB @ 41.5' bgs Boring abandoned and backfilled w/ bentonite and sealed with concrete to flush with surface.	
45 60									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:

Page: 3/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 1/24/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/24/18

BORING LOG TB03

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~18 feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								3" of asphalt	
5	⧖	2 2 4	20	0.4	TB03-05 @1300	GM		5'-6.5': Moist, loose silty GRAVEL, with some sand, dark brown, occasional organics, faint HC?/solvent-like? odor. (25-10-65) (FILL?)	
10	⧖	3 3 2	90	0.0	TB03-10 @1305	ML		10'-11.5': Moist, medium stiff fine sandy SILT, dark brown to gray	
15									

Drilling Co./Driller: Holocene / Rowdy
Drilling Equipment: HSA truck rig
Sampler Type: SPT
Hammer Type/Weight: AUTO / 140 lbs
Total Boring Depth: 46.5 feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: — / 8 inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal: Concrete
Annular Seal: Bentonite
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see page 1

BORING LOG TB03

Site Address:
4208 Rainier Ave
South,
Seattle, WA

▽ **Water Depth At Time of Drilling:** ~18 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		3 3 4	100	0.0		CL		Moist, medium stiff silty CLAY, light brown, no HC/solvent odor. (100-0-0)	
▽									
20		1 1 2	100	0.0		CL		Wet, soft ~~medium stiff~~, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
25		2 2 3	100	0.0		CL		Wet, medium stiff, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

see page 1

BORING LOG TB03

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~18 feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		1 2 2	100	0.0		CL		Wet, soft, silty CLAY, gray, no HC/solvent odor. (100-0-0)	
35		2 3 4	100	0.0		CL		Wet, medium stiff silty CLAY, gray, no HC/solvent odor. (100-0-0)	
40		4				CL		40'-40.5': Wet, soft silty CLAY, gray, no HC/solvent odor, (100-0-0)	
41		15 31	100	0.0		SM		40.5-41.5': Wet, dense SAND w/ some silt, gray, no HC/solvent odor. (15-85-0)	
42									
43									
44									
45		11 38 46	80	0.1		SP		45'-46.5': Wet, very dense SAND, trace of silt, gray, no HC/solvent odor. (5-95-0)	
46									
47 45								EOB at 46.5' bgs.	

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:
Boring abandoned at 46.5' bgs, backfilled w/ bentonite, and sealed with concrete to surface.

Page: 3/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/25/18

BORING LOG TB04

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~20 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		5 10 13	55	0.3	TB04-05 @0905	SM		moist, gray-brn, silty SAND w/ grvl, no odor (35-55-10)	
10		2 3 5	100	0.1	TB04-10 @0810	ML		Moist, light-brn w/ trace FeO stain, SILT w/ SAND no odor (80-20-0)	
15									

Drilling Co./Driller: Holocene
Drilling Equipment: truck HCA
Sampler Type: SPT
Hammer Type/Weight: Auto /140 lbs
Total Boring Depth: 46.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 6OD inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: Asphalt
Annular Seal: Bentonite
Monument Type: —

Notes/Comments:

Page: 1 of 4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/28/08
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB04

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		7 4 5	100	0.1	TB04-15 @ 0815	ML		moist, light tan, SILT w/ SAND, no odor (85-15-0)	
20		1 1 1	100	0.1	—	ML/CL		moist to wet, light gray clay/ SILT w/ SAND, no odor (90-10-0)	
25		1 2 7	100	0.1	—	ML/CL		wet, light gray, SILT/clay w/ tr fine SAND, no odor (95-5-0)	
30									

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LBS
Date Started: 1/25/10
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB-04

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	X	9 20 21	100	0.2	–	ML SM		wet-sat, gray, silty SAND, no odor (30-70-0) w/ 8" previous cuttings	
35	X	2 4 5	100	0.2	–	ML/CL		wet-sat, gray, silt/clay, no odor (100-0-0)	
40	X	11 20 29	100	0.3	–	SM		Sat, gry, silty SAND w/ gravel, no odor (35-55-10) [Glacial till?]	
45									

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/12
Surface Conditions:
Well Location N/S: See Page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB04

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45	X	12 32 50/3"	100	0.3	—	SM		wet-sat, gry, SAND w/ silt + grvl, no odr (20-65-15)	
								EOB @ 46.4' bgs,	
50									
55									
60									

Drilling Co./Driller:
Drilling Equipment: See Page 1
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 4 of 4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/25/18

BORING LOG | TB05

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~25 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		7 6 6	90	5.6	TB05-05 @0945	SP-SM		8" dk. brn, moist sand w/ silt + gravel, faint HC odor (15-65-20) over 4" light brn, coarse sand w/ silt & gravel, no odor (10-80-10)	
10		3 3 4	100	0.6	TB05-10 @0950	ML/CL		~4" previous (slough) over moist, gray-brn, silt clay w/ sand, no odor (90-10-0)	
15									

Drilling Co./Driller: Holocene
Drilling Equipment: track HSA
Sampler Type: SPT
Hammer Type/Weight: Auto / 140 lbs
Total Boring Depth: 40' 1" feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 5OD inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: Asphalt
Annular Seal: Cement
Monument Type: —

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions:
Well Location N/S:
Well Location E/W: See page 1
Reviewed by:
Date Completed:

BORING LOG | TB05

Site Address: 4208 Rainier Ave South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	X	2 3 5	100	0.5	TB05-15 @0955	ML/CL		Moist, light brn SILT/clay w sand, no odr (40-10-0)	
20	X	0 1 1	100	0.4	-	CL/ML		Moist-wet, gry, clay-silt, no odr (100-0-0)	
25	X	4 4 3	100	0.4	-	CL/ML		wet-sat, gry, SILT/clay w/ SAND, no odr (40-10-0)	▽
								Driller notes gravel @ 29' bgs	
30									

Drilling Co./Driller:
Drilling Equipment: See page 1
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions:
Well Location N/S:
Well Location E/W: See pg 1
Reviewed by:
Date Completed:

BORING LOG TB05

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		14 10 15	100	0.5	—	CL		wet, dark gray, SILT/clay, no odor (100-0-0)	
35		50/2"	0	—	—	—		No recovery	
40		50/1"	5	0.0	—	CL		core driven for recovery. ~50 blows wet-Sat, gray, silt/clay, no odor (100-0-0) EOB @ 40' 1" bgs GW observed at ~25' ATD.	
45									

Drilling Co./Driller:
Drilling Equipment: See pg 1
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/25/18

BORING LOG TB06

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: NG feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		4 4 5	10	3.6	TB06-05 @1110	SM		4" gry silt wet, ovr moist, brn, silty SAND w/ gravel, faint petroleum ~~HC~~ odor (25-60-15)	
		CAL	50	3.5	—			redrove to improve recovery for Geotech sample	
10		2 2 2	40	0.2	TB06-10 @1115	SM		Moist to wet, gry-brn, silty SAND w/ gravel, no HC/solv odors (30-60-10) 2" overlying silt.	
15									

Drilling Co./Driller: Holocene
Drilling Equipment: track HSA
Sampler Type: split
Hammer Type/Weight: Auto/140 lbs
Total Boring Depth: 51.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 6 OD inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: Asphalt
Annular Seal: Bentonite
Monument Type: —

Notes/Comments:

Page: 1 of 4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions: See page 1
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB06

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		3 5 6	100	0.4	TB06-15 @1120	ML/CL		Moist, tan, Clay/Silt, w/ SAND No odor (90-10-0)	
20		1 1 2	100	0.2	—	CL/ML		moist to wet, tan Clay/Silt, No HC/Solv odor (100-0-0)	▽
25		2 3 5	100	0.3	—	CL/ML		wet, gray, Clay/Silt, no HC/Solv odor (100-0-0)	
30									

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2 of 4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LBS
Date Started: 1/25/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See pg 1

BORING LOG TB06

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		31 16 29	100	0.2	—	SP-SM		wet-Sat, gray silty SAND w/ gravel, no HC/solv odor (20-70-10) Driller Adds H_2O to prevent heave.	
35		20 50/2"	85	0.0	—	SP-SM		Sat, gray, silty SAND ~~w/~~ no fine grd no HC/solv odor (15-80-5) Driller Adds more water	
40		10 50/2"	70	0.1	—	SP-SM		Same as previous, no HC/solv odor	
45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See pg 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/25/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See page 1

DRAFT

BORING LOG TB06

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45		30 50/4"	80	0.0	—	SM	S	Wet ~~to moist~~ UMS, gry-silty SAND, no HC/solv odr (35-65-0)	
50		10 36 50/5"	80	0.0	—	ML-SM		Moist, gray, Sandy silt, no HC/Solvent odor (70-30-0)	
								EOB @ 51.4' bgs	
55									
60									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/26/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/26/18

BORING LOG TB07/MW04

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~27 feet bgs
Water Depth After Completion: ~13.7 feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		3 5 6	20	0.2	TB07-05 @0810	SM		Moist, gray, silty SAND, trace gravel, no odor (25-70-5)	
10		1 2 50/5"	55	0.5	TB07-10 @0815	SM		Moist to wet, gray, silty SAND w/ gravel, no HC/solv odor (30-60-10)	
		8 3 2	40	0.3	TB07-12.5 @0820	ML/CL		Moist, dark gray SILT/clay, no HC/solv odor (100-0-0)	
15									

Drilling Co./Driller: Holocene
Drilling Equipment: track HSA
Sampler Type: SPT
Hammer Type/Weight: Auto/140 lbs
Total Boring Depth: 41.5 feet bgs
Total Well Depth: 35 feet bgs
State Well ID No.: BICC 019

Well/Auger Diameter: 2 / 6 OD inches
Well Screened Interval: 15 35 feet bgs
Screen Slot Size: 0.10 inches
Filter Pack Used: Colorado Silica Sand
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments:
Sand Pack 13-36

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/20/12
Surface Conditions:
Well Location N/S: See pg 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB07

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		2 3 4	75	0.5	TB07-15 @0825	ML		moist, tan silt/clay, trace to w/ sand, no odor (90-10-0)	
		2 4 7	100	0.7	TB07-17.5 @0830	ML/CL		moist, medium brown, silt/clay no HC/solv odor (100-0-0)	
20		2 1 1	100	0.5	TB07-20 @0835	ML/CL		wet, light tan silt/clay no HC/solv odor (100-0-0)	
25		3 1 3	100	0.5	TB07-25 @0840	ML/CL		wet, gray, silt/clay w/ sand, no HC/solv odor (90-10-0) Sand stringer. Driller indicates gravel @ 29' bgs	
30									

Drilling Co./Driller: —
Drilling Equipment: See pg 1
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: 15-35 feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:
Sand ~36

Page: 2 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/26/12
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB07

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	X	14 18 16	70	0.6	TB07-30 @0845	ML		Silt, gry SILT w/ SAND, no HC/sol odr (85-15-0)	
35	X	17 34 50/6"	70	0.5 [illegible]	TB07-35 @0850			Silt, gry, SILT w/ sand, no HC/solv odr (90-10-0)	
40	X	11 20 24	100	0.3	TB07-40 @0900	ML/CL		Mud, gry, v-clys silt, no HC/solv odr (100-0-0)	
								EOD @ 41.5, bckfl'd + set well scrn 15-35	
45									

Drilling Co./Driller: See page 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/26/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 1/26/18

BORING LOG | TB08/MW05

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ? No GW ATD feet bgs
Water Depth After Completion: ~27 (-115 Mg?) feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		6 9 6	80	0.2	TB08-05 @1100	SM		moist, brn, silty SAND w/ gravel, trace IO stainy, no HC/Sol odor (30-60-10)	
10		2 2 3	100	0.4	TB08-10 @1105	ML/SM		12" moist, gray-tan SILT w/ SAND no HC odor (85-15-0) over 8" moist, dark brn, orange char silty SAND (40-60-0) no odor	
		3 5 8	90	12.9	TB08-12.5 @1110	ML/SM		Moist, tan-gray SILT/clay, trace IO stainy no odor. (100-0-0)	
15									

Drilling Co./Driller: Holocene
Drilling Equipment: track HSA
Sampler Type: SPT
Hammer Type/Weight: Auto/140 lbs
Total Boring Depth: 41.5 feet bgs
Total Well Depth: 35 feet bgs
State Well ID No.: BKC 620

Well/Auger Diameter: 2 / 6OD inches
Well Screened Interval: 15-35 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Colorado Silica Sand
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments:
Sand Pack 13-36

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LAS
Date Started: 1/26/15
Surface Conditions:
Well Location N/S: See pg 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB08

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		2 4 5	100	48.2	TB08-15 @1115	ML		Sm as prev, No HC/Solv odor (100-0-0)	
		2 2 3	100	72	TB08-17.5 @1120	ML		Sm as prev	
20		2 3 4	100	4.3	TB08-20 @1125	ML		Moist, 12" prev, 6" moist, gry silt w/ Fe staining + possible decayed root fragments, no HC/Solv odor	
25		7 12 17	100	0.3	TB08-25 @1130	ML/CL		Moist, gry, silt/clay no HC/Sol odor (100-0-0)	
30									

Drilling Co./Driller: See pg 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: LDS
Date Started: 1/26/16
Surface Conditions:
Well Location N/S: See pg 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG TB08

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		10 17 25	100	0.6	TB08-30 @ 1135	SM/ML		Same as prev no HC/Solv odrs (100-0-0)	
35		17 20 25	100	0.3	TB08-35 @ 1145	SM/ML		Same as prev, no HC/Solv odrs (100-0-0)	
40		12 22 29	100	0.2	TB08-40 @ 1155	SM/ML		Same as prev no HC/Solv odrs (100-0-0)	
								EOB @ 41.5 set well. Screen 15-35' bgs. NO GW observed at time of drilling.	
45									

Drilling Co./Driller: See pg 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: GCF
Date Started: 1/28/13
Surface Conditions: asphalt
Well Location N/S: SEE Fig.
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B08

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~20 feet bgs
Water Depth After Completion: / feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5	X	7 6 6	100	0.2	P08-05 @ 1335	ML/CL		Moist, stiff, silt w/clay, Gray, no HC/solvent odor. (100-0-0)	
10	X	4 7 8	100	0.2	P08-10 @ 1345	ML/CL		Moist stiff, silt w/clay, Gray/tan, no HC/solvent odor. (100-0-0)	
	X	5 5 6	100	0.2	P08-12.5 @ 1355	ML/CL		Moist stiff, silt w/clay and trace fine sand, Gray/tan; no HC/solvent odor. [illegible] Sample. (95-5-0)	
15									

Drilling Co./Driller: Cascade/ James
Drilling Equipment: HSA
Sampler Type: D&M
Hammer Type/Weight: Downhole / 300 lbs
Total Boring Depth: 50.5' feet bgs
Total Well Depth: feet bgs
State Well ID No.: /

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: GF
Date Started: 1/25/18
Surface Conditions: asphalt
Well Location N/S:
Well Location E/W:
Reviewed by: SEERG1.
Date Completed:

BORING LOG B08

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	☒	3 4 4	100	0.4	B08-15 @ 1400	ML		Moist, stiff, silt w/ clay and fine sand, brown, no HC/solvent odor. (70-30-0)	
	☒	4 4 4	100	0.3	B08-17.5 @ 1405	ML/CL		Moist, stiff, silt w/ clay, brown to gray, no HC/solvent odor. (100-0-0)	
20	☒	4 3 4	100	0.2	B08-20 @ 1410	ML/CL		Moist, medium stiff, silty w/ clay, gray and brown, no HC/solvent odor. (100-0-0)	
25	☒	6 4 4	100	0.2	B08-25 @ 1420	ML/CL		Moist to wet, stiff, silty w/ clay, ~~Gray~~ Gray, no HC/solvent odor. (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type: SEERG1.
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE PG. 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B08

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30		5 4 4	100	0.2	B08-30 @ 1425	ML/CL		Moist to wet, Silt w/clay, Gray, thin layer of fine sand at 30'. No HC/solvent odor. (100-0-0)	
35		13 21 23	100	0.2	B08-35 @ 1430	SM		Moist, dense Silty SAND w/gravel, Gray, medium sand. No HC/solvent odor. (15-70-15)	
40		50/6"			~~B08-40 @~~			~~Driller~~ Driller notes hard/heaving condition. Sample full of slough @ 40'. No sample collected.	
45									

Drilling Co./Driller: SEE PG. 1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG. 1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE PG.1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B08

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45		50/6"	70	0.2	B08-45 @ 1505	ML/CL		Moist to dry, very stiff, silt with clay, no HC/solvent odor. (100-00)	
50		50/6"	30	0.2	~~1530~~ B08-50 @ 1530	ML/CL		Same as above.	
								EOB @ 52' bgs, backfill boring with bentonite and patch surface.	
55									
60									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: SEE PG.1 lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG.1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 4/4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: CMF
Date Started: 1/25/18
Surface Conditions: asphalt
Well Location N/S: –
Well Location E/W: 7' W of D6
Reviewed by:
Date Completed: 1/25/18

BORING LOG B09/MW02

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~20' feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5	☒	2 2 3	100	0.3	B09-05 @ 0820	SM		loose Moist, silty SAND w/ trace gravel and organics, Gray, no HC or solvent odor. (45-50-5) (Fill)	
10	☒	3 3 3	100	0.2	B09-10 @ 0825	SM ML/CL		10-11': Same as above 11-11.5': Moist, soft, SILT w/ clay, Gray, no HC or solvent odor. (100-0-0)	
	☒	4 5 5	100	0.2	B09-12.5 @ 0835	ML/CL		Moist, stiff, silt w/ clay, light gray, no HC or solvent odor, trace organics, (100-0-0)	
15									

Drilling Co./Driller: Cascade / James
Drilling Equipment: HSA
Sampler Type: D and M
Hammer Type/Weight: downhole / 300 lbs
Total Boring Depth: 31.5' feet bgs
Total Well Depth: 30' feet bgs
State Well ID No.: ~~MW02~~ BKF103 GW

Well/Auger Diameter: 2 / 8.25 OD inches
Well Screened Interval: 15-30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: 2/12 silica SAND
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments:
EOB at 31.5' BGS.
Set well MW02 screened from 15-30'
Sand Pack 13-31.5'
Bentonite 2-13'

Page: 1/2

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE Pg. 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B09

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		4 4 4	100	0.2	B09-15 @ 0840	CL ML		Moist, stiff, Silt w/clay, light gray mottled tan, no HC/solvent odor, trace organics (100-0-0)	
		4 3 4	100	0.2	B09-17.5 @ 0845	CL/ML		Moist, medium stiff, silty w/clay, tan, thin (~1cm) fine sand/silt varves at ~13.5'; no HC/solvent odor. (100-0-0)	
20		4 3 3	100	0.3	B09-20 @ 0850	CL/ML		Wet, medium stiff, Silt w/clay and fine to medium Sand, Gray, becomes more soft and wet at 20.5' BGS. No HC/solvent odor. (80-20-0)	
25		2 2 2	100	0.2	B09-25 @ 0855			25-25.5: wet to moist, Silty medium SAND. gray, no HC/solvent odor. (40-60-0) 25.5-26.5: wet to moist, soft Silt w/clay and trace fine sand, No HC, solvent odor. (95-5-0)	
30		2 2 2	100	6.2	B09-30 @ 0900			30-30.5: wet to moist silty medium SAND, Gray, no HC or Solvent odor. (15-85-0) 30.5-31.5, wet to moist, soft Silt w/clay and trace fine sand, gray. No HC/Solvent odor. (95-5-0)	

31.5

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: SEE Pg 1 lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE Pg. 1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2 2

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: GCF
Date Started: 1/25/18
Surface Conditions: asphalt
Well Location N/S: — GCP
Well Location E/W: ~~7' west of D6~~ 12' E of G3
Reviewed by:
Date Completed: 1/25/18

BORING LOG MW03 B07

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~20 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								6" asphalt.	
5	☒	5 4 3	100	0.1	B07-05 @ 1025	SM		Moist, loose, Silty SAND w/ gravel, medium, gray, no HC/solvent odor. (25-65-10)	
10	☒	5 9 6	100	0.2	B07-10 @ 1030	ML/CL		Moist, stiff, Silty w/ clay, Gray and tan Varves, no HC or solvent odor. medium plasticity	
	☒	2 9 6	100	0.2	B07-12.5 @ ~~1030~~ 1035 GCF	ML/CL		Moist, stiff, Silt w/ clay, Mostly tan w/ Gray Varves, Several very thin (<1cm) fine to medium sand lenses. No HC/solvent odor. (100-0-0	
15									

Drilling Co./Driller: Cascade / James
Drilling Equipment: HSA
Sampler Type: D and M
Hammer Type/Weight: downhole / 300 lbs
Total Boring Depth: 31.5' feet bgs
Total Well Depth: 30' feet bgs
State Well ID No.: BKF 104

Well/Auger Diameter: 2" / 8.25 inches
Well Screened Interval: 15-30' feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: #2/12 sand
Surface Seal: Concrete
Annular Seal: Bentonite
Monument Type: Flushmount.

Notes/Comments: EOB at 31.5'
Set well MW03
Screen 15-30'
Sand 13-31.5'
Bentonite -13

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: GLF
Date Started: 1/23/18
Surface Conditions: asphalt
Well Location N/S:
Well Location E/W: SEE PG 1.
Reviewed by:
Date Completed:

BORING LOG B07

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	X	3 4 4	100	0.1	B07-15 @ 1100	ML/CL		Moist, stiff, silt w/ clay, tan with mottled gray, no HC or solvent odor. (100-0-0)	
	X	3 2 2	100	0.2	B07-17.5 @ 1105	ML/CL		Moist to wet, medium stiff, silt w/ clay and trace fine sand, no HC or solvent odor. (95-5-0)	
20	X	3 3 3	100	0.2	B07-20 @ 1110	ML/CL (SM)?		20-21: Moist to wet, silt w/ clay and fine to medium sand, No HC/solvent odor. (90-10-0) 21-21.5: Moist to wet, silty w/ clay and fine to medium sand, No HC/solvent odor. (80-20-0)	
25	X	3 4 3	~~3 4 5~~ 100 GLF	0.2	B07-25 @ 1115	ML/CL		wet to moist, medium stiff, silt w/ clay and trace fine sand, gray, no HC/solvent odor. (95-5-0)	
30		3 4 4	100	0.2	B07-30 @ 1120	ML/CL		wet to moist, medium stiff, silt w/ clay and trace medium sand, gray, no HC/solvent odor. (95-5-0	

31.5

Drilling Co./Driller: CAS
Drilling Equipment:
Sampler Type: SEE PG 1
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG 1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2/2

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started: 1/26/19
Surface Conditions: asphalt
Well Location N/S: SEE Fig.
Well Location E/W:
Reviewed by:
Date Completed: 1/26/19

BORING LOG B06

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: / feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5	☒	11 12 12	100	0.5	B06-05 @ 0945	SM		medium dense Moist, ~~[illegible]~~ silty SAND w/ gravel, Organic debris, no HC/solvent odor. (25-60-15)	
10	☒	6 6 7	100	0.1	B06-10 @ 0950	SM	Fill	Moist, loose, silty SAND w/ gravel, Brown and organic debris. No HC/solvent odor. (05-95-0)	
						ML	Native	Moist, Soft, SILT w/ Sand, Brown with mottled gray. No HC/solvent odor. (80-20-0)	
	☒	7 6 6		3.1 0.1 5.2	B06-12.5 @ 0955		ML	Moist, medium stiff, SILT, mottled brown and gray. No HC/solvent odor. (100-0-0) Thin (<1cm) Sand lenses at 13.5 and 14' BGS.	
15									

Drilling Co./Driller: Cascade / James
Drilling Equipment: HSA
Sampler Type: D and M
Hammer Type/Weight: downhole 300 lbs
Total Boring Depth: 51 feet bgs
Total Well Depth: feet bgs
State Well ID No.: /

Well/Auger Diameter: / inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:
No GW encountered in boring.

Page: 1/4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started: 1/26/18
Surface Conditions: asphalt
Well Location N/S:
Well Location E/W: SEE Fig.
Reviewed by:
Date Completed: 1/26/18

BORING LOG B06

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: / feet bgs
Water Depth After Completion: / feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		11 12 12	100	0.5	B06-05 @ 0945	SM		Moist, ~~[illegible]~~ [illegible] Silty SAND w/ gravel, Organic debris, no HC/solvent odor. (25-60-15)	
10		6 6 7	100	0.1	B06-10 @ 0950	SM	Fill	Moist, loose, silty SAND w/ gravel, Brown and organic fibers. No HC/solvent odor. (05-95-0)	
						ML	Mottled	Moist, soft, SILT w/ sand, Brown with mottled gray. No HC/solvent odor. (80-20-0)	
		7 6 6		3.1 0.1 5.2	B06-12.5 @ 0955		ML	Moist, medium stiff, SILT, mottled brown and gray. No HC/solvent odor. (100-0-0) Thin (<1cm) sand lenses at 13.5 and 14' BGS.	
15									

Drilling Co./Driller: Cascade / James
Drilling Equipment: HSA
Sampler Type: D and M
Hammer Type/Weight: downhole 300 lbs
Total Boring Depth: 51 feet bgs
Total Well Depth: feet bgs
State Well ID No.: /

Well/Auger Diameter: / inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments: No GW encountered in boring.

Page: 1/4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE PG. 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B06

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		7 6 8	100	11.2 8.4	B06-15 @ 1005	ML		Moist, stiff, SILT w/ sand, gray and brown, medium, no HC/solvent odor. (90-10-0)	
		4 4 7	100	1.1 1.0 0.1	B06-17.5 @ 1010	ML		Moist, stiff, SILT w/ fine sand, brown to gray, no HC/solvent odor. (90-10-0)	
20		8 7 5	100	0.4 0.2	~~B06~~ B06-20 @ 1015	ML SP ML		20-20.5 Moist, stiff, SILT w/ trace fine sand, gray, no HC/solvent odor (95-5-0) 20.5-21: Moist, loose, SAND w/ trace silt, medium, gray, no odor (HC/solvent) (5-95-0) 21-21.5: Back into SILT. (95-5-0)	
25		20 20 20	100	0.3	B06-25 @ 1030	ML		Moist to dry, Hard, SILT, gray, no odor (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type: SEE PG. 1
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG. 1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE PG. 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B06

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	☒	16 18 18	100	0.3	B06-30 @ 1040	ML/CL		Dry to moist, Hard, SILT with clay, gray, no HC/solvent odor. (100-0-0)	
35	☒	23 25 27	100	0.5	B06-35 @ 1050	ML/CL		Dry to moist, Hard, SILT w/clay, gray, no HC/Solvent odor. (100-0-0)	
40	☒	25 26 24	100	0.3	B06-40 @ 1105	ML/CL		Dry to moist, hard, SILT w/clay, gray, no HC/solvent odor. (100-0-0)	
45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type: SEE PG. 1
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG. 1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 3/4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE PG.1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B06

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45		37 50/6"	~~100~~ 150 [illegible]	0.3	B06-45 @ 1115	ML/CL		Dry to moist, Hard, SILT w/clay, gray with Varvis, No HC/solvent odor. (100-0-0) Same as above.	
50		33 50/6"	150 ~~[illegible]~~ [illegible]	0.4	B06-50 @ 1120	ML/CL		Same as above, no HC/solvent odor. (100-0-0)	
								EOB@ 51' BGS.	
55									
60									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: SEE PG.1 lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG.1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 4/4

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: GLF
Date Started: 1/26/18
Surface Conditions: Asphalt
Well Location N/S: SEE Fig.
Well Location E/W:
Reviewed by:
Date Completed: 1/26/18

BORING LOG B10

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~20 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
	☒	4 4 3	80	0.0	B10-02.5 @ 0825	SM		Moist to dry, brown silty Sand with trace gravel, brick and organic debris. No HC/solvent odor. (30-65-5)	
5	☒	5 6 7	100	0.0	B10-05 @ 0830	SM		Moist, brown, silty Sand w/gravel, some roots. No HC/solvent odor (25-65-10)	
10	☒	6 8 7	100	0.0	B10-10 @ 0835	SM ML		10-11: Moist, silty SAND, brown with gray silt layers (<1mm). No HC/solvent odor. (30-70-0) 11-11.5: Moist, sandy SILT, brown with mottled gray, no HC/solvent odor. (65-35-0)	
15									

Drilling Co./Driller: Cascade / James
Drilling Equipment: HAS
Sampler Type: D and M
Hammer Type/Weight: Downhole / 300 lbs
Total Boring Depth: 20.5 feet bgs
Total Well Depth: / feet bgs
State Well ID No.: /

Well/Auger Diameter: 8.25" inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

Project: Rainier Mall
Project Number: 0611-017
Logged by: GCF
Date Started: 1/26/18
Surface Conditions: asphalt
Well Location N/S: SEE Fig. 1
Well Location E/W:
Reviewed by:
Date Completed: 1/26/18

DRAFT

BORING LOG B11

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: / feet bgs
Water Depth After Completion: / feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								Fill debris/cobbles observed in spoils. Drill straight to 10' BGS	
5									
10	X	5 6 7	50	0.0	B11-10 @ 1250	SM/ML		Fill, glass debris. large cobbles, Silty SAND no HC/solvent odor.	
	X	14 15 15	100	0.1	B11-~~12.5~~ 15 @ 1255			Moist, stiff, SILT w/ clay and fine sand, brown with some gray mottling. (90-10-0) Thin medium sand lenses (<1cm) at 16 and 16.5'	
15									

Drilling Co./Driller: Cascade / James
Drilling Equipment: HSA
Sampler Type: D and M
Hammer Type/Weight: downhole / 300 lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0811-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S: SEE PG1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B01

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15				See PG1					
20		6 5 11	90	0.2	B01-20 @ 1305	ML/CL		Moist, stiff, SILT w/ clay, Gray, Low plasticity, no HC/solvent odor. (100-0-0)	
								(GP)	
25		36 50/6"	100	0.2	B11-25 @ 1310	~~SM~~ SP		Moist, very dense, ~~SILTY~~ medium SAND with subrounded Gravel and trace SILT, gray, no HC/solvent odor & (5-65-30)	
								BOB @ 26' BGS. Backfill boring with Bentonite and Patch surface with Concrete. No ~~GW~~ encountered in boring.	
30									

Drilling Co./Driller: SEE PG1
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used: SEE PG1
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 2/7/18
Surface Conditions: ASPHALT
Well Location N/S: 13' S of passive sample location D1
Well Location E/W: 13' W OR 3' N of MW05 1' E
Reviewed by:
Date Completed: 2/7/18

BORING LOG B12

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~15 feet bgs
Water Depth After Completion: feet bgs

linear feet of auger

10	7
15	10.5
20	14
24	17
28	20
35	25

Depth (~~feet bgs~~)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								4" of ASPHALT	
								Driller measures auger angle w/ cell phone inclinometer: 48°	
5									
		~~3~~ ~~3~~ ~~3~~	~~50~~	~~1.1~~	~~B12-07 @1020~~			~~7' 8.5': Moist, loose, gravelly, silty SAND, brown, no HC/solvent odor (25-30-45)~~	
10		3 3 3	50	1.1	B12-07 @1020	SM		10'-11.5' (7'-8.5' bgs): Moist, loose, gravelly, silty SAND, brown, no HC/solvent odor (25-45-30)	
15									

Drilling Co./Driller: CASCADE/Curtis
Drilling Equipment: HSA truck rig
Sampler Type: ~~Dames & Moore~~ SPT split spoon
Hammer Type/Weight: AUTO/140 lbs
Total Boring Depth: 36.5 (26.5') feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: 8 inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal: ASPHALT
Annular Seal: Bentonite
Monument Type:

Notes/Comments:
45° ANGLED BORING
Depth = linear feet of auger.
Sample depths = feet bgs
(i.e. B12-07 = sample depth 7' bgs)

Page: 1/3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:
see page 1

BORING LOG B12

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~15' feet bgs ✓
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description (10.5'-12' bgs)	Well Construction Detail
15	⧗	15 20 22	90	24.1	B12-10.5 @1035	ML		15'-16.5': Moist, dense, fine sandy SILT, brown to gray, no HC/solvent (80-20-0)	
20	⧗	13 14 15	100	18.7	B12-14 @1050	ML		20'-21.5' (14'-15.5' bgs) Moist to dense wet, fine sandy SILT with 2" wet layer of silty SAND, brown to tan, no HC/solvent odor (80-20-0)	
	⧗	NR	90	1.6	B12-17 @1100	ML		24'-25.0' (17'-18.0' bgs) Moist, SILT, trace of fine sand, brown, no HC/solvent odor. (95-5-0)	
25						ML		25'-25.5' (18'-18.5' bgs): Moist, clayey SILT, blue to gray, no HC/solvent odor. (100-0-0)	
	⧗	NR	90	1.1	B12-20 @1115	ML		28'-29.5' (20'-21.5' bgs) Moist, SILT with some clay, blue to gray, no HC/solvent odor. (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:
see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:
see page 1

Notes/Comments:
NR = Blow counts Not reported by driller

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See page 1

BORING LOG B12

Site Address:
4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: ~15 feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30									
35	☒	NR	100	1.5	B12-25 @1130	ML		35'-36.5' (25'-26.5' bgs): Moist, clayey SILT, blue to gray, no HC/solvent odor. (100-0-0)	
								EOB @ 36.5' bgs. Borehole abandoned, backfilled with bentonite and sealed w/ ~~asphalt~~ black-dyed concrete flush to surface. JJ	
40									
45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

see page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

see page 1

Notes/Comments:
NR = Blow counts not reported by driller.

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 2/7/18
Surface Conditions: ASPHALT
Well Location N/S: 3'S of passive sample location B0
Well Location E/W: 3'E
Reviewed by:
Date Completed: 2/7/18

BORING LOG B13

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~11 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		5 5 5	40	0.9	B13-05 @1335	SM		5'-6.5': Moist, med. dense silty SAND with some gravel, gray to brown, occasional organics no HC/solvent odor. (30-60-10)	
10		5 8 8	50	1.7	B13-10 @1345	SM ML		10'-11': Moist to wet, med. dense silty SAND with some gravel, brown, large 4" piece of wood, no HC/solvent odor. (30-60-10) 11'-11.5': Wet, very stiff clayey SILT, trace of fine gravel, blue to gray, no HC/solvent odor (95-0-5)	
15									

Drilling Co./Driller: CASCADE / CURTIS
Drilling Equipment: HSA
Sampler Type: ~~Dames and Moore~~ SPT split spoon
Hammer Type/Weight: AUTO / 140 lbs
Total Boring Depth: 21.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: ~ 8" inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: ASPHALT
Annular Seal: BENTONITE
Monument Type: —

Notes/Comments:

Page: 1/2

SoundEarth Strategies

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 2/7/18
Surface Conditions: ASPHALT
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 2/7/18

DRAFT

BORING LOG B13

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~11 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		5 6 7	100	1.7	B13-15 @1355	ML		15'-16.5': Moist, stiff, clayey SILT, tan to gray, no HC/solvent odor. (100-0-0)	
20		5 6 8	80	2.3	B13-20 @1405	SM ML		20'-20.7': Moist, med. dense, silty SAND w/ some gravel, brown, no HC/solvent odor. (20-70-10) 20.7'-21.5': Moist, stiff, clayey SILT, gray, no HC/solvent odor. (100-0-0) EOB at 21.5' bgs. Borehole abandoned, backfilled with bentonite, sealed with black-dyed concrete flush to surface.	
25									
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

See page 1

Notes/Comments:

SoundEarth
Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by: JSL
Date Started: 2/7/18
Surface Conditions: ASPHALT
Well Location N/S: 0.5' N
Well Location E/W: 2' E of passive sample location F1
Reviewed by:
Date Completed: 2/7/18

BORING LOG B14

Site Address: 4208 Rainier Ave
South,
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5		3 8 9	100	0.6	B14-05 @1425	SM		5'-6.5': Moist, silty SAND, trace of gravel, brown to gray, no HC/solvent odor. (20-75-5)	
10		3 3 4	100	1.7	B14-10 @1430	ML		10'-11.5': Moist, med. stiff clayey SILT, gray to tan, no HC/solvent odor (100-0-0)	
15									

Drilling Co./Driller: CASCADE / CURTIS
Drilling Equipment: HSA truck rig
Sampler Type: SPT split spoon
Hammer Type/Weight: AUTO / 140 lbs
Total Boring Depth: 21.5 feet bgs
Total Well Depth: — feet bgs
State Well ID No.: —

Well/Auger Diameter: — / 8 inches
Well Screened Interval: — feet bgs
Screen Slot Size: — inches
Filter Pack Used: —
Surface Seal: Concrete
Annular Seal: Bentonite
Monument Type: —

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 0611-017
Logged by:
Date Started:
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See page 1

BORING LOG B14

Site Address: 4208 Rainier Ave South, Seattle, WA

Water Depth At Time of Drilling: ~16 feet bgs
Water Depth After Completion: — feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	☒	5 7 8	100	4.9	B14-15 @ 1440	ML		15'-16.5': Moist to wet, very stiff clayey SILT, tan, no HC/solvent odor. (100-0-0)	
20	☒	2 2 3	100	0.9	B14-20 @1450	CL		20'-21.5': Wet to moist, med. stiff CLAY, gray, no HC/solvent odor (100-0-0)	
								EOB at 21.5' bgs. Borehole abandoned, backfilled with bentonite, sealed with concrete flush to surface.	
25									
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

See page 1

Notes/Comments:

Page: 2/2

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 10/1/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 10/1/18

BORING LOG | BIS

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: 20 feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								~4" Asphalt at Surface 0-~10' lower. Moist brn silty SAND spoils, apparent fill. Driller here	
5									
10	X	19 19 23 (42)	100	0.0	BIS-07 @1335	SM		10-11.5' (7-8.5' bgs) Moist, v-dense, brown w/ gray, silty SAND, trace gravel, no HC/solv. odor (40-55-5)	
15									

Drilling Co./Driller: Cascade / Sams
Drilling Equipment: HSA
Sampler Type: CAL
Hammer Type/Weight: Autohmr / 300 lbs
Total Boring Depth: 40' lower / 29 feet bgs
Total Well Depth: 40' lower / 29 feet bgs
State Well ID No.: BKF 728

Well/Auger Diameter: 2 / 4.5 inches
Well Screened Interval: 25-40 feet bgs lower
Screen Slot Size: 0.10 inches
Filter Pack Used: Pioneer silica sand
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments: 46" wide bore

Page: 1 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 10/1/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See page 1

BORING LOG B15

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		16 22 19 41	100	0.0	B15-11 @1340	ML/CL		15-16.5' (10.5-12' bgs) Moist to wet, gry-brn, SILT/Cly w/ Sand lenses/glens, no HC/Solv odor (90-10-0) trace peat lenses.	
20		16 22 20 42	95	0.0	B15-14 @1400	ML		20-21.5' (14-15' bgs) Moist to wet, brn w/ gry strks SILT w/ v-fine Sand, no HC/Solv odor (95-10-0)	
25		14 17 22 39	70	0.0	B15-17 @1410	SM ML		24-25.5' (17-18' bgs) ~6" wet to sat, brn, silty SAND w/ gravel (40-50-10) over 6" wet to moist, blue-gry fine SANDy SILT, no HC/Solv odor (80-20-0)	
		20 20 20 40	100	0.0	B15-20 @1420	ML/CL		28-29.5' (20-21' bgs) Moist, gry-blue SILT, no HC odor (100-0-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001-01
Logged by: LDS
Date Started: 10/2/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B15

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30 ~~45~~									
35 ~~50~~		18 22 22	80	0.0	B15-25 @1435	ML		35-36.5' (25-26' bgs) Moist, light gray-blue, SILT, no HC/solv. odor (100-0-0)	
40 ~~55~~		50/6"	110	0.0	B15-28 @1445	ML		40-40.5 (28-28.5'bgs) Same as previous.	
45 ~~60~~									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: See page 1 feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 10/1/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 10/1/18

BORING LOG | B16

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: ~15 feet bgs
Water Depth After Completion: 18 feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								4" Asphalt Driller notes auger angle w/ inclinometer 46.5°.	
5								drilling spoils 5-10' Moist silty SAND w/ Brick fragments [FILL]	
10		15 21 20 ㊶	100	0.0	B16-07 @0905	SM		10-11.5' (7-8.5' bgs) Moist, Medium v-dense, silty SAND, w/ gravel, no HC or solv. odor (35-55-10)	
15									

Drilling Co./Driller: Cascade / [illegible]
Drilling Equipment: HSA
Sampler Type: CAL
Hammer Type/Weight: Inhole / 300 lbs
Total Boring Depth: 40' linear / 29 feet bgs
Total Well Depth: 40' linear / 29 feet bgs
State Well ID No.: BKF 727

Well/Auger Diameter: 2 / 4.5 inches
Well Screened Interval: 25-40 feet ~~bgs~~ (linear
Screen Slot Size: 0.10 inches
Filter Pack Used: Process Silica SAND
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments:
46° [illegible] Boring

Page: 1 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LPS
Date Started: 10/1/18
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B16

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		13 19 17 (36)	100	4.9	B16-~~10.5~~ 11 @0915	SM		15-16.5 (10.5-12' bgs) Moist, dense, fine sand SILT, brn to gray, trace peat lenses @11' no HC/solv odor (80-20-0)	
20		15 22 17 (39)	70	0.0	B16-14 C0930	ML		20-21.5' (14-15.5' ~~bgs~~) Moist to wet, fine sandy SILT w/ some silty H2O and seeps, brn to tan, no HC/solv odor (80-20-0)	
25		28 21 36 (57)	100	0.1	B16-17 C0940	ML		24-25.5' (17-18.' bgs) Moist v-dense, SILT, ~~trace of fine sand~~, blue to gray, no HC/solv odor (100-0-0)	
		50/6"	120	0.0	B16-20 C0950	ML		28-29' (20-21' bgs) Moist, v-dense SILT, blue to gray, trace sand lenses no HC/solv odor (95-5-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: See page 1 feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001-01
Logged by: LDS
Date Started: 10/1/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG | B16

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
~~45~~ 30									
~~50~~ 35	14	42 50/6"	110	0.0	B16-25 @1010	ML		35-36' bgs (25-26' bgs) Moist, v-dense gry-blue silt no HC/solv odor (100-0-0)	
~~55~~ 40		21 37 36	100	0.0	B16-28 @1025	ML		40-41.5 (28-29' bgs) Same as previous.	
								EOB @ 41.5 bmr feet set well screened 25-40' bmr.	
~~60~~ 45									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: See page 1 feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 10/2/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 10/2/18

BORING LOG B17

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								~4" Asphalt at Surface	
5		3 3 2 ⑤	100	0.0	B17-05 @1030	SM		Moist, brn-gry, Silty SAND w/ grvl, no HC/solv. odr Probable Fill (35-55-10)	
10		3 6 4 ⑩	100	0.0	B17-10 @1033	SM		Moist to damp, brn-gry, Silty SAND w/ grvl, no HC/slv odr (30-50-10)	
		3 4 7 ⑪	100	0.0	B17-12.5 @1037	ML/CL		Moist, blue gry w/ brn mottling, Silt/clay w/ fine SAND, no HC odor, fine peat lenses (90-10-0)	
15									

Drilling Co./Driller: Cascade/Jones
Drilling Equipment: HSA
Sampler Type: CAL
Hammer Type/Weight: M-hmr/300 lbs
Total Boring Depth: 35 feet bgs
Total Well Depth: 35 feet bgs
State Well ID No.: BKF 730

Well/Auger Diameter: 2/4.5 inches
Well Screened Interval: 25-35 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Premier Silica SAND
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments:

Page: 1 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 10/2/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

See page 1

BORING LOG B17

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	X	6 8 6 (14)	100	0.0	B17-15 @ 1042	ML/CL		Moist, gray-blue w/ brn mottling, silt/clay w/ small sand lenses, no HC/solv odor (95-5-0)	
	X	7 7 7 (14)	100	0.0	B17-17.5 @ 1048	ML/CL		Moist to wet, light brn SILT/clay w/ fine SAND, no HC/solv odor (80-20-0)	
20	X	6 6 5 (11)	100	0.0	B17-20 @1053	ML/CL		Moist to dry, light brown-gray, SILT/clay, trace organic peaty fragments. no HC/solv odor (100-0-0)	
25	X	20 50/6"	100	1.7	B17-25 @1058	SM-SP		Saturated, gray, fine to med. SAND w/ silt, no HC/solv odor (15-85-0)	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Project: Rainier Mall Property
Project Number: 1276-001-01
Logged by: LDS
Date Started: 10/2/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG | B17

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

DRAFT

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30 ~~45~~	X	50/6"	100	0.3	B17-30 @1107	SP		Loose, same as prev no HC/solv odr (15-85-0)	
35 ~~50~~	X	50/6"	200	0.0	B17-35 @1135	SP SM		8" prev ovr wet to S.A, gry, silty SAND, no HC/solv odrs (25-75-0)	
40 ~~55~~									
45 ~~60~~									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: See page 1 feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LDS
Date Started: 10/2/18
Surface Conditions: Asphalt
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed: 10/2/18

BORING LOG B18

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: 7 feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								~4" Asphalt at surface	
5	X	8 8 6 ⑭	100	0.2	B18-05 @0840	SM		Moist, light gray-brown, silty fine SAND w/ gravel, no odor (35-55-10)	
10	X	6 8 9 ⑰	100	12.4	B18-10 @0845	ML/CL		Moist light blue-gray, Silt/Clay w/ trace fine sand + organics/peat (95-5-0) no HC/solv odor.	
	X	7 5 5	100	145	B18-12.5 @0850	ML/CL		Same as previous	
15									

Drilling Co./Driller: Cascade / Sims
Drilling Equipment: HSA
Sampler Type: CAL
Hammer Type/Weight: Autohammer/300 lbs
Total Boring Depth: 31 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BKF 729

Well/Auger Diameter: 2 / 4.5 inches
Well Screened Interval: 15-30 feet bgs
Screen Slot Size: 0.10 inches
Filter Pack Used: Pioneer Silica Sand
Surface Seal: Cement
Annular Seal: Bentonite
Monument Type: Flushmount

Notes/Comments:

SoundEarth Strategies

DRAFT

Project: Rainier Mall
Project Number: 1276-001
Logged by: LGS
Date Started: 10/2/18
Surface Conditions:
Well Location N/S: See page 1
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B18

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15		9 9 8 (17)	100	40	B18-15 @0900	ML/CL		Moist to damp, light brn, silt/clay w/ v-fine sand, no HC/solv odr (90-10-0)	
		14 24 20 (44)	100	0.3	B18-17.5 @0902	ML/CL		Moist, blue-gray - v-close clay/silt, no HC odr (100-0-0)	
20		14 21 17 (38)	100	0.1	B18-20 @0905	ML/CL		Same as prevs	
25		23 27 29	100	0.0	B18-25 @0912	ML/CL		Same as prevs	
30									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: See page 1 feet bgs
Total Well Depth: feet bgs
State Well ID No.:

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 2 of 3

SoundEarth Strategies

DRAFT

Project: Rainier Mall Property
Project Number: 1276-001-01
Logged by: LDS
Date Started: 10/2/18
Surface Conditions:
Well Location N/S:
Well Location E/W:
Reviewed by:
Date Completed:

BORING LOG B18

Site Address: 4208 Rainier Avenue S
Seattle, WA

Water Depth At Time of Drilling: feet bgs
Water Depth After Completion: feet bgs

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30 45	X	33 50/6"	100	0.0	B18-30 @ 0920	ML/CL		Sme as previous EOB @ 31' bgs, set GW well screen 15-30.	
35 50									
40 55									
45 60									

Drilling Co./Driller:
Drilling Equipment:
Sampler Type:
Hammer Type/Weight: lbs
Total Boring Depth: feet bgs
Total Well Depth: feet bgs
State Well ID No.:

See page 1

Well/Auger Diameter: inches
Well Screened Interval: feet bgs
Screen Slot Size: inches
Filter Pack Used:
Surface Seal:
Annular Seal:
Monument Type:

Notes/Comments:

Page: 3 of 3

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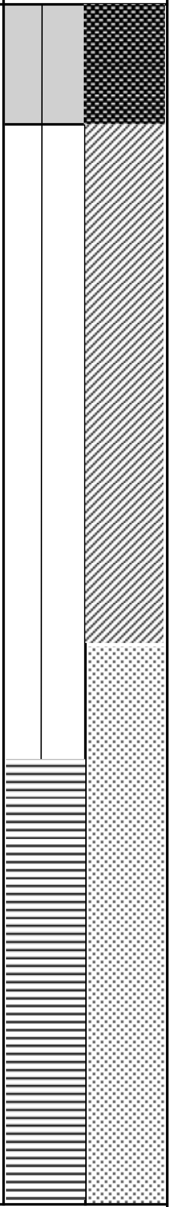
Project: Rainier Mall
Logged by: KMC
Date Started: April 20, 2019
Date Completed: April 20, 2019
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 20 feet bgs
Water Depth After Completion: 14.05 feet bgs

Boring No.
UB10/MW10

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
								Air knifed to 3 feet
5								No soil samples collected between 0 and 10 feet
10	▨		85	0.7	UB10-10	SM	▩	Brown SILTY SAND trace GRAVEL and CLAY, moist 11.0 - gray and wet
	▨		100	0.6	UB10-13	CL	▥	Gray CLAY, moist
15								

Well Construction Detail



Driller: Holocene
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight: N/A
Total Boring Depth: 31.5 feet bgs
Total Well Depth: 29.5 feet bgs
State Well ID No.: BLI 147

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 9.5 - 29.5 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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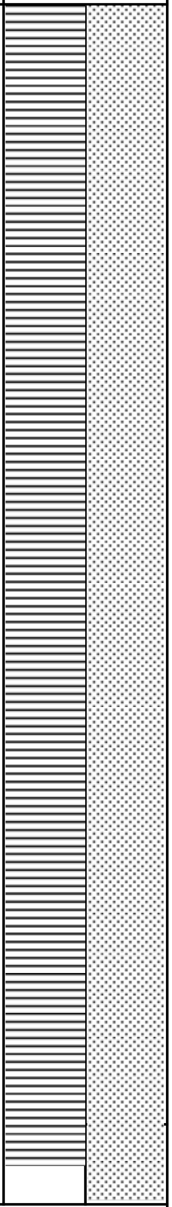
Project: Rainier Mall
Logged by: KMC
Date Started: April 20, 2019
Date Completed: April 20, 2019
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 20 feet bgs
Water Depth After Completion: 14.05 feet bgs

Boring No.
UB10/MW10

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
15	■		100	0.5	UB10-15	CL		Gray CLAY, moist
	■		100	0.5	UB10-18			Gray/brown mottled CLAY, moist <1" lenses of SILTY SAND every 3-4"
20	■		100	0.6	UB10-20		▽	
	■		100	0.6	UB10-23			Gray, moist to wet
25	■		100	0.5	UB10-25	SP		Gray, medium SAND trace GRAVEL, wet
	■		100	0.9	UB10-28			some SILT
30								

Well Construction Detail



Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 31.5 feet bgs
Total Well Depth: 29.5 feet bgs
State Well ID No.: BLI 147

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 9.5 - 29.5 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: April 20, 2019
Date Completed: April 20, 2019
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 20 feet bgs
Water Depth After Completion: 14.05 feet bgs

Boring No.
UB10/MW10

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	■		100				▨	Gray SAND trace GRAVEL, increasing fines	
								31.5 - Bottom of Boring	
35									
40									
45									

Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 31.5 feet bgs
Total Well Depth: 29.5 feet bgs
State Well ID No.: BLI 147

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 9.5 - 29.5 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Page:
3/3

Urban Environmental Partners llc
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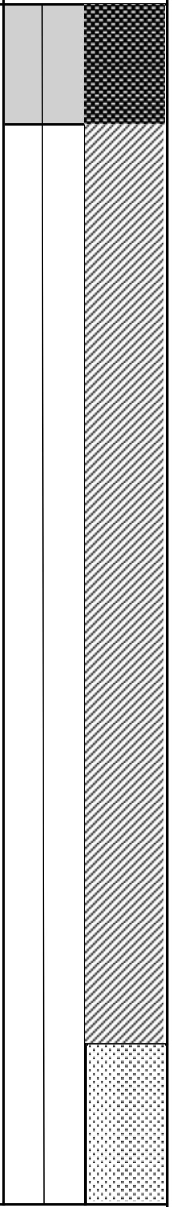
Project: Rainier Mall
Logged by: KMC
Date Started: April 20, 2019
Date Completed: April 20, 2019
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 32 feet bgs
Water Depth After Completion:

Boring No.
UB11/MW11

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
								Air knifed to 3 feet	
5								No soil samples collected between 0 and 10 feet	
10	▨		0.0					no recovery	
	▨		100	0.0	UB11-13	CL	▨	Gray CLAY, moist 13.0 - with brown mottling	
15									



Driller: Holocene
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight: N/A
Total Boring Depth: 36.5 feet bgs
Total Well Depth: 35 feet bgs
State Well ID No.: BLI 148

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 15 - 35 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Page:

Urban Environmental Partners llc
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Project: Rainier Mall
Logged by: KMC
Date Started: April 20, 2019
Date Completed: April 20, 2019
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 32 feet bgs
Water Depth After Completion:

Boring No.
UB11/MW11

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	■		100	0.8	UB11-15	CL		Gray/brown mottled CLAY, moist <1" lenses of SILTY SAND every 3-4"	
	■		100	0.2	UB11-18			0.4-foot lens of brown/gray mottled SILTY fine SAND	
20	■		100	0.4	UB11-20				
	■		100	0.6	UB11-23			wet	
25	■		80	0.5	UB11-25				
	■		75	0.9	UB11-28	SP		Gray, SILTY SAND with GRAVEL, moist	
30									

Driller: Holocene
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight: N/A
Total Boring Depth: 36.5 feet bgs
Total Well Depth: 35 feet bgs
State Well ID No.: BLI 148

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 15 - 35 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Project: Rainier Mall
Logged by: KMC
Date Started: April 20, 2019
Date Completed: April 20, 2019
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 13.25 feet bgs

Boring No.
UB11/MW11

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30			80	1.6		SM	▽	Gray SAND with SILT, trace GRAVEL, wet	
35			100	2.1		CL		Gray CLAY, moist	
								36.5 - Bottom of Boring	
40									
45									

Driller: Holocene
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 36.5 feet bgs
Total Well Depth: 35 feet bgs
State Well ID No.: BLI 148

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 15 - 35 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Urban
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Project: Rainier Mall
Logged by: KMC
Date Started: March 4, 2020
Date Completed: March 4, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 13.25 feet bgs

Boring No.
UB12/MW12

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
5	▮		45	0.0 NS	UB12-5	SW-SM	▩	Gray SILTY fine SAND trace GRAVEL, moist FILL	
							▼		
15	▮		100	5.6 NS	UB12-14	CL	▨	Gray/brown mottled CLAY, moist	

Driller:	Boretech		**Well/Auger Diameter:**	2/8	inches
Drilling Equipment:	Hollow-Stem Auger		**Well Screened Interval:**	31-46	feet bgs
Sampler Type:	Split Spoon		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:			**Filter Pack Used:**	Industrial Sand	
Total Boring Depth:	48	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	46	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BKH 351		**Monument Type:**	Flush	

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: March 4, 2020
Date Completed: March 4, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 13.25 feet bgs

Boring No.
UB12/MW12

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	▨		100			CL		Gray/brown mottled CLAY, moist	
20									
	▨			7.5	UB12-22	SM			
			70	NS				22.0 to 22.3 - lens of gray fine silty SAND, moist	
						CL			
								Gray CLAY, moist with intermixed gray fine sand	
25									
30									

Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 48 feet bgs
Total Well Depth: 46 feet bgs
State Well ID No.: BKH 351

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 31-46 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

No free water at 22 feet bgs

Page:

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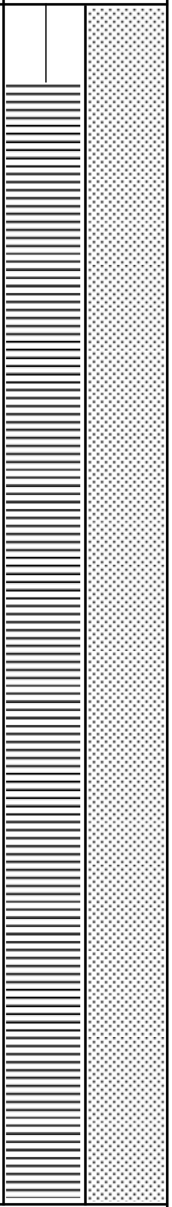
Project: Rainier Mall
Logged by: KMC
Date Started: March 4, 2020
Date Completed: March 4, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 13.25 feet bgs

Boring No.
UB12/MW12

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30									
35									
	▨		0					36' - No Soil Recovery	
	▨		40	1.8 NS	UB12-37	CL		Gray CLAY (CL), moist, without fine sand	
40									
45									



Driller:	Boretech		**Well/Auger Diameter:**	2/8	inches
Drilling Equipment:	Hollow-Stem Auger		**Well Screened Interval:**	31-46	feet bgs
Sampler Type:	Split Spoon		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:			**Filter Pack Used:**	Industrial Sand	
Total Boring Depth:	48	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	46	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BKH 351		**Monument Type:**	Flush	

Notes/Comments

No free water at 37'

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Project: Rainier Mall
Logged by: KMC
Date Started: March 4, 2020
Date Completed: March 4, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 13.25 feet bgs

Boring No.
UB12/MW12

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45	▨		90		UB12-46	CL	▨	Gray CLAY, moist	▤ ▨
								48 - Bottom of Boring	
50									

Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 48 feet bgs
Total Well Depth: 46 feet bgs
State Well ID No.: BKH 351

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 31-46 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 12.76 feet bgs

Boring No.
UB13/MW13

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0									
5			35	0.4	UB13-4	SP		Brown fine to medium SAND trace GRAVEL, moist FILL 4.2 - Gray, no GRAVEL	
10			50		UB13-9	SM	▼	9.0 to 9.3 - Brown with gray silty SAND with GRAVEL, moist 9.3 to 9.6 - wood debris 9.6 - as above with 0.2' lens of concrete	
15									

Driller:	Boretech	
Drilling Equipment:	Hollow-Stem Auger	
Sampler Type:	Split Spoon	
Hammer Type/Weight:		
Total Boring Depth:	45	feet bgs
Total Well Depth:	42	feet bgs
State Well ID No.:	BKH 353	

Well/Auger Diameter:	2/8	inches
Well Screened Interval:	28-42	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Industrial Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

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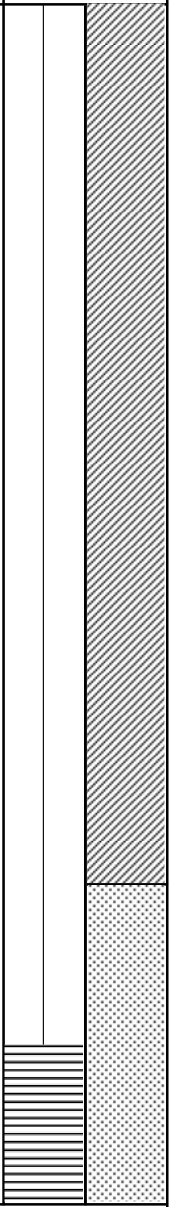
Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 12.76 feet bgs

Boring No.
UB13/MW13

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
15						SM	▒	
20								
	▇		100	0.5 NS	UB13-23 UB13-23(GW)	CL	▥ ▽	Gray CLAY, wet
	▇					SM	▒	Gray silty fine SAND, wet, with organics
25								
30								

Well Construction Detail



Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 45 feet bgs
Total Well Depth: 42 feet bgs
State Well ID No.: BKH 353

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 28-42 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 12.76 feet bgs

Boring No.
UB13/MW13

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30									
35									
40									
			65	2.3 NS	UB13-43	CL		Gray CLAY, wet 42.0 to 42.4 - some fine sand 44.0 - Bottom of Boring	
45									

Driller:	Boretech	**Well/Auger Diameter:**	2/8 inches
Drilling Equipment:	Hollow-Stem Auger	**Well Screened Interval:**	28-42 feet bgs
Sampler Type:	Split Spoon	**Screen Slot Size:**	0.010 inches
Hammer Type/Weight:		**Filter Pack Used:**	Industrial Sand
Total Boring Depth:	44 feet bgs	**Annular Seal:**	Bentonite
Total Well Depth:	42 feet bgs	**Surface Seal:**	Concrete
State Well ID No.:	BKH 353	**Monument Type:**	Flush

Notes/Comments

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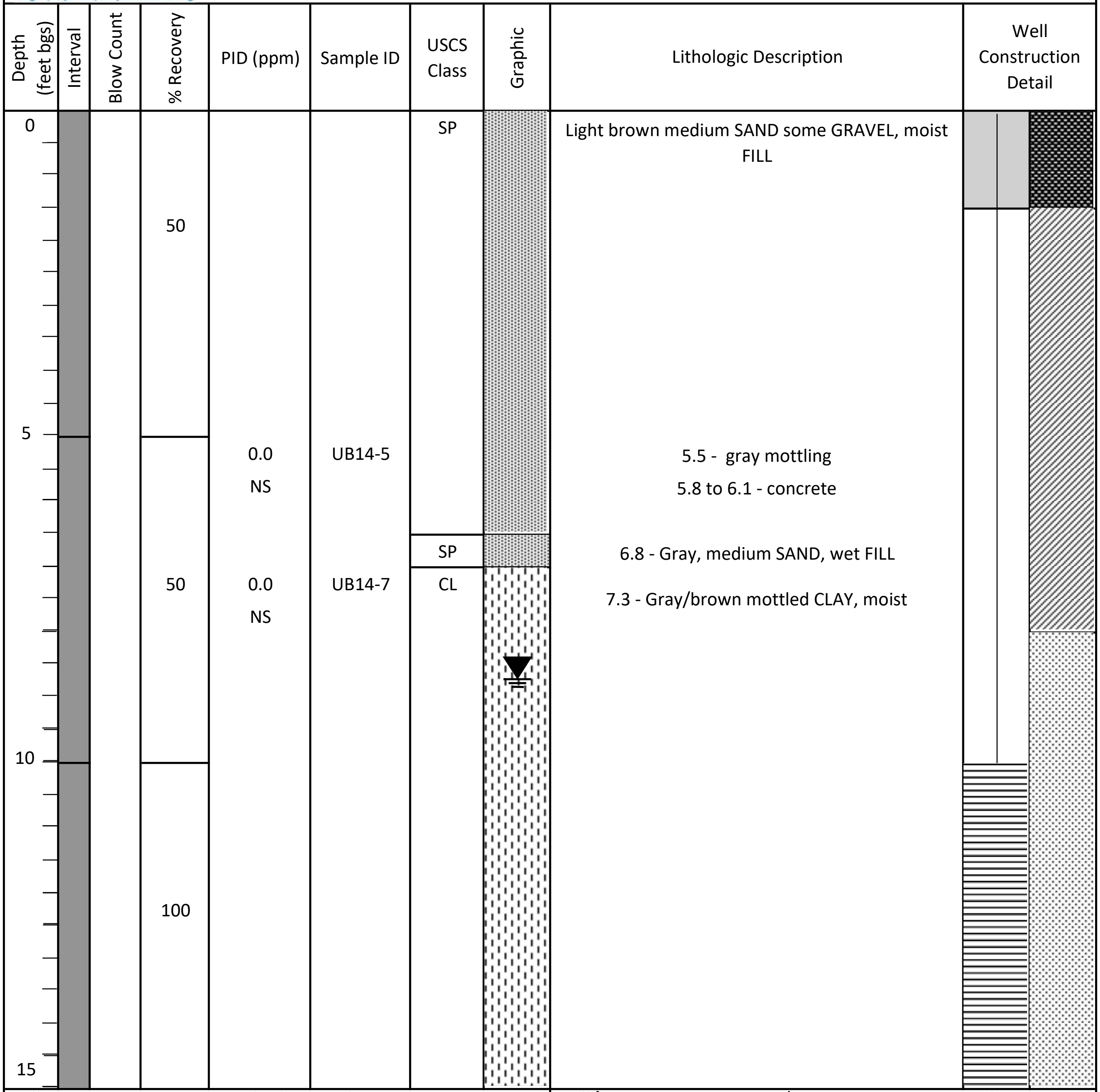
Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 17 feet bgs
Water Depth After Completion: 8.70 feet bgs

Boring No.
UB14/MW14

Site Address:
4208 Rainier Avenue
Seattle, Washington



Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						SP		Light brown medium SAND some GRAVEL, moist FILL	
			50						
5				0.0 NS	UB14-5			5.5 - gray mottling 5.8 to 6.1 - concrete	
						SP		6.8 - Gray, medium SAND, wet FILL	
			50	0.0 NS	UB14-7	CL		7.3 - Gray/brown mottled CLAY, moist	
10									
			100						
15									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Direct Push CAB Liner
Hammer Type/Weight:
Total Boring Depth: 20 feet bgs
Total Well Depth: 20 feet bgs
State Well ID No.: BLS 039

Well/Auger Diameter: 1/2 inches
Well Screened Interval: 10-20 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Groundwater monitoring well sample MW14-20200305 collected

Gray/brown mottling indicates the presence of iron precipitates.

Page:

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 17 feet bgs
Water Depth After Completion: 8.70 feet bgs

Boring No.
UB14/MW14

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	▇		100			CL	▽		▤
						CH	▨	Gray CLAY, wet	▤
20					UB14-20			20.0 - Bottom of Boring	

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Direct Push CAB Liner
Hammer Type/Weight:
Total Boring Depth: 20 feet bgs
Total Well Depth: 20 feet bgs
State Well ID No.: BLS 039

Well/Auger Diameter: 1/2 inches
Well Screened Interval: 10-20 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 16 feet bgs
Water Depth After Completion: 9.03 feet bgs

Boring No.
UB15/MW15

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						SP		Light brown medium SAND, some gravel, moist FILL	
			36						
5									
				0.0	UB15-6	CL		Brown/gray mottled CLAY, moist FILL	
				NS		ML		Brown SILT with organics, moist FILL	
			64			SP		Gray medium SAND, wet FILL	
						SM		Gray/green mottled, silty fine SAND, wet FILL	
							▼		
10						CL		Brown/gray mottled CLAY, moist	
			100						
				0.2					
15				NS					

Driller:	Standard Geoprobe	
Drilling Equipment:	Direct Push	
Sampler Type:	Direct Push CAB Liner	
Hammer Type/Weight:		
Total Boring Depth:	20	feet bgs
Total Well Depth:	20	feet bgs
State Well ID No.:	BLS 040	

Well/Auger Diameter:	1/2	inches
Well Screened Interval:	10-20	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Industrial Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 16 feet bgs
Water Depth After Completion: 9.03 feet bgs

Boring No.
UB15/MW15

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15			100			CL	▽	18.0 to 18.7 - wet	
20				0.0	UB15-20	CH		Gray CLAY, wet	
								20.0 - Bottom of Boring	
25									
30									

Driller:	Standard Geoprobe	**Well/Auger Diameter:**	1/2 inches
Drilling Equipment:	Direct Push	**Well Screened Interval:**	10-20 feet bgs
Sampler Type:	Direct Push CAB Liner	**Screen Slot Size:**	0.010 inches
Hammer Type/Weight:		**Filter Pack Used:**	Industrial Sand
Total Boring Depth:	20 feet bgs	**Annular Seal:**	Bentonite
Total Well Depth:	20 feet bgs	**Surface Seal:**	Concrete
State Well ID No.:	BLS 040	**Monument Type:**	Flush

Notes/Comments

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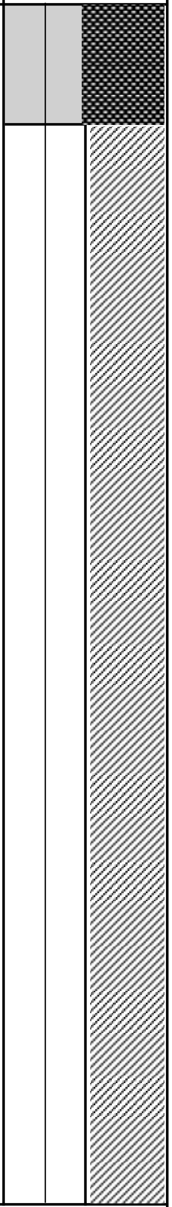
Project: Rainier Mall
Logged by: KMC
Date Started: March 4, 2020
Date Completed: March 4, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Soil
Water Depth at Time of Drilling: 20 feet bgs
Water Depth After Completion: 13.41 feet bgs

Boring No.
UB16/MW16

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
0								
	▒		35			GW	⁘	Gray, well graded GRAVEL with SAND, moist FILL
5								
	▒		35	3.9 NS	UB16-6			
10								
							▼	
	▒		100	0.2 NS	UB16-14	CL		Gray/light brown mottled CLAY, moist
15								

Well Construction Detail



Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 30 feet bgs
Total Well Depth: 28 feet bgs
State Well ID No.: BKH 352

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 18-28 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

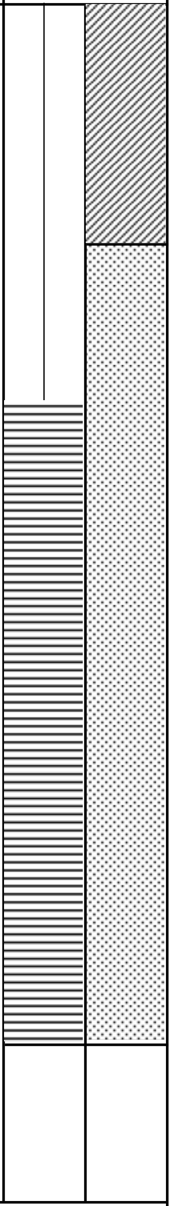
Gray/brown mottling indicates the presence of iron precipitates.

Project: Rainier Mall
Logged by: KMC
Date Started: March 4, 2020
Date Completed: March 4, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 20 feet bgs
Water Depth After Completion: 13.41 feet bgs

Boring No.
UB16/MW16

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL		Gray/light brown mottled CLAY (CL), moist	
20									
25									
								28.0 - Gray CLAY, moist to wet	
			100			CL		29.0 to 29.6 - Gray well graded fine GRAVEL with SAND, moist to wet	
				0.0	UB16-29	GW		29.6 - Gray CLAY, moist to wet	
30				0.0	UB16-29.5	CL		30.0 - Bottom of Boring	



Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 30 feet bgs
Total Well Depth: 28 feet bgs
State Well ID No.: BKH 352

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 18-28 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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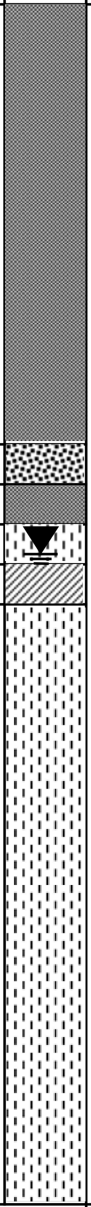
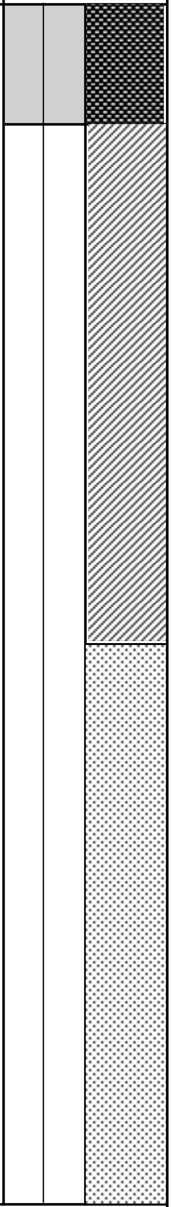
Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 21 feet bgs
Water Depth After Completion: 6.69 feet bgs

Boring No.
UB17/MW17

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			66	0.0 NS	UB17-3	SM		Gray silty SAND, trace gravel, moist FILL 1.2 - Brown/gray, with gravel 1.6 - Gray, with trace gravel	
5			80			GW SM CL ML CL		5.4 - Dark brown/black sandy GRAVEL, sub-rounded, moist FILL 5.9 - Dark gray silty SAND, moist FILL 6.4 - Gray CLAY, moist 7.0 - Gray fine sandy SILT, moist 7.2 - Gray CLAY, moist 7.7 - 8.0 dark brown/gray	
10			100	0.0 NS	UB17-11			Gray/brown mottled, CLAY, moist	
15									





Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Direct Push CAB Liner
Hammer Type/Weight:
Total Boring Depth: 25 feet bgs
Total Well Depth: 25 feet bgs
State Well ID No.: BLS 038

Well/Auger Diameter: 1/2 inches
Well Screened Interval: 15-25 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Urban Environmental Partners llc
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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 21 feet bgs
Water Depth After Completion: 6.69 feet bgs

Boring No.
UB17/MW17

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15			100			CL		Gray/brown mottled, CLAY, moist to wet 16.0 to 16.3 - Gray SILT, wet	
20			100	0.1	UB17-24	CH	▽	Gray CLAY, wet	
25								25.0 - Bottom of Boring	
30									

Driller:	Standard Geoprobe		**Well/Auger Diameter:**	1/2	inches
Drilling Equipment:	Direct Push		**Well Screened Interval:**	15-25	feet bgs
Sampler Type:	Direct Push CAB Liner		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:			**Filter Pack Used:**	Industrial Sand	
Total Boring Depth:	25	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	25	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BLS 038		**Monument Type:**	Flush	

Notes/Comments

Groundwater monitoring well sample MW17-20200305 collected

Gray/brown mottling indicates the presence of iron precipitates.

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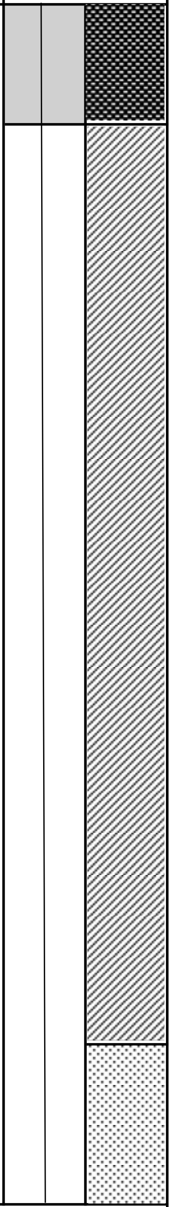
Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 24 feet bgs
Water Depth After Completion: 11.12 feet bgs

Boring No.
UB18/MW18

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
0								
5			45	0.0	UB18-3	SW		Gray, fine to medium SAND with GRAVEL, moist
10								▼
			30	0.2 NS	UB18-12	CL		Gray/ brown mottled CLAY, moist some interbedded lenses (<0.1 foot) of fine sand
15								

Well Construction Detail



Driller:	Boretech	
Drilling Equipment:	Hollow-Stem Auger	
Sampler Type:	Split Spoon	
Hammer Type/Weight:		
Total Boring Depth:	32	feet bgs
Total Well Depth:	30	feet bgs
State Well ID No.:	BKH 354	

Well/Auger Diameter:	2/8	inches
Well Screened Interval:	15-30	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Industrial Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Soil
Water Depth at Time of Drilling: 24 feet bgs
Water Depth After Completion: 11.12 feet bgs

Boring No.
UB18/MW18

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL			
20									
	▨		100	0.3 NS	UB18-24 UB18W-24	CH	▽	Gray CLAY, wet	
25									
30									

Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 32 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BKH 354

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 15-30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Soil
Water Depth at Time of Drilling: 24 feet bgs
Water Depth After Completion: 11.12 feet bgs

Boring No.
UB18/MW18

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30	█		90	0.3	UB18-30	CH	▨	Gray CLAY, wet	
								32.0 - Bottom of Boring	
35									

Driller:	Boretech	
Drilling Equipment:	Hollow-Stem Auger	
Sampler Type:	Split Spoon	
Hammer Type/Weight:		
Total Boring Depth:	32	feet bgs
Total Well Depth:	30	feet bgs
State Well ID No.:	BKH 354	

Well/Auger Diameter:	2/8	inches
Well Screened Interval:	15-30	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Industrial Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB19/MW19

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			70	0.4 NS		SP		Gray fine SAND and GRAVEL, moist FILL	
						SC		2.3 - Green/gray CLAYEY SAND, trace GRAVEL, moist FILL	
5			50						
						ML		7.2 Dark brown SILT, moist FILL	
10			100			CL		Gray/brown mottled CLAY, moist some lenses (<0.1') of fine SAND, approximately 1 per foot	
15									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Direct Push CAB Liner
Hammer Type/Weight:
Total Boring Depth: 30 feet bgs
Total Well Depth: N/A feet bgs
State Well ID No.: N/A

Well/Auger Diameter: N/A inches
Well Screened Interval: N/A feet bgs
Screen Slot Size: N/A inches
Filter Pack Used: N/A
Annular Seal: N/A
Surface Seal: N/A
Monument Type: N/A

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: March 5, 2020
Date Completed: March 5, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB19/MW19

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15			100			CL		Gray/brown mottled CLAY, moist some lenses (<0.1') of fine SAND, approximately 1 per foot	
						ML		17.2 - Brown SILT, moist	
						CL		Gray/brown mottled CLAY, moist some lenses (<0.1') of fine SAND, approximately 1 per foot	
20			100	0.6 NS	UB19-20				
								21.5 - gray, wet	
					UB19-24	ML		Gray SILT, wet	
25			100			CH		Gray CLAY, moist to wet	
								29.0 - Gray fine SAND, moist to wet	
				0.1		SP		29.5 - Gray CLAY, moist to wet	
30				NS	UB19-30	CH		30.0 - Botttom of Boring	

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Direct Push CAB Liner
Hammer Type/Weight:
Total Boring Depth: 20 feet bgs
Total Well Depth: N/A feet bgs
State Well ID No.: N/A

Well/Auger Diameter: N/A inches
Well Screened Interval: N/A feet bgs
Screen Slot Size: N/A inches
Filter Pack Used: N/A
Annular Seal: N/A
Surface Seal: N/A
Monument Type: N/A

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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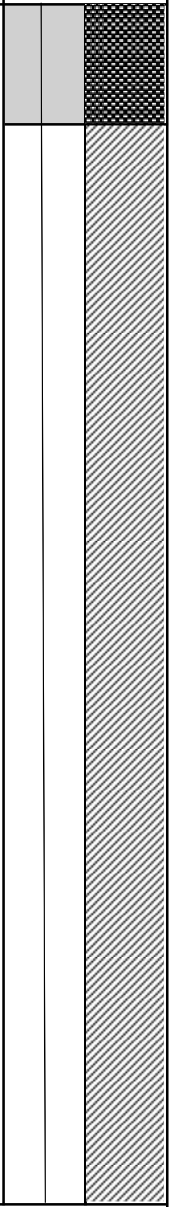
Project: Rainier Mall
Logged by: KMC
Date Started: March 12, 2020
Date Completed: March 12, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Soil
Water Depth at Time of Drilling: 15-20 feet bgs
Water Depth After Completion: 14.70 feet bgs

Boring No.
UB20/MW20

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
0						SP-SM	▨	Light brown medium SAND and GRAVEL, trace silt, moist
5 10								No samples collected. Cuttings appear as fine SAND and SILT, trace gravel.
15							▼	

Well Construction Detail


Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 37 feet bgs
Total Well Depth: 37 feet bgs
State Well ID No.: BKH 350

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 22-37 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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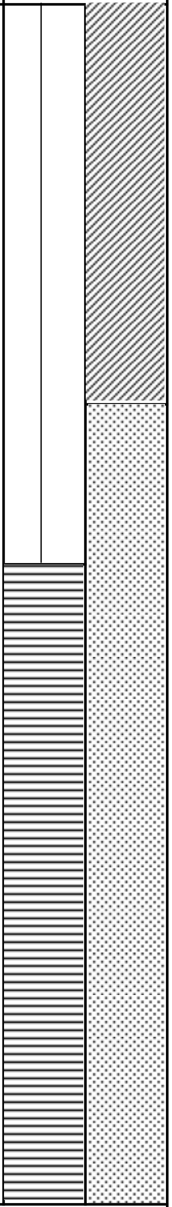
Project:	Rainier Mall		**Boring No.**
Logged by:	KMC		**UB20/MW20**
Date Started:	March 12, 2020		
Date Completed:	March 12, 2020		**Site Address:**
Checked by:	Richard Martin, LHG		4208 Rainier Avenue
Surface Conditions:	Soil		Seattle, Washington
Water Depth at Time of Drilling:		15-20 feet bgs	
Water Depth After Completion:		14.70 feet bgs	

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	▨		100	0.0 NS	UB20-15	CH	▨	Brown/gray mottled CLAY, moist	
20	▨		100	0.0 NS	UB20-20			moist to wet; lens (<0.1') of gray medium SAND	
								21.6 - lens (<0.1') of gray medium SAND 21.8 - gray	
25	▨		100	0.0 NS	UB20-25			25.3 - lens (<0.1') of gray medium SAND 25.7 - lens (<0.1') of gray medium SAND 26.5 - lens (<0.1') of gray medium SAND 26.7 - lens (<0.1') of gray medium SAND	
30									



Driller:	Boretech		**Well/Auger Diameter:**	2/8	inches
Drilling Equipment:	Hollow-Stem Auger		**Well Screened Interval:**	22-37	feet bgs
Sampler Type:	Split Spoon		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:			**Filter Pack Used:**	Industrial Sand	
Total Boring Depth:	37	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	37	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BKH 350		**Monument Type:**	Flush	

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: March 12, 2020
Date Completed: March 12, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Soil
Water Depth at Time of Drilling: 15-20 feet bgs
Water Depth After Completion: 14.70 feet bgs

Boring No.
UB20/MW20

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30				0.3	UB20-30	SP		Gray medium SAND, wet	
			90	NS				30.2 - 0.15' lens of gray CLAY, wet	
35				0.0	UB20-35				
			90	NS					
								37.0 - Bottom of Boring	
40									

Driller: Boretech
Drilling Equipment: Hollow-Stem Auger
Sampler Type: Split Spoon
Hammer Type/Weight:
Total Boring Depth: 37 feet bgs
Total Well Depth: 37 feet bgs
State Well ID No.: BKH 350

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 22-37 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Industrial Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Page:

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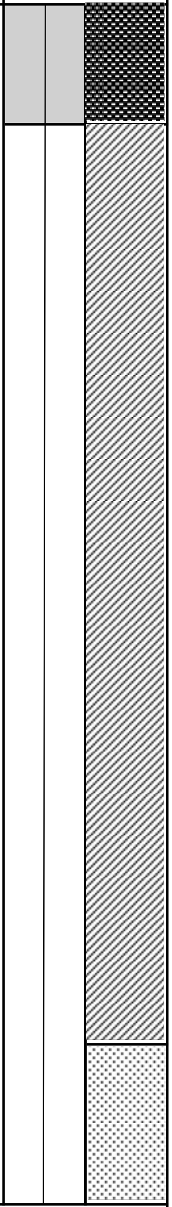
Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB21/MW21

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC	▩	Asphalt/GRAVEL FILL	
						ML	▨	Light brown SILT, moist	
5			30				▨		
10							▨	Dark brown SILT with organics, moist to wet	
				0.2			▨		
			50			CL	▥	Gray/light brown mottled CLAY, moist	
15							▥		



Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 34 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 048

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB21/MW21

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL		Gray/light brown mottled CLAY , moist	
			100	0.2		ML		Gray/light brown mottled SILT, moist to wet	
						CL		Gray/light brown mottled CLAY, moist	
20						CH		Gray/light brown mottled CLAY, moist to wet	
			100	0.2					
								Gray	
25			100	0.2	UB21-25				
			100						
						SP		Gray medium SAND, wet	
30				0.2	UB21-30				

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 34 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 048

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB21/MW21

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30			100	0.2	UB21-34	SP		Gray medium SAND, wet	
								34.0 - Boring Completed	
35									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 34 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 048

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB22/MW22

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0								Asphalt/GRAVEL FILL	
						SM		Light brown SILTY fine SAND some GRAVEL, moist FILL	
5			15						
10								Dark brown SILT with organics, moist to wet	
				0.4		CL		Gray/light brown mottled CLAY, moist	
			20						
15									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 34 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 047

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB22/MW22

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15			100	0.2		CL		Gray/light brown mottled CLAY, moist	
						ML		Gray/light brown mottled SILT, moist to wet	
						CL		Gray/light brown mottled CLAY, moist	
20			100	0.2		CH		Gray/light brown mottled CLAY, moist to wet	
25			100	0.2	UB22-25	SP		Gray medium SAND, some GRAVEL, moist to wet	
30								No soil recovered below 27 feet. Expendable point used to drive well screen to depth.	

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 34 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 048

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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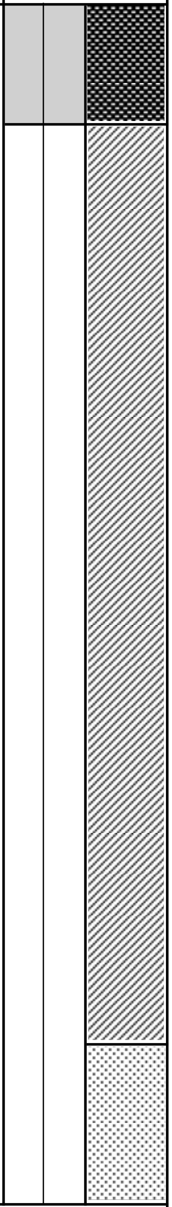
Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Concrete
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB23/MW23

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0							▩	Concrete/GRAVEL FILL	
						SM	▩	Brown SILTY fine SAND trace GRAVEL, moist FILL	
5			10						
10						CL	▥	Gray/light brown mottled CLAY, moist	
			40	0.5					
15									



Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 33 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 046

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB23/MW23

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL		Gray/light brown mottled CLAY, moist	
				0.4					
			100						
						ML		Gray/light brown mottled SILT, moist to wet	
						CL		Gray/light brown mottled CLAY, moist	
20						CH		Brown CLAY, moist to wet	
			100						
				0.4				Gray	
25			100	0.2	UB23-25				
						SP		Gray medium SAND, moist to wet	
						CH			
			100						
30					UB23-30				

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 33 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 047

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Page:

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB23/MW23

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30			100			CH		Gray CLAY, moist to wet	
				0.2	UB23-33	SP		Gray medium SAND, wet	
								34.0 - Boring Completed	
35									

Driller:	Standard Geoprobe	
Drilling Equipment:	Direct Push	
Sampler Type:	Lined Core	
Hammer Type/Weight:	N/A	
Total Boring Depth:	33	feet bgs
Total Well Depth:	30	feet bgs
State Well ID No.:	BLS 047	

Well/Auger Diameter:	1/2.25	inches
Well Screened Interval:	15 - 30	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

Page:

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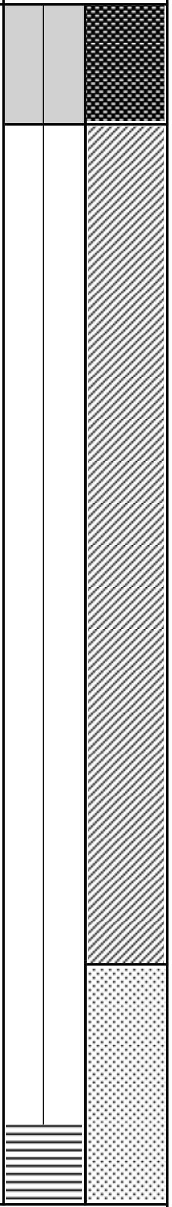
Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion: 20.8 feet

Boring No.
UB24/MW24

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC		Asphalt/GRAVEL FILL	
						SM		Light brown SILTY fine SAND some GRAVEL, moist	
5			30						
10						CL		Gray/light brown mottled CLAY, moist	
			50						
15									



Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 29 feet bgs
Total Well Depth: 29 feet bgs
State Well ID No.: BLS 049

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 14 - 29 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB24/MW24

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15			95			CL		Gray/light brown mottled CLAY, moist	
						SM			
20			100			CH		Light brown/some grey mottles CLAY, moist	
			100			CH		Gray SILTY CLAY, moist to wet	
25						CH		Gray CLAY, moist to wet	
			100			CH		Gray CLAY with interbedded lenses of SILTY fine SAND, moist to wet	
								29.0 - Boring Completed	
30									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 34 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLS 048

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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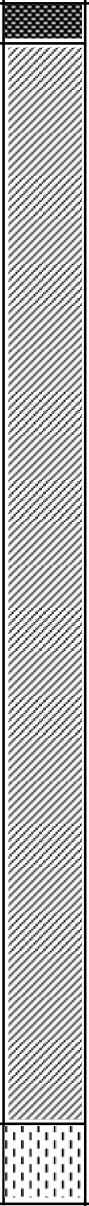
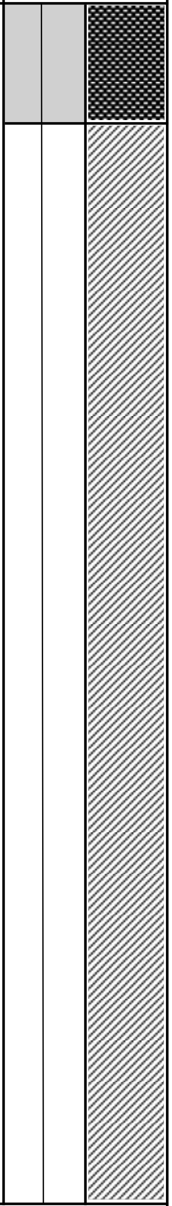
Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB25/MW25

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			90	1.5				Asphalt/GRAVEL FILL	
						ML		Gray SILT with GRAVEL, moist	
5								No recovery 5 - 10	
10			100	2.8				Gray SILT with SAND and GRAVEL, moist	
						CL		Gray/light brown mottled CLAY, moist	
15									





Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 50 feet bgs
Total Well Depth: 40 feet bgs
State Well ID No.: BLU 338

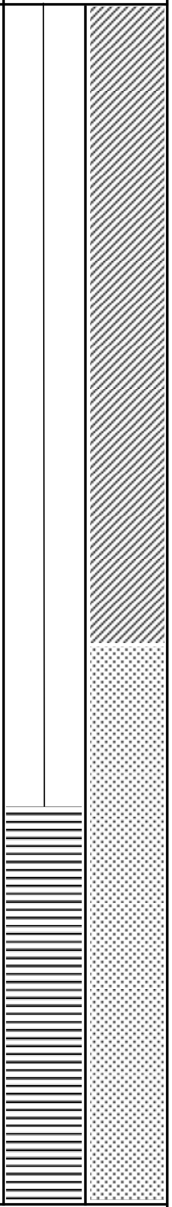
Well/Auger Diameter: 2/8 inches
Well Screened Interval: 25 - 40 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Project:	Rainier Mall		**Boring No.**
Logged by:	KMC		**UB25/MW25**
Date Started:	April 10, 2020		
Date Completed:	April 10, 2020		**Site Address:**
Checked by:	Richard Martin, LHG		4208 Rainier Avenue
Surface Conditions:	Asphalt		Seattle, Washington
Water Depth at Time of Drilling:			
Water Depth After Completion:			

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
15						CH		Gray/light brown mottled CLAY, moist to wet
				1.5				
			100					
20								
								Gray, wet
			100					
25				1.3	UB25-25			
			100					
				1.2	UB25-27	SM		Gray, SILTY fine SAND, wet
						CH		
30								

Well Construction Detail



Driller:	Holocene		**Well/Auger Diameter:**	2/8	inches
Drilling Equipment:	Sonic		**Well Screened Interval:**	25 - 40	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:	N/A		**Filter Pack Used:**	Sand	
Total Boring Depth:	50	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	40	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BLU 338		**Monument Type:**	Flush	

Notes/Comments

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Project:	Rainier Mall	**Boring No.**	
Logged by:	KMC	**UB25/MW25**	
Date Started:	April 7, 2020		
Date Completed:	April 7, 2020	**Site Address:**	
Checked by:	Richard Martin, LHG	4208 Rainier Avenue	
Surface Conditions:	Asphalt	Seattle, Washington	
Water Depth at Time of Drilling:			
Water Depth After Completion:			

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30						CH		Gray/light brown mottled CLAY, moist to wet	
						SP		Gray medium SAND with GRAVEL, moist	
			100						
35				1.2	UB25-35	CL		Gray CLAY, moist	
			100						
				1.1					
40									
			100						
				1.2					
45				1.0	UB25-45				

Driller:	Holocene		**Well/Auger Diameter:**	2/8	inches
Drilling Equipment:	Sonic		**Well Screened Interval:**	25 - 40	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:	N/A		**Filter Pack Used:**	Sand	
Total Boring Depth:	50	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	40	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BLU 338		**Monument Type:**	Flush	

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 7, 2020
Date Completed: April 7, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB25/MW25

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
45			100	0.9		CL		Gray CLAY, moist	
50								50.0 - Bottom of Boring	

Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 50 feet bgs
Total Well Depth: 40 feet bgs
State Well ID No.: BLU 338

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 25 - 40 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB26/MW26

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			0			AC		Asphalt/GRAVEL FILL	
5			0					No recovery 0 - 10	
10			100	2.8		SP		Brown, SILTY fine SAND with GRAVEL, moist FILL	
15									

Driller:	Holocene	
Drilling Equipment:	Sonic	
Sampler Type:	Lined Core	
Hammer Type/Weight:	N/A	
Total Boring Depth:	45	feet bgs
Total Well Depth:	40	feet bgs
State Well ID No.:	BLU 339	

Well/Auger Diameter:	2/8	inches
Well Screened Interval:	25 - 40	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

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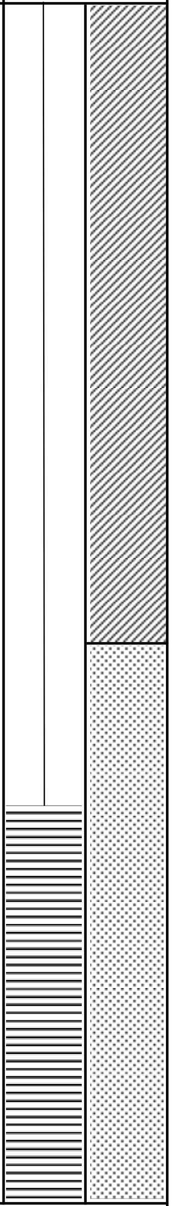
Project:	Rainier Mall	**Boring No.**	
Logged by:	KMC	**UB26/MW26**	
Date Started:	April 10, 2020		
Date Completed:	April 10, 2020	**Site Address:**	
Checked by:	Richard Martin, LHG	4208 Rainier Avenue	
Surface Conditions:	Asphalt	Seattle, Washington	
Water Depth at Time of Drilling:			
Water Depth After Completion:			

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						SP		Brown, SILTY fine SAND with GRAVEL, moist FILL	
						CL		Gray/light brown mottled CLAY, moist	
			100						
20				0.7				moist to wet	
			100						
25				1.2	UB26-25	SP		Gray, medium SAND with gravel, wet	
			100						
30				1.0	UB26-30				



Driller:	Holocene		**Well/Auger Diameter:**	2/8	inches
Drilling Equipment:	Sonic		**Well Screened Interval:**	25 - 40	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:	N/A		**Filter Pack Used:**	Sand	
Total Boring Depth:	45	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	40	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BLU 338		**Monument Type:**	Flush	

Notes/Comments

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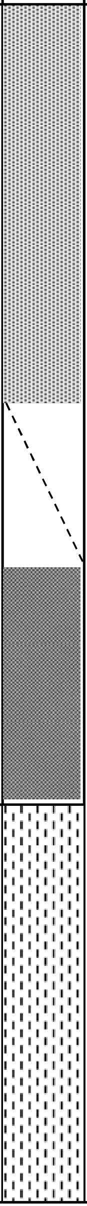
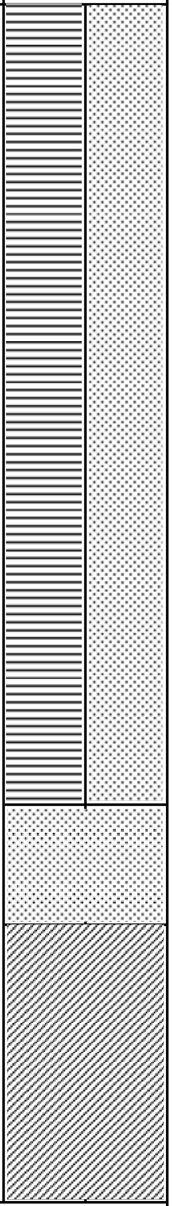
Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB26/MW26

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Lithologic Description
30						SP	Gray medium SAND, moist
							Gray medium SAND with GRAVEL, moist
			100				
				1.2	UB26-35		
35							Transitions from medium SAND to SILTY fine SAND
			100				
						SM	Gray SILTY fine SAND, moist
				1.1			
					UB26-40		
40						CL	Gray CLAY, moist
			100				
				1.2			
45				1.0	UB26-45		45.0 - Boring Completed





Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 45 feet bgs
Total Well Depth: 40 feet bgs
State Well ID No.: BLU 338

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 25 - 40 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Project:	Rainier Mall	**Boring No.**	
Logged by:	KMC	**UB27**	
Date Started:	April 10, 2020		
Date Completed:	April 10, 2020	**Site Address:**	
Checked by:	Richard Martin, LHG	4208 Rainier Avenue	
Surface Conditions:	Asphalt	Seattle, Washington	
Water Depth at Time of Drilling:			
Water Depth After Completion:			

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC		Asphalt/GRAVEL FILL	
						SP		Brown medium SAND with GRAVEL, moist	
			50						
5									
			40	0.0	UB27-6				
10						CL		Gray/light brown mottled CLAY, moist	
			60	0.0	UB27-12				
15									

Driller:	Standard Geoprobe		**Well/Auger Diameter:**	N/A	inches
Drilling Equipment:	Direct Push		**Well Screened Interval:**	N/A	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	N/A	inches
Hammer Type/Weight:	N/A		**Filter Pack Used:**	N/A	
Total Boring Depth:	17	feet bgs	**Annular Seal:**	N/A	
Total Well Depth:	N/A	feet bgs	**Surface Seal:**	N/A	
State Well ID No.:	N/A		**Monument Type:**	N/A	

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: N/A
Water Depth After Completion: N/A

Boring No.
UB27

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15	■		100		UB27-17	CL	▨	Gray/light brown mottled CLAY, moist	▨
								17.0 - Boring Completed	
5									
10									
15									

Driller:	Standard Geoprobe		**Well/Auger Diameter:**	N/A	inches
Drilling Equipment:	Direct Push		**Well Screened Interval:**	N/A	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	N/A	inches
Hammer Type/Weight:	N/A		**Filter Pack Used:**	N/A	
Total Boring Depth:	17	feet bgs	**Annular Seal:**	N/A	
Total Well Depth:	N/A	feet bgs	**Surface Seal:**	N/A	
State Well ID No.:	N/A		**Monument Type:**	N/A	

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB28

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			60					Asphalt/GRAVEL FILL	
						SP		Brown medium SAND with GRAVEL, moist	
5			80						
						CL		Light brown CLAY, moist	
						SM		Gray/light brown mottled SILTY fine SAND, moist to wet	
10			100						
				0.0	UB28-11	CL		Gray/light brown mottled CLAY, moist	
15				0.0	UB28-15			15.0 - Boring Completed	

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 15 feet bgs
Total Well Depth: N/A feet bgs
State Well ID No.: N/A

Well/Auger Diameter: N/A inches
Well Screened Interval: N/A feet bgs
Screen Slot Size: N/A inches
Filter Pack Used: N/A
Annular Seal: N/A
Surface Seal: N/A
Monument Type: N/A

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: April 10, 2020
Date Completed: April 10, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: N/A
Water Depth After Completion: N/A

Boring No.
UB29

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0			75			AC		Asphalt/GRAVEL FILL	
						SP		Brown medium SAND with GRAVEL, moist	
5			80						
				0.0	UB29-6				
						CL		Gray/light brown mottled CLAY, moist	
						SM		Dark brown SILTY fine SAND, wet	
10			100			CL		Gray/light brown mottled CLAY, moist	
				0.0	UB29-11				
15				0.0	UB29-15			15.0 - Boring Completed	

Driller:	Standard Geoprobe		**Well/Auger Diameter:**	N/A	inches
Drilling Equipment:	Direct Push		**Well Screened Interval:**	N/A	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	N/A	inches
Hammer Type/Weight:	N/A		**Filter Pack Used:**	N/A	
Total Boring Depth:	15	feet bgs	**Annular Seal:**	N/A	
Total Well Depth:	N/A	feet bgs	**Surface Seal:**	N/A	
State Well ID No.:	N/A		**Monument Type:**	N/A	

Notes/Comments

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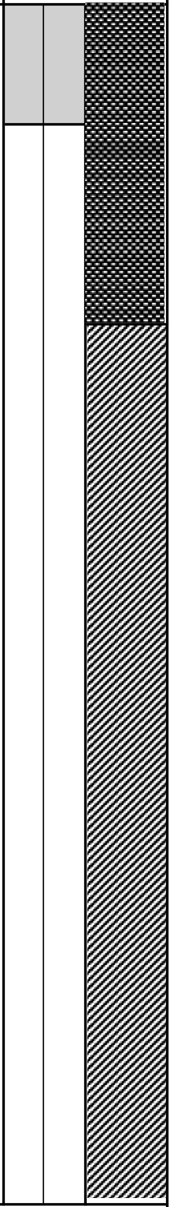
Project: Rainier Mall
Logged by: KMC
Date Started: May 15, 2020
Date Completed: May 15, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB30/MW30

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
0			25			AC	▩	Asphalt/GRAVEL FILL
						GW	▨	Dark gray/Black GRAVEL and SAND, moist FILL
5			25					
10			80	0.7	UB30-12	ML	▨	Gray/Brown, SANDY SILT with GRAVEL, moist FILL
15								

Well Construction Detail



Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 40 feet bgs
Total Well Depth: 40 feet bgs
State Well ID No.: BLH 416

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 25 - 40 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Page: 1/3

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Project: Rainier Mall
Logged by: KMC
Date Started: May 15, 2020
Date Completed: May 15, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB30/MW30

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						ML	▨	Brown, SILTY fine SAND with GRAVEL, moist FILL	
								16.0 - Abundant Organics	
				0.4					
			100			CL	⁞	Gray/Brown mottled CLAY, moist	
20						CH	▨	Gray CLAY, moist to wet	
			100	0.3	UB30-23			23.0 - some intermixed fine SAND	
				0.4	UB30-24				
25						SP	░	Gray, fine SAND with gravel, wet	
					UB30-26	CL	⁞	Gray CLAY, moist	
			100						
30				0.7	UB30-30				

Driller:	Holocene	
Drilling Equipment:	Sonic	
Sampler Type:	Lined Core	
Hammer Type/Weight:	N/A	
Total Boring Depth:	40	feet bgs
Total Well Depth:	40	feet bgs
State Well ID No.:	BLH 416	

Well/Auger Diameter:	2/8	inches
Well Screened Interval:	25 - 40	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: May 15, 2020
Date Completed: May 15, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB30/MW30

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30						SP		Gray coarse medium SAND with GRAVEL, moist	
				0.7	UB30-31				
			90						
				0.7	UB30-34				
35				0.3	UB30-35				
			100						
						CL		Gray CLAY, moist	
				0.6	UB30-38				
				0.6	UB30-39				
40								40.0 - Boring Completed	
45									

Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 40 feet bgs
Total Well Depth: 40 feet bgs
State Well ID No.: BLH 416

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 25 - 40 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

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Project: Rainier Mall
Logged by: KMC
Date Started: May 15, 2020
Date Completed: May 15, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB31/MW31

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC		Asphalt/GRAVEL FILL	
						SW		Dark gray/Black GRAVEL and SAND, moist FILL	
			50	0.9		ML		Gray/Brown, SANDY SILT with GRAVEL, moist FILL	
5									
			90					Traces of debris (brick and tile)	
				1.1					
10								10 to 12 - wet	
			65					11.5 to 12.0 - Abundant Organics	
						CL		Gray CLAY, moist	
15									

Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 45 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLH 415

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Drillers addded approximately 50 gallons of water to drive casing

Gray/brown mottling indicates the presence of iron precipitates.

Project: Rainier Mall
Logged by: KMC
Date Started: May 15, 2020
Date Completed: May 15, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB31/MW31

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL		Gray CLAY, moist	
			95	1.0					
20								Gray CLAY, moist to wet	
			100						
								23.0 - some intermixed fine SAND	
				1.0	UB31-24				
						SP		Gray, medium SAND, moist to wet	
						CL			
25						ML		Gray SANDY SILT, moist to wet	
				1.2	UB31-26				
						SP		Gray medium SAND with GRAVEL, wet	
			100						
				1.2	UB31-28	ML		Gray SANDY SILT, moist to wet	
30									

Driller:	Holocene	
Drilling Equipment:	Sonic	
Sampler Type:	Lined Core	
Hammer Type/Weight:	N/A	
Total Boring Depth:	45	feet bgs
Total Well Depth:	30	feet bgs
State Well ID No.:	BLH 415	

Well/Auger Diameter:	2/8	inches
Well Screened Interval:	15 - 30	feet bgs
Screen Slot Size:	0.010	inches
Filter Pack Used:	Sand	
Annular Seal:	Bentonite	
Surface Seal:	Concrete	
Monument Type:	Flush	

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

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Project: Rainier Mall
Logged by: KMC
Date Started: May 15, 2020
Date Completed: May 15, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB31/MW31

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
30								Gray CLAY, moist	
						CL			
				1.2	UB31-31				
				1.0	UB31-32				
			90						
35				0.3	UB31-35				
			100						
				0.5	UB31-37				
40									
			80						
				0.8	UB31-43				
45								45.0 - Boring Completed	

Driller: Holocene
Drilling Equipment: Sonic
Sampler Type: Lined Core
Hammer Type/Weight: N/A
Total Boring Depth: 45 feet bgs
Total Well Depth: 30 feet bgs
State Well ID No.: BLH 415

Well/Auger Diameter: 2/8 inches
Well Screened Interval: 15 - 30 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Page:

3/3

Urban Environmental Partners llc
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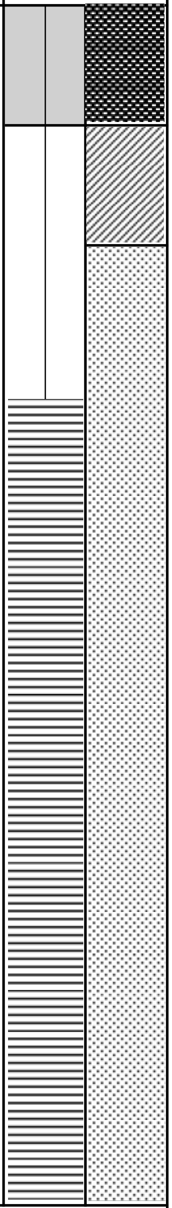
Project: Rainier Mall
Logged by: KMC
Date Started: June 3, 2020
Date Completed: June 3, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling: 17 feet
Water Depth After Completion:

Boring No.
UB32/MW32

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description
0						AC		Asphalt/GRAVEL FILL
						SP		Light brown, medium SAND, some GRAVEL, moist
			65	0.3	UB32-2			
5								
						ML		Gray SILT with SAND and GRAVEL, moist
			75	0.0	UB32-7			
10								
						CL		Dark brown/gray CLAY, moist
			100					
								Gray with brown mottling
				0.0	UB32-13			
15								

Well Construction Detail



Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 20 feet bgs
Total Well Depth: 20 feet bgs
State Well ID No.: BLS 127

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 5 - 20 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Urban Environmental Partners llc
Diligent, responsive, and practical consulting!

Project: Rainier Mall
Logged by: KMC
Date Started: June 3, 2020
Date Completed: June 3, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB32/MW32

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL			
			100	0.0	UB32-18			Moist to wet 0.2' lens of brown/gray mottled fine SANDY SILT, moist	
20								Bottom of Boring	
25									
30									

Driller:	Standard Geoprobe		**Well/Auger Diameter:**	1/2.25	inches
Drilling Equipment:	Direct Push		**Well Screened Interval:**	5 - 20	feet bgs
Sampler Type:	Lined Core		**Screen Slot Size:**	0.010	inches
Hammer Type/Weight:			**Filter Pack Used:**	Sand	
Total Boring Depth:	20	feet bgs	**Annular Seal:**	Bentonite	
Total Well Depth:	20	feet bgs	**Surface Seal:**	Concrete	
State Well ID No.:	BLS 127		**Monument Type:**	Flush	

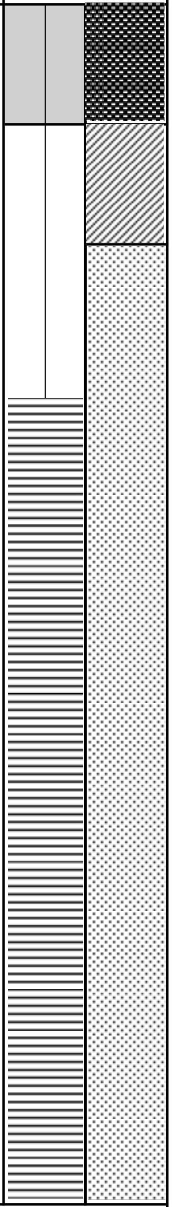
Notes/Comments

Urban Environmental Partners llc
Diligent, responsive, and practical consulting!

Project: Rainier Mall
Logged by: KMC
Date Started: June 3, 2020
Date Completed: June 3, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB33/MW33

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC	▩	Asphalt/GRAVEL FILL	
			55	0.2	UB33-2	SP	░	Light brown, medium SAND, some GRAVEL, moist	
5			25	0.4	UB33-5	ML	▨	Gray brown SILT with SAND and GRAVEL, some wood and brick, moist	
10			100	0.4	UB32-12	CL	┆	Brown gray mottled CLAY, moist	
15									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 20 feet bgs
Total Well Depth: 20 feet bgs
State Well ID No.: BLS 128

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 5 - 20 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Project: Rainier Mall
Logged by: KMC
Date Started: June 3, 2020
Date Completed: June 3, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB32/MW32

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
15						CL		15.0 to 15.5 wet	
			100	0.0	UB33-17.5			0.5' lens of brown fine SANDY SILT, moist to wet	
20								Bottom of Boring	
25									
30									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 20 feet bgs
Total Well Depth: 20 feet bgs
State Well ID No.: BLS 128

Well/Auger Diameter: 1/2.25 inches
Well Screened Interval: 5 - 20 feet bgs
Screen Slot Size: 0.010 inches
Filter Pack Used: Sand
Annular Seal: Bentonite
Surface Seal: Concrete
Monument Type: Flush

Notes/Comments

Urban Environmental Partners llc
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Project: Rainier Mall
Logged by: KMC
Date Started: June 3, 2020
Date Completed: June 3, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB34

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC		Asphalt/GRAVEL FILL	
						SP		Brown medium SAND with GRAVEL, moist	
			65						
				0.4	UB34-3				
5									
								Wet	
						CL		Gray CLAY, moist	
			60						
				0.6	UB34-7				
						ML		Gray/dark brown SILT with organics, moist	
10									
						CL		Gray/brown mottled CLAY, moist	
			100						
					UB34-13				
								0.2' lens of brown medium SAND, moist	
15									

Driller:	Standard Geoprobe	
Drilling Equipment:	Direct Push	
Sampler Type:	Lined Core	
Hammer Type/Weight:		
Total Boring Depth:	15	feet bgs
Total Well Depth:	N/A	feet bgs
State Well ID No.:	N/A	

Well/Auger Diameter:	N/A	inches
Well Screened Interval:	N/A	feet bgs
Screen Slot Size:	N/A	inches
Filter Pack Used:	N/A	
Annular Seal:	N/A	
Surface Seal:	N/A	
Monument Type:	N/A	

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Page:

1/1

Urban Environmental Partners llc
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Project: Rainier Mall
Logged by: KMC
Date Started: June 3, 2020
Date Completed: June 3, 2020
Checked by: Richard Martin, LHG
Surface Conditions: Asphalt
Water Depth at Time of Drilling:
Water Depth After Completion:

Boring No.
UB35

Site Address:
4208 Rainier Avenue
Seattle, Washington

Depth (feet bgs)	Interval	Blow Count	% Recovery	PID (ppm)	Sample ID	USCS Class	Graphic	Lithologic Description	Well Construction Detail
0						AC		Asphalt/GRAVEL FILL	
						SP		Brown medium SAND , moist	
			50						
				1.2	UB35-4				
5								Wet	
								Gray CLAY, moist	
			50						
						ML		Gray/dark brown SILT with organics, moist	
10				0.4	UB35-10	CL		Gray/brown mottled CLAY, moist	
			95						
				0.3	UB35-14			0.2' lens of brown medium SAND, moist	
15									

Driller: Standard Geoprobe
Drilling Equipment: Direct Push
Sampler Type: Lined Core
Hammer Type/Weight:
Total Boring Depth: 15 feet bgs
Total Well Depth: N/A feet bgs
State Well ID No.: N/A

Well/Auger Diameter: N/A inches
Well Screened Interval: N/A feet bgs
Screen Slot Size: N/A inches
Filter Pack Used: N/A
Annular Seal: N/A
Surface Seal: N/A
Monument Type: N/A

Notes/Comments

Gray/brown mottling indicates the presence of iron precipitates.

Appendix C: TRS Design Plans for ERH

ELECTRICAL RESISTANCE HEATING DESIGN PACKAGE

PRELIMINARY

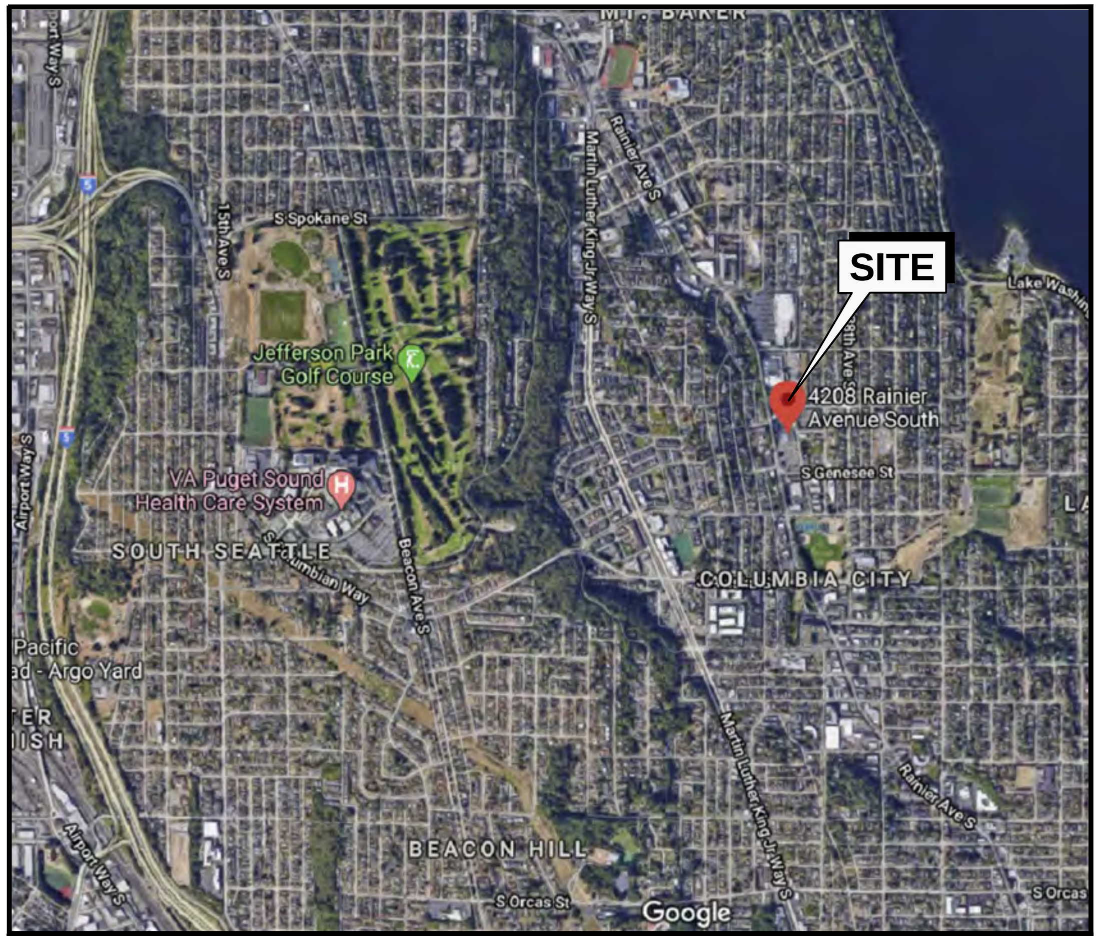
Not Approved for Construction

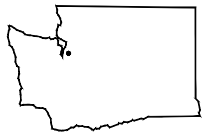
RAINER MALL PROPERTY
4208 RANIER AVE. SOUTH
SEATTLE, WASHINGTON 98118

Prepared by:

TRS
Accelerating Value

MAY 2020



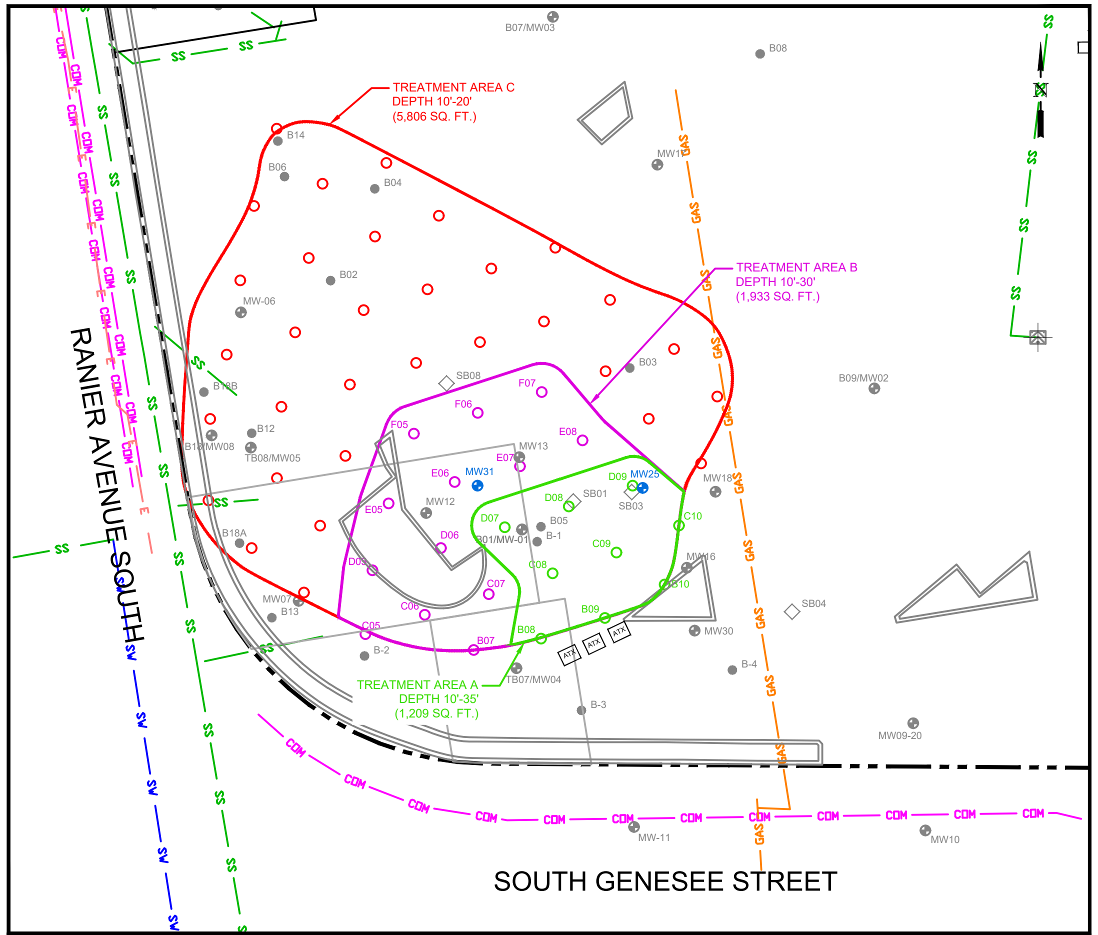


WASHINGTON

SITE LOCATION MAP

SHEET INDEX

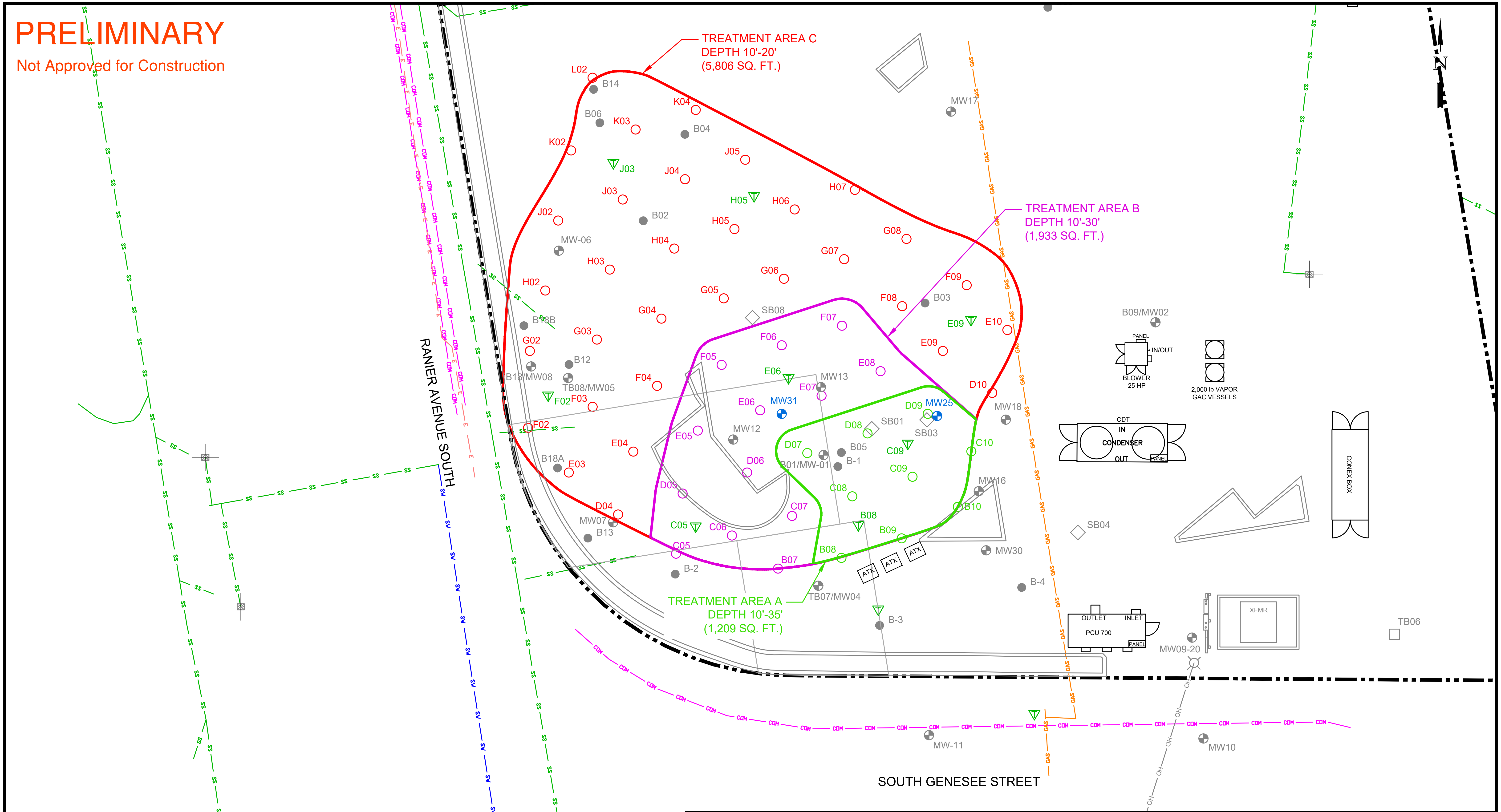
DRAWING NUMBER	TITLE AND DESCRIPTION
Y-1	SITE PLAN
Y-2	PROPOSED ELECTRICAL SERVICE LOCATION
M-1	ELECTRODE DETAIL TYPE A
M-2	ELECTRODE DETAIL TYPE B
M-3	ELECTRODE DETAIL TYPE C
M-4	TEMPERATURE MONITORING POINT DETAIL TYPE A
M-5	TEMPERATURE MONITORING POINT DETAIL TYPE B
M-6	AREA 1 TEMPERATURE MONITORING POINT DETAIL TYPE C
E-1	ELECTRICAL ONE-LINE DIAGRAM LEGEND
E-2	ELECTRICAL ONE-LINE DIAGRAM REQUIREMENTS
E-3	ELECTRICAL ONE-LINE DIAGRAM
E-4	ELECTRICAL ONE-LINE DIAGRAM



SITE PLAN

PRELIMINARY

Not Approved for Construction



TREATMENT AREA C
DEPTH 10'-20'
(5,806 SQ. FT.)

TREATMENT AREA B
DEPTH 10'-30'
(1,933 SQ. FT.)

TREATMENT AREA A
DEPTH 10'-35'
(1,209 SQ. FT.)

LEGEND

○○○ ELECTRODE (QTY. 54)

▽ TEMPERATURE MONITORING POINT (QTY. 8)

◐ EXISTING MONITORING WELL

◐ EXISTING S.S. MONITORING WELL

● ◇ EXISTING BORING LOCATION

0 10 20 40

SCALE IN FEET

TRS

Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

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DESIGNED BY
D. SEILER

DRAWN BY
A. PEABODY

CHECKED BY
PENDING APPROVAL

PROJECT MANAGER
TRS PERSONNEL

QSAT REVIEW
xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

SITE PLAN

APPROVED FOR CONSTRUCTION

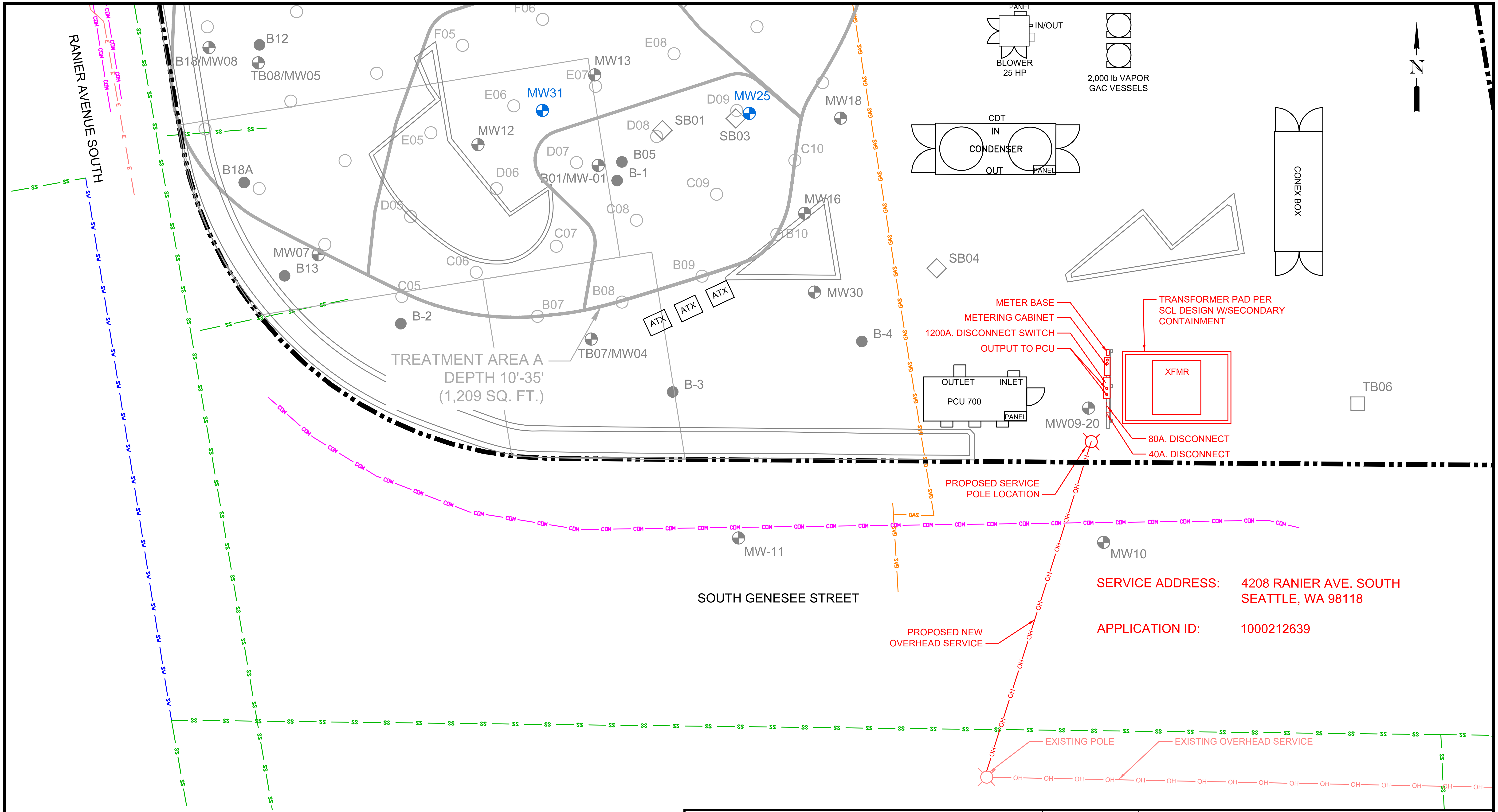
BY ____________________

DATE ____________________

DATE 2020.MAY.28

PROJECT WA.RAI.2136

SHEET Y-1



LEGEND

◐ EXISTING MONITORING WELL

● ◇ EXISTING BORING LOCATION

○ ELECTRODES

PRELIMINARY

Not Approved for Construction

0 7.5 15 30

SCALE IN FEET

TRS
Accelerating Value

TRS GROUP, INC. 338 COMMERCE AVE., SUITE 304, LONGVIEW, WA 98632

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DESIGNED BY
D. SEILER

DRAWN BY
A. PEABODY

CHECKED BY
PENDING APPROVAL

PROJECT MANAGER
TRS PERSONNEL

QSAT REVIEW
xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

PROPOSED ELECTRICAL SERVICE LOCATION

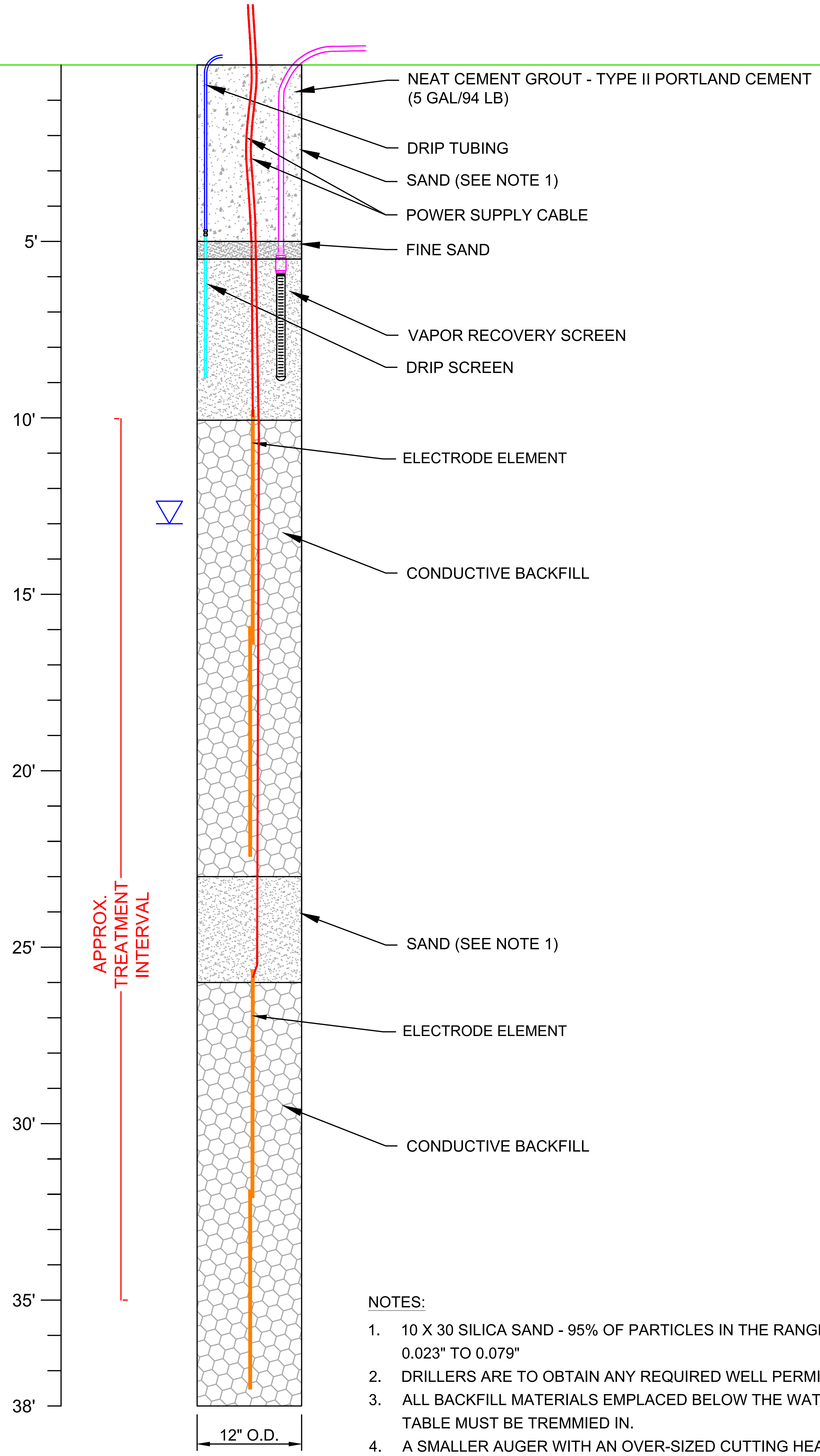
APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE 2020.MAY.28
PROJECT WA.RAI.2136
SHEET Y-2

PRELIMINARY

Not Approved for Construction

ABOVE GRADE BORED ELECTRODE TYPE A (TYPICAL OF 9)



NOTES:

1. 10 X 30 SILICA SAND - 95% OF PARTICLES IN THE RANGE OF 0.023" TO 0.079"
2. DRILLERS ARE TO OBTAIN ANY REQUIRED WELL PERMITS.
3. ALL BACKFILL MATERIALS EMPLACED BELOW THE WATER TABLE MUST BE TREMMIED IN.
4. A SMALLER AUGER WITH AN OVER-SIZED CUTTING HEAD IS NOT ACCEPTABLE. AUGERS WITH FLIGHTS MUST PROVIDE THE OD AS SHOWN IN THIS DETAIL
5. BACKFILL IS TO BE PRE-MIXED BEFORE EMPLACEMENT.

TRS Accelerating Value

TRS GROUP, INC. PO BOX 737 LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY A. PEABODY
CHECKED BY PENDING APPROVAL
PROJECT MANAGER TRS PERSONNEL
QSAT REVIEW xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

ELECTRODE DETAIL
TYPE A

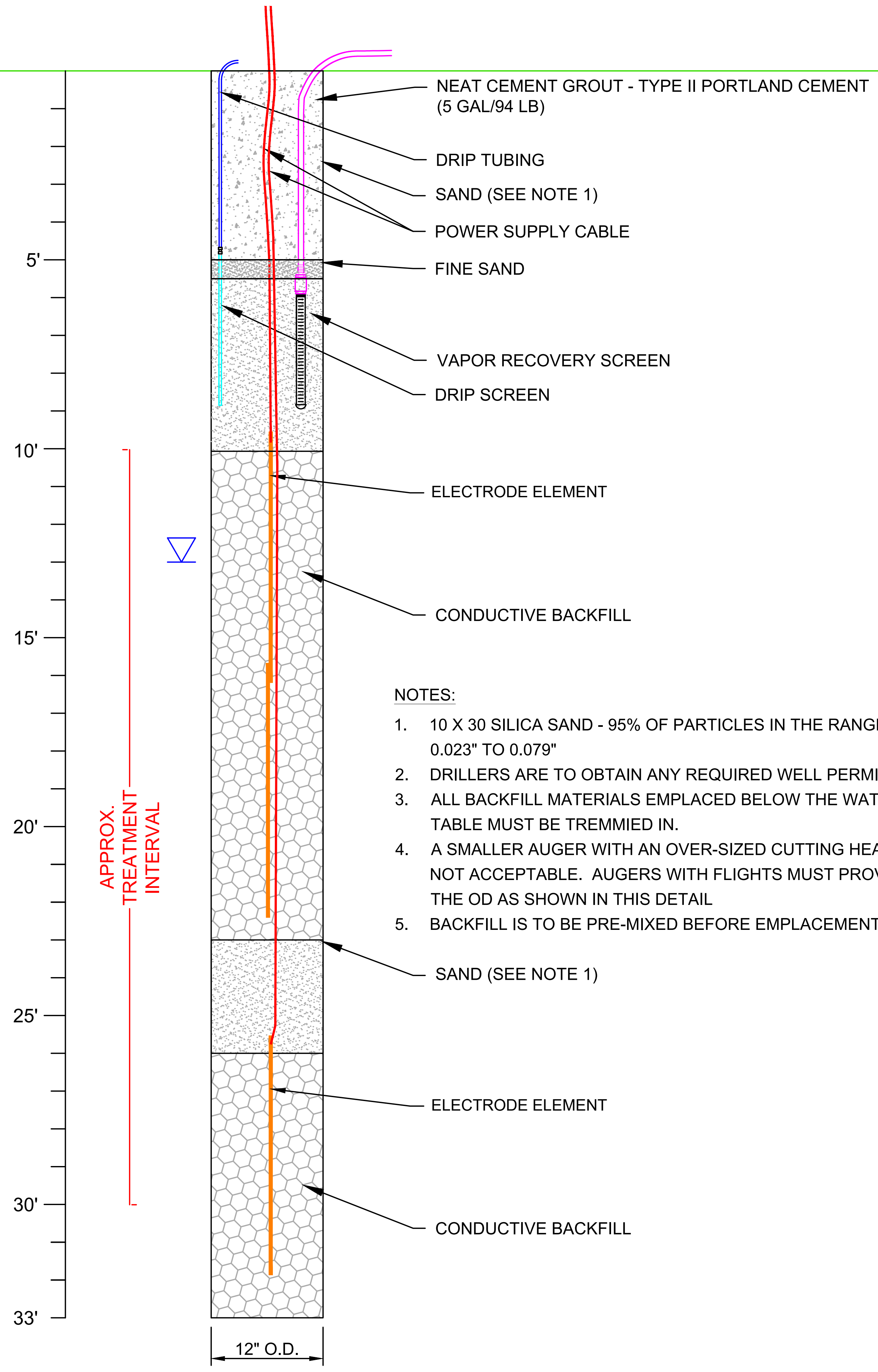
APPROVED FOR CONSTRUCTION
BY ________________
DATE ________________

DATE 2020.MAY.21
PROJECT WA.RAI.2136
SHEET M-1

PRELIMINARY

Not Approved for Construction

ABOVE GRADE BORED ELECTRODE
TYPE B
(TYPICAL OF 13)



NOTES:

1. 10 X 30 SILICA SAND - 95% OF PARTICLES IN THE RANGE OF 0.023" TO 0.079"
2. DRILLERS ARE TO OBTAIN ANY REQUIRED WELL PERMITS.
3. ALL BACKFILL MATERIALS EMPLACED BELOW THE WATER TABLE MUST BE TREMMIED IN.
4. A SMALLER AUGER WITH AN OVER-SIZED CUTTING HEAD IS NOT ACCEPTABLE. AUGERS WITH FLIGHTS MUST PROVIDE THE OD AS SHOWN IN THIS DETAIL
5. BACKFILL IS TO BE PRE-MIXED BEFORE EMPLACEMENT.

TRS Accelerating Value

TRS GROUP, INC. PO BOX 737 LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY A. PEABODY
CHECKED BY PENDING APPROVAL
PROJECT MANAGER TRS PERSONNEL
QSAT REVIEW xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

ELECTRODE DETAIL
TYPE B

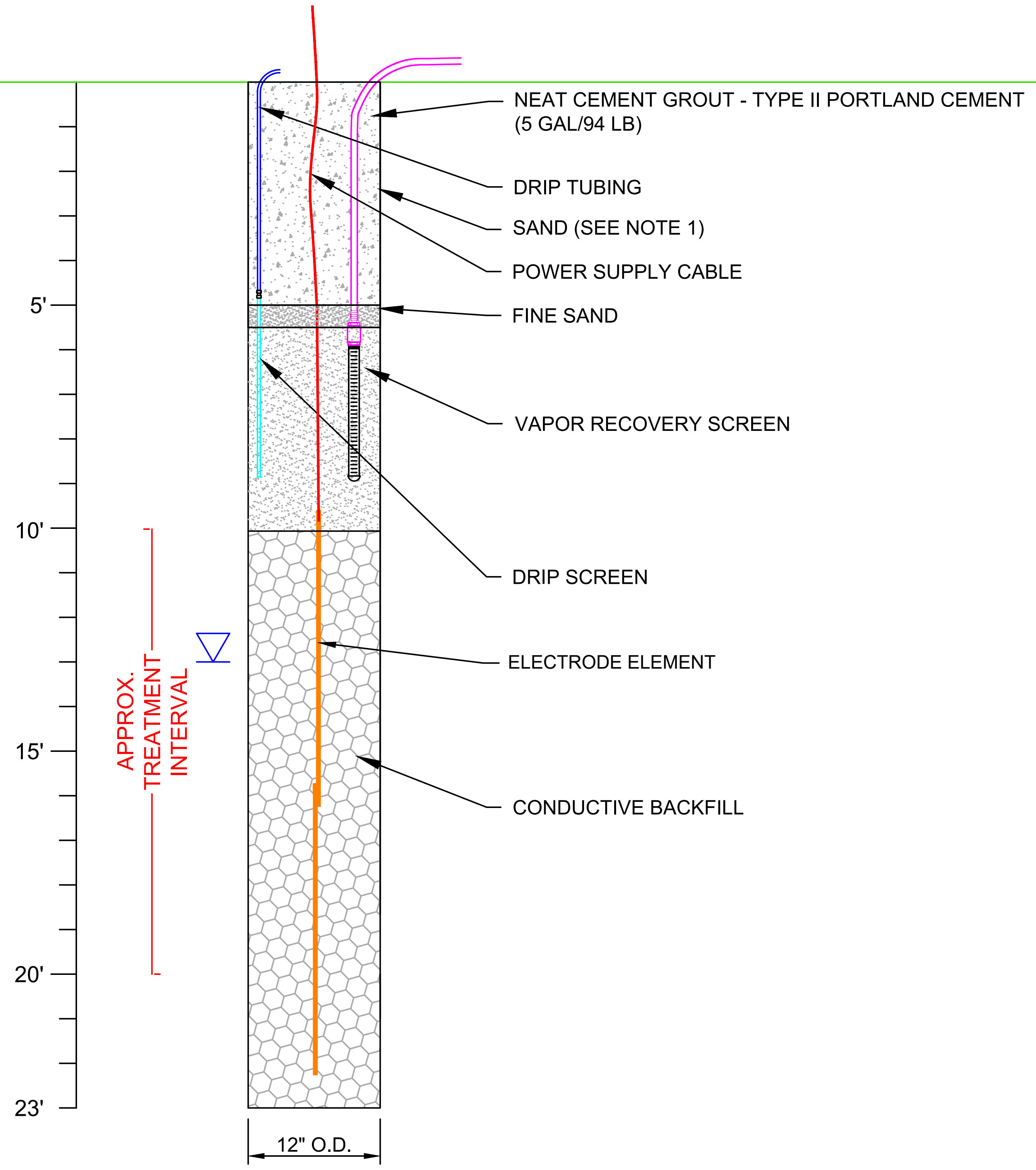
APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2020.MAY.21
PROJECT WA.RAI.2136
SHEET M-2

PRELIMINARY

Not Approved for Construction

ABOVE GRADE BORED ELECTRODE
TYPE C
(TYPCAL OF 32)



NOTES:

1. 10 X 30 SILICA SAND - 95% OF PARTICLES IN THE RANGE OF 0.023" TO 0.079"
2. DRILLERS ARE TO OBTAIN ANY REQUIRED WELL PERMITS.
3. ALL BACKFILL MATERIALS EMPLACED BELOW THE WATER TABLE MUST BE TREMMIED IN.
4. A SMALLER AUGER WITH AN OVER-SIZED CUTTING HEAD IS NOT ACCEPTABLE. AUGERS WITH FLIGHTS MUST PROVIDE THE OD AS SHOWN IN THIS DETAIL
5. BACKFILL IS TO BE PRE-MIXED BEFORE EMPLACEMENT.

TRS
Accelerating Value

TRS GROUP, INC. PO BOX 737 LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY A. PEABODY
CHECKED BY PENDING APPROVAL
PROJECT MANAGER TRS PERSONNEL
QSAT REVIEW xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

ELECTRODE DETAIL
TYPE C

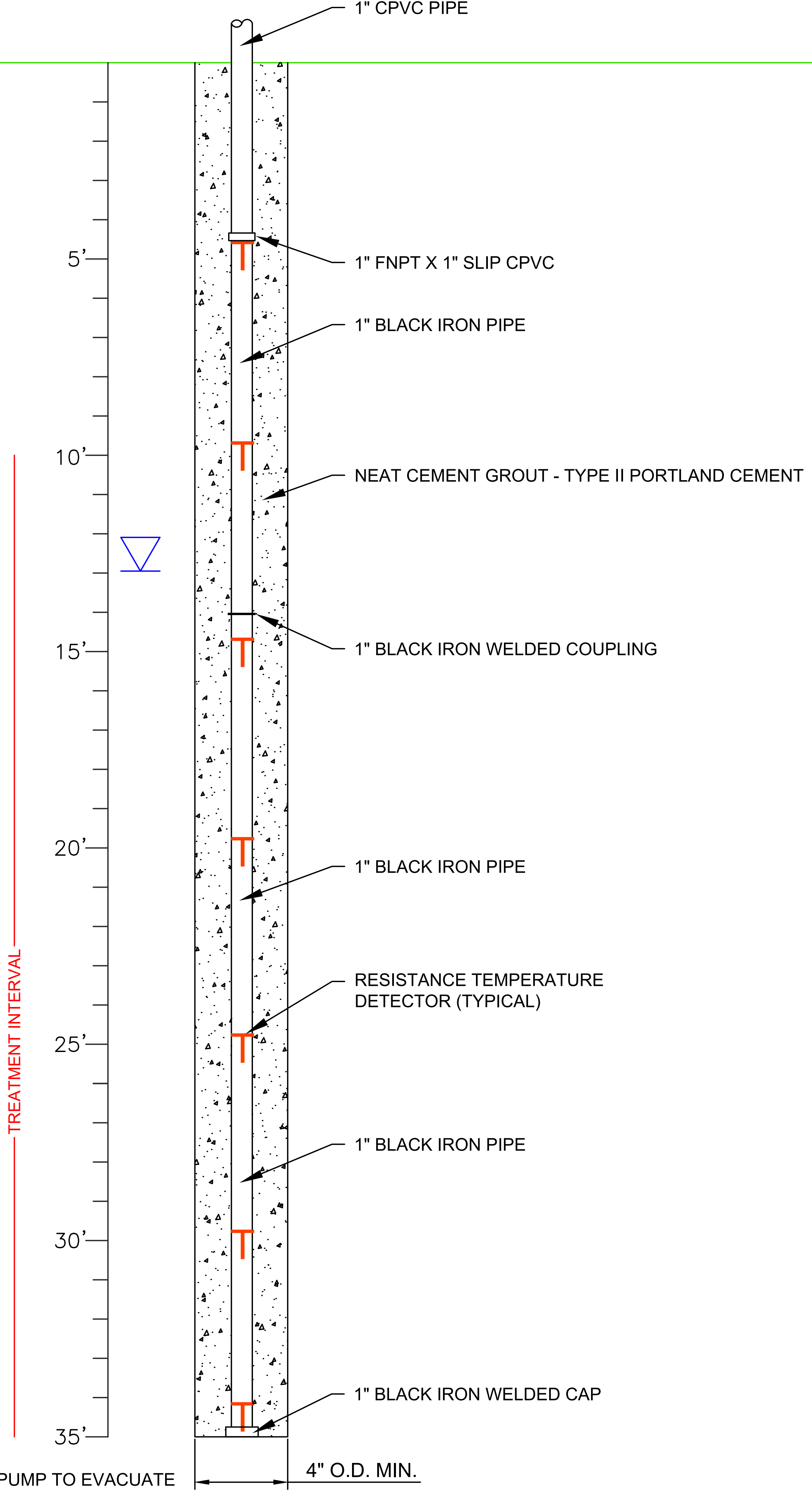
APPROVED FOR CONSTRUCTION
BY ____________
DATE ____________

DATE 2020.MAY.21
PROJECT WA.RAI.2136
SHEET M-3

PRELIMINARY

Not Approved for Construction

ABOVE GRADE TEMPERATURE MONITORING POINT TYPE A (TYPICAL OF 2)



NOTE:
USE A WATER PUMP TO EVACUATE WATER FROM THE TMP CASING, IF WATER IS OBSERVED.

TRS Accelerating Value

TRS GROUP, INC. PO BOX 737 LONGVIEW, WA 98632

DESIGNED BY
D. SEILER

DRAWN BY
A. PEABODY

CHECKED BY
PENDING APPROVAL

PROJECT MANAGER
TRS PERSONNEL

QSAT REVIEW
xx/xx/xx

SITE: RANIER MALL PROPERTY
LOCATION: SEATTLE, WASHINGTON
CLIENT: CLIENT NAME

TEMPERATURE MONITORING POINT DETAIL
TYPE A

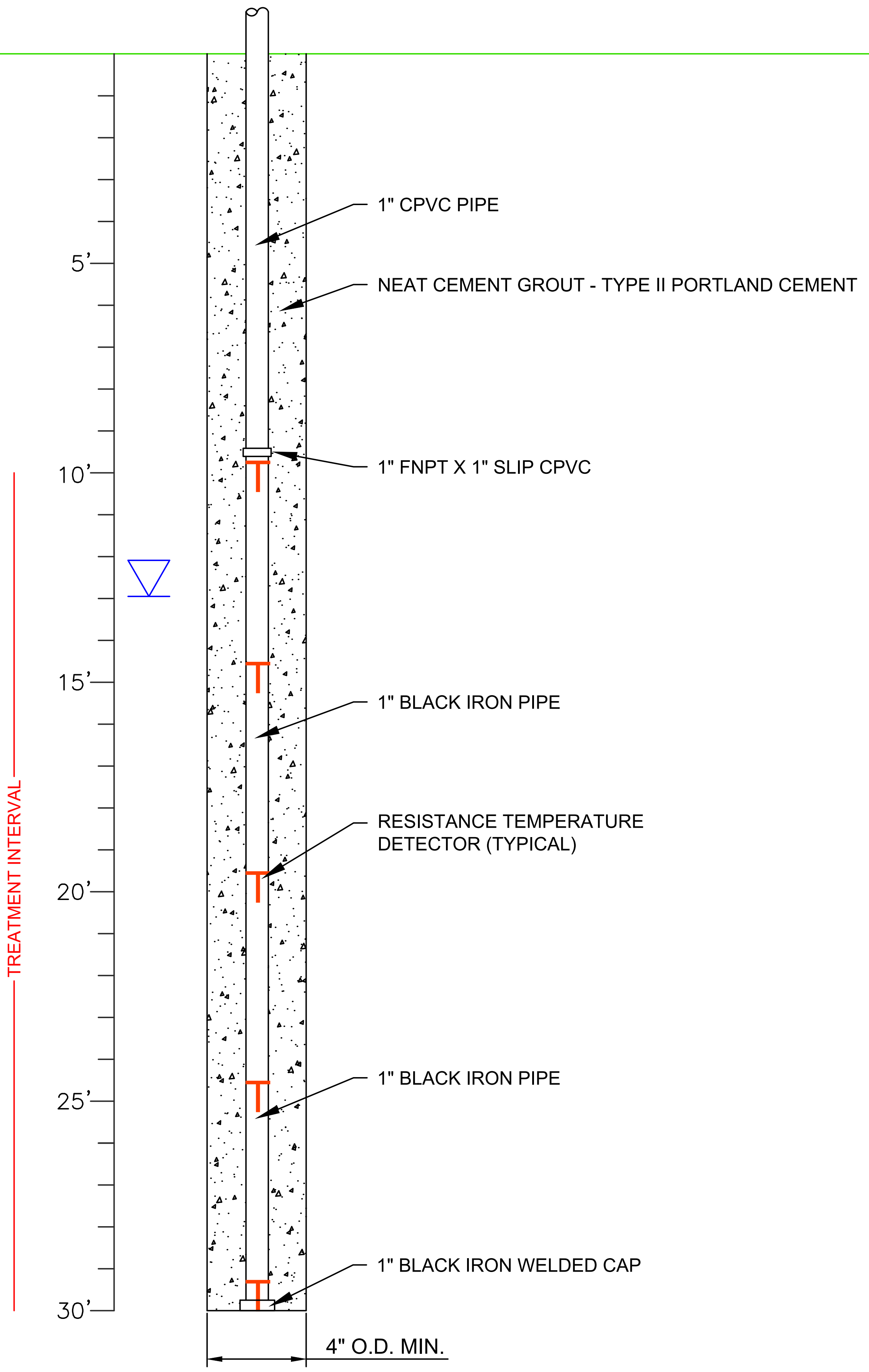
APPROVED FOR CONSTRUCTION
BY ______________________
DATE ______________________

DATE: 2020.MAY.21
PROJECT: WA.RAI.2136
SHEET: M-4

PRELIMINARY

Not Approved for Construction

ABOVE GRADE
TEMPERATURE MONITORING POINT
TYPE B
(TYPICAL OF 2)



NOTE:
USE A WATER PUMP TO EVACUATE
WATER FROM THE TMP CASING, IF
WATER IS OBSERVED.

TRS
Accelerating Value
TRS GROUP, INC. PO BOX 737 LONGVIEW, WA 98632

DESIGNED BY
D. SEILER
DRAWN BY
A. PEABODY
CHECKED BY
PENDING APPROVAL
PROJECT MANAGER
TRS PERSONNEL
QSAT REVIEW
xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

TEMPERATURE MONITORING POINT DETAIL
TYPE B

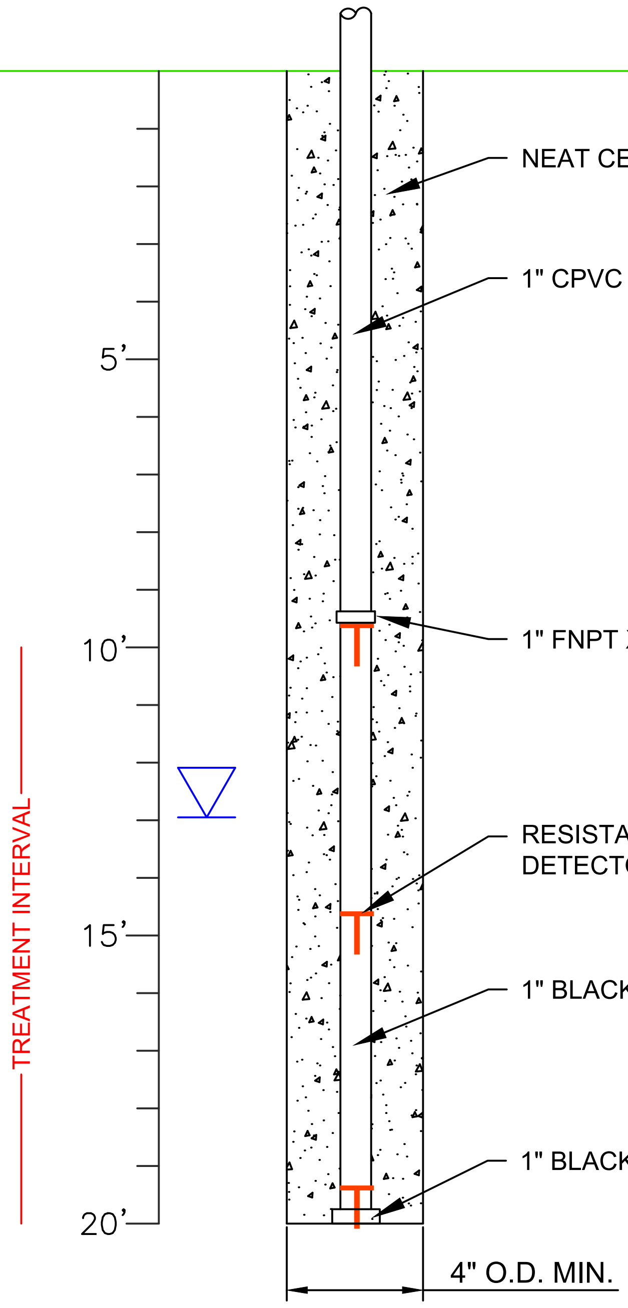
APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2020.MAY.21
PROJECT WA.RAI.2136
SHEET M-5

PRELIMINARY

Not Approved for Construction

ABOVE GRADE
TEMPERATURE MONITORING POINT
TYPE C
(TYPICAL OF 4)



NOTE:
USE A WATER PUMP TO EVACUATE
WATER FROM THE TMP CASING, IF
WATER IS OBSERVED.

TRS
Accelerating Value

TRS GROUP, INC. PO BOX 737 LONGVIEW, WA 98632

DESIGNED BY D. SEILER
DRAWN BY A. PEABODY
CHECKED BY PENDING APPROVAL
PROJECT MANAGER TRS PERSONNEL
QSAT REVIEW xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

TEMPERATURE MONITORING POINT DETAIL
TYPE C

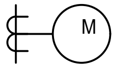
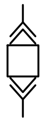
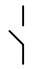
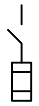
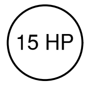
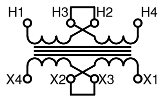
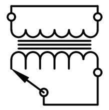
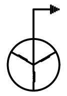
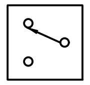
APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2020.MAY.21
PROJECT WA.RAI.2136
SHEET M-6

PRELIMINARY

Not Approved for Construction

SYMBOLS

	UTILITY METERING
	MEDIUM VOLTAGE DRAW OUT CIRCUIT BREAKER
	FUSE
	DISCONNECT SWITCH
	FUSED DISCONNECT SWITCH
	CIRCUIT BREAKER
	N.O. CONTACT A NORMALLY OPEN (N.O.) CONTACT IS OPEN WHEN IT, OR THE DEVICE OPERATING IT, IS IN A DE-ENERGIZED
	N.C. CONTACT A NORMALLY CLOSED (N.C.) CONTACT IS CLOSED WHEN IT, OR THE DEVICE OPERATING IT, IS IN A DE-ENERGIZED STATE OR RELAXED STATE.
	THERMAL OVERLOAD
	PUMP/MOTOR
	TRANSFORMER
	VARIABLE OUTPUT 3 PHASE TRANSFORMER
	GENERATOR
	AUTOMATIC TRANSFER SWITCH

ABBREVIATIONS

A	AMPERES
ATS	AUTOMATIC TRANSFER SWITCH
FLA	FULL LOAD AMPS
HP	HORSEPOWER
KW	KILOWATT
KVA	KILOVOLT-AMPERES
KV	KILO-VOLTS
N.O.	NORMALLY OPEN
OL	OVERLOAD
P	POLE
PH, Ø	PHASE
SRGAC	STEAM REGENERATED GAS ACTIVATED CARBON
VAC	VOLTAGE ALTERNATING CURRENT
VFD	VARIABLE FREQUENCY DRIVE
V	VOLT
W	WATTS, WIRE

NOTE: THIS IS AN ALL INCLUSIVE LEGEND SHEET. NOT ALL SYMBOLS/ABBREVIATIONS WILL APPEAR ON EACH SHEET.

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DESIGNED BY
D. SEILER
DRAWN BY
A. PEABODY
CHECKED BY
PENDING APPROVAL
PROJECT MANAGER
TRS PERSONNEL
QSAT REVIEW
xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

ELECTRICAL ONE-LINE DIAGRAM LEGEND

APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2020.MAY.15
PROJECT WA.RAI.2136
SHEET E-1

PRELIMINARY

Not Approved for Construction

GENERAL NOTES

1. PERFORM INSTALLATION IN ACCORDANCE WITH THE CURRENT EDITION OF THE NATIONAL ELECTRICAL CODE (NEC) AND THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA). EQUIPMENT SHALL BE LISTED BY A NATIONALLY RECOGNIZED TESTING LABORATORY (NRTL).
2. PROVIDE AND MAINTAIN A CLEAR WORKING SPACE ABOUT ELECTRIC EQUIPMENT IN ACCORDANCE WITH NEC ARTICLES 110.26 AND 110.34.
3. PROVIDE CIRCUIT BREAKERS WITH UL LISTED INTERRUPTING RATING (RMS SYMMETRICAL AMPERES) GREATER THAN THE AVAILABLE FAULT CURRENT SHOWN IN THE SHORT CIRCUIT REPORT.
4. PROVIDE PADLOCKING PROVISIONS FOR EACH TWO AND THREE POLE CIRCUIT BREAKERS.
5. USE #12AWG OR LARGER CONDUCTORS FOR POWER WIRING.
6. USE #14AWG OR LARGER CONDUCTORS FOR CONTROL WIRING UNLESS OTHERWISE SPECIFIED OR SHOWN ON THE DRAWINGS.
7. LIMIT USE OF ELECTRICAL METALLIC TUBING (EMT) AND SCHEDULE 40 PVC CONDUIT TO AREAS WHERE IT WILL NOT BE SUBJECT TO PHYSICAL DAMAGE.
8. USE LIQUID TIGHT FLEXIBLE METAL CONDUIT FOR FLEXIBLE CONNECTIONS TO EQUIPMENT OUTDOORS.
9. USE INTERMEDIATE METALLIC CONDUIT (IMT) OR RIGID GALVANIZED STEEL CONDUIT (RGS) OR SCHEDULE 80 PVC CONDUIT FOR WORK EMBEDDED IN CONCRETE OR EXPOSED TO PHYSICAL DAMAGE. THESE CONDUIT TYPES MAY BE USED IN ALL APPLICATIONS WHERE SCHEDULE 40 PVC OR EMT WOULD BE APPROPRIATE, AT THE DISCRETION OF THE DESIGN ENGINEER.
10. USE THE FOLLOWING CONDUCTOR COLOR CODES.

	240/120V	208Y/120V	480Y/277V	MED VOLTAGE	ELECTRODE CABLES
PHASE A	BLACK	BLACK	BROWN	RED	RED W/ELECTRODE MARKER
PHASE B	RED	RED	ORANGE	YELLOW	YELLOW W/ELECTRODE MARKER
PHASE C		BLUE	YELLOW	BLUE	BLUE W/ELECTRODE MARKER
NEUTRAL	WHITE	WHITE	GRAY		
EQUIP, GND	GREEN/BARE	GREEN/BARE	GREEN/BARE	GREEN/BARE	

ISOLATED GROUND SHALL BE GREEN WITH YELLOW TRACER.

11. USE ONLY COPPER CONDUCTORS.
12. POWER CONDUCTORS 10AWG AND SMALLER SHALL BE SOLID. POWER CONDUCTORS 8AWG AND LARGER SHALL BE STRANDED
13. FOR NON-ELECTRODE CIRCUITS, PROVIDE TYPE THHN/THWN WIRE INSULATION. XHHW INSULATION MAY BE USED FOR 1AWG AND LARGER. TYPE W AND DLO CABLE MAY BE USED FOR CIRCUITS WHICH REQUIRE FLEXIBILITY. CONDUCTORS THAT REQUIRE FLEXIBILITY ARE PERMITTED TO BE STRANDED REGARDLESS OF CONDUCTOR SIZE. USE OF WIRE FERRULES ON UN-LUGGED FLEXIBLE CABLE IS REQUIRED. SOW CABLE IS PERMITTED FOR SKID POWER FEEDERS.
14. ARRANGE CONNECTIONS FOR SINGLE PHASE CIRCUITS TO ACHIEVE THREE PHASE LOAD BALANCE WITHIN 10% OF THE AVERAGE PHASE LOAD CURRENT FOR SCR POWERED LOADS.
15. ARRANGE CONNECTIONS FOR SINGLE PHASE CIRCUITS TO ACHIEVE THREE PHASE LOAD BALANCE WITHIN 20% OF THE AVERAGE PHASE LOAD CURRENT FOR NON-SCR POWERED LOADS.
16. INSTALL OUTDOOR EQUIPMENT TO BE WEATHERPROOF AND TO EXCLUDE BIRDS AND RODENTS WITH A MAXIMUM ½” DIAMETER UNPROTECTED OPENINGS IN ENCLOSURES.
17. TEST CONDUCTORS FOR CONTINUITY AND FREEDOM FROM SHORTS AND UNINTENTIONAL GROUNDS.
18. ELECTRICAL MATERIALS AND CONSTRUCTION SHALL CONFORM TO TRS GROUP INC STANDARD CONSTRUCTION SPECIFICATIONS WHERE APPLICABLE.
19. IF A CONFLICT ARISES BETWEEN THE FIELD CONDITIONS AND THESE GENERAL ELECTRICAL REQUIREMENTS, STOP WORK AND CONTACT THE PROJECT ENGINEER.
20. TIE-INS TO EXISTING POWER SYSTEMS WILL BE PERFORMED BY OTHERS, WORKING UNDER THE DIRECTION OF A LOCALLY LICENSED ENGINEER OR UTILITY AUTHORITY. SEE TRS ELECTRICAL CONTRACTING SPECIFICATION FOR ADDITIONAL REQUIREMENTS IF PERFORMED BY TRS SUBCONTRACTOR.

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PROJECT MANAGER
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QSAT REVIEW
xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

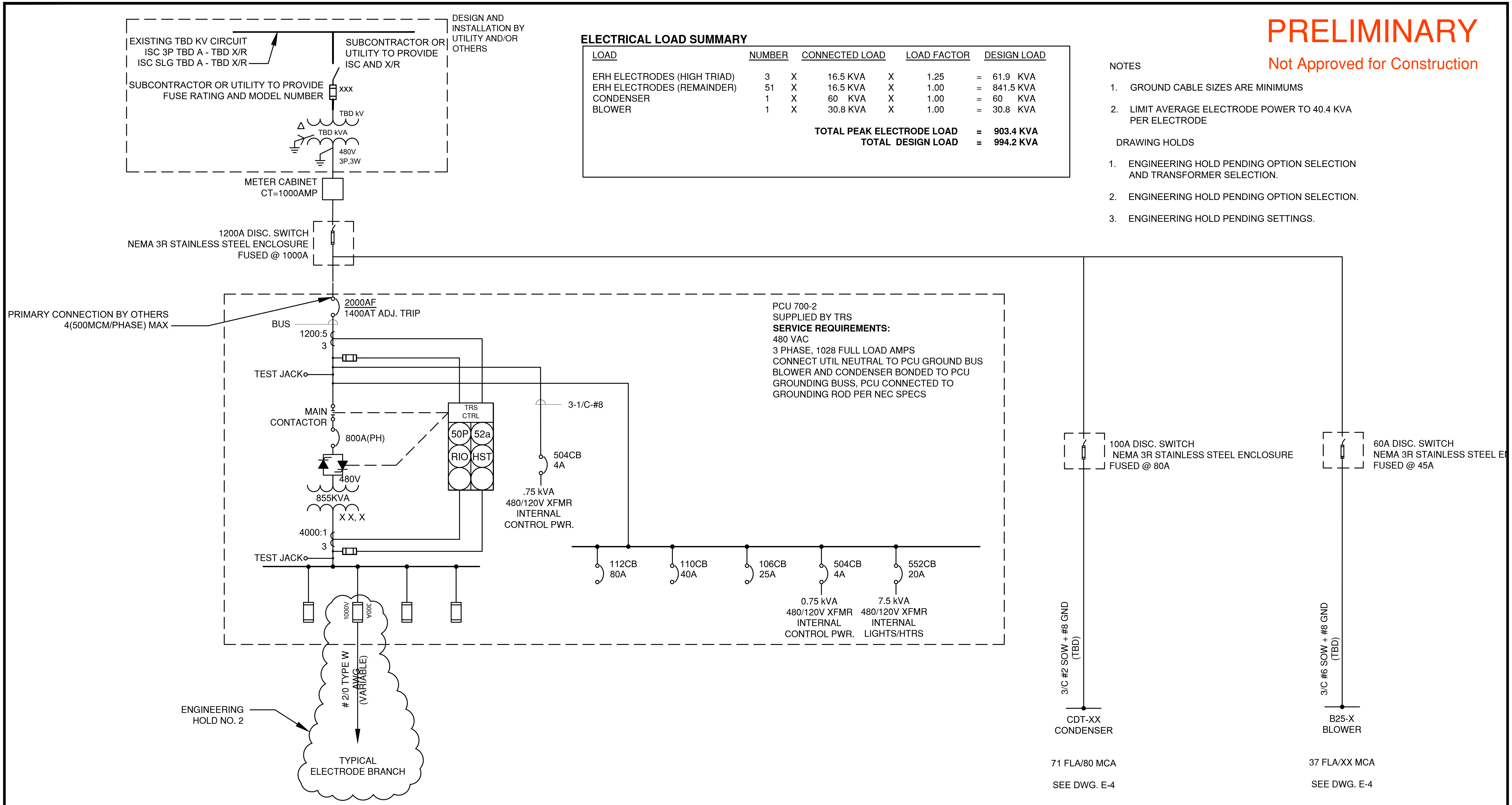
ELECTRICAL ONE-LINE REQUIREMENTS

APPROVED FOR CONSTRUCTION
BY ____________________
DATE ____________________

DATE 2020.MAY.15
PROJECT WA.RAI.2136
SHEET E-2

PRELIMINARY

Not Approved for Construction



PCU 700-2
SUPPLIED BY TRS
SERVICE REQUIREMENTS:
480 VAC
3 PHASE, 1028 FULL LOAD AMPS
CONNECT UTIL NEUTRAL TO PCU GROUND BUS
BLOWER AND CONDENSER BONDED TO PCU
GROUNDING BUSS, PCU CONNECTED TO
GROUNDING ROD PER NEC SPECS

ELECTRICAL LOAD SUMMARY

LOAD	NUMBER		CONNECTED LOAD		LOAD FACTOR		DESIGN LOAD
ERH ELECTRODES (HIGH TRIAD)	3	X	16.5 KVA	X	1.25	=	61.9 KVA
ERH ELECTRODES (REMAINDER)	51	X	16.5 KVA	X	1.00	=	841.5 KVA
CONDENSER	1	X	60 KVA	X	1.00	=	60 KVA
BLOWER	1	X	30.8 KVA	X	1.00	=	30.8 KVA

TOTAL PEAK ELECTRODE LOAD = 903.4 KVA
TOTAL DESIGN LOAD = 994.2 KVA

NOTES

1. GROUND CABLE SIZES ARE MINIMUMS
2. LIMIT AVERAGE ELECTRODE POWER TO 40.4 KVA PER ELECTRODE

DRAWING HOLDS

1. ENGINEERING HOLD PENDING OPTION SELECTION AND TRANSFORMER SELECTION.
2. ENGINEERING HOLD PENDING OPTION SELECTION.
3. ENGINEERING HOLD PENDING SETTINGS.

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DRAWN BY A. PEABODY
CHECKED BY PENDING APPROVAL
PROJECT MANAGER TRS PERSONNEL
QSAT REVIEW xx/xx/xx

SITE RANIER MALL PROPERTY
LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

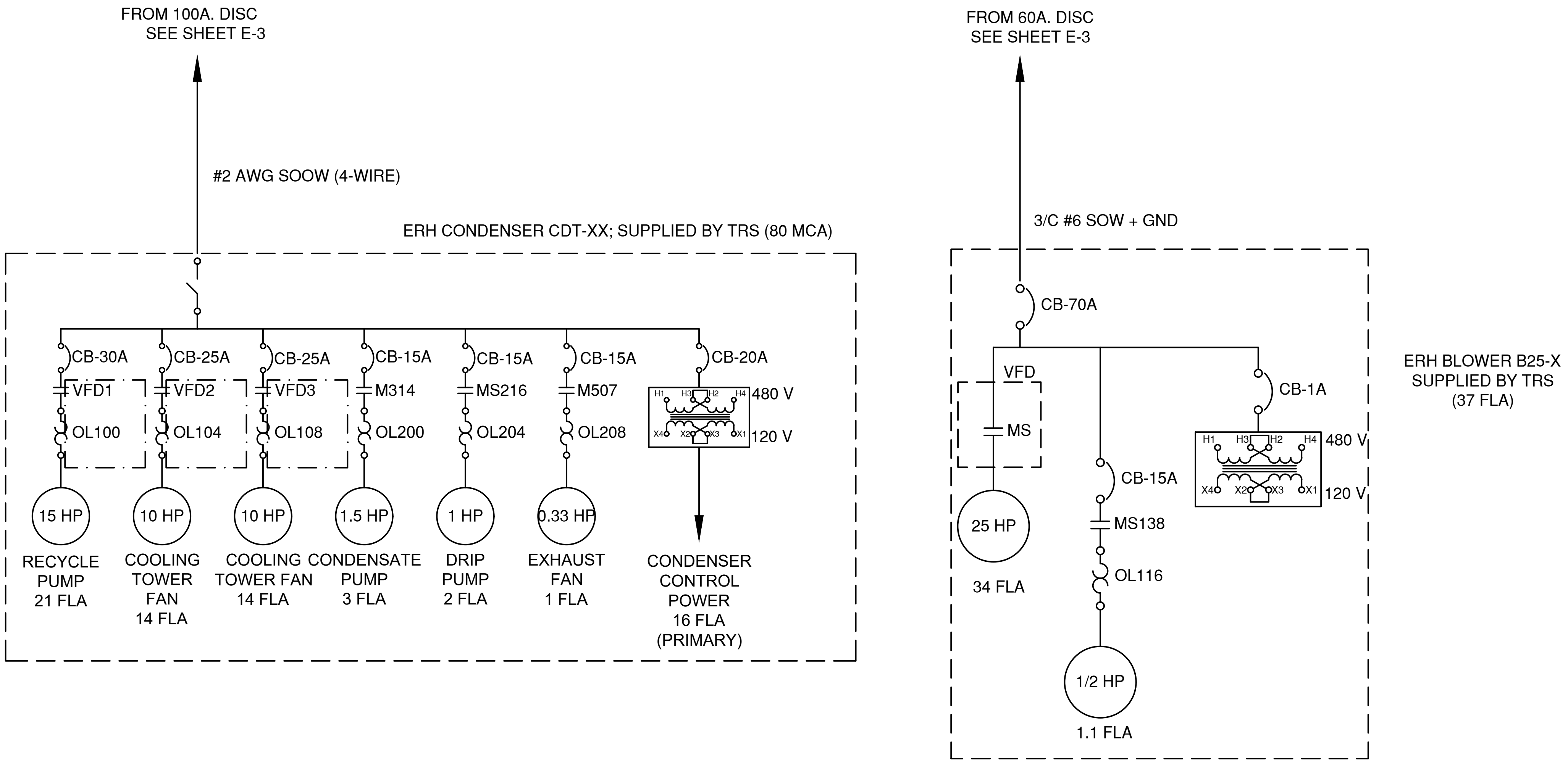
ELECTRICAL ONE-LINE DIAGRAM

APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2020.MAY.15
PROJECT WA.RAI.2136
SHEET E-3

PRELIMINARY

Not Approved for Construction



TRS Accelerating Value

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LOCATION SEATTLE, WASHINGTON
CLIENT CLIENT NAME

ELECTRICAL ONE-LINE DIAGRAM

APPROVED FOR CONSTRUCTION
BY
DATE

DATE 2020.MAY.15
PROJECT WA.RAI.2136
SHEET E-4

Appendix D: TRS Soil and Groundwater Sampling Protocols for ERH

STANDARD OPERATING PROCEDURE

PROCEDURE
No: 3.2

Procedure Title:

HOT SOIL SAMPLING

Author:	TRS Team	**Issue Date:**	4/22/08

Revisions:

Date	Initials	Revision Description	Revision #
01-04-10	LS	Add Scope, responsibilities, training, definitions, recordkeeping	1
5-6-14	TP	Added caution concerning hot water, steam expulsion	2
2-22-16	TP	Review, revised power off requirement	3
12-4-17	GK	Removed Geoprobe® Dual-Tube Sampler reference and revised determination for use of Teflon liners.	4
12-02-19	GK	Added section on hot sampling with sonic drill rig	5

Reviewed and Approved by (initial and date):

SOP/ Revision #	Safety & Quality	Engineering
Original	4/22/08	4/22/08
REV 1	1/4/10	1/4/10
REV 2	5/6/14	5/6/14
REV 3	2/24/16	2/22/16
REV 4	12/4/17	12/6/17
REV 5	12/2/2019	12/2/2019

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a procedure for the safe collection of representative soil samples during, or after, the application of *in situ* thermal remediation (ISTR) technologies.

2.0 SCOPE

This SOP serves as a guideline for the collection of soil samples during, or after, the application of ISTR. To minimize the risk due to electrical hazards, lockout/tagout (LOTO) procedures must be applied to the ISTR power control unit (PCU) throughout the duration of the soil sampling effort. Only authorized persons trained in procedures and requirements described in SOP 1.1 are permitted to conduct LOTO on TRS equipment. Samples collected using this SOP are generally used for evaluating treatment effectiveness, and/or confirming treatment goals have been met.

TRS Group, Inc. (TRS) personnel shall use this procedure in conjunction with site-specific sample analysis plans and permit requirements. These are standard (i.e., typically applicable) operating procedures, which may be varied or changed as required, dependent on site conditions, equipment limitations, permit requirements, or limitations imposed by the procedure. The ultimate procedures, including any deviations from this SOP, shall be documented in the soil sampling form.

3.0 DEFINITIONS

Authorized Employee

> Any designated employee who locks out or tags out equipment to perform servicing or maintenance. This person must have completed the mandatory LOTO training described in SOP 1.1 LOTO to be qualified as an authorized worker. Only an authorized worker installs and removes his or her own lock and tag as required by this program.

Competent Person

> Any designated employee who has been trained in proper procedures for the application of ISTR to the subsurface at remediation sites.

ISTR – In Situ Thermal Remediation

> A process whereby soil and groundwater are heated to the desired temperature to volatilize the target contaminants. Some ISTR technologies are electrical resistance heating (ERH), thermal conduction heating (TCH), and steam enhanced extraction (SEE).

LOTO – Lockout/Tagout

> The practice of using a tag for visibility and awareness in conjunction with placement of a keyed device ("lock") on an energy isolating device, in accordance with SOP 1.1, to prevent the unwanted activation of mechanical or electrical equipment. Lockout ensures the equipment being controlled cannot be operated until the lock is removed.

4.0 EQUIPMENT LIST

1) Soil Sampling Field Form and pen (recommend indelible).
2) Drill rig and related equipment. Soil sampling is best achieved using a direct push drill rig such as a Geoprobe®. Alternative types of drilling methods are hollow stem auger (HSA) or rotosonic (sonic).

3) Ice bath for soil samples. An example is a cooler filled with ice. The cooler (or container) must be equipped with an opening at the bottom to allow water from melting ice to drain.

4) Standard cooking thermometer. Calibrated to both zero (0) degrees Celsius (°C) and 100°C (an infrared thermometer can be substituted when sampling denser soils or bedrock. Keep in mind the sample tube will likely be a few degrees cooler than the internal temperature of the sample).
5) LOTO equipment as described in TRS SOP 1.1.
6) Sample containers, labels, and chain-of-custody forms (as required by the laboratory for the analysis).
7) Safety Glasses with side shields. Additional option: full face-shield (wear over safety glasses).
8) Hearing protection adequate for sampling equipment decibel level. Refer to site-specific Health and Safety Plan (HASP).
9) Latex or nitrile gloves. Additional option: cotton or leather outer gloves (wear over inner latex gloves).
10) Site-specific personal protective equipment (PPE) requirements. Refer to site-specific HASP.
11) Packaging material, chain-of-custody seals, and shipping labels.

5.0 HOT SOIL SAMPLING PROCEDURES

A soil-sampling event begins with the shutdown and application of LOTO to the PCU. This is done to prevent any electrical hazards between the steel drill string and sampling personnel. The vapor recovery system should continue to operate to maintain capture of steam in the subsurface, rather than allowing it to exit through the sample borehole. Interim and final soil sampling is best achieved using a direct push drill rig such as a Geoprobe®. As the probe casing is extracted from the subsurface, it should be considered to be very hot, and handled with proper precaution and personal protective equipment.

Choose a sample sleeve compatible with the conditions being encountered. For example, if the sample location temperature is elevated above 100°C, then a stainless steel sleeve will be a better choice than a Teflon sleeve as the Teflon sleeve will become soft and deform at elevated temperatures. Consult engineering for the appropriate sleeve. Teflon sleeves are only recommended for sampling when expected subsurface temperatures will be at or below 70°C.

Note: sample sleeves can be custom fabricated if supplier inventories are inadequate. Please contact equipment@thermalrs.com if additional resources are needed to procure sampling sleeves.

5.1 Safety Considerations

There are certain hazards associated with the application of ISTR to contaminated soil and groundwater. These hazards include possible contact with hazardous voltages, steam, hot water, hot soil, other hot surfaces, and/or hazardous chemicals. Exposure to these hazards can be mitigated through engineering controls and strict adherence to documented procedures and safety protocols such as the following restrictions:

- The ISTR PCU system must be turned off and LOTO applied during soil sampling activities. Only trained and authorized TRS personnel can perform LOTO of ISTR equipment.
- High temperatures, hot water, and steam may be encountered when collecting subsurface soil samples; the use of the proper PPE is mandatory and caution is advised.
- Contaminant vapors may be present at the borehole during sampling.
- Personnel shall be trained on hazards and engineering controls associated with drilling before beginning sampling operations. Potential hazards include rotating equipment, overhead loads, and slips trips and falls.

Refer to the site-specific Sampling and Analysis Plan (SAP) and HASP for site-specific requirements and restrictions.

Caution: Exposure to hot groundwater and steam possible

The removal of water and soil from the sample borehole can change the temperature/pressure equilibrium conditions existing within the borehole prior to drilling and sampling by reducing the hydrostatic head in the borehole, allowing hot water and steam to eject from the borehole. Review the site conditions prior to commencing drilling or boring. If sampling soil beneath the groundwater surface level elevation, always remove the boring equipment and samples slowly from the boring to allow the borehole conditions to safely re-equilibrate.

Stop and complete the attached Site Sampling Evaluation Checklist before proceeding with this procedure.

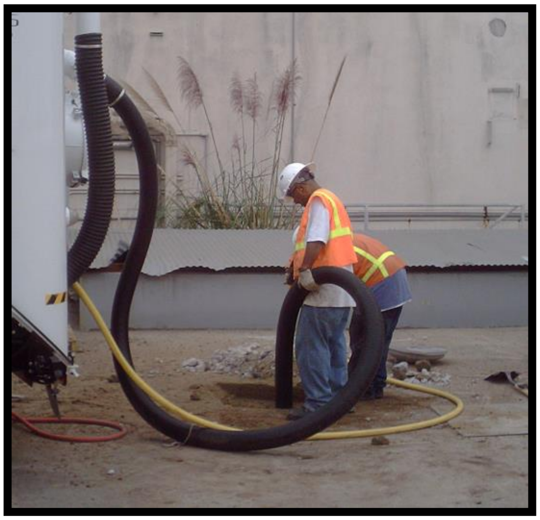
5.2 Hot Soil Sampling Procedures

Whenever possible, sampling shall be completed in order from sample locations having the lowest anticipated concentrations of contaminants of concern (COCs) to locations having the highest anticipated COC concentrations (i.e.; outside treatment area, treatment area boundary, locations within the source area). The steps outlined below must be followed for iterative, interim, and/or final hot soil sampling.

Contact the TRS Project Manager (PM) the day prior to sampling to coordinate a shutdown. A shutdown period of 4 hours is preferred prior to soil sampling.

1) An authorized person shall apply LOTO to the ISTR PCU by site-specific instructions. Note: Only personnel who have been trained and certified by TRS in LOTO procedures can complete this procedure.
2) Position drill rig in the area to be sampled and perform a visual check for any safety concerns. Potential concerns include: high voltage lines, uneven terrain, underground utilities, and egress limitations with rig placement.

3) Hand auger or air knife the first five (5) feet of the boring to clear the location for potential buried utilities.



4) Advance the push sampler to the depth required and collect samples. If subsurface temperatures are expected to be greater than 70°C, the sample sleeves used must be made of brass or stainless steel. Sample sleeves made of acrylic or other materials can melt and bias sample results.

5) The sample sleeves must be capped immediately and placed into the ice bath to begin the cool-down process. Water from melting ice must be allowed to drain, as the sample sleeves should not be submerged at any time.

6) The sample sleeves should be cooled until the soil nears ambient temperature (approximately 20°C or 70 degrees Fahrenheit [°F]). A standard cooking thermometer can be inserted through the end cap for temperature monitoring. The sample sleeve may be opened and sampled once near-ambient temperatures have been reached. Soil samples, including quality control (QC) samples, are collected, labeled, preserved, and shipped per the site-specific SAP.
7) Plugging/sealing of the soil borehole will be in accordance with Federal, State, and/or Local regulatory and client requirements.
8) Soil cuttings not consumed in the sampling process will be disposed of according to Federal, State, and/or Local regulatory and client requirements.

6.0 Hot Soil Sampling Using Rotosonic Method

The procedures for hot soil sampling with a Sonic rig are similar to the steps outlined in **Section 5.2**, except for the following deviations:

- Sonic drilling methods produce large soil cores, 4 to 6 inches in diameter. Cool the cores in a large trough of ice, with drainage of melt water. Ice consumption may range from 500-1,000 pounds per day depending on soil temperature, ambient temperature, and soil core production rate.
- In ambient temperature soil conditions, Sonic drilling methods use a low-density polyethylene (LDPE) sleeve to recover soil cores from the Sonic rig sample apparatus. The LDPE bags used for

this method of sample retrieval are typically only rated for temperatures below 90°C, therefore liners must be used with additional precautions:

  - Cool the exterior of the sonic barrel with a garden hose prior to contact with the LDPE liner and extraction of the soil core. It is recommended to double-bag hot soil cores in the LDPE liners. Have an ice bath ready for immediate cooling of the soil cores.
  - Direct contact with ice below and above the bagged soil core cools the soil cores in approximately 1 hour. Additional plastic may be preferred to further eliminate risk of cross contamination but does slow the cooling rate.

- For sampling at ISTR sites where soil temperatures are greater than 90°C, lexan polycarbonate liners (or equivalent) are an alternative. Lexan polycarbonate is rated to approximately 130°C.
- Some subsurface conditions may make the lexan polycarbonate liners prohibitive.
- Verify with the drilling subcontractor that a second sample core barrel is available to maintain production while the first sample core barrel is cooling and during core extraction.
- Extreme caution will be exercised in cutting the lexan polycarbonate liners when the soil core is ready to be sampled.

7.0 RESPONSIBILITIES

Role	Responsibility
VP Operations	• Develop and implement SOPs • Periodically review and update procedures based on project feedback • Provide training and maintain training documentation
TRS Safety & Quality Manager	• Assist VP Operations with providing training and maintaining training documentation. • Assist Site Health and Safety Officer (SHSO) with modifying SOP to meet site-specific HASP requirements.
PM	• Review procedures in conjunction with site-specific sample requirements and scope of work (SOW). Coordinate changes to procedures as necessary. • Schedule and coordinate sampling effort. Ensure adequate supplies are available.
SHSO	• Conduct orientations for subcontractors and employees • Coordinate training needs with TRS SQM • Review procedures in conjunction with site-specific HASP. Coordinate changes to procedures as necessary to maintain safe working procedures.
Sampling Personnel	• Complete training to the level of competent person prior to initiating sampling activities. • Follow procedures and document information related to soil sampling effort as identified in this SOP, including and deviations from the SOP.

8.0 TRAINING

Training in SOPs is provided upon initial assignment and annually thereafter. Additional retraining is provided if there is a change in procedures or if inadequacies are observed in the individual's application of procedures. Subcontractors must train their own employees. LOTO training requirements for personnel are outlined in SOP 1.1.

9.0 RECORD KEEPING

These are standard (i.e., typically applicable) procedures, which may be varied or changed as required dependent on site conditions, equipment limitations, permit requirements, or limitations imposed by the procedure. The ultimate procedures used during any sampling event, including any deviations from these procedures, shall be documented in the sample logbook.

At a minimum, the following information shall be maintained in the sample logbook related to hot soil sampling at ISTR sites:

- Date
- Sample identification and corresponding location
- Sample time
- Sample identifications and analysis to be performed
- Chain-of-custody number
- Shipping information
- Deviations from this SOP
- Any other information deemed relevant to the sample results

Copies of chain-of-custody forms and shipping documentation shall be maintained and kept with the sample logbook.

10.0 REFERENCES

TRS Group, Inc., 2013. SOP 1.1, Lockout/Tagout (LOTO), Most Recent Version.

US EPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, Most Recent Version (Method 5035)

SOP 3.2 Hot Soil Sampling

Training Acknowledgment

All personnel that receive training on this procedure will review and sign the acknowledgement form contained in this section.

I have been trained by TRS Group, Inc. (TRS) to perform hot soil sampling at TRS ISTR project sites. By signing this document, trainee acknowledges that SOP 3.2 Hot Soil Sampling has been read and the contents of the document are understood. Trainee has received hands-on training from a competent person who is authorized to use and instruct others on sampling procedures at TRS project sites.

Date	Trainee (print)	Trainee (Sign)	Trainer

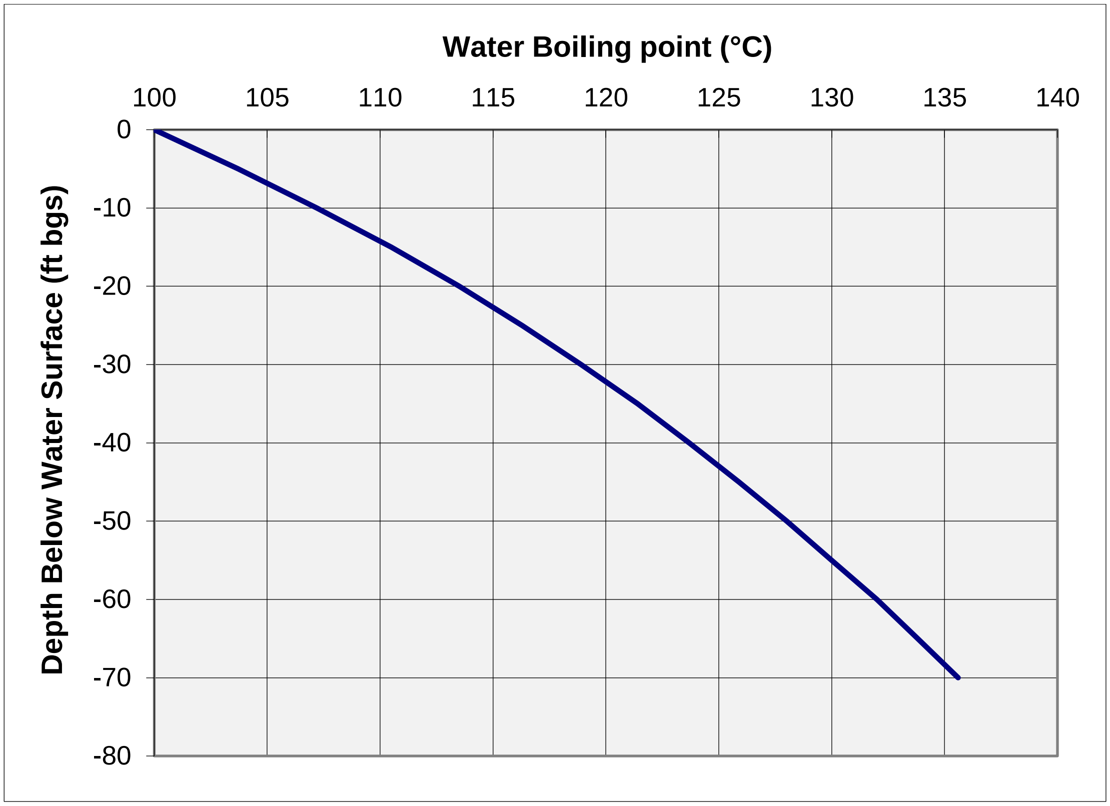
Site Sampling Evaluation Checklist

Project #: _________________

Date: ______________________

Subsurface Conditions

1) Are soil samples being recovered from beneath the groundwater surface?
2) What is the depth to groundwater at the time of sampling?
3) How deep below the groundwater surface elevation are we sampling?
4) What are the current temperatures at or near each boring location?
5) Are there confining layers on site? Clay or silt over saturated zone sand for example.
6) Use the figure below to determine where the sites actual temperatures fit on the boiling point curve.



7) Actual temperature for each depth elevation that is higher in value than the temperatures represented by this curve suggest a temperature value greater than the hydrostatic boiling point of water.

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STANDARD OPERATING PROCEDURE

PROCEDURE No: 3.1

Procedure Title:

Hot Groundwater Sampling

Author: TRS Team

Issue Date: 4/22/08

Revisions:

Date	Initials	Revision Description	Revision #
12/15/14	TP	Annual Review, MW access caution	6
12/4/17	GK	Annual review; procedure updates	7
12/02/19	GK	Annual Review, revised sample rate to 0.2 L/m, added steam reference	8

Reviewed and Approved by (initial and date):

SOP/ Revision #	Safety & Quality		Engineering	
Original	4/22/08		4/22/08	
REV 5	7/27/12		7/27/12	
REV 6	1/21/16		1/21/16	
REV 7	12/4/17		12/4/17	
REV 8		12/2/2019		12/2/2019

TRS Accelerating Value	**STANDARD OPERATING PROCEDURE**	**PROCEDURE No: 3.11**

Procedure Title:

Hot Groundwater Sampling-DPT

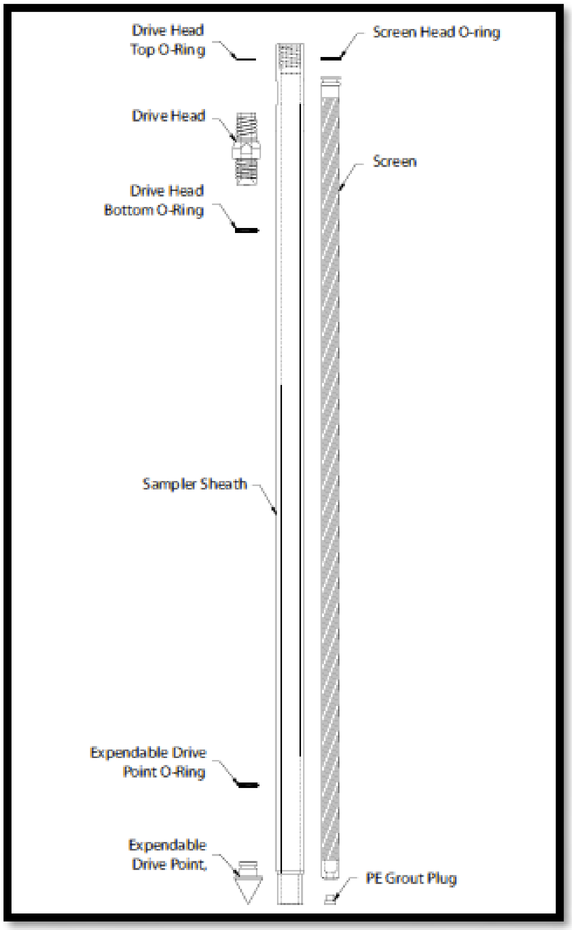
Author:	TRS Team	**Issue Date:**	8/4/16

Revisions:

Date	Initials	Revision Description	Revision #

Reviewed and Approved by (initial and date):

SOP/ Revision #	Health & Safety		Operations	
Original		8/4/2016	Thomas Powell	8/4/2016



1.0 PURPOSE

This standard operating procedure (SOP) provides uniform procedures for the safe collection of representative groundwater samples during or after the application of Electrical Resistance Heating (ERH) using direct push technology (DPT) to advance the sample screen to the desired depth. This procedure specifically addresses sampling of groundwater that has been heated during the ERH process.

2.0 SCOPE

This SOP provides guidance for the collection of groundwater samples during the application of ERH using modified low-flow sampling procedures in conjunction with the DPT screen advancement method. This SOP draws information primarily from the United States Environmental Protection Agency's (USEPA's) groundwater issue paper, Low-Flow (minimal drawdown) Ground-Water Sampling Procedure (Puls and Barcelona, 1996). Modifications to the EPA methodology have been made to accommodate groundwater temperatures that have been elevated as a result of ERH application. Only personnel trained to the minimum requirements outlined in Section 7.0 of this SOP are authorized to collect hot groundwater samples using this SOP.

The USEPA guidance document recommends continual monitoring of water levels during the purge and sample process to ensure that minimal drawdown is occurring (Puls and Barcelona, 1996). Due to the safety hazards associated with driving DPT sampling apparatus into the subsurface where heated groundwater is present, groundwater level measurements (depth to groundwater) will not be collected as part of hot groundwater sampling activities.

These procedures assume that new tubing will be used for each sample location. Samples collected using this SOP are generally used for optimizing system performance or may also be used for regulatory compliance and/or Site closure.

TRS Group, Inc. (TRS) personnel shall use this procedure in conjunction with site-specific Health and Safety Plans and any applicable sample analysis plans and/or permit requirements. These are standard (i.e., typically applicable) operating procedures that may be varied or changed as required, dependent on site conditions, equipment limitations, permit requirements, or limitations imposed by the procedure. The ultimate procedures, including any deviations from this SOP, shall be documented on the groundwater sampling form.

Since the procedure to drive a DPT sampling screen into the subsurface is similar to soil sampling procedures, under no circumstances will intrusive activities occur while ERH electrical power is being applied to the treatment volume. Refer to TRS SOP 1.1 Lockout/Tagout (TRS 2009), TRS SOP 3.2 Hot Soil Sampling (TRS 2008), the site-specific HASP, and consult with the Project Manager (PM) and Site Health and Safety Officer (SHSO) for additional site-specific requirements, restrictions, and/or additional information.

3.0 DEFINITIONS

Authorized employee – Any designated employee who locks out or tags out equipment in order to perform servicing or maintenance. This person must have completed the mandatory LOTO training described in SOP 1.1 LOTO to be qualified as an authorized worker. Only an authorized worker installs and removes his or her own lock and tag as required by this program.

Competent Person – Any designated employee who has been trained in proper procedures for the application of energy to the subsurface at ERH sites. This person must have completed the mandatory training outlined in **Section 7.0** to be qualified as a competent person.

ERH – Electrical Resistance Heating. ERH is a process whereby soils and groundwater are heated by passing an electrical current through the subsurface volume to be remediated.

DPT – a stainless steel and Teflon® *in situ* sampling tool that allows for the collection of representative groundwater samples without the installation of a groundwater monitoring well. The sampling screen is driven to the desired depth using DPT. Once at the desired sampling depth, the sampling screen is exposed and water is extracted from the temporary sampling location via tubing and above grade pump.

LOTO – Lockout/Tagout. The practice of using a tag for visibility and awareness in conjunction with placement of a keyed device ("lock") on an energy isolating device, in accordance with TRS SOP 1.1, Lockout/Tagout to prevent the unwanted activation of mechanical or electrical equipment. Lockout ensures the equipment being controlled cannot be operated until the lock is removed.

Low-Flow Purging – A USEPA approved purge-and-sample method used to minimize stress on the formation (minimal drawdown) which results in less mixing of stagnant casing water with formation water. Additional advantages of using low-flow purging methods include the following:

- Samples are more representative of actual contaminant loading.
- Disturbance at the sampling point is minimal which minimizes sampling artifacts.
- Less operator variability occurs between sampling events.
- Decreased amount of investigation-derived waste (IDW) is produced.
- Need for filtration is reduced.
- Sample consistency is increased.

Flow-rates during low-flow purging/sampling are site-specific, based on hydrology, but are generally in the order of 0.1 to 0.5 liters per minute (L/min). Proper screen location and screen length may impact the effectiveness of low-flow purging. (Puls and Barcelona, 1996)

Multi-probe and Flow-Through Cell – The flow through cell allows for in-line sampling of water quality parameters with a multi-probe to determine stabilization for water sampling. At a minimum, groundwater quality parameters include pH, conductivity, temperature, dissolved oxygen (DO), and turbidity. Examples of multi-probes used for collecting water quality parameters include the Horiba U-22 and YSI 556 (shown below).

Peristaltic Pump – A positive displacement pump used for pumping fluids. Generally, flexible tubing is fitted inside a circular pump casing. A rotor with a number of "rollers", "shoes" or "wipers" attached to the external circumference compresses the flexible tube. As the rotor turns, the part of tube under compression closes thus forcing the fluid to move through the tube.

SHSO – Site Health and Safety Officer

Trip Blank – The purpose of trip blanks it to identify any potential contamination of samples during sample handling and shipment. These blanks are prepared in the laboratory by filling a volatile organic analysis (VOA) bottle with distilled/deionized water. Trip blanks shall accompany shipment of empty bottles to the site and shipment of samples back to the laboratory.

VOA Vials – EPA recommended glass sample containers used to collect liquid samples for laboratory analysis. VOA vials have a nominal volume of 40 milliliters (mL) and are manufactured of clear or amber borosilicate glass. Depending on type of analysis being conducted, the VOA vials may contain small amounts of preservative when shipped from the laboratory. When collecting samples in VOA vials, fill the vial completely full (ensure that a meniscus has formed at the top of the vial before securing the cap) and check that there are no air bubbles in the closed sample. If there is a preservative present, use caution to not overfill the vial.

4.0 EQUIPMENT LIST

The required equipment for groundwater sampling may differ from this SOP based on the requirements set by the local regulatory oversight agency. Typically, the required equipment will be as follows:

1) Groundwater Sampling Field Form and indelible pen.
2) Safety Glasses with side shields and full face-shield (wear over safety glasses).
3) Hot water/Steam protective outer clothing (PVC rain gear is recommended).
4) Cotton Gloves with Latex (or equivalent) over-gloves. Cotton gloves should be worn to protect against water having high temperatures (wear under outer latex gloves). Leather gloves should be worn over sampling gloves when handling hot sampling equipment (i.e., DPT tubes).
5) Site-specific personal protective equipment (PPE) requirements. Refer to site specific HASP.
6) Peristaltic Pump.
7) Direct Push Technology (DPT) drill rig and associated equipment.
8) Geoprobe® SP-16 Groundwater Sampler assembly (or similar) and associated tools and supplies (stainless steel screens for this procedure are mandatory. Polyvinyl chloride (PVC)-type screens are not temperature rated for this application and are not acceptable). Associated equipment includes, but is not limited to:
    a) 1.5-inch probe rods,
    b) Drive and pull caps,
    c) Rod grip pull system,
    d) Drive head,
    e) Expendable drive points,
    f) Extension rods, quick links or couplers, and extension rod handle, and
    g) O-ring service kit.
9) Disposable Teflon™ and silicone tubing (Masterflex™) for use with the peristaltic pump. Silicone tubing should be used only above the ground surface at the pump head in order to minimize potential for degradation by contaminants. The silicone tubing is then connected to the Teflon™ tubing, which is lowered to depth within the DPT drive casing to the sampling screen. Tubing shall be replaced at each sampling location.
10) Power supply (12-volt automotive battery or similar, or portable generator).
11) Cooler with ample supply of ice.
12) 10-ft length of ¼-inch stainless steel or copper tubing.
13) One-ft length of four-inch diameter pipe.
14) Tray, bucket, or cooler for ice bath.
15) Field water quality measuring equipment w/flow-through cell or similar device for monitoring groundwater parameters (pH, conductivity, ORP, temperature, DO, etc.) and calibration standards.
16) Turbidity meter.
17) Empty buckets for purge water.

18) Sample containers (with preservative as required by the laboratory analytical method), labels, and chain-of-custody forms (as required by the laboratory for the analysis). Pre-printed labels are generally available from the laboratory if requested in advance.
19) Scissors or tubing cutter (for cutting tubing lengths).
20) Decontamination water and a non-phosphate detergent for decontamination of DPT sampling apparatus and components after each sample.
21) Packaging material, shipping containers (coolers), chain of custody forms, and shipping labels.
22) LOTO equipment as described in TRS SOP 1-1.

5.0 HOT GROUNDWATER SAMPLING PROCEDURES

A groundwater sampling event with DPT begins with the shutdown and application of LOTO of the ERH PCU in accordance with TRS SOP 1.1. This is required to prevent any electrical hazards between the steel drill string and sampling personnel. DPT sampling is best achieved using a DPT rig such as a Geoprobe® or similar. As the probe casing makes contact with the heated subsurface or is extracted from the subsurface, it should be considered to be very hot, and handled with proper precaution and use of the prescribed personal protective equipment (PPE). In addition, there is the potential for hazardous steam and/or hot water to be expulsed from the borehole due to changes in hydrostatic head of the soil bore during the extraction of advancement casings. To minimize the risk of expulsion of steam/soil/groundwater from the borehole during casing extraction, casing should be extracted at a significantly slower rate than at a non-heated site.

Groundwater purging is generally accepted as a required component of groundwater sampling in order to remove non-representative water from the well casing (Puls and Barcelona, 1996). Low-flow purging and sampling techniques will be used to minimize the impact on groundwater chemistry and collect representative samples. This technique also reduces the amount of investigation-derived waste (IDW) produced from a well.

5.1 Safety Considerations

There are certain hazards associated with ERH during the remediation of soil and groundwater. These hazardous include possible contact with hazardous voltage, steam, hot water, or hazardous chemicals. Exposure to these hazards can be mitigated through engineering controls and strict adherence to documented procedures and safety protocols, such as the following restrictions:

- The ERH PCU system must be turned off and LOTO applied during soil and/or groundwater sampling activities. Only trained and authorized TRS personnel are allowed to perform LOTO of ERH equipment.
- Extreme temperatures and steam may be encountered when collecting groundwater samples; the use of the proper personal protective equipment (PPE) is mandatory and caution is advised.
- Personnel shall be trained on hazards and engineering controls associated with drilling before beginning sampling operations. Potential hazards include rotating equipment, overhead loads, and slips, trips, and falls. Drilling equipment is to be operated only by trained drilling personnel.

- Personnel shall be trained on hazards and engineering controls associated with hot groundwater sampling. Potential hazards include steam, hot groundwater, hot mud/soil, and heated sampling equipment. Personnel should also be familiar with general site hazards identified in TRS SOP 3.1 Hot Groundwater Sampling, and TRS SOP 3.2 Hot Soil Sampling.

Refer to the site-specific Sampling and Analysis Plans (SAPs) and site-specific HASP for site-specific requirements and restrictions.

Caution: Exposure to hot groundwater and steam possible

The removal of water and steam from a DPT sampling screen can change the temperature/pressure equilibrium conditions existing in the subsurface prior to sampling by reducing the hydrostatic head in the borehole, allowing hot water and steam to flash within and along the outside of the sampling apparatus casing.

The stratigraphy of the Site can contribute to this issue. Sites with a semi-confined aquifer condition may present additional hazards because of the influence on hydrostatic head. Extreme caution should be used when driving the DPT sampling assembly into the water table and especially upon removal. The DPT assembly and drive casing should be removed at an extremely slow rate to minimize disturbance to the hydrostatic pressure within the borehole.

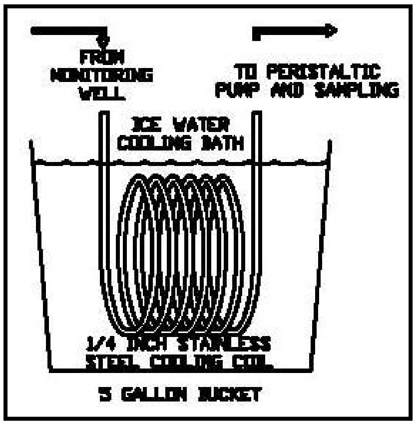
Stop and complete the attached Site Sampling Evaluation Checklist (attached) before proceeding with this procedure.

5.2 Ice Bath Construction

Groundwater heated through the ERH process presents both a potential safety hazard and a potential concern for collecting representative samples. If a boiling or near-boiling liquid is collected in a volatile organic analysis (VOA) vial, the formation of air bubbles as the sample cools within the VOA vial renders the sample non-representative. Additionally, hot liquids collected in the VOA vial may result in failure of the VOA septum.

The ice bath is designed to cool the groundwater prior to sample collection while limiting the impact on groundwater chemistry and contaminant concentrations. Cooling the groundwater prior to sample collection allows for both the safe handling of highly elevated water temperatures and prevents the formation of volatile organic compound (VOC) bubbles in the VOA vial after sample collection.

Prior to initial sampling, a cooling coil shall be constructed by wrapping a 10-ft length of ¼-inch stainless steel or copper tubing 6 full turns around a 4-inch diameter pipe. The ends of the tubing shall be fashioned such that both ends of the tubing extend upward, as shown in the figure below.



5.3 Peristaltic Pumps

Peristaltic pumps are used for purging and sampling wells that have a depth to water of approximately 20-ft bgs or less.

Each sample location will use a section of dedicated Teflon™ tubing for downhole use and a dedicated section of silicone tubing at the peristaltic pump.

The downhole end of the tubing shall be located in the middle or slightly above the middle of the screened interval. Placing the intake in the middle or near the middle of the screened interval, the amount of mixing between the overlaying stagnant casing water with the water within the screened interval is minimized. If the pump-intake is too close to the bottom of the well, increased entrainment of solids may occur. Pump-intake placement should only be used at the top of the water column in unconfined aquifers screened across the water table, where this is the required sampling point.

5.4 DPT Advancement

The TRS project team should coordinate, in advance, with all applicable parties to schedule an ERH system shutdown. The PM and SHSO shall determine a site-specific shutdown period. When possible, sampling shall be completed in order from the sampling locations anticipated to have the lowest concentrations of contaminants of concern (COC) to wells having the highest anticipated COC concentrations (usually from exterior wells to boundary control wells to wells located within the source area).

The TRS project team shall also determine the optimum pathways of approach for situating the DPT rig at the designated sample locations. ERH cabling and vapor recovery piping may need to be disconnected and removed to navigate the DPT rig to the sample locations. Interruption to the vapor recovery system may be required if removal of a section(s) of vapor recovery piping is required.

The DPT advancement procedure is as follows:

1) Cease power application to the treatment volume and perform LOTO procedures on the ERH PCU as required by site-specific protocols. Note: LOTO application shall only be completed by personnel who have been trained and certified by TRS according to SOP 1-1.
2) The drilling subcontractor will navigate and situate the DPT rig into position via the predetermined pathway to the desired sample location.

3) Proper PPE should be donned (i.e., face shield, leather gloves, hot water/steam protective clothing) at this time.

4) The drilling subcontractor will advance the DPT sample assembly into the subsurface. Additional casings are added incrementally and advanced until the desired sampling depth is reached. Advance the sampler with caution upon reaching the estimated water table depth.

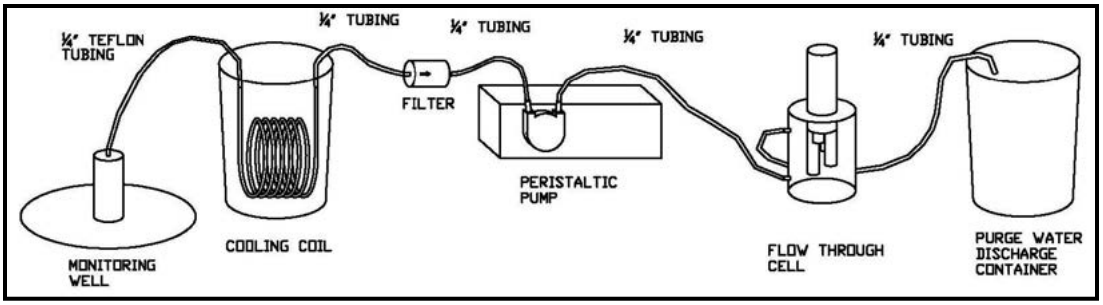
5) Using extension rods to keep the sample screen in place, the DPT assembly is retracted the distance of the screen length. Once the screen is exposed, remove the extension rods.

6) Proceed to **Section 5.5**, Groundwater sampling.

5.5 Groundwater Sampling

The groundwater sampling procedure is as follows:

1) At the start of the work day, calibrate probes used to monitor water quality parameters according to the manufacturer's instructions (as necessary). Calibration frequencies should adhere to the manufacturer's recommendations. Document all calibrations done to the probes used. Documentation should include: date, time, calibration solutions used, solution expiration dates, solution lot numbers, calibration results, outliers, and any illuminating comments.
2) The dedicated Teflon™ sample tubing will be inserted into the DPT drive casing until the approximate mid-point of the DPT sampling assembly screen is reached. Ensure tubing has entered the screen interval, tubing can catch at the top of the screen head simulating the feeling that the bottom of the screen has been reached.
3) Connect the sample tubing from the DPT sample screen to the inlet of the cooling coil and place the coil in a bucket or cooler with ice to form the ice bath as described in **Section 4.2**.
4) Connect the peristaltic pump tubing to a section of tubing connected to the outlet of the cooling coil. A filter can be placed between the cooling coil and the peristaltic pump if sample methods dictate filtering of sample.
5) Connect the peristaltic pump discharge tubing to a flow-through cell with the calibrated meter probes/sensors securely held in the flow-through cell.
6) Connect tubing from the discharge of the flow-through cell to the purge water collection bucket.



7) Begin purging the well at a low-flow rate. Target pumping rates should generally be in the order of 0.1 to 0.5 L/min to ensure stabilization of parameters and reduce mixing of formation water with stagnant borehole groundwater. (Puls and Barcelona, 1996). Depending on site parameters and pumping method used, maintaining a steady low-flow rate may require pumping up to a rate of 1 L/min. Adjustments to the pumping rate are best made within the first 15 minutes of purging to minimize purging time.

8) The pumping rate is recorded on purge data sheets every 3 to 5 minutes during purging. Any adjustments to the pumping rate are recorded. At the initiation of well purging and after recording pumping rates, water quality parameters are measured and recorded with a multi-parameter water quality meter equipped with a flow-through cell. The measured water quality parameters are temperature, turbidity, specific conductance, pH, DO, and oxygen reduction potential (ORP or Redox). Pumping shall continue until the water quality parameters have stabilized (refer to **Section 5.5.1**) or the minimum purge volume has been removed (refer to Section 5.4.2).

   After all water quality parameters have stabilized (refer to **Section 5.5.1**) and/or the minimum purge volume is purged (refer to **Section 5.5.2**), sampling may begin. If all parameters have stabilized, but turbidity remains above 10 nephelometric turbidity units (NTUs), decrease the pump rate and continue monitoring. If the pump rate cannot be reduced and turbidity remains above 10 NTUs, the information will be recorded and sampling initiated. For low yield wells, sampling commences as soon as the well has recovered sufficiently to collect the appropriate volume for the anticipated samples. If well purging has caused the well to become dry, refer to **Section 5.5.3** for sampling procedures.

9) Disconnect the tubing from the inlet side of the flow-through cell. The tubing from the pump outlet will be used to fill the groundwater sample bottles. Samples for VOCs shall be collected first followed by semi-volatile organic compounds (SVOCs). All other parameters should be collected in order from most volatile to least.

10) Groundwater samples including quality control (QC) samples are labeled and preserved per the site-specific Sampling and Analysis Plan (SAP).

11) All pertinent information will be documented in the sample log book and on the chain of custody forms including: date, time of sample, sample identification, analysis being completed, and any other information deemed relevant to the sample results. The following additional information shall be documented in the sample logbook: time at beginning and end of well purging, flow rate and any changes during the well purge, equipment used for well purge, and water quality parameter readings used to determine sample time.

12) Package and ship samples with a laboratory supplied trip blank to the offsite laboratory for analysis.

13) Meters, DPT sample apparatus, and drilling components used for groundwater sampling effort shall be decontaminated according to manufacturer recommendations. Dispose of decontamination liquids and purge water in accordance with site-specific documents.

5.5.1 Water Quality Parameters

Readings are recorded on the purge data sheets every 3 to 5 minutes. Field parameters are monitored until stabilization occurs. Unless local regulatory requirements differ, readings are generally considered stable when three consecutive readings are within the following criteria:

- Specific conductance readings within 3 percent;
- Redox potential within 10mV;
- pH within +/-0.1 standards units;
- Turbidity and DO readings within 10 percent.

5.5.2 Minimum Purge Volume

The purpose of low-flow purgin (or low stress approach) is to reduce the amount of water generated during this procedure. Generally, low-flow purging is considered to have been accomplished once the water quality parameters monitored have stabilized to within a 10 percent margin of error. The key to successful low-flow purging is minimize draw-down in the monitoring well (less than 0.33 feet). Purge flow rates are preferred to be between 0.1 and 0.5 L/min whenever possible, but rates up to 1.0 L/min are acceptable if hydrogeological conditions dictate. However, if the water quality parameters will not stabilize, a TRS established minimum purge volume will be used.

The minimum purge volume for the standard monitoring well purge approach is three times the static saturated well volume. To reduce investigative derived waste (IDW), the TRS minimum purge volume required when water quality parameters do not stabilize will be one well volume. The equation to calculate the minimum purge volume is:

$$V = 7.48*\pi r^2(td-dtw)$$

Where V = one purge volume in gallons; r= radius of well casing in feet; td = total depth of well in feet; dtw = typical depth to groundwater in feet.

5.5.3 Dry Borehole Sampling

If purging activities has caused the sampling borehole to become dry, the following procedures will be used to sample the well and allow for recharge:

1) A column of water is drawn in the cooling coil tubing with the pump.
2) The sample valve and the peristaltic pump inlet valve are closed and the pump shut off.
3) The cooling coil is disconnected from the sample valve.
4) The cooling coil is carefully removed from the ice bath.
5) The pump inlet valve is opened.
6) The sample is decanted into the sample vials from the pump end of the tubing via gravity flow.

The process is repeated until the sample volume is collected. Any other sample fractions (cations, anions) are sampled from the well end of the cooling coil tubing.

5.6 DPT Assembly Extraction and Grouting

The DPT sampling assembly can also be used to abandon the borehole during the casing extraction process. A removable plug allows for the deployment of grout through the drive casing into the subsurface, slowly filling the borehole with grout as the casing is removed from the borehole.

The DPT assembly extraction and grouting procedure is as follows:

1) Prepare grout to meet quantity and quality requirements specified by the borehole size, and local, state, federal, and/or other regulatory requirements**. Extreme caution should be exercised to minimize disturbance to the hydrostatic head within the borehole during the sealing process.**
2) Extract sample tubing from casing. Dispose of tubing as per site-specific requirements.
3) All extraction rates should be significantly slower than extraction rates used at non-heated sites. Carefully and slowly, raise the casing string to allow for the release the grout plug.

4) Advance the plug push adapter and extension rods down the casing string until the plug is reached. Apply pressure to extension rods until plug is released. Remove extension rods and plug push adapter form the casing string.
5) Attach grout nozzle to grout tubing and lower tubing into casing string until the bottom of the screen is reached. Connect grout tubing to grout pump.
6) As grout is pumped into the borehole, the casing string is slowly extracted from the subsurface. Each section of drive casing is removed as it clears the ground surface and allows for access to the threaded connections. Grouting ceases while the exposed casing section is removed. Coordinate grout pumping rates so grout fills the void at the speed the casing string is being extracted. Slower than average pumping rates are anticipated.
7) The drilling subcontractor will continue repeating the previous step until the DPT sample apparatus is extracted from the borehole. Extreme caution should be exercised to minimize disturbance to the hydrostatic head within the borehole during extraction. Extracted casings and DPT sample apparatus will be hot to the touch upon removal from the borehole.
8) Promptly clean all casings and DPT assembly to remove grout before it sets.
9) DPT assembly, casing, and components used in the sampling effort shall be decontaminated according to manufacturer recommendations after each sample location. Dispose of decontamination liquids and purge water in accordance with site-specific requirements.

6.0 RESPONSIBILITIES

Role	Responsibility
TRS Technical Group Lead	• Develop and implement SOPs • Periodically review and update procedures based on project feedback
TRS HSO	• Provide training and maintain training documentation. • Assist SHSO with modifying SOP to meet site-specific HASP and SAP requirements. • Work with PM to develop AHA for any intrusive work required to complete groundwater sampling efforts.
PM	• Review procedures in conjunction with site-specific SAP requirements and scope of work (SOW). Coordinate changes to procedures as necessary. • Schedule and coordinate sampling effort. Ensure adequate supplies are available. • Work with HSO to develop AHA for any intrusive work required to complete groundwater sampling efforts.
SHSO	• Conduct orientations for subcontractors and employees • Coordinate training needs with TRS HSO • Review procedures in conjunction with site-specific HASP. Coordinate changes to procedures as necessary to maintain safe working procedures.
Sampling Personnel	• Complete training to the level of competent person prior to initiating sampling activities. • Follow procedures and document information related to groundwater sampling effort as identified in this SOP, including and deviations from the SOP.

7.0 TRAINING

Training in SOPs is provided upon initial assignment and annually thereafter. Practical training is provided on a site-specific basis. Additional retraining is provided if there is a change in procedures or if inadequacies are observed in the individual’s application of procedures.

Competent persons in hot groundwater sampling are determined by the ERH PM and SHSO and must, at a minimum, complete the following requirements:

- Read this SOP (SOP 3.11) and understand the general process and the specific requirements of this SOP.
- Sign the training acknowledgement form.
- Obtain onsite instruction by a knowledgeable person on the task-specific hazards associated with hot groundwater sampling and the methods used to control these hazards.
- Obtain onsite instruction by a knowledgeable person on important technical components of the hot groundwater sampling program to ensure the collection of representative samples.

8.0 RECORD KEEPING

These are standard (i.e., typically applicable) procedures which may be varied or changed as required, dependent on Site conditions, equipment limitations, permit requirements, or limitations imposed by the procedure. The ultimate procedures used during any sampling event, including any deviations from these procedures, shall be documented in the sample logbook. AHA's developed for any intrusive work conducted in conjunction with this SOP shall be maintained with the groundwater sample logbook.

Calibrations of water quality meters used to measure water quality readings shall be completed according to the manufacturer's recommendations. Calibration results shall be maintained in a written log kept at the site throughout the operational phase of the project.

At a minimum, the following information shall be maintained in the sample logbook related to well purging and groundwater sample collection:

- Date;
- Sample/purge location identification;
- Depth of DPT sample apparatus and screened interval;
- Type of pump used for well purge;
- Duration of well purge;
- Sample time;
- Flow rate (including changes throughout purge);
- Meter(s) used for collection of water quality parameters and calibration documentation;
- Water quality parameter readings;
- Volume of purge water collected prior to sampling;
- Sample identifications and analysis to be performed;
- Chain of custody number;
- Shipping information;
- Procedure and material used for borehole plugging/sealing;
- Procedures used for equipment decontamination;
- Deviations from this SOP, and;
- Any other information deemed relevant to the sample results.

Copies of chains of custody forms and shipping documentation shall be maintained and kept with the sample log book.

9.0 REFERENCES

Puls, R.W. and M.J. Barcelona, 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure, EPA/540/S-95/504.

Yeskis, Douglas and Zavala, Bernard, 2002, Ground Water Sampling Guidelines for Superfund and RCRA Project Managers, EPA/542-S-02-001.

Vail, Jonathon, France, Danny, and Lewis, Bobby, 2013, SESD Operating Procedure Groundwater Sampling, EPA Region 4/SESDPROC-301-R3.

Geoprobe®, 2006, Geoprobe® Screen Point 16 Groundwater Sampler, Standard Operating Procedure, Technical Bulletin No. MK3142.

Edge, Russel W., and Cordry, Ken, 1989, The DPT: An *In Situ* Sampling Tool for Collecting Groundwater from Unconsolidated Sediments.

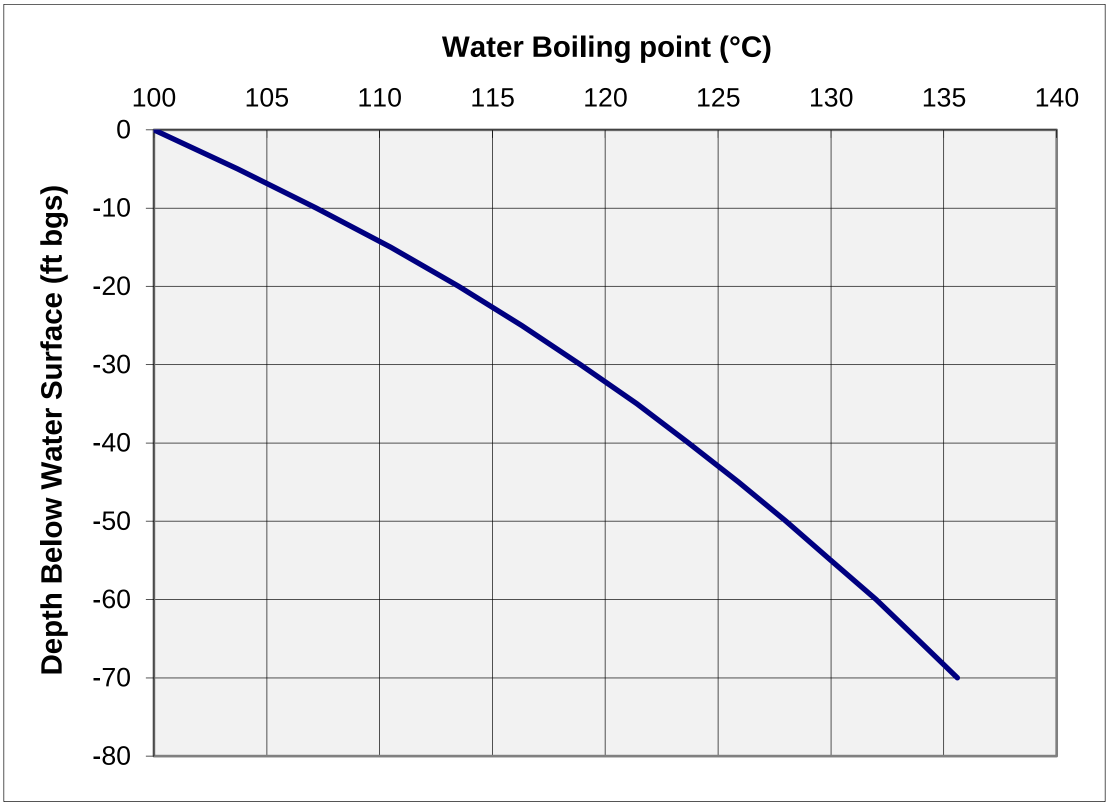
Site Sampling Evaluation Checklist

Project #: ________________

Date: ______________________

Subsurface Conditions

1) What is the anticipated depth to groundwater at the time of sampling?
2) How deep below the groundwater surface elevation are the screens?
3) What are the current temperatures at or near each boring location?
4) Are there confining layers on site? Clay or silt over saturated zone sand for example.
5) Use the figure below to determine where the site's actual temperatures fit on the boiling point curve.



6) Actual temperature for each depth elevation that is higher in value than the temperatures represented by this curve suggest a temperature value greater than the hydrostatic boiling point of water.

SOP 3.11 Hot Groundwater Sampling-DPT Training Acknowledgment

All personnel that receive training on this procedure will review and sign the acknowledgement form contained in this section.

I have been trained by TRS Group, Inc. (TRS) to perform non-intrusive hot groundwater sampling at the SITE-SPECIFIC project site. By signing this document, trainee acknowledges that SOP 3.11 Hot Groundwater Sampling-DPT has been read and the contents of the document are understood. Trainee has received hands-on training from a competent person who is authorized to use and instruct others on sampling procedures at TRS project sites.

Date	Trainee (print)	Trainee (Sign)	Trainer

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Appendix E: Regenesis Information on ISCR/ERD Injection Products

REGENESIS

Proposal for Site Remedy

To: Richard Martin Ground Water **June 30, 2020**
richard.martin.gw@gmail.com

From: Craig Sandefur, Andrew Punsoni
csandefur@regenesis.com apunsoni@regnesis.com 503.504.1399

Subject: ***Preliminary Design and Cost Estimate Proposal***

Site: *Rainier Mall*
Seattle WA

Treatment Unit: Treatment Unit

Applicable Products	**Links to View/Download Product Information**
3-D Microemulsion® Factory Emulsified	3-D Microemulsion - Factory Emulsified
Bio-Dechlor INOCULUM® Plus	BDI Plus
S-MicroZVI	S-MicroZVI

Technical and Cost Summary

The following is a preliminary remedial design for the above-referenced site. Based on the site data provided, the preliminary design and cost estimate includes the combined application of 3-D MicroEmulsion® Factory Emulsified (3-D Microemulsion), Bio-Dechlor INOCULUM® Plus (BDI Plus) and S-MicroZVI® (SMZVI). to treat chlorinated solvents. The treatment areas are shown on the attached treatment map with text boxes summarizing relevant information for the remedial design. Design assumptions and technical specifications regarding the proposed design are contained on the attached tables behind the map. The following table provides a summary of pertinent information pertaining to the treatment areas, basic design elements and product cost.

Treatment Unit	Treatment Surface Area (sq ft)	Treatment Thickness (ft)	Cubic Yards (cy)	Technology	# of inject points	Product Quantity	Units	Injection Volume (gals)	Product Cost*
Treatment Unit	7,900	10	2,926	**3-D Microemulsion**	51	6,000	Lbs	17,975	$ 24,840
				BDI Plus	51	45	Liters	450	$ 8,910
				S-MicroZVI	51	6,000	Lbs	397	$ 43,800
							Estimated Tax and Freight	15%	$11,633
							Project Totals	***18,822***	***$ 89,183***

*****Tax and freight charges are estimated. Please contact Customer Service Department at 949-366-8000 for a shipping quote.**

Product Description and Use Rationale

The areas proposed for treatment is impacted by chlorinated VOCs. As such, we recommend enhanced anaerobic bioremediation in this/these areas with 3-D Microemulsion, an advanced technology designed specifically to enhance anaerobic bioremediation of chlorinated solvents. Enhanced anaerobic bioremediation is a method to accelerate the natural attenuation of chlorinated solvents by adding a fermentable carbon source to the subsurface. The carbon source is fermented by native microorganisms to produce hydrogen, which is utilized by native or introduced microorganisms to accelerate degradation of chlorinated hydrocarbons through a process called reductive dechlorination. Addition of 3-D Microemulsion is a cost-effective method to accelerate natural attenuation of the chlorinated compounds detected in the proposed treatment area.

3-D Microemulsion is engineered to be applied as a dilute suspension with unique subsurface distribution characteristics. Once emplaced in the subsurface, 3-D Microemulsion provides a controlled release of organic acids to the aquifer to stimulate reductive dechlorination in the aquifer for 2-3 years on average. 3-D Microemulsion incorporates the proven Hydrogen Release Compound (HRC®) patented technology in addition to an entirely new and unique molecule (patent pending) that is specifically designed to provide a sequential release of highly efficient electron donors.

We have also proposed application of BDI Plus, a natural microbial consortium containing species of Dehalococcoides sp. (DHC). This microbial consortium has been enriched to increase its ability to rapidly dechlorinate chlorinated ethenes (PCE, TCE, DCE and VC), chlorinated ethanes (e.g. 1,1,1 TCA and 1,1, DCA) and halomethanes (carbon tetrachloride and chloroform) during in situ bioremediation processes.

In many instances, populations of microbes responsible for reductive dechlorination will develop in situ after a period of time in the presence of a carbon source such as 3-D Microemulsion. Addition of BDI Plus will result in the direct application to the subsurface (i.e., seeding) of a bacterial population capable of complete reductive dechlorination to ethene. It is proposed here as an optional enhancement which may be beneficial toward the goal of reaching remedial objectives more quickly and/or minimizing the potential for temporary build up of daughter products (e.g., cis-1,2-DCE) in the dissolved phase, which is commonly observed during reductive dechlorination.

Additionally, for this site, we recommend addition of S-MicroZVI an ISCR delivered as a colloidal suspension 40% ZVI by weight in glycerol with a particle size of less than 5 microns. S-MicroZVI is manufactured using a state-of-the-art sulfidation process resulting in a particle coating which increases activation toward specific contaminants and extends performance longevity. S-MicroZVI destroys contaminants abiotically and applied to stimulate ISCR-enhanced bioremediation.

Conceptual Model and Treatment Area Technical Considerations

In generating this design proposal Regenesis relied upon professional judgment and site specific information provided by others. Using this information as input, we performed calculations based upon known chemical and geologic relationships to generate an estimate of the mass of product and subsurface placement required to affect remediation of the site. The attached design summary tables specify the assumptions used in preparation of this technical design. We request that these modeling input assumptions be verified by your firm prior to application.

REGENESIS developed this Scope of Work in reliance upon the data and professional judgments provided by those whom completed the earlier environmental site assessment(s). The fees and charges associated with the Scope of Work were generated through REGENESIS' proprietary formulas and thus may not conform to billing guidelines, constraints or other limits on fees. REGENESIS does not seek reimbursement directly from any government agency or any governmental reimbursement fund (the "Government"). In any circumstance where REGENESIS may serve as a supplier or subcontractor to an entity which seeks reimbursement from the Government for all or part of the services performed or products provided by REGENESIS, it is the sole responsibility of the entity seeking reimbursement to ensure the Scope of Work and associated charges are in compliance with and acceptable to the Government prior to submission. When serving as a supplier or subcontractor to an entity which seeks reimbursement from the Government, REGENESIS does not knowingly present or cause to be presented any claim for payment to the Government.

Application Guidance

We are recommending these products be applied in situ using a direct push technology (DPT) injection method. It is important that the materials be applied per the design, including material loading rates and injection point spacing specified, to the extent site conditions allow. A brief description of the application method is provided below along with links to application instructions for these products. Regenesis can assist with further site-specific application design information, as needed, upon notification that our proposed remedy is chosen for implementation.

	Description	Application Inst.	
Direct Push Injection	Direct push drilling rods are advanced to target depth. Reagent is injected through rods, evenly throughout the treatment zone.	3DME App Inst	BDI App Inst

Given the complexities associated with applications, it is recommended that a contractor with proven experience mixing and injecting the remediation products proposed for this project. As part of the selection process, it is suggested to question the application contractor on the following:

- Specific experience injecting the reagent proposed
- of the appropriate injection pump (type, pressure rating, flow rate, etc.)
- Use of in-line flow meters and pressure gauges
- In-line safety values for bleeding high pressure from injection lines
- Injection tooling for bottom up or top down application
- Other project specific tooling (i.e. air compressor)
- Distribution monitoring during injection

The contractor should provide a detailed log of field activities for the application process. This information is critical to the post-injection assessment of remediation performance across the site.

Performance Monitoring

We recommend groundwater samples be collected from select performance observation wells to evaluate enhanced reductive dechlorination processes. Ideally, wells from within and outside of the treatment area (i.e., upgradient and downgradient of the plume) should be sampled. A round of sampling should be conducted prior to treatment with 3-D Microemulsion to evaluate the baseline aquifer conditions. After 3-D Microemulsion has been installed into the subsurface, groundwater samples should be collected on a quarterly, or more frequent, basis. We recommend samples be collected using low-flow methods and analyzed for field redox parameters (pH, Temp, DO, ORP, turbidity). Additionally, submit representative samples to a qualified laboratory for analysis of: chemicals of concern, nitrate, total and dissolved iron and manganese, sulfate, COD, BOD (5 day) and dissolved gases (methane, ethane, ethene and CO2). If treating in or near a source area we recommend collecting and submitting for analysis, soil samples from the proposed treatment area just below the water table for the contaminants of concern. This is useful in estimating the amount of contamination that can continue to partition from the soil to the dissolved phase as new equilibriums are established post-application.

Closing

Please feel free to contact me if you need additional information or have any questions regarding our evaluation and/or this correspondence (contact info provided above). I will be following up with you in the near future regarding this proposal. We appreciate the opportunity and thank you for considering Regenesis as your remedial solution provider for this project.

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3-D Microemulsion®, S-MZVI®, BDI® Plus Application Design Summary

Treatment Unit		
Treatment Type	**Grid**	**BDI should be injected with anoxic water**
Treatment Areal Extent (sq ft)	7,900	
Spacing Within Rows (ft)	11	
Spacing Between Rows (ft)	14	
DPT Injection Points	51	
Top Application Depth (ft bgs)	25	**Field Mixing Ratios**
Bottom Application Depth (ft bgs)	35	3DME Concentrate per Pt (gals)
3DME to be Applied (lbs)	**6,000**	14
3DME to be Applied (gals)	719	Mix Water per Pt (gals)
3DME Mix %	4%	338
Volume Water (gals)	**17,256**	3DME Mix Volume per Pt (gals)
3DME Mix Volume (gals)	17,975	352
S-MZVI to be Applied (lbs)	**6,000**	S-MZVI Volume per Pt (gals)
S-MZVI Volume (gals)	397	8
BDI Plus to be Applied (L)	**45**	BDI Volume per Pt (L)
BDI Plus Mix Water Volume (gals)	450	0.9
Total Application Volume (gals)	**18,834**	Volume per pt (gals)
Estimated Radius of Injection (ft)	5.5	369
Prepared by:	**Andrew Punsoni**	Volume per vertical ft (gals)
Date:	**6/30/2020**	37

Technical Notes/Discussion

3DMe & S-MZVI may be co-injected. Volumes and points may be adjusted based on field conditions.

Assumptions/Qualifications

In generating this preliminary estimate, Regenesis relied upon professional judgment and site specific information provided by others. Using this information as input, we performed calculations based upon known chemical and geologic relationships to generate an estimate of the mass of product and subsurface placement required to affect remediation of the site.

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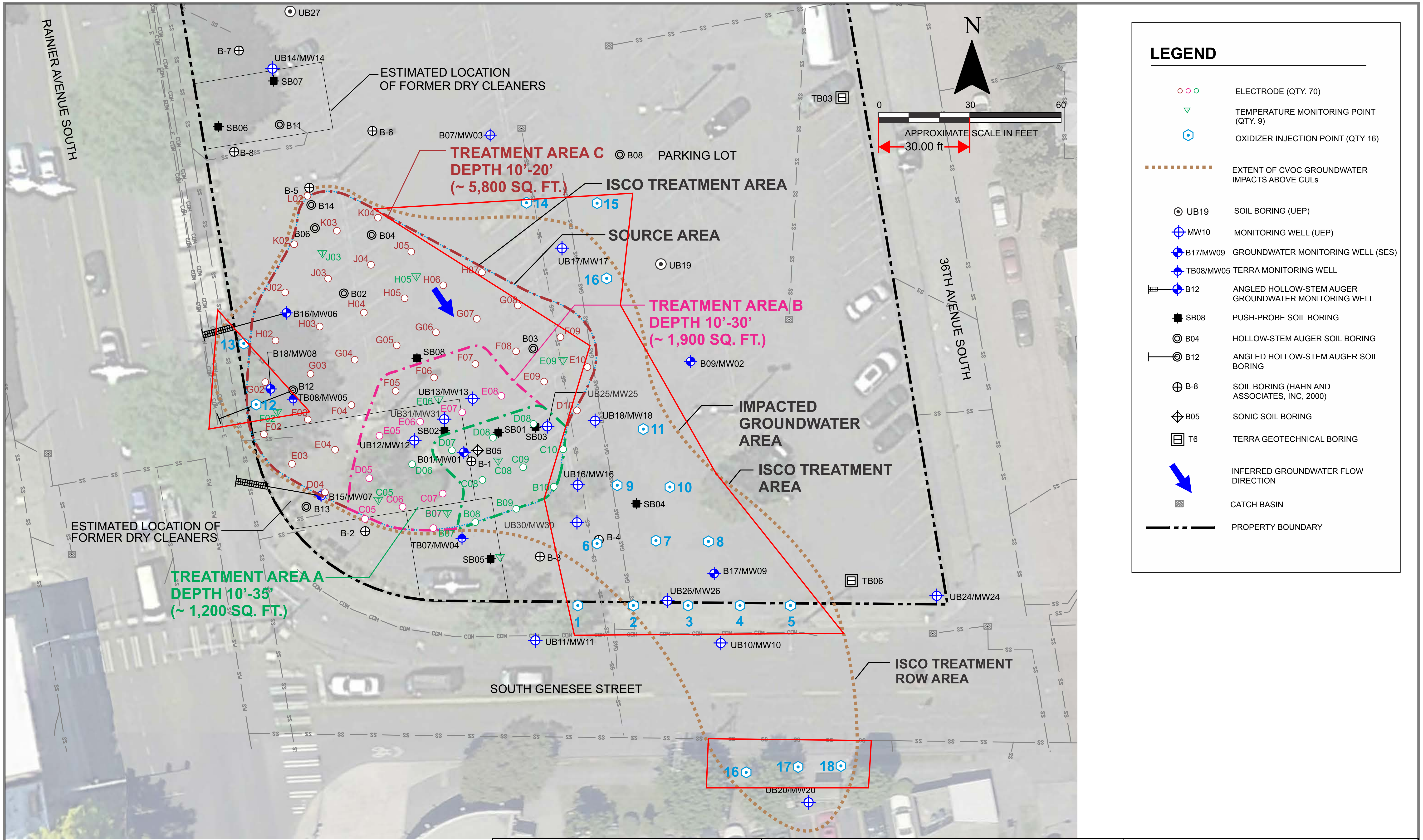

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Figure 19 - Alternative 4
ERH (Source Area) and
ISCO (Groundwater)

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ISCR-Enhanced Bioremediation

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S-MicroZVI®

Sulfidated Zero-Valent Iron

Summary

In Situ Chemical Reduction (ISCR) enhanced bioremediation is a remediation approach that combines zero valent iron (ZVI), an organic hydrogen donor, and contaminant-degrading microbes to degrade contaminants in soil and groundwater. This approach is most commonly used for chlorinated contaminants including chlorinated ethenes. ISCR-enhanced bioremediation is particularly effective because it stimulates anaerobic biological degradation by rapidly creating a reducing environment favorable to reductive dechlorination. Furthermore, ISCR-enhanced bioremediation may limit the formation of toxic daughter products such as cis-1,2-dichloroethene (*cis*-DCE) and vinyl chloride (VC) by degrading parent compounds abiotically, or via direct chemical reduction. This tech bulletin describes this remedial approach in more detail and showcases the performance of S-MicroZVI® a sulfidated zero-valent iron amendment developed by REGENESIS.

Background

In situ bioremediation is an established and cost-effective option for managing chlorinated groundwater contaminants. Traditionally, contaminants are treated by adding an organic hydrogen donor (e.g., fatty acids) and allowing anaerobic microbes (native or augmented) to convert the contaminants into harmless end-products. This strategy can be greatly enhanced by the addition of strong reducing agents like ZVI, which create favorable aquifer conditions for contaminant-degrading bacteria as well as directly reacting with many chlorinated compounds. This approach is referred to as ISCR-enhanced bioremediation. Regenesis offers S-MicroZVI® a sulfidated ZVI, which facilitates ISCR-enhanced bioremediation and owing to the sulfidation, is longer-lived and more reactive than standard ZVI. S-MicroZVI is a colloidal suspension containing 40% sulfidated ZVI (S-ZVI) by weight with < 5 µm iron particles suspended in food grade glycerol. S-MicroZVI is formulated to be easily injected, transport well in the subsurface during application and be long-lasting.

S-MicroZVI®
Sulfidated Zero-Valent Iron

Enhanced Reductive Dechlorination

Enhanced reductive dechlorination (ERD) describes the bioremediation of contaminants by anaerobic bacteria that are supported by the molecular hydrogen produced by fermentation of organic hydrogen donors. The biological degradation pathway for perchloroethene (PCE) and trichloroethene (TCE) is provided in **Figure 1.** This pathway, also known as hydrogenolysis, involves the sequential replacement of a chlorine atom with a hydrogen atom and is always accompanied by the formation of chlorinated intermediates. Many common anaerobic bacteria can transform PCE to TCE and then to *cis*-DCE, but only *Dehalococcoides ethenogenes* (DHC) is known to transform *cis*-DCE and VC to ethene.

Supplementing dechlorinating bacteria with zero-valent iron and organic hydrogen donors can enable more rapid and complete biodegradation. ZVI quickly deoxygenates groundwater and provides an electrochemically reducing environment that is highly fertile for the microbes involved in anaerobic bioremediation. In many situations this favorable environment can be sustained for several years.

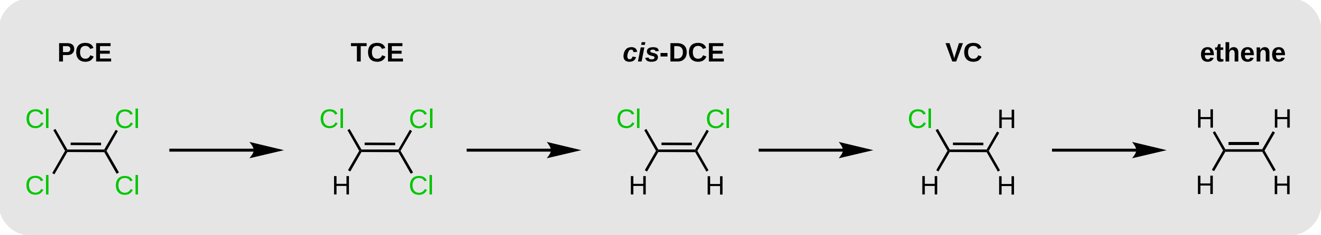

Figure 1. *Reductive dechlorination sequentially replaces chlorine atoms with hydrogen atoms. The intermediates cis-DCE and VC are more toxic than parent compounds PCE and TCE.*

Abiotic Degradation

Beyond the benefits of accelerated bioremediation, ZVI provides an abiotic degradation mechanism involving the direct reaction of ZVI with groundwater contaminants. The abiotic, beta-elimination pathway for chlorinated ethenes is shown in the bottom track of **Figure 2.** The beta-elimination pathway involves short-lived dichloroacetylene and chloroacetylene intermediates and bypasses the formation *cis*-DCE and VC intermediates. An ISCR-enhanced bioremediation approach can utilize both the reductive dechlorination and the beta-elimination pathways and reduce the observed concentrations of *cis*-DCE and VC relative to an approach using ERD alone.

Abiotic Degradation - Continued

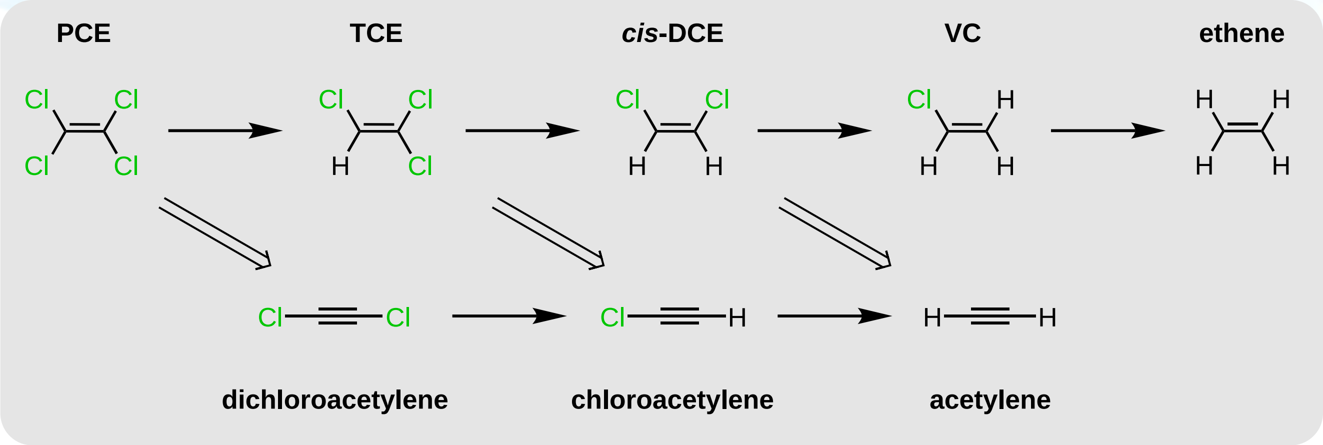

Figure 2. *ISCR-enhanced bioremediation allows the degradation of chlorinated contaminants by reductive dechlorination (single-line arrows) or beta-elimination (double-line arrows). Beta-elimination avoids the formation of cis-DCE and VC.*

When to Use ISCR-Enhanced Bioremediation

ISCR-enhanced bioremediation can be used to treat contaminants such as chlorinated solvents, haloalkanes, and chlorinated pesticides. Contaminants that are resistant to abiotic degradation (e.g.1,2-dichloroethane, dichloromethane) and compounds that can inhibit bioremediation (e.g. 1,1,1-trichloroethane, chloroform) may be effectively treated by ISCR-enhanced bioremediation. ISCR-enhanced bioremediation can be used for source zones, plumes, and barrier applications.

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Column Study Demonstrating ISCR-Enhanced Bioremediation

Study Objective:

The objective of this study was to demonstrate that the use of the combination of S-MZVI, dechlorinating bacteria, and an organic electron donor results in a more complete degradation of TCE with less formation of *cis*-DCE and VC compared to an approach using only dechlorinating bacteria and an electron donor.

Experimental Setup:

Three Omnifit™ columns, 25 mm in diameter and 500 mm in length, were dry-packed with medium-fine sand (200-500 µm), purged with carbon dioxide for 15 minutes, and filled with deoxygenated tap water. The column conditions were:

- **Sterile TCE control:** Column was sterilized with one pore volume (90 mL) of 200 mg/L sodium azide.

- **Biotic treatment:** One pore volume (90 mL) of deoxygenated lactate/nutrient solution (1000 mg/L sodium lactate, 10 mg/L nutrients) was flowed through the column. Next, an additional pore volume of dechlorinating bacteria solution (10^9 cells/L *Dehalococcoides ethenogenes*, 1000 mg/L lactate, 10 mg/L nutrients, prepared in deoxygenated water) was flowed through the column. The column flow was turned off for approximately 20 hours to allow the bacteria to acclimate.

- **ISCR-enhanced bioremediation treatment:** One pore volume (90 mL) of S-MicroZVI was flowed through the column as a dilute aqueous solution (1 % as iron). The column was then flushed with deoxygenated tap water until the effluent appeared clear. After this S-MicroZVI treatment, the column was prepared in the same manner as the Biotic control column described above.

After the conditioning, TCE was continuously flowed through all three columns as a 2 mg/L solution at a rate of one pore volume (90 mL) per week. The influent for the sterile control contained TCE as well as 200 mg/L sodium azide. The influent for the biotic control column and the ISCR-enhanced bioremediation column contained TCE as well as 100 mg/L lactate and 1 mg/L nutrients. Effluent samples from each column were collected weekly and analyzed by GC-MS for their TCE, *cis*-DCE, and VC concentrations.

Results & Discussion

The effluent concentration data from the columns are depicted in **Figure 3.**

The concentration of TCE in the sterile control trended upward for the first 10 pore volumes with no daughter products produced. The biotic column displayed conversion of TCE from the influent to *cis*-DCE and VC in the effluent. The ISCR-enhanced bioremediation column facilitated the complete removal of TCE from the effluent solution throughout the experiment. Some *cis*-DCE and VC were eluted during the first 7 pore volumes with a cumulative elution about 40% of the TCE eluted in the sterile column. After 7 pore volumes, no chlorinated ethenes were detected in the effluent solution. These results demonstrate the effectiveness of ISCR-enhanced bioremediation in promoting the complete degradation of TCE and limiting the formation of *cis*-DCE and VC.

Column Study Demonstrating ISCR-Enhanced Bioremediation - Continued

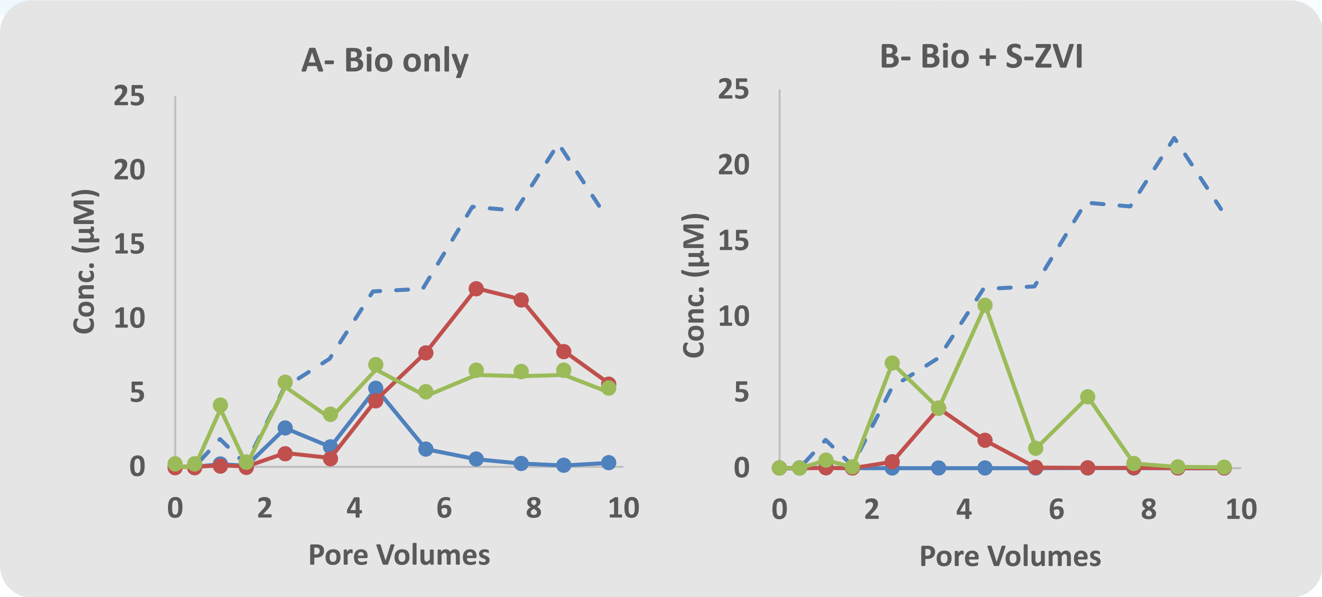

Figure 3. *Effluent concentration of chlorinated ethenes, A) Biotic Control and B) Biotic S-MicroZVI.*
Sterile TCE Control - - - *TCE* — *cDCE* — *VC* —

Conclusion

ISCR-enhanced bioremediation combines multiple degradation pathways to promote the rapid removal of chlorinated contaminants from solution. While chlorinated compounds can be slowly degraded using only an electron donor and dechlorinating bacteria, the addition of S-ZVI generates strongly anaerobic and reducing conditions that further enhance biologically-mediated ERD. The presence of S-ZVI also provides a secondary abiotic, beta-elimination pathway. The availability of multiple pathways allows the removal of parent compounds and lessens the potential for the formation of more toxic daughter products.

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Zerovalent Iron Electrochemical Fundamentals

Oxidation Half Reaction: $4\ Fe \rightarrow 4\ Fe^{+2} + 8\ e^-$

Reduction Half Reaction: $C_2Cl_4 + 4H^+ + 8\ e^- \rightarrow C_2H_4 + 4\ Cl^-$

Add these together

Balanced Redox Reaction: $4Fe + C_2Cl_4 + 4\ H^+ \rightarrow 4\ Fe^{+2} + C_2H_4 + 4\ Cl^-$

Redox reactions involve the oxidation of one species. The electrons supplied by the oxidation reaction are used to reduce another compound. An example is the reduction of PCE (C_2Cl_4) by zero valent iron (Fe). In this reaction, 4 atoms of iron are oxidized to supply eight electrons that are required to convert C_2Cl_4 to ethene (C_2H_4). The four protons (H+) that are required for the reduction reaction are supplied by the hydrolysis of water.

Another way to write this includes the hydrolysis reaction with water as a reactant and hydroxide as a product.

Oxidation Half Reaction: $4\ Fe \rightarrow 4\ Fe^{+2} + 8\ e^-$

Reduction Half Reaction: $C_2Cl_4 + 4H^+ + 8\ e^- \rightarrow C_2H_4 + 4\ Cl^-$

Hydrolysis Reaction: $4\ H_2O$ è $4H^+ + 4OH^-$

Balanced Redox Reaction: $4Fe + C_2Cl_4 + 4\ H_2O \rightarrow 4\ Fe^{+2} + C_2H_4 + 4\ Cl^- + 4\ OH^-$

Appendix F: Conceptual Remediation Schedule

Conceptual Remediation Schedule

	Task Name
1	**DESIGN WORK, POWER PERMITTING, INTEGRATION WITH DEVELOPMENT**
2	TRS Initiates ERH Design Work
3	SCL - Permit Application and Approval
4	TRS - 30% Design
5	TRS- FINAL DESIGN WORK
6	MILESTONE - Remedial Design Completion with ECOLOGY APPROVAL
7	SCL Builds Transformer and Installs Power Drop/Connection
8	ERH Remedy Plan Complete and Ecology Approved
9	TRS/ERH - Order Electrode Material and Wiring
10	
11	**GW PLUME - IN SITU CHEMICAL REDUCTION (ISCR)/ENHANCED REDUCTIVE DECHLORINATION (ERD)**
12	Pilot Test to Confirm Radius of Influence
13	Mobilize to Install injection Points
14	Install CMP MWs 34, 35, and 36
15	Inject mS-ZVI and 3DME
16	
17	**SOURCE AREA - IMPLEMENT ZVI/ELECTRICAL RESISTIVE HEATING/SOIL VAPOR EXTRACTION (ERH/SVE)**
18	UEP - Mobe: Water Supply, Decommi. MWs, Fencing, Remove Gas Line/Drums/Sewer
19	TRS - Mobe: Electrode Installation and Wiring SVE System Install
20	TRS - Installation of ERH Power Controls, Checks, Start Up
21	Quarterly GW Monitoring - Baseline before ERH/SVE; Post ISCR/ERD
22	ERH - Operations and Monitoring
23	Perimeter GW Quarterly Monitoring - MWs 02, 03, 04, 10, 11, 20, 30, and 36
24	ERH - Progress Monitoring (PM) at 90 degrees C-2 Soil and GW - MWs 25, 31, 34, and 35
25	ERH Opns "Deemed Complete by TRS" Based on Energy Use and Air/Vapor Checks
26	Post ERH Confirmation Monitoring - 4 GW - MWs
27	Post ISCR/ERD Confirmation Monitoring - xx GW - MWs
28	Ecology Review of GW Compliance Data
29	ERH Remediation Successful - Remdial Goals Achieved and Confirmed
30	Demobilization of ERH Equipment
31	Install Replacement GW Compliance Points
32	Electrode and Resource Well Decommissioning
33	
34	**COMPLIANCE GROUNDWATER MONITORING**
35	Quarterly GW Monitoring
36	POC - Quarterly GW Monitoring 1
37	POC - Quarterly GW Monitoring 2
38	POC - Quarterly GW Monitoring 3
39	POC - Quarterly GW Monitoring 4