Chevron Environmental Management Company

FINAL INTERIM ACTION WORK PLAN

Temple Distributing Carson Oil Site
808 South Columbus Avenue
Goldendale, Washington
Cleanup Site ID: 11985
Facility Site ID: 95474961

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Acronyms and Abbreviations

Arcadis	Arcadis U.S., Inc.
AST	aboveground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Cleanup Action Plan
CEMC	Chevron Environmental Management Company
COC	constituent of concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CUL	cleanup level
CUSA	Chevron U.S.A. Inc.
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
Ecology	Washington State Department of Ecology
EDB	ethylene dibromide
EDC	ethylene dichloride
EO	Enforcement Order No. DE 14134
°F	degrees Fahrenheit
LNAPL	light non-aqueous phase liquid
µg/L	microgram per liter
mg/kg	milligrams per kilogram
MTCA	Model Toxics Control Act
PCB	polychlorinated biphenyl
PLP	Potentially Liable Party
Property	Klickitat County Tax Parcel 04162132000100
QA/QC	quality assurance/quality control
RI/FS	Remedial Investigation/Feasibility Study
ROW	right-of-way
SEPA	State Environmental Policy Act

Site	all areas where hazardous substances originating from the Temple Distributing Carson Oil facility located at 808 South Columbus Avenue in Goldendale, Washington have come to be located.
TEE	terrestrial ecological evaluation
TGI	Technical Guidance Instruction
TPH-DRO	total petroleum hydrocarbons in the diesel range
TPH-GRO	total petroleum hydrocarbons in the gasoline range
TPH-HO	total petroleum hydrocarbons in the heavy oil range
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound
WAC	Washington Administrative Code

1 Introduction

On behalf of Chevron Environmental Management Company (CEMC), Temple Distributing, Temple Family Credit Shelter Trust, and Temple Family Survivor Trust, collectively referred to as the Potentially Liable Parties (PLPs), Arcadis U.S., Inc. (Arcadis) prepared this Final Action Work Plan (IAWP) for the Temple Distributing Carson Oil Site, located at 808 South Columbus Avenue, Goldendale, Washington (Site; Figure 1). CEMC manages environmental matters at the Site on behalf of Chevron U.S.A. Inc. (CUSA). This IAWP was prepared to comply with Enforcement Order No. DE 14134 (EO), effective April 28, 2017, issued by the Washington State Department of Ecology (Ecology [2017]).

The Site refers to all areas where hazardous substances originating from the Temple Distributing Carson Oil Site have come to be located. The Property refers to the former Temple Distributing Carson Oil Facility and is part of the overall Site.

1.1 Background

The PLPs submitted a Draft Remedial Investigation/Feasibility Study (Draft RI/FS; Arcadis 2020) on November 5, 2020, proposing Remedial Alternative 3 (targeted soil excavation) as the preferred remedial alternative for the remaining petroleum hydrocarbon impacts at the Site. The Draft RI/FS (Arcadis 2020) was a follow up to a prior document in which full-scale remedial excavation was proposed (Leidos Inc. 2019). Submission of a revised Draft RI/FS was agreed to by Ecology due to a change in the PLPs' consultant. In a letter dated January 20, 2021 (Ecology 2021), Ecology presented comments to the Draft RI/FS (Arcadis 2020) and requested a meeting to discuss cleanup options for the Site. Subsequent conference calls between Ecology, Arcadis, and CEMC were held on March 4, 11, and 17, 2021 to discuss the path forward for the Site. As a result of these calls, and as stated in a letter dated March 23, 2021 (Arcadis 2021), it was agreed that an interim remedial action (targeted source removal excavation) would be the next step at the Site, with an IAWP to be prepared. Performing this interim remedial action will allow for the removal of residual secondary source material containing the highest concentrations of petroleum constituents that may be continuing to impact perched groundwater at the Site, as well as allow for additional data collection that is necessary to further evaluate the potential groundwater exposure pathway.

1.2 Objectives

Ecology stated that it is appropriate to implement Remedial Alternative 3, as proposed in the Draft RI/FS (Arcadis 2020) as an interim remedial action. The specific objectives of this interim remedial action are presented below:

- Reduce the groundwater cleanup timeframe and the potential for direct soil contact by human and ecological receptors by excavating and disposing of site soil containing the highest concentrations of petroleum constituents.
- Obtain the additional data necessary to further evaluate the potential groundwater exposure pathway at the Site.

This IAWP addresses the portions of the Site with the greatest concentrations of petroleum hydrocarbons where excavation is practicable. The proposed interim action does not directly remediate perched groundwater outside of the footprint of the excavation or off-property impacts, although source area remediation at the Property is anticipated to have a beneficial effect on the cleanup of the entire Site.

1.3 Final Interim Action Work Plan Organization

The remaining sections of this IAWP are summarized below:

- *Section 2 – Site Background*. Describes the site, historical facilities, operations, and releases at the Site. Summarizes historical property ownership and regulatory actions, including the EO (Ecology 2017).
- *Section 3 – Nature and Extent of Contamination*. Describes constituents of concern (COCs) and remaining soil and groundwater impacts.
- *Section 4 – Conceptual Site Model*. Evaluates fate and transport, potential receptors, and potential exposure pathways.
- *Section 5 – Cleanup Standards*. Describes cleanup standards and development of cleanup levels (CULs) for soil and groundwater.
- *Section 6 – Proposed Interim Action*. Describes the components of the proposed interim action.
- *Section 7 – Remedial Implementation.* Presents remedial implementation components.
- *Section 8 – Other Potentially Applicable Requirements.* Describes regulatory requirements to be considered for the construction activities at the Site.
- *Section 9 – Performance and Compliance Monitoring.* Describes performance and compliance sampling to be conducted at the Site.
- *Section 10 – Reporting.* Describes documents to be submitted after excavation.
- *Section 11 – References*. Lists the references cited throughout this IAWP.

2 Site Background

Background information, including a description of the site, site historical information, and summary of the site environmental setting, is discussed below.

2.1 Site Description

The Property currently consists of Klickitat County Tax Parcel 04162132000100, which is a relatively flat lot approximately 0.85 acre in size. The Property contains a warehouse and office building, concrete pads, and underground piping infrastructure; and is currently unoccupied. Aboveground pumps and aboveground storage tanks (ASTs) have been removed (Figure 2).

The Property is bounded by South Columbus Avenue to the west, a gravel city of Goldendale (city) right-of-way (ROW) to the north, the Department of Social and Health Services and a metal/electrical contracting business to the south, and farm or range land to the east (Figure 3). Perez Collision Repair/Powers Motors is located to the west across South Columbus Avenue. There is a maintenance/storage building behind the Department of Social and Health Services to the south. There is currently a mobile home court to the north of the Property, directly across the ROW.

The Site is located in the south-central area of Goldendale. The site vicinity is characterized by mixed-use residential, commercial, and industrial parcels. The Property is zoned C-2 (general commercial), which allows for commercial businesses. South Columbus Avenue was a former State Highway (SR 8) until the 1970s, when the highway was rerouted.

2.2 Site History

CUSA's predecessor, Standard Oil Company of California, acquired the Property in 1916 and operated a bulk petroleum distribution facility (leaded gasoline, diesel, unleaded gasoline) from 1927 until 1980. In 1980, CUSA sold the Property to Edward W. Temple and Joyce I. Temple, and operation of the bulk plant was continued by Temple Distributing, Inc. In 1994, Edward W. Temple and Joyce I. Temple granted the deed to the Property to the Temple Family Trust. The Temple Family Credit Shelter Trust acquired the Property in 1997. In June 2011, Carson Oil Company, Inc. (Carson Oil) acquired all aboveground equipment at the Property from Temple Distributing, Inc. including tanks, a card reader system, high-speed satellite dispensers, transfer pumps, meters, and dispensers.

On February 29, 2012, Carson Oil delivered fuel to the facility and approximately 970 gallons of gasoline were released from an overfilled AST into the bermed, unlined containment area. Site investigations conducted in March and April 2012 confirmed that Site soils and groundwater contained gasoline; diesel; lube oil; benzene, toluene, ethylbenzene, and total xylenes (BTEX); naphthalene; and other petroleum constituents at concentrations exceeding Model Toxics Control Act (MTCA) cleanup levels (CULs). Carson Oil conducted a limited excavation as an interim action to remove petroleum-contaminated soil in April 2012. This work is discussed in Section 2.3.

On April 28, 2017, the PLPs were placed under the EO (Ecology 2017) by Ecology. Under the EO, the PLPs proposed this IAWP pursuant to Washington Administrative Code (WAC) 173-340-430.

2.3 Site Environmental Setting

2.3.1 Climate

Goldendale has a borderline Mediterranean/Continental Mediterranean climate (Köppen Csb/Dsb). The rain shadow of the Cascade Mountains creates a distinct and visible difference between the arid and dry areas south of the city and the lusher treed areas to the north. This produces a landscape of open bunchgrass prairies dotted with sagebrush containing the occasional juniper tree, while the more sheltered areas consist of ponderosa pine and oak savannahs.

During the warmest summer months, afternoon temperatures range from the upper 80s into the 90s (degrees Fahrenheit [°F]) and may at times exceed 100 °F at the peak of the summer season. In the winter months, average maximum temperatures are in the lower 30s and 40s °F, while minimum temperatures range in the 10s to 20s °F. The average annual air temperature ranges from 47 to 50 °F.

There are approximately 135 frost-free days annually. The last freezing temperatures are typically recorded in mid-April, and the first freezing temperatures begin in late October. Precipitation in the Goldendale region averages 16 to 19 inches annually. Summer precipitation is light and characterized by thunderstorms.

2.3.2 Site Geology

The dominant geologic feature of the Goldendale region is the Columbia River Basalt formation. This geological stratum is composed of several layers of undeformed, solidified lava. The Columbia River Basalt formation was created through volcanic processes and comprises the parent material from which Goldendale area soils were formed. The basalts typically have blocky columns or vertical platy joints.

Based on previous investigations, the general stratigraphy of the Site (from the surface down) consists of 1 to 1.5 feet of fill, underlain by 1 to 7 feet of silt/clays, then by a silty sand/weathered basalt, and finally by basalt bedrock. The general stratigraphy of the Site is shown on Figures 4 and 5.

As shown on Figures 4, 5, and 6 the depth to basalt at the Site ranges from 3 feet in the northeast corner to approximately 9 feet in the center of the Property.

2.3.3 Site Hydrogeology

Shallow groundwater beneath the Site is perched on top of the basalt layer. The depths to the perched groundwater measured during the April 2021 groundwater monitoring activities ranged from 4.66 to 6.96 feet below ground surface (bgs). Field measurements indicate that there may be multiple perched groundwater zones within relatively small areas and that the wells are dry during the late summer and fall seasons. During the wetter season (spring), when the wells have water, the groundwater flow gradient appears to be generally toward the north (Figure 7).

According to the Ecology well log database, several domestic or commercial water wells are located within a 0.5-mile radius of the Site ranging in depth between 100 and 200 feet bgs. The nearest identified well is located approximately 0.4 mile away. The City of Goldendale Public Works Department provides domestic water service within the city limits. Goldendale's municipal water supply is provided by a gravity-fed, mountain springs diversion system and wells. There are three municipal water supply wells, the closest of which is approximately 0.6 miles to the southwest of the Site.

2.3.4 Surface Water

Surface water near the Site drains to the west toward Columbus Avenue or infiltrates into unpaved soils. The nearest surface water is the Little Klickitat River, located approximately 0.65 mile north-northwest of the Site.

2.4 Historical Site Investigations and Cleanup Actions

Environmental investigation at the Site began following the 2012 fuel release. Investigation and excavation activities were limited to the eastern portion of the Property near the location of the 2012 release (Figure 8). Tim O’Gara prepared the associated report on behalf of Carson Oil, which is provided as Appendix A.

Following the 2012 release, 14 exploratory borings (B-1 through B-14) were drilled and four monitoring wells (MW-1 through MW-4) were installed on the Property. Twelve grab soil samples were also collected from within the bermed containment area. Soil samples were collected at each of the exploratory boring locations (B-1 through B-14), and groundwater samples were also collected from all the borings except B-3, B-5, and B-7. Results of soil sample analyses indicated that total petroleum hydrocarbons as gasoline-range organics (TPH-GRO) and BTEX were present at the Site in multiple locations at concentrations that exceeded MTCA Method A CULs. Additionally, three of the soil samples collected from within the bermed containment area [N-Center (0.5 feet bgs), NW (3.0 feet bgs) and N-Center (4.83 feet bgs)] contained concentrations of total petroleum hydrocarbons as diesel-range organics (TPH-DRO) that exceeded MTCA Method A CULs. Initial groundwater samples collected from the borings and monitoring wells MW-1 through MW-4 indicated MTCA Method A CUL exceedances of TPH-GRO, TPH-DRO, total petroleum hydrocarbons in the heavy oil range (TPH-HO), and BTEX in groundwater beneath the Property.

In April 2012, impacted soil (415 tons) was excavated at the Property to the top of the bedrock (approximately 6 to 8 feet bgs) and disposed of off-site. Nineteen confirmational soil samples (C-1 through C-19) were collected from the excavation base and sidewalls and analyzed for TPH-GRO and BTEX. All of the samples contained TPH-GRO at concentrations that exceeded the MTCA Method A CUL of 30 milligrams per kilogram (mg/kg). The detected concentrations of one or more BTEX constituents in all the samples also exceeded the MTCA A CULs.

In April 2015, Ecology completed a supplemental assessment of the Columbus Square property located north of the Site (TerraGraphics Environmental Engineering, Inc. 2015). As a component of this assessment, soil borings BH-32, BH-33, and BH-34 were completed in the ROW just north of the Site, and boring BH-31 was drilled in South Columbus Avenue adjacent to the northwest corner of the Site (Figure 8). Analytical results from soil samples collected from borings BH-32 (8 feet bgs) and BH-33 (7 feet bgs) exceeded the MTCA Method A CUL for TPH-GRO. The detected soil impacts in the area of BH-32 and BH-33 appear to be associated with the historical operations at the Site.

In accordance with the EO (Ecology 2017) and the Remedial Investigation Work Plan (RI Work Plan; Leidos Inc. 2017), RI activities consisting of confirmation soil borings (SB-1 through SB-44) and the installation of additional monitoring wells (MW-5 through MW-9) were initiated in April 2018. Based on the initial sample results, additional borings (SB-45 through SB-51) were completed to delineate soil impacts to the south and west of the release area. This investigative work was completed by Leidos Inc. in December 2018 (Leidos Inc. 2019).

The approximate boring, well, and soil sample locations for these investigations are shown on Figure 9 and the data are presented in Table 1. The boring logs are provided in Appendix B.

3 Nature and Extent of Contamination

This section describes the COCs in soil and groundwater at the Site.

3.1 Soil Impacts

As part of the 2018 RI activities, 51 soil borings and five groundwater monitoring wells were completed on the Property to delineate the lateral and vertical extents of petroleum hydrocarbon impacted soil. Soil analytical results from the RI are presented in Tables 1 and 2.

Based on the results of the soil sampling, TPH-GRO, TPH-DRO, naphthalene, and BTEX were identified as the COCs in Site soils. No other contaminants were detected at concentrations exceeding the CULs. TPH-GRO is the most prevalent COC at the Site, occurring throughout the footprint of the former bulk plant facilities including the AST area, loading racks, warehouse, and associated product transfer lines (Figure 9). TPH-DRO impacts with concentrations greater than the MTCA Method A CUL are limited, as shown on Figure 9, and are encompassed by the area of TPH-GRO impacts.

As shown on Figure 9, residual soil impacts at concentrations exceeding MTCA Method A CULs are primarily limited to the Property but extend into the city ROW adjacent to the north.

The vertical extent of soil impacts is shown on Figures 4 and 5. As shown on the cross sections and in previous reports, the vertical extent of soil impacts is delineated by the layer of basalt bedrock beneath the Site.

3.2 Groundwater Impacts

Analytical results from groundwater samples collected during the initial 2012 investigation (Appendix A) exceeded MTCA Method A CULs at the following locations:

- B-2-W: TPH-GRO (10,500 micrograms per liter [µg/L]) and benzene (20.7 µg/L)
- B-4-W: TPH-GRO (2,770 µg/L), TPH-DRO (7,980 µg/L) and benzene (11.5 µg/L)
- B-6-W: TPH-GRO (127,000 µg/L), TPH-DRO (853 µg/L), benzene (11,500 µg/L), toluene (40,000 µg/L), ethylbenzene (2,430 µg/L), and total xylenes (11,300 µg/L)
- B-8-W: TPH-GRO (4,240 µg/L), TPH-DRO (1,240 µg/L), and benzene (43.6 µg/L)
- B-9-W: TPH-DRO (2,080 µg/L)
- B-10-W: TPH-DRO (20,700 µg/L), TPH-HO (1,300 µg/L)
- B-11-W: TPH-DRO (294,000 µg/L), TPH-HO (773 µg/L)
- B-12-W: TPH-DRO (169,000 µg/L), TPH-HO (808 µg/L)
- B-13-W: TPH-DRO (36,500 µg/L)
- B-14-W: TPH-DRO (213,000 µg/L)
- MW-1: Benzene (5.38 µg/L)
- MW-2: TPH-GRO (8,910 µg/L), benzene (1,250 µg/L), and toluene (1,800 µg/L)
- MW-3: TPH-GRO (5,080 µg/L)
- MW-4: TPH-GRO (6,000 µg/L).

Wells MW-1 through MW-6, and MW-9 were sampled in April 2021 (MW-7 and MW-8 were dry). During this sampling event, wells MW-3 (TPH-GRO at 2,480 µg/L, TPH-DRO at 824 µg/L), MW-5 (TPH-DRO at 1,210 µg/L, TPH-HO at 534 µg/L) and MW-6 (TPH-HO at 704 µg/L) exhibited COC concentrations that exceeded MTCA Method A CULs. All other COCs were either not detected or were detected at concentrations less than MTCA Method A CULs. Groundwater analytical results are presented in Tables 3 and 4, and the 2021 results are shown on Figure 10.

4 Conceptual Site Model

This section evaluates contaminant fate and transport, potential receptors, and potential exposure pathways.

4.1 Contaminants of Concern

The MTCA defines a contaminant as “any hazardous substance that does not occur naturally or occurs at greater than natural background levels” (WAC 173-340-200). COCs include those hazardous substances known to be present at a site, or that are suspected to be present based on information regarding the nature of a known release or past operations at a site. Sample data from the RI field work, prior environmental investigations, and cleanup actions have identified the presence (or potential presence) of the COCs presented in Table 5, below, for each of the impacted media at the Site.

Table 5. Groundwater, Soil, and Potential Soil Gas Site COCs

COCs	Groundwater	Soil	Soil Gas (Potential)
Benzene	X	X	X
Toluene	X	X	X
Ethylbenzene	X	X	X
Total xylenes	X	X	X
Naphthalene		X	X
Gasoline-range hydrocarbons	X	X	X
Diesel-range hydrocarbons	X	X	
Heavy oil-range hydrocarbons	X	X	
1,2-Dibromoethane (EDB)		X	

4.2 Exposure Pathways and Potential Receptors

Petroleum release(s) originating from the Property have impacted shallow (uppermost 10 feet) soil and groundwater beneath the Site at concentrations above MTCA Method A CULs, as described above. The MTCA defines an exposure pathway as: “the path a hazardous substance takes or could take from a source to an exposed organism. An exposure pathway describes the mechanism by which an individual or population is exposed or has the potential to be exposed to hazardous substances at or originating from a Site. Each exposure pathway includes an actual or potential source or release from a source, an exposure point, and the exposure route. If the exposure point differs from the source of the hazardous substance, the exposure pathway also includes a transport/exposure medium” (WAC 173-340-200). Primary exposure pathways are those routes known to be currently transporting contaminants to or within a certain medium (e.g., soil contamination to groundwater). Secondary exposure pathways are those routes that have transported contaminants in the past but may not be currently (e.g., releases from ASTs), or may transport contaminants in the future but do not currently. Precluded exposure pathways are those that are not possible at any time, based on physical evidence, and are therefore considered closed pathways.

Petroleum constituents have been detected in soil and groundwater samples collected at the Site. Therefore, soil and groundwater are impacted media and may also be considered secondary contaminant sources. The potential exposure pathways associated with each medium/source are discussed below along with the rationale for excluding or including that pathway.

4.2.1 Potential Soil Exposure Pathways

Soil impact depths range from approximately 1 foot to 9 feet bgs. Ingestion of, or dermal contact with, contaminated soil, inhalation of vapors and/or airborne particulates (e.g., dust) in outdoor air, or dermal contact or accidental ingestion of contaminated groundwater could become temporary exposure pathways to future workers if intrusive construction is performed at the Site. Vapor intrusion to indoor air is also a potential exposure pathway to future Site workers or residents. Residual impacted soil could also pose a potential direct-contact exposure pathway. The potential soil exposure pathways at the Site are presented in Table 6, below.

Table 6. Potential Soil Exposure Pathways

Potential Soil Exposure Pathways	Applicability
Ingestion of, or dermal contact with, contaminated soil	*Open*. The residual soil impacted by COCs at the Site is currently at depths from 1 foot to 9 feet bgs. The current potential for ingestion or dermal contact is limited based on the current land use (unoccupied). However, potential ingestion or direct contact exposure is possible for future workers performing excavation, site assessment, or subsurface utility work at the Site.
Inhalation of hazardous vapors and/or airborne particulates (i.e., dust) in outdoor air	*Open*. Volatilization of hazardous substances or dust from contaminated soil may create an inhalation exposure pathway for future workers performing excavation, site assessment, or subsurface utility work at the Site.
Contamination of groundwater by hazardous substances leaching from soil	*Open*. Soil contamination in contact with groundwater has resulted in concentrations of dissolved-phase petroleum contamination in groundwater.
Inhalation of hazardous substances that have volatilized from contaminated soil and migrated to indoor air	*Open*. This pathway will be investigated once the interim remedial action is completed.

4.2.2 Potential Groundwater Exposure Pathways

The potential groundwater exposure pathways at the Site are presented in Table 7, below.

Table 7. Potential Groundwater Exposure Pathways

Potential Groundwater Exposure Pathways	Applicability
Ingestion/household contact	*Open but not considered significant*. The perched groundwater is seasonal and has a sustained yield of less than 0.5 gallon per minute. Additional data will be gathered during execution of the interim remedial action to determine if groundwater is not potable as per WAC 173-340-720.
Incidental exposure resulting from site development or utility construction	*Open*. Groundwater is typically located at depths of approximately 3 to 10 feet bgs. Dermal contact exposures are possible for workers during future site redevelopment or utility work.
Groundwater to surface water	*Closed*. The shallow perched seasonal aquifer does not discharge to surface water.
Inhalation of vapors in outdoor air	*Open*. Volatilization of hazardous substances from contaminated groundwater may create an inhalation exposure pathway for future workers performing excavation, site assessment, or subsurface utility work at the Site.
Inhalation of vapors in indoor air	*Open (on-Property)*. Volatilization of hazardous substances from contaminated groundwater may create an inhalation exposure pathway for the on-Property buildings. On-Property buildings are currently unoccupied. *Open (off-Property)*. Volatilization of hazardous substances from contaminated groundwater may create an inhalation exposure pathway for off-Property buildings. Vapor intrusion risks will be further evaluated, but not as part of this Interim Action.

4.2.3 Potential Soil Vapor Exposure Pathways

Currently, most of the Site (containing one unoccupied small office and an unoccupied warehouse) is undeveloped. Based on analytical results from the soil samples collected during the RI, the soil vapor to indoor air pathway may represent a potential exposure pathway. The potential for vapor intrusion will be evaluated following the interim action and will be detailed in the Cleanup Action Plan (CAP). This will allow the investigation results to represent more appropriate potential risks to future site use.

4.2.4 Terrestrial Ecological Evaluation

In addition to evaluation of human health risk, the MTCA requires that one of the following actions be taken following the release of hazardous substances to soil at a site to determine the potential impacts to terrestrial organisms at the site:

- Documentation of an exclusion from any further terrestrial ecological evaluation (TEE) using the criteria in WAC 173-340-7491
- Completion of a simplified TEE as specified in WAC 173-340-7492

- Completion of a site-specific TEE as specified in WAC 173-340-7493.

A site may be excluded from the requirement for a TEE if any of the following criteria are met:

- All soil contaminated with hazardous substances is, or will be, located below the point of compliance established under WAC 173-340-7490(4).
- All soil contaminated with hazardous substances is, or will be, covered by buildings, paved roads, pavement, or other physical barriers that will prevent plants or wildlife from being exposed to the soil contamination.
- There is less than 0.25 acre of contiguous undeveloped land on or within 500 feet of any area of the site contaminated with chlorinated dioxins or furans, polychlorinated biphenyl (PCB) mixtures, dichlorodiphenyltrichloroethane (DDT), dichlorodiphenyldichloroethene (DDE), dichlorodiphenyldichloroethane (DDD), aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene.
- There is less than 1.5 acres of contiguous undeveloped land on the site or within 500 feet of any area of the site, and contamination at the site does not include any of the contaminants listed in the preceding bullet.

The Site does not meet the above-listed requirements for TEE exclusion. Therefore, a simplified TEE, completed for the Site using WAC 173-340-7492, Table 749-1, is presented in Table 8, below.

Table 8. Simplified Terrestrial Ecological Evaluation

Table 749-1

Simplified Terrestrial Ecological Evaluation-Exposure Analysis Procedure

Estimate the area of contiguous (connected) undeveloped land on the Site or within 500 feet of any area of the Site to the nearest ½ acre (¼ acre if the area is less than 0.5 acre).

1) From the table below, find the number of points corresponding to the area and enter this number in the field to the right.

Area (acres)	Points
0.25 or less	4
0.5	5
1.0	6
1.5	7
2.0	8
2.5	9
3.0	10
3.5	11
4.0 or more	12

Table 749-1

Simplified Terrestrial Ecological Evaluation-Exposure Analysis Procedure

2) Is this an industrial or commercial property? If yes, enter a score of 3. If no, enter a score of 1	3
3) [a]Enter a score in the box to the right for the habitat quality of the Site, using the following rating system[b]. High=1, Intermediate=2, Low=3	2
4) Is the undeveloped land likely to attract wildlife? If yes, enter a score of 1 in the box to the right. If no, enter a score of 2.[c]	1
5) Are there any of the following soil contaminants present: Chlorinated dioxins/furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, pentachlorobenzene? If yes, enter a score of 1 in the box to the right. If no, enter a score of 4.	4
6) Add the numbers in the boxes on lines 2-5 and enter this number in the box to the right. If this number is larger than the number in the box on line 1, the simplified evaluation may be ended.	10

Based on the results presented in Table 8, above, the TEE is ended at this point; the Site does not pose a threat of adverse effects to terrestrial ecological receptors.

5 Cleanup Standards

This section describes cleanup standards and the development of CULs for soil and groundwater. Laboratory reporting limits will be verified to be below CULs.

5.1 Soil Cleanup Levels and Points of Compliance

The MTCA provides three approaches for establishing soil CULs: Method A, Method B, and Method C. Method A may be used at sites involving relatively few hazardous substances or where cleanup action may be routine. Under Method A, CULs are determined by the most stringent criteria specified under state and federal laws and Tables 720-1, 740-1, and 745-1 of the MTCA. Method B is the universal method for determining CULs at all sites. For sites contaminated with petroleum hydrocarbons, Method B CULs are determined using the fractionated analytical approach for petroleum. This approach involves testing the samples to determine the light nonaqueous phase liquid (LNAPL) composition. CULs must consider the measured or predicted ability of the fractions to migrate from one medium to other media. When multiple exposure pathways are identified for a single medium, the most stringent CUL is selected. Method C is used in situations such as industrial sites. Site cleanups under Method C will require restrictions placed on the property to ensure future protection of human health and the environment.

The MTCA states that CULs are based on the reasonable maximum exposure expected to occur during both current and future land use. By default, the MTCA further states that residential land use represents the reasonable maximum exposure. Therefore, CULs must be protective of residential or unrestricted land use. On sites where the cleanup action is routine or may involve relatively few hazardous substances, the MTCA allows the use of Method A CULs. For this interim action, the soil and groundwater data will be compared to MTCA Method A CULs presented in MTCA Table 740-1 (Soil Cleanup Levels for Unrestricted Land Use).

The soil CULs combined with the point of compliance determines the cleanup standard for a site. Under the MTCA, the point of compliance is pathway dependent. Potential pathways for exposure to contaminants in soil are discussed below:

- *Protection of human exposure via direct contact/incidental ingestion.* The point of compliance is in the soils throughout a site to a reasonable estimate of the depth of soil that could be excavated and distributed at the soil surface during site development activities (i.e., ground surface to 15 feet bgs).
- *Protection of ecological receptors.* The standard point of compliance is in the soils throughout a site from ground surface to 15 feet bgs (the reasonable depth of soil that could be excavated during site development and could result in exposure to ecological organisms). For sites with institutional controls preventing excavation of deeper soil, the MTCA allows the use of a conditional point of compliance set in the soils throughout the sites at a depth of 6 feet bgs.
- *Protection of groundwater.* The point of compliance is throughout a site.

5.2 Groundwater Cleanup Levels and Points of Compliance

The MTCA requires that groundwater CULs be based on the highest beneficial use and reasonable maximum exposure under both current and future land use at a site. For groundwater, MTCA specifies that drinking water is the highest beneficial use and that ingestion of drinking water represents the reasonable maximum exposure (WAC 173-340-720). As discussed in Sections 2.2.3 and 4.2.2, the shallow groundwater beneath the Site (e.g., 2.23 to 7.70 feet bgs) is intermittently present based on seasonal variations and produces low yields (less than 0.5 gallon per minute) when present. Therefore, it is highly unlikely that shallow groundwater beneath the Site will be used for drinking water. For interim action, groundwater data will be compared to MTCA Method A CULs. Based on discussions with Ecology, it is anticipated that the CULs for the Site will be based on MTCA Method A levels for unrestricted land use.

The MTCA states that groundwater CULs will be attained in all groundwater from the point of compliance to the outer boundary of the hazardous substance plume. The standard point of compliance, as defined by the MTCA, is throughout the Site from the uppermost level of the saturated zone extending vertically to the lowest depth that could potentially be affected by the Site.

5.3 Summary of Proposed Interim Action Cleanup Goals

Per the MTCA, cleanup standards establish the concentrations of hazardous substances that are protective of human health and the environment (CULs) and the location(s) on site where those CULs must be attained (points of compliance).

The interim action is intended to address the areas of known greatest concentrations of COCs at the Site and is not designed to remove all soil with COC concentrations greater than MTCA Method A CULs. Other processes such as natural attenuation will be required to achieve CULs throughout the Site. Table 9, below, presents the proposed cleanup standards that have been developed for the interim action. The anticipated cleanup standards for the Site are MTCA Method A CULs at a standard point of compliance, as presented in Table 9, below.

Table 9. Site Cleanup Standards

Medium	Point of Compliance	TPH-GRO	TPH-DRO	TPH-HO	B	T	E	X	Naphthalene	EDB
Soil (mg/kg) 0-15 feet bgs	Entire site	30/100	2,000	2,000	0.03	7	6	9	5	0.005
Groundwater (µg/L)	Entire site	800/1,000	500	500	5	1,000	700	1,000	160	0.01

Notes:
B = benzene
E = ethylbenzene
T = toluene
X = xylene

These CULs are derived from:

- MTCA Table 740-1, Method A soil CULs for unrestricted land uses
- MTCA Table 720-1, Method A CULs for groundwater.

6 Proposed Interim Action

To address objectives under the EO, this IAWP proposes to implement Remedial Alternative 3, as proposed in the Draft RI/FS (Arcadis 2020). Remedial Alternative 3 consists of:

- Excavation of the SB-24, SB-25, SB-29, SB-40, and B-14 vicinity.
- Excavation of the B-13 vicinity.
- Excavation of the SB-1, SB-36, SB-39, and B-10 vicinity.
- Excavation of the MW-3 and B-11 vicinity.
- Excavation of the MW-4, SB-16, SB-17, and B-7 vicinity.
- Excavation of the SB-6 vicinity.

Alternative 3 will meet the objectives of the interim action described in Section 1.2 as follows:

- Reduce the groundwater cleanup timeframe and the potential for direct soil contact by human and ecological receptors by excavating and disposing of on-property soil containing the greatest concentrations of petroleum constituents.
- Installation of additional monitoring wells and routine groundwater monitoring will obtain the data necessary to evaluate the groundwater exposure pathway at the Site.

7 Remedial Implementation

This section describes the implementation of Alternative 3 as described in the Draft RI/FS (Arcadis 2020). Alternative 3 includes several limited excavation areas to address residual impacted soil at the Site.

Excavation is an effective remediation strategy because contaminants are physically removed from the Site. It has been both implementable and effective at removing impacted soil. Excavation also has the potential to reduce dissolved-phase petroleum hydrocarbon concentrations in groundwater by removing secondary source material, potentially to less than CULs or within 1 order of magnitude of CULs across the Site.

7.1 Description of Work

Targeted excavations will remove soil from areas on the Property and the adjacent ROW identified as having the greatest concentrations of petroleum hydrocarbons.

7.2 Excavation Description

Six targeted excavation areas are proposed at the Site. The proposed excavations will extend to approximately 5 to 9 feet bgs. Approximately 820 cubic yards of excavated soil will be hauled offsite for disposal as part of excavation activities. The extent of the excavation has been pre-defined by borings SB-1, SB-6, SB-16, SB-17, SB-24, SB-25, SB-29, SB-36, SB-39, SB-40, B-7, B-10, B-11, B-13, B-14, MW-3, and MW-4. Proposed excavation extents are shown on Figure 11. Excavated soil will be transported to a CEMC-approved disposal facility. As further discussed in Section 9.1 below, confirmation soil samples will be collected from the bottom and sidewalls of the excavated areas to document remaining soil quality.

7.3 Site Preparation

Prior to the excavation activities, initial site preparations and protective measures will be taken, including:

- Development of an appropriate Traffic Control Plan with decontamination procedures for equipment and workers.
- Development of a Stormwater Management Plan.
- Decommissioning of monitoring wells MW-3 and MW-4.

The Traffic Control Plan will include procedures detailing the proposed traffic flow pattern to minimize traffic-related incidents at the Site and minimize excavation down time. Prior to leaving the Site, routine truck inspections will take place to verify loads are secured.

Prior to excavation, a stormwater collection system consisting of submersible pumps will be prepared to remove stormwater that may potentially collect in the excavation areas, if diversion is not feasible. Stormwater and/or groundwater, if any, will be removed from the excavation areas and deposited into a holding tank on the Property.

Existing monitoring wells located in the excavation area will be decommissioned prior to excavation. Monitoring wells MW-3 and MW-4 will be decommissioned according to the requirements of WAC 173-160-460.

8 Other Potentially Applicable Requirements

The specific permits or consultations to be completed are listed below:

- *Local*. City of Goldendale Right-of-Way Access Permit
- *State*. State Environmental Policy Act (SEPA) Environmental Checklist

All other potentially applicable requirements and permits required to maintain compliance with WAC 173-340-710 are provided in Appendix C. The SEPA Environmental Checklist is provided in Appendix D.

The laws and regulations cited in Appendix C pertain to nonhazardous waste only because hazardous waste does not exist at the Site and hazardous waste generation, handling, and treatment/disposal is not anticipated as part of the interim action. Appendix C does not refer to state dangerous waste regulations (WAC 173-304) or Resource Conservation and Recovery Act Subtitle C regulations (40 CFR 260-268), which control the management and disposal of hazardous waste.

9 Performance and Compliance Monitoring

Alternative 3 includes compliance monitoring as required by WAC 173-340-410 and 173-340-720 through 173-340-760. This section describes the components of compliance monitoring that will include protection and confirmation monitoring during and following excavation activities to meet the following requirements:

- Protection monitoring will verify that human health and the environment are adequately protected during the excavation.
- Confirmation monitoring will verify the long-term effectiveness of the remediation efforts following completion of remedial activities.

General components of protection and compliance monitoring for the excavation activities discussed in this IAWP are described below.

9.1 Excavation Activities Performance Monitoring

Performance monitoring associated with excavation activities will consist of the following components:

- Excavated soil stockpile sampling to characterize the soil for disposal at a permitted landfill.

Excavated soil will be temporarily stockpiled on the Property for characterization sampling to determine appropriate disposal or treatment at the offsite waste facility. Characterization sampling will be conducted as required by the selected waste facility. Discrete soil samples will be collected with hand tools 6 to 12 inches beneath the surface of the pile, where field instrument readings indicate contamination is most likely to be present. If field instruments do not indicate contamination, the pile will be divided into sections and a sample will be collected from each section. The number of samples to be collected from each pile will be consistent with Table 6.9 of the Ecology Guidance for Remediation of Petroleum Contaminated Sites (Guidance; Ecology 2016). The samples will be immediately preserved and submitted for chemical analysis. It is not anticipated that excavated soil will be reused on the Property as backfill material.

Confirmation soil samples will be collected from the bottom and sidewalls of the excavated areas to document remaining soil quality. From the Ecology Guidance, the actual number of samples sent to a laboratory for analysis will vary depending on the size of the excavation and results of visual observations and field screening tests. To ensure adequate characterization of remaining soils, at least one soil sample will be collected from each side of each excavation area, and one soil sample will be collected from the bottom of each excavation area (i.e., a minimum of five samples per area). One sample will be collected for every 20 feet horizontally along the sidewalls, and one sample will be collected for every 400 square feet of exposed bottom (Ecology 2016).

Samples will be analyzed for the following constituents of concern:

- TPH-GRO by NWTPH-Gx
- TPH-DRO and TPH-HO by NWTPH-Dx
- BTEX by EPA Method 8260
- Naphthalene by EPA Method 8270
- EDB by EPA Method 8260

Note that as requested by Ecology, a figure (or figures) showing the soil sample results will be provided prior to backfilling the excavation areas.

All material proposed to be imported to the Site for use as backfill following the excavation work will be sampled and analyzed for RCRA 8 Metals (plus copper, zinc, and nickel) by EPA Method 6010D and organochlorine pesticides by EPA Method 8081 to ensure that the material is suitable for use at the Site. The backfill soil sample frequency will be conducted in accordance with Table 6.9 of the Ecology Guidance.

9.2 Long-Term Groundwater Compliance Monitoring

Periodic groundwater monitoring of site groundwater monitoring wells will be conducted to measure long-term COC trends following excavation activities to verify the long-term effectiveness of remediation efforts. Compliance groundwater monitoring will continue at the Site until COC concentrations in site wells meet CULs for four consecutive quarters. Laboratory reporting limits will be verified to be below CULs.

9.3 Monitoring Well Installation

As discussed in Section 7.3, monitoring wells MW-3 and MW-4 in the excavation vicinity will be decommissioned prior to excavation activities. Following the completion of excavation activities, three new monitoring wells (MW-3A, MW-4A, and MW-10) will be installed in accordance with WAC 173-160-420 (Figure 12) and will be included in the groundwater compliance monitoring to confirm long-term effectiveness of excavation activities. Arcadis' Technical Guidance Instructions (TGIs) will be used during the collection of soil and groundwater samples, and monitoring well installation.

9.3.1 Utility Locate

A public utility clearance using Washington 811 dig alert will be conducted prior to excavation activities. A private utility locating service will also be scheduled for site clearance using ground-penetrating radar and magnetic locating equipment to identify utilities not included under the public locate. Representatives from the general contractor will be present at the time of the private utility location activities to ensure that equipment maneuverability and site access are adequate around areas of excavation and shoring.

9.3.2 Well Borings

Monitoring well boring locations will first be pre-cleared to at least 5 feet bgs using a hand auger and/or an air knife and vacuum truck to avoid any unidentified utilities. After pre-clearance, the boreholes will be advanced using direct-push technology or hollow-stem auger drilling methods to a target depth of approximately 8 feet bgs.

During preclearance, soil samples will be collected by hand auger at approximately 2.5 foot intervals for lithologic logging in accordance with Arcadis' TGI for Soil Description (Appendix E) and screened for volatile organic compounds (VOCs) using a photo ionization detector. During drilling, soil samples will be collected from MW-10 at 2.5-foot intervals for VOC screening. Soil samples from MW-10 will be collected for laboratory analysis at 5.0 feet bgs, and at the total depth of the boring.

Soil boring MW-10 is not proposed to confirm or delineate specific soil impacts; however, at a minimum, soil samples will be collected from just above the water table, at intervals with visible staining and/or elevated VOC screening impacts, and at the total depth of boring. Additional soil samples may be collected for laboratory analysis based on field observations. MW-3A and MW-4A will be installed within the excavation backfill; therefore, it is not anticipated that soil samples will be collected for chemical analysis or lithologic logging. Soil samples collected during the installation of MW-10 will be submitted to an Ecology-approved laboratory for the following analyses:

- BTEX by USEPA Method 8260
- cPAHS by USEPA Method 8270 SIM
- TPH-GRO by Ecology Method NWTPH-Gx
- TPH-DRO and TPH-HO by Ecology Method NWTPH-Dx
- Total lead by USEPA Method 6010D
- Naphthalene by USEPA Method 8270
- EDB by USEPA Method 8260

Groundwater has previously been tested for methyl tert-butyl ether (MTBE) and 1,2-Dichloroethane (EDC) and were not detected. Therefore, these constituents will not be analyzed in soil.

In accordance with WAC 173-340-708(8)(e), mixtures of cPAHs will be considered a single hazardous substance when determining compliance with CULs. Per Implementation Memo 10, Toxicity Equivalency Factors (TEFs) will be used to estimate the toxicity of the individual cPAH compounds with respect to benzo(a)pyrene (0.1 mg/kg).

9.3.3 Well Construction

Soil borings MW-3A, MW-4A, and MW-10 will be converted to monitoring wells. Monitoring wells will be installed in accordance with WAC 173-160 Minimum Standards for Construction and Maintenance of Wells by a Washington-licensed driller. Monitoring wells MW-3A, MW-4A, and MW-10 will be installed to a target depth of approximately 8 feet bgs. This target depth is based on depth to water measurements in wells that are closest to the proposed monitoring wells and historical boring logs.

Each well will be constructed of 2-inch-diameter Schedule 40 polyvinyl chloride (PVC) 0.010-inch slotted screen from approximately 2 to 7 feet bgs. Blank PVC casing will be installed from the top of the screen to near surface grade. Sand filter pack will be placed in the annular space of the borehole from the bottom of the boring to approximately 0.5 foot above the top of the well screen, followed by transition sealing consisting of hydrated bentonite chips to approximately 1 foot bgs. The remaining open borehole annulus will be sealed with neat cement to near ground surface.

The wellhead will be completed at the ground surface with a locking well cap and traffic-rated, bolt-down well vault. The vault will be installed slightly above the surrounding surface grade and finished with a concrete apron to provide positive relief away from the wellhead. Following the installation of monitoring wells MW-3A, MW-4A, and MW-10, well location, groundwater surface, and top of casing elevations will be surveyed by a professional Washington-licensed land surveyor. Monitoring wells will be developed according to the Arcadis TGI for Monitoring Well Development (Appendix E). Well development will include surging the screen interval and purging fine-grained material out of the well.

9.3.4 Groundwater Sample Collection and Analysis

Groundwater compliance monitoring will include gauging and sampling the site monitoring wells. Wells will be gauged to measure water levels and to calculate hydraulic gradient across the Site. Groundwater samples will be collected from monitoring wells MW-1, MW-2, MW-3A, MW-4A, and MW-5 through MW-10 in accordance with the Arcadis TGI for Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Appendix E). Groundwater samples will be collected for at least four consecutive quarters following monitoring well installation.

Groundwater samples will be collected using low-flow methods to monitor dissolved-phase COC concentrations in compliance wells. During purging, water quality parameters (dissolved oxygen, oxidation-reduction potential, pH, conductivity, and temperature) will be monitored. Samples will be collected once parameters stabilize.

Analytes will include:

- BTEX by USEPA Method 8260
- Semi-volatile organic compounds (including naphthalene) by USEPA Method 8270 SIM
- TPH-GRO by Ecology Method NWTPH-Gx
- TPH-DRO and TPH-HO by Ecology Method NWTPH-Dx
- Total lead by USEPA Method 6010D
- EDB by USEPA Method 8011

9.4 Sampling and Analysis Plan and Quality Assurance Project Plan

A Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) are included in Appendix F.

10 Reporting

Within 90 days of completing the interim action, Arcadis will submit the Draft Interim Action Report to Ecology on behalf of the PLPs, as required by the EO. Ecology's comments will be incorporated into the Final Interim Action Report. The following information will be provided in the Draft Interim Action Report:

- Field activity descriptions, to include any unusual or unexpected events or conditions
- Excavation figures showing final vertical and lateral excavation extents and confirmation soil sample results
- Summary, in tons or cubic yards, of soil disposed of off site
- Summary, in gallons, of recovered groundwater transported off site
- Daily field documentation and reports
- Tables presenting sample analytical results, including the depths where confirmation samples were obtained
- A figure showing the location of confirmation sampling
- Copies of chain of custody forms and laboratory reports for confirmation soil samples, soil boring samples, groundwater samples, and soil waste characterization samples.
- Copies of waste disposal manifests
- Electronic database on CD, containing sample data. All sample data will be submitted to Ecology's Environmental Information Management System as required by the EO.

A groundwater monitoring report will be prepared after each quarter of sampling. Ecology will review and provide comments on each groundwater monitoring report before it is finalized. The quarterly report will present data from quarterly groundwater monitoring activities and will include:

- Details of all water quality field measurements
- Descriptions of field activities, to include any unusual or unexpected events or conditions
- Figures displaying COC concentrations in groundwater samples
- Figures containing COC concentrations versus time in the wells
- Cross-sectional figures of groundwater elevations
- Tables containing groundwater monitoring data, as well as groundwater sample analytical results
- Groundwater concentration plots versus elevation over time
- Copies of laboratory reports and chain of custody documentation
- Electronic database containing all sample data.

11 References

Arcadis. 2020. Draft Remedial Investigation/Feasibility Study. Former Temple Distributing Site No. 375289. 808 South Columbus Ave. Goldendale, Washington. November 5.

Arcadis. 2021. Letter from Steve Mahony (Arcadis) to Mary Monahan (Ecology) re: Ecology Comments on the Draft RI/FS. March 23.

Ecology. 2016. Guidance for Remediation of Petroleum Contaminated Sites. Toxics Cleanup Program. Publication No. 10-09-057. June.

Ecology. 2017. Enforcement Order No. DE 14134, effective April 28.

Ecology. 2021. Letter from Mary Monahan (Ecology) to Timothy L. Bishop (CEMC) re: Ecology comments on the DRAFT Temple Distributing Remedial Investigation and Feasibility Study. January 20.

Leidos Inc. 2017. Remedial Investigation Work Plan, Former Temple Distributing Site. October 3.

Leidos Inc. 2019. Draft Remedial Investigation/Feasibility Study, Former Temple Distributing Site. April 12.

TerraGraphics Environmental Engineering, Inc. 2015. Final 2015 Supplemental Environmental Site Assessment Report, Columbus Square, Goldendale, Washington. December 18.

Tables

Table 1
Soil TPH, BTEX, Fuel Additives, and Lead Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil
808 South Columbus Ave, Goldendale, Washington

Sample Location	Date	Sample Depth (feet bgs)	TPH-GRO	TPH-DRO	TPH-HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Lead
MTCA Method A CULs			**30/100**	**2000**	**2000**	**0.03**	**7**	**6**	**9**	**0.1**	**0.005**	**NE**	**250**
(Tim O'Gara, R.G. 2012)													
Soil inside berm area													
S- Center	3/1/2012	0-0.5	**14,200**	609	178	--	--	--	--	--	--	--	--
N-Center	3/1/2012	0-0.5	**18,300**	**2,560**	1,430	--	--	--	--	--	--	--	--
NW	3/1/2012	0-0.5	**15,600**	686	899	--	--	--	--	--	--	--	--
NE	3/1/2012	0-0.5	**96.5**	675	<60.8	--	--	--	--	--	--	--	--
SE	3/1/2012	0-0.5	**34,000**	1,800	807	**48.4**	**1,200**	**452**	**2,332**	**<3.38**	**<1.69**	<1.69	**1,640**
SW	3/1/2012	0-0.5	**13,600**	165	101	--	--	--	--	--	--	--	--
S-Center	3/2/2012	4.5	<3.50	25.6	<69.9	--	--	--	--	--	--	--	--
S-Center	3/2/2012	4.66	**833**	694	89.1	--	--	--	--	--	--	--	--
NW	3/2/2012	3.0	**4,060**	**3,320**	137	--	--	--	--	--	--	--	--
NW	3/2/2012	5.16	**1,170**	367	91.6	--	--	--	--	--	--	--	--
N-Center	3/2/2012	4.83	**2,100**	**2,020**	147	--	--	--	--	--	--	--	--
N-Center	3/2/2012	3.0	**1,120**	118	<64.2	--	--	--	--	--	--	--	--
B-1	3/1/2012	5.0	<6.41	--	--	<0.0641	0.316	<0.257	<0.770	--	--	--	--
B-2	3/1/2012	5.0	<6.15	--	--	<0.0615	<0.246	<0.246	<0.738	--	--	--	--
B-2	3/1/2012	7.0	**256**	--	--	<0.0581	0.543	1.12	2.62	--	--	--	--
B-3	3/1/2012	5.0	<6.02	--	--	<0.0602	<0.241	<0.241	<0.722	--	--	--	--
B-3	3/1/2012	7.0	15.7	--	--	<0.0825	<0.330	<0.330	<0.990	--	--	--	--
B-4	3/1/2012	5.0	19.9	--	--	<0.0626	<0.250	<0.250	<0.751	--	--	--	--
B-4	3/1/2012	7.0	<6.67	--	--	<0.0667	<0.267	<0.267	<0.800	--	--	--	--
B-5	3/1/2012	5.0	<6.49	--	--	<0.0649	<0.260	<0.260	<0.779	--	--	--	--
B-5	3/1/2012	8.0	<5.36	160	<60.8	<0.0536	<0.214	<0.214	<0.643	--	--	--	--
B-6	3/1/2012	5.0	**1,330**	--	--	**29.5**	**155**	**36.3**	**176**	<0.0111	<0.0111	<0.0111	<1.96
B-6	3/1/2012	8.0	**36.1**	1,050	<65.1	<0.0875	<0.350	<0.350	<1.05	--	--	--	--
B-7	3/1/2012	5.0	**1,380**	755	<63.9	<0.0319	<0.128	2.52	0.946	--	--	--	--
B-7	3/1/2012	8.0	**5,840**	1,470	<57.6	<0.0498	1.14	**6.76**	3.22	--	--	--	--
B-8	3/1/2012	5.0	<5.57	--	--	<0.0557	<0.223	<0.223	<0.669	--	--	--	--
B-8	3/1/2012	8.0	<5.79	--	--	<0.0585	<0.234	<0.234	<0.702	--	--	--	--
B-9	3/1/2012	5.0	<6.13	--	--	<0.0613	<0.245	<0.245	<0.736	--	--	--	--
B-9	3/1/2012	7.0	<6.22	399	<61.2	<0.0622	<0.249	<0.249	<0.746	--	--	--	--
B-10	3/1/2012	5.0	<6.91	<19.2	<64.1	**0.311**	0.633	<0.276	<0.829	--	--	--	--
B-10	3/1/2012	9.0	<2.80	--	--	<0.0280	<0.112	<0.112	<0.336	--	--	--	--
B-11	3/1/2012	5.0	--	909	<65.7	--	--	--	--	--	--	--	--
B-11	3/1/2012	7.0	**1,090**	384	<62.2	**0.414**	2.89	4.84	6.96	--	--	--	--

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MTCA Method A CULs			**30/100**	**2000**	**2000**	**0.03**	**7**	**6**	**9**	**0.1**	**0.005**	**NE**	**250**
B-12	3/1/2012	5.0	--	215	<65.4	--	--	--	--	--	--	--	--
B-12	3/1/2012	8.0	**36.7**	99.9	<64.0	<0.0723	<0.289	0.440	<0.868	--	--	--	--
B-13	3/1/2012	5.0	--	113	<64.9	--	--	--	--	--	--	--	--
B-13	3/1/2012	9.0	**222**	41.3	<62.6	**0.103**	2.36	5.35	7.75	--	--	--	--
B-14	3/1/2012	5.0	--	121	<65.4	--	--	--	--	--	--	--	--
B-14	3/1/2012	7.0	**752**	360	<62.7	**0.202**	4.31	**9.55**	**13.1**	--	--	--	--
Southeast corner													
C-1	4/6-8/2012	4.0	**346**	--	--	**2.0**	2.2	2.0	**13**	--	--	--	--
East wall													
C-2	4/6-8/2012	3.0	**1,060**	--	--	**6.5**	**20**	**30**	**64**	--	--	--	--
C-3	4/6-8/2012	3.5	**2,190**	--	--	**7.7**	**26**	**45**	**120**	--	--	--	--
C-4	4/6-8/2012	4.0	**843**	--	--	**4.3**	**7.1**	**13**	**53**	--	--	--	--
South wall													
C-5	4/6-8/2012	3.0	**1,660**	--	--	**3.7**	**22**	**27**	**120**	--	--	--	--
North side of pipe run													
C-6	4/6-8/2012	3.5	**1,970**	--	--	**27**	**32**	**160**	**160**	--	--	--	--
South wall below berm													
C-7	4/6-8/2012	4.0	**2,480**	--	--	**36**	**46**	**220**	**240**	--	--	--	--
C-8	4/6-8/2012	8.0	**3,080**	--	--	**13**	**7.4**	**12**	**32**	--	--	--	--
Southeast bottom													
C-9	4/6-8/2012	7.5	**1,490**	--	--	**6.6**	**18**	**3.9**	**32**	--	--	--	--
Center south bottom @ 8 feet													
C-10	4/6-8/2012	4.0	**1,590**	--	--	**7.3**	**15**	**25**	**73**	--	--	--	--
C-11	4/6-8/2012	4.0	**2,550**	--	--	**11**	**33**	**56**	**200**	--	--	--	--
C-12	4/6-8/2012	3.0	**2,860**	--	--	**9.4**	**13**	**48**	**67**	--	--	--	--
Wall by pipe run													
C-13	4/6-8/2012	3.5	**1,970**	--	--	**13**	**27**	**95**	**160**	--	--	--	--
Bottom beneath berm													
C-14	4/6-8/2012	8.0	**561**	--	--	**1.6**	**1.1**	**1.8**	**2.7**	--	--	--	--
Bottom beneath B-6													
C-15	4/6-8/2012	8.0	**1,810**	--	--	**4.9**	**4.1**	**2.3**	**9.0**	--	--	--	--
South wall at edge of B-6 boring													
C-16	4/6-8/2012	5.0	**766**	--	--	**3.9**	**13**	**45**	**74**	--	--	--	--

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Soil TPH, BTEX, Fuel Additives, and Lead Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil
808 South Columbus Ave, Goldendale, Washington

Sample Location	Date	Sample Depth (feet bgs)	TPH-GRO	TPH-DRO	TPH-HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Lead
		MTCA Method A CULs	**30/100**	**2000**	**2000**	**0.03**	**7**	**6**	**9**	**0.1**	**0.005**	**NE**	**250**
North wall at edge of B-6 boring													
C-17	4/6-8/2012	5.0	**1,140**	--	--	**8.7**	**17**	**70**	**96**	--	--	--	--
West bottom													
C-18	4/6-8/2012	7.5	**1,290**	--	--	**6.6**	**3.7**	**2.0**	**5.7**	--	--	--	--
West wall													
C-19	4/6-8/2012	4.0	**1,220**	--	--	**7.0**	**22**	**79**	**110**	--	--	--	--
(TerraGraphics Environmental Engineering, Inc. 2015)													
BH-31	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--
BH-32	4/8/2015	8.0	**460 J**	8.0	<4.8	<0.021 J	<0.052 J	<0.052 J	<0.104 J	<0.052 J	**<0.052 J**	<0.052 J	4.6
BH-33	4/8/2015	7.0	**590 J**	230	15	<0.022 J	<0.056 J	<0.056 J	<0.112 J	<0.056 J	**<0.022 J**	<0.022 J	6.6
BH-34	4/8/2015	6.0	<5.1 J	<4.7	<4.7	<0.020 J	<0.051 J	<0.051 J	<0.10 J	<0.051 J	**<0.051 J**	<0.051 J	4.2
(Leidos, Inc. 2018)													
SB-1	4/10/2018	1.5	53	4.1	<12	<0.029	<0.058	0.28	0.91	<0.029	**<0.058**	<0.058	21.4
SB-1	4/10/2018	2.5	37	<3.6	<12	<0.030	<0.061	0.28	0.79	<0.030	**<0.061**	<0.061	21.9
SB-1	4/10/2018	4.0	**270**	<3.8	<13	<0.033	<0.066	<0.066	0.22	<0.033	**<0.066**	<0.066	29.2
SB-1	4/10/2018	6.5	**1,300**	**3,000**	<230	<0.022	<0.044	0.049	0.16	<0.022	**<0.044**	<0.044	38.5
SB-2	4/10/2018	2.5	<1.3	<3.8	<13	0.003	0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	25.6
SB-2	4/10/2018	5.0	4.8	260	22	0.002	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	29.2
SB-3	4/10/2018	2.0	<1.2	<3.7	<12	0.002	<0.0009	<0.0009	<0.0009	<0.0005	<0.0009	<0.0009	27.5
SB-3	4/10/2018	4.0	<1.4	<3.7	<12	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	26.9
SB-4	4/10/2018	2.5	<1.3	<3.8	<13	0.003	<0.002	<0.002	<0.002	<0.0009	<0.002	<0.002	25.2
SB-4	4/10/2018	4.0	<1.3	<3.7	<12	0.002	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	31.7
SB-5	4/5/2018	2.5	<1.4	10	43	0.001	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	9.55
SB-5	4/5/2018	5.5	5.4	91	21	0.002	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	16.9
SB-5	4/5/2018	6.0	**33**	26	<13	0.006	0.001	0.023	0.010	<0.0006	<0.001	<0.001	34.4
SB-6	4/5/2018	2.5	<1.5	<3.9	<13	0.004	0.002	<0.001	<0.001	<0.0006	<0.001	<0.001	13.0
SB-6	4/5/2018	5.5	**290**	76	37	**0.043**	<0.078	1.5	1.1	<0.039	**<0.078**	<0.078	23.8
SB-7	4/5/2018	2.5	<1.5	<3.8	18	0.004	0.002	<0.001	<0.001	<0.0007	<0.001	<0.001	9.10
SB-7	4/5/2018	5.5	<1.4	8.5	<13	0.001	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	9.63
SB-8	4/5/2018	3.5	<1.7	<4.0	<13	0.003	<0.001	<0.001	<0.001	<0.0007	<0.001	<0.001	8.09
SB-8	4/5/2018	6.5	**300**	770	<63	**<0.034**	<0.068	<0.068	<0.068	<0.034	**<0.068**	<0.068	6.43
SB-9	4/5/2018	3.5	<1.3	<3.9	<13	0.003	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	8.9
SB-9	4/5/2018	6.0	19	21	<13	0.001	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	10.7

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Sample Location	Date	Sample Depth (feet bgs)	TPH-GRO	TPH-DRO	TPH-HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Lead
	MTCA Method A CULs		**30/100**	**2000**	**2000**	**0.03**	**7**	**6**	**9**	**0.1**	**0.005**	**NE**	**250**
SB-10	4/17/2018	3.0	<1.3	<3.8	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<2.92
DUP-4-041718	4/17/2018	3.0	<1.4	<4.1	<14	0.0009	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<3.34
SB-10	4/17/2018	5.0	<1.3	<3.9	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<2.91
SB-11	4/4/2018	3.5	<1.4	<4.0	<13	0.001	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	10.2
SB-11	4/4/2018	6.0	**460**	480	<13	<0.026	<0.052	<0.052	<0.052	<0.026	**<0.052**	<0.052	12.3
SB-12	4/4/2018	4.0	<1.3	<3.9	<13	0.0006	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	10.9
SB-12	4/4/2018	5.0	<1.1	<3.7	<12	<0.0004	<0.0009	<0.0009	<0.0009	<0.0004	<0.0009	<0.0009	10.6
SB-13	4/4/2018	3.5	<1.2	<3.8	<13	0.001	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	9.23
SB-13	4/4/2018	5.5	**770**	5.6	<13	**<0.031**	<0.061	0.13	<0.061	<0.031	**<0.061**	<0.061	12.3
SB-14	4/4/2018	3.5	<1.4	<4.0	<13	0.003	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	10.5
SB-14	4/4/2018	6.5	63	54	<13	<0.028	<0.056	<0.056	<0.056	<0.028	**<0.056**	<0.056	10.3
SB-15	4/4/2018	3.5	<1.6	<3.9	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	10.4
SB-15	4/4/2018	6.0	**440**	86	<13	<0.026	<0.052	<0.052	<0.052	<0.026	**<0.052**	<0.052	9.01
SB-16	4/4/2018	3.5	<1.5	<3.9	<13	0.003	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	11.7
SB-16	4/4/2018	6.0	**1,200**	2,000	<59	<0.020	<0.039	<0.039	<0.039	<0.020	**<0.039**	<0.039	5.47
SB-17	4/5/2018	3.5	**1,300**	660	<26	**<0.036**	<0.073	<0.073	<0.073	<0.036	**<0.073**	<0.073	8.36
SB-17	4/5/2018	6.0	**1,100**	830	<65	**<0.045**	<0.090	<0.090	<0.090	<0.045	**<0.090**	<0.090	8.92
SB-18	4/6/2018	2.5	<1.4	<3.9	<13	0.004	0.002	<0.001	<0.001	<0.0006	<0.001	<0.001	13.3
SB-18	4/6/2018	5.5	<1.4	<4.0	<13	0.0008	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	10.5
SB-19	4/5/2018	2.5	<1.6	<3.9	<13	0.003	<0.001	<0.001	<0.001	<0.0007	<0.001	<0.001	9.63
SB-19	4/5/2018	4.5	<1.3	<3.8	<13	0.0006	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	7.79
SB-20	4/6/2018	2.5	<1.4	<3.8	<13	0.004	0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	8.05
SB-20	4/6/2018	5.5	<1.3	<3.9	<13	0.001	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	9.38
SB-21	4/17/2018	3.0	<1.3	<3.9	<13	0.003	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	6.7
SB-21	4/17/2018	6.5	**250**	110	<13	**<0.033**	<0.067	<0.067	<0.067	<0.033	**<0.067**	<0.067	<3.45
SB-22	4/4/2018	3.5	<1.2	<3.8	<13	0.003	0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	7.92
SB-22	4/4/2018	6.0	91	200	<14	<0.026	<0.052	<0.052	<0.052	<0.026	**<0.052**	<0.052	11
SB-23	4/3/2018	2.5	<1.1	<3.8	<13	0.003	0.002	0.003	0.023	<0.0005	<0.001	<0.001	17.3
SB-23	4/3/2018	3.5	<1.4	4.3	15	0.002	0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	19.9
SB-23	4/3/2018	7.5	**380**	83	<11	<0.018	<0.036	<0.036	<0.036	<0.018	**<0.036**	<0.036	10.6
SB-24	4/11/2018	2.0	<1.2	<3.7	<12	0.003	0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	21.2
SB-24	4/11/2018	4.0	**730**	**3,200**	<260	**<0.034**	<0.068	<0.068	<0.068	<0.034	**<0.068**	<0.068	27.8
SB-24	4/11/2018	6.5	**1,500**	1,700	<130	**0.068**	<0.059	0.12	<0.059	<0.029	**<0.059**	<0.059	28.2
SB-25	4/11/2018	3.0	**650**	**4,100**	<260	**<0.033**	<0.066	<0.066	<0.066	<0.033	**<0.066**	<0.066	22.5
SB-25	4/11/2018	6.0	**570**	1,700	<140	**<0.036**	<0.072	0.080	<0.072	<0.036	**<0.072**	<0.072	28.3

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Sample Location	Date	Sample Depth (feet bgs)	TPH-GRO	TPH-DRO	TPH-HO	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE	EDB	EDC	Lead
MTCA Method A CULs			**30/100**	**2000**	**2000**	**0.03**	**7**	**6**	**9**	**0.1**	**0.005**	**NE**	**250**
SB-26	4/11/2018	3.5	<1.3	<3.8	<13	0.002	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	21.6
DUP-3-041118	4/11/2018	3.5	<1.4	<3.7	<12	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	23.0
SB-26	4/11/2018	6.0	**600**	26	<13	**<0.035**	<0.070	<0.070	<0.070	<0.035	**<0.070**	<0.070	31.9
SB-27	4/12/2018	4.0	<1.1	<3.6	<12	0.0008	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	27.5
SB-27	4/12/2018	7.0	<1.3	<3.7	<12	<0.0004	<0.0009	<0.0009	<0.0009	<0.0004	<0.0009	<0.0009	28.3
SB-28	4/12/2018	4.5	<1.4	<3.8	<13	0.001	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	29.6
SB-28	4/12/2018	5.5	<1.4	<3.9	<13	0.0007	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	31.2
SB-28	4/12/2018	6.5	12	12	<13	<0.0005	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	21.6
SB-29	4/11/2018	4.0	<1.5	<3.8	14	0.003	<0.001	<0.001	<0.001	<0.0007	<0.001	<0.001	27.0
SB-29	4/11/2018	6.0	**920**	**2,300**	<130	**0.19**	<0.058	0.10	<0.058	<0.029	**<0.058**	<0.058	26.1
SB-30	4/11/2018	3.5	<1.3	<3.8	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	25.7
SB-30	4/11/2018	5.5	**430**	310	<13	**<0.039**	<0.079	<0.079	<0.079	<0.039	**<0.079**	<0.079	38.5
SB-31	4/12/2018	3.5	<1.4	<3.7	<12	0.001	<0.0009	<0.0009	<0.0009	<0.0005	<0.0009	<0.0009	27.2
SB-31	4/12/2018	6.5	<1.1	<3.7	<12	<0.0005	<0.0009	<0.0009	<0.0009	<0.0005	<0.0009	<0.0009	40.3
SB-32	4/11/2018	3.5	<1.3	<3.7	<12	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	26.3
SB-32	4/11/2018	5.0	9.7	<4.0	<13	<0.0006	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	25.1
SB-33	4/11/2018	3.0	<1.2	<3.7	<12	0.002	<0.0009	<0.0009	<0.0009	<0.0005	<0.0009	<0.0009	21.8
SB-33	4/11/2018	5.0	<1.2	<3.6	<12	0.002	<0.001	<0.001	<0.001	0.0005	<0.001	<0.001	26.7
SB-34	4/11/2018	3.0	<1.2	<3.7	<12	0.003	<0.0009	<0.0009	<0.0009	<0.0005	<0.0009	<0.0009	21.9
SB-34	4/11/2018	5.0	<1.2	<3.7	<12	0.001	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	28.8
SB-35	4/11/2018	2.5	<1.1	<3.4	<11	0.001	<0.0009	<0.0009	<0.0009	<0.0004	<0.0009	<0.0009	27.6
SB-36	4/10/2018	2.5	**34**	<3.6	<12	0.005	0.002	0.066	0.22	<0.0005	<0.001	<0.001	23.1
SB-36	4/10/2018	4.0	**32**	<3.8	<13	0.004	0.002	0.042	0.23	<0.0005	<0.001	<0.001	27.4
SB-36	4/10/2018	6.0	**1,400**	240	13	**0.065**	<0.057	**9.3**	0.17	<0.028	**<0.057**	<0.057	45.4
SB-37	4/5/2018	3.5	<1.4	26	93	0.003	0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	13.5
SB-37	4/5/2018	5.5	**520**	390	<13	**<0.034**	<0.068	<0.068	<0.068	<0.034	**<0.068**	<0.068	9.34
DUP-1-040518	4/5/2018	5.5	56	550	17	<0.020	<0.039	<0.039	<0.039	<0.020	**<0.039**	<0.039	12.5
SB-38	4/5/2018	2.0	15	9.9	<13	**<0.038**	<0.077	<0.077	<0.077	<0.038	**<0.077**	<0.077	22.8
SB-39	4/10/2018	3.5	<1.3	<3.8	<13	0.003	0.002	<0.001	<0.001	<0.0005	<0.001	<0.001	19.6
DUP-2-041018	4/10/2018	3.5	<1.4	<3.8	<13	0.003	0.002	<0.001	<0.001	<0.0006	<0.001	<0.001	24.8
SB-39	4/10/2018	6.0	**880**	230	<13	**<0.031**	<0.063	<0.063	<0.063	<0.031	**<0.063**	<0.063	34.8
SB-40	4/11/2018	3.5	<1.5	<3.9	<13	0.002	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	25.9
SB-40	4/11/2018	5.5	**280**	2,000	<130	**<0.036**	<0.072	<0.072	<0.072	<0.036	**<0.072**	<0.072	30.8
SB-40	4/11/2018	7.0	**2,200**	260	<12	**<0.054**	<0.11	<0.11	<0.11	<0.054	**<0.11**	<0.11	36.4
SB-41	4/17/2018	3.0	<1.4	<3.9	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<3.61
SB-41	4/17/2018	5.5	2.5	<3.9	<13	0.0006	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<2.73

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MTCA Method A CULs			**30/100**	**2000**	**2000**	**0.03**	**7**	**6**	**9**	**0.1**	**0.005**	**NE**	**250**
SB-42	4/17/2018	2.0	<1.5	<3.9	<13	0.003	0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	9.74
SB-42	4/17/2018	5.5	**330**	140	<13	**<0.034**	<0.068	<0.068	<0.068	<0.034	**<0.068**	<0.068	<3.58
SB-43	4/17/2018	2.5	<1.2	<3.8	<13	0.003	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<2.85
SB-43	4/17/2018	5.5	<1.2	60	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	<2.81
SB-44	4/17/2018	5.0	<1.4	37	33	0.0008	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	10.4
SB-44	4/17/2018	6.0	**110**	20	<13	**<0.037**	<0.073	<0.073	<0.073	<0.037	**<0.073**	<0.073	<3.52
SB-45	9/24/2018	3.5	<0.3	<3.7	<12	0.002	0.001	<0.0004	<0.001	<0.0005	<0.0004	<0.0006	6.59
SB-45	9/24/2018	6.5	**270**	270	<13	<0.029	<0.035	<0.023	<0.058	<0.029	**<0.023**	<0.035	9.18
SB-46	9/25/2018	3.0	<0.3	<3.6	<12	0.001	0.0007	<0.0004	<0.001	<0.0005	<0.0004	<0.0006	8.00
SB-46	9/25/2018	4.5	<0.3	<3.6	<12	0.0008	<0.0005	<0.0004	<0.0009	<0.0004	<0.0004	<0.0005	7.27
SB-47	9/25/2018	3.5	<0.3	<3.4	12	0.003	0.001	<0.0005	<0.001	<0.0006	<0.0005	<0.0007	6.47
SB-47	9/25/2018	7.5	<0.3	<3.7	<12	0.001	0.001	0.003	0.027	<0.0005	<0.0004	<0.0005	10.0
SB-48	9/25/2018	3.5	<0.3	<3.4	18	0.003	0.001	<0.0005	<0.001	<0.0006	<0.0005	<0.0007	7.64
SB-48	9/25/2018	7.5	0.3	3.7	12	<0.0005	<0.0006	<0.0004	<0.0009	<0.0005	<0.0004	<0.0006	8.98
SB-49	9/25/2018	3.0	<0.3	<3.4	<11	0.003	0.002	<0.0005	<0.001	<0.0006	<0.0005	<0.0007	6.08
SB-49	9/25/2018	7.0	<0.3	<3.7	<12	<0.0004	<0.0005	<0.0004	<0.0009	<0.0004	<0.0004	<0.0005	9.14
SB-50	9/25/2018	--	--	--	--	--	--	--	--	--	--	--	--
SB-50	9/25/2018	--	--	--	--	--	--	--	--	--	--	--	--
SB-51	12/6/2018	2.5	0.3	<4.6	49	0.0008	0.0006	<0.0004	<0.0009	<0.0005	<0.0004	<0.0005	6.72
SB-51	12/6/2018	5.0	<0.3	<5.0	<12	0.0008	0.001	<0.0004	<0.001	<0.0005	<0.0004	<0.0006	6.97
MW-5	4/12/2018	4.5	<1.6	<4.0	<13	0.002	<0.001	<0.001	<0.001	<0.0007	<0.001	<0.001	28.6
MW-5	4/12/2018	5.5	16	16	<13	0.0005	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	30.8
MW-6	4/12/2018	4.0	<1.2	95	360	0.001	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	28.6
MW-6	4/12/2018	6.0	<1.2	34	120	<0.0005	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	27.5
MW-7	4/12/2018	3.5	<1.2	<3.7	<12	0.003	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	26.7
MW-7	4/12/2018	4.0	<1.3	<3.7	<12	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	28.8
MW-8	4/10/2018	3.0	<1.3	<3.9	<13	0.002	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	26.2
MW-8	4/10/2018	4.5	<1.2	16	<13	0.001	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	31.8
MW-9	4/4/2018	3.5	<1.2	<3.9	<13	0.002	<0.001	<0.001	<0.001	<0.0006	<0.001	<0.001	9.68
MW-9	4/4/2018	6.5	<1.4	<4.0	<13	<0.0005	<0.001	<0.001	<0.001	<0.0005	<0.001	<0.001	8.92

Table 1
Soil TPH, BTEX, Fuel Additives, and Lead Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil
808 South Columbus Ave, Goldendale, Washington

Notes:

1. 30/100 = TPH-GRO MTCA Method A CUL with benzene present is 30 mg/kg and without benzene present is 100 mg/kg.
2. Analytical results are presented in mg/kg.
3. Green shading indicates boring location was overexcavated.
4. **BOLD and highlighted** values are greater than their respective MTCA Method A CUL.
5. **BOLD** values are nondetect, but the MDL is greater than the MTCA Method A CUL.
6. Full 8260 analytical results for sample B-6 available in laboratory report presented in Tim O'Gara Report

Acronyms and Abbreviations:

-- = not analyzed
bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and xylenes
CUL = cleanup level
DUP = blind duplicate sample results
EDB = 1,2-dibromoethane
EDC = 1,2-dichloroethane
mg/kg = milligram per kilogram
MTBE = methyl tertiary butyl ether
MTCA = Model Toxics Control Act
NE = no applicable MTCA Method A CUL
TPH-DRO = total petroleum hydrocarbons as diesel-range organics
TPH-GRO = total petroleum hydrocarbons as gasoline-range organics
TPH-HO = total petroleum hydrocarbons as heavy-oil range organics
USEPA = United States Environmental Protection Agency

Qualifiers:

<n = Not detected at or greater than the laboratory method detection limit (MDL) or reporting limit.
J = reported result was flagged "J" because it is an estimated value.

Analytical Methods:

Year	Analyte and Analytical Method
2012	Analytes analyzed by SW 8260B method: BTEX MTBE EDC EDB TPH-GRO analyzed by NWTPH-Gx method TPH-DRO analyzed by NWTPH-Dx method Lead analyzed by E6010 method Analytes analyzed by SW 8021B method: BTEX
2015	Analytes analyzed by USEPA Method 8260B: BTEX MTBE EDC EDB TPH-GRO analyzed by NWTPH-Gx Analytes analyzed by NWTPH-Dx without silica gel cleanup: TPH-DRO TPH-HO Lead analyzed by USEPA 6020
2018	Analytes analyzed by USEPA Method 8260C: BTEX MTBE EDC EDB TPH-GRO analyzed by NWTPH-Gx Analytes analyzed by NWTPH-Dx without silica gel cleanup: TPH-DRO TPH-HO Lead analyzed by USEPA 6010D

References:

Leidos, Inc. 2019. Draft Remedial Investigation/ Feasibility Study Former Temple Distributing Site. 808 South Columbus Ave., Goldendale, Washington. April 12.
TerraGraphics Environmental Engineering, Inc. 2015. Final 2015 Supplemental Environmental Site Assessment Report Columbus Square, Goldendale, Washington. December 18.
Tim O'Gara, R.G. 2012. Carson - Goldendale Fuel Spill. May 4.

Table 2
Soil cPAH Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Sample Location ID	Sample Depth (feet bgs)	Sample Date	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Ideno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total cPAHs
MTCA Method A CULs			**NE**	**NE**	**NE**	**NE**	**0.1**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**5**	**NE**	**NE**	**0.1**
(Tim O'Gara, R.G. 2012)																			
Soil inside berm area																			
S- Center	0-0.5	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Center	0-0.5	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NW	0-0.5	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NE	0-0.5	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SE	0-0.5	3/1/2012	0.474	0.344	0.396	0.155	0.0685	0.0775	0.128	0.0216	0.0649	<0.018	0.171	0.546	0.036	**159**	0.955	0.299	0.099059
SW	0-0.5	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-Center	4.5	3/2/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-Center	4.66	3/2/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NW	3.0	3/2/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
NW	5.16	3/2/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Center	4.83	3/2/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-Center	3.0	3/2/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-1	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-2	7.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-3	7.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-4	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-4	7.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-5	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-5	8.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-6	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-6	8.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-7	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-7	8.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-8	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-8	8.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-9	7.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-10	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-10	9.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-11	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-11	7.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-12	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-12	8.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 2
Soil cPAH Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Sample Location ID	Sample Depth (feet bgs)	Sample Date	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Ideno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total cPAHs
	MTCA Method A CULs		**NE**	**NE**	**NE**	**NE**	**0.1**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**5**	**NE**	**NE**	**0.1**
B-13	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-13	9.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-14	5.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
B-14	7.0	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
(TerraGraphics Environmental Engineering, Inc. 2015)																			
BH-31	--	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
BH-32	8.0	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.052 J	--	--	--
BH-33	8.0	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	3.6 J+	--	--	--
BH-34	6.0	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	<0.051 J	--	--	--
(Leidos, Inc. 2018)																			
SB-1	1.5	4/10/18	--	--	--	<0.0008	<0.0008	0.001	--	<0.0008	0.002	<0.0008	--	--	<0.0008	0.47	--	--	0.00068
SB-1	2.5	4/10/18	--	--	--	<0.0008	<0.0008	0.001	--	<0.0008	0.001	<0.0008	--	--	<0.0008	0.49	--	--	0.00067
SB-1	4.0	4/10/18	--	--	--	0.002	<0.0009	<0.0009	--	<0.0009	0.001	<0.0009	--	--	<0.0009	0.24	--	--	0.00084
SB-1	6.5	4/10/18	--	--	--	<0.008	<0.008	<0.008	--	<0.008	0.010	<0.008	--	--	<0.008	<0.008	--	--	0.0061
SB-2	2.5	4/10/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-2	5.0	4/10/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000677
SB-3	2.0	4/10/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-3	4.0	4/10/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	0.0004	<0.0008	--	--	<0.0008	0.042	--	--	0.000604
SB-4	2.5	4/10/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-4	4.0	4/10/18	--	--	--	0.001	<0.0008	0.001	--	<0.0008	0.001	<0.0008	--	--	<0.0008	0.002	--	--	0.00073
SB-5	2.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-5	5.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-5	6.0	4/5/18	--	--	--	0.003	0.002	0.003	--	0.001	0.005	<0.0009	--	--	0.001	<0.0009	--	--	0.002865
SB-6	2.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-6	5.5	4/5/18	--	--	--	0.001	0.001	0.001	--	<0.0009	0.002	<0.0009	--	--	<0.0009	0.039	--	--	0.001355
SB-7	2.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-7	5.5	4/5/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	0.001	--	--	0.001	0.003	--	--	0.000787
SB-8	3.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-8	6.5	4/5/18	--	--	--	<0.009	<0.009	<0.009	--	<0.009	0.004	<0.009	--	--	<0.009	<0.009	--	--	0.000715
SB-9	3.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-9	6.0	4/5/18	--	--	--	<0.0009	<0.0009	0.001	--	<0.0009	0.001	<0.0009	--	--	<0.0009	0.007	--	--	0.00074
SB-10	3.0	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DUP-4-041718	3.0	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-10	5.0	4/17/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	<0.0009	--	--	<0.0009	0.005	--	--	0.000679
SB-11	3.5	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-11	6.0	4/4/18	--	--	--	0.0009	<0.0009	<0.0009	--	<0.0009	0.003	<0.0009	--	--	<0.0009	<0.0009	--	--	0.00075

Table 2
Soil cPAH Analytical Results
Interim Action Work Plan
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Sample Location ID	Sample Depth (feet bgs)	Sample Date	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Ideno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total cPAHs
MTCA Method A CULs			**NE**	**NE**	**NE**	**NE**	**0.1**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**5**	**NE**	**NE**	**0.1**
SB-12	4.0	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-12	5.0	4/4/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	0.006	--	--	0.000602
SB-13	3.5	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-13	5.5	4/4/18	--	--	--	<0.0009	<0.0009	0.0009	--	<0.0009	0.001	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000685
SB-14	3.5	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-14	6.5	4/4/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	0.001	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000685
SB-15	3.5	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-15	6.0	4/4/18	--	--	--	0.001	<0.0008	<0.0008	--	<0.0008	0.001	<0.0008	--	--	<0.0008	0.043	--	--	0.00067
SB-16	3.5	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-16	6.0	4/4/18	--	--	--	<0.004	<0.004	<0.004	--	<0.004	0.005	<0.004	--	--	<0.004	<0.004	--	--	0.00305
SB-17	3.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-17	6.0	4/5/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	0.0008	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000738
SB-18	2.5	4/6/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-18	5.5	4/6/18	--	--	--	0.003	0.001	0.003	--	0.001	0.004	<0.0009	--	--	<0.0009	0.012	--	--	0.00183
SB-19	2.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-19	4.5	4/5/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	0.001	--	--	0.001	<0.0008	--	--	0.000722
SB-20	2.5	4/6/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-20	5.5	4/6/18	--	--	--	<0.0009	0.001	0.002	--	<0.0009	0.0009	<0.0009	--	--	0.001	<0.0009	--	--	0.001444
SB-21	3.0	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-21	6.5	4/17/18	--	--	--	0.001	<0.0009	0.002	--	<0.0009	0.003	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000915
SB-22	3.5	4/4/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-22	6.0	4/4/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	0.001	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000685
SB-23	2.5	4/3/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-23	3.5	4/3/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-23	7.5	4/3/18	--	--	--	0.005	0.006	0.006	--	0.002	0.008	<0.0007	--	--	0.003	0.027	--	--	0.007715
SB-24	2.0	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-24	4.0	4/11/18	--	--	--	<0.009	<0.009	<0.009	--	<0.009	0.024	<0.009	--	--	<0.009	1.2	--	--	0.00699
SB-24	6.5	4/11/18	--	--	--	<0.008	<0.008	<0.008	--	<0.008	0.024	<0.008	--	--	<0.008	3.2	--	--	0.00624
SB-25	3.0	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-25	6.0	4/11/18	--	--	--	0.011	<0.009	<0.009	--	<0.009	0.036	<0.009	--	--	<0.009	3.8	--	--	0.00776
SB-26	3.5	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DUP-3-041118	3.5	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-26	6.0	4/11/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000677
SB-27	4.0	4/12/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-27	7.0	4/12/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	<0.0008	--	--	0.000602

Table 2
Soil cPAH Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Sample Location ID	Sample Depth (feet bgs)	Sample Date	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Ideno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total cPAHs
	MTCA Method A CULs		**NE**	**NE**	**NE**	**NE**	**0.1**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**5**	**NE**	**NE**	**0.1**
SB-28	4.5	4/12/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-28	5.5	4/12/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000677
SB-28	6.5	4/12/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	<0.0008	--	--	0.000602
SB-29	4.0	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-29	6.0	4/11/18	--	--	--	<0.008	<0.008	<0.008	--	<0.008	0.016	<0.008	--	--	<0.008	2.9	--	--	0.00616
SB-30	3.5	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-30	5.5	4/11/18	--	--	--	0.003	0.001	0.002	--	<0.0009	0.007	<0.0009	--	--	<0.0009	<0.0009	--	--	0.001705
SB-31	3.5	4/12/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-31	6.5	4/12/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	<0.0008	--	--	0.000602
SB-32	3.5	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-32	5.0	4/11/18	--	--	--	0.002	0.001	0.001	--	0.001	0.002	<0.0009	--	--	<0.0009	0.001	--	--	0.00151
SB-33	3.0	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-33	5.0	4/11/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	0.002	--	--	0.000602
SB-34	3.0	4/11/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-34	5.0	4/11/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0009	<0.0004	<0.0008	--	--	<0.0008	0.009	--	--	0.000607
SB-35	2.5	4/11/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	0.0005	<0.0008	--	--	<0.0008	0.002	--	--	0.000605
SB-36	2.5	4/10/18	--	--	--	<0.0008	<0.0008	0.002	--	<0.0008	0.002	<0.0008	--	--	0.0009	0.37	--	--	0.00083
SB-36	4.0	4/10/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	0.10	--	--	0.000602
SB-36	6.0	4/10/18	--	--	--	0.004	0.001	0.002	--	<0.0008	0.004	<0.0008	--	--	<0.0008	**5.9**	--	--	0.00176
SB-37	3.5	4/5/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-37	5.5	4/5/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	0.001	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000685
DUP-1-040518	5.5	4/5/18	--	--	--	<0.0009	0.0009	0.001	--	0.0009	0.001	0.002	--	--	0.002	<0.0009	--	--	0.001545
SB-38	2.0	4/5/18	--	--	--	<0.0009	<0.0009	0.002	--	<0.0009	0.002	<0.0009	--	--	<0.0009	0.032	--	--	0.00085
SB-39	3.5	4/10/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DUP-2-041018	3.5	4/10/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-39	6.0	4/10/18	--	--	--	0.003	0.001	0.002	--	<0.0009	0.004	<0.0009	--	--	<0.0009	0.17	--	--	0.001675
SB-40	3.5	4/11/18	--	--	--	--	--	--		--	--	--	--	--	--	--	--	--	
SB-40	5.5	4/11/18	--	--	--	<0.009	<0.009	<0.009		<0.009	0.017	<0.009	--	--	<0.009	<0.009	--	--	0.00692
SB-40	7.0	4/11/18	--	--	--	<0.0008	<0.0008	<0.0008		<0.0008	0.001	<0.0008	--	--	<0.0008	0.087	--	--	0.00061
SB-41	3.0	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-41	5.5	4/17/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	<0.0009	--	--	<0.0009	0.001	--	--	0.000677
SB-42	2.0	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
SB-42	5.5	4/17/18	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	0.0006	<0.0009	--	--	<0.0009	0.002	--	--	0.000681
SB-43	2.5	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-43	5.5	4/17/18	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	0.0005	<0.0008	--	--	<0.0008	0.001	--	--	0.000605

Table 2
Soil cPAH Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Sample Location ID	Sample Depth (feet bgs)	Sample Date	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Ideno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total cPAHs
	MTCA Method A CULs		NE	NE	NE	NE	0.1	NE	NE	NE	NE	NE	NE	NE	NE	5	NE	NE	0.1
SB-44	5.0	4/17/18	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
SB-44	6.0	4/17/18	--	--	--	0.002	0.001	0.002	--	0.0009	0.002	<0.0009	--	--	<0.0009	<0.0009	--	--	0.0016
SB-45	3.5	9/24/2018	--	--	--	<0.0008	<0.0008	0.001	--	<0.0008	0.0007	<0.0008	--	--	<0.0008	<0.002	--	--	0.000667
SB-45	6.5	9/24/2018	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	0.001	<0.0008	--	--	<0.0008	<0.002	--	--	0.00061
SB-46	3.0	9/25/2018	--	--	--	<0.0008	<0.0008	0.001	--	<0.0008	0.0009	<0.0008	--	--	<0.0008	<0.002	--	--	0.000669
SB-46	4.5	9/25/2018	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	0.0007	<0.0008	--	--	<0.0008	<0.002	--	--	0.000607
SB-47	3.5	9/25/2018	--	--	--	<0.0008	<0.0008	0.004		<0.0008	0.003	<0.0008	--	--	<0.0008	<0.002	--	--	0.00099
SB-47	7.5	9/25/2018	--	--	--	0.004	0.005	0.009		0.003	0.005	0.001	--	--	0.004	0.002	--	--	0.00715
SB-48	3.5	9/25/2018	--	--	--	0.0008	0.0008	0.006	--	0.001	0.005	<0.0008	--	--	0.001	<0.002	--	--	0.00177
SB-48	7.5	9/25/2018	--	--	--	<0.0008	<0.0008	0.0009	--	<0.0008	0.0007	<0.0008	--	--	<0.0008	<0.002	--	--	0.000657
SB-49	3.0	9/25/2018	--	--	--	0.003	0.004	0.008	--	0.003	0.005	<0.0007	--	--	0.002	<0.001	--	--	0.005685
SB-49	7.0	9/25/2018	--	--	--	0.002	0.002	0.005	--	0.002	0.003	<0.0008	--	--	0.001	0.003	--	--	0.00307
SB-50	--	9/25/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-50	--	9/25/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SB-51	2.5	12/6/2018	--	--	--	0.004	<0.004	0.012	--	<0.004	0.019	<0.004	--	--	<0.004	0.16	--	--	0.00439
SB-51	5.0	12/6/2018	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	0.0005	<0.0008	--	--	<0.0008	0.011	--	--	0.000605
MW-5	4.5	4/12/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-5	5.5	4/12/2018	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	0.0005	<0.0009	--	--	<0.0009	0.003	--	--	0.00068
MW-6	4.0	4/12/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-6	6.0	4/12/2018	--	--	--	0.002	0.008	0.013	--	0.005	0.002	0.002	--	--	0.009	0.001	--	--	0.01112
MW-7	3.5	4/12/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-7	4.0	4/12/2018	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	<0.0008	--	--	0.000602
MW-8	3.0	4/10/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-8	4.5	4/10/2018	--	--	--	<0.0008	<0.0008	<0.0008	--	<0.0008	<0.0004	<0.0008	--	--	<0.0008	<0.0008	--	--	0.000602
MW-9	3.5	4/4/2018	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MW-9	6.5	4/4/2018	--	--	--	<0.0009	<0.0009	<0.0009	--	<0.0009	<0.0004	<0.0009	--	--	<0.0009	<0.0009	--	--	0.000677

Table 2
Soil cPAH Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Notes:
1. Analytical results are presented in mg/kg.
2. Green shading indicates boring location was overexcavated.
3. **BOLD and highlighted** values are greater than their respective MTCA Method A CUL.
4. Full 8260 analytical results for sample SE available in laboratory report presented in Tim O'Gara Report

Acronyms and Abbreviations:
-- = not analyzed
bgs = below ground surface
cPAH = carcinogenic polycyclic aromatic hydrocarbon
CUL = cleanup level
DUP = blind duplicate sample results
mg/kg = milligram per kilogram
MTCA = Model Toxics Control Act
NE = no applicable MTCA Method A CUL
USEPA = United States Environmental Protection Agency

Qualifiers:
<n = Not detected at or greater than the laboratory method detection limit or reporting limit.
J = Reported result was flagged "J" because it is an estimated value.
J+ = Reported result was flagged "J" because it is an estimated value with a high bias.

Analytical Methods:

Year	Analyte and Analytical Method
2012	Not applicable
2015	Naphthalene analyzed by USEPA Method 8260B
2018	cPAHs analyzed by USEPA Method 8270D

References:
Leidos, Inc. 2019. Draft Remedial Investigation/ Feasibility Study Former Temple Distributing Site. 808 South Columbus Ave., Goldendale, Washington. April 12.
TerraGraphics Environmental Engineering, Inc. 2015. Final 2015 Supplemental Environmental Site Assessment Report Columbus Square, Goldendale, Washington. December 18.
Tim O'Gara, R.G. 2012. Carson - Goldendale Fuel Spill. May 4.

Table 3
Groundwater Gauging Data and TPH, BTEX, Fuel Additive, and Lead Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Sample Location	Date	TOC (feet)	DTW (feet bgs)	Total Depth (feet bgs)	Water Column (feet)	GWE (feet)	TPH-GRO	TPH-DRO	TPH-HO	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE	EDB	EDC	Dissolved Lead	Comments
						MTCA Method A CULs	**800/1,000**	**500**	**500**	**5**	**1,000**	**700**	**1,000**	**20**	**0.01**	**5**	**15**	
(Tim O'Gara, R.G. 2012)																		
B-1-W	3/1/2012	--	--	--	--	--	227	<0.0853	<0.213	0.485	1.17	1.43	1.99	--	--	--	--	Grab sample
B-2-W	3/1/2012	--	--	--	--	--	**10,500**	--	--	**20.7**	14.0	615	961	--	--	--	--	Grab sample
B-4-W	3/1/2012	--	--	--	--	--	**2,770**	**7,980**	322	**11.5**	9.58	48.9	88.6	--	--	--	--	Grab sample
B-6-W	3/1/2012	--	--	--	--	--	**127,000**	**853**	437	**11,500**	**40,000**	**2,430**	**11,300**	--	--	--	--	Grab sample
B-8-W	3/1/2012	--	--	--	--	--	**4,240**	**1,240**	393	**43.6**	5.34	45.9	45.5	--	--	--	--	Grab sample
B-9-W	3/1/2012	--	--	--	--	--	288	**2,080**	<216	2.07	3.26	2.17	2.75	--	--	--	--	Grab sample
B-10-W	3/1/2012	--	--	--	--	--	--	**20,700**	**1,300**	--	--	--	--	--	--	--	--	Grab sample
B-11-W	3/1/2012	--	--	--	--	--	--	**294,000**	**773**	--	--	--	--	--	--	--	--	Grab sample
B-12-W	3/1/2012	--	--	--	--	--	--	**169,000**	**808**	--	--	--	--	--	--	--	--	Grab sample
B-13-W	3/1/2012	--	--	--	--	--	--	**36,500**	112	--	--	--	--	--	--	--	--	Grab sample
B-14-W	3/1/2012	--	--	--	--	--	--	**213,000**	472	--	--	--	--	--	--	--	--	Grab sample
(TerraGraphics Environmental Engineering, Inc. 2015)																		
DPW-2	4/8/2015	--	--	--	--	--	530	<120 J	<270	<2.0	0.87 J	<0.2 J	0.76 J	<2.0	<0.01 J+	<2.0	3.1	Grab sample
DPW-2 DUP	4/8/2015	--	--	--	--	--	510	130 Y J	<260	<2.0	3.2 J	0.3 J	1.91 J	<2.0	<0.01 J+	<2.0	2.8	Grab sample
(Tim O'Gara, R.G. 2012) and (Leidos, Inc. 2018)																		
MW-1	4/20/2012	1,644.50	6.33	9.00	2.67	1,638.17	<100	--	--	**5.38**	9.05	<1.0	<3.0	<1.0	<0.023	<1.0	--	
MW-1	4/18/2018	1,644.50	7.70	9.00	1.30	1,636.80	<50	<47	<100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0096	<0.5	<6.0	
MW-2	4/20/2012	1,641.38	5.60	8.50	2.90	1,635.78	**8,910**	--	--	**1,250**	**1,800**	72.8	773	<1.0	<0.023	<1.0	--	
MW-2	4/30/2012	1,641.38	--	8.50	--	--	**14,500**	--	--	**829**	**1,490**	104	**1,039**	<1.0	<0.023	<1.0	--	Resample of MW-2
MW-2	4/19/2018	1,641.38	4.10	8.50	4.40	1,637.28	51	--	--	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0094	<0.5	--	
MW-3	4/20/2012	1,642.02	2.73	8.50	5.77	1,639.29	**5,080**	--	--	4.0	6.41	27.0	9.37	<1.0	<0.023	<1.0	--	
MW-3	4/30/2012	1,642.02	--	8.50	--	--	**6,180**	--	--	0.60	ND	7.75	6.08	<1.0	<0.023	<1.0	--	Resample of MW-3
MW-3	4/18/2018	1,642.02	3.65	8.50	4.85	1,638.37	**3,500**	250	<110	<0.5	0.60	7.0	<0.5	<0.5	<0.0094	<0.5	<6.0	
MW-4	4/20/2012	1,641.93	2.26	8.00	5.74	1,639.67	**6,000**	--	--	<0.30	<1.0	<1.0	<3.0	<1.0	<0.023	<1.0	--	
MW-4	4/19/2018	1,641.93	2.90	8.00	5.10	1,639.03	120	470	160	<0.5	4.0	<0.5	<0.5	<0.5	<0.0095	<0.5	<6.0	
MW-5	4/18/2018	1,641.44	4.59	6.50	1.91	1,636.85	490	250	<100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0094	<0.5	<6.0	
MW-6	4/18/2018	1,641.11	4.29	6.80	2.51	1,636.82	<50	<45	<100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0094	<0.5	<6.0	
MW-7	4/18/2018	--	DRY	5.00	--	--	--	--	--	--	--	--	--	--	--	--	--	Not sampled – well dry
MW-8	4/18/2018	1,641.18	2.34	5.00	2.66	1,638.84	<50	<49	<110	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0094	<0.5	<6.0	
MW-9	4/18/2018	1,642.88	3.01	7.00	3.99	1,639.87	<50	<47	<100	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0094	<0.5	<6.0	

Table 3
Groundwater Gauging Data and TPH, BTEX, Fuel Additive, and Lead Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Notes:
1. 800/1,000 = TPH-GRO MTCA Method A CUL with benzene present is 800 µg/L and without is 1,000 µg/L.
2. Analytical results are presented in µg/L.
3. **BOLD and highlighted** values are greater than their respective MTCA Method A CUL.

Acronyms and Abbreviations:
-- = not analyzed
µg/L = microgram per liter
bgs = below ground surface
BTEX = benzene, toluene, ethylbenzene, and total xylenes
CUL = cleanup level
DTW = depth to water in feet below TOC
DUP = blind duplicate sample results
EDB = 1,2-dibromoethane
EDC = 1,2-dichloroethane
GWE = groundwater elevation
MTBE = methyl tertiary butyl ether
MTCA = Model Toxics Control Act
ND = analyte not detected
TOC = top of casing
TPH = total petroleum hydrocarbons
TPH-DRO = total petroleum hydrocarbons as diesel-range organics
TPH-GRO = total petroleum hydrocarbons as gasoline-range organics
TPH-HO = total petroleum hydrocarbons as heavy-oil range organics
USEPA = United States Environmental Protection Agency

Qualifiers:
<n = Not detected at or greater than the laboratory method detection limit.
J = Reported result was flagged "J" because it is an estimated value.
J+ = Reported result was flagged "J" because it is an estimated value with a high bias.
Y = The chromatograph response resembles a typical fuel pattern.

Analytical Methods:

Year	Analyte and Analytical Method
2012	Analytes analyzed by USEPA Method 8260B:
	BTEX
	MTBE
	EDC
	EDB analyzed by USEPA Method 8011
	TPH-GRO analyzed by NWTPH-Gx
2018	Analytes analyzed by USEPA Method 8260C:
	BTEX
	MTBE
	EDC
	EDB analyzed by USEPA Method 8011
	TPH-GRO analyzed by NWTPH-Gx
	Analytes analyzed by NWTPH-Dx without silica gel cleanup
	TPH-DRO
	TPH-HO
	Dissolved lead analyzed by USEPA 6010D

References:
Leidos, Inc. 2019. Draft Remedial Investigation/ Feasibility Study Former Temple Distributing Site. 808 South Columbus Ave., Goldendale, Washington. April 12.
TerraGraphics Environmental Engineering, Inc. 2015. Final 2015 Supplemental Environmental Site Assessment Report Columbus Square, Goldendale, Washington. December 18.
Tim O'Gara, R.G. 2012. Carson - Goldendale Fuel Spill. May 4.

Table 4
Groundwater Gauging Data and cPAH Analytical Results
Interim Action Work Plan
Temple Distributing Carson Oil Site
808 South Columbus Ave, Goldendale, Washington

Sample Location	Date	TOC (feet)	DTW (feet bgs)	Total Depth (feet bgs)	Water Column (feet)	GWE (feet)	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total cPAHs	Comments
						MTCA Method A CULs	**NE**	**NE**	**NE**	**NE**	**0.1**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**160**	**NE**	**NE**	**0.1**	
(Tim O'Gara, R.G. 2012)																								
B-1-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-2-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-4-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-6-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-8-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-9-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-10-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-11-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-12-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-13-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
B-14-W	3/1/2012	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
(TerraGraphics Environmental Engineering, Inc. 2015)																								
DPW-2	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
DPW-2 DUP	4/8/2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Grab sample
(Tim O'Gara, R.G. 2012) and (Leidos, Inc. 2018)																								
MW-1	4/20/2012	1,644.50	6.33	9.00	2.67	1,638.17	--	--	--	--	--	--	--	--	--	--	--	--	--	<1.0	--	--	--	
MW-1	4/18/2018	1,644.50	7.70	9.00	1.30	1,636.80	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.1	<0.0151	
MW-2	4/20/2012	1,641.38	5.60	8.50	2.90	1,635.78	--	--	--	--	--	--	--	--	--	--	--	--	--	8.7	--	--	--	
MW-2	4/30/2012	1,641.38	--	8.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.2	--	--	--	Resample of MW-2
MW-2	4/19/2018	1,641.38	4.10	8.50	4.40	1,637.28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
MW-3	4/20/2012	1,642.02	2.73	8.50	5.77	1,639.29	--	--	--	--	--	--	--	--	--	--	--	--	--	66.0	--	--	--	
MW-3	4/30/2012	1,642.02	--	8.50	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	39.6	--	--	--	Resample of MW-3
MW-3	4/18/2018	1,642.02	3.65	8.50	4.85	1,638.37	0.3	0.1	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	5.0	<0.03	<0.1	<0.0151	
MW-4	4/20/2012	1,641.93	2.26	8.00	5.74	1,639.67	--	--	--	--	--	--	--	--	--	--	--	--	--	7.19	--	--	--	
MW-4	4/19/2018	1,641.93	2.90	8.00	5.10	1,639.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.01	<0.0151	
MW-5	4/18/2018	1,641.44	4.59	6.50	1.91	1,636.85	0.09	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.30	<0.01	<0.03	0.050	<0.1	<0.0151	
MW-6	4/18/2018	1,641.11	4.29	6.80	2.51	1,636.82	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.01	<0.01	<0.0151	
MW-7	4/18/2018	--	DRY	5.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	Not Sampled - Well Dry
MW-8	4/18/2018	1,641.18	2.34	5.00	2.66	1,638.84	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.03	<0.03	<0.1	<0.0151	
MW-9	4/18/2018	1,642.88	3.01	7.00	3.99	1,639.87	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04	<0.04	<0.1	<0.0151	

Notes:
1. Analytical results are presented in µg/L.
2. **BOLD and highlighted** values are greater than their respective MTCA Method A CUL.
3. Total cPAHs derived according to MTCA Cleanup Regulation Table 740-1 [d].

Acronyms and Abbreviations:
-- = not analyzed
µg/L = microgram per liter
bgs = below ground surface
cPAH = carcinogenic polycyclic aromatic hydrocarbons
CUL = cleanup level
DTW = depth to water in feet below TOC
DUP = blind duplicate sample results
GWE = groundwater elevation
MTCA = Model Toxics Control Act
NE = no applicable MTCA Method A CUL
TOC = top of casing
USEPA = United States Environmental Protection Agency

Qualifier:
<n = Not detected at or above the laboratory Method Detection Limit (MDL)

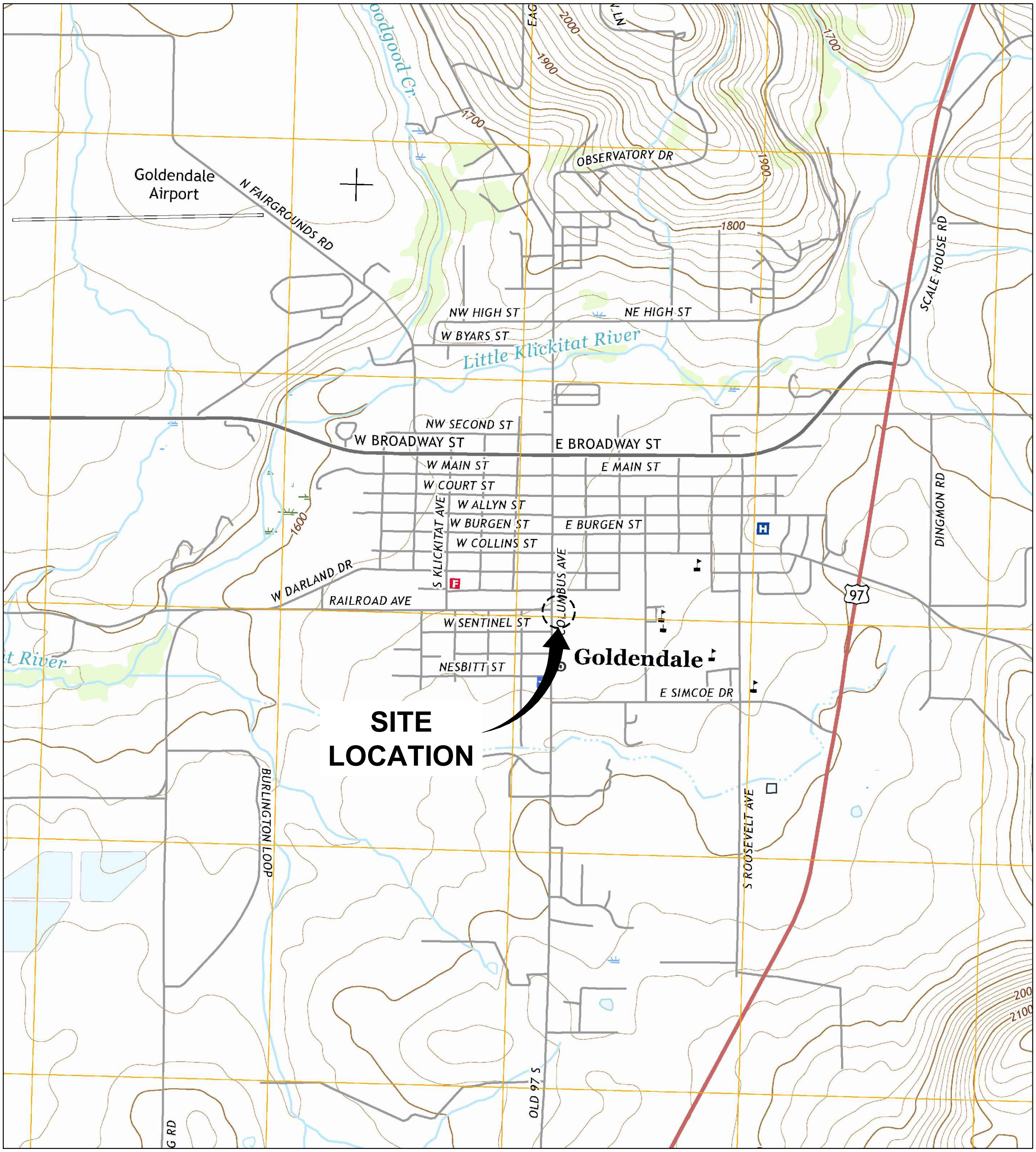
Analytical Methods:

Year	Analyte and Analytical Method
2012	Naphthalene analyzed by USEPA Method 8260B
2018	cPAHs analyzed by USEPA Method 8270D

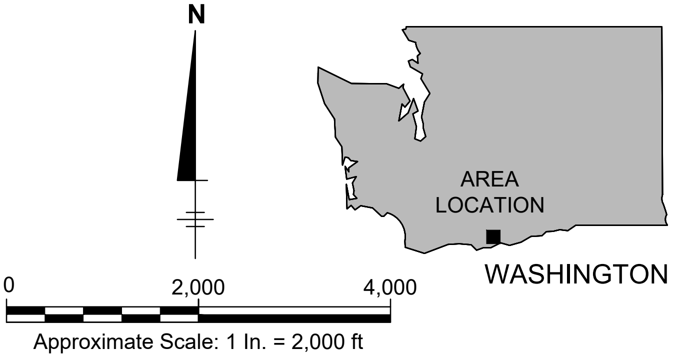
References:

Leidos, Inc. 2019. Draft Remedial Investigation/ Feasibility Study Former Temple Distributing Site. 808 South Columbus Ave., Goldendale, Washington. April 12.
TerraGraphics Environmental Engineering, Inc. 2015. Final 2015 Supplemental Environmental Site Assessment Report Columbus Square, Goldendale, Washington. December 18.
Tim O'Gara, R.G. 2012. Carson - Goldendale Fuel Spill. May 4.

Figures



SOURCE: BASEMAP USGS 7.5. MIN. TOPO. QUAD., GOLDENDALE, WASHINGTON 2017.



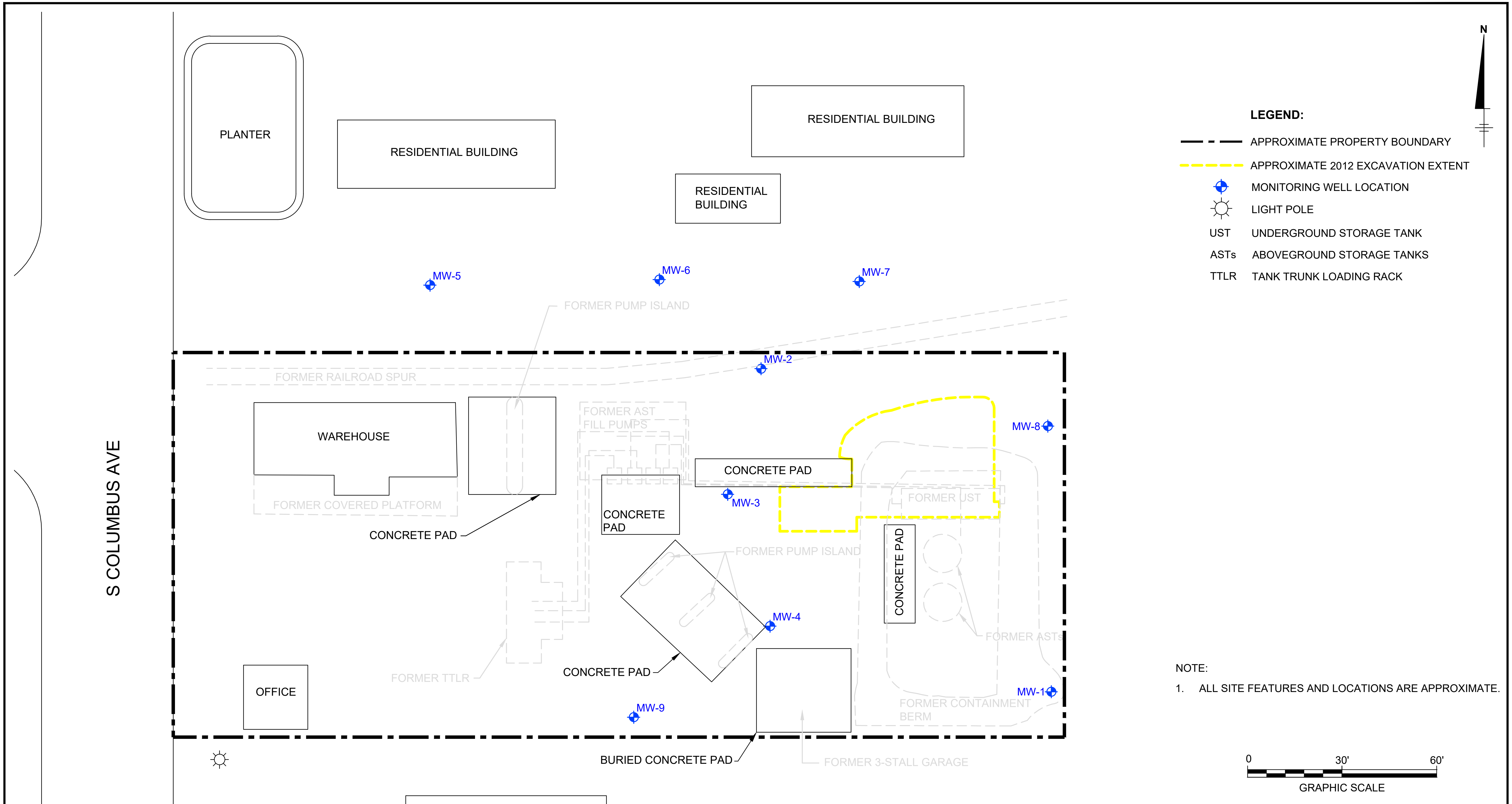
FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

SITE LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
1

CITY: CITY DIV/GROUP:ENV_CAD DB:CAD
C:\Users\shasarek6736\BIM 360\Arcadis\ANA - CHEVRON CORPORATION\Project Files\375289 Goldendale Figures\2020\30012456\01-DWG\375289 FIG 1 SLM.dwg LAYOUT: 1 SAVED: 9/16/2020 12:44 PM PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 9/23/2020 10:05 AM BY: S HASARE, KAREPPA



NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

SITE LAYOUT MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
C:\Users\shasare\6736\BIM 360\Arcadis\NA - CHEVRON CORPORATION\Project Files\375289 Goldendale Figures\2020\30012456\01-DWG\375289 FIG 3 MWL.dwg LAYOUT: 2-1 SAVED: 9/18/2020 7:12 PM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/23/2020
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LEGEND:

— — — APPROXIMATE PROPERTY BOUNDARY

——— PARCEL BOUNDARY

NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.

SOURCE: DIGITAL GLOBE CNEC 2019 DISTRIBUTION
AIRBUS DS

0 150' 300'

GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

SITE VICINITY MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
C:\Users\shasarek6736\BIM 360\Arcadis\ANA - CHEVRON CORPORATION\Project Files\375289 Goldendale Figures\2020\30012456\01-DWG\375289 FIG 2 SVM.dwg LAYOUT: 2-2 SAVED: 9/18/2020 7:11 PM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/23/2020
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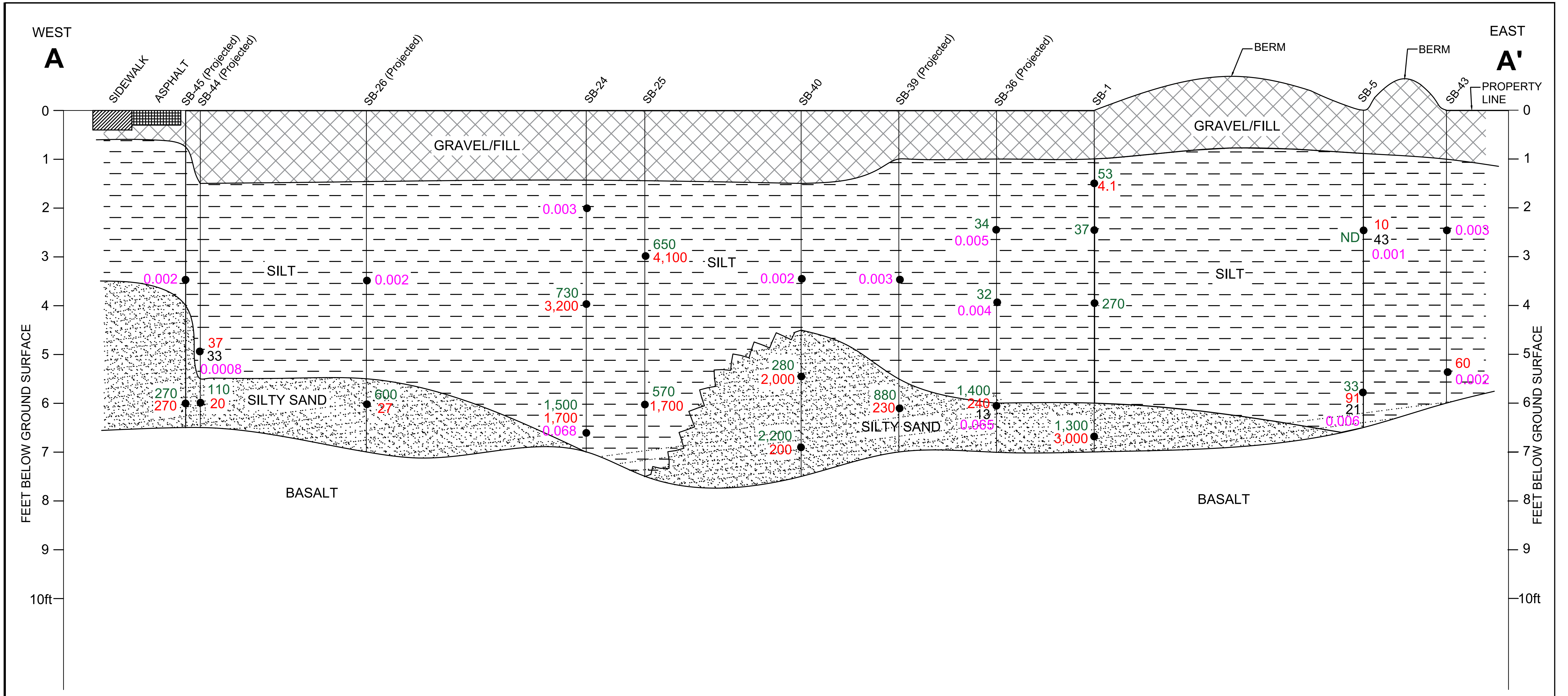

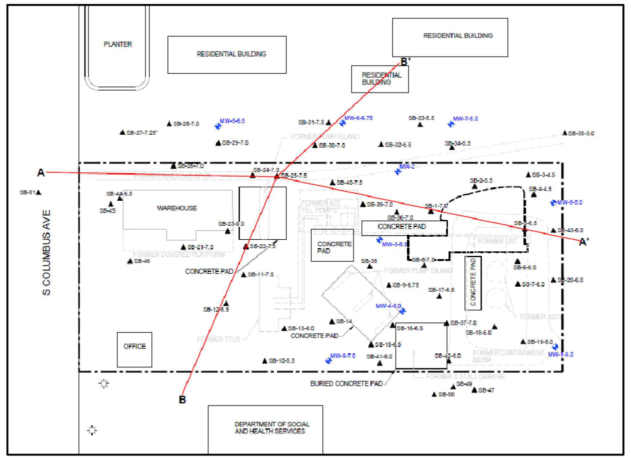

LEGEND:

0.002	BENZENE CONCENTRATION IN MILLIGRAMS PER KILOGRAM (mg/kg)
63	GASOLINE-RANGE HYDROCARBON CONCENTRATION IN mg/kg
20	DIESEL-RANGE HYDROCARBON CONCENTRATION IN mg/kg
83	HEAVY OIL-RANGE HYDROCARBON CONCENTRATION IN mg/kg
MTCA	MODEL TOXIC CONTROL ACT
ND	NO ANALYTES DETECTED ABOVE MTCA METHOD A CLEANUP LEVELS

▨ EXCAVATION BACKFILL

☐ BASALT

▤ SILT

▒ SILTY SAND

0 10' 20'
GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

GEOLOGIC CROSS-SECTION A-A'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
4

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
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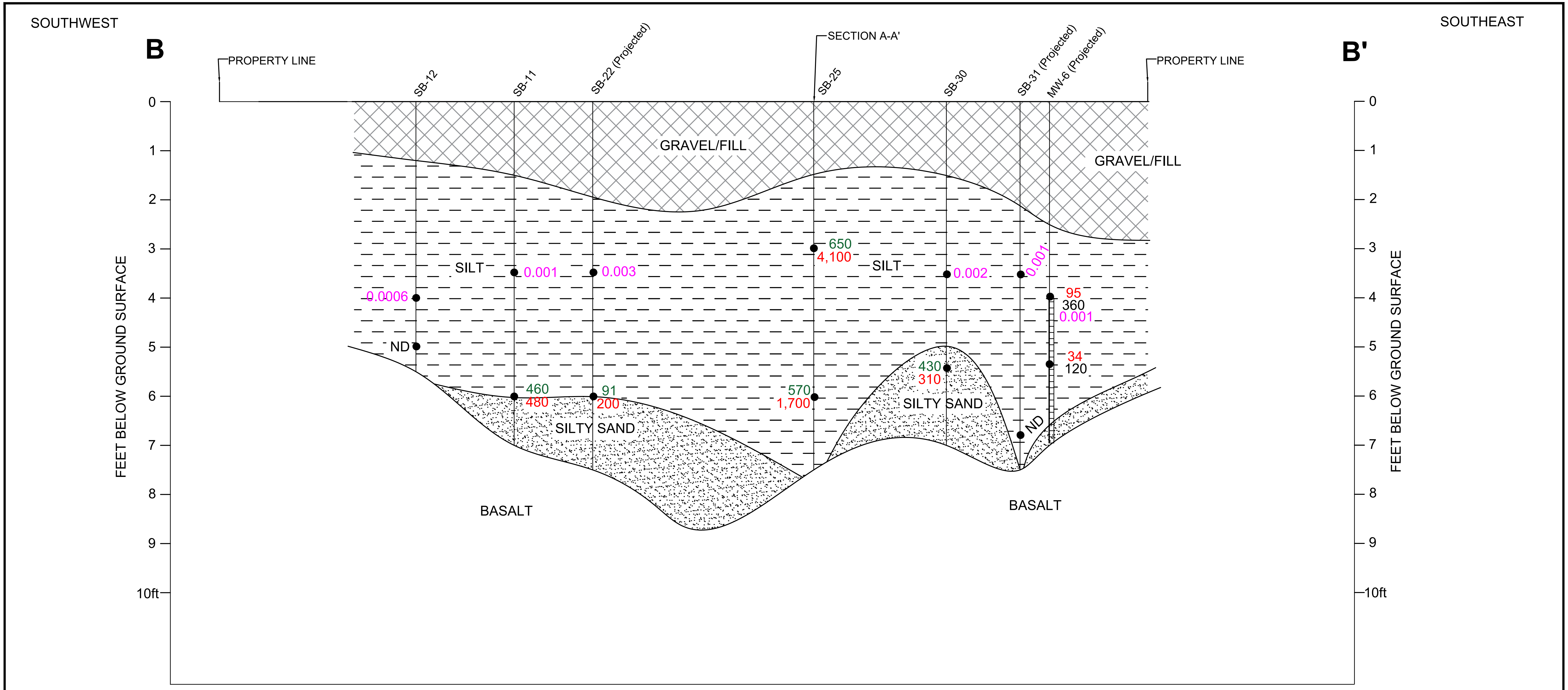
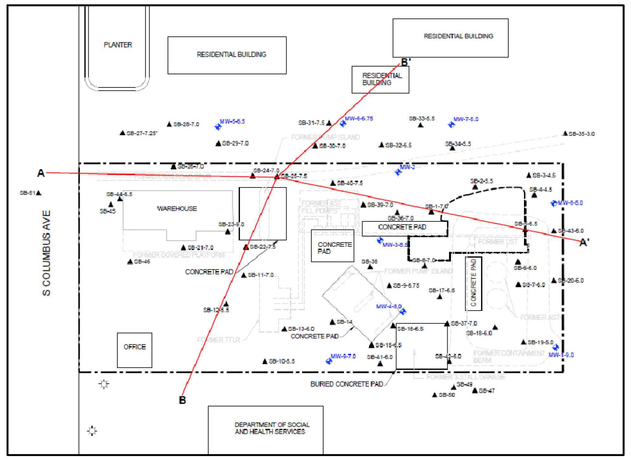
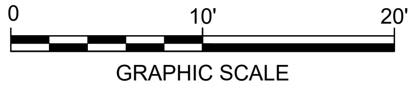




LEGEND:

0.002	BENZENE CONCENTRATION IN MILLIGRAMS PER KILOGRAM (mg/kg)
63	GASOLINE-RANGE HYDROCARBON CONCENTRATION IN mg/kg
20	DIESEL-RANGE HYDROCARBON CONCENTRATION IN mg/kg
83	HEAVY OIL-RANGE HYDROCARBON CONCENTRATION IN mg/kg
MTCA	MODEL TOXIC CONTROL ACT
ND	NO ANALYTES DETECTED ABOVE MTCA METHOD A CLEANUP LEVELS

▨	EXCAVATION BACKFILL
☐	BASALT
▤	SILT
░	SILTY SAND



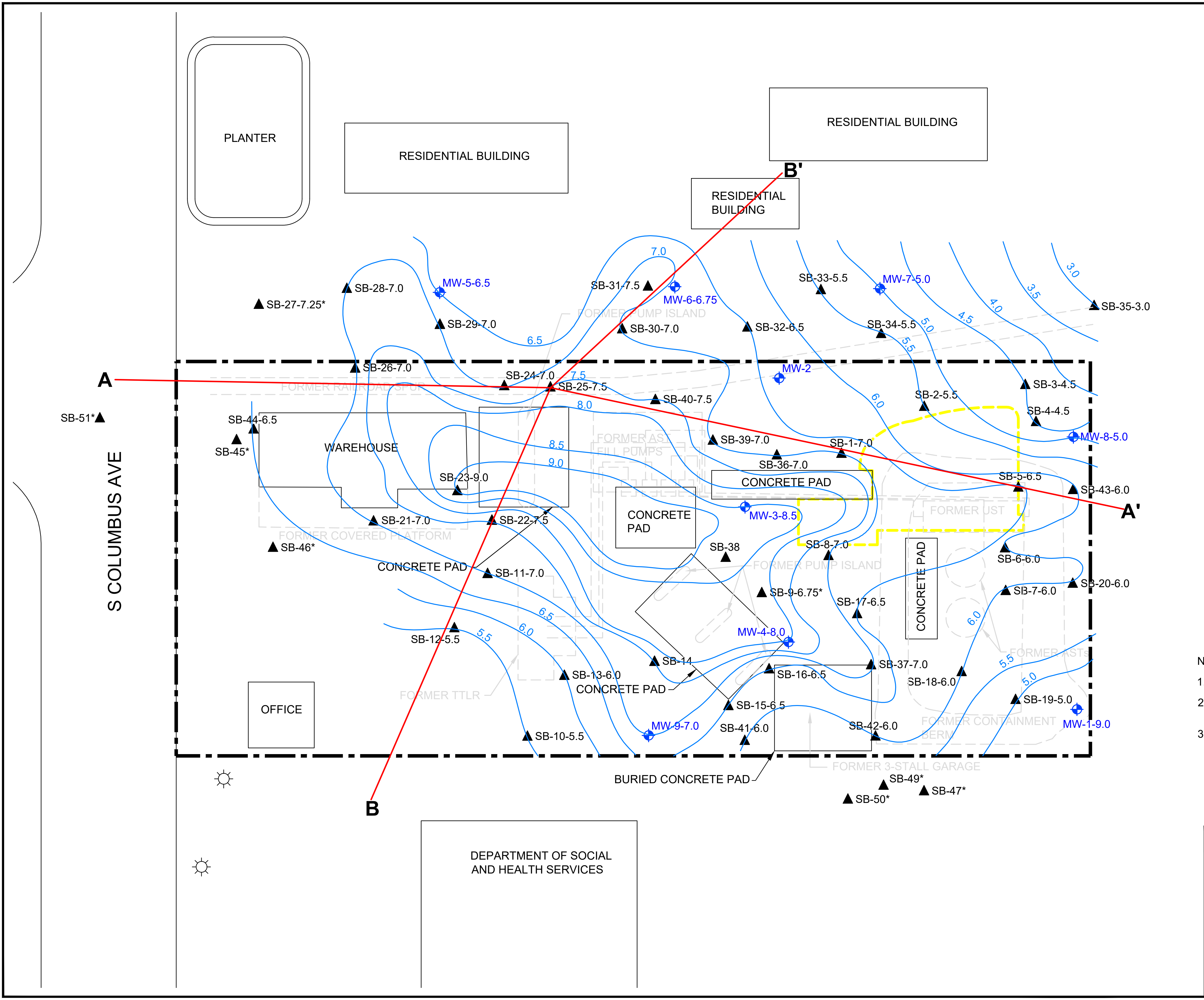
GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

GEOLOGIC CROSS-SECTION B-B'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
5



N

LEGEND:

— · —	APPROXIMATE PROPERTY BOUNDARY
- - -	APPROXIMATE 2012 EXCAVATION EXTENT
⌖	MONITORING WELL LOCATION
▲	2018 SOIL BORING LOCATION
☼	LIGHT POLE
UST	UNDERGROUND STORAGE TANK
ASTs	ABOVEGROUND STORAGE TANKS
TTLR	TANK TRUNK LOADING RACK
—	DEPTH TO BASALT
6.0	BOTTOM OF BOREHOLE
*	BOREHOLE DEPTH NOT USED IN CONTOUR MAP

NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.
2. SOIL BORING SB-48 LOCATION NOT PROVIDED TO ARCADIS U.S., INC.
3. SOIL BORING LOCATIONS IN GRAY WERE OVEREXCAVATED DURING THE 2012 REMEDIAL EXCAVATION.

0 30' 60'

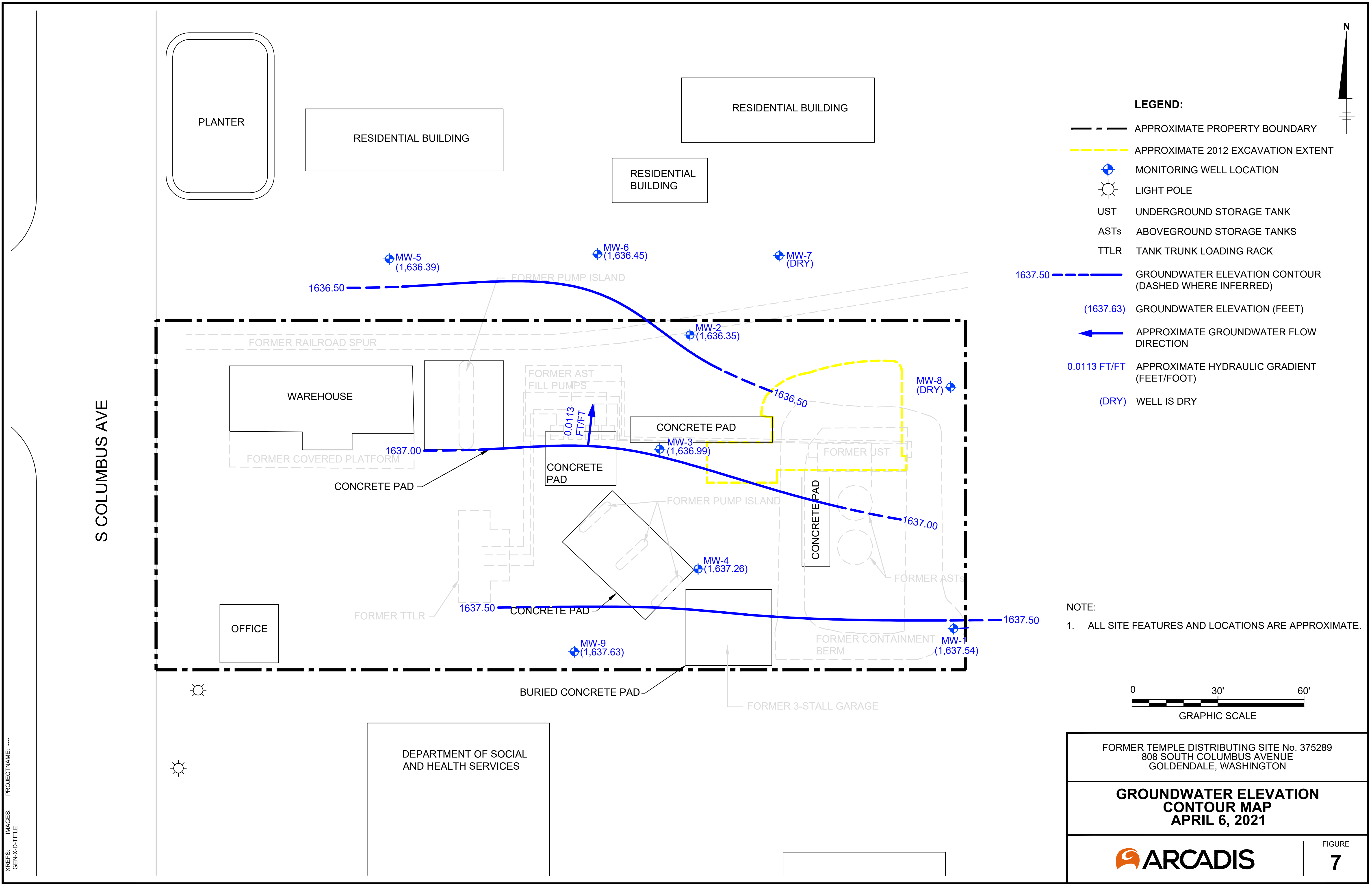
GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

DEPTH TO BASALT AND GEOLOGIC CROSS-SECTION LOCATIONS MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
6



NOTE:

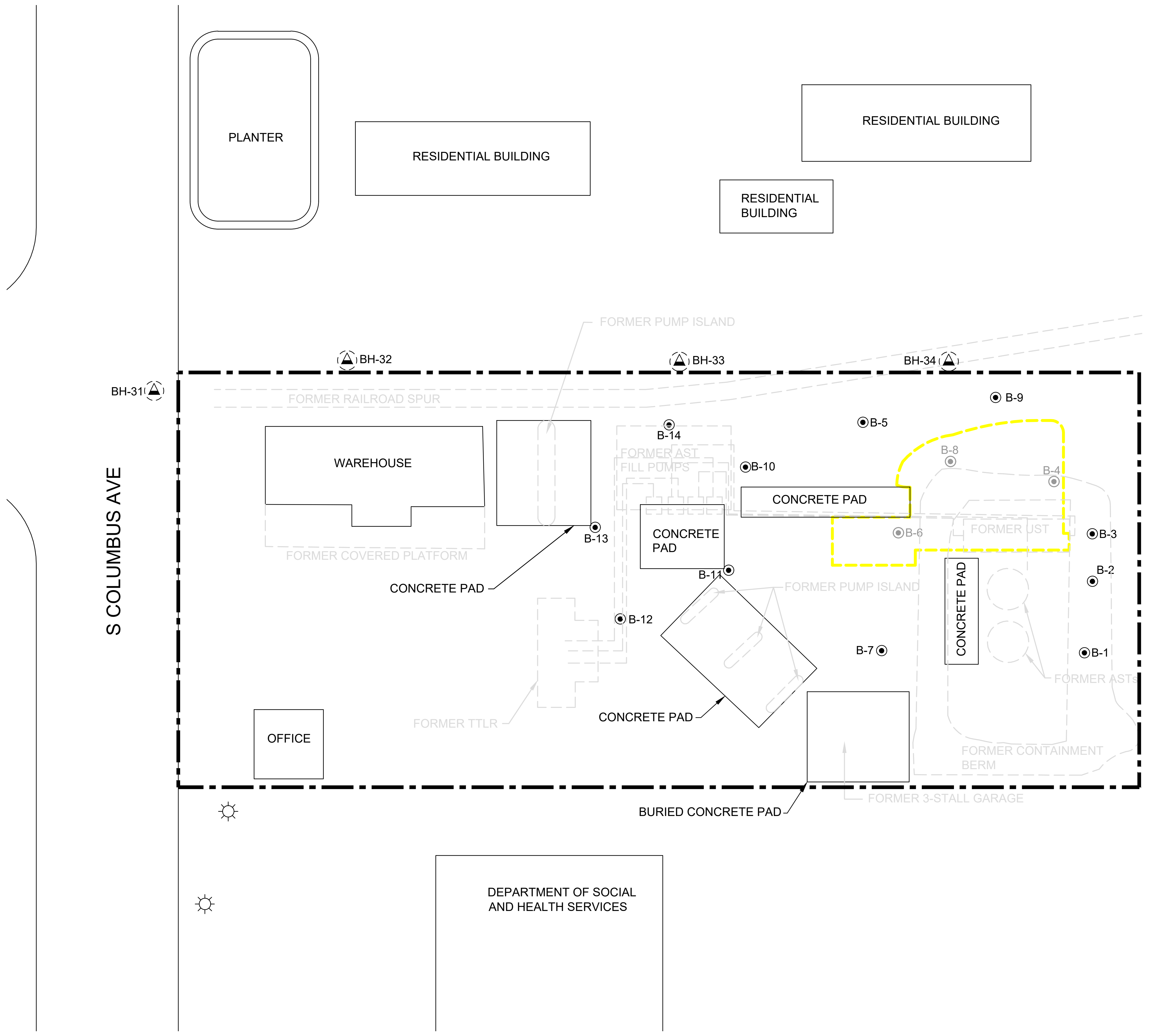
1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

GROUNDWATER ELEVATION CONTOUR MAP APRIL 6, 2021

ARCADIS

FIGURE
7



N

LEGEND:

— - —	APPROXIMATE PROPERTY BOUNDARY
- - -	APPROXIMATE 2012 EXCAVATION EXTENT
⦿	2012 SOIL BORING LOCATION
▲	2015 SOIL BORING LOCATION
☼	LIGHT POLE
UST	UNDERGROUND STORAGE TANK
ASTs	ABOVEGROUND STORAGE TANKS
TTLR	TANK TRUNK LOADING RACK

NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.
2. SOIL BORING SB-48 LOCATION NOT PROVIDED TO ARCADIS U.S., INC.
3. SOIL BORING LOCATIONS IN GRAY WERE OVEREXCAVATED DURING THE 2012 REMEDIAL EXCAVATION.

0 30' 60'

GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

PRE-REMEDIAL INVESTIGATION SAMPLE LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
8

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
C:\Users\shasarek6796\BIM 360\Arcadis\ANA - CHEVRON CORPORATION\Project Files\375289 Goldendale Figures\2020\30012456\01-DWG\375289 FIGURE 4A SCL.dwg LAYOUT: 2-3 SAVED: 9/23/2020 11:08 AM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED:
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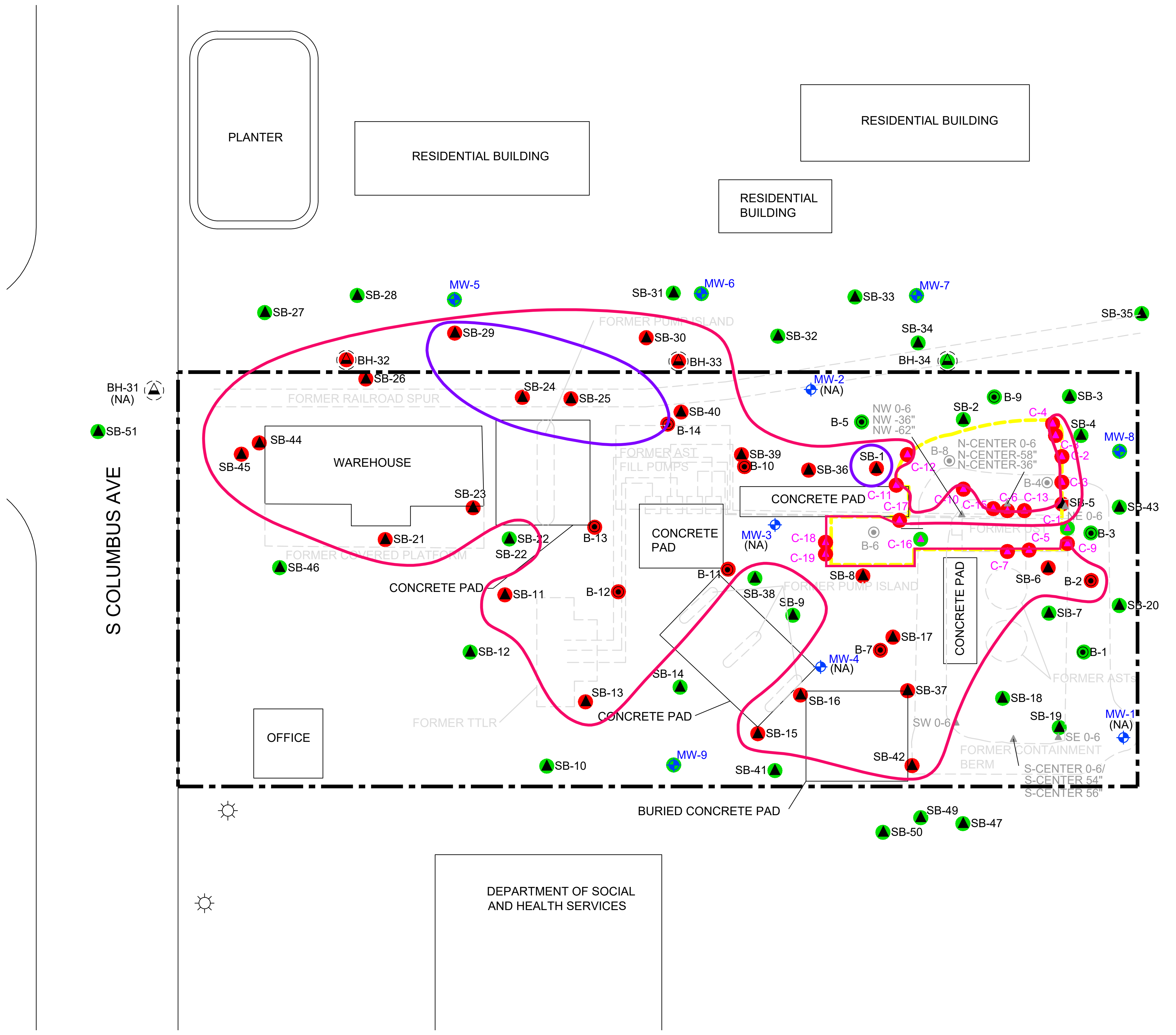


LEGEND:

— · —	APPROXIMATE PROPERTY BOUNDARY
- - -	APPROXIMATE EXCAVATION EXTENT 2012
⌖	MONITORING WELL LOCATION
⊙	2012 SOIL BORING LOCATION
(▲)	2015 SOIL BORING LOCATION
▲	2018 SOIL BORING LOCATION
▲	2012 REMEDIAL EXCAVATION CONFIRMATION SOIL SAMPLE LOCATION
▲	2012 CONTAINMENT BERM SOIL SAMPLE LOCATION
☼	LIGHT POLE
UST	UNDERGROUND STORAGE TANKS
AST	ABOVEGROUND STORAGE TANKS
TTLR	TANK TRUNK LOADING RACK
TPH-DRO	TOTAL PETROLEUM HYDROCARBONS AS DIESEL-RANGE ORGANICS
MTCA	MODEL TOXIC CONTROL ACT
CULs	CLEAN UP LEVELS
NA	NOT ANALYZED
—	MTCA BOUNDARY FOR ALL CONSTITUENTS
—	MTCA BOUNDARY FOR TPH-DRO
🔴	ONE OR MORE CONSTITUENTS ANALYZED EXCEEDED MTCA METHOD A CULs
🟢	CONSTITUENTS ANALYZED WERE BELOW MTCA METHOD A CULs

NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.
2. SOIL BORING SB-48 LOCATION NOT PROVIDED TO ARCADIS U.S., INC.
3. SOIL BORING LOCATIONS IN GRAY WERE OVEREXCAVATED DURING THE 2012 REMEDIAL EXCAVATION.

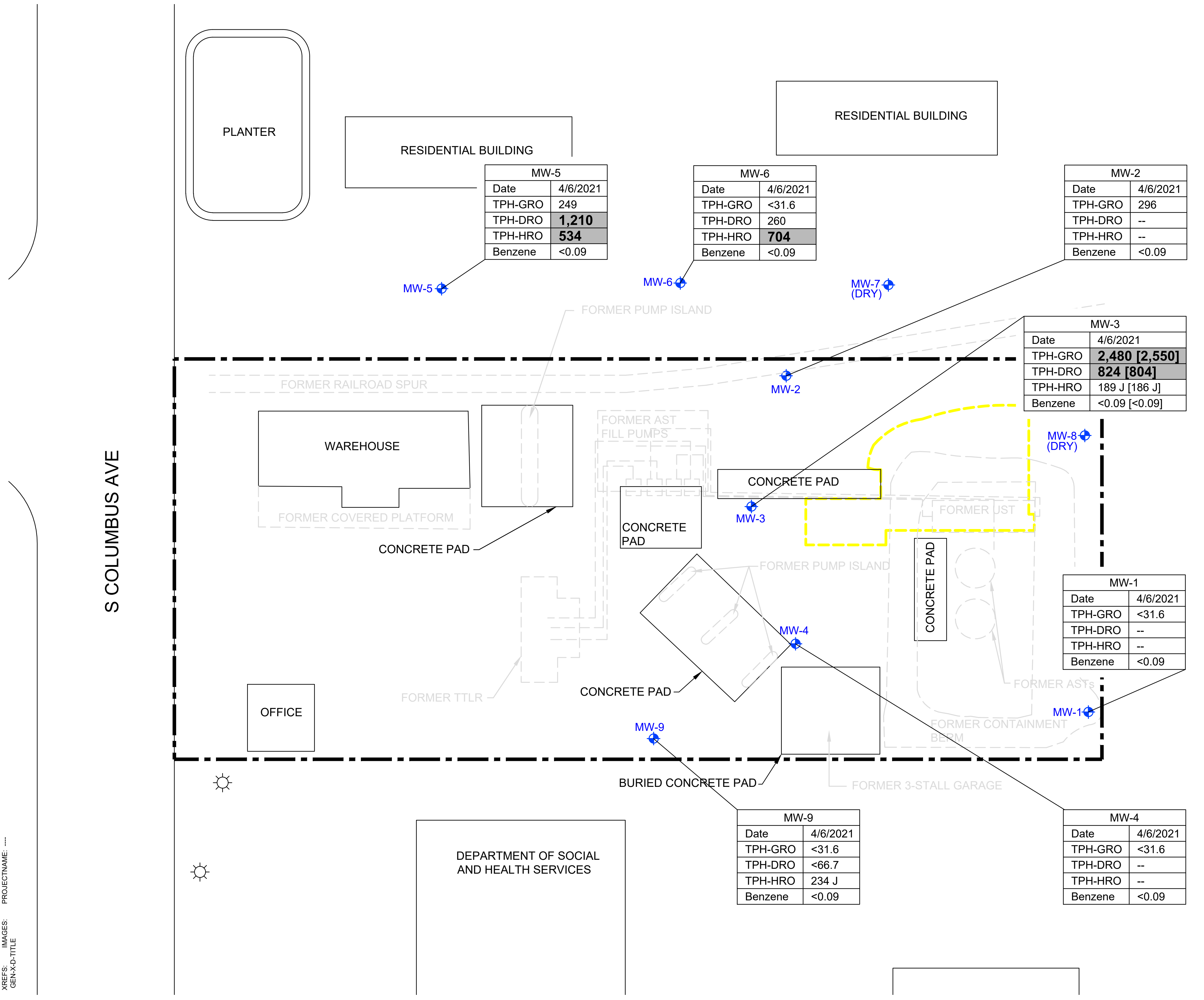
0 30' 60'
GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

EXTENT OF SOIL IMPACTS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
9



MW-5	
Date	4/6/2021
TPH-GRO	249
TPH-DRO	**1,210**
TPH-HRO	**534**
Benzene	<0.09

MW-6	
Date	4/6/2021
TPH-GRO	<31.6
TPH-DRO	260
TPH-HRO	**704**
Benzene	<0.09

MW-2	
Date	4/6/2021
TPH-GRO	296
TPH-DRO	--
TPH-HRO	--
Benzene	<0.09

MW-3	
Date	4/6/2021
TPH-GRO	**2,480 [2,550]**
TPH-DRO	**824 [804]**
TPH-HRO	189 J [186 J]
Benzene	<0.09 [<0.09]

MW-1	
Date	4/6/2021
TPH-GRO	<31.6
TPH-DRO	--
TPH-HRO	--
Benzene	<0.09

MW-9	
Date	4/6/2021
TPH-GRO	<31.6
TPH-DRO	<66.7
TPH-HRO	234 J
Benzene	<0.09

MW-4	
Date	4/6/2021
TPH-GRO	<31.6
TPH-DRO	--
TPH-HRO	--
Benzene	<0.09

LEGEND:

— - —	APPROXIMATE PROPERTY BOUNDARY
- - -	APPROXIMATE 2012 EXCAVATION EXTENT
⊕	MONITORING WELL LOCATION
☼	LIGHT POLE
UST	UNDERGROUND STORAGE TANK
ASTs	ABOVEGROUND STORAGE TANKS
TTLR	TANK TRUNK LOADING RACK
TPH-GRO	TOTAL PETROLEUM HYDROCARBONS, GASOLINE RANGE ORGANICS
TPH-HRO	TOTAL PETROLEUM HYDROCARBONS, HEAVY OIL-RANGE ORGANICS
TPH-DRO	TOTAL PETROLEUM HYDROCARBONS, DIESEL RANGE ORGANICS
BOLD	VALUES ARE GREATER THAN THEIR RESPECTIVE MODEL TOXICS CONTROL ACT (MTCA) METHOD A CLEANUP LEVEL
<	NOT DETECTED AT OR ABOVE THE LABORATORY METHOD DETECTION LIMIT (MDL)
J	ESTIMATED VALUE BETWEEN MDL AND REPORTED DETECTION LIMIT (RDL)
800/1,000	TPH-GRO MTCA METHOD A CLEANUP LEVELS (CULs) WITH BENZENE PRESENT IS 800 µg/L AND WITHOUT IS 1,000 µg/L
*	ECOLOGY MTCA METHOD A CULs FOR GROUNDWATER, WASHINGTON ADMINISTRATIVE CODE CHAPTER 173-340-900, TABLE 720-1
--	NOT ANALYZED
(DRY)	WELL IS DRY
[ ]	DUPLICATE RESULT

Well ID	
Constituent	MTCA CULs*
TPH-GRO	**800/1,000**
TPH-DRO	**500**
TPH-HRO	**500**
Benzene	**5**

NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.
2. ALL VALUES REPORTED IN MICROGRAMS PER LITER (µg/L).

0 30' 60'

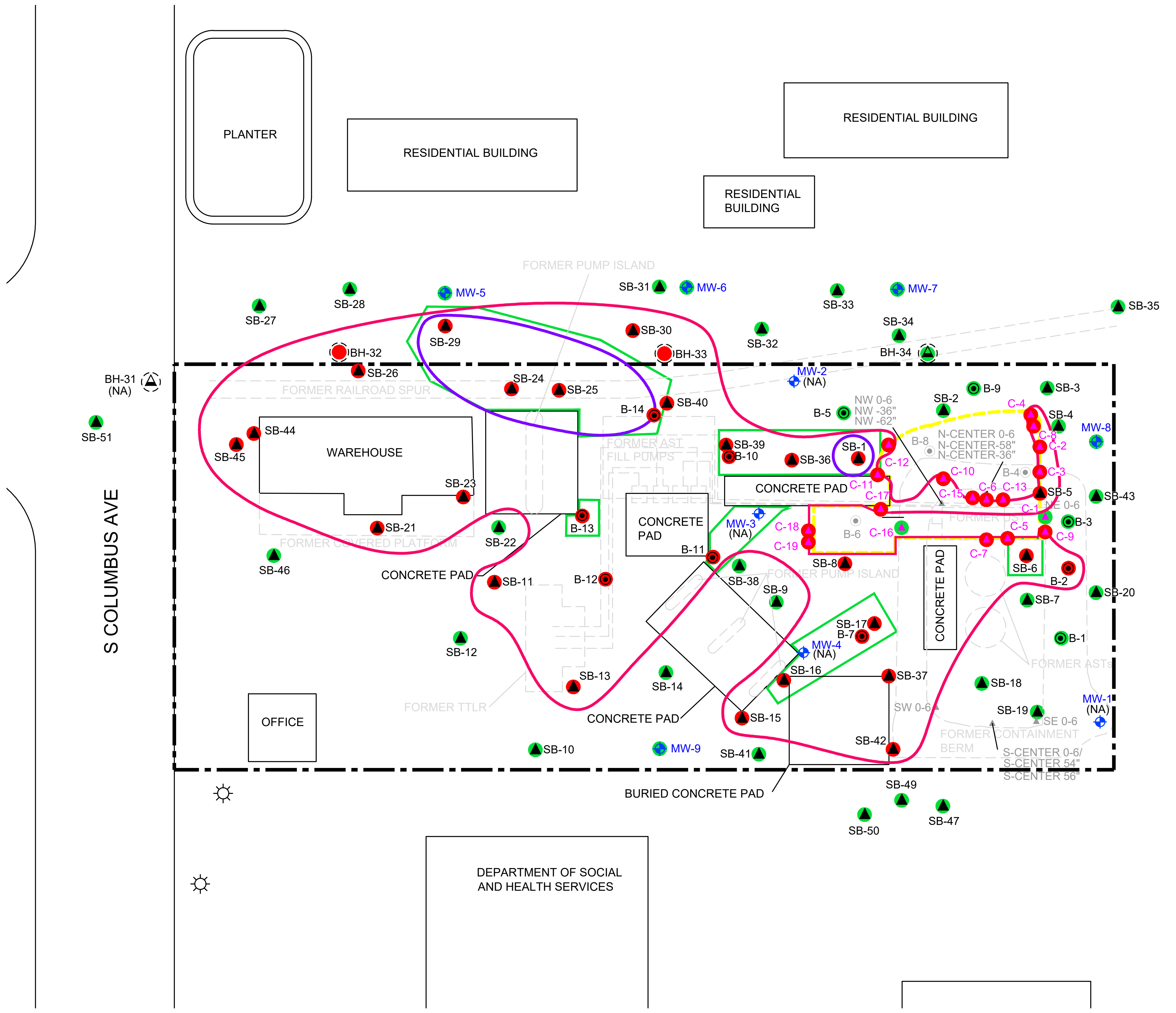
GRAPHIC SCALE

FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

GROUNDWATER ANALYTICAL MAP
APRIL 6, 2021

ARCADIS

FIGURE
10



LEGEND:

— · —	APPROXIMATE PROPERTY BOUNDARY
— — —	APPROXIMATE EXCAVATION EXTENT 2012
⌖	MONITORING WELL LOCATION
⊙	2012 SOIL BORING LOCATION
(▲)	2015 SOIL BORING LOCATION
▲	2018 SOIL BORING LOCATION
▲	2012 REMEDIAL EXCAVATION CONFIRMATION SOIL SAMPLE LOCATION
▲	2012 CONTAINMENT BERM SOIL SAMPLE LOCATION
☼	LIGHT POLE
UST	UNDERGROUND STORAGE TANKS
AST	ABOVEGROUND STORAGE TANKS
TTLR	TANK TRUNK LOADING RACK
TPH-DRO	TOTAL PETROLEUM HYDROCARBONS AS DIESEL-RANGE ORGANICS
MTCA	MODEL TOXIC CONTROL ACT
CULs	CLEAN UP LEVELS
NA	NOT ANALYZED
——	MTCA BOUNDARY FOR ALL CONSTITUENTS
——	MTCA BOUNDARY FOR TPH-DRO
——	PROPOSED EXCAVATION
🔴	ONE OR MORE CONSTITUENTS ANALYZED EXCEEDED MTCA METHOD A CULs
🟢	CONSTITUENTS ANALYZED WERE BELOW MTCA METHOD A CULs

NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.
2. SOIL BORING SB-48 LOCATION NOT PROVIDED TO ARCADIS U.S., INC.
3. SOIL BORING LOCATIONS IN GRAY WERE OVEREXCAVATED DURING THE 2012 REMEDIAL EXCAVATION.

0 30' 60'
GRAPHIC SCALE

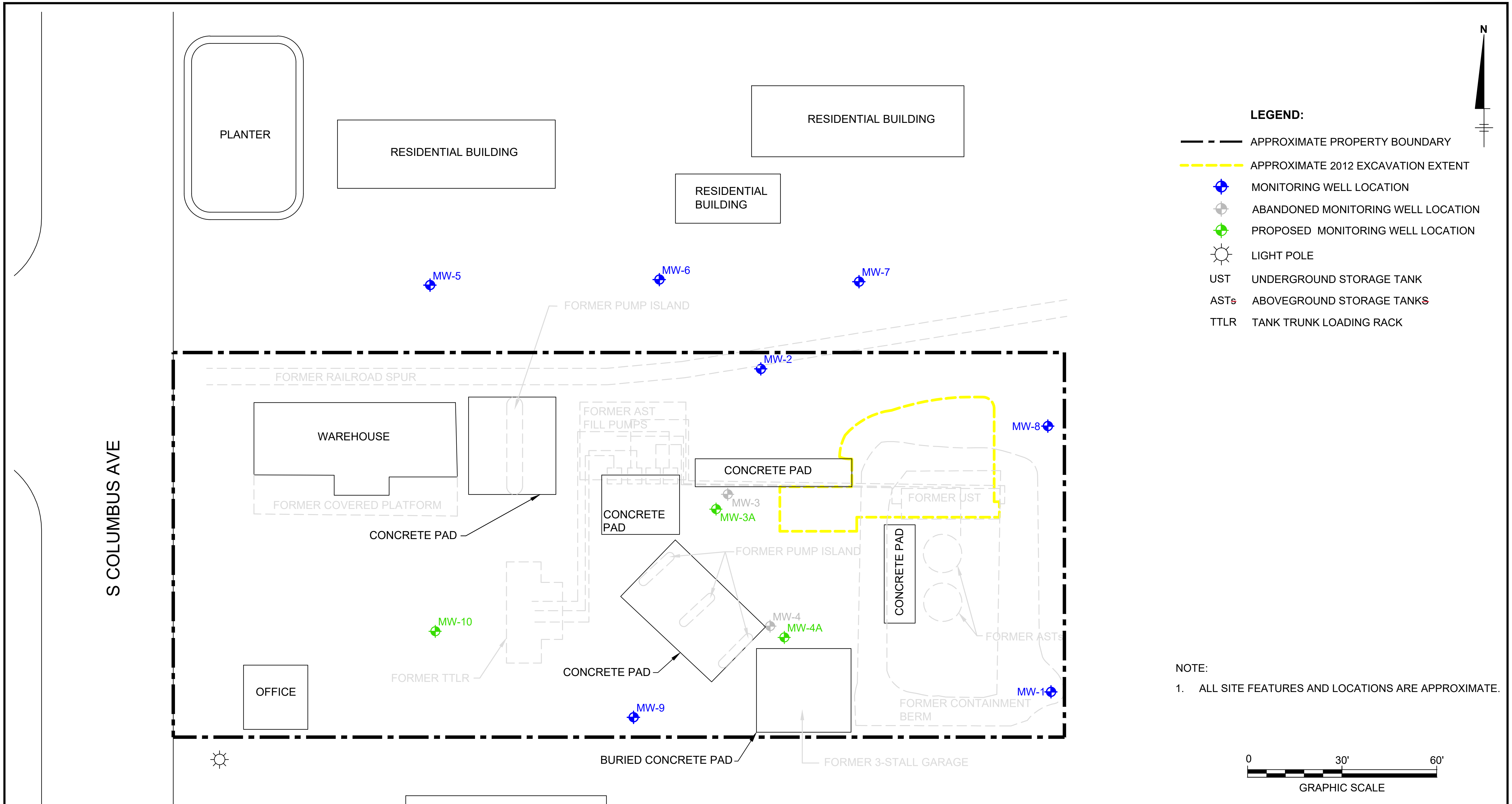
FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

PROPOSED EXCAVATION EXTENTS

ARCADIS Design & Consultancy for natural and built assets

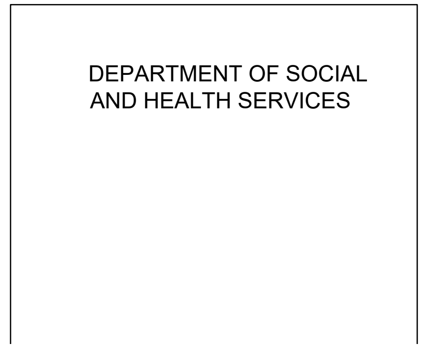
FIGURE
11

CITY:(Reqd) DIV/GROUP:(Reqd) DB:(Reqd) LD:(Opt) PIC:(Opt) PM:(Reqd) TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
C:\Users\tfatto\BIM 360\Arcadis\ANA - CHEVRON CORPORATION\Project Files\375289 Goldendale Figures\2020\30012456\01-DWG\375289 FIG 3 MWL.dwg LAYOUT: 9-1 SAVED: 4/12/2021 2:37 PM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 4/12/2021 2:37 PM
BY: FATTO, TRACEY



NOTE:

1. ALL SITE FEATURES AND LOCATIONS ARE APPROXIMATE.



FORMER TEMPLE DISTRIBUTING SITE No. 375289
808 SOUTH COLUMBUS AVENUE
GOLDENDALE, WASHINGTON

PROPOSED MONITORING WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
12

Appendix A

O’Gara Report of Goldendale Fuel Spill

▼Tim O'Gara, R.G.

Consulting Hydrogeologist

May 4, 2012

Tim Love
Operations Manager
Carson Oil Company
P.O. Box 10948
Portland, OR 97296-0948

Re: Carson – Goldendale Fuel Spill

Tim,

The site is located at 808 South Columbus Avenue in the town of Goldendale, WA. The site has operated as a bulk fuel supplier since 1927 and is paved mostly with gravel.

Early on the morning of April 29, there was a fuel spill at the site. According to reports, up to 970 gallons of unleaded gasoline may have been spilled due to overfilling of one of the above ground tanks. An effort was made to clean up the spill immediately, but there is no record of how much of the fuel percolated into the ground. This report documents the initial response and removal of the fresh gasoline spill. At this time, there is still weathered gasoline and diesel contamination remaining at the site. Figure 1 shows the site location. Figure 2 shows the site layout.

On March 1, 2012, a series of borings were drilled around the tank area to determine how widespread the soil contamination was. A total of 14 boring locations were drilled and sampled. In addition, 12 grab samples were collected from depths ranging from 6-inches to 62 inches below grade from within the bermed area beneath the tank that was overfilled.

Volcanic bedrock was found throughout the site at depths ranging from 7-10 feet below grade also. The water was sitting on top of the bedrock in most of the borings, however no water was found in three of them. It appears that there are preferential pathways that run on top of the bedrock in areas where it is lower. The main soil type at the site is silt to clayey silt, but there were a few borings that detected a sand layer immediately above the basalt bedrock. Boring locations are found on Figure 2. Depth to bedrock in the

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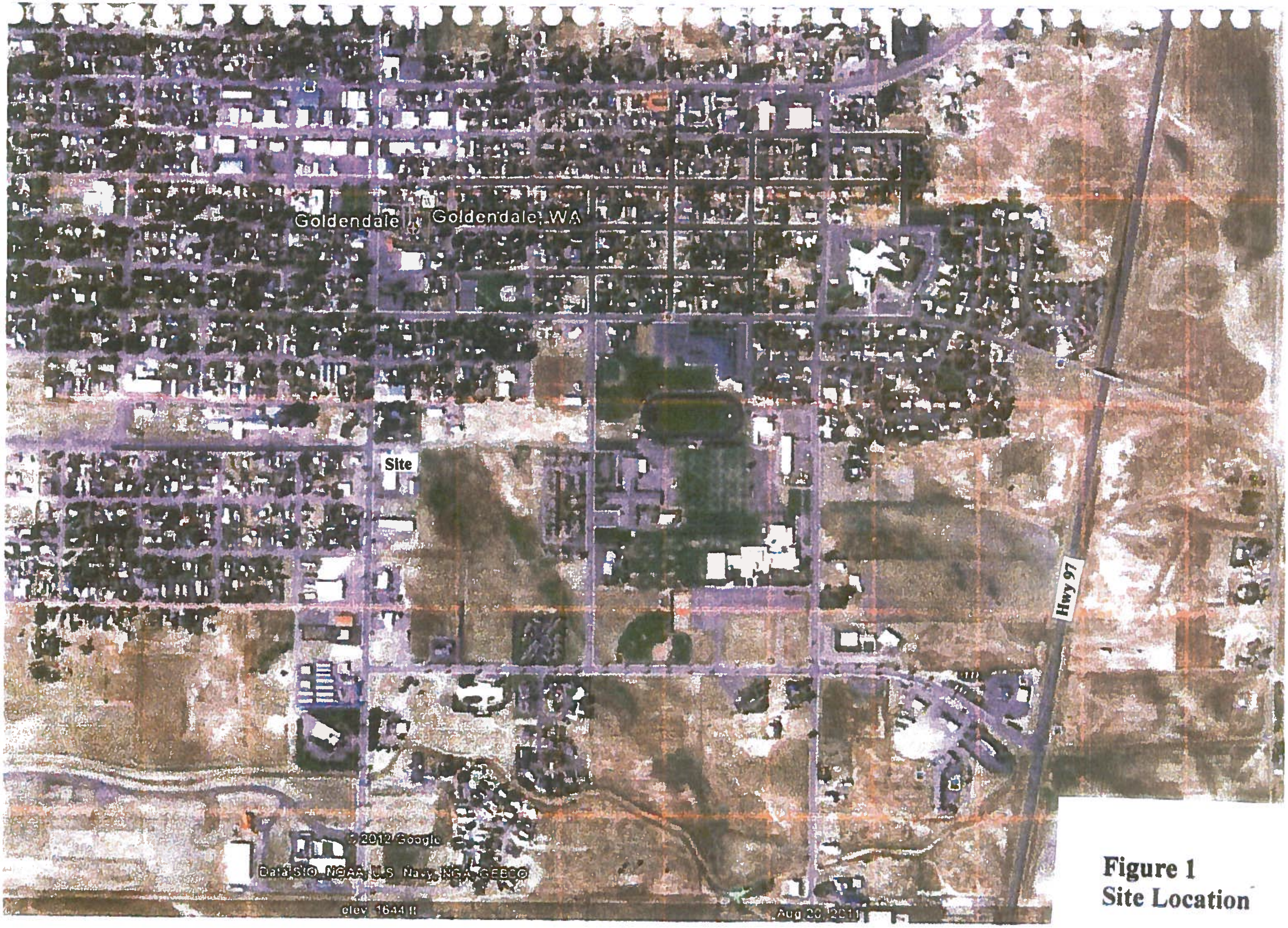


Figure 1
Site Location

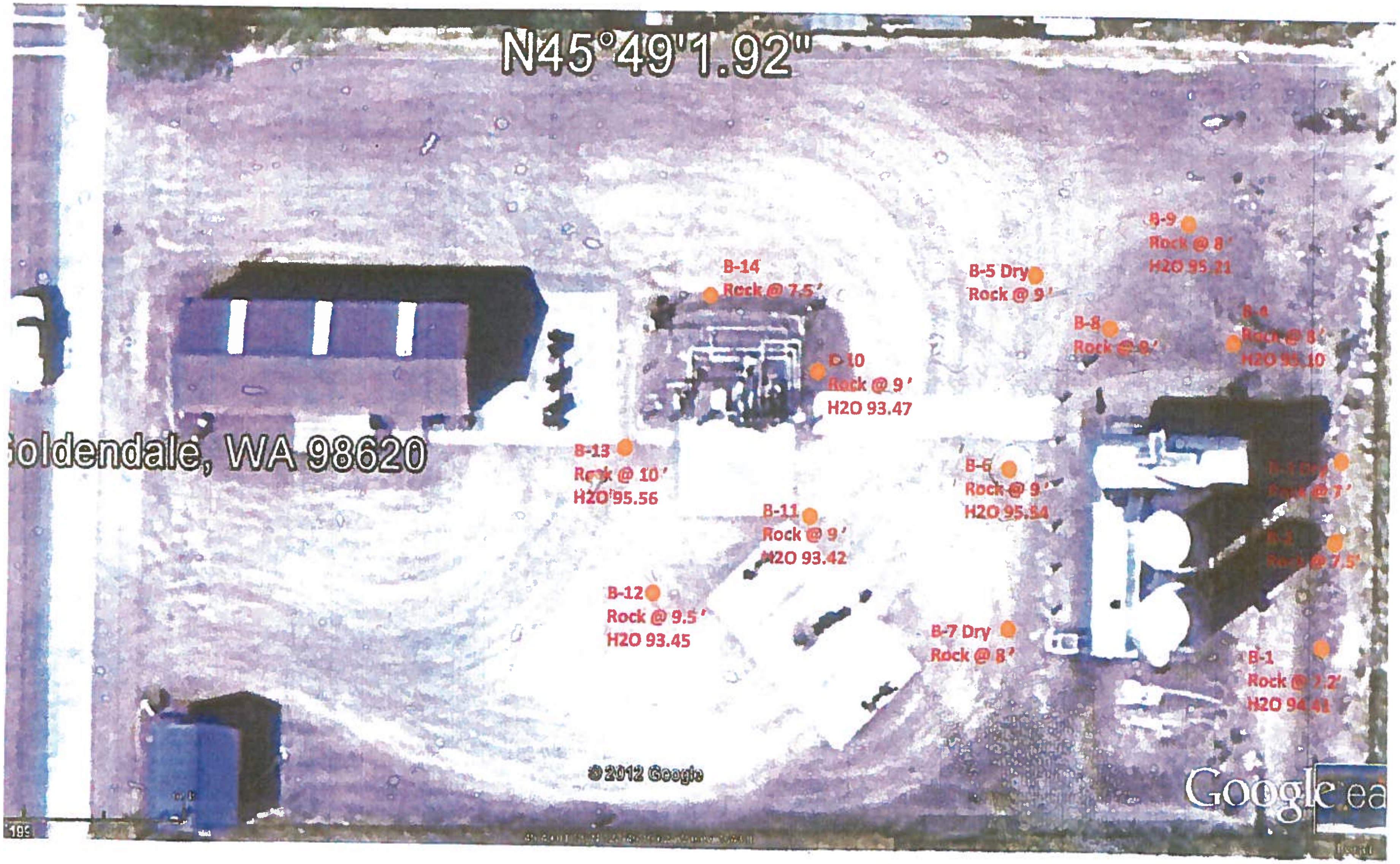


Figure 2
Soil Boring Locations,
Showing Bedrock Depths and
Water levels in open Borings

borings is shown as Table 1. Boring logs for the soil sample location are included in Appendix A.

Soil from the immediate area within the berm was also removed and stored on site for later disposal. During the initial excavation, ground water was detected in the pit at approximately 5-6 feet below grade. Water was pumped from the excavation and stored on site in a 19,000 gallon tank until it could be sampled and disposed of properly.

Because these samples were being collected to determine the lateral extent of the fresh gasoline spill, and not for compliance, soil and water samples that were collected from the excavation were analyzed for gasoline and diesel range hydrocarbons as well as BTEX. Tables 2, 3, and 4 show the sample results. A few of the higher concentration samples were later analyzed for TCLP Lead to determine the proper disposal methodology also.

Table 1
Approximate Depth to bedrock

Location	Depth to bedrock (ft)	Wet?
B-1	7.2	Yes
B-2	7.5	Yes
B-3	7	No
B-4	8	Yes
B-5	9	No
B-6	9	Yes
B-7	8	No
B-8	9	Yes
B-9	8	Yes
B-10	9	Yes
B-11	9	Yes
B-12	9.5	Yes
B-13	10	Yes
B-14	7.5	Yes

Table 2
Soil inside berm area (mg/kg)

Location	Gx	Dx
S- Center 0-6	14200	609
N-Center 0-6	18300	2560
NW 0-6	15600	686
NE 0-6	96.5	675
SE 0-6	34000	1800
SW 0-6	13600	165
S-Center 54"	ND	25.6
S-Center 56"	833	694
NW-36"	4060	3320
NW – 62"	1170	367
N- Center - 58"	2100	2020
N-Center 36"	1120	118
Exc pit Water*	44700 (ug/l)	16100 (mg/l)

* Also have PAHs for exc pit water

Table 3 Boring Samples

Soil Samples (mg/kg)

location	Gx	Dx	Benz	Tol	Ethyl	Xylene
1-5	ND		ND	0.316	ND	ND
2-5	ND		ND	ND	ND	ND
2-7	256		ND	0.543	1.12	2.62
3-5	ND		ND	ND	ND	ND
3-7	ND		ND	ND	ND	ND
4-5	19.9		ND	ND	ND	ND
4-7	ND		ND	ND	ND	ND
5-5	ND		ND	ND	ND	ND
5-8	ND	160	ND	ND	ND	ND
6-5	1330		29.5	155	36.3	176
6-8	36.1	1050	ND	ND	ND	ND
7-5	1380	755	ND	ND	2.52	0.946
7-8	5840	1470	ND	1.14	6.76	3.22
8-5	ND		ND	ND	ND	ND
8-8	ND		ND	ND	ND	ND
9-5	ND		ND	ND	ND	ND
9-7	ND	399	ND	ND	ND	ND
10-5	ND	ND	0.311	0.633	ND	ND
10-9	ND		ND	ND	ND	ND
11-5		909				
11-7	1090	384	0.414	2.89	4.84	6.96
12-5		215				
12-8	36.7	99.9	ND	ND	0.440	ND
13-5		113				
13-9	222	41.3	0.103	2.36	5.35	7.75
14-5		121				
14-7	752	360	0.202	4.31	9.55	13.1

Table 4

Boring Water Samples`

Location	Gx (ug/l)	Dx (mg/l)	Benz (ug/l)	Tol (ug/l)	Ethyl (ug/l)	Xylene (ug/l)
B-1-W	227	ND	0.485	1.17	1.45	1.99
B-2-W	10500		20.7	14.0	615	961
B-4-W	2770	7.96	11.5	9.58	48.9	88.6
B-6-W	127000	8.53	11500	40000	2430	11300
B-8-W	4240	1.24	43.6	5.34	45.9	45.5
B-9-W	288	2.08	2.07	3.26	2.17	2.75
B-10-W		20.7				
B-11-W		294				
B-12-W		169				
B-13-W		36.5				
B-14-W		213				

Complete analytical results are found in Attachment B.

On April 13, 2012, the stockpiled soils from the initial excavation were removed from the site to the Columbia Ridge landfill

Monitoring Well Installation

Four monitoring wells were installed on April 4, 2012. The wells were installed using push probe technology and all had 5 feet of prepacked 0.010 slot screen. Prior to installing the wells, a proposal was given to the Department of Ecology with locations and sampling methodology for the work. Unfortunately, since the site is not in the Voluntary Cleanup Program, Ecology spill response or Toxic Cleanup Program personnel could not comment on the locations.

Without any input from Ecology, the wells were installed using the following rationale:

MW-1 was placed as close as possible to the SE corner of the site. This was done to get background water from the area of the site that was assumed to be least likely to have been contaminated by site activities over the years.

MW-2 was placed in the north central portion of the site. This well was be used to see if the plume is moving to the northwest.

MW-3 was placed between boring B-6 and the fill stand. This well location was chosen because the boring program at this site seems to indicate that there is a preferential pathway for ground water flow in the B-6 area.

The final well, MW-4, was placed south and west of boring B-7. Based on our soil samples, this was assumed to place the well outside of the plume. It is also in a location that would show us if the plume is moving to the southwest. Figure 3 shows the location of the wells. Boring Logs for the wells are included in Appendix A after the soil boring logs.

Remedial Excavation

As mentioned earlier, during the first few days after the initial spill, soil from within the immediate area beneath the overfilled tank was removed and stockpiled on site for later disposal. Prior to disposing of the soil, a landfill permit needed to be issued to assure the proper disposal methods were followed. In discussions with the Waste Management Company that runs the Arlington Landfill, the area around boring B-6 was found to contain too much toluene to allow disposal in the non-haz landfill. An agreement was made to segregate the soils from within 5-feet of boring B-6 in all directions and landfill that soil under a separate manifest so it could be properly treated.

On April 6 and 8, 2012, the remaining soils containing the fresh gasoline were excavated and a series of 19 confirmation samples were collected from the walls and floor of the excavation. Within the excavation area, all soil was removed down to the top of the

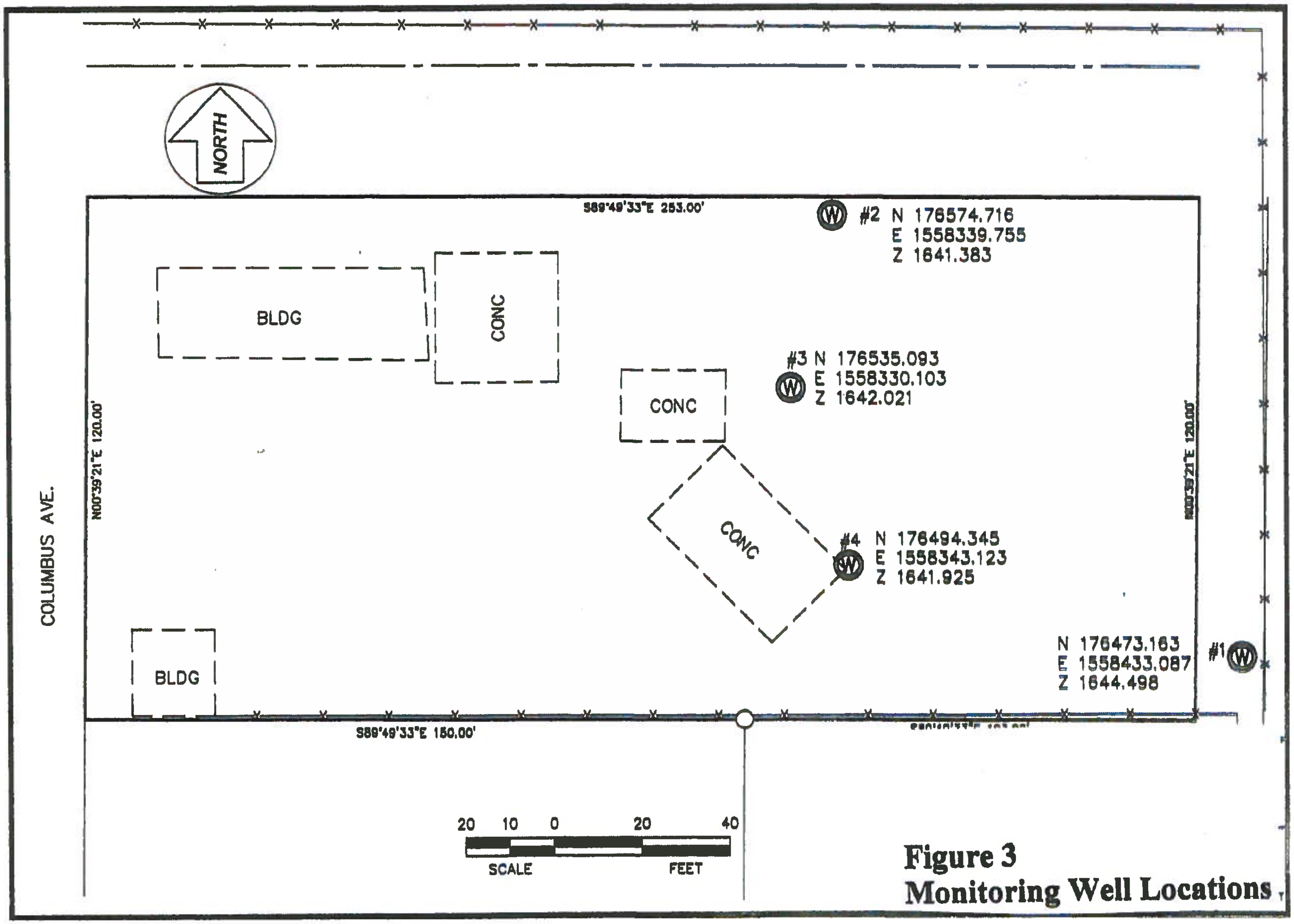


Figure 3
Monitoring Well Locations

basalt bedrock. There was a small area that could not be removed below the pipe run, so samples were collected from the wall in that area to confirm that the soil that was left did not contain fresh gasoline. A total of 389.68 tons of soil was taken off site to the non-haz landfill and an additional 23.94 tons of soil from around B-6 was taken to the hazardous landfill Figure 4 shows the area of excavation in relation to the whole site. Figure 5 is a more detailed drawing showing the locations of all the confirmation samples.

According to Washington Department of Ecology guidance documents, the difference between fresh and weathered gasoline can be determined by the ratio of benzene + toluene divided by the concentration of the ethylbenzene + xylene (B+T)/(E+X). If the result of this is 3 to 5, the gasoline is considered to be fresh. A number of less than 0.5 is considered to be very weathered.

Because the purpose of this work was to remediate the fresh gasoline spill and not to clean up the residual contamination from 85 years of site operations, confirmation samples from the remedial excavation were all tested for gasoline range hydrocarbons and BTEX. The resulting concentrations were all analyzed according to Ecology protocol to determine if any fresh product remained. Table 5 shows the result of the confirmation sampling.

While it is apparent that there is no fresh gasoline remaining in the excavation area, four of the samples were found to be higher than the 0.50 that delineates very weathered gasoline. All four of these samples are bottom samples that were scraped from the top of the bedrock. Since it is difficult to scrape basalt, it is very possible that some of the overlying lightly contaminated soils were also picked up from pockets or low areas in the surface of the rock. The excavation was cleaned as well as possible, but it is impossible to get all soil off a surface that isn't completely flat using an excavator bucket.

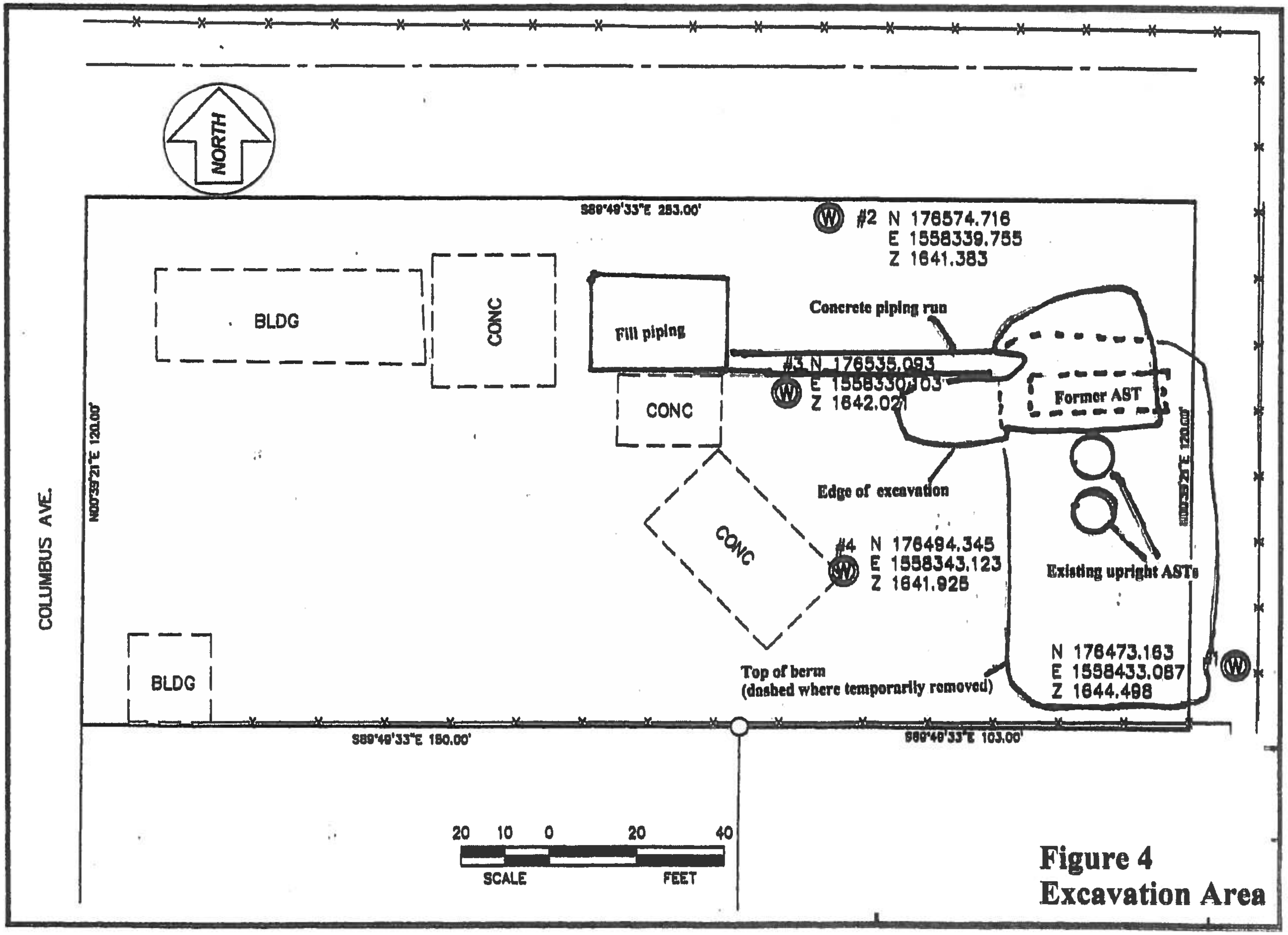


Figure 4
Excavation Area

100/30 0.03 7 6 9

Table 5
Confirmation Sampling Results (mg/kg)

Sample Number	Location/depth	Gx	B	T	E	X	(B+T)/(E+X)
C-1	SE corner @ 4 ft.	346	2.0	2.2	2.0	13	0.29
C-2	East wall @ 3 ft.	1060	6.5	20	30	64	0.28
C-3	East wall @ 3.5 ft.	2190	7.7	26	45	120	0.20
C-4	NE corner @4 ft.	843	4.3	7.1	13	53	0.17
C-5	S. wall @ 3 ft.	1660	3.7	22	27	120	0.17
C-6	N side of pipe run @ 3.5 ft.	1970	27	32	160	160	0.18
C-7	S. wall below berm @4 ft.	2480	36	46	220	240	0.17
C-8	NE Bottom @ 8 ft	3080	13	7.4	12	32	0.46
C-9	SE bottom @7.5 ft	1490	6.6	18	3.9	32	0.68
C-10	Center S. bottom @ 8 ft. @4 ft	1590	7.3	15	25	73	0.22
C-11	NW wall @4 ft	2550	11	33	56	200	0.17
C-12	NW corner @ 3 ft.	2860	9.4	13	48	67	0.19
C-13	Wall by pipe run @ 3.5 ft.	1970	13	27	95	160	0.15
C-14	Bottom beneath berm @ 8 ft.	561	1.6	1.1	1.8	2.7	0.60
C-15	Bottom beneath B-6 @ 8 ft.	1810	4.9	4.1	2.3	9.0	0.79
C-16	S wall at edge of B-6 boring @ 5 ft	766	3.9	13	45	74	0.14
C-17	N wall at edge of B-6 boring @ 5 ft.	1140	8.7	17	70	96	0.15
C-18	W bottom @ 7.5 ft	1290	6.6	3.7	2.0	5.7	1.06
C-19	W wall @ 4 ft.	1220	7.0	22	79	110	0.15

0.03 7 6 9

Monitoring Well Sampling

The wells were sampled on April 20, 2012. Each well was sampled using a peristaltic pump Prior to collecting water samples, the wells were opened and allowed to equilibrate before the water levels were measured. The measuring point on wells had earlier been surveyed, so the ground water could be determined. Table 6 shows the ground water elevations in the 4 wells. Figure 6 shows the water level in the wells.

Table 6
Ground Water Elevations 4-20-11

Well #	Depth to water (ft.)	Surveyed measuring point elevation (ft. MSL)	Ground water elevation (ft. MSL)
MW-1	6.33	1644.50	1638.17
MW-2	5.60	1641.38	1635.78
MW-3	2.73	1642.02	1639.29
MW-4	2.26	1641.93	1639.67

Based on the widely varying water levels, it appears that the wells are tapping at least two different perched water zones. MW-1, MW-3 and MW-4 are possibly in the same zone, but it appears that MW-2, which is at least 2.5 feet lower than the rest, is tapping a separate perched water body. A ground water direction was determined based on wells 1, 3, and 4. That gradient moves to the northeast.

All of the wells were easily pumped dry after only removing approximately 1.5 well volumes of water. None of them recharged easily either, taking approximately an hour to get enough water in the well casing to fill four 80ml VOA vials for the testing. Well MW-3 seemed to recharge the best, but that was expected because there is a silty sand lens of soil sitting directly on top of the basalt that may provide for a more permeable pathway for water.

During sampling field tests were run for pH, temperature and electrical conductivity. Table 7 shows the initial readings for each well and the readings that were present during pumping after they stabilized.

Table 7
Water Evaluation Parameters

Well	pH	EC	Temp
MW-1 – initial	6.43	457	56.7
MW-1 stabilized	7.01	358	53.4
MW-2 initial	6.96	472	55.3
MW-2 stabilized	7.10	336	57.4
MW-3 initial	7.07	448	54.5
MW-3 stabilized	7.28	460	58.0
MW-4 initial	6.95	318	54.2
MW-4 stabilized	7.80	319	58.8

Because this is a gasoline site, the sample were analyzed for VOCs , including BTEX, MTBE, and EDC, using EPA method 8260B. EDB was analyzed using EPA method 8011. Table 8 shows the sample results.

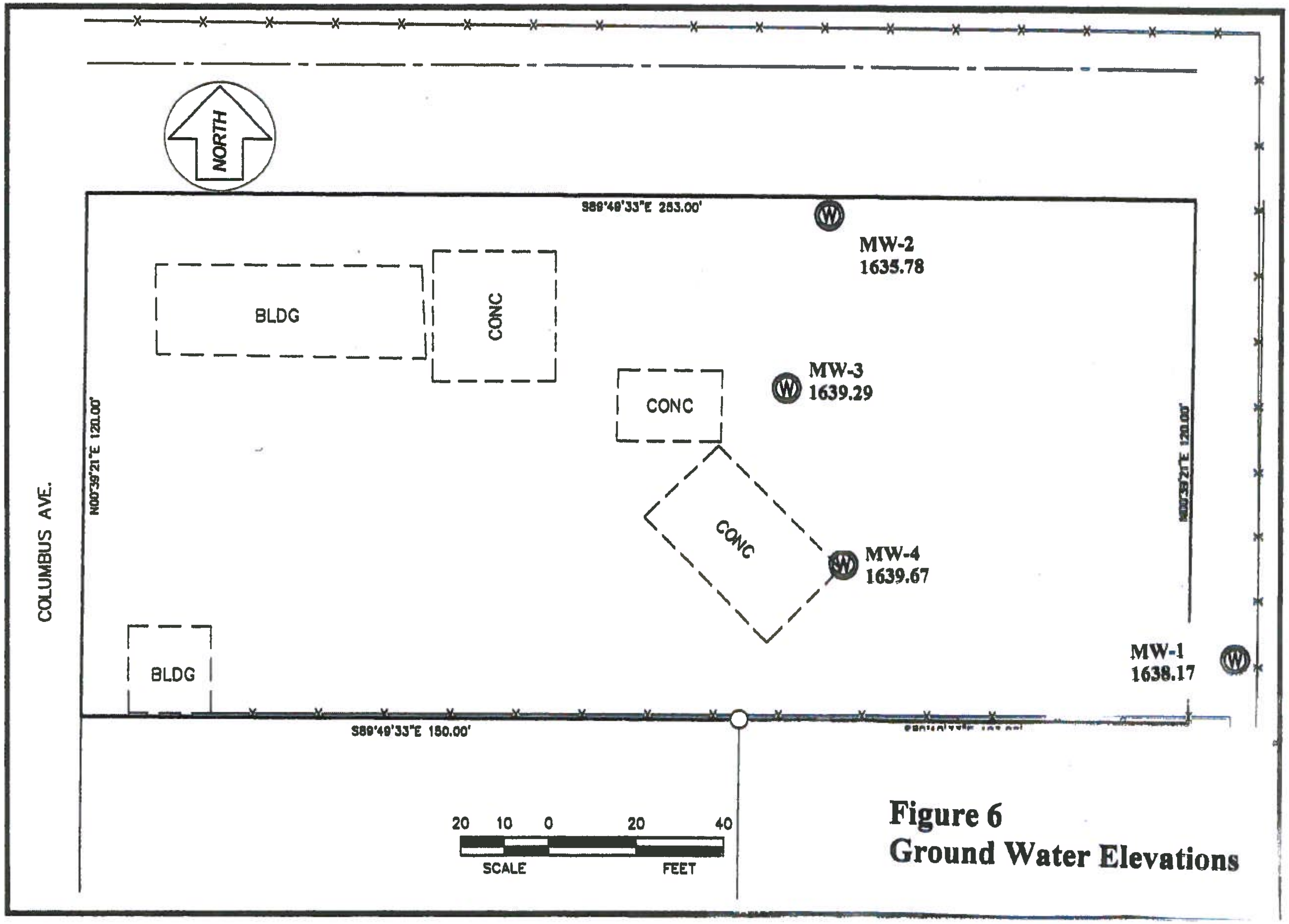


Figure 6
Ground Water Elevations

Table 8
Ground Water sample Results (ug/l)

Chemical	MW-1	MW-2	MW-3	MW-4	Method A Levels
Gasoline Range Hydrocarbons	ND	8,910	5,080	6,000	1,000 (fresh) 800 (weathered)
1,2,4 trimethylbenzene	ND	27.3	125	ND	-
*1,2, dibromoethane (EDB)	ND	ND	ND	ND	0.01
1,2 dicholorethane (EDC)	ND	ND	ND	ND	-
1,3,5 trimethylbenzene	ND	7.79	71.4	ND	-
Benzene	5.38	1,250	4.00	ND	5
Ethylbenzene	ND	72.8	27.0	ND	-
Isopropylbenzene	ND	4.78	30.6	6.76	-
m,p-Xylene	ND	422	9.37	ND	-
MTBE	ND	ND	ND	ND	20
Naphthalene	ND	8.70	66.0	7.19	160
n-Propylbenzene	ND	10.3	124	13.7	-
o-Xylene	ND	351	ND	ND	-
Toluene	9.05	1,800	6.41	ND	1,000

Notes: EDB analysis by EPA Method 8011, all other VOCs by EPA Method 8260
Gasoline Range Hydrocarbons by the NWTPH-Gx Method.

As you can see, if we apply the (B+T)/(E+X) test, the water in monitoring well MW-2 contains fresh gasoline and the others do not. This indicates that the ground water flow from the tank farm is moving to the northwest as expected. Additionally, wells MW-3 and MW-4 were found to contain extremely weathered product. Well MW-1 only contained 5.36 ug/l of benzene and 9.05 ug/l of toluene. This indicates that at one time there may have been a spill in this area, but it is extremely weathered.

After the initial data was receive from the lab, it did not conform to our expectations that well MW-3 was going to be the one with elevated fresh gasoline. Just to make sure that there was no mistake in labeling with the initial sampling, a second set of samples was collected from wells MW-2 and MW-3 on April 30, 2012. This additional sampling confirmed that the fresh gasoline was indeed in well MW-2 and the gasoline in MW-3 was weathered. The resample results are found in Table 9.

Table 9
Resample of MW-2 and MW-3
4-30-12

Chemical	MW-2 (ug/l)	MW-3 (ug/l)	Method A Levels
Gasoline Range Hydrocarbons	14,500	6,180	1,000 (fresh) 800 (weathered)
1,2,4 trimethylbenzene	29.4	67.1	-
*1,2, dibromoethane (EDB)	ND	ND	0.01
1,2 dicholorethane (EDC)	ND	ND	-
1,3,5 trimethylbenzene	14.0	38.1	-
Benzene	829	0.600	5
Ethylbenzene	104	7.75	-
Isopropylbenzene	8.31	13.8	-
m,p-Xylene	221	6.08	-
MTBE	ND	ND	20
Naphthalene	10.2	39.6	160
n-Propylbenzene	17.5	56.8	-
o-Xylene	208	ND	-
Toluene	1,490	ND	1,000

Notes: EDB analysis by EPA Method 8011, all other VOCs by EPA Method 8260
Gasoline Range Hydrocarbons by the NWTPH-Gx Method.

Discussion

Based on the work that has been completed at the site and the confirmation samples, it is evident that the soils containing the fresh gasoline from the recent spill have been removed.

Based on the ground water levels, it appears that there at least two perched water bearing zones at the site. In particular, the water level in MW-2, which was the only well with fresh gasoline in it, was 2.39 feet lower than any other well that was on site. If we plot a ground water gradient using wells MW-1, MW-3, and MW-4, the shallow ground water is moving to the northeast, which is not what we had expected for this site.

Considering the confirmed contamination in MW-2, it is also odd that, during the soil boring program, the nearest borings (B-5 and B-10) did not have any gasoline detections in the soil samples. Also, boring B-5 was a dry boring.

This leads me to believe that the contamination in MW-2 is not associated with the original spill, but there is a leak from some other buried piping in the area. Because we are dealing with individual perched water zones and not an interconnected aquifer system, we cannot be certain that the ground water in the perched zone that is feeding MW-2 is moving in the same direction as the higher one. If it is, that would lead us to believe that the gasoline in MW-2 is coming either from the fill stand or piping leading to the gasoline dispensers that are located to the west.

While it appears that all of the fresh gasoline from the initial spill has been remediated at this time, further investigation as to the source of the fresh gasoline in MW-2 needs to be completed.

Respectfully Submitted,

Tim O'Gara, LG, LHg
Consulting Hydrogeologist

State of Washington
Hydrogeologist
1589
Licensed Geologist
Timothy O'Gara

Appendix A

Boring Logs

And

Monitoring Well Logs

BORING LOG

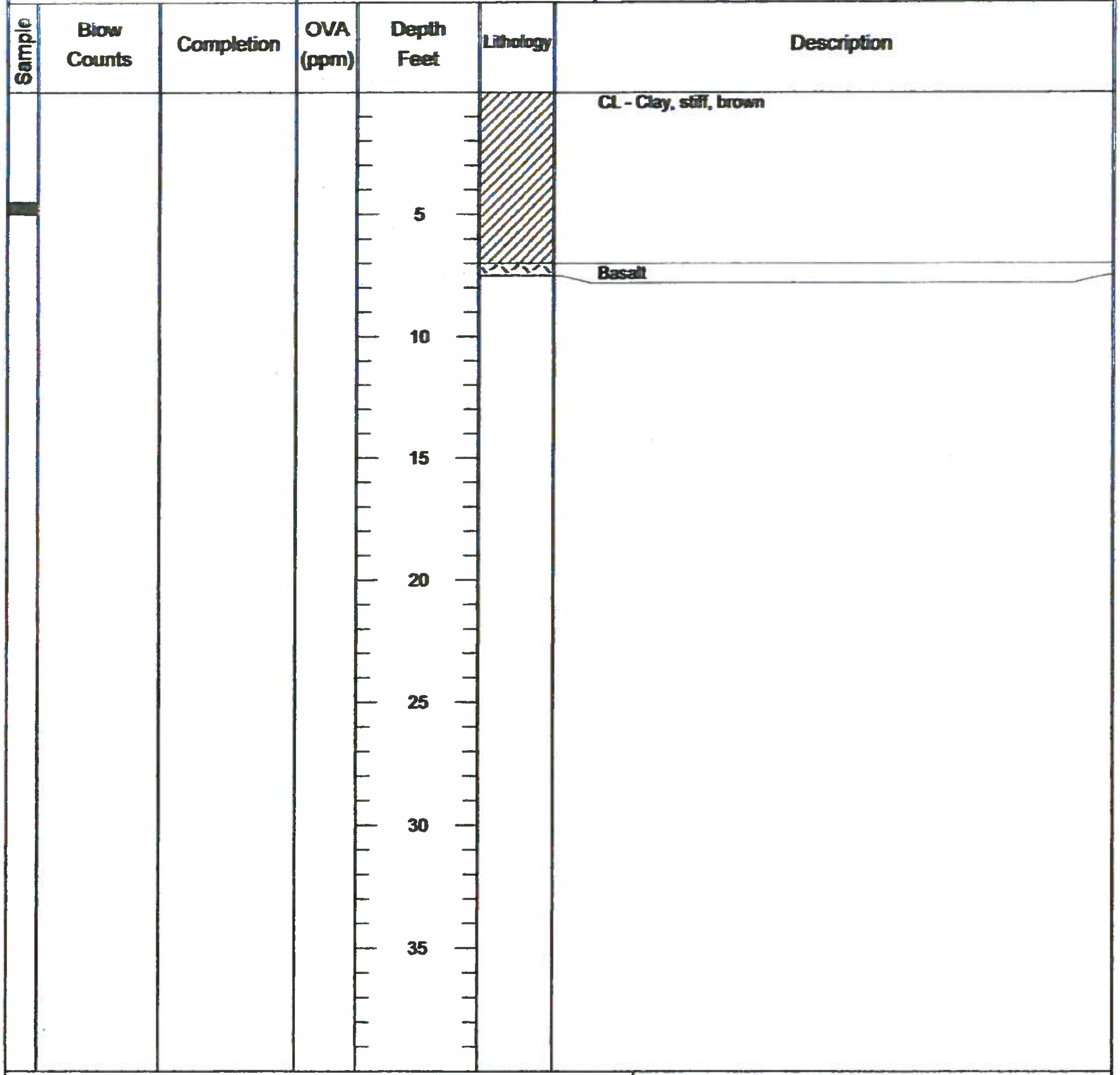
Drill Rig:

Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-1

Logged By: Tim O'Gara, LG, LHg



CL - Clay, stiff, brown

Basalt

Completion Notes:

Backfilled boring with bentonite after soil and water sample collection

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

Drill Rig:

Date Drilled: 3-1-12

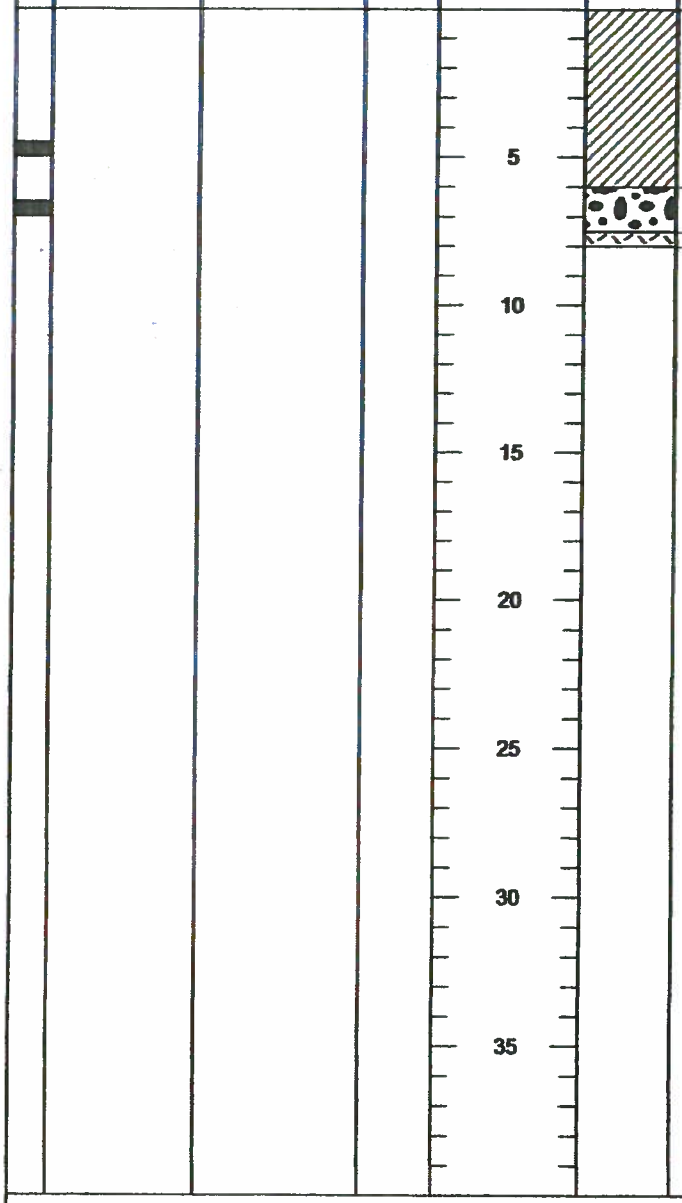
Logged By:

Boring Dia: Inches

Boring Number: B-2

Tim O'Gara LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description
						Cl - Clay, brown
						GP - Coarse Sand and Gravel, slight hydrocarbon odor
						Basalt



Completion Notes:

Backfilled boring with bentonite after collecting soil and water samples

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

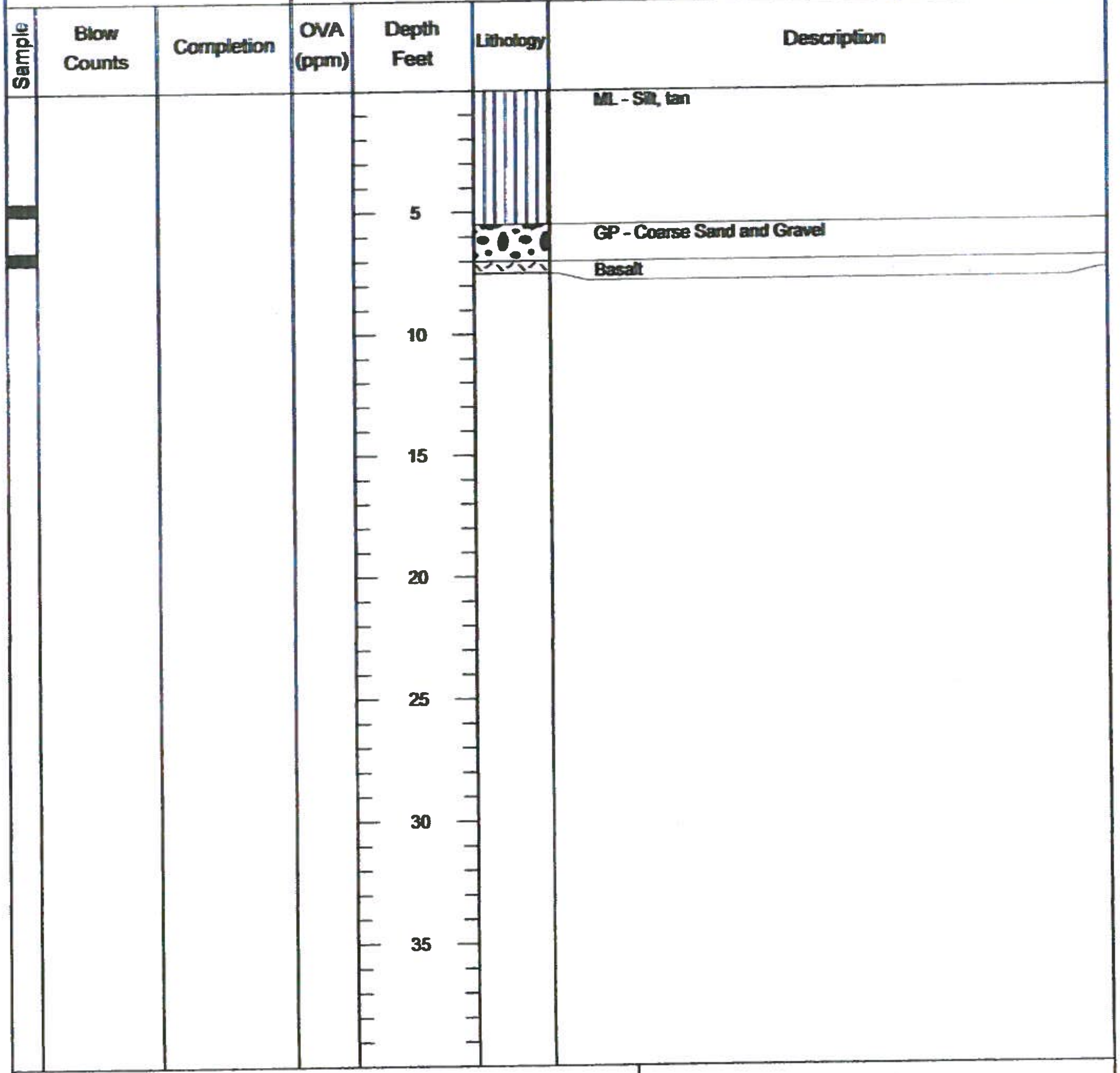
Drill Rig:

Date Drilled: 3-1-12

Logged By: Tim O'Gara, LG, LHg

Boring Dia: Inches

Boring Number: B-3



Completion Notes:

Backfilled boring with bentonite after collecting soil samples. No water detected in this boring

Site:

Carson - Goldendale

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Project No.:

Page 1

BORING LOG

Drill Rig:

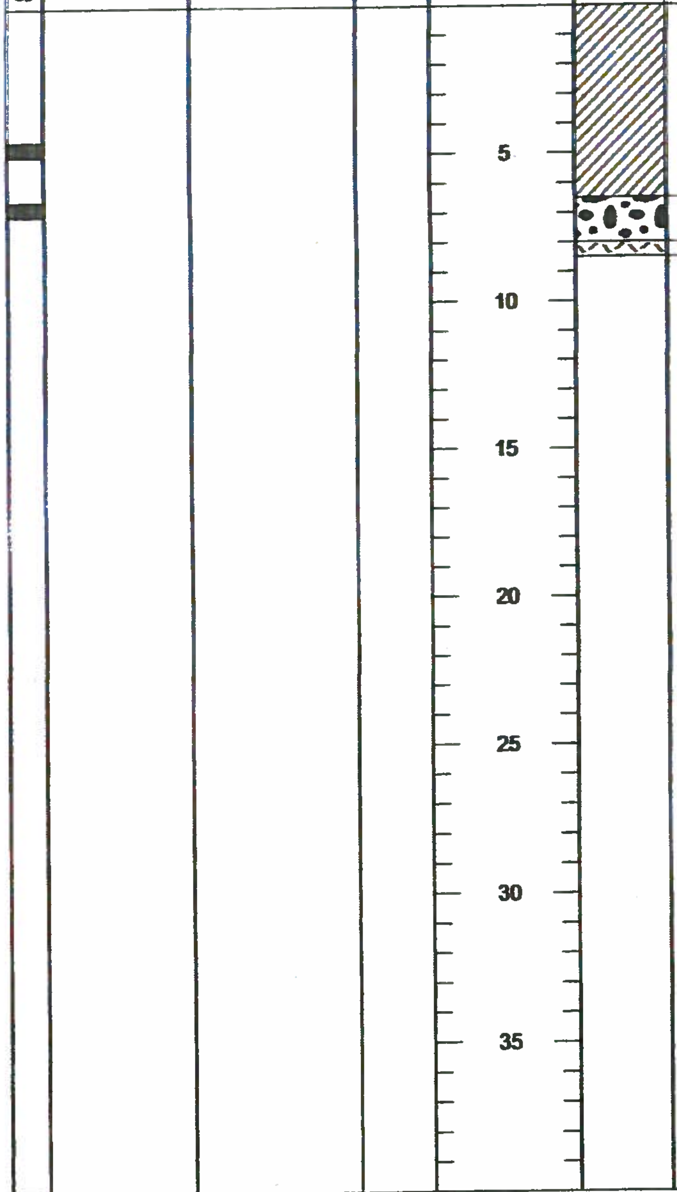
Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-4

Logged By: Tim O'Gara, LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description
						CL - Silty Clay, tan GP - Coarse Sand and Gravel Basalt



Completion Notes:

Backfilled boring with bentonite after collecting soil and water samples

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

Drill Rig:

Boring Dia: Inches

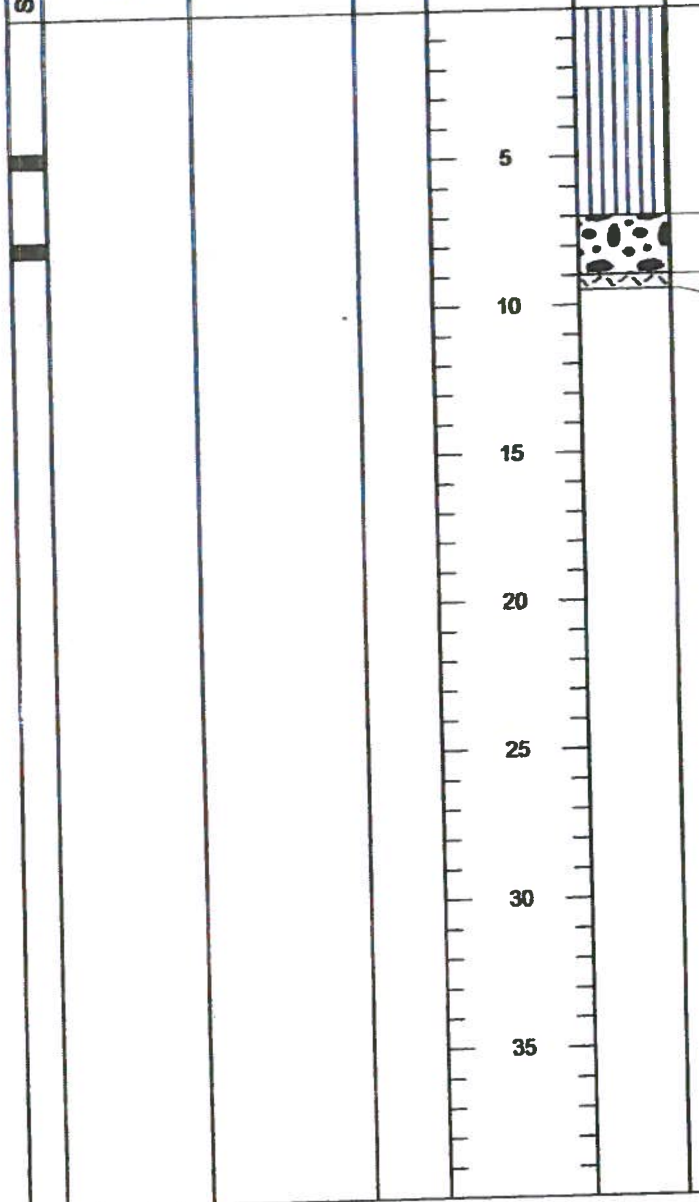
Date Drilled: 3-1-12

Boring Number: B-5

Logged By:

Tim O'Gara, LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description
						ML - Silt, brown, stiff
						GP - Sand and Gravel, cemented
						Basalt



Completion Notes:

Backfilled boring with bentonite after collecting soil sample. No water found in this boring.

Site:

Carson - Goldendale

Project No.:

Page 1

BORING LOG

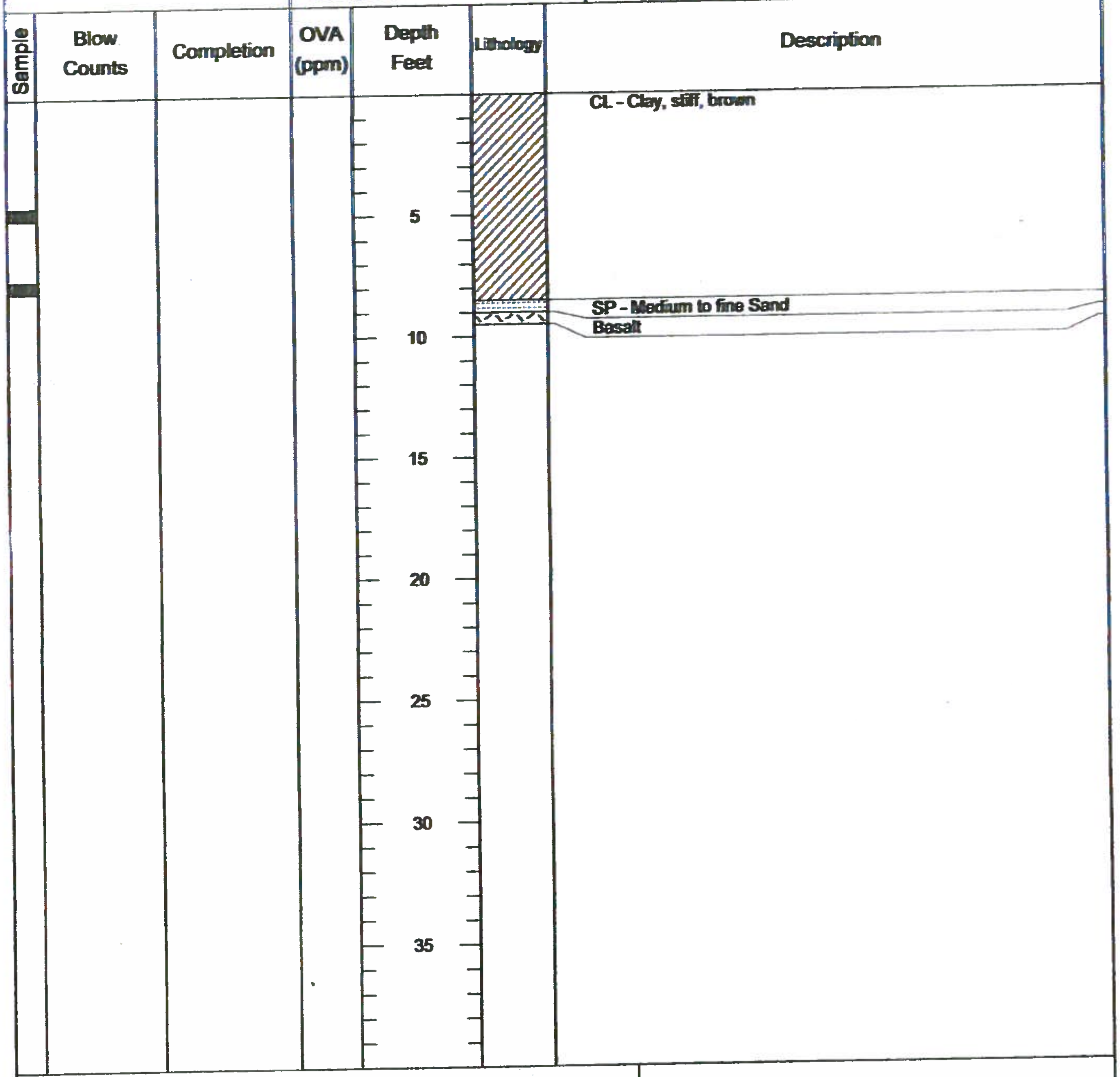
Drill Rig:

Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-6

Logged By: Tim O'Gara, LG, LHg



CL - Clay, stiff, brown

SP - Medium to fine Sand

Basalt

Completion Notes:

Backfilled boring with bentonite after collecting soil and water samples.

Site:

Carson - Goldendale

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Project No.:

Page 1

BORING LOG

Drill Rig:

Boring Dia: Inches

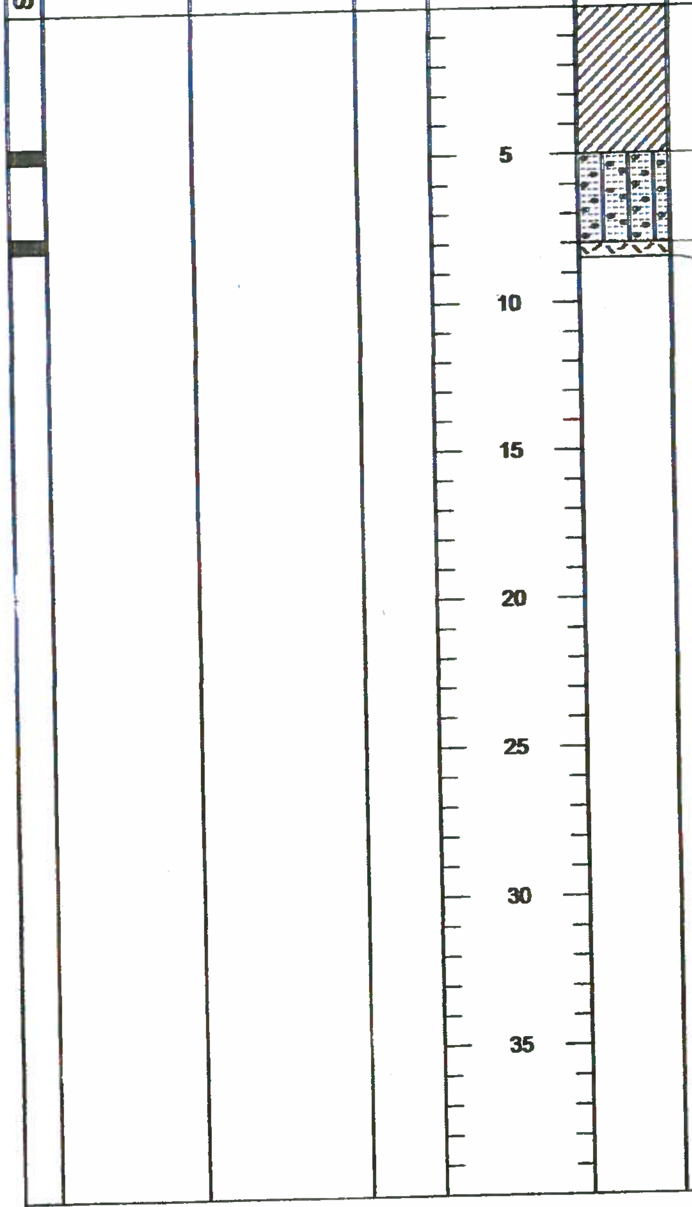
Date Drilled: 3-1-12

Boring Number: B-7

Logged By:

Tim O'Gara, LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description



CL - Silty Clay, stiff, dark brown

SM - Silty Sand, brown

Basalt

Completion Notes:

Backfilled with bentonite after collecting soil samples. No water found in this boring.

Site:

Carson - Goldendale

Project No.:

Page 1

BORING LOG

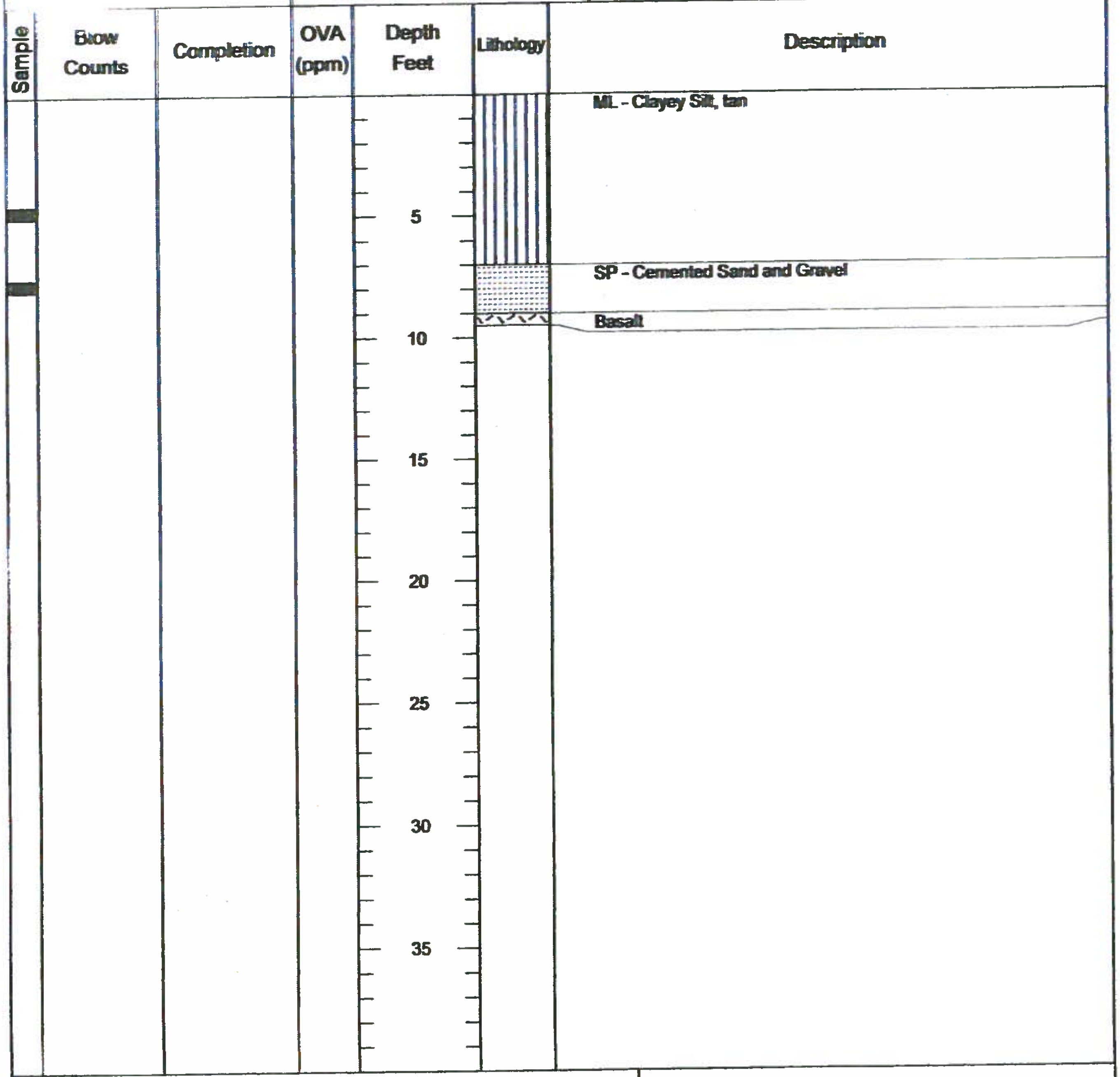
Drill Rig:

Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-8

Logged By: Tim O'Gara, LG, LHg



Completion Notes:

Backfilled with bentonite after collecting soil and water samples

Site:

Carson - Goldendale

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Project No.:

Page 1

BORING LOG

Drill Rig:

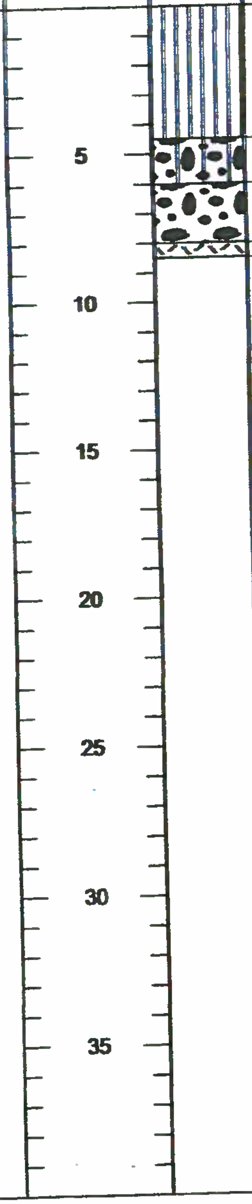
Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-9

Logged By:

Tim O'Gara, LG, LHg



Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description
						ML - Silt, tan
						GM - Silty angular Gravel
						GP - Cemented Sand and Gravel
						Basalt

Completion Notes:

Backfilled with bentonite after collecting soil and water samples

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

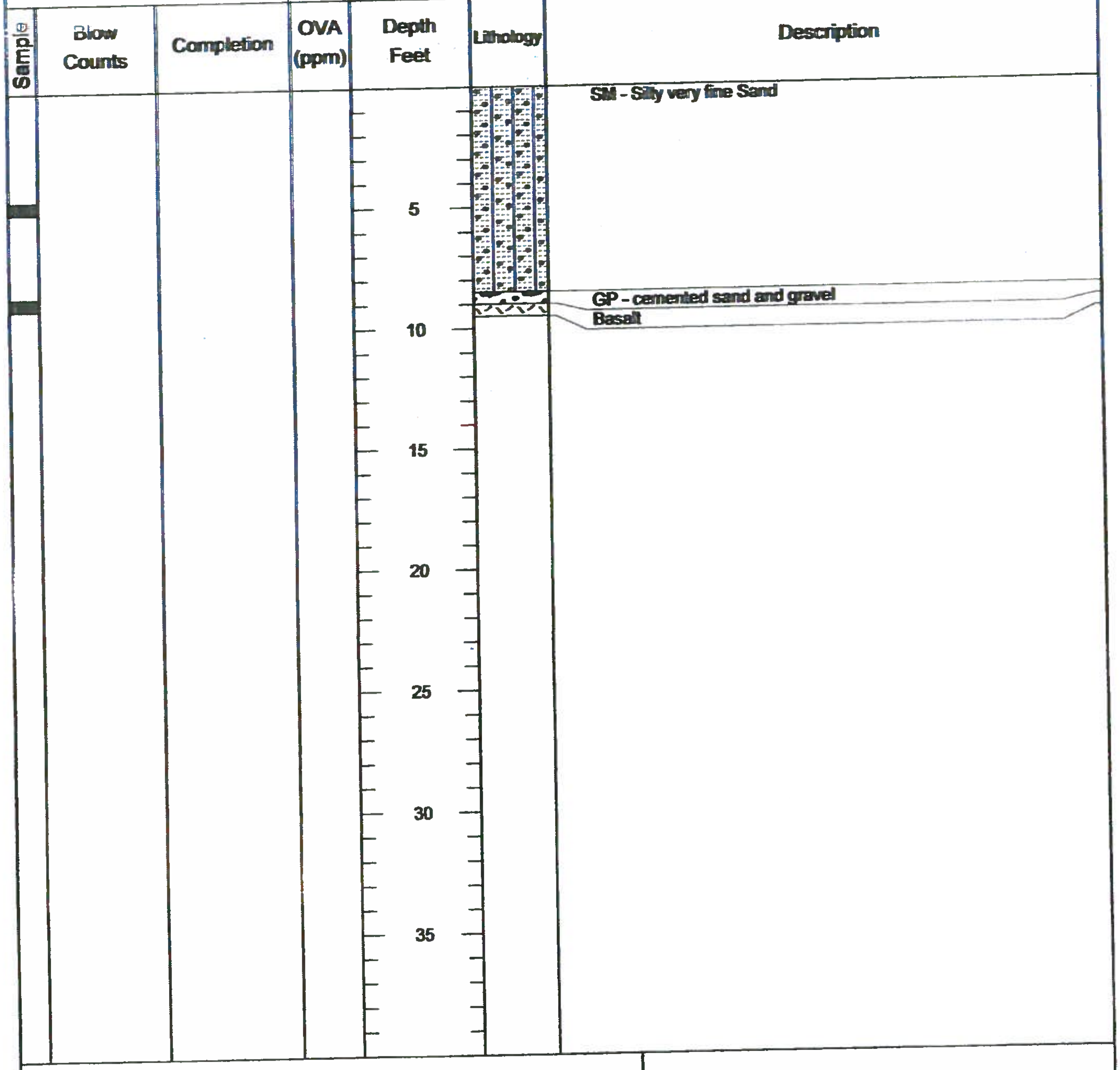
Drill Rig:

Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-10

Logged By: Tim O'Gara, LG,LHg



Completion Notes:

Backfilled with bentonite after collecting soil and water samples.

Site:

Carson - Goldendale

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Project No.:

Page 1

BORING LOG

Drill Rig:

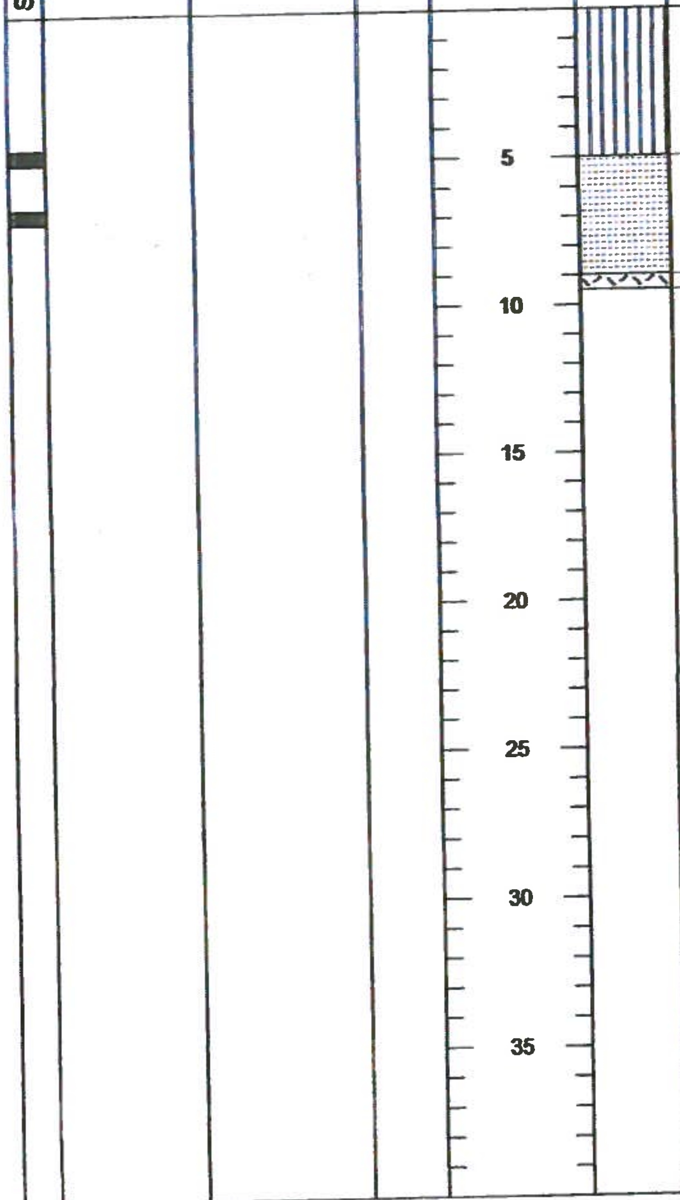
Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-11

Logged By: Tim O'Gara, LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description
						ML - Silt, black
						SP - Partially cemented coarse sand, black
						basalt



Completion Notes:

Backfilled boring with bentonite after collecting soil and water samples

Site:

Carson - Goldendale

Project No.:

Page 1

BORING LOG

Drill Rig:

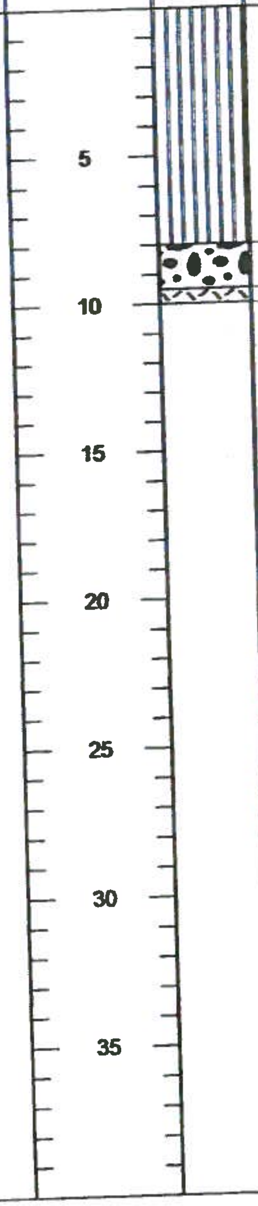
Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-12

Logged By: Tim O'Gara, LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description
						ML - Silt, black
						GP - Partially cemented Sand and Gravel
						Basalt



Completion Notes:

backfilled boring with bentonite after collecting soil and water samples.

Site:

Carson - Goldendale

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Project No.: .

BORING LOG

Drill Rig:

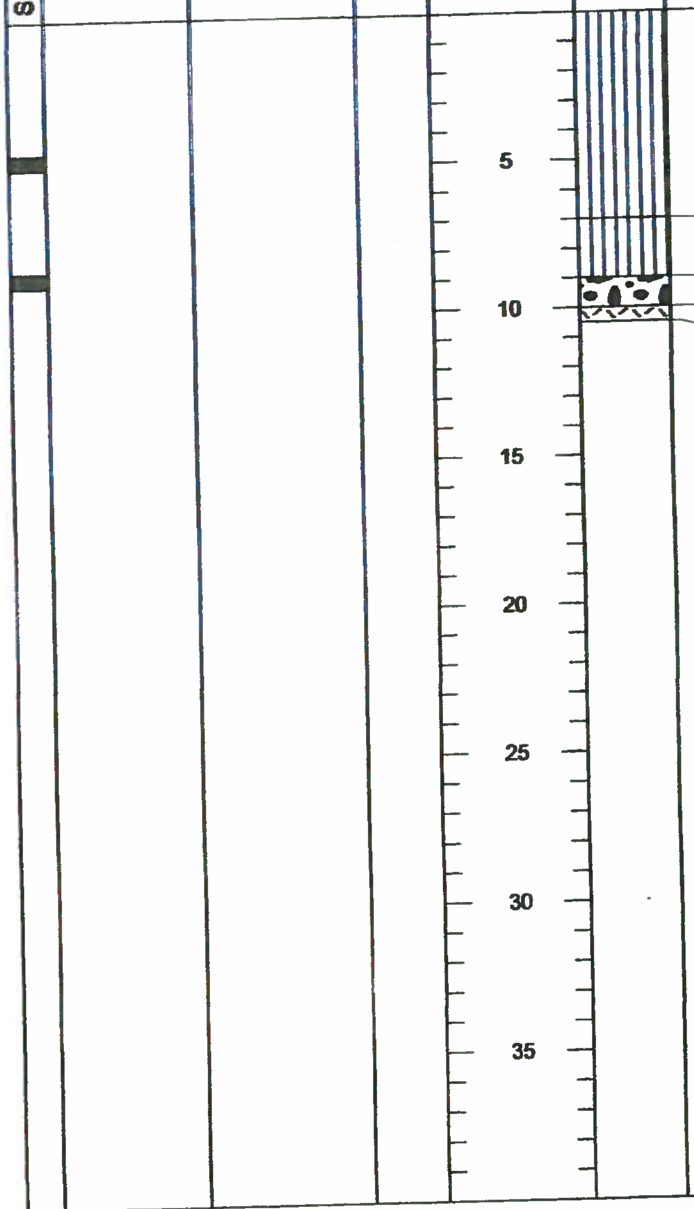
Boring Dia: Inches

Date Drilled: 3-1-12

Boring Number: B-13

Logged By: Tim O'Gara, LG, LHg

Sample	Blow Counts	Completion	OVA (ppm)	Depth Feet	Lithology	Description



ML - Silt, dark brown

ML - Silt, black

GP - Partially cemented Gravel with some Sand

Basalt

Completion Notes:

Backfilled boring with bentonite after collecting soil and water samples

Site:

Carson - Goldendale

Project No.:

Page 1

BORING LOG

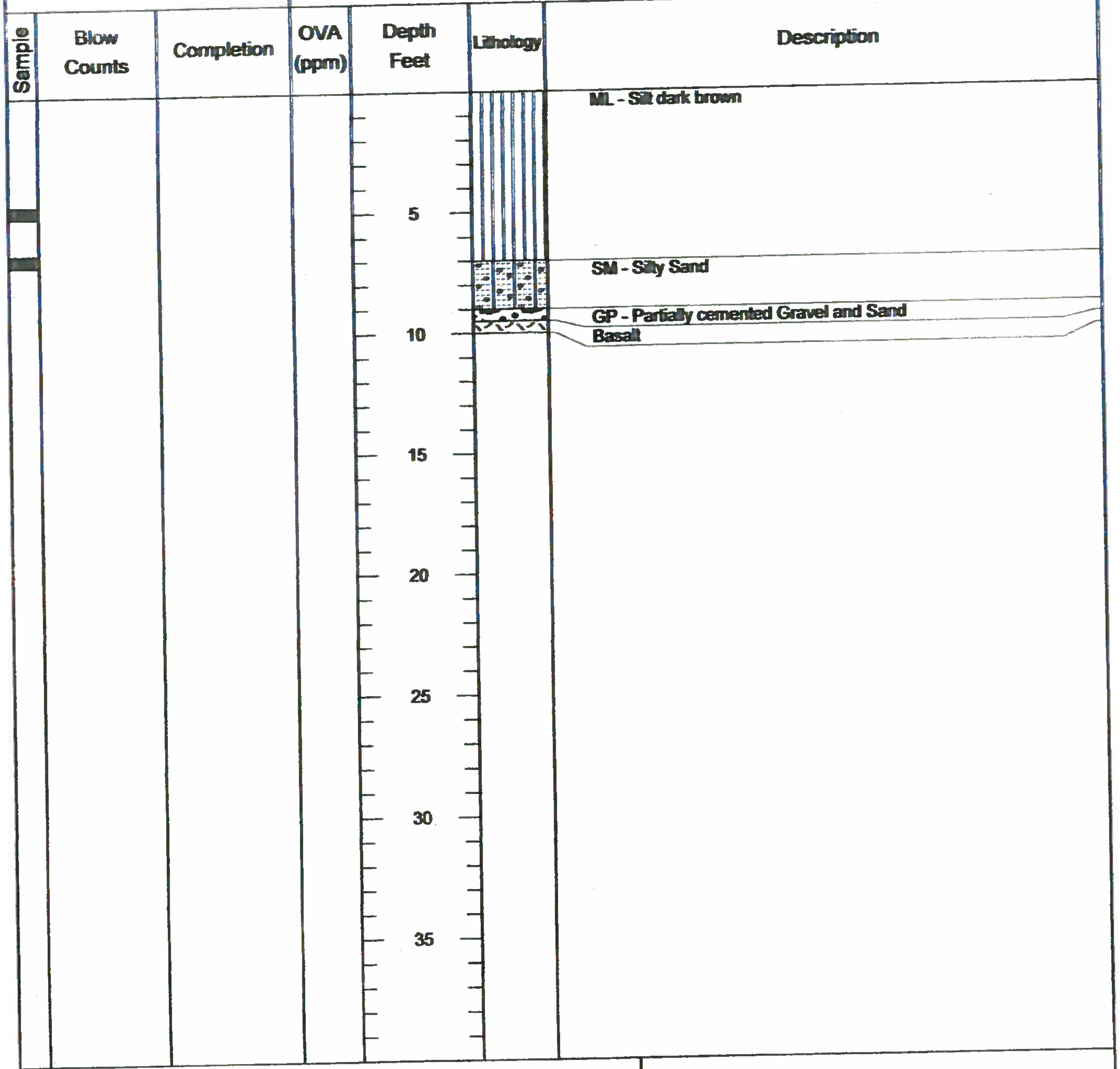
Drill Rig:

Date Drilled: 3-1-12

Logged By: Tim O'Gara, LG, LHg

Boring Dia: Inches

Boring Number: B-14



ML - Silt dark brown

SM - Silty Sand

GP - Partially cemented Gravel and Sand

Basalt

Completion Notes:

Backfilled boring with bentonite after collecting soil and water samples.

Site:

Carson - Goldendale

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Project No.:

Page 1

BORING LOG

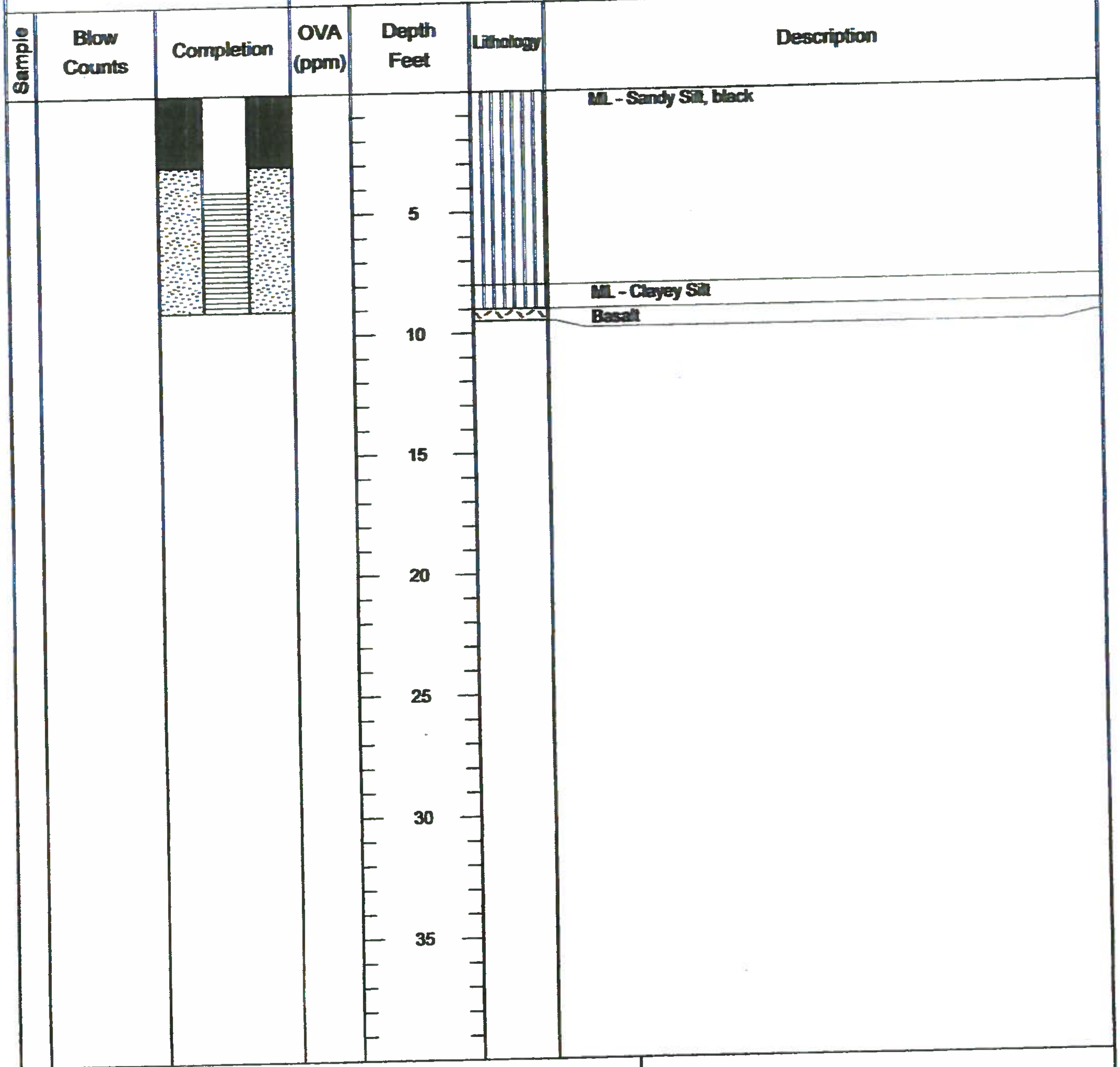
Drill Rig:

Boring Dia: Inches

Date Drilled: 4-5-12

Boring Number: MW-1

Logged By: Tim O'Gara, LG, LHg



ML - Sandy Silt, black

ML - Clayey Silt

Basalt

Completion Notes:

Flush mount completion.
Well is 2-inch pvc with 5 feet of prepack 0.010 slot screen

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

Drill Rig:

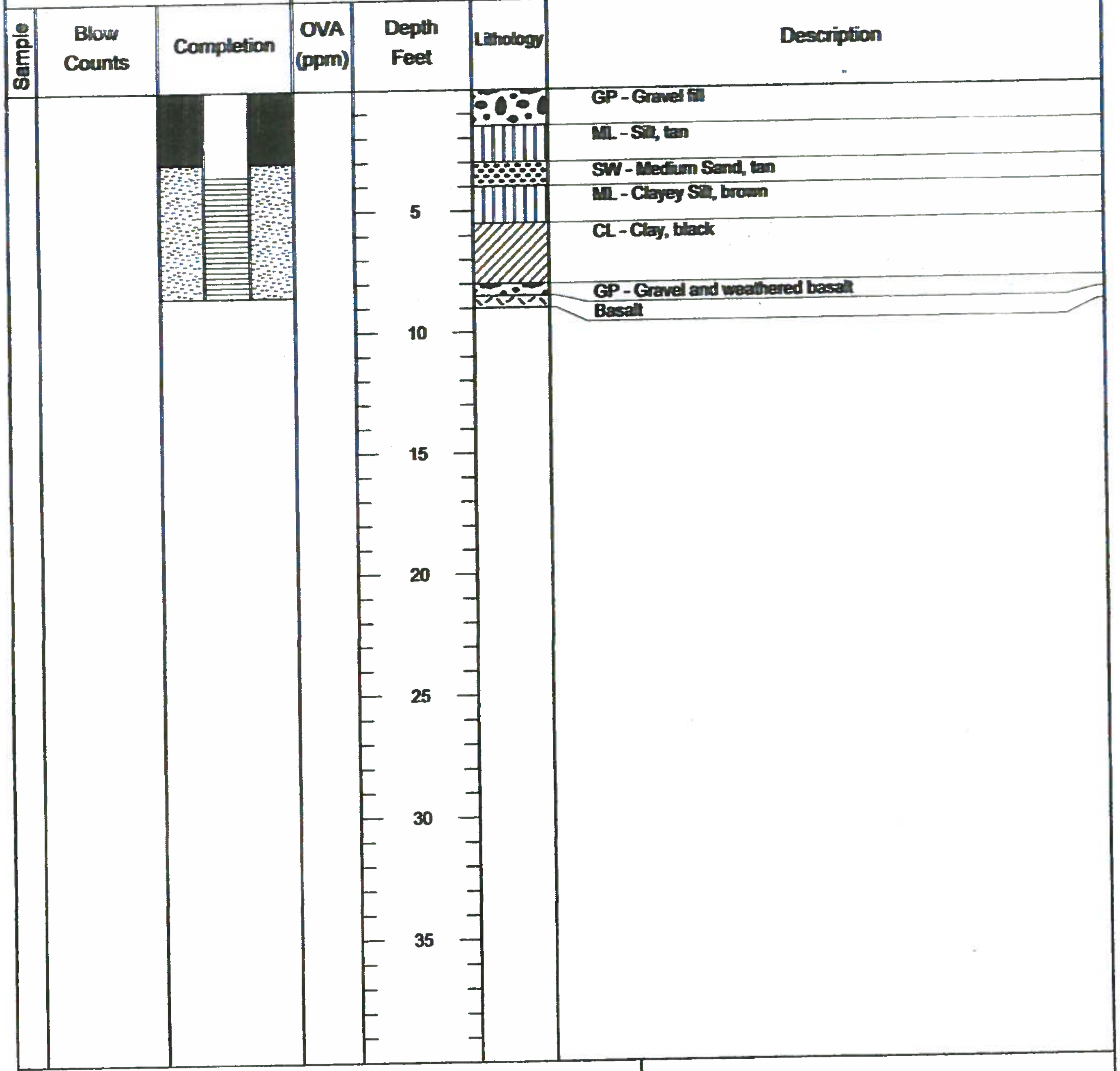
Boring Dia: Inches

Date Drilled: 4-5-12

Boring Number: MW-2

Logged By:

Tim O'Gara, LG, LHg



GP - Gravel fill

ML - Silt, tan

SW - Medium Sand, tan

ML - Clayey Silt, brown

CL - Clay, black

GP - Gravel and weathered basalt

Basalt

Completion Notes:

Flush mount completion

Well is 2-inch pvc with 5 feet of prepacked 0.010 slot screen

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

Drill Rig:

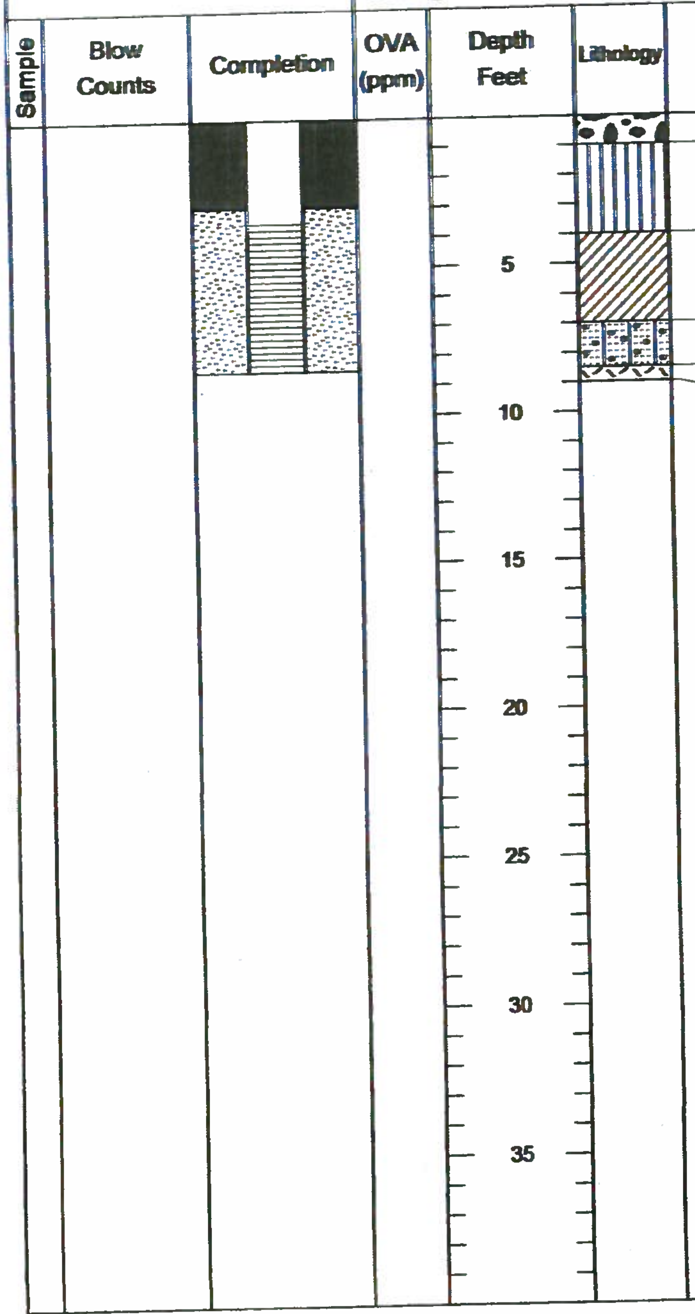
Boring Dia: Inches

Date Drilled: 4-5-12

Boring Number: MW-3

Logged By:

Tim O'Gara, LG, LHg



Description

GP - Gravel fill

ML - Sandy Silt, black

CL - Clay, black

SM - Medium Sand with Silt, black

Basalt

Completion Notes:

Flush mount completion

Well is 2-inch pvc with 0.010 slot prepacked screen

Site:

Carson - Goldendale

,

Project No.:

Page 1

BORING LOG

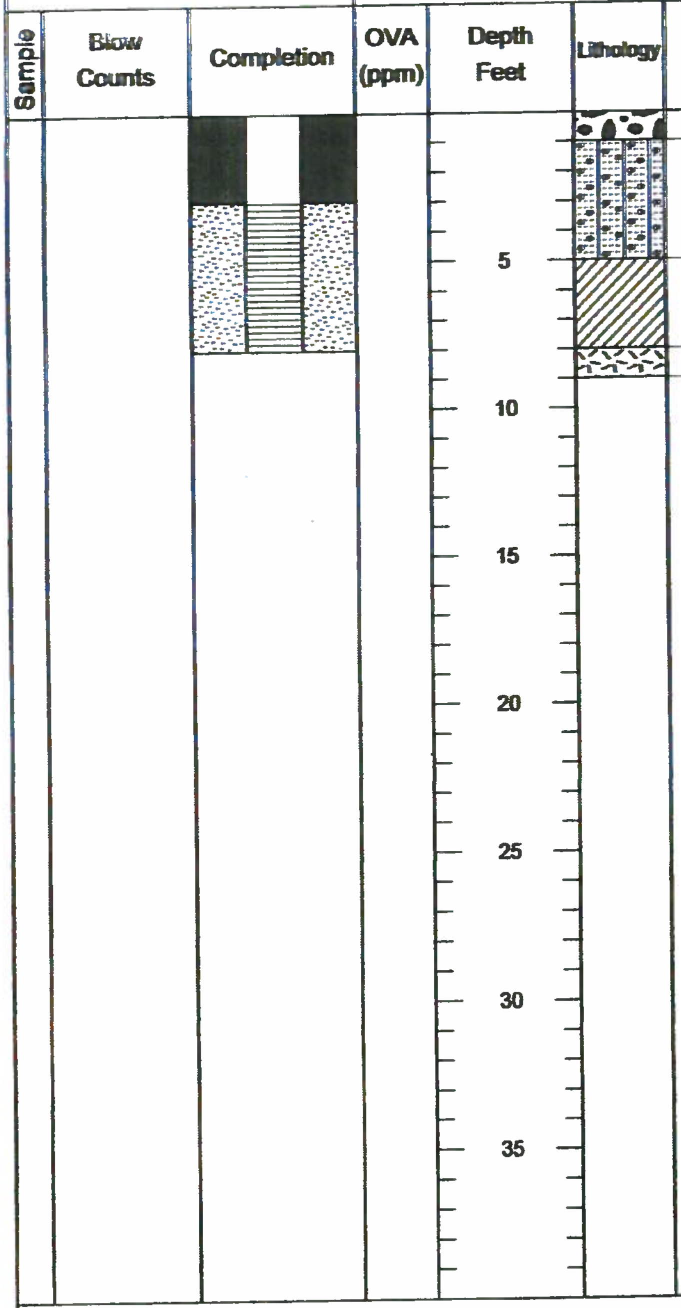
Drill Rig:

Boring Dia: Inches

Date Drilled: 4-5-12

Boring Number: MW-4

Logged By: Tim O'Gara, LG, LHg



Description

GP - Gravel fill

SM - Silty Sand with minor Clay, black

CL - Clay, black

Basalt

Completion Notes:

Flush mount completion

Well is 2-inch pvc with 0.010 slot prepack screen

Site:

Carson - Goldendale

Project No.:

Page 1

Appendix B

Boring Logs and Monitoring Well Construction Details

leidos

18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Soil Boring: SB-1

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩		Dense silty GRAVEL/Topsoil/Fill
Damp	65.1	✋			ML	▥	1	(ML) Dark brown to black, loose SILT, strong odor, no sheen
Damp	65.1	☒	SB-1-1.5	G = 53 D = 4.1 HO <12 B <0.029		▥		
					ML	▥	2	(ML) Dark brown to black, loose SILT, strong odor, no sheen
Damp	43.1	☒	SB-1-2.5	G = 37 D <3.6 HO <12 B <0.030	ML	▥		(ML) Dark brown to black, loose SILT, strong odor, no sheen
						▥	3	
Wet	47.5	✋			ML	▥		(ML) Dark brown to black, loose SILT, strong odor, no sheen
Wet	76.1	☒	SB-1-4.0	G = 270 D <3.8 HO <13 B <0.033	ML	▥	4	(ML) Dark brown to black, loose SILT, strong odor, no sheen Groundwater encountered at 4.0' at time of drilling
Wet	76.1	✋			ML	▥	5	(ML) Dark brown to black, loose SILT, strong odor, no sheen
		✋			SM/ML	░	6	(SM/ML) Gray, loose, silty SAND to sandy SILT, strong odor, moderate sheen
Wet	94.5	☒	SB-1-6.5	G = 1300 D = 3000 HO <230 B <0.022	SM/ML	░		(SM/ML) Gray, loose, silty SAND to sandy SILT, strong odor, moderate sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Soil Boring: SB-2

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 5.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
Damp	0.1	✋			ML	▥	1	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.1	☒	SB-2-2.5	G <1.3 D <3.8 HO <13 B = 0.003	ML	▥	2	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
						▥		Groundwater encountered at 2.5' at time of drilling
Wet	0.0	✋			ML	▥	3	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Wet	0.1	✋			ML	▥		(ML) Brown, loose SILT with trace gravel, no odor, no sheen
						▥	4	
Wet	0.2	✋			ML	▥		(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Wet	0.2	☒	SB-2-5.0	G = 4.8 D = 260 HO = 22 B = 0.002	ML	░	5	(ML) Gray, loose to firm, sandy SILT with trace pebbles, slight odor, no sheen
								-BASALT- Bottom of borehole at 5.5 feet.
							6	
							7	
							8	
							9	
							10	

18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Soil Boring: SB-3

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 4.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
Damp	0.1	✋			ML	▥	1	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
Wet	0.2	☒	SB-3-2.0	G <1.2 D <3.7 HO <12 B = 0.002	ML	▥	2	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
						▥		Groundwater encountered at 2.5' at time of drilling
Wet	0.1	✋			ML	▥	3	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
Wet	0.2	☒	SB-3-4.0	G <1.4 D <3.7 HO <12 B = 0.002	ML	▥	4	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
								-BASALT- Bottom of borehole at 4.5 feet.
							5	
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-4

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 4.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
Damp	0.1	✋			ML	▥	1	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
Damp	0.2	☒	SB-4-2.5	G <1.3 D <3.8 HO <13 B = 0.003	ML	▥	2	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
						▥		Groundwater encountered at 2.5' at time of drilling
Wet	0.2	✋			ML	▥	3	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
Wet	0.2	☒	SB-4-4.0	G <1.3 D <3.7 HO <12 B = 0.002	ML	▥	4	(ML) Brown, loose, clayey SILT with trace sand, no odor, no sheen
								-BASALT- Bottom of borehole at 4.5 feet.
							5	
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-5

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
	1.2	✋			ML		1	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
	1.1	✋			ML			(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
	0.5	✋			ML		2	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
	0.2	☒	SB-5-2.5	G <1.4 D = 10 HO = 43 B = 0.001	ML			(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
							3	Groundwater encountered at 3.0' at time of drilling
	0.5	✋			ML			(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
	0.8	✋			ML		4	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
	1.0	✋			ML			(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
	1.0	✋			ML		5	(ML) Brown, loose, clayey SILT with trace gravel, slight odor, no sheen
	1.2	☒	SB-5-5.5	G = 5.4 D = 91 HO = 21 B = 0.002	ML			(ML) Brown, loose, clayey SILT with trace gravel, slight odor, no sheen
	48.3	☒	SB-5-6.0	G = 33 D = 26 HO <13 B = 0.006	ML		6	(ML) Gray, loose SILT with basalt fragments, strong odor, moderate sheen
								-BASALT- Bottom of borehole at 6.5 feet.

18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Soil Boring: SB-6

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩		Dense silty GRAVEL/Topsoil/Fill
	0.1	✋			SC-SM	▨	1	(SC-SM) Brown, loose, silty clayey SAND with trace roots and organics, moderate odor, no sheen
	0.2	✋			ML	▥	2	(ML) Brown, loose, clayey SILT, no odor, no sheen
	0.2	☒	SB-6-2.5	G <1.5 D <3.9 HO <13 B = 0.004	ML	▥		(ML) Brown, loose, clayey SILT, no odor, no sheen
						▥	3	Groundwater encountered at 3.0' at time of drilling
	0.5	✋			ML	▥	4	(ML) Brown, loose, clayey SILT, no odor, no sheen
	0.2	✋			ML	▥	5	(ML) Brown, loose, clayey SILT, slight odor, no sheen
	35.4	☒	SB-6-5.5	G = 290 D = 76 HO = 37 B = 0.043	ML	▥		(ML) Brown, loose, clayey SILT, strong odor, moderate sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Bothell, WA, 98011

Soil Boring: SB-7

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
								(SC-SM) Brown, loose, silty clayey SAND, no odor, no sheen
	0.3	✋			SC-SM		1	
	0.2	✋						
	0.1	✋			SC-SM		2	(SC-SM) Brown, loose, silty clayey SAND, no odor, no sheen
	1.0	☒	SB-7-2.5	G <1.5 D <3.8 HO = 18 B = 0.004	ML			(ML) Brown, loose, clayey SILT, no odor, no sheen
							3	Groundwater encountered at 3.0' at time of drilling
	1.0	✋						(ML) Brown, loose, clayey SILT, no odor, no sheen
					ML		4	
	0.2	✋						(ML) Brown, loose, clayey SILT, no odor, no sheen
					ML		5	
	1.1	☒	SB-7-5.5	G <1.4 D = 8.5 HO <13 B = 0.001	ML			(ML) Brown, loose, clayey SILT, no odor, no sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-8

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	1.0	✋			ML		2	(ML) Brown, loose, clayey SILT, no odor, no sheen
Damp	3.4	☒	SB-8-3.5	G <1.7 D <4.0 HO <13 B = 0.003	ML		3	(ML) Brown, loose, clayey SILT, no odor, no sheen
Wet	8.4	✋			ML		4	(ML) Brown, loose, clayey SILT, no odor, no sheen Groundwater encountered at 4.0' at time of drilling
Wet	9.2	✋			ML		5	(ML) Brown, loose, clayey SILT, no odor, no sheen
					SM			(SM) Gray, loose, silty SAND, strong odor, heavy sheen
Wet Wet Wet	270 245.6 810	☒	SB-8-6.5	G = 300 D = 770 HO <63 B <0.034	SM		6	(SM) Gray, loose, silty SAND, strong odor, heavy sheen
					SM			(SM) Gray, loose, silty SAND, strong odor, heavy sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-9

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.75 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
Damp	1.0	✋			ML		1	(ML) Dark brown, clayey SILT, no odor, no sheen
Damp	1.7	✋			ML		2	(ML) Dark brown, clayey SILT, no odor, no sheen
							3	
Wet	1.2	☒	SB-9-3.5	G <1.3 D <3.9 HO <13 B = 0.003	ML			(ML) Dark brown, clayey SILT, no odor, no sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	1.4	✋			ML			(ML) Dark brown, clayey SILT, slight odor, no sheen
							5	
Wet	1.2	✋			ML			(ML) Dark brown, clayey SILT, slight odor, no sheen
Wet	1.2	☒	SB-9-6.0	G = 19 D = 21 HO <13 B = 0.001	ML		6	(ML) Gray, loose SILT, slight odor, no sheen
							7	-BASALT- Bottom of borehole at 6.8 feet.
							8	
							9	
							10	

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Soil Boring: SB-10

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/17/2018
Date Completed: 4/17/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 5.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
							1	Dense silty GRAVEL/Topsoil/Fill
Damp	0.1	✋			ML			(ML) Brown, low plastic SILT with occasional gravel (fill), no odor, no sheen
Damp	0.1	✋			ML		2	(ML) Brown, low plastic SILT with occasional gravel (fill), no odor, no sheen
Damp	0.1	✋			ML			(ML) Brown, low plastic SILT with occasional gravel (fill), no odor, no sheen
Damp	0.1	☒	SB-10-3.0	G <1.3 D <3.8 HO <13 B = 0.002	ML		3	(ML) Brown, low plastic SILT with occasional gravel (fill), no odor, no sheen Groundwater encountered at 3.0' at time of drilling
Damp	0.1	✋			ML			(ML) Brown, low plastic SILT with occasional gravel (fill), no odor, no sheen
Wet	0.1	✋			ML		4	(ML) Brown, low plastic SILT with occasional gravel (fill), no odor, no sheen
Wet	0.0	✋			SM			(SM) Brown, loose, gravelly, silty SAND with occasional basalt cobbles, no odor, no sheen
Wet	0.1	☒	SB-10-5.0	G <1.3 D <3.9 HO <13 B = 0.002	SM		5	(SM) Brown, loose, gravelly, silty SAND with occasional basalt cobbles, no odor, no sheen
							6 7 8 9 10	-BASALT- Bottom of borehole at 5.5 feet.

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Soil Boring: SB-11

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
						▨	1	
Moist	1.2	✋					2	(ML) Brown to black, loose, clayey SILT with trace gravel, no odor, no sheen
					ML			
Moist	0.9	✋			ML		3	(ML) Brown to black, loose, clayey SILT with trace gravel, no odor, no sheen
Wet	1.1	☒	SB-11-3.5	G <1.4 D <4.0 HO <13 B = 0.001	ML			(ML) Brown to black, loose, clayey SILT with trace gravel, no odor, no sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	1.0	✋						(ML) Brown to black, loose, clayey SILT with trace gravel, no odor, no sheen
							5	
					ML			
Wet	224	☒	SB-11-6.0	G = 460 D = 480 HO <13 B <0.026	SM	⁘	6	(SM) Gray, loose, silty SAND, moderate odor, heavy sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-12

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 5.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩		Dense silty GRAVEL/Topsoil/Fill
						▩	1	
						▥		
Damp	1.4	✋			ML	▥	2	(ML) Dark brown, clayey SILT, no odor, no sheen
Damp	0.4	✋			ML	▥	3	(ML) Dark brown, clayey SILT, no odor, no sheen
Wet	1.1	☒	SB-12-4.0	G <1.3 D <3.9 HO <13 B = 0.0006	ML	▥	4	(ML) Dark brown, clayey SILT, no odor, no sheen Groundwater encountered at 4.0' at time of drilling
Wet	1.1	☒	SB-12-5.0	G <1.1 D <3.7 HO <12 B <0.0004	ML	▥	5	(ML) Dark brown, clayey SILT, no odor, no sheen
								-BASALT- Bottom of borehole at 5.5 feet.
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-13

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	0.9	✋					2	(ML) Brown, loose, clayey SILT, no odor, no sheen
					ML			
							3	
		☒	SB-13-3.5	G <1.2 D <3.8 HO <13 B = 0.001	ML			(ML) Brown, loose, clayey SILT, no odor, no sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	1.1	✋						(ML) Brown, loose, clayey SILT, no odor, no sheen
					ML		5	
Wet	250	☒	SB-13-5.5	G = 770 D = 5.6 HO <13 B <0.031	ML			(ML) Brown, loose, clayey SILT, strong odor, moderate sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-14

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	0.4	✋			ML		2	(ML) Black, soft, clayey SILT, no odor, no sheen
Damp	0.4	✋			ML		3	(ML) Black, soft, clayey SILT, no odor, no sheen
Wet	0.4	☒	SB-14-3.5	G <1.4 D <4.0 HO <13 B = 0.003	ML			(ML) Black, soft, clayey SILT, no odor, no sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	0.2	✋			ML			(ML) Black, soft, clayey SILT, no odor, no sheen
							5	
Wet	1.6	✋			ML			(ML) Black, soft, clayey SILT, slight odor, no sheen
							6	
Wet	1.2	☒	SB-14-6.5	G = 63 D = 54 HO <13 B <0.028	ML			(ML) Black, soft, clayey SILT, moderate odor, no sheen
Wet	244	✋			SM/ML		7	(SM/ML) Gray, loose, silty SAND to sandy SILT, strong odor, heavy sheen
								-BASALT- Bottom of borehole at 7.5 feet.
							8	
							9	
							10	

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Soil Boring: SB-15

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	3.9	✋			ML		2	(ML) Brown, loose SILT, no odor, no sheen
Damp	2.2	✋			ML		3	(ML) Brown, loose SILT, no odor, no sheen
Wet	1.2	☒	SB-15-3.5	G <1.6 D <3.9 HO <13 B = 0.002	ML			(ML) Brown, loose SILT, no odor, no sheen Groundwater encountered at 3.5' at time of drilling
							4	
Wet	1.0	✋			ML		5	(ML) Brown, loose SILT, no odor, no sheen
Wet	1.4	✋			ML			(ML) Brown, loose SILT, moderate odor, slight sheen
Wet	4.5	☒	SB-15-6.0	G = 440 D = 86 HO <13 B <0.026	ML		6	(ML) Brown, loose SILT, moderate odor, moderate sheen
								-BASALT- Bottom of borehole at 6.5 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-16

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	1.1	✋					2	(ML) Black, loose SILT with trace gravel, no odor, no sheen
					ML			
							3	
Damp	1.3	☒	SB-16-3.5	G <1.5 D <3.9 HO <13 B = 0.003	ML			(ML) Black, loose SILT with trace gravel, no odor, no sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	1.3	✋					5	(ML) Black, loose SILT with trace gravel, slight odor, no sheen
					ML			
Wet	44.5	☒	SB-16-6.0	G = 1200 D = 2000 HO <59 B <0.020	ML		6	(ML) Black, loose SILT with trace gravel, strong odor, heavy sheen
								-BASALT- Bottom of borehole at 6.5 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-17

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	1.2	✋					2	(ML) Dark brown, clayey SILT, moderate odor, no sheen
					ML			
							3	
Wet	89.5	☒	SB-17-3.5	G = 1300 D = 660 HO <26 B <0.036	ML			(ML) Dark brown, clayey SILT, strong odor, slight sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	228	✋					5	(ML) Dark brown, clayey SILT, strong odor, heavy sheen
					ML			
Wet	350.8	☒	SB-17-6.0	G = 1100 D = 830 HO <65 B <0.045	SM		6	(SM) Gray to black, loose, silty SAND, strong odor, moderate sheen
								-BASALT- Bottom of borehole at 6.5 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-18

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/6/2018
Date Completed: 4/6/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								(SC) Dark brown, loose, clayey silty SAND with roots and bio-action, no odor, no sheen
					SC		1	
Damp	1.0	✋						
							2	
Damp	1.1	☒	SB-18-2.5	G <1.4 D <3.9 HO <13 B = 0.004	ML			(ML) Dark brown, loose, clayey SILT, no odor, no sheen
							3	Groundwater encountered at 3.0' at time of drilling
Wet	1.0	✋						(ML) Dark brown, loose, clayey SILT, no odor, no sheen
					ML		4	
Wet	0.8	✋						(ML) Dark brown, loose, clayey SILT, no odor, no sheen
					ML		5	
Wet	1.1	☒	SB-18-5.5	G <1.4 D <4.0 HO <13 B = 0.0008	ML			(ML) Dark brown, loose, clayey SILT, no odor, no sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-19

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
					SM		1	(SM) Brown to black, clayey silty fine SAND with organics throughout, no odor, no sheen
Damp	0.2	✋			ML		2	(ML) Brown, loose, clayey SILT, no odor, no sheen
Wet	1.2	☒	SB-19-2.5	G <1.6 D <3.9 HO <13 B = 0.003	ML			(ML) Brown, loose, clayey SILT, no odor, no sheen
							3	Groundwater encountered at 3.0' at time of drilling
Wet	0.8	✋			ML		4	(ML) Brown, loose, clayey SILT, no odor, no sheen
Wet	1.2	☒	SB-19-4.5	G <1.3 D <3.8 HO <13 B = 0.0006	ML			(ML) Brown, loose, clayey SILT, no odor, no sheen
							5	-BASALT- Bottom of borehole at 5.0 feet.
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-20

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/6/2018
Date Completed: 4/6/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								(SC) Brown clayey silty SAND with rocks and debris
Damp		✋						
					SC		1	
Damp		✋						
							2	
Damp	2.9	☒	SB-20-2.5	G <1.4 D <3.8 HO <13 B = 0.004	ML			(ML) Brown, loose, clayey SILT, no odor, no sheen
							3	Groundwater encountered at 3.0' at time of drilling
Wet	1.1	✋						(SM) Brown, loose, silty fine SAND with trace clay, no odor, no sheen
					SM		4	
Wet	0.0	✋						(SM) Brown, loose, silty fine SAND with trace clay, no odor, no sheen
					SM		5	
Wet	1.1	☒	SB-20-5.5	G <1.3 D <3.9 HO <13 B = 0.001	SM			(SM) Brown, loose, silty fine SAND with trace clay, no odor, no sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-21

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/17/2018
Date Completed: 4/17/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
						▨	1	
Damp	0.1	✋				‖		(ML) Dark brown, loose, clayey SILT with trace sand, no odor, no sheen
					ML	‖	2	
Damp	0.1	✋				‖		(ML) Dark brown, loose, clayey SILT with trace sand, no odor, no sheen
					ML	‖		
Wet	0.2	☒	SB-21-3.0	G <1.3 D <3.9 HO <13 B = 0.003	ML	‖	3	(ML) Dark brown, loose, clayey SILT with trace sand, no odor, no sheen
						‖		Groundwater encountered at 3.5' at time of drilling
Wet	0.0	✋				‖	4	(ML) Dark brown, loose, clayey SILT with trace sand, no odor, no sheen
					ML	‖		
Wet	0.1	✋				‖	5	(ML) Dark brown, loose, clayey SILT with trace sand, no odor, no sheen
					ML	‖		
Wet	15.1	✋				‖	6	
						⁙		(SM) Gray, loose to medium dense, silty SAND, strong odor, medium sheen
Wet	17.7	☒	SB-21-6.5	G = 250 D = 110 HO <13 B <0.033	SM	⁙		
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-22

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/4/2018
Date Completed: 4/4/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	0.0	✋			ML	▥	2	(ML) Dark brown to black, clayey SILT with trace gravel, no odor, slight sheen
Damp	0.3	✋				▥		(ML) Dark brown to black, clayey SILT with trace gravel, no odor, no sheen
					ML	▥	3	
Wet	0.5	☒	SB-22-3.5	G <1.2 D <3.8 HO <13 B = 0.003	ML	▥		(ML) Dark brown to black, clayey SILT with trace gravel, no odor, no sheen
						▥	4	Groundwater encountered at 4.0' at time of drilling
Wet		✋				▥		(ML) Light brown, soft, clayey SILT, no odor, no sheen
					ML	▥	5	
Wet	1.5	☒	SB-22-6.0	G = 91 D = 200 HO <14 B <0.026	SM	░	6	(SM) Gray, loose, silty SAND, strong odor, heavy sheen
Wet	110.3 123.3	✋			SM	░	7	(SM) Gray, loose, silty SAND, strong odor, heavy sheen
							8	-BASALT- Bottom of borehole at 7.5 feet.
							9	
							10	

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Soil Boring: SB-23

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/3/2018
Date Completed: 4/3/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 9 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
Wet	1.5	✋			SM		1	(SM) Dark brown, silty SAND with trace gravel, no odor, no sheen
Moist	1.1	✋			ML		2	(ML) Dark brown, sandy SILT, no odor, no sheen
Wet	0.4	☒	SB-23-2.5	G <1.1 D <3.8 HO <13 B = 0.003	ML		3	(ML) Dark brown SILT with trace gravel, no odor, no sheen
Wet	0.3	☒	SB-23-3.5	G <1.4 D = 4.3 HO = 15 B = 0.002	ML		4	(ML) Dark brown SILT with trace gravel, no odor, no sheen Groundwater encountered at 4.0' at time of drilling
Wet	0.2	✋			ML		5	(ML) Dark brown SILT with trace gravel, no odor, no sheen
Wet	0.2	✋			ML		6	(ML) Dark brown SILT with trace gravel, no odor, no sheen
Wet	0.2	✋			ML		7	(ML) Dark brown SILT with trace gravel, no odor, no sheen
Wet	11.5	☒	SB-23-7.5	G = 380 D = 83 HO <11 B <0.018	SM		8	(SM) Brown, loose, silty SAND with gravel, strong odor, heavy sheen
Damp	695	✋			SM			(SM) Brown to gray, medium dense, fine to medium, silty SAND with trace gravel and basalt at base, strong odor, moderate to heavy sheen
							9	--BASALT- Bottom of borehole at 9.0 feet.
							10	

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Soil Boring: SB-24

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	3.1	☒	SB-24-2.0	G <1.2 D <3.7 HO <12 B = 0.003	ML	▥	2	(ML) Brown, loose, clayey SILT, slight odor, no sheen
Damp	30.3	✋					3	(ML) Brown, loose, clayey SILT, slight odor, no sheen
Damp	95	✋			ML			
Damp	105.8	☒	SB-24-4.0	G = 730 D = 3200 HO <260 B <0.034	ML		4	(ML) Gray, loose SILT with trace sand, strong odor, slight sheen
Wet	108.3	✋			ML		5	(ML) Gray, loose SILT with trace sand, strong odor, heavy sheen Groundwater encountered at 5.0' at time of drilling
Wet	663	✋			ML		6	(ML) Gray, loose SILT with trace sand, strong odor, heavy sheen
Wet	688	☒	SB-24-6.5	G = 1500 D = 1700 HO <130 B = 0.068	ML			(ML) Gray, loose SILT with trace sand, strong odor, heavy sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-25

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨	1	Dense silty GRAVEL/Topsoil/Fill
Damp	0.2	✋			ML			(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
Damp		✋			ML		2	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
Damp	1.2	✋			ML			(ML) Gray, medium dense SILT, strong odor, no sheen
Damp	98.7	☒	SB-25-3.0	G = 650 D = 4100 HO <260 B <0.033	ML		3	(ML) Gray, medium dense SILT, strong odor, heavy sheen
Damp	92.8	✋			ML		4	(ML) Gray, medium dense SILT, strong odor, heavy sheen
								Groundwater encountered at 4.5' at time of drilling
Wet	112.2	✋			ML		5	(ML) Gray, medium dense SILT, strong odor, heavy sheen
Wet	225.1	✋			ML			(ML) Gray, medium dense SILT, strong odor, heavy sheen
Wet	1280	☒	SB-25-6.0	G = 570 D = 1700 HO <140 B <0.036	ML		6	(ML) Gray, medium dense SILT, strong odor, heavy sheen
								(ML) Gray, medium dense SILT, strong odor, heavy sheen
Wet	788	✋			ML		7	
								-BASALT- Bottom of borehole at 7.5 feet.
							8	
							9	
							10	

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Soil Boring: SB-26

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	2.1	✋			ML		2	(ML) Black, loose SILT with trace gravel and woody debris, no odor, no sheen
Damp	2.8	✋			ML			(ML) Black, loose SILT with trace gravel and woody debris, no odor, no sheen
					ML		3	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
Damp	3.2	☒	SB-26-3.5	G <1.3 D <3.8 HO <13 B = 0.002	ML		4	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
Wet	3.1	✋			ML		5	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen Groundwater encountered at 4.5' at time of drilling
Wet	2.8	✋			SM			(SM) Brown to gray, loose, medium to coarse, silty SAND with trace gravel, strong odor, moderate sheen
Wet	3.4	☒	SB-26-6.0	G = 600 D = 26 HO <13 B <0.035	SM		6	(SM) Gray, loose, medium to coarse, silty SAND with trace gravel, strong odor, moderate sheen
Wet	3.8	✋			SM			(SM) Gray, loose, medium to coarse, silty SAND with trace gravel, strong odor, moderate sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-27

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/12/2018
Date Completed: 4/12/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7.25 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩		Dense silty GRAVEL/Topsoil/Fill
						▩	1	
						▩	2	
Damp	0.1	✋			ML	▥		(ML) Brown, loose to slightly dense SILT, no odor, no sheen (fill)
Damp	0.1	✋			ML	▥	3	(ML) Brown, loose to slightly dense SILT, no odor, no sheen (fill)
Damp	0.1	✋			ML	▥		(ML) Brown, loose to slightly dense SILT, no odor, no sheen (fill)
Damp	0.2	☒	SB-27-4.0	G <1.1 D <3.6 HO <12 B = 0.0008	ML	▥	4	(ML) Brown, loose to slightly dense SILT, no odor, no sheen (fill)
Damp	0.1	✋			ML	▥	5	(ML) Brown, loose to slightly dense SILT, no odor, no sheen (fill)
					GP	○		(GP) Pebbly GRAVEL, no odor, no sheen Groundwater encountered at 5.5' at time of drilling
Wet	0.2	✋			SM	░	6	(SM) Gray, loose, silty SAND, slight odor, no sheen
Wet	0.1	☒	SB-27-7.0	G <1.3 D <3.7 HO <12 B <0.0004	SM	░	7	(SM) Gray, loose, silty SAND, slight odor, no sheen
								-BASALT Bottom of borehole at 7.3 feet.
							8	
							9	
							10	

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Soil Boring: SB-28

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/12/2018
Date Completed: 4/12/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▦		Dense silty GRAVEL/Topsoill/Fill
						▦	1	
						▦	2	
Damp	0.0	✋			ML	▥	3	(ML) Brown, loose, clayey SILT with debris (fill), no odor, no sheen
Damp	0.0	✋			ML	▥	4	(ML) Brown, loose, clayey SILT with debris (fill), no odor, no sheen
Damp	0.0	☒	SB-28-4.5	G <1.4 D <3.8 HO <13 B = 0.001	ML	▥	5	(ML) Brown, loose, clayey SILT with debris (fill), no odor, no sheen
Wet	0.0	☒	SB-28-5.5	G <1.4 D <3.9 HO <13 B = 0.0007	ML	▥	6	(ML) Brown to light brown, loose, clayey SILT with orange mottling, no odor, no sheen Groundwater encountered at 6.0' at time of drilling
Wet	8.6	☒	SB-28-6.5	G = 12 D = 12 HO <13 B <0.0005	SM	░		(SM) Gray, loose, silty SAND, strong odor, no sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-29

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	2.1				ML		2	(ML) Dark brown, loose, clayey SILT with sand, woody debris (fill), no odor, no sheen
Damp	2.8				ML		3	(ML) Dark brown, loose, clayey SILT with sand, woody debris (fill), no odor, no sheen
Damp	2.1				ML			(ML) Dark brown, loose, clayey SILT with sand, woody debris (fill), no odor, no sheen
Damp	3.9		SB-29-4.0	G <1.5 D <3.8 HO = 14 B = 0.003	ML		4	(ML) Brown, loose to medium dense SILT, no odor, no sheen
Damp	14.3				SM		5	(SM) Gray, loose, silty SAND, strong odor, moderate sheen Groundwater encountered at 5.25' at time of drilling
Wet	243.4		SB-29-6.0	G = 920 D = 2300 HO <130 B = 0.19	SM		6	(SM) Gray, loose, silty SAND, strong odor, heavy sheen
Wet	198.3				SM			(SM) Gray, loose, silty SAND, strong odor, heavy sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-30

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	0.1	✋						(ML) Dark brown, medium dense, clayey SILT with trace gravel, no odor, no sheen
					ML		2	
Damp	0.5	✋						(ML) Dark brown, medium dense, clayey SILT with trace gravel, no odor, no sheen
					ML		3	
Damp	0.7	☒	SB-30-3.5	G <1.3 D <3.8 HO <13 B = 0.002				(ML) Dark brown, medium dense, clayey SILT with trace gravel, slight odor, no sheen
					ML		4	
Damp	0.4	✋			ML			(ML) Dark brown, medium dense, clayey SILT with trace gravel, slight odor, no sheen
					SM		5	(SM) Gray, loose, silty SAND with trace gravel, strong odor, no sheen Groundwater encountered at 5.0' at time of drilling
Wet	88.7	☒	SB-30-5.5	G = 430 D = 310 HO <13 B <0.039				(SM) Gray, loose, silty SAND with trace gravel, strong odor, moderate sheen
					SM		6	
Wet	65.7	✋			SM			(SM) Gray, loose, silty SAND with trace gravel, strong odor, moderate sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-31

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/12/2018
Date Completed: 4/12/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨	1	Dense silty GRAVEL/Topsoil/Fill
Damp	0.0	✋			ML	▥	2	(ML) Light brown, medium dense SILT with trace fine gravel, no odor, no sheen
Damp	0.0	✋			ML	▥	3	(ML) Light brown, medium dense SILT with trace fine gravel, no odor, no sheen
Damp	0.1	☒	SB-31-3.5	G <1.4 D <3.7 HO <12 B = 0.001	ML	▥	4	(ML) Light brown, medium dense SILT with trace fine gravel, no odor, no sheen
Damp	0.0	✋			ML	▥	5	(ML) Light brown, medium dense SILT with trace fine gravel, no odor, no sheen
Damp	0.3	✋			ML	▥	6	(ML) Light brown, medium dense SILT with trace fine gravel, no odor, no sheen Groundwater encountered at 5.5' at time of drilling
Wet	0.2	☒	SB-31-6.5	G <1.1 D <3.7 HO <12 B <0.0005		▥		(ML) Light brown, medium dense SILT with trace fine gravel, no odor, no sheen
Wet	0.2	✋			ML	▥	7	
							8 9 10	-BASALT- Bottom of borehole at 7.5 feet.

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Soil Boring: SB-32

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	0.5	✋						
							2	(ML) Brown to black, loose, clayey SILT, no odor, no sheen
					ML			
Damp	0.6	✋						(ML) Brown to black, loose, clayey SILT, no odor, no sheen
					ML		3	
Damp	0.8	☒	SB-32-3.5	G <1.3 D <3.7 HO <12 B = 0.002				(ML) Brown to black, loose, clayey SILT, no odor, no sheen
					ML		4	
								Basalt pieces, cobbles
Wet	0.9	☒	SB-32-5.0	G = 9.7 D <4.0 HO <13 B <0.0006	SM		5	(SM) Gray, loose, silty SAND with trace gravel, strong odor, no sheen Groundwater encountered at 5.0' at time of drilling
								(SM) Gray, loose, silty SAND with trace gravel, strong odor, moderate sheen
Wet	1.1	✋			SM		6	
								-BASALT- Bottom of borehole at 6.5 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-33

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 5.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
Damp		✋				▨	1	
						▥		(ML) Dark brown SILT with basalt cobbles (fill), no odor, no sheen
Damp		✋			ML	▥	2	
Damp	0.8	☒	SB-33-3.0	G <1.2 D <3.7 HO <12 B = 0.002	ML	▥	3	(ML) Dark brown SILT with basalt cobbles (fill), no odor, no sheen
Damp	0.5	✋			ML	▥	4	(ML) Dark brown SILT with basalt cobbles (fill), no odor, no sheen Groundwater encountered at 4.0' at time of drilling
Damp	0.6	✋			ML	▥		(ML) Dark brown SILT with basalt cobbles (fill), no odor, no sheen
Wet	0.8	☒	SB-33-5.0	G <1.2 D <3.6 HO <12 B = 0.002	ML	▥	5	(ML) Dark brown SILT with basalt cobbles (fill), no odor, no sheen
					SM	░		(SM) Brown to gray, loose, silty SAND, no odor, no sheen
								-BASALT- Bottom of borehole at 5.5 feet.
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-34

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 5.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
						▨	1	
Damp	0.8	✋				▥	2	
Damp		✋				▥		
Damp	1.4	☒	SB-34-3.0	G <1.2 D <3.7 HO <12 B = 0.003		▥	3	(ML) Brown, loose SILT, no odor, no sheen
					ML	▥		
Wet	1.4	✋				▥	4	(ML) Brown, loose SILT, no odor, no sheen Groundwater encountered at 4.0' at time of drilling
					ML	▥		
Wet	1.4	☒	SB-34-5.0	G <1.2 D <3.7 HO <12 B = 0.001	ML	▥	5	(ML) Brown, loose SILT, no odor, no sheen
								-BASALT- Bottom of borehole at 5.5 feet.
							6	
							7	
							8	
							9	
							10	

18939 120th Ave NE, Suite 112
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Soil Boring: SB-35

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 3 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
						▨	1	
Damp	1.0	✋			ML	▥	2	(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
Damp	1.3	☒	SB-35-2.5	G <1.1 D <3.4 HO <11 B = 0.001	ML	▥		(ML) Brown, loose, clayey SILT with trace gravel, no odor, no sheen
							3	-BASALT- No groundwater encountered at time of drilling Bottom of borehole at 3.0 feet.
							4	
							5	
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-36

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	103.3	✋			ML		2	(ML) Brown, loose SILT, strong odor, no sheen
Damp	98.3	☒	SB-36-2.5	G = 34 D <3.6 HO <12 B = 0.005	ML			(ML) Brown, loose SILT, strong odor, no sheen
Damp	86.3	✋			ML		3	(ML) Brown, loose SILT, strong odor, no sheen
Damp	90.3	✋			ML			(ML) Brown, loose SILT, strong odor, no sheen
Wet	76.3	☒	SB-36-4.0	G = 32 D <3.8 HO <13 B = 0.004	ML		4	(ML) Brown, loose SILT, strong odor, no sheen Groundwater encountered at 4.25' at time of drilling
Wet	50.1	✋			ML			(ML) Brown, loose SILT, strong odor, no sheen
Wet		✋			ML		5	(ML) Brown, loose SILT, strong odor, no sheen
Wet		✋			ML			(ML) Brown, loose SILT, strong odor, no sheen
Wet	1286.5	☒	SB-36-6.0	G = 1400 D = 240 HO = 13 B = 0.065	SM		6	(SM) Gray, loose, silty SAND, strong odor, strong sheen
Wet	1308.1	✋			SM			(SM) Gray, loose, silty SAND, strong odor, strong sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-37

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	1.0	✋			ML		2	(ML) Dark brown to black, loose, clayey SILT with trace gravel, no odor, slight sheen
Damp	1.0	✋			ML		3	(ML) Dark brown to black, loose, clayey SILT with trace gravel, no odor, slight sheen
	1	☒	SB-37-3.5	G <1.4 D = 26 HO = 93 B = 0.003	ML			(ML) Dark brown to black, loose, clayey SILT with trace gravel, no odor, slight sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	1.8	✋			ML		5	(ML) Dark brown to black, loose, clayey SILT with trace gravel, no odor, no sheen
Wet	1.1	☒	SB-37-5.5	G = 520 D = 390 HO <13 B <0.034				(ML) Gray, loose, sandy SILT, strong odor, heavy sheen
Wet	3.9							
Wet	49.8	✋			ML		6	
					ML			(ML) Gray, loose, sandy SILT, strong odor, heavy sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

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Soil Boring: SB-38

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/5/2018
Date Completed: 4/5/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 2.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	48	☒	SB-38-2.0	G = 15 D = 9.9 HO <13 B <0.038	ML	▥	2	(ML) Brown to black, loose, clayey SILT, strong odor, no sheen
								-REFUSAL- No groundwater encountered at time of drilling Bottom of borehole at 2.5 feet.
							3	
							4	
							5	
							6	
							7	
							8	
							9	
							10	

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Soil Boring: SB-39

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/10/2018
Date Completed: 4/10/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩		Dense silty GRAVEL/Topsoil/Fill
Damp	0.2	✋			ML	▥	1	(ML) Brown to black, loose to dense SILT, no odor, no sheen
Damp	0.2	✋			ML	▥	2	(ML) Brown to black, loose to dense SILT, no odor, no sheen
Damp	0.2	✋			ML	▥	3	(ML) Brown to black, loose to dense SILT, no odor, no sheen
Damp	0.1	☒	SB-39-3.5	G <1.3 D <3.8 HO <13 B = 0.003	ML	▥		(ML) Brown to black, loose to dense SILT, no odor, no sheen
						▥	4	Groundwater encountered at 4.0' at time of drilling
Wet		✋			ML	▥	5	(ML) Brown to black, loose to dense SILT, no odor, no sheen
Wet	86.6	✋			SM	░		(SM) Gray, loose, silty SAND with trace gravel, strong odor, moderate sheen
Wet	50.1	☒	SB-39-6.0	G = 880 D = 230 HO <13 B <0.031	SM	░	6	(SM) Gray, loose, silty SAND with trace gravel, strong odor, moderate sheen
Wet	989.8	✋			SM	░		(SM) Gray, loose, silty SAND with trace gravel, strong odor, moderate sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

Soil Boring: SB-40

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/11/2018
Date Completed: 4/11/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▩	1	Dense silty GRAVEL/Topsoil/Fill
Damp	1.0	✋			ML	▥	2	(ML) Brown, loose, clayey SILT, no odor, no sheen
Damp	0.8	✋			ML	▥	3	(ML) Brown, loose, clayey SILT, no odor, no sheen
Damp	1.5	☒	SB-40-3.5	G <1.5 D <3.9 HO <13 B = 0.002	ML	▥	4	(ML) Dark brown, loose SILT, no odor, no sheen
Wet	65.3	✋			SM	░	5	(SM) Dark brown to gray, mottled, loose to firm, silty SAND to SILT, strong odor, slight sheen Groundwater encountered at 5.0' at time of drilling
Wet	85.6	☒	SB-40-5.5	G = 280 D = 2000 HO <130 B <0.036	SM	░	6	(SM) Gray, loose to dense, silty SAND, strong odor, heavy sheen
Wet	1387.5	✋			SM	░		(SM) Gray, loose to dense, silty SAND, strong odor, heavy sheen
Wet	158	☒	SB-40-7.0	G = 2200 D = 260 HO <12 B <0.054	SM	░	7	(SM) Gray, loose to dense, silty SAND, strong odor, heavy sheen
							8 9 10	-BASALT- Bottom of borehole at 7.5 feet.

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Soil Boring: SB-41

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/17/2018
Date Completed: 4/17/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
						▨	1	
Damp	0.1	✋			ML	│		(ML) Dark brown, loose SILT with occasional gravel and sand, no odor, no sheen
Damp	0.0	✋				│	2	(ML) Dark brown, loose SILT with occasional gravel and sand, no odor, no sheen
					ML	│		
Wet	0.0	☒	SB-41-3.0	G <1.4 D <3.9 HO <13 B = 0.002	ML	│	3	(ML) Dark brown, loose SILT with occasional gravel and sand, no odor, no sheen
Wet	0.1	✋			ML	│		(ML) Dark brown, loose SILT with occasional gravel and sand, no odor, no sheen
Wet	0.1	✋				│	4	(ML) Dark brown, loose SILT with occasional gravel and sand, no odor, no sheen
					ML	│		
Wet	0.2	✋			SM	⁘	5	(SM) Light brown, loose, fine silty SAND with occasional gravel, no odor, no sheen
Wet	0.1	☒	SB-41-5.5	G = 2.5 D <3.9 HO <13 B = 0.0006	SM	⁘		(SM) Light brown, loose, fine silty SAND with occasional gravel, no odor, no sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-42

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/17/2018
Date Completed: 4/17/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		Dense silty GRAVEL/Topsoil/Fill
						▨	1	
Damp	0.1	✋			ML	▥		(ML) Dark brown, low plastic SILT with occasional gravel, sand, and organics (fill), no odor, no sheen
Wet	0.0	☒	SB-42-2.0	G <1.5 D <3.9 HO <13 B = 0.003	ML	▥	2	(ML) Dark brown, low plastic SILT with occasional gravel, sand, and organics (fill), no odor, no sheen
						▥		Groundwater encountered at 2.5' during drilling
Wet	0.0	✋			ML	▥	3	(ML) Dark brown, low plastic SILT with occasional gravel, sand, and organics (fill), no odor, no sheen
Wet	0.0	✋			ML	▥	4	(ML) Dark brown, low plastic SILT with occasional gravel, sand, and organics (fill), no odor, no sheen
Wet	4.0	✋			ML	░	5	(ML) Light brown, loose, sandy SILT, slight odor, no sheen
Wet	4.4	☒	SB-42-5.5	G = 330 D = 140 HO <13 B <0.034	ML	░		(ML) Light brown, loose, sandy SILT, moderate odor, no sheen
							6	Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-43

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/17/2018
Date Completed: 4/17/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
Damp	0.0	✋				▨		Dense silty GRAVEL/Topsoil/Fill
		✋				▨		
Damp	0.1	✋			ML		1	(ML) Brown, loose SILT with trace clay, sand, and organics, no odor, no sheen
Damp	0.0	✋			ML			(ML) Brown, loose SILT with trace clay, sand, and organics, no odor, no sheen
Damp	0.0	✋			ML		2	(ML) Brown, loose SILT with occasional sand, no odor, no sheen
Damp	0.2	☒	SB-43-2.5	G <1.2 D <3.8 HO <13 B = 0.003	ML			(ML) Brown, loose SILT with occasional sand, no odor, no sheen
Wet	0.1	✋			ML		3	(ML) Brown, loose SILT with occasional sand, no odor, no sheen Groundwater encountered at 3.0' at time of drilling
		✋			ML			(ML) Brown, loose SILT with occasional sand, no odor, no sheen
Wet	0.1	✋			ML		4	(ML) Brown, loose SILT with occasional sand, no odor, no sheen
Wet	0.0	✋			ML			(ML) Brown, loose SILT with occasional sand, no odor, no sheen
Wet	0.2	✋			ML		5	(ML) Brown, loose SILT with occasional sand, no odor, no sheen
Wet	0.2	☒	SB-43-5.5	G <1.2 D = 60 HO <13 B = 0.002	ML			(ML) Brown, loose SILT with occasional sand, no odor, no sheen
							6	-BASALT- Bottom of borehole at 6.0 feet.
							7	
							8	
							9	
							10	

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Soil Boring: SB-44

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA

Logged By: A. Wisher
Date Started: 4/17/2018
Date Completed: 4/17/2018

Driller: Cascade Drilling
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft
Elevation: ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
							1	Dense silty GRAVEL/Topsoil/Fill
Damp	0.1	✋			ML		2	(ML) Dark brown, medium plastic, clayey SILT with occasional sand, no odor, no sheen
Damp	0.1	✋			ML		3	(ML) Dark brown, medium plastic, clayey SILT with occasional sand, no odor, no sheen
Damp	0.2	✋			ML		4	(ML) Dark brown, medium plastic, clayey SILT with occasional sand, no odor, no sheen
Damp	0.0	✋			ML			(ML) Dark brown, medium plastic, clayey SILT with occasional sand, no odor, no sheen
Wet	0.1	☒	SB-44-5.0	G <1.4 D = 37 HO = 33 B = 0.0008	ML		5	(ML) Dark brown, medium plastic, clayey SILT with occasional sand, no odor, no sheen Groundwater encountered at 5.0' at time of drilling
Wet	1.2	✋			SM			(SM) Gray, loose, silty SAND with occasional gravel, slight odor
Wet	6.0	☒	SB-44-6.0	G = 110 D = 20 HO <13 B <0.037	SM		6	(SM) Gray, loose, silty SAND with occasional gravel, moderate odor
							7	-BASALT- Bottom of borehole at 6.5 feet.
							8	
							9	
							10	

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Soil Boring: SB-45

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AW
Date Started: 9/24/2018
Date Completed: 9/24/2018

Driller: Cascade
Drill Method: Hand Auger
Total Boring Depth: 6.5 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		FILL. gravel, silt
	0.1							
	0.0				ML		1	(ML) dark brown to black, loose to firm, fine SILT, no odor, no sheen
	0.0						2	SAA, no odor, no sheen
damp	0.2	✋	SB-45-3.5	G <0.3 D <3.7 HO <13 B = 0.002			3	SAA, no odor, no sheen
damp	148						4	(MLS) light gray to brown, dense, sandy SILT, strong odor, slight sheen
					MLS		5	
damp	114	✋	SB-45-6.5	G = 270 D = 270 HO <12 B <0.029			6	SAA, strong odor, slight sheen
								Bottom of borehole at 6.5 feet.
							7	
							8	

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Soil Boring: SB-46

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AW
Date Started: 9/28/2018
Date Completed: 9/28/2018

Driller: Cascade
Drill Method: Hand Auger
Total Boring Depth: 4.5 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								FILL. gravel, silt
	0.1				MLS		1	(MLS) dark brown to black, loose, sandy SILT with occasional fine gravel, no odor, no sheen
	0.0						2	SAA, no odor, no sheen
	0.1		SB-46-3.0	G <0.3 D <3.6 HO <12 B = 0.001			3	SAA, no odor, no sheen
damp	0.0		SB-46-4.5	G <0.3 D <3.6 HO <12 B = 0.0008			4	SAA, no odor, no sheen
damp	0.0							
								Bottom of borehole at 4.5 feet.
							5	
							6	
							7	
							8	

Soil Boring: SB-47

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AW
Date Started: 9/25/2018
Date Completed: 9/25/2018

Driller: Cascade
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		FILL. gravel, silt
					ML		1	(ML) brown, loose SILT with occasional gravel, no odor, no sheen
dry	0.0							
							2	
dry	0.0		SB-47-3.5	G <0.3 D <3.4 HO = 12 B = 0.003			3	SAA, no odor, no sheen
							4	SAA, no odor, no sheen
							5	SAA, no odor, no sheen
							6	SAA, no odor, no sheen
damp	0.0		SB-47-7.5	G <0.3 D <3.7 HO <12 B = 0.001			7	
								Bottom of borehole at 7.5 feet.
							8	

Soil Boring: SB-48

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AW
Date Started: 9/25/2018
Date Completed: 9/25/2018

Driller: Cascade
Drill Method: Hand Auger
Total Boring Depth: 7.5 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								FILL. gravel, silt
dry	0.0				MLS		1	(MLS) brown, loose, sandy SILT, no odor, no sheen
	0.1						2	
dry	0.0	✋	SB-48-3.5	G <0.3 D <3.4 HO = 18 B = 0.003			3	SAA
	0.0						4	SAA, no odor, no sheen
	0.0						5	SAA
	0.0						6	SAA
damp	0.0	✋	SB-48-7.5	G <0.3 D <3.7 HO <12 B <0.0005			7	SAA, no odor, no sheen basalt encountered below 7.5 feet
								Bottom of borehole at 7.5 feet.
							8	

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Soil Boring: SB-49

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AW
Date Started: 9/25/2018
Date Completed: 9/25/2018

Driller: Cascade
Drill Method: Hand Auger
Total Boring Depth: 7 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						▨		FILL. silt, gravel, debris
	0.0					▨	1	
					ML	▥	2	(ML) brown, loose SILT with occasional cobbles, no odor, no sheen
dry	0.0	✋	SB-49-3.0	G <0.3 D <3.4 HO <11 B = 0.003		▥		
						▥	3	SAA, no odor, no sheen
	0.0					▥	4	SAA, no odor, no sheen
	0.0					▥	5	SAA, no odor, no sheen
						▥	6	SAA, no odor, no sheen
damp	0.0	✋	SB-49-7.0	G <0.3 D <3.7 HO <12 B <0.0004		▥		SAA, no odor, no sheen
							7	Bottom of borehole at 7.0 feet.
							8	

Soil Boring: SB-50

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AW
Date Started: 9/25/2018
Date Completed: 9/25/2018

Driller: Cascade
Drill Method: Hand Auger
Total Boring Depth: 7 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								FILL. silt, gravel, debris
	0.0						1	
dry	0.0				ML		2	(ML) brown SILT with occasional cobbles, no odor, no sheen
	0.0						3	SAA, no odor, no sheen
	0.0						4	SAA, no odor, no sheen
	0.0						5	SAA, no odor, no sheen
	0.0						6	SAA, no odor, no sheen
							7	Bottom of borehole at 7.0 feet.
							8	

Soil Boring: SB-51

Project: 375289 Goldendale
Client: Chevron EMC
Location: 802 S Columbus Ave, Goldendale WA

Logged By: AS
Date Started: 12/6/2018
Date Completed: 12/6/2018

Driller: Cascade
Drill Method: Air Knife/ Hand Auger
Total Boring Depth: 5.35 ft

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	Analyical Results (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
						░		asphalt (9 inches)
						▩	1	FILL. base rock dark gray, silt, gravel
							2	
						▨		(CL-ML) dark brown and gray, clayey SILT, no odor, no sheen
	0.0	✋	SB-51-2.5	G = 0.3 D <4.6 HO = 49 B = 0.0008				
							3	
								brown, clayey SILT, no odor, no sheen
					CL-ML		4	
	0.0	✋	SB-51-5.0	G <0.3 D <5.0 HO <12 B = 0.0008				
							5	basalt encountered at 5.4 feet
								Bottom of borehole at 5.4 feet.
							6	
							7	
							8	

18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Monitoring Well: MW-5

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA
Logged By: A. Wisher

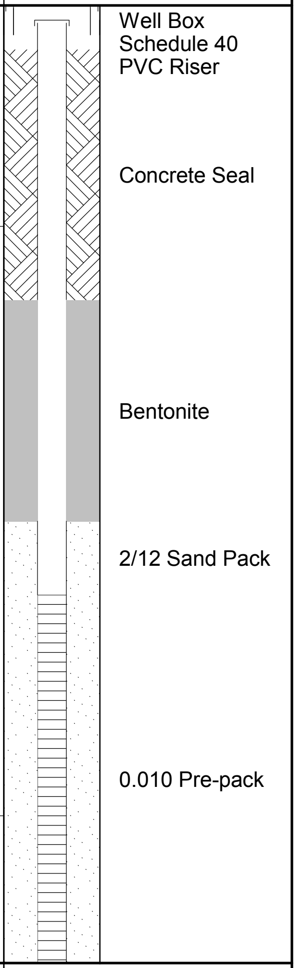
Date Started: 4/12/2018
Date Completed: 4/12/2018
Driller: Cascade Drilling
Drill Method: Hand Auger

Total Boring Depth: 6.5 ft
Hole Diameter: 2.5 in
Well Depth: 6.5 ft
TOC Elevation: ft

Well Diameter: 2 in
Well Screen: 0.010 Slot in
Filter Pack: Pre-pack 2/12 Sand
Well Casing: Schedule 40 PVC

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
							1	Dense silty GRAVEL/Topsoil/Fill
					ML		2	(ML) Brown, loose to firm, clayey SILT with debris (fill), no odor, no sheen
Damp	0.0	✋						
					ML		3	(ML) Brown, loose to firm, clayey SILT, no odor, no sheen
Damp	0.0	✋						
					ML		4	(ML) Brown, loose to firm, clayey SILT, no odor, no sheen
Damp	0.1	☒	MW-5-4.5	G <1.6 D <4.0 HO <13 B = 0.002	ML		5	(ML) Brown, loose to firm, clayey SILT, no odor, no sheen
Wet	14.3	☒	MW-5-5.5	G = 16 D = 16 HO <13 B = 0.0005	SM			(SM) Gray, loose, silty SAND, strong odor, no sheen Groundwater encountered at 5.5' at time of drilling
					SM		6	(SM) Gray, loose, silty SAND, strong odor, no sheen
							7 8 9 10	-BASALT- Bottom of borehole at 6.5 feet.

WELL DIAGRAM



18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Monitoring Well: MW-6

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA
Logged By: A. Wisher

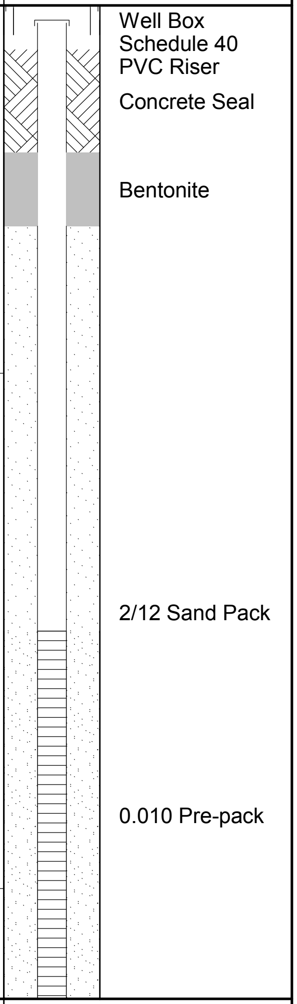
Date Started: 4/12/2018
Date Completed: 4/12/2018
Driller: Cascade Drilling
Drill Method: Hand Auger

Total Boring Depth: 6.75 ft
Hole Diameter: 2.5 in
Well Depth: 6.75 ft
TOC Elevation: ft

Well Diameter: 2 in
Well Screen: 0.010 Slot in
Filter Pack: Pre-pack 2/12 Sand
Well Casing: Schedule 40 PVC

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
							2	
Damp	0.2	✋			ML			(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.1	✋			ML		3	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.1	☒	MW-6-4.0	G <1.2 D = 95 HO = 360 B = 0.001	ML		4	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.0	✋			ML		5	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Wet	0.2	☒	MW-6-5.5	G <1.2 D = 34 HO = 120 B <0.0005	SM		6	(SM) Brown, loose, silty SAND, no odor, no sheen Groundwater encountered at 6.0' at time of drilling
Wet	0.2	✋			SM			(SM) Brown, loose, silty SAND, no odor, no sheen
							7	-BASALT- Bottom of borehole at 6.8 feet.
							8	
							9	
							10	

WELL DIAGRAM



leidos

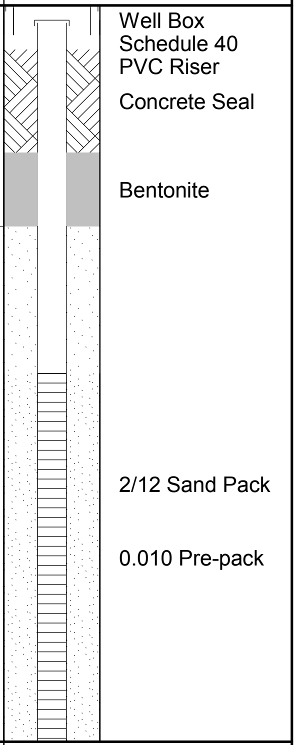
18939 120th Ave NE, Suite 112
Bothell, WA, 98011

Monitoring Well: MW-7

Project: Former Chevron Bulk Plant No. 375289	Date Started: 4/12/2018	Total Boring Depth: 5 ft	Well Diameter: 2 in
Client: Chevron CEMC	Date Completed: 4/12/2018	Hole Diameter: 2.5 in	Well Screen: 0.010 Slot in
Location: 808 S Columbus Ave, Goldendale, WA	Driller: Cascade Drilling	Well Depth: 5.0 ft	Filter Pack: Pre-pack 2/12 Sand
Logged By: A. Wisher	Drill Method: Hand Auger	TOC Elevation: ft	Well Casing: Schedule 40 PVC

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
							1	Dense silty GRAVEL/Topsoil/Fill
Damp	0.1	✋			ML			(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.0	✋			ML		2	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.0	✋			ML			(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.2	✋			ML		3	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.1	☒	MW-7-3.5	G <1.2 D <3.7 HO <12 B = 0.003	ML			(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Damp	0.1	☒	MW-7-4.0	G <1.3 D <3.7 HO <12 B = 0.002	ML		4	(ML) Brown, loose SILT with trace gravel, no odor, no sheen
Wet	0.1	✋			ML			(ML) Brown, loose SILT with trace gravel, no odor, no sheen
							5	-BASALT- Groundwater encountered at 5.0' at time of drilling Bottom of borehole at 5.0 feet.
							6	
							7	
							8	
							9	
							10	

WELL DIAGRAM



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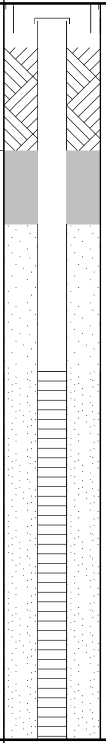
Monitoring Well: MW-8

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA
Logged By: A. Wisher

Date Started: 4/10/2018
Date Completed: 4/10/2018
Driller: Cascade Drilling
Drill Method: Hand Auger

Total Boring Depth: 5 ft
Hole Diameter: 2.5 in
Well Depth: 5.0 ft
TOC Elevation: ft

Well Diameter: 2 in
Well Screen: 0.010 Slot in
Filter Pack: Pre-pack 2/12 Sand
Well Casing: Schedule 40 PVC

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION	WELL DIAGRAM
						▨		Dense silty GRAVEL/Topsoil/Fill	 Well Box Schedule 40 PVC Riser Concrete Seal
Damp	1.5	✋			ML		1	(ML) Brown to dark brown, loose SILT with trace gravel, no odor, no sheen	Bentonite
Damp	1.7	✋			ML		2	(ML) Brown to dark brown, loose SILT with trace gravel, no odor, no sheen	
Wet	1.8	☒	MW-8-3.0	G <1.3 D <3.9 HO <13 B = 0.002	ML		3	(ML) Brown to dark brown, loose SILT with trace gravel, no odor, no sheen Groundwater encountered at 3.0' at time of drilling	2/12 Sand Pack 0.010 Pre-pack
		✋			ML		4	(ML) Brown to dark brown, loose SILT with trace gravel, no odor, no sheen	
Wet	1.9	☒	MW-8-4.5	G <1.2 D <16 HO <13 B = 0.001	ML			(ML) Brown to dark brown, loose SILT with trace gravel, no odor, no sheen	
							5	-BASALT- Bottom of borehole at 5.0 feet.	
							6		
							7		
							8		
							9		
							10		

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Monitoring Well: MW-9

Project: Former Chevron Bulk Plant No. 375289
Client: Chevron CEMC
Location: 808 S Columbus Ave, Goldendale, WA
Logged By: A. Wisher

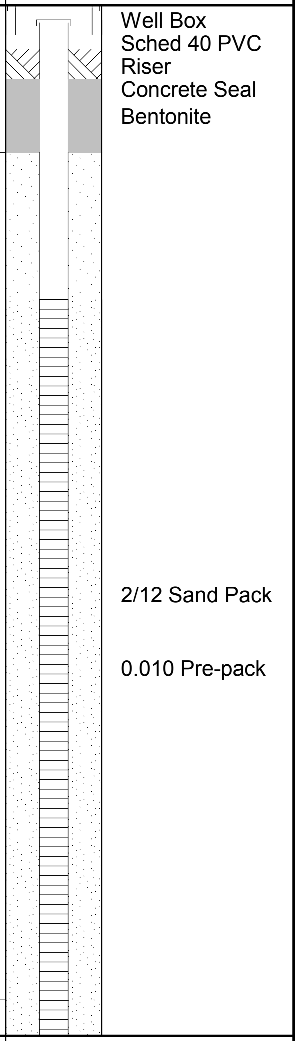
Date Started: 4/4/2018
Date Completed: 4/4/2018
Driller: Cascade Drilling
Drill Method: Hand Auger

Total Boring Depth: 7 ft
Hole Diameter: 2.5 in
Well Depth: 7.0 ft
TOC Elevation: ft

Well Diameter: 2 in
Well Screen: 0.010 Slot in
Filter Pack: Pre-pack 2/12 Sand
Well Casing: Schedule 40 PVC

MOISTURE CONTENT	ORGANIC VAPOR (ppm)	SAMP. INTERVAL	ANALYTICAL SAMPLE	ANALYTICAL RESULTS (mg/kg)	U.S.C.S. SYMBOL	GRAPHIC LOG	DEPTH (ft)	LITHOLOGY/DESCRIPTION
								Dense silty GRAVEL/Topsoil/Fill
							1	
Damp	0.2	✋			ML		2	(ML) Dark brown to black, loose, clayey SILT, no odor, no sheen
Damp	0.2	✋			ML		3	(ML) Dark brown to black, loose, clayey SILT, no odor, no sheen
Wet	1.0	☒	MW-9-3.5	G <1.2 D <3.9 HO <13 B = 0.002	ML			(ML) Dark brown to black, loose, clayey SILT, no odor, no sheen
							4	Groundwater encountered at 4.0' at time of drilling
Wet	1.0	✋			ML		5	(ML) Dark brown to black, loose, clayey SILT, no odor, no sheen
							6	
Wet	1.0	☒	MW-9-6.5	G <1.4 D <4.0 HO <13 B <0.0005	ML			(ML) Dark brown to black, loose, clayey SILT, no odor, no sheen
Wet	125	✋			SM			(SM) Gray, loose, silty SAND with basalt cobbles, strong odor, heavy sheen
							7	-BASALT- Bottom of borehole at 7.0 feet.
							8	
							9	
							10	

WELL DIAGRAM



Appendix C

Applicable or Relevant and Appropriate Requirements

SUMMARY OF POTENTIALLY APPLICABLE REQUIREMENTS

According to WAC 173-340-360(2), all cleanup actions under the Model Toxics Control Act (MTCA) must comply with applicable state and federal laws. Such laws are defined under the MTCA as including Applicable or Relevant and Appropriate Requirements (ARARs). ARARs for the site are discussed below:

Summary of Generally Applicable or Relevant and Appropriate Regulations

Resource Conservation and Recovery Act (RCRA)

Investigation –derived waste (IDW), soil, water or other substances removed from the site during the implementation of remedial activities will be handled per RCRA regulations and implemented according to WAC 173-303.

Natural Resource Damages

Remedial design and implementation will establish means and methods to ensure that the remedial action minimizes risks that could potentially damage natural resources, such as surface-water resources, groundwater resources, air resources, geologic resources, and biological resources. Damages to natural resource caused by remedial action implementation will be avoided, and are not expected to occur.

U.S. Department of Transportation Hazardous Materials Regulations

The U.S. Department of Transportation has published regulations, including communications and emergency response requirements, shipping, and packaging requirements (49 CFR 107, 171)), that govern the transportation of hazardous materials to or from the site. Hazardous waste generated at the site will be appropriately characterized to determine package, transportation and transportation requirements prior to implementing remedial action.

National Ambient Air Quality Standards Attainment Area

Air emissions generated by the remedial implementation at the site are subject to applicable air-quality standards in order to control or prevent the emission of air contaminants. The applicable pollutants at the site would be particulate matter (dust) and carbon monoxide. Degradation of ambient air quality caused by remedial action implementation at the site will be avoided, and is not expected to occur.

Occupational Safety and Health Administration (OSHA)

Site activities will be conducted in a manner compliant with OSHA standards and regulations (29 CFR 1910).

Model Toxics Control Act

All elements of the remedial design and site activities will occur in accordance with MTCA statutes and regulations.

Noise Regulations

Site activities will be conducted at appropriate noise levels, according to the City of Edmonds Municipal Code. Noise production during remedial activities may limit operating hours of project work.

State Environmental Policy Act

The State Environmental Policy Act (SEPA) provides the framework for agencies to consider the environmental consequences of a proposed land use action. SEPA requires the preparation of an environmental checklist and review of the potential environmental impacts and mitigation measures used to protect the environment. A SEPA checklist will be prepared with the permitting of the remedial action to be conducted at the site.

Spill Prevention, Preparedness, and Response

A spill prevention, control, and countermeasures plan will be developed for the storage and handling of these materials. This will include potential groundwater treatment system facilities and heavy equipment used onsite, as well as any stored materials.

Minimum Standards for Construction and Maintenance of Wells, Regulation and Licensing of Well Contractors and Operators

Resource protection wells will be decommissioned, constructed, and maintained according to the appropriate regulations

Washington Industrial Safety and Health Act

Site activities will be conducted in a manner compliant with Washington Industrial Safety and Health Act (WISHA) standards and regulations.

City of Goldendale Permits

The City of Goldendale requires a right-of-way access permit for activities conducted in the City of Goldendale right-of-way. All required permits needed from the City of Goldendale will be obtained during the design phase of the remedial action and will apply to all of the remedial activities.

Appendix D

State Environmental Policy Act Environmental Checklist

SEPA ENVIRONMENTAL CHECKLIST

Purpose of checklist:

Governmental agencies use this checklist to help determine whether the environmental impacts of your proposal are significant. This information is also helpful to determine if available avoidance, minimization or compensatory mitigation measures will address the probable significant impacts or if an environmental impact statement will be prepared to further analyze the proposal.

Instructions for applicants:

This environmental checklist asks you to describe some basic information about your proposal. Please answer each question accurately and carefully, to the best of your knowledge. You may need to consult with an agency specialist or private consultant for some questions. You may use "not applicable" or "does not apply" only when you can explain why it does not apply and not when the answer is unknown. You may also attach or incorporate by reference additional studies reports. Complete and accurate answers to these questions often avoid delays with the SEPA process as well as later in the decision-making process.

The checklist questions apply to all parts of your proposal, even if you plan to do them over a period of time or on different parcels of land. Attach any additional information that will help describe your proposal or its environmental effects. The agency to which you submit this checklist may ask you to explain your answers or provide additional information reasonably related to determining if there may be significant adverse impact.

Instructions for Lead Agencies:

Please adjust the format of this template as needed. Additional information may be necessary to evaluate the existing environment, all interrelated aspects of the proposal and an analysis of adverse impacts. The checklist is considered the first but not necessarily the only source of information needed to make an adequate threshold determination. Once a threshold determination is made, the lead agency is responsible for the completeness and accuracy of the checklist and other supporting documents.

Use of checklist for nonproject proposals:

For nonproject proposals (such as ordinances, regulations, plans and programs), complete the applicable parts of sections A and B plus the SUPPLEMENTAL SHEET FOR NONPROJECT ACTIONS (part D). Please completely answer all questions that apply and note that the words "project," "applicant," and "property or site" should be read as "proposal," "proponent," and "affected geographic area," respectively. The lead agency may exclude (for non-projects) questions in Part B - Environmental Elements –that do not contribute meaningfully to the analysis of the proposal.

A. Background [HELP]

1. Name of proposed project, if applicable:

Interim Action at the Former Temple Distributing Carson Oil Facility.

2. Name of applicant:

Chevron Environmental Management Company.

3. Address and phone number of applicant and contact person:

Chevron Environmental Management Company

4. Date checklist prepared:

April 13, 2021.

5. Agency requesting checklist:

Washington State Department of Ecology (Ecology).

6. Proposed timing or schedule (including phasing, if applicable):

The interim action at the Former Temple Distributing Carson Oil Facility will consist of removal of contaminated soil from open excavations, and the abandonment and installation of groundwater monitoring wells. The remedial implementation is tentatively scheduled to begin in Fall 2021.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

Groundwater monitoring acitivites will continue at the site after the proposed excavation work for a currently undetermined amount of time. Additional monitoring well abandonment activities will be conducted at the conclusion of the groundwater monitoring period.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

The following list are the most applicable environmental reports that have been prepared regarding this proposal. These reports are available at Ecology's Central Region Office Central Records unless otherwise noted. Reports marked with a † are available online at Ecology's Former Temple Distributing Facility web site: https://apps.ecology.wa.gov/gsp/Sitepage.aspx?csid=11985, click on View Electronic Documents in the sidebar.

- Arcadis U.S., Inc. 2020. Draft Revsied Remedial Investigation/Feasibility Study, Former Temple Distributing Site. November 5.
- †Golder Associates. 2012. Mass Balance Calculations for Gasoline Release – Goldendale, Washington. September 5.
- †Leidos. 2017. Remedial Investigation Work Plan, Former Temple Distributing Site. October 3.
- †Leidos. 2019. Draft Remedial Investigation/Feasibility Study, Former Temple Distributing Site. April 12.
- †O'Gara, Tim. 2012. Carson – Goldendale Fuel Spill. May 4.

9. Do you know whether applications are pending for governmental approvals of other proposals directly affecting the property covered by your proposal? If yes, explain.

None known.

10. List any government approvals or permits that will be needed for your proposal, if known.

City of Goldendale Right-of-Way Permit

11. Give brief, complete description of your proposal, including the proposed uses and the size of the project and site. There are several questions later in this checklist that ask you to describe certain aspects of your proposal. You do not need to repeat those answers on this page. (Lead agencies may modify this form to include additional specific information on project description.)

The project site includes a total area of 0.85 acres. The specific objective of this Interim Action is to reduce the groundwater cleanup timeframe and the potential for direct soil contact by human and ecological receptors by excavating and disposing of on-property soil containing the highest concentrations of petroleum constituents, excavate and remove on-property soil containing the highest concentrations of petroleum constituents that may be acting as a contamination source for perched groundwater at the site, and to obtain the data necessary to evaluate the groundwater exposure pathway at the site. These objectives will be achieved through a series of targeted excavations at the site in the following areas:

- Excavation of the SB-24, SB-25, SB-29, SB-40, and B-14 vicinity.
- Excavation of the B-13 vicinity.
- Excavation of the SB-1, SB-36, SB-39, and B-10 vicinity.
- Excavation of the MW-3 and B-11 vicinity.
- Excavation of the MW-4, SB-16, SB-17, and B-7 vicinity.
- Excavation of the SB-6 vicinity.

This project will also include the insallation and sampling of additional groundwater monitoring wells. This work is anticipated to take one construction season.

12. Location of the proposal. Give sufficient information for a person to understand the precise location of your proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available. While you should submit any plans required by the agency, you are not required to duplicate maps or detailed plans submitted with any permit applications related to this checklist.

The Former Temple Distributing Carson Oil site is located at 808 South Columbus Avenue in Goldendale, Washington (Klickitat County). The site is in the northwest quarter of the southwest quarter of Section 21, Township 4 North, Range 16 East, Willamette Meridian. The site is approximately 0.85 acres. A site vicinity map can be found as Figure 1 of the Interim Action Work Plan (IAWP).

B. Environmental Elements [HELP]

1. *Earth* [help]

a. General description of the site:

(circle one): **Flat**, rolling, hilly, steep slopes, mountainous, other _____________

b. What is the steepest slope on the site (approximate percent slope)?

The site is essentially flat.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any agricultural land of long-term commercial significance and whether the proposal results in removing any of these soils.

The dominant geologic feature of the Goldendale region is the Columbia River Basalt formation. This geological stratum is composed of several layers of under formed, solidified lava. The Columbia River Basalt formation was created through volcanic processes and comprises the parent material from which Goldendale area soils were formed. The basalts typically have blocky columns or vertical platy joints.

The general stratigraphy of the site (from the surface down) consists of 1 to 1.5 feet of fill, underlain by 1 to 7 feet of silt/clays, underlain by a silty sand/weathered basalt, underlain by basalt bedrock.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

There are no unstable soils in the vicinity of the planned excavations.

e. Describe the purpose, type, total area, and approximate quantities and total affected area of any filling, excavation, and grading proposed. Indicate source of fill.

Excavation to remove petroleum hydrocarbon-impacted soil will typically extend to a depth of approximately 5-9 feet below ground surface (bgs). The excavation was delineated in the 2018 Remedial Investigation (Leidos 2018). The excavation boundary is limited to the following areas with a total area estimate of 0.08 acres:

- Excavation of the SB-24, SB-25, SB-29, SB-40, and B-14 vicinity.
- Excavation of the B-13 vicinity.
- Excavation of the SB-1, SB-36, SB-39, and B-10 vicinity.
- Excavation of the MW-3 and B-11 vicinity.
- Excavation of the MW-4, SB-16, SB-17, and B-7 vicinity.

- Excavation of the SB-6 vicinity.

The total estimated amount of excavated contaminated soil is expected to be approximately 820 cubic yards. These areas will be backfilled to match the original grade. Excavated soil will be hauled offsite for disposal. Future imported fill is anticipated to be obtained from an Ecology-approved supplier, and will be certified as clean. The planned areas of soil excavation are shown on Figure 8-1 in the IAWP.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Potential erosion could occur during excavation if the work is conducted during rainy periods. Erosion will be controlled per an erosion control and sedimentation plan.

g. About what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

No impervious surface will be added as part of the interim action.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any:

Prepare and implement an erosion control and sedimentation plan. Measures will include use of filter fabric fences, straw bales barriers, and storm drain inlet protection.

2. Air [help]

a. What types of emissions to the air would result from the proposal during construction, operation, and maintenance when the project is completed? If any, generally describe and give approximate quantities if known.

During the excavation activities, dust, truck emissions, and petroleum hydrocarbon odors could be emitted to the air. There would be no anticipated emissions after excavation activities are completed.

b. Are there any off-site sources of emissions or odor that may affect your proposal? If so, generally describe.

No.

c. Proposed measures to reduce or control emissions or other impacts to air, if any:

Dust will be controlled by water spray. No visible dust will be allowed.

3. Water [help]

a. Surface Water: [help]

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

No.

2) Will the project require any work over, in, or adjacent to (within 200 feet) the described waters? If yes, please describe and attach available plans.

Not applicable.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

Not applicable.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

Not applicable.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

No.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

No.

b. Ground Water: [help]

1) Will groundwater be withdrawn from a well for drinking water or other purposes? If so, give a general description of the well, proposed uses and approximate quantities withdrawn from the well. Will water be discharged to groundwater? Give general description, purpose, and approximate quantities if known.

Small amounts of groundwater (<1 gallon) will be withdrawn from each monitoring well for the purposes of laboratory testing.

2) Describe waste material that will be discharged into the ground from septic tanks or other sources, if any (for example: Domestic sewage; industrial, containing the following chemicals. . . ; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

None.

c. Water runoff (including stormwater):

1) Describe the source of runoff (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Storm water will be collected from within exacavation areas and will be containerized for offsite disposal.

2) Could waste materials enter ground or surface waters? If so, generally describe.

No.

3) Does the proposal alter or otherwise affect drainage patterns in the vicinity of the site? If so, describe.

No.

d. Proposed measures to reduce or control surface, ground, and runoff water, and drainage pattern impacts, if any:

Prior to excavation, a stormwater collection system consisting of submersible pumps will be prepared to remove stormwater that may potentially collect in the excavation areas. Stormwater will be removed from the excavation areas and deposited into an onsite holding tank for offsite disposal.

4. Plants [help]

a. Check the types of vegetation found on the site:

____deciduous tree: alder, maple, aspen, other
____evergreen tree: fir, cedar, pine, other
_X__shrubs
_X_ grass
____pasture
____crop or grain
____ Orchards, vineyards or other permanent crops.
____ wet soil plants: cattail, buttercup, bullrush, skunk cabbage, other
____water plants: water lily, eelgrass, milfoil, other
____other types of vegetation

b. What kind and amount of vegetation will be removed or altered?

Nothing other than routine weed abatement work.

c. List threatened and endangered species known to be on or near the site.

None known.

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

None.

e. List all noxious weeds and invasive species known to be on or near the site.

None known.

5. *Animals* [help]

a. List any birds and other animals which have been observed on or near the site or are known to be on or near the site.

Examples include:

birds: hawk, heron, eagle, songbirds, other:
mammals: deer, bear, elk, beaver, other:
fish: bass, salmon, trout, herring, shellfish, other ________

None historically observed.

b. List any threatened and endangered species known to be on or near the site.

None.

c. Is the site part of a migration route? If so, explain.

No.

d. Proposed measures to preserve or enhance wildlife, if any:

None.

e. List any invasive animal species known to be on or near the site.

None.

6. *Energy and Natural Resources* [help]

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

None.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

None.

7. Environmental Health [help]

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

Risk of exposure to construction workers (dermal contact, ingestion, inhalation) by dust, petroleum hydrocarbon vapors, petroleum product, or petroleum hydrocarbon-contaminated soil/groundwater. Risks to be controlled by site-specific health and safety plan, including dust control, air monitoring, and protective clothing.

1) Describe any known or possible contamination at the site from present or past uses.

On February 29, 2012, Carson Oil Company delivered fuel to the facility, and approximately 970 gallons of gasoline were released from an overfilled AST into the bermed, unlined containment area. A site investigation conducted in 2012 confirmed that site soils and groundwater contained gasoline; diesel; lube oil; benzene, toluene, ethylbenzene, total xylenes (collectively, BTEX); naphthalene; and other petroleum constituents at concentrations exceeding Model Toxics Control Act (MTCA) cleanup levels. Carson Oil conducted a limited excavation as an interim action to remove petroleum affected soil in 2012.

2) Describe existing hazardous chemicals/conditions that might affect project development and design. This includes underground hazardous liquid and gas transmission pipelines located within the project area and in the vicinity.

The chemicals expected to be present in the water generated from the excavation include TPH, cPAHs, and benzene. These chemicals are the focus of the project development and design.

3) Describe any toxic or hazardous chemicals that might be stored, used, or produced during the project's development or construction, or at any time during the operating life of the project.

No significant quantities of toxic or hazardous chemicals are planned for use, storage, or production.

4) Describe special emergency services that might be required.

Routine medical facility services as necessary in case of worker exposures noted above.

5) Proposed measures to reduce or control environmental health hazards, if any:

Workers will have received Hazardous Waste Operations and Emergency Response training. Workers will follow a site-specific health and safety plan, including use of protective clothing as required. Air monitoring with field instruments and visual monitoring of fugitive dust will be performed during the interim action.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

There is little noise in the area. The most significant noise in the area is from passing traffic on Columbus Avenue. Noise will not affect this project.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

There will be short-term noise associated with heavy equipment operation, disposal truck traffic, and construction activities. The construction activities will be limited to business hours of operation. The most significant short-term noise is likely to be backup horns on heavy equipment and trucks.

3) Proposed measures to reduce or control noise impacts, if any:

Excavation and construction activities will be limited ot during daytime/business hours. Noise from backup horns cannot be abated.

8. Land and Shoreline Use [help]

a. What is the current use of the site and adjacent properties? Will the proposal affect current land uses on nearby or adjacent properties? If so, describe.

The site is bounded by South Columbus Avenue to the west, a gravel City of Goldendale right-of-way (ROW) to the north, the Department of Social and Health Services to the south, and farm or range land to the east. Perez Collision Repair/Powers Motors is located to the west across South Columbus Avenue from the former Temple Distributing bulk facility. There is a maintenance/storage building behind the Department of Social and Health Services to the south. There is currently a mobile home court to the north of the Site directly across the ROW. The project is not anticipated to significantly affect nearby land uses.

b. Has the project site been used as working farmlands or working forest lands? If so, describe. How much agricultural or forest land of long-term commercial significance will be converted to other uses as a result of the proposal, if any? If resource lands have not been designated, how many acres in farmland or forest land tax status will be converted to nonfarm or nonforest use?

No.

1) Will the proposal affect or be affected by surrounding working farm or forest land normal business operations, such as oversize equipment access, the application of pesticides,

tilling, and harvesting? If so, how:

No.

c. Describe any structures on the site.

The site is a vacant parcel containing a warehouse and office building, concrete pads, and underground piping infrastructure

d. Will any structures be demolished? If so, what?

None.

e. What is the current zoning classification of the site?

The site is located in the south-central area of Goldendale in Klickitat County, Washington. The vicinity is characterized by mixed-use residential and commercial parcels. The Site is zoned C-2 (general commercial), which allows for commercial businesses.

f. What is the current comprehensive plan designation of the site?

The 2014 City of Goldendale Comprehensive Plan, dated March, 2014, designates the site as General Commerical.

g. If applicable, what is the current shoreline master program designation of the site?

No designation.

h. Has any part of the site been classified as a critical area by the city or county? If so, specify.

No.

i. Approximately how many people would reside or work in the completed project?

None.

j. Approximately how many people would the completed project displace?

None.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

L. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

There will be little change from current site conditions. All excavation locations will be backfilled to match the original grade.

m. Proposed measures to reduce or control impacts to agricultural and forest lands of long-term commercial significance, if any:

Does not apply.

9. *Housing* [help]

a. Approximately how many units would be provided, if any? Indicate whether high, middle, or low-income housing. |

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high, middle, or low-income housing.

Does not apply.

c. Proposed measures to reduce or control housing impacts, if any:

Does not apply.

10. *Aesthetics* [help]

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

No structures are proposed.

b. What views in the immediate vicinity would be altered or obstructed?

None.

b. Proposed measures to reduce or control aesthetic impacts, if any:

Does not apply.

11. *Light and Glare* [help]

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

None.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

Does not apply.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light and glare impacts, if any:

Does not apply.

12. Recreation [help]

a. What designated and informal recreational opportunities are in the immediate vicinity?

None

b. Would the proposed project displace any existing recreational uses? If so, describe.

No.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any:

Does not apply.

13. Historic and cultural preservation [help]

a. Are there any buildings, structures, or sites, located on or near the site that are over 45 years old listed in or eligible for listing in national, state, or local preservation registers ? If so, specifically describe.

None known.

b. Are there any landmarks, features, or other evidence of Indian or historic use or occupation? This may include human burials or old cemeteries. Are there any material evidence, artifacts, or areas of cultural importance on or near the site? Please list any professional studies conducted at the site to identify such resources.

None known.

c. Describe the methods used to assess the potential impacts to cultural and historic resources on or near the project site. Examples include consultation with tribes and the department of archeology and historic preservation, archaeological surveys, historic maps, GIS data, etc.

Arcadis will prepare an Inadvertant Discovery Plan: Plan and Procedures for the Discovery of Cultural Resources and Human Skeletal Remains for the site prior to the execution of excavation activities.

d. Proposed measures to avoid, minimize, or compensate for loss, changes to, and disturbance to resources. Please include plans for the above and any permits that may be required.

Arcadis will prepare an Inadvertant Discovery Plan: Plan and Procedures for the Discovery of Cultural Resources and Human Skeletal Remains for the site prior to the execution of excavation activities.

14. Transportation [help]

a. Identify public streets and highways serving the site or affected geographic area and describe proposed access to the existing street system. Show on site plans, if any.

Site is served by Columbus Avenue.

b. Is the site or affected geographic area currently served by public transit? If so, generally describe. If not, what is the approximate distance to the nearest transit stop?

The City of Goldendale is serviced by Mt. Adams Transportation Service. The Mt. Adams Transportation Service provides bus transportation for the general public between the City of Goldenale and The City of The Dalles. The closest transit stop is located at the intersection of South Columbus Avenue and West Nesbitt Street, approximately 0.17 miles south of the site.

c. How many additional parking spaces would the completed project or non-project proposal have? How many would the project or proposal eliminate?

Does not apply.

d. Will the proposal require any new or improvements to existing roads, streets, pedestrian, bicycle or state transportation facilities, not including driveways? If so, generally describe (indicate whether public or private).

No.

e. Will the project or proposal use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

No.

f. How many vehicular trips per day would be generated by the completed project or proposal? If known, indicate when peak volumes would occur and what percentage of the volume would be trucks (such as commercial and nonpassenger vehicles). What data or transportation models were used to make these estimates?

None.

g. Will the proposal interfere with, affect or be affected by the movement of agricultural and forest products on roads or streets in the area? If so, generally describe.

No.

h. Proposed measures to reduce or control transportation impacts, if any:

Does not apply.

15. Public Services [help]

a. Would the project result in an increased need for public services (for example: fire protection, police protection, public transit, health care, schools, other)? If so, generally describe.

No.

b. Proposed measures to reduce or control direct impacts on public services, if any.

Does not apply.

16. Utilities [help]

a. Circle utilities currently available at the site:
electricity, natural gas, **water**, refuse service, **telephone**, **sanitary sewer**, septic system, other ___________

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

None.

C. Signature **[HELP]**

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

Signature: Paul T. McCullough

Name of signee Paul McCullough

Position and Agency/Organization Principal Environmental Engineer. Arcadis U.S., Inc.

Date Submitted: 5/7/2021

Appendix E

Arcadis Technical Guidance Instructions

TGI - SOIL DESCRIPTION

Rev #: 1

Rev Date: April 18, 2017

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	May 20, 2008	All		Joe Quinnan Joel Hunt
1	April 18, 2017	All	Updated Rev0	Nick Welty Patrick Curry

APPROVAL SIGNATURES

Prepared by:

04/18/2017

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Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This document describes proper soil description procedures, and should be followed for all unconsolidated material unless there is an established client-required specific procedure or regulatory-required specific procedure. In cases where there is a required specific procedure, it should be followed and should be referenced and/or provided as an appendix to reports that include soil classifications and/or boring logs. When following a required non-Arcadis procedure, additional information required by this SOP should be included in field notes with client approval.

This guidance has been developed to emphasize field observation and documentation of details required to:

- Make hydrostratigraphic interpretations guided by depositional environment/geologic settings;
- Provide information needed to understand the distribution of constituents of concern; properly design wells, piezometers, and/or additional field investigations; and develop appropriate remedial strategies.

This guidance incorporates elements from various standard systems such as ASTM D2488-06, Unified Soil Classification System, Burmister and Wentworth. However, none of these standard systems focus specifically on contaminant hydrogeology and remedial design. Therefore, although each of these systems contain valuable guidance and information related to correct descriptions, strict application of these systems can omit information critical to our clients and the projects that we perform.

This guidance does not address details of health and safety; drilling method selection; boring log preparation; sample collection; or laboratory analysis. Refer to other Arcadis guidance, the project work plans including the quality assurance project plan, sampling plan, and health and safety plan (HASP), as appropriate.

3 PERSONNEL QUALIFICATIONS

Soil descriptions will be completed only by persons who have been trained in Arcadis soil description procedures. Field personnel will complete training on the Arcadis soil description guidance in the office and/or in the field under the guidance of an experienced field geologist. For sites where soil descriptions have not previously been well documented, soil descriptions should be performed only by trained persons with a degree in geology or a geology-related discipline.

4 EQUIPMENT LIST

The following equipment should be taken to the field to facilitate soil descriptions:

- field book, field forms or PDA to record soil descriptions;
- field book for supplemental notes;
- this TGI for Soil Descriptions and any project-specific SOPs or TGIs (if required);
- field card showing Wentworth scale;
- Munsell® soil color chart;
- tape measure divided into tenths of a foot;
- stainless steel knife or spatula;
- hand lens;
- water squirt bottle;
- jar with lid;
- personal protective equipment (PPE), as required by the HASP; and
- digital camera

5 CAUTIONS

Drilling and drilling-related hazards including subsurface utilities are discussed in other TGIs, SOPs and site-specific HASPs and are not discussed herein.

Soil samples may contain hazardous substances that can result in exposure to persons describing soils. Routes for exposure may include dermal contact, inhalation and ingestion. Refer to the project specific HASP for guidance in these situations.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with soil sampling and description will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Know what hazardous substances may be present in the soil and understand their hazards. Avoid touching soils with bare hands, placing soils close to your nose, or tasting soils.

7 PROCEDURE

1. Select the appropriate sampling method to obtain representative samples in accordance with the selected sub-surface exploration method (split-spoon or Shelby sample for hollow-stem drilling, Lexan or acetate sleeves for dual-tube direct push, etc.).

2. Proceed with field activities in required sequence. Although completion of soil descriptions is often not the first activity after opening sampler, identification of stratigraphic changes is often necessary to select appropriate intervals for field screening and/or selection of laboratory samples.

3. Set up boring log field sheet. Drillers in both the US and Canada generally work in feet due to equipment specifications. Use the preferred standard boring log (attached) or another standard Arcadis format. The preferred boring log includes a graphic log of the principal component to support quick visual evaluation of grain size. Record depths along the left-hand side at a standard scale to aid in the use of this tool. See example boring log (attached).

4. Examine all of each individual soil sample (this is different than examining each sample selected for laboratory analysis), and record the following for each stratum:

- depth interval;
- principal component with descriptors, as appropriate;
- amount and identification of minor component(s) with descriptors as appropriate;
- moisture;
- consistency/density;
- color; and
- additional description or comments (recorded as notes).

5. At the end of the boring, record the amount of drilling fluid used (if applicable) and the total depth logged.

The above is described more fully below.

DEPTH

To measure and record the depth below ground level (bgl) of top and bottom of each stratum, the following information should be recorded.

1. Measured depth to the top and bottom of sampled interval. Use starting depth of sample based upon measured tool length information and the length of sample interval.

2. Length of sample recovered, not including slough (material that has fallen into hole from previous interval), expressed as fraction with length of recovered sample as numerator over length of sampled interval as denominator (e.g. 14/24 for 14 inches recovered from 24-inch sampling interval that had 2 inches of slough discarded).

3. Thickness of each stratum measured sequentially from the top of recovery to the bottom of recovery.

4. Any observations of sample condition or drilling activity that would help identify whether there was loss from the top of the sampling interval, loss from the bottom of the sampling interval, or compression of the sampling interval. Examples: 14/24, gravel in nose of spoon; or 10/18 bottom 6 inches of spoon empty.

DETERMINATION OF COMPONENTS

Obtain a representative sample of soil from a single stratum. If multiple strata are present in a single sample interval, each stratum should be described separately. More specifically, if the sample is from a 2-foot long split-spoon where strata of coarse sand, fine sand and clay are present, then the resultant description should be of the three individual strata unless a combined description can clearly describe the interbedded nature of the three strata. Example: Fine Sand with interbedded lenses of Silt and Clay, ranging between 1 and 3 inches thick.

Identify principal component and express volume estimates for minor components on logs using the following standard modifiers.

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

Determination of components is based on using the Udden-Wentworth particle size classification (see below) and measurement of the average grain size diameter. Each size grade or class differs from the next larger grade or class by a constant ratio of ½. Due to visual limitations, the finer classifications of Wentworth's scale cannot be distinguished in the field and the subgroups are not included. Visual determinations in the field should be made carefully by comparing the sample to the field gauge card that shows Udden-Wentworth scale or by measuring with a ruler. Use of field sieves is recommended to assist in estimating percentage of coarse grain sizes. Settling test or wash method (Appendix X4 of ASTM

D2488) is recommended for determining presence and estimating percentage of clay and silt. Note that “gravel” is not an Udden-Wentworth size class.

Udden-Wenworth Scale
Modified ARCADIS, 2008

Size Class	Millimeters	Inches	Standard Sieve #
Boulder	256 – 4096	10.08+	
Large cobble	128 - 256	5.04 -10.08	
Small cobble	64 - 128	2.52 – 5.04	
Very large pebble	32 – 64	0.16 - 2.52	
Large pebble	16 – 32	0.63 – 1.26	
Medium pebble	8 – 16	0.31 – 0.63	
Small pebble	4 – 8	0.16 – 0.31	No. 5 +
Granule	2 – 4	0.08 – 0.16	No.5 – No.10
Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
Fine sand	1/8 -¼	0.005 – 0.1	No.60 - No.120
Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
Clay (subgroups not included	1/2048 – 1/256	.00002 – 0.0002	

Identify components as follows. Remove particles greater than very large pebbles (64-mm diameter) from the soil sample. Record the volume estimate of the greater than very large pebbles. Examine the sample fraction of very large pebbles and smaller particles and estimate the volume percentage of the pebbles, granules, sand, silt and clay. Use the jar method, visual method, and/or wash method (Appendix X4 of ASTM D2488) to estimate the volume percentages of each category.

Determination of actual dry weight of each Udden-Wentworth fraction requires laboratory grain-size analysis using sieve sizes corresponding to Udden-Wentworth fractions and is highly recommended to determine grain-size distributions for each hydrostratigraphic unit.

Lab or field sieve analysis is advisable to characterize the variability and facies trends within each hydrostratigraphic unit. Field sieve-analysis can be performed on selected samples to estimate dry weight fraction of each category using ASTM D2488 Standard Practice for Classification of Soils for Engineering Purposes as guidance, but replace required sieve sizes with the following Udden-Wentworth set: U.S. Standard sieve mesh sizes 6; 12; 20; 40; 70; 140; and 270 to retain pebbles; granules; very coarse sand; coarse sand; medium sand; fine sand; and very fine sand, respectively.

PRINCIPAL COMPONENT

The principal component is the size fraction or range of size fractions containing the majority of the volume. Examples: the principal component in a sample that contained 55% pebbles would be “Pebbles”; or the principal component in a sample that was 20% fine sand, 30% medium sand and 25% coarse sand would be “Fine to coarse Sand” or for a sample that was 40% silt and 45% clay the principal component would be “Clay and Silt”. On the boring log, shade the boxes on the graphic log up to and including the box with the principal component.

Include appropriate descriptors with the principal component. These descriptors vary for different particle sizes as follows.

Angularity – Describe the angularity for very coarse sand and larger particles in accordance with the table below (ASTM D-2488-06). Figures showing examples of angularity are available in ASTM D-2488-06 and the ARCADIS Soil Description Field Guide.

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

Plasticity – Describe the plasticity for silt and clay based on observations made during the following test method (ASTM D-2488-06).

- As in the dilatancy test below, select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
- Shape the test specimen into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble when the soil is near the plastic limit.

Description	**Criteria**
Non-plastic	A 1/8-inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

Dilatancy – Describe the dilatancy for silt and silt-sand mixtures using the following field test method (ASTM D-2488-06).

- From the specimen select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material adding water if necessary, until it has a soft, but not sticky, consistency.
- Smooth the ball in the palm of one hand with a small spatula.
- Shake horizontally, striking the side of the hand vigorously with the other hand several times.
- Note the reaction of water appearing on the surface of the soil.
- Squeeze the sample by closing the hand or pinching the soil between the fingers, and not the reaction as none, slow, or rapid in accordance with the table below. The reaction is the speed with which water appears while shaking and disappears while squeezing.

Description	**Criteria**
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

Note that silt and silt-sand mixtures will be non-plastic and display dilatency. Clay mixtures will have some degree of plasticity but do not typically react to dilatency testing. Therefore, it is uncommon for a soil to be both plastic and display dilatency and the tests outlined above can be used to differentiate between silt dominated and clay dominated soils.

MINOR COMPONENT(S)

The minor component(s) are the size fraction(s) containing less than 50% volume. Example: the identified components are estimated to be 60% medium sand to granules, 25 % silt and clay; 15 % pebbles – there are two identified minor components: silt and clay; and pebbles.

Include a standard modifier to indicate percentage of minor components (see modifier table included in this TGI) and the same descriptors that would be used for a principal component. Plasticity should be provided as a descriptor for the silt and clay. Dilatancy should be provided for silt and silt-sand mixtures. Angularity should be provided as a descriptor for pebbles and coarse sand. For the example above, the minor constituents with modifiers could be: some silt and clay, low plasticity; little medium to large pebbles, sub-round.

SORTING

Sorting is the opposite of grading, which is a commonly used term in the USCS or ASTM methods to describe the uniformity of the particle size distribution in a sample. Well-sorted samples are poorly graded and poorly sorted samples are well graded. Arcadis prefers the use of sorting for particle size distributions and grading to describe particle size distribution trends in the vertical profile of a sample or hydrostratigraphic unit because of the relationship between sorting and the energy of the depositional process. For soils with sand-sized or larger particles, sorting should be determined as follows:

Well sorted – the range of particle sizes is limited (e.g. the sample is comprised of predominantly one or two grain sizes)

Poorly sorted – a wide range of particle sizes are present

You can also use sieve analysis to estimate sorting from a sedimentological perspective; sorting is the statistical equivalent of standard deviation. Smaller standard deviations correspond to higher degree of sorting (see Remediation Hydraulics, 2008).

MOISTURE

Moisture content should be described for every sample since increases or decreases in water content is critical information. Moisture should be described in accordance with the table below (percentages should not be used unless determined in the laboratory).

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet (Saturated)	Visible free water, soil is usually below the water table.

CONSISTENCY or DENSITY

This can be determined by standard penetration test (SPT) blow counts (ASTM D-1586) or field tests in accordance with the tables below. For SPT blow counts the N-value is used. The N-value is the blows per foot for the 6” to 18” interval. Example: for 24-inch spoon, recorded blows per 6-inch interval are: 4/6/9/22. Since the second interval is 6” to12”, the third interval is 12” to 18”, the N value is 6+9, or 15. Fifty blow counts for less than 6 inches is considered refusal.

Fine-grained soil – Consistency

Description	Criteria
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated one inch by thumb.
Medium stiff	N-value 9-15 or indented about ¼ inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty

Coarse-grained soil – Density

Description	Criteria
Very loose	N-value 1- 4
Loose	N-value 5-10
Medium dense	N-value 11-30
Dense	N-value 31- 50
Very dense	N-value >50

COLOR

Color should be described using simple basic terminology and modifiers based on the Munsell system. Munsell alpha-numeric codes are required for all samples. If the sample contains layers or patches of varying colors this should be noted and all representative colors should be described. The colors should be described for moist samples. If the sample is dry it should be wetted prior to comparing the sample to the Munsell chart.

ADDITIONAL COMMENTS (NOTES)

Additional comments should be made where observed and should be presented as notes with reference to a specific depth interval(s) to which they apply. Some of the significant information that may be observed includes the following.

- Odor - You should not make an effort to smell samples by placing near your nose since this can result in unnecessary exposure to hazardous materials. However, odors should be noted if they are detected during the normal sampling procedures. Odors should be based upon descriptors such as those used in NIOSH “Pocket Guide to Chemical Hazards”, e.g. “pungent” or “sweet” and should not indicate specific chemicals such as “phenol-like” odor or “BTEX” odor.
- Structure
- Bedding planes (laminated, banded, geologic contacts)
- Presence of roots, root holes, organic material, man-made materials, minerals, etc.
- Mineralogy
- Cementation
- NAPL presence/characteristics, including sheen (based on client-specific guidance)
- Reaction with HCl (typically used only for special soil conditions)
- Origin, if known (capital letters: LACUSTRINE; FILL; etc.)

EXAMPLE DESCRIPTIONS

51. 4 to 54.0’ Clay, some silt, medium to high plasticity; trace small to large pebbles, subround to subangular up to 2” diameter; moist; stiff; dark grayish brown (10YR 4/2) NOTE: Lacustrine; laminated 0.01 to 0.02 feet thick, laminations brownish yellow (10 YR 4/3).

32.5 to 38.0’ Sand, medium to Pebbles, coarse; sub-round to sub-angular; trace silt; poorly sorted; wet; grayish brown (10YR5/2). NOTE: sedimentary, igneous and metamorphic particles.

Unlike the first example where a density of cohesive soils could be estimated, this rotosonic sand and pebble sample was disturbed during drilling (due to vibrations in a loose Sand and Pebble matrix) so no density description could be provided. Neither sample had noticeable odor so odor comments were not included.

The standard generic description order is presented below.

- Depth
- Principal Components
    - Angularity for very coarse sand and larger particles
    - Plasticity for silt and clay
    - Dilatancy for silt and silt-sand mixtures
- Minor Components
- Sorting
- Moisture
- Consistency or Density
- Color
- Additional Comments

8 WASTE MANAGEMENT

Project-specific waste management requirements should be identified and followed. The following procedures, or similar waste management procedures are generally required.

Water generated during cleaning procedures is collected and contained onsite in appropriate containers for future analysis and appropriate disposal. PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities is placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

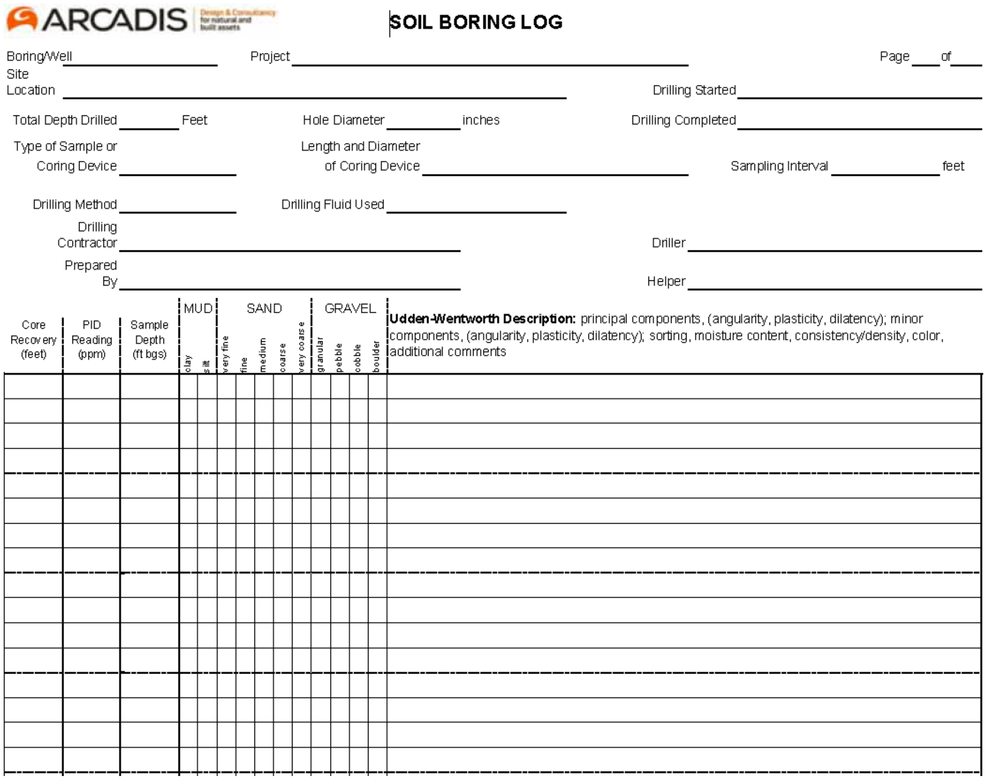
Soil materials are placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material is analyzed to determine the appropriate disposal method.

9 DATA RECORDING AND MANAGEMENT

Upon collection of soil samples, the soil sample should be logged on a standard boring log and/or in the field log book depending on Data Quality Objectives (DQOs) for the task/project. The preferred standard boring log is presented below and is attached in full at the end of this SOP.

The general scheme for soil logging entries is presented above; however, depending on task/project DQOs, specific logging entries that are not applicable to task/project goals may be omitted at the project manager's discretion. In any case, use of a consistent logging procedure is required.

Completed logs and/or logbook will be maintained in the task/project field records file. Digital photographs of typical soil types observed at the site and any unusual features should be obtained whenever possible. All photographs should include a ruler or common object for scale. Photo location, depth and orientation should be recorded in the daily log or log book and a label showing this information in the photo is recommended.



SOIL BORING LOG

Boring/Well ________ Project ________ Page ___ of ___
Site Location ________ Drilling Started ________
Total Depth Drilled ________ Feet Hole Diameter ________ inches Drilling Completed ________
Type of Sample or Coring Device ________ Length and Diameter of Coring Device ________ Sampling Interval ________ feet
Drilling Method ________ Drilling Fluid Used ________
Drilling Contractor ________ Driller ________
Prepared By ________ Helper ________

Core Recovery (feet)	PID Reading (ppm)	Sample Depth (ft bgs)	MUD		SAND					GRAVEL				**Udden-Wentworth Description:** principal components, (angularity, plasticity, dilatency); minor components, (angularity, plasticity, dilatency); sorting, moisture content, consistency/density, color, additional comments
			clay	silt	very fine	fine	medium	coarse	very coarse	granular	pebble	cobble	boulder	

10 QUALITY ASSURANCE

Soil descriptions should be completed only by appropriately trained personnel. Descriptions should be reviewed by an experienced field geologist for content, format and consistency. Edited boring logs should be reviewed by the original author to assure that content has not changed.

11 REFERENCES

ARCADIS Soil Description Field Guide, 2008.

ASTM D-1586, Test Method for Penetration Test and Split-Barrel Sampling of Soils

ASTM D-2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

Field Gauge Card that Shows Udden-Wentworth scale – available from Forestry Suppliers, Inc. – Item 77332 “Sand Grain Sizing Folder”

Munsell® Color Chart – available from Forestry Suppliers, Inc.- Item 77341 “Munsell® Color Soil Color Charts

NIOSH Pocket Guide to Chemical Hazards

Petrology of Sedimentary Rocks, Robert L. Folk, 1980, p. 1-48

Remediation Hydraulics, Fred C. Payne, Joseph A. Quinnan, and Scott T. Potter, 2008, p 59-63

United States Bureau of Reclamation. Engineering Geology Field Manual. United States Department of Interior, Bureau of Reclamation. http://www.usbr.gov/pmts/geology/fieldmap.htm

TECHNICAL GUIDANCE INSTRUCTION - MONITORING WELL DEVELOPMENT

Rev: #0

Rev Date: April 24, 2017

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/24/2017	All	Re-written as TGI	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:
Jay Erickson
4/24/2017
Date:

Technical Expert Reviewed by:
Marc Killingstad
4/24/2017
Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) covers the development of screened wells used for obtaining representative groundwater information and samples from granular aquifers (i.e., monitoring wells). Note that this TGI only applies to monitoring well development and not remediation (injection/extraction) well development.

The purposes of Monitoring Well Development are:

1. Repair damage to the borehole wall from drilling that can include clogging, smearing or compaction of aquifer materials;
2. Remove fine grained sediment from the formation and filter pack that may result in high turbidity levels in groundwater samples;
3. To re-sort formation and filter pack material adjacent to the well screen;

4. To recover any drilling fluids (if used) that may affect the permeability of the formation and filter pack or alter the water quality around the well; and
5. To optimize the well efficiency and hydraulic communication between the well screen and the formation.

Successful monitoring well development is dependent on the following:

1. Hydrostratigraphy – Permeable formations containing primarily sand and gravel are more easily developed due to lower percentages of silt and clay material. Water in permeable formations can be moved in and out of the screen and/or through the formation easier than in less permeable deposits
2. Well Diameter – Development tooling including brushes, surge blocks, pumps and jetting tools are more readily available for wells 4 inches in diameter and greater.
3. Well Design – Wells with filter packs and screens designed to match the formation through the analysis of formation sieve samples are easier to develop. An important aspect to well design is to minimize the size of the annular space between the formation and well screen. Adequate room must be allowed for the proper installation of well materials, but not too large as to prevent/reduce communication with the surrounding formation.
4. Drilling Methods – Different drilling methods result in varying amount of borehole damage and, therefore, impact the degree to which development will be successful.

Well development methods for monitoring wells include the following:

1. Bailing – use of a bailer to remove water and sediment from the well casing. This technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen.
2. Pumping/overpumping – use of a pump to remove water and sediment from the well casing, overpumping involves pumping the well at a rate that exceeds the design capacity of the well. Similar to bailing, this technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen. Small diameter monitoring wells have the additional constraint on pump size and flow rates.
3. Backwashing (rawhiding) – consists of starting and stopping a pump intermittently to produce rapid pressure changes in a well. This method can produce better results than pumping alone since the procedure involves movement of the water in and out of the screen and formation. However, in many cases the surging action is not rigorous enough to fully develop the well.
4. Surging/swabbing – use of a mechanical surge block or swabbing tool to operate like a piston with an up and down motion. The downstroke causes a backwash action that breaks up bridged sediment and the upstroke pulls the dislodged sediment into the well. This method works well for small and large diameter wells. Care should be taken on the downstroke so as not to force fines back into the formation, frequent pumping/purging during surging help to keep fines out of the well. Double surge blocks are recommended.
5. Jetting – use of a tool fitted with nozzles that direct streams of water horizontally into well screens at high velocity. Due to the size of the tooling, this method is better suited for wells 4 inch in diameter and larger. The method is also more effective with wire-wrapped/continuous slot screens due to the

increased open area. Jetting requires specialized equipment and concurrent pumping to prevent reintroducing fines into the filter pack. Additionally, jetting requires subsequent surging to remove fines dislodged in the filter pack and formation.

For most situations, gentle surging coupled with bailing or pumping to remove dislodged materials is recommended.

Well development for properly designed and constructed monitoring wells may begin after the annular seal materials have been installed and allowed to cure, since these wells are designed to retain 90-99% of the filter pack material. This cure time is typically at least 24 to 48 hours after the sealing materials have been installed.

This TGI is meant to provide a general guide for proper monitoring well development. A site-specific field implementation plan for well installation and development detailing the specific methods and tools should be developed to provide site-specific instruction and guidance.

3 PERSONNEL QUALIFICATIONS

Monitoring well development activities will be performed by persons who have been trained in proper well development procedures under the guidance of an experienced field geologist, engineer, or technician.

4 EQUIPMENT LIST

Required equipment depends on the selected method and should be detailed in the site-specific field implementation plan. However, the following are typically required.

- Health and safety equipment, as required by the site Health and Safety Plan (HASP):
- Cleaning equipment
- Field notebook and/or personal digital assistant (PDA)
- Monitoring well keys
- Water level indicator
- Field parameter meter (YSI)
- Well Development Logs
- Well construction logs/diagrams
- Weighted tape (measure depth)
- Turbidity meter
- Camera
- Watch/timing device.

5 CAUTIONS

Where surging is performed to assist in removing fine-grained material from the sand pack, surging must be performed in a gentle manner. Excessive suction could promote fine-grained sediment entry into the outside of the sand pack from the formation.

Avoid using development fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

In some cases, it may be necessary to add potable water to a well to allow surging and development, especially for new monitoring wells installed in low permeability formations. Before adding potable water to a well, the Certified Project Manager (CPM) and/or Project Hydrogeologist must be notified and the CPM shall make the decision regarding the appropriateness and applicability of adding potable water to a well during well development procedures. If potable water is to be added to a well as part of development, the potable water source should be sampled and analyzed for constituents of concern, and the results evaluated by the CPM prior to adding the potable water to the well. If potable water is added to a well for development purposes, at the end of development the well will be purged dry to remove the potable water, or if the well no longer goes dry then the well will be purged to remove at least three times the volume of potable water that was added.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well development will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

7 PROCEDURE

As indicated above, for most monitoring wells, gentle surging coupled with bailing or pumping to remove dislodged sediment is recommended.

1 Ensure sufficient time has passed to allow for proper curing of the well seal.

2 Don appropriate PPE (as required by the site-specific HASP).

3 Place plastic sheeting around the well.

4 Clean all equipment entering each monitoring well, except for new, disposable materials that have not been previously used.

5 Open the well cover while standing upwind of the well, remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field notebook. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don the appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings.

6 Obtain an initial measurement of the depth to water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book. It is recommended to use a weighted tape for the total well depth measurement.

7 The depth to the bottom of the well should be sounded and then compared to the completion form or construction diagram for the well. Any discrepancies should be reported immediately to the CPM and/or Project Hydrogeologist. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the CPM and/or Project Hydrogeologist and obtain approval to continue or cease well development activities.

8 Lower a double surge block into the screened portion of the well. Starting from the bottom of the screen using 2 foot throws, gently raise and lower the surge block to force water in and out of the screen slots and sand pack. Continue surging for 15 to 30 minutes.

9 Lower a bottom-loading bailer, submersible pump, or inertia pump tubing with check valve to the bottom of the well and gently bounce on the bottom of the well to collect/remove accumulated sediment, if any. Remove and empty the bailer, if used. Repeat until the bailed/pumped water is free of excessive sediment and contact at the bottom of the well feels solid. Alternatively, measurement of the well depth with a weighted tape can be used to verify that sediment and/or silt has been removed to the extent practicable, based on a comparison with the well installation log or previous measurement of total well depth.

10 After surging the well for a minimum of two cycles and removing excess accumulated sediment from the bottom of the well, re-measure the depth-to-water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.

11 Remove formation water by pumping/bailing. Where pumping is used, measure and record the pre-pumping water level. Operate the pump at a relatively constant rate. Measure the pumping rate using a calibrated container and stop watch, and record the pumping rate in the field log book. Measure and record the water level in the well at least once every 5 minutes during pumping. Note any relevant observations in terms of water color, visual level of turbidity, sheen, odors, etc. Pump or bail until termination criteria specified in the Site-Specific Field Implementation plan are reached. Note: the project-specific field implementation plan may also specify a maximum turbidity requirement for completion of development. Unless otherwise specified the maximum turbidity should be 50 NTUs or less. Record the total volume of water purged from the well.

12 While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Log.

13 While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Log.

14 While developing, water is also periodically collected directly from the well or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified), the extracted water is clear and free

of fine sediment and most importantly, when acceptable volume of water has been removed and/or a sufficient amount of surging has been performed.

15 In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete when minimal amounts of fine-grained sediments are recovered and acceptable volume of water has been removed.

16 If the well goes dry, stop pumping or bailing. Note the time that the well went dry. After allowing the well to recover, note the time and depth to water. Resume pumping or bailing when sufficient water has recharged the well.

17 Contain all development water in appropriate containers.

18 When complete, secure the lid back on the well.

19 Place disposable materials in plastic bags for appropriate disposal and decontaminate reusable, downhole pump components and/or bailer

8 WASTE MANAGEMENT

Materials generated during monitoring well installation and development will be placed in appropriate labeled containers and disposed of as described in the Work Plan/Field Implementation Plan or Field Sampling Plan.

9 DATA RECORDING AND MANAGEMENT

All well development activities should be documented on appropriate log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site; times of arrival and departure; significant weather conditions; timing of well development activities; development method(s); observations of purge water color, turbidity, odor, sheen, etc.; purge rate; and water levels before, during, and after pumping.

10 QUALITY ASSURANCE

All reused, non-disposable, downhole well development equipment should be cleaned in accordance with the procedures outlined in the project documents.

11 REFERENCES

American Society for Testing Materials (ASTM), Designation D5521-05. *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

TGI - LOW-FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURES FOR MONITORING WELLS

Rev: #1

Rev Date: May 8, 2020

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 12, 2018	All	Updated and re-written as TGI with new branding and content	Marc Killingstad
1	May 8, 2020	Pages 5, 10-11	Added clarification/details for equipment requirements and procedure steps based on USEPA guidance	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:		10/12/2018
	Ryan McKinney	Date:
Technical Expert Reviewed by:		May 8, 2020
	Marc Killingstad (Technical Expert)	Date:

1 INTRODUCTION

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2 SCOPE AND APPLICATION

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. Project teams will evaluate the last time the monitoring wells were developed and determine if additional development might be necessary. Water samples will not be taken immediately following well development. Sufficient time will be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

4 EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) will be used:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records, sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (phone or tablet)
- Low-flow sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16” socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending on site-specific constituents of concern)
- Electronic water-level indicator (e.g., Solinist Model 101) or oil/water interface probe with 0.01-foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multi-parameter water-quality sonde (temperature/pH/specific conductivity/oxidation reduction [ORP]/turbidity/dissolved oxygen) meter coupled with flow-through-cell for measurements, for example:

  - YSI 6-Series Multi-Parameter Instrument
  - Horiba U-22 Multi-Parameter Instrument.
  - Hydrolab Series 3 or Series 4a Multiprobe and Display.

  NOTE: *Transparent, small volume flow-through-cells (e.g., 250 milliliters or less) are preferred as they allow for easy detection of air bubbles and sediment buildup in the cell, which can interfere with the monitoring instrument probes. A small volume cell also allows for quick turnover of water in the cell between measurements of the indicator field parameters. It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.*

- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
  - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
  - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Sampling pump, which may consist of one or more of the following:
  - Submersible pump (e.g., Grundfos Redi-Flo 2)
  - Peristaltic pump (e.g., ISCO Model 150)
  - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:
  - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery
  - Submersible pumps such as Grundfos require a pump controller to run the pump
  - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N2 or CO2 gas cylinders)
- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used
  - For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) will be used through the pump apparatus
  - Teflon® will not be used when sampling for per- and polyfluoroalkyl substances (PFAS)
- Graduated cylinder and stop watch or other device to measure time to determine pumping rate

- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- Sample labels and Chain-of-Custody forms (COC)
- 0.45-micron disposable filters (if field filtering is required)
- A supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020) may be required for specific projects and will be specified in the project FIP/ work plan and the kick-off notes.
    - If used, in-line 'T' and valve allows for collection of water for turbidity measurements before the pump discharge enters the flow-through cell

NOTE: *The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.*

5 CAUTIONS

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Weather

- If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rain water could compromise groundwater samples.
- Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).
    - Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing or flow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible, and avoid the hottest times of the day.
    - Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

Cross-Contamination

- To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of up-gradient, then furthest down-gradient to source area locations.

- Note that permanent markers could introduce volatile constituents into the samples; *therefore, indelible ink is recommended* to be used for labels on sample containers or sample coolers.
- When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Pumps

- Preferred methods of extracting groundwater are adjustable rate, submersible pumps - such as centrifugal pumps or bladder pumps – constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®). However, *PTFE will not be used when sampling for per- and polyfluoroalkyl substances (PFAS). PTFE could contain PFAS*.
- When using a bladder pump for collecting VOCs and dissolved gases, "best practice" is to set-up the pump to deliver sufficient water to fill a 40 mL VOC vial.
- The use of peristaltic pumps will be based on the type of data to be collected. *Because the use a peristaltic pump can result in de-gassing of VOC and / or dissolved gases from groundwater, a different type of pump will be considered if these compounds are of concern.*
- *Manual or motor driven inertial pumping devices are not recommended because they cause greater disturbance during purging and pumping than regular pumps and are less easily controlled. This could cause a higher degree of data variability.*

Tubing

- When sampling for VOCs, SVOCs, pesticides, PCBs and inorganics, use of PTFE (Teflon®) or PTFE-lined tubing is preferred. However, PTFE tubing will not be used when sampling for PFAS.
- PVC, polypropylene or polyethelene tubing may be used when sampling for metals or other inorganics.
- Tubing with inside diameters of 1/4 or 3/8 inch is recommended because this will help ensure tubing remains water filled when operating at very low pumping rates.

General Precautions

- Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/work plan will list the samples that require field filtering.
- Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

7 PROCEDURE

Field personnel will set up and perform low-flow sampling in accordance with the following procedures.

1. Review FIP and groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for each well to perform sampling as efficiently as possible (i.e., reach a stabilized pumping condition).
2. Calibrate field instruments according to manufacturer procedures for calibration and record calibration procedure and results in field log.
3. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination)* prior to use.
4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
    a) Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
    b) Record well construction and conditions on the Low-Flow Sampling Field Form (**Attachment A**)
5. Place clean plastic sheeting on the ground near the well to keep monitoring and sampling equipment off the surface unless the equipment is elevated above the ground (e.g. on a table).
6. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. If appropriate or required for site-specific conditions, insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
7. Measure and record the initial depth to groundwater prior to placing the pumps.

8. Prepare and install the pump in the well.

   NOTE: *Groundwater will be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet below ground surface), a submersible or bladder pump will be used, provided that the well is constructed with a casing diameter of at least two (2) inches (the minimum well diameter capable of accommodating such pumps). For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Bladder pumps are preferred over peristaltic and submersible pumps to prevent volatilization if sampling of VOCs and/or dissolved gasses is required. Purge water will be collected and containerized according to the direction of the project team.*

   a) For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well. Attach the air-line tubing to the air-port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to unintended contamination.

   b) If using a bladder pump, connect the air-line to the pump controller output port. The pump controller will be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power (if an on/off switch is present) and verify that all batteries are charged and fully functioning before starting the pump.

   c) If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two (2) feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

   d) If using an in-line ‘T’ and valve, install between pump discharge water line and the bottom inlet port of the flow-through cell. Attach a short piece of tubing to the outlet. This set-up will be used to collect samples for turbidity readings.

9. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the multi-parameter water-quality sonde and make sure to record equipment/instrument identification (manufacturer and model number).
10. Before starting the pump, ensure that the water level inside the well has stabilized (i.e., measure the water level multiple times after deploying the pump in the well).
11. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified) and adjust the pumping rate to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement): the water level should stabilize, however, this is not always possible.
12. If the well diameter is of sufficient size, measure the water level every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping.
13. Maintain a steady flow rate to the extent practicable and do not break pump suction or cause entrainment of air in the sample.
14. Record pumping rate adjustments and depths to water.

    If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters; if the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position.

    For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

    For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 feet) is maintained and monitoring for stabilization of field indicator parameters can commence; if a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen.
15. After water levels have stabilized and a sufficient volume has been purged (*see note below*), continue pumping and begin monitoring field indicator parameters using a multi-parameter water-quality sonde coupled with a flow-through-cell.

    NOTE: *The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.*
16. Use the flow to measure all indicator field parameters, except for turbidity, every 3 to 5 minutes (or after each volume of the flow-through cell has been purged or other appropriate interval); turbidity samples will be collected before the flow-through-cell using the T-valve and a clean container such as a glass beaker.
17. Record field indicator parameters on the groundwater sampling log.

18. The well is considered stabilized and ready for sample collection when three consecutive readings are within the following limits:

    - **Turbidity** within ± 10% for values greater than 5 nephelometric turbidity units [NTUs] or if three turbidity values are less than 5 NTUs, consider the values stabilized
    - **Dissolved Oxygen (DO)** within ± 10% for values greater than 0.5 mg/L or if three DO values are less than 0.5 mg/L, consider the values stabilized
    - **Specific Conductance** within ± 3%
    - **Temperature** within ± 3%
    - **pH** within ± 0.1 unit
    - **Oxidation/Reduction Potential (ORP)** within ±10 millivolts (mV)

    NOTE: *Alternate stabilization goals may exist in different geographic regions, consult the site-specific FIP/work plan for stabilization criteria).*

    NOTE: *While achieving turbidity levels less than 5 NTU and a stable drawdown of less than 0.3 feet is desirable, sample collection may still take place provided the indicator field parameter criteria in this procedure are met.*

19. If the parameters have stabilized but turbidity remains relatively high (e.g., greater than 50 NTUs), the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. If groundwater turbidity has been minimized (i.e., consecutive readings within ± 10%) and the values for all other parameters have stabilized, the well may be sampled; however, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

20. If after one (1) hour of purging indicator field parameters have not stabilized, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

    In general, three potential options are available if stabilization criteria are not met:

    a) Continue purging until stabilization is achieved.

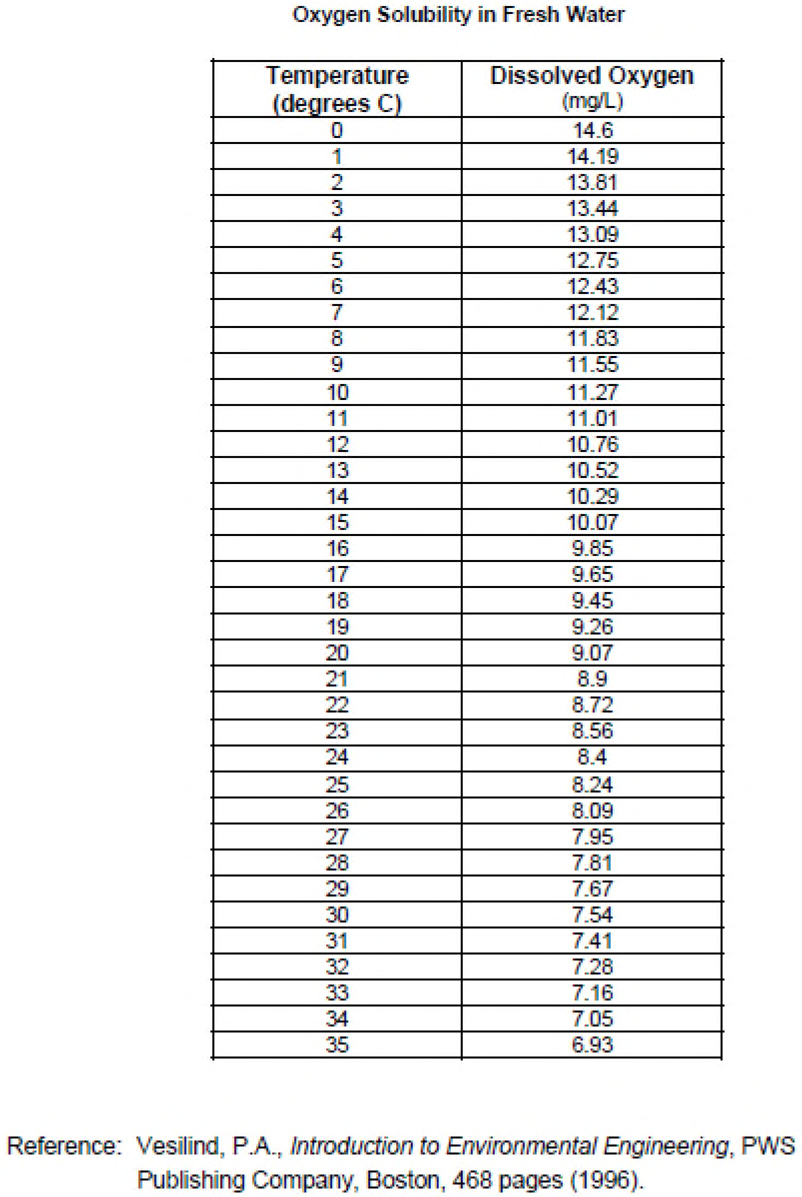
    b) Discontinue purging, do not collect any samples, and record in field logbook/on the sampling form that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

    c) Discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization. *There is a risk that the analytical data obtained under these conditions, particularly metals and hydrophobic organic analytes, may reflect a sampling bias and, as a result, the data may not meet the data quality objectives of the sampling event.*

    NOTE: *DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); therefore, great care will be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater, again check for and remove air bubbles on the probe before re-measuring. The table below may be* *used as a general guide for DO values under various temperatures; however, understand that the table corresponds to freshwater solubility and groundwater contaminants may affect oxygen solubility. If DO value is 0.00 or less, then the meter will be serviced and re-calibrated. If DO values are above possible results, then the meter will be serviced and re-calibrated.*

NOTE: *During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field logbook/on the sampling form.*

NOTE: *If other field conditions are suspected of preventing stabilization of certain parameters, detailed observations will be documented in the field logbook/on the sampling form.*



Oxygen Solubility in Fresh Water

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., *Introduction to Environmental Engineering*, PWS Publishing Company, Boston, 468 pages (1996).

21. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.
22. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container.
    a) If a flow-through analytical cell is being used to measure field parameters, the flow-through cell will be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection.
    b) Under no circumstances will analytical samples be collected from the discharge of the flow-through cell.
    c) If an in-line ‘T’ and valve are used, the valve needs to be removed as well.
    d) Samples will be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific FIP/work plan).
    e) When the container is full, tightly screw on the cap.
23. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample will be collected.
    a) Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected.
    b) Continue to run the pump until an initial volume of “flush” water has been run through the filter in accordance with the manufacturer’s directions (generally 100 to 300 mL).
    c) Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container.
    d) When the container is full, tightly screw on the cap.
24. Secure with packing material and store the samples on ice in an insulated transport container provided by the laboratory and include a temperature blank in each container to be shipped.
25. Record on the Low-Flow Sampling Field Form (and bound field logbook) the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (see **Attachment A**).
26. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.
27. Slowly remove the pump, tubing, lines, and safety cable from the well.
    a) If using dedicated tubing, do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
    b) If using dedicated tubing, it will be folded - without pinching it - to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events.
    c) Use a length of rope or string to tie the tubing to the well cap.

  d) Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, coil the tubing neatly and placed in a clean plastic bag that is clearly labeled with the well ID ensuring the bag is tightly sealed before placing it in storage.

28. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.

29. Complete the procedures for packaging, shipping, and handling with the associated Chain-of-Custody.

30. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate (*TGI – Groundwater and Soil Sampling Equipment Decontamination*).

31. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log.

8 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment and excess purge water, will be stored on site in appropriately labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field logbook.

9 DATA RECORDING AND MANAGEMENT

Management of the original documents from the field will be completed in accordance with the site-specific QAPP.

In general, forms (e.g., Low-Flow Sampling Field Forms), logs/notes (including daily field and calibration logs), digital records, and Chain-of-Custody records will be maintained by the field team lead.

Field logs and Chain-of-Custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

10 QUALITY ASSURANCE

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Unless described otherwise in the project-specific FIP/work plan, QAPP, or Sampling and Analysis Plan, quality assurance/quality control samples will be collected as follows:

- One duplicate for every 10 samples

- One laboratory matrix/matrix spike sample for every 20 samples

In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
- Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures—calibrate instruments at the beginning of each day, verify the calibration at the end of each day, and record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for equipment decontamination

11 REFERENCES

USEPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (September 1986).

USEPA. 1991. *Handbook Groundwater, Volume II Methodology*, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July 1991).

USEPA Region I. 2017. *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

U.S. Geological Survey (USGS). 1977. *National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination*. Reston, Virginia.

12 ATTACHMENTS

A. Low-Flow Sampling Field Form

GROUNDWATER SAMPLING FORM

ARCADIS

Page ____ of ____

Project No. ____________ Well ID ____________ Date ____________

Project Name/Location ____________ Weather ____________

Measuring Pt. Description ____________ Screen Setting (ft-bmp) ____________ Casing Diameter (in.) ____________ Well Material ____ PVC ____ SS

Static Water Level (ft-bmp) ____________ Total Depth (ft-bmp) ____________ Water Column (ft) ____________ Gallons in Well ____________

MP Elevation ____________ Pump Intake (ft-bmp) ____________ Purge Method: ____________ Sample Method ____________

Centrifugal ____________

Submersible ____________

Other ____________

Pump On/Off ____________

Sample Time: ____________ Volumes Purged ____________

Purge Start ____________ Gallons Purged ____________ Sample ID ____________ Sampled by ____________

Purge End ____________ Replicate/Code No. ____________

Time	Minutes Elapsed	Rate (gpm)/(mL/min) 200mL/min +	Depth to Water (ft) -0.3	Gallons Purged	pH ± 0.1	Cond. (µMhos)/(mS/cm) ± 3%	Turbidity (NTU) ± 10%	DO (mg/L) ± 10%	Temp. (°C)/(°F) ± 3%	Redox (mV) ± 10mV	Appearance	
											Color	Odor
Stabilization Calculations (±)												
Stabilization Criteria					**± 0.1 s.u.**	**±3%**	**± 10% or within 1 NTU (1)**	**± 10%**	**±3%**	**±10 mV**		

(1) **Turbidity** < 50 NTU and ±10% or within 1 NTU of a previous reading when <10 NTU

Constituents Sampled	**Container**	**Number**	**Preservative**

Comments ____________

____

Well Casing Volumes

Gallons/Foot	*1" = 0.04*	*1.5" = 0.09*	*2.5" = 0.26*	*3.5" = 0.50*	*6" = 1.47*
	1.25" = 0.06	*2" = 0.16*	*3" = 0.37*	*4" = 0.65*	

Well Information

Well Location: ____________ Well Locked at Arrival: Yes / No

Condition of Well: ____________ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well:

Appendix F

Sampling Analysis Plan and Quality Assurance Project Plan

Chevron Environmental Management Company

SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

Temple Distributing Carson Oil Site
808 South Columbus Avenue
Goldendale, Washington
Cleanup Site ID: 11985
Facility Site ID: 95474961

May 19, 2022

SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

Temple Distributing Carson Oil Site
808 South Columbus Avenue
Goldendale, Washington
Cleanup Site ID: 11985
Facility Site ID: 95474961

May 19, 2022

Prepared By:
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Our Ref:
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Eric Epple
Project Manager

Paul T. McCullough

Paul McCullough, P.E.
Principal Environmental Engineer

Contents

Tables

Attachment 1

1 Introduction

On behalf of Chevron Environmental Management Company (CEMC), Temple Distributing, Temple Family Credit Shelter Trust, and Temple Family Survivor Trust, collectively referred to as the Potentially Liable Parties (PLPs), Arcadis U.S., Inc. (Arcadis) prepared this Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) for the Temple Distributing Carson Oil Site, located at 808 South Columbus Avenue in Goldendale, Washington (Site). This SAP/QAPP is an appendix to the Draft Interim Action Work Plan (Draft IAWP; Arcadis 2021) which is being prepared pursuant to the terms of Enforcement Order No. DE 14134, effective April 28, 2017, issued by the Washington State Department of Ecology (Ecology [2017]).

1.1 Purpose and Objectives

The purpose of this SAP/QAPP is to outline the specific procedures for the sampling and monitoring activities described in the Draft IAWP and to identify the quality assurance requirements for the sampling and laboratory analysis in compliance with Model Toxics Control Act (MTCA) regulations for sampling and analysis plans (WAC 173-340-820).

1.2 Document Organization

This SAP/QAPP is organized into the following sections:

Section 1 – Introduction. Describes the scope and purpose of this document.

Section 2 – Field Sampling Plan (FSP). Describes the sampling methodology for the field sampling and monitoring activities.

Section 3 – QAPP. Describes the quality assurance (QA) procedures for the field activities and laboratory analyses.

1.3 Roles and Responsibilities

Chevron Project Manager – James Kiernan: CEMC’s representative for the site.

Arcadis Project Manager – Steve Mahony: Responsible for providing technical oversight and reviewing all activities performed to verify that project objectives are met.

Health and Safety Officer – To be determined (TBD): Responsible for overseeing project health and safety issues and implementing corrective actions as needed.

Arcadis Field Lead – TBD: Responsible for overseeing sampling activities to verify that all field and analytical objectives are in compliance with this SAP.

Arcadis Field Personnel – TBD: Responsible for implementing the activities described in this SAP.

Ecology-Certified Laboratory – Pace Analytical Laboratories, Inc. (Pace) located in Mt. Juliet, Tennessee: Responsible for providing the analytical testing specified in this SAP.

2 Field Sampling Plan

2.1 Scope of Work

The proposed activities are described in the Draft IAWP and listed below. The IAWP activities are as follows:

1. Decommissioning of monitoring wells MW-3 and MW-4.
2. Excavation in the vicinity of historical soil sampling locations SB-24, SB-25, SB-29, SB-40, B-13, B-14, SB-1, SB-36, SB-39, B-10, MW-3, B-11, MW-4, SB-16, SB-17, B-7, and SB-6.
3. Installation of additional monitoring wells MW-3A, MW-4A, and MW-10.
4. Long-term groundwater gauging and sampling.

2.2 Sampling Objectives

The objectives of the soil and groundwater activities are presented below:

- Reduce the groundwater cleanup timeframe and the potential for direct soil contact by human and ecological receptors by excavating and disposing of Site soil containing the highest concentrations of petroleum constituents.
- Obtain the additional data necessary to further evaluate the potential groundwater exposure pathway at the Site.

2.3 Sampling Methodology

The sampling methodology was developed to collect data that are of sufficient quality to meet the objectives presented in Section 2.2. The sample collection techniques and specific sampling procedures will follow the methods presented in the Technical Guidance Instructions (TGIs) provided in Attachment 1.

2.3.1 Utility Locate

Prior to all intrusive subsurface activities, Arcadis will contact the Northwest Utility Location Center serving Klickitat County, Washington a minimum of 48 hours prior to initiating the field activities. A private utility locating company will also be subcontracted by Arcadis to conduct a utility scan that will include the use of ground-penetrating radar to confirm that the proposed investigation locations are clear of underground utilities or other obstructions. A third-line of evidence to clear the locations of utilities prior to drilling will include clearing the boreholes a minimum of 110% of the diameter of the intrusive device (e.g., hollow-stem auger) or an additional 2-inches of overall diameter, whichever is greater, to a minimum depth of 5-feet below ground surface. Boreholes will be cleared using soft-digging methods (e.g., air knife and/or vacuum excavation).

2.3.1.1 Monitoring Well Installation and Development

Arcadis will install monitoring wells as described in the Draft IAWP. Monitoring wells will be installed and developed according to the methodology presented in the TGIs for Monitoring Well Installation and Monitoring Well Development (Attachment 1).

2.3.1.2 Subsurface Soil Sampling

Arcadis will collect soil samples as described in the Draft IAWP. Soil samples will be collected according to the methodology presented in the TGI for Soil Drilling and Sample Collection (Attachment 1).

- Arcadis field staff will conduct field screening which will include visual observation and using a photoionization detector (PID) to measure VOCs according to the TGI for Soil Drilling and Sample Collection (Attachment 1). All sampling field activity and data will be recorded on field sampling logs. Samples will be labeled and shipped using the procedures described in the Arcadis Standard Operating Procedure (SOP) for Sample Chain of Custody (Attachment 1).

- Samples will be submitted to Pace for analysis as described in the Draft IAWP.

2.3.1.3 Groundwater Sampling

Arcadis will collect groundwater samples from Site groundwater monitoring wells as described in the Draft IAWP. Groundwater samples will be collected according to the methodology presented in the TGI for Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells (Attachment 1).

- Samples will be submitted to Pace for analysis as described in the Draft IAWP.

2.4 Quality Assurance/Quality Control Samples

The following QA samples will be collected during implementation of the sampling program.

- One duplicate sample per 10 field samples collected per medium (e.g., one duplicate collected for soil, one duplicate collected for groundwater). Field duplicate samples will be sequentially numbered and for the purposes of laboratory analysis and chain-of-custody there will be no identifying markers of duplicate samples.
- One matrix spike/matrix spike duplicate per 20 field samples.
- One rinsate blank sample per day for decontaminated, non-dedicated sampling equipment, as needed.

- One trip blank per cooler containing samples that will be analyzed for volatile compounds.

2.5 Sample Nomenclature

Samples will be identified with a unique alpha-numeric code that will identify the type of sample and the location where the sample was collected.

The following sample identification will be used:

- Soil samples will be labeled with the prefix “MW-“and will include the boring identification number and depth. For example, a soil sample collected from monitoring well MW-1 at a depth of 5 feet would be labeled MW-1-5.
- Groundwater samples will be labeled with the monitoring well designation and the date of sample collection (MW-X-YYYYMMDD).
- QA samples will be given the following labels:
- Field duplicate samples will be given the prefix “DUP-“followed by the matrix, and the date the sample was collected. For example, a field duplicate for a soil sample collected on September 15, 2021, would be labeled DUP-S-09152.
- Trip blank samples will be given the prefix “TB-“ followed by the date the sample was collected. For example, a trip blank sample collected on September 15, 2021, would be labeled TB-091521.

2.6 Sample Labeling, Handling, and Chain of Custody

Sampling packaging and shipping will be in accordance with the procedures outlined in the Arcadis SOP for Sample Chain of Custody (Attachment 1). All sample container labels will be completed with the following information:

Project name and project number
Sample designation
Name or initials of the sampler
Date and time of sample collection

2.7 Equipment Decontamination

Equipment decontamination will be performed using the procedures outlined in the TGI for Groundwater and Soil Sampling Equipment Decontamination (Attachment 1). Site personnel will perform decontamination of all equipment prior to removal from the Site, between borehole locations, and between borehole sample intervals.

2.8 Investigation-Derived Waste Management

All soil, water, decontamination liquids, personal protective equipment (PPE), and other investigation-derived waste (IDW) generated during the field sampling activities will be managed in accordance with applicable local, state, and federal requirements. IDW will be managed in accordance with the procedures outlined in the TGI for Investigation-Derived Waste Handling and Storage (Attachment 1).

Waste profiles will be generated for each waste stream to be transported off-site as required by the selected disposal facility. Disposal characterization samples will be collected as needed to meet facility requirements.

3 Quality Assurance Project Plan

3.1 Objective

The objective of this SAP/QAPP is to document the planning, implementation, and assessment procedures for the planned compliance monitoring and sampling activities described in the Draft IAWP. The SAP/QAPP also documents the QA/QC activities that will be performed to confirm that the data collected are of known and acceptable quality. The analytical methods and procedures used to analyze samples will be summarized in laboratory reports.

3.2 Quality Assurance Indicators

QA indicators are generally defined in terms of six parameters: representativeness, comparability, sensitivity, completeness, precision, and accuracy. Representativeness is the degree to which the sampling data accurately and precisely represent the site conditions. Comparability is the degree of confidence with which one data set can be compared to another. The remaining four parameters are described below.

3.2.1 Completeness

Completeness is defined as a measure of the amount of valid data obtained from the sampling event compared to the total amount of data that was obtained. Completeness of a field or laboratory data set will be calculated by comparing the number of valid sample results generated to the total number of results generated.

$$Completeness = \frac{Number\ of\ Valid\ Results}{Total\ Number\ of\ Results\ Generated} x\ 100$$

The completeness acceptance criterion for samples collected in the field will be 90% of the quantity of samples planned for collection. Corrective action may be implemented to recollect samples where necessary and possible (e.g., modifying a planned sample location, addressing sample jars broken during shipment). Laboratory notification of sample receipt and conditions will be used to determine, as soon as possible, whether any problems during sample shipment would necessitate recollection of samples.

3.2.2 Precision

Precision is a measure of the reproducibility of sample results. To maximize precision, sampling and analytical procedures will be followed. Checks for precision will include the analysis of laboratory duplicates and field duplicates. Checks for field measurement precision will include duplicate field measurements. Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements.

Field duplicates will be used to assess precision for the entire measurement system, including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision will be monitored through the use of laboratory duplicate sample analyses.The precision of data will be measured by calculation of the relative percent difference (RPD) using the following equation:

$$RPD = \frac{|A - B| \times 100}{(A + B)/2}$$

Where:

A = Analytical result from one of two duplicate measurements

B = Analytical result from the second measurement

For laboratory duplicate analyses, RPD will meet the laboratory-specific limit. Field duplicate RPD criteria are ≤35% for aqueous samples and ≤50% for soil and soli vapor samples.

3.2.3 Accuracy

Accuracy is a measure of how close a measured result is to the true value. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, reference standards, matrix spikes (MSs), blank spikes, and surrogate standards will be used to assess the accuracy of the analytical data.

The accuracy of field measurements will be controlled by using experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs. Laboratory accuracy will be assessed through the use of MS, surrogate spikes and laboratory control samples. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated in terms of percent recovery as follows:

$$Percent\ Recovery = \frac{(A - X) \times 100}{B}$$

Where:

A = Value measured in spiked sample or standard

X = Value measured in original sample

B = True value of amount added to sample or true value of standard

This formula is derived under the assumption of constant accuracy between the original and spiked measurements.

3.2.4 Sensitivity

Sensitivity is a quantitative measurement to determine if the analytical laboratory’s procedures/methodologies and their associated limits of quantitation (LOQs) can satisfy the project requirements as they relate to the project action limits. The table below outlines the specific Pace LOQs and the associated MTCA Method A Cleanup Levels (CULs) for proposed site soil and groundwater analytes outlined in the Draft IAWP:

Table 3-2 Sensitivity Limits of Quantitation Values - Soil

Analyte	**Soil**			
	Analytical Method	Pace LOQ (mg/kg)	MTCA Method A CUL (mg/kg)	MTCA Method B CUL* (mg/kg)
Total Petroleum Hydrocarbons				
TPH-GRO	NWTPH-Gx	2.5	30	-
TPH-DRO	NWTPH-Dx-NO SGT	4	2,000	-
TPH-HO	NWTPH-Dx-NO SGT	10	2,000	-
Volatile Organic Compounds				
Benzene	EPA 8260	0.001	0.03	-
Toluene	EPA 8260	0.005	7	-
Ethylbenzene	EPA 8260	0.0025	6	-
Xylenes, total	EPA 8260	0.0065	9	-
1,2-Dibromoethane (EDB)	EPA 8260	0.0025	0.005	-
cPAHs				
Benzo(a)anthracene	EPA 8270 SIM	0.006	--	--
Benzo(b)fluoranthene	EPA 8270 SIM	0.006	--	--
Benzo(k)fluoranthene	EPA 8270 SIM	0.006	--	--
Benzo(a)pyrene	EPA 8270 SIM	0.006	0.1	--
Chrysene	EPA 8270 SIM	0.006	--	--
Dibenz(a,h)anthracene	EPA 8270 SIM	0.006	--	--
Indeno(1,2,3-cd)pyrene	EPA 8270 SIM	0.006	--	--
PAHs				
Acenaphthene	EPA 8270	0.0333	--	4800

Analyte	Soil			
	Analytical Method	Pace LOQ (mg/kg)	MTCA Method A CUL (mg/kg)	MTCA Method B CUL* (mg/kg)
Acenaphthylene	EPA 8270	0.0333	--	--
Anthracene	EPA 8270	0.0333	--	24,000
Benzo(g,h,i)perylene	EPA 8270	0.0333	--	--
Fluoranthene	EPA 8270	0.0333	--	3,200
Fluorene	EPA 8270	0.0333	--	3,200
Pyrene	EPA 8270	0.0333	--	2,400
Naphthalene	EPA 8270	0.0333	5	-
1-methylnaphthalene	EPA 8270	0.02	--	34
2-methylnaphthalene	EPA 8270	0.02	--	320
Metals				
Lead, total	EPA 6010D	0.5	250	--

-- = Not applicable / No Established MTCA CUL; * = Most conservative Method B CUL

Table 3-3 Sensitivity Limits of Quantitation Values - Groundwater

Analyte	Groundwater			
	Analytical Method	Pace LOQ (µg/L)	MTCA Method A CUL (µg/L)	MTCA Method B CUL* (µg/L)
Total Petroleum Hydrocarbons				
TPH-GRO	NWTPH-Gx	100	800	--
TPH-DRO	NWTPH-Dx-NO SGT	100	500	--
TPH-HO	NWTPH-Dx-NO SGT	250	500	--

Analyte	Groundwater			
	Analytical Method	Pace LOQ (µg/L)	MTCA Method A CUL (µg/L)	MTCA Method B CUL* (µg/L)
Volatile Organic Compounds				
Benzene	EPA 8260	1	5	--
Toluene	EPA 8260	1	1,000	--
Ethylbenzene	EPA 8260	1	700	--
Xylenes, total	EPA 8260	3	1,000	--
1,2-Dibromoethane (EDB)	EPA 8011	0.005	0.01	--
cPAHs				
Benzo(a)anthracene	EPA 8270 SIM	0.05	--	--
Benzo(b)fluoranthene	EPA 8270 SIM	0.05	--	--
Benzo(k)fluoranthene	EPA 8270 SIM	0.05	--	--
Benzo(a)pyrene	EPA 8270 SIM	0.05	0.1	--
Chrysene	EPA 8270 SIM	0.05	--	--
Dibenz(a,h)anthracene	EPA 8270 SIM	0.05	--	--
Indeno(1,2,3-cd)pyrene	EPA 8270 SIM	0.05	--	--
PAHs				
Acenaphthene	EPA 8270 SIM	0.05	--	480
Acenaphthylene	EPA 8270 SIM	0.05	--	--
Anthracene	EPA 8270 SIM	0.05	--	2400
Benzo(g,h,i)perylene	EPA 8270 SIM	0.05	--	--
Fluoranthene	EPA 8270 SIM	0.1	--	640
Fluorene	EPA 8270 SIM	0.05	--	320
Pyrene	EPA 8270 SIM	0.05	--	240

Analyte	**Groundwater**			
	Analytical Method	Pace LOQ (µg/L)	MTCA Method A CUL (µg/L)	MTCA Method B CUL* (µg/L)
Naphthalene	EPA 8270 SIM	0.25	160	--
1-methylnaphthalene	EPA 8270 SIM	0.25	---	1.5
2-methylnaphthalene	EPA 8270 SIM	0.25	--	32
Metals				
Lead, total	EPA 6010D	6	15	--

-- = Not applicable / No Established MTCA CUL; * = Most conservative Method B CUL

3.3 Laboratory Quality Control

Internal laboratory QC checks will be used to monitor data integrity. These checks will include method blanks, laboratory control samples, internal standards, surrogate samples, and calibration standards.

3.3.1 Method Blanks

Sources of contamination in the analytical process, whether specific analyses or interferences, must be identified, isolated, and corrected. The method blank is useful in identifying possible sources of contamination within the analytical process. For this reason, it is necessary that the method blank be initiated at the beginning of the analytical process and encompass all aspects of the analytical work. As such, the method blank would assist in accounting for any potential contamination attributable to glassware, reagents, instrumentation, or other sources that could affect sample analysis. One method blank will be analyzed with each analytical series associated with no more than 20 samples.

3.3.2 Laboratory Control Samples

Laboratory Control Samples (LCS) are standards of known concentration and are independent in origin from the calibration standards. The intent of LCS analysis is to provide insight into the analytical proficiency within an analytical series. This includes preparation of calibration standards, validity of calibration, sample preparation, instrument set-up, and the premises inherent in quantitation. Reference standards will be analyzed at the frequencies specified within the analytical methods.

3.3.3 Surrogate Spikes

Surrogates are compounds that are unlikely to occur under natural conditions but that have properties similar to the analytes of interest. This type of control is primarily used for organic samples analyzed by gas chromatography/mass spectrometry (GC/MS) and GC methods and is added to the samples prior to purging or extraction. The surrogate spike is utilized to provide broader insight into the proficiency and efficiency of an analytical method on a sample-specific basis. This control reflects analytical conditions that may not be attributable to sample matrix.

If surrogate spike recoveries exceed specified QC limits, the analytical results must be evaluated thoroughly in conjunction with other control measures. In the absence of other control measures, the integrity of the data may not be verifiable, and re-analysis of the samples with additional control may be necessary.

Surrogate spike compounds will be selected utilizing the guidance provided in the analytical methods.

3.3.4 Laboratory Duplicates

Laboratory duplicates will be analyzed to assess laboratory precision. Laboratory duplicates are defined as a separate aliquot of an individual sample that is analyzed as a separate sample.

3.3.5 Calibration Standards

Calibration check standards analyzed within a particular analytical series provide insight regarding instrument stability. A calibration check standard will be analyzed at the beginning and end of an analytical series, or periodically throughout a series containing a large number of samples.

In general, calibration check standards will be analyzed after every 12 hours or more frequently, as specified in the applicable analytical method. If results of the calibration check standard exceed specified tolerances, samples analyzed since the last acceptable calibration check standard will be re-analyzed.

3.4 Field Instruments and Equipment

Prior to field sampling, each piece of field equipment will be inspected to confirm that it is operational and calibrated in accordance with the manufacturer's instruction manual or the analytical method used. All meters that require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, the maintenance arrangements will be made for timely service. Field instruments will be maintained according to the instructions provided by the manufacturer.

Logbooks will be kept for each field instrument. Logbooks will contain records of operation, maintenance, calibration, and any problems and repairs. Logbooks for each piece of equipment will be maintained in project records.

3.5 Laboratory Instruments and Equipment

Laboratory instrument and equipment documentation procedures include details of any observed problems, corrective measure(s), routine maintenance, and instrument repair (including information regarding the repair and the individual who performed the repair). Preventive maintenance of laboratory equipment generally will follow the guidelines recommended by the manufacturer. Paperwork associated with service calls and preventative maintenance calls will be kept on file by the laboratory.

The laboratory manager will be responsible for the routine maintenance of instruments used in the particular laboratory. Any routine preventative maintenance carried out is logged into the appropriate logbooks. The frequency of routine maintenance is dictated by the nature of samples being analyzed, the requirements of the method used, and/or the judgment of the laboratory manager.

All major instruments are backed up by comparable (if not equivalent) instrument systems in the event of unscheduled downtime.

3.6 Assessment and Response Actions

Performance and systems audits may be completed in the field and laboratory. Field performance audit summaries will contain an evaluation of field activities to verify that the activities are performed according to established protocols. The observations made during field performance audits and any recommended changes/deviations to the field procedures will be recorded and documented. In addition, systems audits comparing scheduled QA/QC activities with actual QA/QC activities completed will be performed. The audits will be performed periodically as required by the task needs and duration.

3.7 Data Management

The purpose of data management is to confirm that the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The field activities will include a significant number of samples that require a structured, comprehensive, and efficient program for management of data.

3.7.1 Field Data Management

Field activities require consistent documentation and accurate record keeping. Complete and accurate record keeping will be maintained, including field books, digital field forms, and chain of custody forms. Field books or digital field forms will detail observations and measurements made during the site work. Data will be recorded directly into digital field forms.

Chain of custody forms will be used to document and track sample possession. A chain of custody form will accompany each field sample collected, and one copy of the form will be filed in the field office. Field personnel are trained on the proper use of the chain of custody procedure.

All field documentation will be scanned and saved to the Arcadis electronic project folder. Hard copies will be stored in the Arcadis Seattle, Washington office.

3.7.2 Analytical Data Management

Chain of custody documentation, sample receipt information, and analytical data packages received from the laboratory will be reviewed to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis were received. Any discrepancies noted will be promptly corrected in coordination with the laboratory.

All data will be housed in a project database. The project database will include pertinent geographical, field, and analytical data. Information that will be used to populate the database will be derived from the surveying of sampling locations, field observations and analytical results. The project database will be backed up on a weekly basis at minimum or whenever major modifications are made. Access to the database will be limited to authorized project personnel.

3.8 Sample Designation System

A concise and easily understandable sample designation system will be used to facilitate sample tracking and management. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample ID for each field sample collected, as outlined in Section 2.5.

3.9 Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this document. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. All corrective actions for situations including analytical or field equipment malfunctions, nonconformance or noncompliance with the QA requirements, or changes to the sampling procedures will be documented with the project records and maintained in the project file. All corrective action procedures must be initiated prior to continuing with the field or analytical procedure.

3.10 Laboratory Reports

The laboratory will maintain QA records related to analyses, QC, and corrective action. This information will be made available upon request. Routine reporting will include documenting all internal QC checks performed for the project.

3.11 Data Validation and Verification

Data validation entails a review of the QC data and the raw data to verify that the laboratory was operating within required limits; and which, if any, environmental samples were related to out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements.

Data validation during this project will be performed consistent with USEPA Stage 2B criteria, which involves completeness and compliance checks of sample receipt conditions and sample-related and instrument-related quality control results. Data validation on this project will be completed by a qualified chemist or environmental scientist and will be documented in a data validation report that will be appended to the interim action completion report.

Data collected as part of these activities will be uploaded in Ecology’s EIM database. Data will be presented in tables showing laboratory results compared to applicable MTCA CULs.

Attachment 1

Arcadis Technical Guidance Instructions

TGI - MONITORING WELL INSTALLATION

Rev #: 0

Rev Date: April 24, 2017

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/24/2017	All	Re-written as a TGI	Marc Killingstad Peter C. Frederick

APPROVAL SIGNATURES

Prepared by: Jay Erickson — Date: 4/20/17

Technical Expert Reviewed by: Marc Killingstad — Date: 4/24/17

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to any and all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) describes methods used to install groundwater monitoring wells in granular aquifers. It is assumed that the monitoring well has been properly designed, including sizing of the filter pack and screen, the length of the screen, total depth of the well, material strength and compatibility and surface completion. Typical monitoring wells are constructed of manufactured screen and engineered filter pack and are generally suitable for formations with granular materials having a grain size distribution with up to 50% passing a #200 sieve and up to 20% clay-sized material. Monitoring wells installed in formations finer than this may not be able to produce turbidity free water.

The monitoring well installation procedures set forth herein are consistent with the approach and methods presented in the American Society of Testing and Materials (ASTM) D5092 – *Standard Practice for Design and Installation of Groundwater Monitoring Wells* (ASTM D5092). As such, following this TGI in combination with proper well design (see appropriate TGI), well development (see appropriate TGI), groundwater sampling procedures (see appropriate TGI), and well maintenance and rehabilitation (see appropriate TGI), will result in a monitoring well suitable for: (1) collection of groundwater samples representative of the surrounding formation and free of artificial turbidity; (2) measurement of accurate groundwater levels; and (3) hydraulic conductivity testing of formation sediments immediately adjacent to the open interval of the well (e.g., slug testing).

Monitoring well boreholes in unconsolidated (overburden) materials are typically drilled using the hollow-stem auger drilling method. Other drilling methods that are also suitable for installing overburden monitoring wells, and are sometimes necessary due to site-specific geologic conditions or project objectives, include: drive-and-wash, spun casing, Rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and driven well points may also be used in some cases within the overburden. Monitoring wells to be installed within consolidated materials such as fractured bedrock are commonly drilled using water-rotary (coring or tri-cone roller bit), air rotary or Rotasonic methods. For guidance when installing monitoring wells in consolidated materials, please refer to the appropriate document. The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling/well depths, site or regional geologic knowledge, type of monitoring to be conducted using the installed well, project objectives, and cost.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools). No polyvinyl chloride (PVC) glue/cement will be used in constructing or retrofitting monitoring wells that will be used for water-quality monitoring. No coated bentonite pellets will be used in the well drilling or construction process. Specifications of materials to be installed in the borehole will be obtained prior to mobilizing onsite; these materials generally include:

- Well casing (length, material, and diameter);
- Well screen (length, material, diameter, and slot size);
- Bentonite (type, as applicable, chips, non-coated and granular bentonite are acceptable);
- Filter pack (filter pack type and fine sand seal type, as applicable); and
- Grout (type, as applicable).

Well materials will be inspected and, if needed, cleaned or replaced prior to installation.

3 PERSONNEL QUALIFICATIONS

Monitoring well installation activities will be performed by persons who have been trained in proper well installation procedures under the guidance of an experienced field geologist, engineer, or technician. Where field sampling is performed for soil or bedrock characterization, field personnel will have undergone in-field training in soil or bedrock description methods, as described in the appropriate Standard Operating Procedures (SOPs) and/or TGIs for those activities.

4 EQUIPMENT LIST

The following materials will be available during soil boring and monitoring well installation activities, as required:

- Site Plan with proposed soil boring/well locations;

- Work Plan (or equivalent), Field Sampling Plan (FSP), and site-specific Health and Safety Plan (HASP);
- Personal protective equipment (PPE), as required by the HASP;
- Traffic cones, delineators, caution tape, and/or fencing as appropriate for securing the work area, if such are not provided by drillers;
- Appropriate soil sampling equipment (e.g., stainless steel spatulas, knife);
- Soil and/or bedrock logging equipment as specified in the appropriate project documents;
- Appropriate sample containers and labels;
- Drum labels as required for investigation derived waste handling;
- Chain-of-custody forms;
- Insulated coolers with ice, when collecting samples requiring preservation by chilling;
- Photoionization detector (PID) or flame ionization detector (FID);
- Ziplock style bags;
- Water level or oil/water interface meter;
- Locks and keys for securing the well after installation;
- Decontamination equipment (bucket, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels);
- Engineer’s tape/measuring wheel;
- Weighted tape;
- Disposable bailers;
- Digital camera (or phone with camera)
- Field notebook or Personal Digital Assistant (PDA); and
- Appropriate field forms, consider including a photo of the well head and a Google Earth map showing the well location.

Prior to mobilizing to the site, Arcadis personnel will contact the drilling subcontractor or in-house driller (as appropriate) to confirm that appropriate sampling and well installation equipment will be provided. Specifications of the sampling and well installation equipment are expected to vary by project, and so communication with the driller is necessary to ensure that the materials provided will meet the project objectives. Equipment/materials typically provided by the driller could include:

- Drilling equipment required by the ASTM standard guidance document D1586, when performing split-spoon sampling;
- Disposable plastic liners (when drilling with direct-push equipment);
- Drums for investigation derived waste;

- Drilling and sampling equipment decontamination materials;
- Decontamination pad materials, if required; and
- Well construction materials.

5 CAUTIONS

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See appropriate guidance for proper utility clearance protocol.

Prior to beginning field work, contact the project technical team to ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members.

Some regulatory agencies require a minimum annular space between the well or permanent casing and the borehole wall. When specified, the minimum clearance is typically 2 inches on all sides (e.g., a 2-inch diameter well requires a 6-inch diameter borehole). In addition, some regulatory agencies have specific requirements regarding grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the drilling and well installation plan.

If dense non-aqueous phase liquids (DNAPL) are known or expected to exist at the site, refer to the project specific documents for additional details regarding drilling and well installation to reduce the potential for inadvertent DNAPL remobilization.

Similarly, if light non-aqueous phase liquids (LNAPLs) are known or expected to be present as “perched” layers above the water table, refer to the DNAPL Contingency Plan. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Similarly, consider the compatibility between the well materials and the surrounding environment. For example, PVC well materials are not preferred when DNAPL is present. In addition, some groundwater conditions leach metals from stainless steel or are corrosive to metal well materials. If questions arise, contact the CPM and/or project technical lead to discuss.

Water used for drilling and sampling of soil or bedrock, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply should be considered.

Specifications of materials used for backfilling the borehole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPLs are likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.

As noted above, coated bentonite pellets will not be used in monitoring well construction, as the coating could impact the water quality in the completed well.

Heat of hydration during neat cement grout curing must be considered to avoid damage to PVC well materials. The annular space for a typical monitoring well is small enough that heat of hydration should not create excessive temperature increases which may damage PVC well material. However, washouts in the borehole can lead to thick accumulations of grout which can produce enough heat during curing to weaken and potentially damage PVC casing. If heat of hydration is a concern, contact the project technical lead to address the issue.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well installation will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

7 PROCEDURE

The procedures for installing groundwater monitoring wells are presented below:

Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Prior to monitoring well installation, determine the expected volumes of filter pack and seal materials including bentonite (if applicable) and grout (neat cement or cement-bentonite).

2. Locate boring/well location, establish work zone, and set up sampling equipment decontamination area.

3. Advance boring to desired depth. Collect soil and/or bedrock samples at appropriate interval as specified in the Work Plan (or equivalent) and/or FSP. Collect, document, and store samples for laboratory analysis as specified in the Work Plan and/or FSP. Decontaminate equipment between samples in accordance with the Work Plan (or equivalent) and/or FSP. A common sampling method that produces high-quality soil samples with relatively little soil disturbance is described in ASTM D1586 – *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils* (ASTM D1586). Split-spoon samples are obtained during drilling using hollow-stem auger, drive-and-wash, spun casing, and fluid/mud rotary. Rotasonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks. Dual-rotary removes cuttings by compressed air or water/mud and allow only a general assessment of geology.

4. Describe each soil sample as outlined in the appropriate project records. Record descriptions in the field notebook and/or personal digital assistant (PDA). It is also beneficial to photo document the samples. It should be noted that PDA logs must be electronically backed up and transferred to a location accessible to other project team members as soon as feasible to retain and protect the field data. During soil boring advancement, document all drilling events in field notebook, including blow counts (number of blows required to advance split-spoon sampler in 6-inch increments) and work stoppages. Blow counts will not be available if Rotasonic, dual-rotary, or direct-push methods are used.

5. If it is necessary to install a monitor well into a permeable zone below a confining layer, particularly if the deeper zone is believed to have water quality that differs significantly from the zone above the confining layer, then a telescopic well construction should be considered. In this case, the borehole is advanced approximately 3 to 5 feet into the top of the confining layer, and a permanent casing (typically PVC, black steel or stainless steel) is installed into the socket drilled into the top of the confining layer. The casing is then grouted in place. The preferred methods of grouting telescoping casings include: pressure-injection grouting using an inflatable packer installed temporarily into the base of the casing, such that grout is injected out the bottom of the casing until it is observed at ground surface outside the casing; displacement-method grouting (also known as the Halliburton method), which entails filling the casing with grout and displacing the grout out the bottom of the casing by pushing a drillable plug, typically made of wood to the bottom of the casing, following by tremie grouting the remainder of the annulus outside the casing; or tremie grouting the annulus surrounding the casing using a tremie pipe installed to the base of the borehole. In all three cases, the casing is grouted to the ground surface, and the grout is allowed to set prior to drilling deeper through the casing. Site-specific criteria and work plans should be created for the completion of non-standard monitoring wells, including telescopic wells.

6. Before installing a screened, it is important to confirm that the borehole has been advanced into the targeted saturated zone. This is particularly important for wells installed to monitor the water table and/or the shallow saturated zone, as the capillary fringe may cause soils above the water table to appear saturated. If one or more previously installed monitoring wells exist nearby, use the depth to water at such well(s) to estimate the water-table depth at the new borehole location.

   To verify that the borehole has been advanced into the saturated zone, it is necessary to measure the water level in the borehole. For boreholes drilled without using water (e.g., hollow-stem auger, cable-tool, air rotary, air hammer), verify the presence of groundwater (and /or LNAPL, if applicable) in the borehole using an electronic water level probe, oil-water interface probe, or a new or decontaminated bailer. For boreholes drilled using water (e.g., drive and wash, spun-casing with roller-bit wash, Rotasonic, or water rotary with core or roller bit), monitor the water level in the borehole as it re-equilibrates to the static level. In low-permeability units like clay, fine-grained glacial tills, shale and other bedrock formations, it may be necessary to wait overnight to allow the water level to equilibrate. Document depth to water in the borehole on the appropriate field forms and field notebook. If there are questions concerning the depth of the well/screen interval, consult with the project technical lead prior to finalizing well depth/screen interval. To the extent practicable, ensure that the depth of the well below the apparent water table is deep enough so that the installed well can monitor groundwater year-round, accounting for seasonal water-table fluctuations. When in doubt, err on the side of slightly deeper well installation.

7. Upon completing the borehole to the desired depth, if a screened well construction is desired, install the monitoring well by lowering the screen and casing assembly with sump through the augers or casing. Monitoring wells typically will be constructed of 2-inch-diameter (although sometimes 4-inch), flush-threaded PVC or stainless steel slotted or wire wrapped well screen and blank riser casing. Smaller diameters may be used if wells are installed using direct-push methodology or if multiple wells are to be installed in a single borehole. The screen length will be specified in the Work Plan (or equivalent) or FSP based on regulatory requirements and specific monitoring objectives. Monitoring well screens are usually 5 to 10 feet long, but may be up to 25 feet long in very low permeability, thick

geologic formations. The screen length will depend on the purpose for the well and the objectives of the groundwater investigation and will (in most cases) be determined prior to the field mobilization.

The slot size and filter pack gradation should be predetermined in the Work Plan (or equivalent) or FSP and based on site-specific grain-size analysis (sieve analysis) or other geologic considerations or monitoring objectives. Typically, slot sizes for monitoring wells will range from 0.010 inches to 0.020 inches while the filter pack will be 20-40, Morie No. 0, or equivalent. In very fine-grained formations where sample turbidity needs to be minimized, it may be preferred to use a 0.006-inch slot size and 30-65, Morie No. 00, or equivalent filter pack. Alternatively, where monitoring wells are installed in coarse-grained deposits and higher well yield is required, a 0.020-inch slot size and 10-20, Morie No. 1, or equivalent filter pack may be preferred. If the screen slot size and filter pack have not been based on site-specific grain-size analysis, consider collecting soil samples during well installation so future wells can be properly designed.

A blank sump may be attached below the well screen if the well is being installed for DNAPL recovery/monitoring purposes. If so, the annular space around the sump may be backfilled with neat cement grout using a tremie to the bottom of the well screen prior to placing the filter pack around the screen. A blank riser will extend from the top of the screen to approximately 2.5 feet above grade or, if necessary, just below grade where conditions warrant a flush-mounted monitoring well. For wells greater than 50 feet deep, centralizers may be desired to assist in centering the monitoring well in the borehole during construction.

8. When the monitoring well assembly has been set in place and the grout has been placed around the sump (if any), place a washed silica filter pack in the annular space from the bottom of the boring to a height of 1 to 2 feet above the top of the well screen (following specifications in the Work Plan) using a tremie. The filter pack is placed and drilling equipment extracted in increments until the top of the sand pack is at the appropriate depth. Verify that the expected volume of filter pack matches with the actual amount installed. There can be differences due to irregularities in the borehole. Washout of the borehole will result in the need for greater than calculated well materials. If a difference of more than 10% is noted, consult with the project technical team. The filter pack will be consistent with the screen slot size and the soil particle size in the screened interval, as specified in the Work Plan (or equivalent) or FSP. The well should be gently surged to prevent filter pack material bridging and to settled the filter pack prior to well seal installation.

9. A hydrated bentonite seal (a minimum of 2 feet thick) will then be placed in the annular space above the sand pack (alternatively, in some cases a fine sand seal may be installed instead of bentonite—follow the specifications in the Work Plan). If non-hydrated bentonite is used, the bentonite should be permitted to hydrate in place for a minimum of 30 minutes before proceeding. *No coated bentonite pellets will be used in monitoring well drilling or construction*. Potable water may be added to hydrate the bentonite if the seal is above the water table. Monitor the placement of the sand pack and bentonite with a weighted tape measure.

10. During the extraction of the augers or casing, a cement/bentonite or neat cement grout will be placed in the annular space from the bentonite seal to a depth approximately 2 ft. below groundwater surface (bgs) or as specified in the Work Plan (or equivalent). As with the filter pack, it is recommended that seal material be placed with a tremie pipe. Ensure that seal materials are mixed at the proper ratios with water following manufacturer’s recommendations.

11. Install the monitoring well completion as specified Work Plan (or equivalent). Typical completions are a locking, steel protective casing (extended at least 1.5 feet below grade and 2 feet above grade) over the riser casing and secure with a neat cement seal. Alternatively, for flush-mount completions, place a steel curb box with a bolt-down lid over the riser casing and secure with a neat cement seal. In either case, the cement seal will extend approximately 1.5 to 2.0 feet below grade and laterally at least 1 foot in all directions from the protective casing, and should slope gently away to promote drainage away from the well.
12. Monitoring wells should be labeled using indelible ink or paint with the appropriate designation on both the inner and outer well casings or inside of the curb box lid.
13. When an above-grade completion is used, the riser will be sealed using an expandable locking plug and the top of the well will be vented by drilling a small-diameter (1/8 inch) hole near the top of the well casing or through the locking plug, or by cutting a vertical slot in the top of the well casing. When a flush-mount installation is used, the riser will be sealed using an unvented, expandable locking plug.
14. During well installation, record construction details and actual measurements relayed by the drilling contractor and tabulate materials used (e.g., screen and riser footages; bags of bentonite, cement, and sand) in the field notebook as well as appropriate field forms.
15. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 7 below.

Direct-Push Method

The direct-push drilling method may also be used to complete soil borings and install monitoring wells. Examples of this technique include the Diedrich ESP vibratory probe system, GeoProbe®, or AMS Power Probe® dual-tube system. Environmental probe systems typically use a hydraulically operated percussion hammer. Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual-tube liner for sampling soil. The outside diameter (OD) of the outer casing ranges from 1.75 to 2.4 inches and the OD of the inner sampling tube ranges from 1.1 to 1.8 inches. The outer casing isolates shallow layers and permits the unit to continue to probe at depth. The double-rod system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, the inside diameter (ID) of the steel casing provides clearance for the installation of small-diameter (e.g., 0.75- to 1-inch ID) micro-wells. The procedures for installing monitoring wells in soil using the direct-push method are described below.

1. Locate boring/well location, establish work zone, and set up sample equipment decontamination area.
2. Advance soil boring to designated depth, collecting samples at intervals specified in the Work Plan (or equivalent). Samples will be collected using dedicated, disposable, plastic liners. Describe samples in accordance with the procedures outlined in Step 3 above. Collect samples for laboratory analysis as specified in the Work Plan (or equivalent) and/or FSP.
3. Upon advancing the borehole to the desired depth, install the micro-well through the inner drill casing. The micro-well will consist of approximately 1-inch ID PVC or stainless steel slotted screen and blank riser. The sand pack, bentonite seal, and cement/bentonite grout will be installed as described, where applicable, in Steps 9 through 11 above.

4. Install protective steel casing or flush-mount, as appropriate, as described in Step 12 above. During well installation, record construction details and tabulate materials used in field notebook as well as appropriate field forms.
5. After completing the well installation, lock the well, clean the area, and dispose of materials in accordance with the procedures outlined in Section 8 below.

Driven Well Point Installation

Well points will be installed by pushing or driving using a drilling rig or direct-push rig, or hand-driven where possible. The well point construction materials will consist of a 1- to 2-inch-diameter threaded steel casing with either 0.010- or 0.020-inch slotted stainless steel screen. The screen length will vary depending on the hydrogeologic conditions of the site. The casings will be joined together with threaded couplings and the terminal end will consist of a steel well point. Because they are driven or pushed to the desired depth, well points do not have annular backfill materials such as sand pack or grout.

8 WASTE MANAGEMENT

Investigation-derived wastes (IDW), including soil cuttings and excess drilling fluids (if used), decontamination liquids, and disposable materials (well material packages, PPE, etc.), will be placed in clearly labeled, appropriate containers, or managed as otherwise specified in the Work Plan (or equivalent), FSP, and/or IDW management guidance document.

9 DATA RECORDING AND MANAGEMENT

Drilling activities should be documented on appropriate field/log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of well installation activities, soil descriptions, well construction specifications (screen and riser material and diameter, sump length, screen length and slot size, riser length, sand pack type), and quantities of materials used. In addition, the locations of newly-installed wells will be documented photographically or in a site sketch. If appropriate, a measuring wheel or engineer’s tape will be used to determine approximate distances between important site features.

The well location, ground surface elevation, and inner and outer casing elevations will be surveyed using the method specified in the site Work Plan (or equivalent). Generally, a local baseline control will be set up. This local baseline control can then be tied into the appropriate vertical and horizontal datum, such as the National Geodetic Vertical Datum of 1929 or 1988 and the State Plane Coordinate System. At a minimum, the elevation of the top of the inner casing used for water-level measurements should be measured to the nearest 0.01 foot. Elevations will be established in relation to the National Geodetic Vertical Datum of 1929. A permanent mark will be placed on top of the inner casing to mark the point for water-level measurements.

10 QUALITY ASSURANCE

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate SOP. Well materials will also be cleaned prior to well installation.

11 REFERENCES

American Society for Testing Materials (ASTM) D5092 - *Standard Practice for Design and Installation of Ground Water Monitoring Wells*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

American Society of Testing and Materials (ASTM) D1586 - *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

TECHNICAL GUIDANCE INSTRUCTION - MONITORING WELL DEVELOPMENT

Rev: #0

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VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	4/24/2017	All	Re-written as TGI	Marc Killingstad

APPROVAL SIGNATURES

Prepared by:	Jay Erickson	Date: 4/24/2017
Technical Expert Reviewed by:	Marc Killingstad	Date: 4/24/2017

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) covers the development of screened wells used for obtaining representative groundwater information and samples from granular aquifers (i.e., monitoring wells). Note that this TGI only applies to monitoring well development and not remediation (injection/extraction) well development.

The purposes of Monitoring Well Development are:

1. Repair damage to the borehole wall from drilling that can include clogging, smearing or compaction of aquifer materials;
2. Remove fine grained sediment from the formation and filter pack that may result in high turbidity levels in groundwater samples;
3. To re-sort formation and filter pack material adjacent to the well screen;

4. To recover any drilling fluids (if used) that may affect the permeability of the formation and filter pack or alter the water quality around the well; and
5. To optimize the well efficiency and hydraulic communication between the well screen and the formation.

Successful monitoring well development is dependent on the following:

1. Hydrostratigraphy – Permeable formations containing primarily sand and gravel are more easily developed due to lower percentages of silt and clay material. Water in permeable formations can be moved in and out of the screen and/or through the formation easier than in less permeable deposits
2. Well Diameter – Development tooling including brushes, surge blocks, pumps and jetting tools are more readily available for wells 4 inches in diameter and greater.
3. Well Design – Wells with filter packs and screens designed to match the formation through the analysis of formation sieve samples are easier to develop. An important aspect to well design is to minimize the size of the annular space between the formation and well screen. Adequate room must be allowed for the proper installation of well materials, but not too large as to prevent/reduce communication with the surrounding formation.
4. Drilling Methods – Different drilling methods result in varying amount of borehole damage and, therefore, impact the degree to which development will be successful.

Well development methods for monitoring wells include the following:

1. Bailing – use of a bailer to remove water and sediment from the well casing. This technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen.
2. Pumping/overpumping – use of a pump to remove water and sediment from the well casing, overpumping involves pumping the well at a rate that exceeds the design capacity of the well. Similar to bailing, this technique does little to remove fines from the filter pack and may lead to bridging of sediment since the flow in only in one direction, toward the well screen. Small diameter monitoring wells have the additional constraint on pump size and flow rates.
3. Backwashing (rawhiding) – consists of starting and stopping a pump intermittently to produce rapid pressure changes in a well. This method can produce better results than pumping alone since the procedure involves movement of the water in and out of the screen and formation. However, in many cases the surging action is not rigorous enough to fully develop the well.
4. Surging/swabbing – use of a mechanical surge block or swabbing tool to operate like a piston with an up and down motion. The downstroke causes a backwash action that breaks up bridged sediment and the upstroke pulls the dislodged sediment into the well. This method works well for small and large diameter wells. Care should be taken on the downstroke so as not to force fines back into the formation, frequent pumping/purging during surging help to keep fines out of the well. Double surge blocks are recommended.
5. Jetting – use of a tool fitted with nozzles that direct streams of water horizontally into well screens at high velocity. Due to the size of the tooling, this method is better suited for wells 4 inch in diameter and larger. The method is also more effective with wire-wrapped/continuous slot screens due to the

increased open area. Jetting requires specialized equipment and concurrent pumping to prevent reintroducing fines into the filter pack. Additionally, jetting requires subsequent surging to remove fines dislodged in the filter pack and formation.

For most situations, gentle surging coupled with bailing or pumping to remove dislodged materials is recommended.

Well development for properly designed and constructed monitoring wells may begin after the annular seal materials have been installed and allowed to cure, since these wells are designed to retain 90-99% of the filter pack material. This cure time is typically at least 24 to 48 hours after the sealing materials have been installed.

This TGI is meant to provide a general guide for proper monitoring well development. A site-specific field implementation plan for well installation and development detailing the specific methods and tools should be developed to provide site-specific instruction and guidance.

3 PERSONNEL QUALIFICATIONS

Monitoring well development activities will be performed by persons who have been trained in proper well development procedures under the guidance of an experienced field geologist, engineer, or technician.

4 EQUIPMENT LIST

Required equipment depends on the selected method and should be detailed in the site-specific field implementation plan. However, the following are typically required.

- Health and safety equipment, as required by the site Health and Safety Plan (HASP):
- Cleaning equipment
- Field notebook and/or personal digital assistant (PDA)
- Monitoring well keys
- Water level indicator
- Field parameter meter (YSI)
- Well Development Logs
- Well construction logs/diagrams
- Weighted tape (measure depth)
- Turbidity meter
- Camera
- Watch/timing device.

5 CAUTIONS

Where surging is performed to assist in removing fine-grained material from the sand pack, surging must be performed in a gentle manner. Excessive suction could promote fine-grained sediment entry into the outside of the sand pack from the formation.

Avoid using development fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

In some cases, it may be necessary to add potable water to a well to allow surging and development, especially for new monitoring wells installed in low permeability formations. Before adding potable water to a well, the Certified Project Manager (CPM) and/or Project Hydrogeologist must be notified and the CPM shall make the decision regarding the appropriateness and applicability of adding potable water to a well during well development procedures. If potable water is to be added to a well as part of development, the potable water source should be sampled and analyzed for constituents of concern, and the results evaluated by the CPM prior to adding the potable water to the well. If potable water is added to a well for development purposes, at the end of development the well will be purged dry to remove the potable water, or if the well no longer goes dry then the well will be purged to remove at least three times the volume of potable water that was added.

6 HEALTH AND SAFETY CONSIDERATIONS

Field activities associated with monitoring well development will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities.

7 PROCEDURE

As indicated above, for most monitoring wells, gentle surging coupled with bailing or pumping to remove dislodged sediment is recommended.

1. Ensure sufficient time has passed to allow for proper curing of the well seal.
2. Don appropriate PPE (as required by the site-specific HASP).
3. Place plastic sheeting around the well.
4. Clean all equipment entering each monitoring well, except for new, disposable materials that have not been previously used.
5. Open the well cover while standing upwind of the well, remove well cap. Insert PID probe approximately 4 to 6 inches into the casing or the well headspace and cover with gloved hand. Record the PID reading in the field notebook. If the well headspace reading is less than 5 PID units, proceed; if the headspace reading is greater than 5 PID units, screen the air within the breathing zone. If the PID reading in the breathing zone is below 5 PID units, proceed. If the PID reading is above 5 PID units, move upwind from well for 5 minutes to allow the volatiles to dissipate. Repeat the breathing zone test. If the reading is still above 5 PID units, don the appropriate respiratory protection in accordance with the requirements of the HASP. Record all PID readings.

6 Obtain an initial measurement of the depth to water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book. It is recommended to use a weighted tape for the total well depth measurement.

7 The depth to the bottom of the well should be sounded and then compared to the completion form or construction diagram for the well. Any discrepancies should be reported immediately to the CPM and/or Project Hydrogeologist. If sand or sediment is present inside the well, it should first be removed by bailing. Do not insert bailers, pumps, or surge blocks into the well if obstructions, parting of the casing, or other damage to the well is suspected. Instead report the conditions to the CPM and/or Project Hydrogeologist and obtain approval to continue or cease well development activities.

8 Lower a double surge block into the screened portion of the well. Starting from the bottom of the screen using 2 foot throws, gently raise and lower the surge block to force water in and out of the screen slots and sand pack. Continue surging for 15 to 30 minutes.

9 Lower a bottom-loading bailer, submersible pump, or inertia pump tubing with check valve to the bottom of the well and gently bounce on the bottom of the well to collect/remove accumulated sediment, if any. Remove and empty the bailer, if used. Repeat until the bailed/pumped water is free of excessive sediment and contact at the bottom of the well feels solid. Alternatively, measurement of the well depth with a weighted tape can be used to verify that sediment and/or silt has been removed to the extent practicable, based on a comparison with the well installation log or previous measurement of total well depth.

10 After surging the well for a minimum of two cycles and removing excess accumulated sediment from the bottom of the well, re-measure the depth-to-water and the total well depth from the reference point at the top of the well casing. Record these measurements in the field log book.

11 Remove formation water by pumping/bailing. Where pumping is used, measure and record the pre-pumping water level. Operate the pump at a relatively constant rate. Measure the pumping rate using a calibrated container and stop watch, and record the pumping rate in the field log book. Measure and record the water level in the well at least once every 5 minutes during pumping. Note any relevant observations in terms of water color, visual level of turbidity, sheen, odors, etc. Pump or bail until termination criteria specified in the Site-Specific Field Implementation plan are reached. Note: the project-specific field implementation plan may also specify a maximum turbidity requirement for completion of development. Unless otherwise specified the maximum turbidity should be 50 NTUs or less. Record the total volume of water purged from the well.

12 While developing, take periodic water level measurements (at least one every five minutes) to determine if drawdown is occurring and record the measurements on the Well Development Log.

13 While developing, calculate the rate at which water is being removed from the well. Record the volume on the Well Development Log.

14 While developing, water is also periodically collected directly from the well or bailer discharge and readings taken of the indicator parameters: pH, specific conductance, and temperature. Development is considered complete when the indicator parameters have stabilized (i.e., three consecutive pH, specific conductance, and temperature readings are within tolerances specified in the project work plans or within 10% if not otherwise specified), the extracted water is clear and free

of fine sediment and most importantly, when acceptable volume of water has been removed and/or a sufficient amount of surging has been performed.

15 In certain instances, for slow recharging wells, the parameters may not stabilize. In this case, well development is considered complete when minimal amounts of fine-grained sediments are recovered and acceptable volume of water has been removed.

16 If the well goes dry, stop pumping or bailing. Note the time that the well went dry. After allowing the well to recover, note the time and depth to water. Resume pumping or bailing when sufficient water has recharged the well.

17 Contain all development water in appropriate containers.

18 When complete, secure the lid back on the well.

19 Place disposable materials in plastic bags for appropriate disposal and decontaminate reusable, downhole pump components and/or bailer

8 WASTE MANAGEMENT

Materials generated during monitoring well installation and development will be placed in appropriate labeled containers and disposed of as described in the Work Plan/Field Implementation Plan or Field Sampling Plan.

9 DATA RECORDING AND MANAGEMENT

All well development activities should be documented on appropriate log forms as well as in a proper field notebook and/or PDA. Additionally, all documents (and photographs) should be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site; times of arrival and departure; significant weather conditions; timing of well development activities; development method(s); observations of purge water color, turbidity, odor, sheen, etc.; purge rate; and water levels before, during, and after pumping.

10 QUALITY ASSURANCE

All reused, non-disposable, downhole well development equipment should be cleaned in accordance with the procedures outlined in the project documents.

11 REFERENCES

American Society for Testing Materials (ASTM), Designation D5521-05. *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers*. American Society for Testing Materials. West Conshohocken, Pennsylvania.

TGI – SOIL DRILLING AND SAMPLE COLLECTION

Rev #: 1

Rev Date: May 12, 2020

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	Christopher Keen	Date:
Technical Expert Reviewed by:		05/12/2020
	Marc Killingstad (Technical Expert)	Date:

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2 SCOPE AND APPLICATION

This Technical Guidance Instruction (TGI) describes general drilling procedures and the methods to be used to field screen and collect soil samples for laboratory analysis in unconsolidated sediments. For soil description procedures, please refer to the *TGI - Soil Description*. For monitoring well installation in granular aquifers, please refer to the *TGI - Monitoring Well Installation*.

Overburden (unconsolidated sediments) drilling is commonly performed using the hollow-stem auger drilling method. Other drilling methods suitable for overburden drilling, which are sometimes necessary due to site-specific geologic conditions, include: drive-and-wash, spun casing, rotasonic, dual-rotary (Barber Rig), and fluid/mud rotary with core barrel or roller bit. Direct-push techniques (e.g., Geoprobe or cone penetrometer) and hand tools may also be used. Drilling within consolidated materials such as fractured bedrock is commonly performed using water-rotary (coring or tri-cone roller bit), air rotary or rotasonic methods. For guidance when drilling in consolidated materials (i.e., bedrock), please refer to the *TGI – Bedrock Core Collection and Description*.

The drilling method to be used at a given site will be selected based on site-specific consideration of anticipated drilling depths, site or regional geologic knowledge, types of sampling to be conducted, required sample quality and volume, and cost.

Field screening of soil samples is commonly performed using a photoionization detector (PID) and/or a flame ionization detector (FID). These instruments are used to measure relative concentrations of volatile organic compounds (VOCs) for the selection of samples for further laboratory or field analysis. Field screening for dense non-aqueous phase liquids (DNAPL) may be performed using hydrophobic dye (Oil Red O or Sudan IV), which is pertinent at chlorinated solvent sites.

Collection of soil samples for laboratory analysis may be performed using a variety of techniques including grab samples and composite or homogenized samples. Samples may require homogenization across a given depth interval, or several discrete grabs (usually five) may be combined into a composite sample. Samples for VOC analysis will not be homogenized or composited and are collected as discrete grab samples.

No oils or grease will be used on equipment introduced into the boring (e.g., drill rod, casing, or sampling tools).

3 PERSONNEL QUALIFICATIONS

Arcadis field personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or state/federal regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, Arcadis field personnel will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP), Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Personnel responsible for overseeing drilling operations will have at least 16 hours of prior training overseeing drilling activities with an experienced geologist, environmental scientist, or engineer with at least 2 years of prior experience.

Arcadis personnel directing, supervising, or leading soil sampling activities will have a minimum of 1 year of previous environmental soil sampling experience. Field employees with less than 6 months of experience will be accompanied by a supervisor (as described above) to ensure that proper sample collection techniques are employed.

Additionally, the Arcadis field team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

4 EQUIPMENT LIST

The following materials will be available, as required, during soil boring drilling, field screening, and sampling activities:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP)/work plan that includes site map with proposed boring locations, field sampling plan (with corresponding depths, sample analyses, sample volume required, and sample holding time), and previous boring logs (as available)
- Appropriate personal protective equipment (PPE), as specified in the HASP
- Traffic cones, delineators, and caution tape as appropriate for securing the work area as specified in the Traffic Safety Plan (TSP)
- Photoionization detector (PID), flame ionization detector (FID) or other air monitoring equipment, as needed, in accordance with the HASP
- Drilling equipment required by *ASTM D1586*, when performing split-spoon sampling
- Disposable plastic liners, when drilling with direct-push equipment
- Appropriate soil sampling equipment (e.g., stainless steel spatulas/spoons/bowls, knife)
- Stainless steel hand auger and stainless-steel spade if using manual methods
- Indelible ink pens
- Engineer’s ruler or survey rod
- Sealable plastic bags (e.g., Ziploc®)
- Air-tight sample containers and 8-oz. glass Mason jars or driller’s jars
- Aluminum foil
- Plastic sheeting (e.g., Weatherall Visqueen)
- Decontamination equipment (buckets, distilled or deionized water, cleansers appropriate for removing expected chemicals of concern, paper towels)
- Appropriate sample blanks (trip blank supplied by the laboratory), as specified in the FSP
- Soil sample containers and labels (supplied by the laboratory) appropriate for the analytical method(s) with preservative, as needed (parameter-specific)
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials;
- Appropriate soil boring log (**Attachment 1**)
- Chain-of-custody forms
- Field notebook.

- Digital camera (or smart phone with camera)
- Drums or other containers appropriate for soil and decontamination water, as specified by the site investigation-derived waste (IDW) management plan, and appropriate drum labels

5 CAUTIONS

Prior to beginning field work, underground utilities in the vicinity of the drilling areas will be delineated by the drilling contractor or an independent underground utility locator service. See appropriate guidance for proper utility clearance protocol. Work will be performed in accordance with the Arcadis *Utility Location and Clearance Health and Safety Standard* and the *Utilities and Structures Checklist* will be completed before beginning any intrusive work.

Prior to beginning field work, the project technical team will ensure that all field logistics (e.g., access issues, health and safety issues, communication network, schedules, etc.) and task objectives are clearly understood by all team members. An internal call with the project technical team to review the FIP/work plan scope and objectives is strongly recommended prior to mobilization to ensure that the field work will be effectively and efficiently executed.

Some regulatory agencies have specific requirements regarding borehole abandonment and grout mixtures. Determine whether the oversight agency has any such requirements prior to finalizing the drilling plan.

If DNAPL is known or expected to exist at the site, refer to the project specific documents (e.g., DNAPL Contingency Plan) for additional details regarding drilling to reduce the potential for inadvertent DNAPL remobilization.

Similarly, if light non-aqueous phase liquid (LNAPL) is known or expected to be present as “perched” layers above the water table, refer to the DNAPL Contingency Plan. Follow the general provisions and concepts in the DNAPL contingency plan during drilling above the water table at known or expected LNAPL sites.

Avoid using drilling fluids or materials that could impact groundwater or soil quality, or could be incompatible with the subsurface conditions.

Water used for drilling, decontamination of drilling/sampling equipment, or grouting boreholes upon completion will be of a quality acceptable for project objectives. Testing of water supply will be considered.

Specifications of materials used for backfilling the borehole will be obtained, reviewed and approved to meet project quality objectives. Bentonite is not recommended where DNAPL is likely to be present or in groundwater with high salinity. In these situations, neat cement grout is preferred.

Store and/or stage empty and full sample containers and coolers out of direct sunlight. Be careful not to over-tighten lids with Teflon® liners or septa. Over-tightening can impair the integrity of the seal and can cause the glass to shatter and create a risk for hand injuries.

NOTE: *Field logs and some forms are considered to be legal documents. All field logs and forms will therefore be filled out in indelible ink. Do not use permanent marker or felt-tipped pens for labels on* *sample container or sample coolers. Permanent markers could introduce volatile constituents into the samples.*

NOTE: *An Arcadis employee that is appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.*

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Working outside at sites with suspected contamination may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include biological hazards (e.g., stinging insects, ticks in long grass/weeds, etc.), and potentially the use of sharp cutting tools (scissors, knife). Only use non-toxic peppermint oil spray for stinging insect nests. Review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives and use appropriate hand protection.

If thunder or lighting is present, discontinue drilling and sampling until 30 minutes have passed after the last occurrence of thunder or lighting.

7 PROCEDURE

The procedures for drilling and the methods to be used to field screen and collect soil samples for laboratory analysis are presented below:

DRILLING PROCEDURES

Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area.
2. Advance boring to designated depth:
    a. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent)
    b. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent)

   c. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)
   d. A common sampling method that produces high-quality soil samples with relatively little soil disturbance is described in *ASTM D1586 – Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils* (ASTM D1586).
      i. Split-spoon samples are obtained during drilling using hollow-stem auger, drive-and-wash, spun casing, and fluid/mud rotary
   e. Rotasonic drilling produces soil cores that, for the most part, are relatively undisturbed, but note that when drilling in consolidated or finer-grained sediment the vibratory action during core barrel advancement may create secondary fractures or breaks
   f. Dual-rotary removes cuttings by compressed air or water/mud and allow only a general assessment of geology

3. Describe each soil sample as outlined in the appropriate project records (refer to the description procedures outlined in the *TGI - Soil Description*)
   a. Record descriptions on the soil boring log (**Attachment 1**) and/or field notebook.
   b. When possible photo document the samples (e.g., soil cores, split-spoons)
   c. During soil boring advancement, document all drilling events in field notebook, including blow counts (i.e., the number of blows from a soil sampling drive weight [140 pounds] required to drive the split-barrel sampler in 6-inch increments) and work stoppages
   d. Blow counts will not be available if rotasonic, dual-rotary, or direct-push methods are used; however, if standard penetration testing is required during rotasonic drilling, an automatic drop hammer may be used in conjunction with the method to switch from core barrel advancement to standard penetration testing
4. The drilling contractor will be responsible for obtaining accurate and representative samples, informing the supervising Arcadis geologist of changes in drilling pressure, and keeping a separate general log of soils encountered, including blow counts
   a. The term “samples” means soil materials from particular depth intervals, whether or not portions of these materials are submitted for laboratory analyses
   b. Records will also be kept of occurrences of premature refusal due to boulders or construction materials that may have been used as fill
   c. Where a boring cannot be advanced to the desired depth, the boring will be abandoned, and an additional boring will be advanced at an adjacent location to obtain the required sample
   d. Where it is desirable to avoid leaving vertical connections between depth intervals (e.g., if DNAPL or perched LNAPL are known or expected to exist at the site), the borehole will be sealed using cement and/or bentonite (see **Section 5** above)

    e. Multiple refusals may lead to a decision by the supervising geologist to abandon that sampling location

Direct-Push Method

The direct-push drilling method may also be used to complete soil borings. Examples of this technique include Geoprobe®, Diedrich Environmental Soil Probe (ESP) System, or AMS PowerProbe. Environmental probe systems typically use a hydraulically operated percussion hammer.

Depending on the equipment used, the hammer delivers 140- to 350-foot pounds of energy with each blow. The hammer provides the force needed to penetrate very stiff to medium dense soil formations. The hammer simultaneously advances an outer steel casing that contains a dual tube liner for sampling soil (dual tube sampling system).

The outside diameter (OD) of the outer casing ranges from 2.25 to 6 inches and the OD of the inner sampling tube diameter ranges from 1.4 to 4.5 inches. The outer casing isolates overlying soil and permits the unit to continue to probe at depth. The dual tube sampling system provides a borehole that may be tremie-grouted from the bottom up. Alternatively, a single rod system may be used that does not provide a cased boring and which does not allow for tremie-grouting from the bottom up.

The known or expected site conditions (e.g., presence of NAPL) will be evaluated when selecting the type of direct-push sampling system to be employed.

Direct-push drilling can generally achieve target depths 100 feet or less and the achievable depth is based on the site geology.

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area
2. Advance soil boring to designated depth.
    a. Collect soil samples at appropriate interval as specified in in the FIP/work plan (or equivalent)
    b. Collect, document, and store samples for laboratory analysis as specified in in the FIP/work plan (or equivalent)
    c. Decontaminate equipment between samples in accordance with in the FIP/work plan (or equivalent)
    d. Samples will be collected using dedicated, disposable, plastic liners
3. Describe samples in accordance with the procedures outlined in **Step 3** under ***Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods*** above (refer to the description procedures outlined in the *TGI - Soil Description*)

Manual Methods

Manual methods may also be used to complete shallow soil borings. Examples of this technique include using a spade, spoon, scoop, hand auger, or slide hammer. Manual methods are typically used to collect surface soil samples (0 to 6 inches) or to complete soil borings/collect soil samples from a depth of 5 feet or less.

1. Find/identify boring location, establish work zone, and set up sampling equipment decontamination area
2. Clear the ground surface of brush, root mat, grass, leaves, or other debris
3. Use a spade, spoon, scoop, hand auger, or slide hammer to collect a sample of the required depth interval
4. Use an engineer's ruler or survey rod to verify that the sample is collected to the correct depth and record the top and bottom depths from the ground surface
5. To collect samples below the surface interval, remove the surface interval first; then collect the deeper interval
    a. To prevent the hole from collapsing, it may be necessary to remove a wider section from the surface or use cut polyvinyl chloride (PVC) pipe to maintain the opening
    b. Collect soil samples at appropriate interval as specified in the FIP/work plan (or equivalent)
    c. Collect, document, and store samples for laboratory analysis as specified in the FIP/work plan (or equivalent)
    d. Decontaminate equipment between samples in accordance with the FIP/work plan (or equivalent)
6. Describe samples in accordance with the procedures outlined in **Step 3** under ***Hollow-Stem Auger, Drive-and-Wash, Spun Casing, Fluid/Mud Rotary, Rotasonic, and Dual-Rotary Drilling Methods*** above (refer to the description procedures outlined in the *TGI - Soil Description*)

FIELD SCREENING PROCEDURES

PID and FID Screening

Soils are typically field screened with a PID or FID for a relative measure of the total VOCs at sites where VOCs are known or suspected to exist. The PID employs a UV lamp to measure VOCs and the ionization energy (IE) of the site constituents need to be considered when selecting the type of lamp (e.g., 10.6 eV, 11.7 eV) that will be used. In general, any compound with an IE lower than that of the lamp photons can be measured. The FID has a wide linear range and responds to almost all VOCs. Field screening is performed using one (or both) of the following two methods:

1. Upon opening the sampler, the soil is split open and the PID or FID probe is placed in the opening and covered with a gloved hand. Such readings will be obtained at several locations along the length of the sample.
2. A portion of the collected soil is placed in a jar, which is covered with aluminum foil, sealed, and allowed to warm to room temperature. After warming, the cover is removed, the foil is pierced with the PID or FID probe, and a reading is obtained.

Initial PID readings will be recorded on the soil boring log (**Attachment 1**) and/or in the field notebook. The soil sample will be separated from the slough material (if any) by using disposable gloves and a pre-cleaned stainless-steel spoon.

For the second method, a representative portion of the sample will be placed in a pre-cleaned air-tight 8-ounce container (as quickly as possible to avoid loss of VOCs), filling the container half full to allow for the accumulation of vapors above the soil. An aluminum foil seal will be placed between the glass and metal cap and the cap will be screwed on tightly. Unless the screening will be performed immediately after the sample is placed in the container, the sample containers will be stored in a cooler chilled to approximately 4ºC until screening can be performed.

The headspace of the 8-ounce container will be measured using a PID or FID as follows:

1. Samples will be taken to a warm work space and allowed to equilibrate to room temperature for at least one hour.
2. Prior to measuring the soil vapor headspace concentration, the 8-ounce container will be shaken.
3. The headspace of the sample will then be measured directly from the 8-ounce container by piercing the aluminum foil seal with the probe of the PID or FID and measuring the relative concentration of VOCs in the headspace of the soil sample. The initial (peak) reading must be recorded.

The PID or FID must be calibrated according to the manufacturer's specifications at a minimum frequency of once per day prior to collecting PID or FID readings. The PID will be calibrated to a benzene-related compound (isobutylene) while the FID will be calibrated to methane.

The time, date, and calibration procedure must be clearly documented in the field notebook and/or the calibration log book.

If at any time the PID or FID results appear erratic or inconsistent with field observations, then the instrument will be recalibrated.

If calibration is difficult to achieve, then the PID’s lamp will be checked for dirt or moisture and cleaned, or technical assistance will be required. Maintenance and calibration records will be kept as part of the field quality assurance program.

NAPL Screening

To screen for the potential presence of non-aqueous phase liquid (NAPL) in soil, drilling procedures must allow for high-quality porous media samples to be taken. Split-spoon samplers or direct-push samplers will be collected continuously ahead of the auger, drill casing/rods, or probe rods.

Upon opening each split-spoon sampler or direct-push plastic liner sleeve, the soil will immediately be evaluated for the presence of visible NAPL. If NAPL is immediately visible in the sample, its depth will be noted.

Additionally, the soil will be screened for the presence of organic vapors using a PID or FID. During screening, the soil will be split open using a clean spatula or knife and the PID or FID probe will be placed in the opening and covered with a gloved hand (**Method 1** above). Such readings will be obtained along the entire length of the sample. Alternatively, **Method 2** for PID/FID screening (outlined above) may also be performed. If the PID or FID examination reveals the presence of organic vapors above 100 parts per million (ppm), the sample will undergo further detailed evaluation for visible NAPL.

The assessment for NAPL will include the following tests/observations:

- Evaluation for Visible NAPL Sheen or Free-Phase NAPL in Soil Sampler
    - NAPL sheen will be a colorful iridescent appearance on the soil sample
    - NAPL may also appear as droplets or continuous accumulations of liquid with a color typically ranging from yellow to brown to black, depending on the type of NAPL
    - Creosote DNAPL (associated with wood-treating sites) and coal tar DNAPL (associated with manufactured gas plant [MGP] sites) are typically black and have a characteristic, pungent odor
    - Pure chlorinated solvents may be colorless in the absence of hydrophobic dye. Solvents mixed with oils may appear brown
    - Particular care will be taken to fully describe any sheens observed, staining, discoloration, droplets (blebs), or NAPL saturation
- Soil-Water Pan Test
    - A portion of the selected soil interval with the highest PID or FID reading above 100 ppm will be placed in a disposable polyethylene dish along with a small volume of potable or distilled water
    - The dish will be gently tilted back and forth to mix the soil and water, and the surface of the water will be viewed in natural light to observe the development of a sheen, if any
    - A small quantity of Oil Red O or Sudan IV hydrophobic dye powder will be added, and the soil and dye will be manually mixed for approximately 30 to 60 seconds and smeared in the dish to create a paste-like consistency
    - A positive test result will be indicated by a sheen on the surface of the water and/or a bright red color imparted to the soil following mixing with dye
- Soil-Water Shake Test
    - A small quantity of soil (up to 15 cc) will be placed in a clear, colorless, jar containing an equal volume of potable or distilled water (40-mL vials are well suited to this purpose, but not required)
    - After the soil settles into the water, the surface of the water will be evaluated for a visible sheen under natural light
    - The jar will be closed and gently shaken for approximately 10 to 20 seconds
    - Again, the surface of the water will be evaluated for a visible sheen or a temporary layer of foam
    - A small quantity (approximately 0.5 to 1 cc) of Oil Red O or Sudan IV powder will be placed in the jar
    - The sheen layer, if present, will be evaluated for a reaction to the dye (change to bright red color)
    - The jar will be closed and gently shaken for approximately 10 to 20 seconds
    - The contents in the closed jar will be examined under natural light for visible bright red dyed liquid inside the jar

- A positive test result will be indicated by the presence of a visible sheen or foam on the surface of water, a reaction between the dye and the sheen layer upon first addition of the dye powder, a bright red coating on the inside of the vial (particularly above the water line), or red-dyed droplets within the soil

NOTE: *If NAPL is obviously present upon opening the soil sampler or evaluating the soil sample within the split-spoon sampler or direct-push liner sleeve, it is not necessary to perform a soil-water pan test or soil-water shake test. In addition, it is not necessary to perform both a soil-water pan test and a soil-water shake test; either test method is acceptable. The pan test may be preferred in some circumstances because the presence of a sheen may be easier to see on a wider surface.*

NOTE: *When using hydrophobic dye in the tests above, color will be assessed outdoors under natural light during the period between sunrise and sunset, regardless of the degree of cloud cover. The hydrophobic dye Safety Data Sheets (SDS) will be incorporated into the HASP and reviewed prior to use and the dyes will be carefully handled and disposed in accordance with regulations*.

SOIL SAMPLE COLLECTION FOR LABORATORY PROCEDURES

If not specifically identified in the FIP, soil samples will be selected for laboratory analysis based on:

1. Their position in relation to identified source areas
2. The visual presence of source residues (e.g., NAPL)
3. The relative levels of total VOCs based on field screening measurements
4. The judgment of the field coordinator

Samples designated for laboratory analysis will be placed in the appropriate containers.

Sample containers for VOC analysis will be filled first immediately following soil core retrieval to reduce loss of VOCs.

If samples will be collected for other analytical parameters, a sufficient amount of the remaining soil will then be homogenized as described below and sample containers will be filled for other parameters.

VOC samples will be collected as discrete samples using a small diameter core sampler (e.g., En Core® Sampler, Terra Core™ Sampler).

The En Core® Sampler is a disposable volumetric sampling device that collects, stores and delivers soil samples without in-field chemical preservation. The En Core® Sampler requires the use of a reusable T-handle.

The Terra Core™ Sampler is a one-time use transfer tool, designed to collect soil samples and transfer them to the appropriate containers for in-field chemical preservation (e.g., methanol).

The small diameter core sampler will be used according to the manufacturer's instructions (e.g., En Novative Technologies). Some regulatory agencies have specific requirements regarding VOC sample collection. Determine whether the oversight agency has specific requirements prior to commencing sampling and collect samples at appropriate interval as specified in the FIP/work plan (or equivalent). Samples may require homogenization across a given depth interval, or several discrete grabs (usually five) may be combined into a composite sample.

NOTE: *Samples for VOC analysis will NOT be homogenized or composited and will be collected as discrete samples as described above*.

The procedure for mixing samples is provided below.

1. Mix the materials in a stainless steel (or appropriate non-reactive material) bowl using a stainless-steel spoon (or disposable equivalents)
    a. When dealing with large sample quantities, use disposable plastic sheeting and a shovel or trowel
    b. NOTE: *When preparing samples for metals analyses, do not use disposable aluminum (or metal tools or trays other than stainless steel), as it may influence the analytical results*
2. Flatten the pile by pressing the top without further mixing
3. Divide the circular pile by into equal quarters by dividing out two diameters at right angles
4. Mix each quarter individually using appropriate non-reactive bowls, spoons and/or sheeting
5. Mix two quarters (as described above) to form halves, then mix the two halves to form a composite or homogenized sample
6. Place composite or homogenized sample into specified containers
7. Remaining material will be disposed of in accordance with project requirements and applicable regulations
8. Sample containers will be labeled with sample identification number, date, and time of collection and placed on ice in a cooler (target 4° Celsius)
9. Samples selected for laboratory analysis will be documented (chain-of-custody forms), handled, packed, and shipped in accordance with the procedures outlined in the FIP/work plan (or equivalent).

8 WASTE MANAGEMENT

Investigative-Derived Waste (IDW) generated during drilling activities, including soil and excess drilling fluids (if used), decontamination liquids, and disposable materials (plastic sheeting, PPE, etc.) will be stored on site in appropriately labeled containers (disposable materials will be contained separately) and disposed of properly. Containers must be labeled at the time of collection and will include date, location(s), site name, city, state, and description of matrix contained (e.g., soil, PPE). Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field log book.

9 DATA RECORDING AND MANAGEMENT

Management of the original documents from the field will be completed in accordance with the site-specific QAPP.

In general, drilling activities will be documented on appropriate field/log forms as well as in a proper field notebook. All field data will be recorded in indelible ink. Field forms, logs/notes (including daily field and calibration logs), digital records, and chain-of-custody records will be maintained by the field team lead.

Initial field logs and chain-of-custody records will be transmitted to the Arcadis Certified Project Manager (CPM) and Technical Lead at the end of each day unless otherwise directed by the CPM. The field team leader retains copies of the field documentation.

Additionally, all documents (and photographs) will be scanned and electronically filed in the appropriate project directory for easy access. Pertinent information will include personnel present on site, times of arrival and departure, significant weather conditions, timing of drilling activities, soil descriptions, soil boring information, and quantities of materials used.

In addition, the locations of soil borings will be documented photographically and in a site sketch. If appropriate, a measuring wheel or engineer’s tape will be used to determine approximate distances between important site features.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

10 QUALITY ASSURANCE

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

All drilling equipment and associated tools (including augers, drill rods, sampling equipment, wrenches, and any other equipment or tools) that may have come in contact with soil will be cleaned in accordance with the procedures outlined in the appropriate TGI.

Field-derived quality assurance blanks will be collected as specified in the FIP/work plan and/or site-specific QAPP, depending on the project quality objectives. Typically, field rinse blanks (equipment blanks) will be collected when non-dedicated equipment (e.g., split-spoon sampler, stainless steel spoon) is used during soil sampling. Field rinse blanks will be used to confirm that decontamination procedures are sufficient and samples are representative of site conditions. Trip blanks for VOCs, which aid in the detection of contaminants from other media, sources, or the container itself, will be kept with the coolers and the sample containers throughout the sampling activities and during transport to the laboratory.

Operate all monitoring instrumentation in accordance with manufacturer’s instructions and calibration procedures. Calibrate instruments at the beginning of each day and verify the calibration at the end of each day. Record all calibration activities in the field notebook.

11 REFERENCES

ASTM D1586 - *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. ASTM International. West Conshohocken, Pennsylvania.

12 ATTACHMENTS

Attachment 1. Soil Boring Log Form

ATTACHMENT 1

Soil Boring Log Form

ARCADIS Design & Consultancy for natural and built assets

SOIL BORING LOG

Boring/Well ____________ Project ______________________________ Page ___ of ___

Site Location ______________________________ Drilling Started ____________

Total Depth Drilled ______ Feet Hole Diameter ______ inches Drilling Completed ____________

Type of Sample or Coring Device ________ Length and Diameter of Coring Device ____________ Sampling Interval ________ feet

Drilling Method ________ Drilling Fluid Used ________

Drilling Contractor ____________________ Driller ____________

Prepared By ____________________ Helper ____________

			MUD		SAND					GRAVEL				
Core Recovery (feet)	PID Reading (ppm)	Sample Depth (ft bgs)	clay	silt	very fine	fine	medium	coarse	very coarse	granular	pebble	cobble	boulder	**Udden-Wentworth Description:** principal components, (angularity, plasticity, dilatency); minor components, (angularity, plasticity, dilatency); sorting, moisture content, consistency/density, color, additional comments

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SOIL BORING LOG (CONT'D)

Boring/Well __________ Prepared By __________ Page ____ of ____

Core Recovery (feet)	PID Reading (ppm)	Sample Depth (ft bgs)	MUD		SAND					GRAVEL				Udden-Wentworth Description: principal components, (angularity, plasticity, dilatency); minor components, (angularity, plasticity, dilatency); sorting, moisture content, consistency/density, color, addtl. Comments
			clay	silt	very fine	fine	medium	coarse	very coarse	granular	pebble	cobble	boulder	

TGI - LOW-FLOW GROUNDWATER PURGING AND SAMPLING PROCEDURES FOR MONITORING WELLS

Rev: #1

Rev Date: May 8, 2020

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	October 12, 2018	All	Updated and re-written as TGI with new branding and content	Marc Killingstad
1	May 8, 2020	Pages 5, 10-11	Added clarification/details for equipment requirements and procedure steps based on USEPA guidance	Marc Killingstad

APPROVAL SIGNATURES

Prepared by: 10/12/2018

Ryan McKinney

Date:

Technical Expert Reviewed by: May 8, 2020

Marc Killingstad (Technical Expert)

Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. Project teams will evaluate the last time the monitoring wells were developed and determine if additional development might be necessary. Water samples will not be taken immediately following well development. Sufficient time will be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

4 EQUIPMENT LIST

Specific to this activity, the following materials (or equivalent) will be used:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records, sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (phone or tablet)
- Low-flow sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16” socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending on site-specific constituents of concern)
- Electronic water-level indicator (e.g., Solinist Model 101) or oil/water interface probe with 0.01-foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multi-parameter water-quality sonde (temperature/pH/specific conductivity/oxidation reduction [ORP]/turbidity/dissolved oxygen) meter coupled with flow-through-cell for measurements, for example:

  - YSI 6-Series Multi-Parameter Instrument
  - Horiba U-22 Multi-Parameter Instrument.
  - Hydrolab Series 3 or Series 4a Multiprobe and Display.

  NOTE: *Transparent, small volume flow-through-cells (e.g., 250 milliliters or less) are preferred as they allow for easy detection of air bubbles and sediment buildup in the cell, which can interfere with the monitoring instrument probes. A small volume cell also allows for quick turnover of water in the cell between measurements of the indicator field parameters. It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.*

- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
  - Non-phosphate laboratory soap (Alconox or equivalent), brushes, clean buckets or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
  - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Sampling pump, which may consist of one or more of the following:
  - Submersible pump (e.g., Grundfos Redi-Flo 2)
  - Peristaltic pump (e.g., ISCO Model 150)
  - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:
  - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery
  - Submersible pumps such as Grundfos require a pump controller to run the pump
  - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N2 or CO2 gas cylinders)
- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used
  - For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) will be used through the pump apparatus
  - Teflon® will not be used when sampling for per- and polyfluoroalkyl substances (PFAS)
- Graduated cylinder and stop watch or other device to measure time to determine pumping rate

- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- Sample labels and Chain-of-Custody forms (COC)
- 0.45-micron disposable filters (if field filtering is required)
- A supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020) may be required for specific projects and will be specified in the project FIP/ work plan and the kick-off notes.
    - If used, in-line 'T' and valve allows for collection of water for turbidity measurements before the pump discharge enters the flow-through cell

NOTE: *The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.*

5 CAUTIONS

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Weather

- If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rain water could compromise groundwater samples.
- Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).
    - Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing or flow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible, and avoid the hottest times of the day.
    - Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

Cross-Contamination

- To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of up-gradient, then furthest down-gradient to source area locations.

- Note that permanent markers could introduce volatile constituents into the samples; *therefore, indelible ink is recommended* to be used for labels on sample containers or sample coolers.
- When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Pumps

- Preferred methods of extracting groundwater are adjustable rate, submersible pumps - such as centrifugal pumps or bladder pumps – constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e. Teflon®). However, *PTFE will not be used when sampling for per- and polyfluoroalkyl substances (PFAS). PTFE could contain PFAS*.
- When using a bladder pump for collecting VOCs and dissolved gases, “best practice” is to set-up the pump to deliver sufficient water to fill a 40 mL VOC vial.
- The use of peristaltic pumps will be based on the type of data to be collected. *Because the use a peristaltic pump can result in de-gassing of VOC and / or dissolved gases from groundwater, a different type of pump will be considered if these compounds are of concern.*
- *Manual or motor driven inertial pumping devices are not recommended because they cause greater disturbance during purging and pumping than regular pumps and are less easily controlled. This could cause a higher degree of data variability.*

Tubing

- When sampling for VOCs, SVOCs, pesticides, PCBs and inorganics, use of PTFE (Teflon®) or PTFE-lined tubing is preferred. However, PTFE tubing will not be used when sampling for PFAS.
- PVC, polypropylene or polyethelene tubing may be used when sampling for metals or other inorganics.
- Tubing with inside diameters of 1/4 or 3/8 inch is recommended because this will help ensure tubing remains water filled when operating at very low pumping rates.

General Precautions

- Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/work plan will list the samples that require field filtering.
- Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

6 HEALTH AND SAFETY CONSIDERATIONS

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be worn at all times in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

7 PROCEDURE

Field personnel will set up and perform low-flow sampling in accordance with the following procedures.

1. Review FIP and groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for each well to perform sampling as efficiently as possible (i.e., reach a stabilized pumping condition).
2. Calibrate field instruments according to manufacturer procedures for calibration and record calibration procedure and results in field log.
3. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination)* prior to use.
4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
    a) Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
    b) Record well construction and conditions on the Low-Flow Sampling Field Form (**Attachment A**)
5. Place clean plastic sheeting on the ground near the well to keep monitoring and sampling equipment off the surface unless the equipment is elevated above the ground (e.g. on a table).
6. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. If appropriate or required for site-specific conditions, insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
7. Measure and record the initial depth to groundwater prior to placing the pumps.

8. Prepare and install the pump in the well.

   NOTE: *Groundwater will be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet below ground surface), a submersible or bladder pump will be used, provided that the well is constructed with a casing diameter of at least two (2) inches (the minimum well diameter capable of accommodating such pumps). For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Bladder pumps are preferred over peristaltic and submersible pumps to prevent volatilization if sampling of VOCs and/or dissolved gasses is required. Purge water will be collected and containerized according to the direction of the project team.*

   a) For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well. Attach the air-line tubing to the air-port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to unintended contamination.

   b) If using a bladder pump, connect the air-line to the pump controller output port. The pump controller will be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power (if an on/off switch is present) and verify that all batteries are charged and fully functioning before starting the pump.

   c) If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two (2) feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.

   d) If using an in-line ‘T’ and valve, install between pump discharge water line and the bottom inlet port of the flow-through cell. Attach a short piece of tubing to the outlet. This set-up will be used to collect samples for turbidity readings.

9. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the multi-parameter water-quality sonde and make sure to record equipment/instrument identification (manufacturer and model number).

10. Before starting the pump, ensure that the water level inside the well has stabilized (i.e., measure the water level multiple times after deploying the pump in the well).

11. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified) and adjust the pumping rate to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement): the water level should stabilize, however, this is not always possible.

12. If the well diameter is of sufficient size, measure the water level every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping.

13. Maintain a steady flow rate to the extent practicable and do not break pump suction or cause entrainment of air in the sample.

14. Record pumping rate adjustments and depths to water.

    If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters; if the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position.

    For wells screened across the water table, the well may be pumped dry and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

    For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 feet) is maintained and monitoring for stabilization of field indicator parameters can commence; if a lower stabilization level cannot be maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen.

15. After water levels have stabilized and a sufficient volume has been purged (*see note below*), continue pumping and begin monitoring field indicator parameters using a multi-parameter water-quality sonde coupled with a flow-through-cell.

    NOTE: *The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.*

16. Use the flow to measure all indicator field parameters, except for turbidity, every 3 to 5 minutes (or after each volume of the flow-through cell has been purged or other appropriate interval); turbidity samples will be collected before the flow-through-cell using the T-valve and a clean container such as a glass beaker.

17. Record field indicator parameters on the groundwater sampling log.

18. The well is considered stabilized and ready for sample collection when three consecutive readings are within the following limits:

    - **Turbidity** within ± 10% for values greater than 5 nephelometric turbidity units [NTUs] or if three turbidity values are less than 5 NTUs, consider the values stabilized
    - **Dissolved Oxygen (DO)** within ± 10% for values greater than 0.5 mg/L or if three DO values are less than 0.5 mg/L, consider the values stabilized
    - **Specific Conductance** within ± 3%
    - **Temperature** within ± 3%
    - **pH** within ± 0.1 unit
    - **Oxidation/Reduction Potential (ORP)** within ±10 millivolts (mV)

    NOTE: *Alternate stabilization goals may exist in different geographic regions, consult the site-specific FIP/work plan for stabilization criteria).*

    NOTE: *While achieving turbidity levels less than 5 NTU and a stable drawdown of less than 0.3 feet is desirable, sample collection may still take place provided the indicator field parameter criteria in this procedure are met.*

19. If the parameters have stabilized but turbidity remains relatively high (e.g., greater than 50 NTUs), the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. If groundwater turbidity has been minimized (i.e., consecutive readings within ± 10%) and the values for all other parameters have stabilized, the well may be sampled; however, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

20. If after one (1) hour of purging indicator field parameters have not stabilized, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

    In general, three potential options are available if stabilization criteria are not met:

    a) Continue purging until stabilization is achieved.

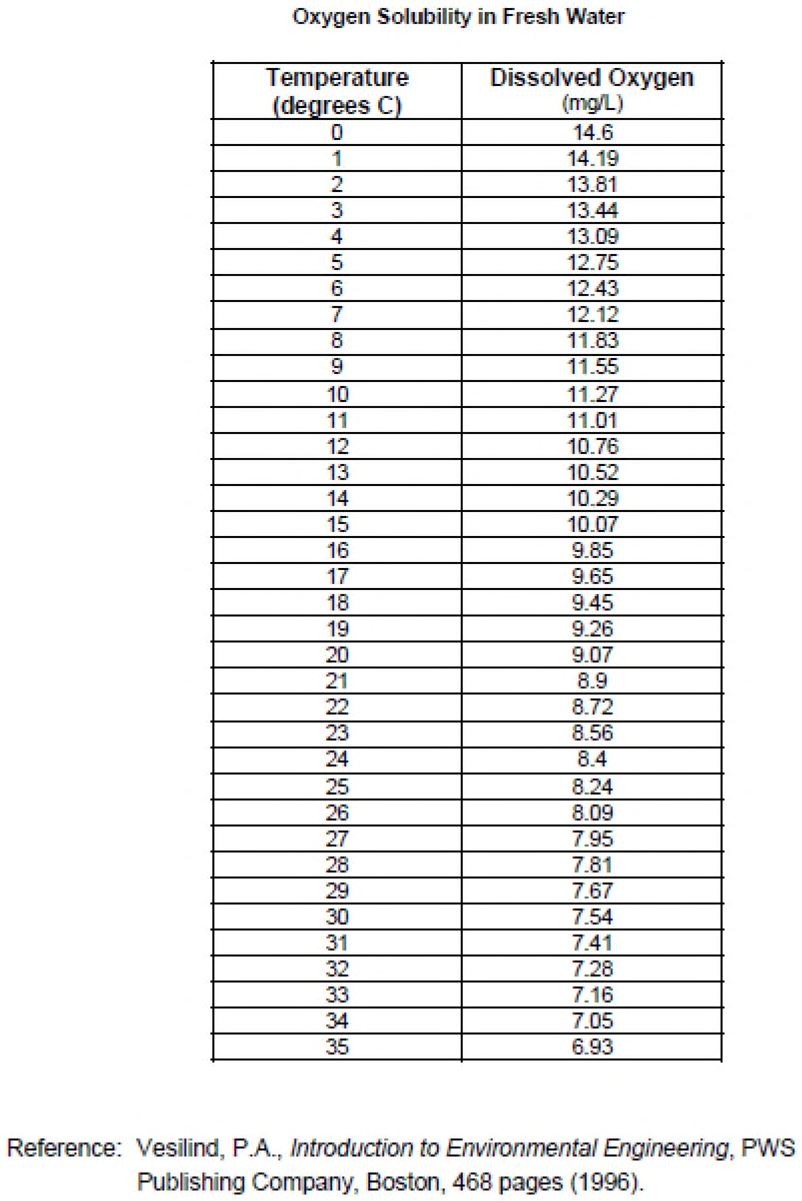
    b) Discontinue purging, do not collect any samples, and record in field logbook/on the sampling form that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

    c) Discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization. *There is a risk that the analytical data obtained under these conditions, particularly metals and hydrophobic organic analytes, may reflect a sampling bias and, as a result, the data may not meet the data quality objectives of the sampling event.*

    NOTE: *DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); therefore, great care will be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater, again check for and remove air bubbles on the probe before re-measuring. The table below may be* *used as a general guide for DO values under various temperatures; however, understand that the table corresponds to freshwater solubility and groundwater contaminants may affect oxygen solubility. If DO value is 0.00 or less, then the meter will be serviced and re-calibrated. If DO values are above possible results, then the meter will be serviced and re-calibrated.*

NOTE: *During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field logbook/on the sampling form.*

NOTE: *If other field conditions are suspected of preventing stabilization of certain parameters, detailed observations will be documented in the field logbook/on the sampling form.*



Oxygen Solubility in Fresh Water

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., *Introduction to Environmental Engineering*, PWS Publishing Company, Boston, 468 pages (1996).

21. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.
22. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container.
    a) If a flow-through analytical cell is being used to measure field parameters, the flow-through cell will be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection.
    b) Under no circumstances will analytical samples be collected from the discharge of the flow-through cell.
    c) If an in-line ‘T’ and valve are used, the valve needs to be removed as well.
    d) Samples will be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific FIP/work plan).
    e) When the container is full, tightly screw on the cap.
23. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample will be collected.
    a) Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected.
    b) Continue to run the pump until an initial volume of “flush” water has been run through the filter in accordance with the manufacturer’s directions (generally 100 to 300 mL).
    c) Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container.
    d) When the container is full, tightly screw on the cap.
24. Secure with packing material and store the samples on ice in an insulated transport container provided by the laboratory and include a temperature blank in each container to be shipped.
25. Record on the Low-Flow Sampling Field Form (and bound field logbook) the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (see **Attachment A**).
26. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.
27. Slowly remove the pump, tubing, lines, and safety cable from the well.
    a) If using dedicated tubing, do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
    b) If using dedicated tubing, it will be folded - without pinching it - to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events.
    c) Use a length of rope or string to tie the tubing to the well cap.

   d) Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, coil the tubing neatly and placed in a clean plastic bag that is clearly labeled with the well ID ensuring the bag is tightly sealed before placing it in storage.

28. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.

29. Complete the procedures for packaging, shipping, and handling with the associated Chain-of-Custody.

30. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate (*TGI – Groundwater and Soil Sampling Equipment Decontamination*).

31. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log.

8 WASTE MANAGEMENT

Materials generated during groundwater sampling activities, including disposable equipment and excess purge water, will be stored on site in appropriately labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage,* the procedures identified in the FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field logbook.

9 DATA RECORDING AND MANAGEMENT

Management of the original documents from the field will be completed in accordance with the site-specific QAPP.

In general, forms (e.g., Low-Flow Sampling Field Forms), logs/notes (including daily field and calibration logs), digital records, and Chain-of-Custody records will be maintained by the field team lead.

Field logs and Chain-of-Custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

10 QUALITY ASSURANCE

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Unless described otherwise in the project-specific FIP/work plan, QAPP, or Sampling and Analysis Plan, quality assurance/quality control samples will be collected as follows:

- One duplicate for every 10 samples

- One laboratory matrix/matrix spike sample for every 20 samples

In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:

- Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
- Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
- Collect equipment blanks after wells with higher concentrations (if known) have been sampled
- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures—calibrate instruments at the beginning of each day, verify the calibration at the end of each day, and record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for equipment decontamination

11 REFERENCES

USEPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (September 1986).

USEPA. 1991. *Handbook Groundwater, Volume II Methodology*, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July 1991).

USEPA Region I. 2017. *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

U.S. Geological Survey (USGS). 1977. *National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination*. Reston, Virginia.

12 ATTACHMENTS

A. Low-Flow Sampling Field Form

GROUNDWATER SAMPLING FORM

ARCADIS

Page ____ of ____

Project No. ____________ Well ID ____________ Date ____________

Project Name/Location ____________ Weather ____________

Measuring Pt. Description ____________ Screen Setting (ft-bmp) ____________ Casing Diameter (in.) ____________ Well Material ____ PVC ____ SS

Static Water Level (ft-bmp) ____________ Total Depth (ft-bmp) ____________ Water Column (ft) ____________ Gallons in Well ____________

MP Elevation ____________ Pump Intake (ft-bmp) ____________ Purge Method: ____________ Sample Method ____________

Pump On/Off ____________ Centrifugal ____________ Submersible ____________ Other ____________

Sample Time: ____________ Volumes Purged ____________

Purge Start ____________ Gallons Purged ____________ Sample ID ____________ Sampled by ____________

Purge End ____________ Replicate/Code No. ____________

Time	Minutes Elapsed	Rate (gpm)/(mL/min)	Depth to Water (ft)	Gallons Purged	pH	Cond. (µMhos)/(mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp. (°C)/(°F)	Redox (mV)	Appearance	
		200mL/min +	-0.3		± 0.1	± 3%	± 10%	± 10%	± 3%	± 10mV	Color	Odor
Stabilization Calculations (±)												
Stabilization Criteria					**± 0.1 s.u.**	**±3%**	**± 10% or within 1 NTU [(1)]**	**± 10%**	**±3%**	**±10 mV**		

(1) **Turbidity** < 50 NTU and ±10% or within 1 NTU of a previous reading when <10 NTU

Constituents Sampled	**Container**	**Number**	**Preservative**

Comments ____________

Well Casing Volumes

Gallons/Foot

1" = 0.04
1.25" = 0.06
1.5" = 0.09
2" = 0.16
2.5" = 0.26
3" = 0.37
3.5" = 0.50
4" = 0.65
6" = 1.47

Well Information

Well Location: ____________ Well Locked at Arrival: Yes / No

Condition of Well: ____________ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well: ____________

TGI – GROUNDWATER AND SOIL SAMPLING EQUIPMENT DECONTAMINATION

Rev: 1

Rev Date: May 8, 2020

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Cassandra McCloud / Pete Frederick
1	May 8, 2020	4-5	Added note regarding use of Liquinox and 1,4-Dioxane	Marc Killingstad

APPROVAL SIGNATURES

Prepared by: Derrick Maurer Date: 02/23/2017

Derrick Maurer

Technical Expert Reviewed by: Date: May 8, 2020

Marc Killingstad (Technical Expert)

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

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In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project’s scope of work based upon site conditions, staffing expertise, state-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

Decontamination is performed on sampling equipment prior to sample collection to ensure that the sampling equipment that contacts a sample, or monitoring equipment that is brought into contact with environmental media to be sampled, is free from analytes of interest and/or constituents that could interfere with laboratory analysis for analytes of interest. Sampling equipment must be appropriately cleaned prior to use for sampling or coming into contact with environmental media to be sampled, and following completion of the sampling event prior to shipment or storage. The effectiveness of the decontamination procedure should be verified by collecting and analyzing equipment blank samples.

The sampling equipment cleaning procedures described herein includes pre-field, in the field, and post-field cleaning of sampling equipment which may be conducted at an established equipment decontamination area (EDA) on site, as appropriate and necessary. Sampling equipment that may require decontamination at a given site includes: soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment. Non-disposable equipment will be cleaned before collecting each sample, between each sample collected, and prior to placing sampling equipment in protective cases, or containers for transport. Cleaning procedures for sampling equipment should be monitored by collecting equipment blank samples as required in project work plans, field sampling plans, quality assurance project plans (QAPP), or other pertinent project documents. Dedicated and/or single-use (i.e., not to be re-used) sampling equipment will not require decontamination.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

4 EQUIPMENT LIST

The equipment required for equipment decontamination is presented below:

- Health and safety equipment, including appropriate PPE, as required in the site Health and Safety Plan (HASP)
- Deionized water that meets that analytical criteria for deionized water with no detectable constituents above the reporting limits for the methods to be used and analytes being analyzed for. Deionized water is used for inorganics, and organic-free water for VOCs, SVOCs, pesticides, etc.
- Non-phosphate detergent such as Alconox or, if sampling for phosphorus or phosphorus-containing compounds, Liquinox (or equivalent). NOTE: *Liquinox has shown to provide false positives for 1,4-Dioxane and should not be used at sites where that may be a constituent of concern (COC).*
- Tap water
- Rinsate collection plastic containers
- DOT-approved waste shipping container(s), as specified in the work plan, field sampling plan, or regulatory requirements if decontamination waste is to be shipped for disposal
- Brushes
- Large heavy-duty garbage bags
- Spray bottles

- (Optional) – Isopropyl alcohol (free of ketones) or methanol. These can be wipes or diluted with water (usually 1part isopropyl/methanol to 10 parts water) if a spray is needed.
- Airtight, sealable plastic baggies, such as Ziploc-type
- Plastic sheeting

5 CAUTIONS

Rinse equipment thoroughly and allow the equipment to dry before re-use or storage to prevent introducing solvent into sample medium. If manual drying of equipment is required, use clean lint-free material to wipe the equipment dry. Ensure all rinsate materials do not adversely affect sample collection efficiency or analytical results.

Store decontaminated equipment in a clean, dry environment. Do not store near combustion engine exhausts. Properly containerize equipment to ensure cross-contamination doesn't happen from other uncontaminated surfaces or equipment.

If equipment is damaged to the extent that decontamination is uncertain due to cracks, gouges, crevices, or dents, the equipment should not be used and should be discarded or submitted for repair prior to use for sample collection.

A proper shipping determination regarding hazardous materials will be performed by a DOT-trained individual for cleaning materials shipped by Arcadis.

Caution should be exercised to avoid contact with the pump casing and water in the container while the pump is running (do not use metal drums or garbage cans) to avoid electric shock.

6 HEALTH AND SAFETY CONSIDERATIONS

Review the safety data sheets (SDS) for the cleaning agents and materials used in decontamination. If solvent is used during decontamination, use appropriate PPE and work in a well-ventilated area and stand upwind while applying solvent to equipment. Apply solvent in a manner that minimizes potential for exposure to workers and bystanders. Follow health and safety procedures outlined in the HASP.

7 PROCEDURE

A designated area will be established to clean sampling equipment in the field prior to and following sample collection. Equipment cleaning areas will be set up within or adjacent to the specific work area, but not at a location that expose equipment to contamination (i.e. exposed to combustion engine exhaust). Detergent solutions will be prepared in clean containers for use in equipment decontamination. Decontaminated equipment should be handled by workers wearing clean gloves, properly changed to prevent cross-contamination.

Cleaning Sampling Equipment

1. Wash the equipment/pump with potable water.

2. Wash with detergent solution (Alconox, Liquinox or equivalent) to remove all visible particulate matter and any residual oils or grease. NOTE: *Liquinox has shown to provide false positives for 1,4-Dioxane and should not be used at sites where that may be a constituent of concern (COC).*

3. If equipment is very dirty, precleaning gross debris with a brush and tap water may be necessary.

4. If non-aqueous phase liquids are present, the use of isopropyl alcohol (free of ketones) or methanol is recommended. Cloth wipes or diluted solution can be used to remove the non-aqueous phase liquids that are hard to remove with detergent solution in step 2. Consult with project manager if non-aqueous phase liquids are present onsite and design an appropriate decontamination procedure that includes step 4.

5. Rinse with deionized water.

Decontaminating Submersible Pumps

Submersible pumps may be used during well development, groundwater sampling, or other investigative activities. The pumps must be cleaned and flushed before and between uses. This cleaning process will consist of an external detergent solution wash and tap water rinse, a flush of detergent solution through the pump, followed by a flush of potable water through the pump. Flushing will be accomplished by using an appropriate container filled with detergent solution and another container filled with potable water. The pump should be flushed with deionized water as the last step prior to use. The pump will run long enough to effectively flush the pump housing and hose (unless new, disposable hose is used). Disconnect the pump from the power source before handling. The pump and hose should be placed on or in clean polyethylene sheeting to avoid contact with the ground surface.

8 WASTE MANAGEMENT

Equipment decontamination rinsate will be managed in conjunction with all other waste produced during the field sampling effort. Waste management procedures are outlined in the work plan or Waste Management Plan (WMP).

9 DATA RECORDING AND MANAGEMENT

Equipment cleaning and decontamination will be noted in the field notebook for project documentation. Information will include the type of equipment cleaned, the decontamination location, specific procedures utilized, solvents and/or cleaning agents used, source of water, and deviations or omissions from this TGI.

Unusual field conditions should be noted if there is potential to impact the efficacy of the decontamination or subsequent sample collection.

An inventory of the solvents brought on site and used and removed from the site will be maintained in the project documentation. Records will be maintained for solvents used in decontamination, including lot number and expiration date.

Containers with decontamination fluids will be labeled.

10 QUALITY ASSURANCE

Equipment blanks should be collected to verify that the decontamination procedures are effective in minimizing potential for cross contamination. The equipment blank is prepared by pouring deionized water (or organic-free water, for organic analyses) over the clean and dry tools and collecting the water into appropriate sample containers. Equipment blanks should be analyzed for the same set of parameters that are performed on the field samples collected with the equipment that was cleaned as specified in the sampling and analysis plan. Equipment blanks are collected per equipment set, which represents all of the tools needed to collect a specific sample.

11 REFERENCES

USEPA Region 9 - Field Sampling Guidance #1230, Sampling Equipment Decontamination.

USEPA Region 1 - Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

TGI - INVESTIGATION-DERIVED WASTE HANDLING AND STORAGE

Rev #: 1

Rev Date: May 15, 2020

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	February 23, 2017	ALL	Conversion from SOP to TGI	Ryan Mattson / Peter Frederick
1	May 15, 2020	ALL	Updated to reflect regulatory changes	

APPROVAL SIGNATURES

Prepared by: Derrick Maurer 02/23/2017

Derrick Maurer Date:

Technical Expert Reviewed by: 05/15/2020

Ryan Mattson (Technical Expert) Date:

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2 SCOPE AND APPLICATION

The objective of this Technical Guidance Instruction (TGI) is to describe the procedures to manage investigation-derived wastes (IDW), both hazardous and nonhazardous, generated during site activities, which may include, but are not limited to: drilling, trenching/excavation, construction, demolition, monitoring well sampling, soil sampling, decontamination and remediation. For the purposes of this TGI, IDW is considered to be discarded materials which are defined as solid waste by United States Environmental Protection Agency (EPA) standard 40 CFR § 261.2 (which may include liquids, solids, or sludges). IDW may include soil, groundwater, drilling fluids, decontamination liquids, as well as contaminated personal protective equipment (PPE), sorbent materials, construction and demolition debris, and disposable sampling materials. Hazardous or uncharacterized IDW will be collected and staged at the point of generation. Quantities small enough to be containerized in 55-gallon drums will be taken to a designated temporary onsite storage area (discussed in further detail under Drum Storage) pending characterization and disposal. IDW materials will be characterized using process knowledge and appropriate laboratory analyses to determine the waste classification and evaluate proper safe handling and disposal methods.

This TGI describes the necessary equipment, field procedures, materials, regulatory references, and documentation procedures necessary for proper handling and storage of IDW up to the time it is properly transported from the project site and disposed. The procedures included in this TGI for handling and temporary storage of IDW are based on the EPA's guidance document *Guide to Management of Investigation Derived Wastes* (USEPA, 1992). IDW is assumed to be contaminated with the site constituents of concern (COCs) until analytical evidence indicates otherwise. IDW will be managed to ensure the protection of human health and the environment and will comply with all applicable or relevant and appropriate requirements (ARAR). Although not comprehensive, the following laws and regulations on Hazardous Waste Management should be considered as potential ARAR. It is the Arcadis Certified Project Manager (CPM) and/or designated Technical Expert to determine which laws and regulations, at all levels of government, are applicable to each project site and activity falling under this TGI.

Federal Laws and Regulations

- Resource Conservation and Recovery Act (RCRA) 42 USC § 6901-6987.
- Federal Hazardous Waste Regulations 40 CFR § 260-265

Department of Transportation (DOT) Hazardous Materials Transportation 49 CFR

Occupational Safety and Health Administration (OSHA) Regulations 29 CFR

State Laws and Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Regional, County, Municipal, and Local Regulations

- To be determined based on location of site and location of treatment, storage, and/or disposal facility (TSDF) to be utilized.

Initial Storage

Pending characterization, IDW will be temporarily stored appropriately within each area of contamination (AOC). Under RCRA, "storage" is defined as the "holding of hazardous waste for a temporary period, at the end of which the hazardous waste is treated, disposed of, or stored elsewhere" (40 CFR § 260.10). The onsite waste staging area will be in a secure and controlled area. Uncharacterized wastes are considered potentially hazardous wastes and must be stored in DOT approved packaging. Liquid wastes must be stored in DOT approved closed head drums or other approved containers (e.g., portable tank containers) that are compatible with the type of material stored therein. Solid materials must be stored in DOT approved open head drums where practicable. Larger quantities of solid IDW can be containerized in bulk containers (such as in a roll-off box). Soil from large excavation projects may be managed in stockpiles with within the AOC and does not need to be containerized until exiting the AOC.

Characterization

Waste characterization can either be based on generator knowledge, such as using historical process knowledge and safety data sheets (SDS), or can be based upon characterization sampling analytical results. IDW typically is not characterized using SDS as it is a mixture of aged chemicals and environmental media. Historical process knowledge should be used to determine if the IDW is a listed hazardous waste (40 CFR § 261.31-33). If the IDW is not a listed hazardous waste, waste characterization can be completed by laboratory analysis of representative samples of the IDW. The laboratory used for waste characterization analysis must have the appropriate state and federal accreditations and may be required to be pre-approved by the Client. IDW will be classified as RCRA hazardous or non-regulated under RCRA based on the waste characterization determination.

If IDW is characterized as RCRA hazardous waste, RCRA and DOT requirements must be followed for packaging, labeling, transporting, storing, and record keeping as described in 40 CFR § 262 and 49 CFR § 171-178. Waste material classified as RCRA nonhazardous may be handled and disposed of as nonhazardous waste in accordance with applicable federal, state, and local regulations.

Storage Time Limitations

Containerized hazardous wastes can be temporarily stored for a maximum of 90 calendar days from the accumulation start date for a large quantity generator or a maximum of 180 calendar days from the accumulation start date for a small quantity generator. Wastes classified as nonhazardous may be handled and disposed of as nonhazardous waste and are not subject to storage time limitations.

This is TGI may be modified by the CPM and/or Technical Expert for a specific project or client program, as required, dependent upon client requirements, site conditions, equipment limitations, or limitations imposed by the procedure. The resulting procedure employed to execute the work will be documented in the project work plans or reports. If changes to the sampling procedures are required due to unanticipated field conditions, the changes will be discussed with the CPM and/or Technical Expert as soon as practicable, and if approved to be performed, be documented.

3 PERSONNEL QUALIFICATIONS

Arcadis field sampling personnel will have current regulatory- and Arcadis-required health and safety training including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. Personnel handling and packaging hazardous waste and performing hazardous waste characterizations must have RCRA hazardous waste management training per 40 CFR § 264.16. Additional state-specific hazardous waste management training is required in certain states (i.e., California).

Although not common practice, in certain situations Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator. Arcadis personnel who sign waste profiles and/or waste manifests will have both current RCRA hazardous waste management training per 40 CFR § 264.16 and current DOT hazardous materials transportation training per 49 CFR § 172.704. Arcadis field personnel will also comply with client-specific training. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project health and safety plan (HASP) and other documents will identify other training requirements or access control requirements.

4 EQUIPMENT LIST

The Following Materials, as required, will be available for IDW handling and Storage:

- Appropriate personal protective equipment as specified in the Site Health and Safety Plan (HASP)
- DOT approved containers
- Hammer
- Leather gloves
- Drum dolly
- Appropriate drum labels (outdoor waterproof self-adhesive)
- Portable tank container
- Appropriate labeling, packing, chain-of-custody forms, and shipping materials as determined by the CPM and/or Technical Expert.
- Indelible ink and/or permanent marking pens
- Plastic sheeting
- Appropriate sample containers, labels, and forms
- Stainless-steel bucket auger
- Stainless steel spatula or knife
- Stainless steel hand spade
- Stainless steel scoop
- Digital camera
- Field logbook

5 CAUTIONS

Filled drums can be very heavy, become unbalanced, or spill its contents. Therefore, use appropriate moving techniques and equipment for safe handling. Similar media (e.g. soils with other soils; or liquids with other liquids) will be stored in the same drums to aid in sample analysis and disposal. Drum lids must be secured to prevent rainwater from entering the drums and leakage during movement. Drums containing solid material may not contain any free liquids. Waste containers stored for extended periods of time may be subject to deterioration. Drum Over Packs may be used as secondary containment. All drums must be visually inspected for condition to ensure that they are in good condition without visible evidence of rusting, holes, breakage, etc., to prevent potential leakage and facilitate subsequent disposal. All drum lids must be verified as having a properly functioning secured lid prior to use.

6 HEALTH AND SAFETY CONSIDERATIONS

As determined by the site's known and suspected hazards, appropriate PPE must be worn by all field personnel within the designated work area. Exposure air monitoring may be required during certain field activities as required in the Site Health and Safety Plan. If soil excavation in areas with potentially hazardous contaminants is possible, contingency plans will be developed to address the potential for encountering gross contamination or non-aqueous phase liquids. All excavation activities shall be in compliance with OSHA standard 29 CFR 1926.651 Excavations, and any other applicable regulations.

Arcadis field personnel and subcontractors will be trained in and perform their work in compliance with all applicable federal, state, and local health and safety regulations as well as Arcadis' HASP and applicable Client health and safety requirements.

7 PROCEDURE

Specific waste temporary storage and handling procedures to be used are dependent upon the type of generated waste, including type of media (e.g. soils or free liquids) and constituents of concern. For this reason, IDW can be stored in a secure location onsite in separate 55-gallon storage drums, where solids can be stockpiled onsite (if nonhazardous) and purge water may be stored in portable tank containers. Waste materials such as broken sample bottles or equipment containers and wrappings will be stored in 55-gallon drums unless they were not in contact with sample media.

Management of IDW

Minimization of IDW should be considered by the project team during all phases of the project. Site managers may want to consider techniques such as replacing solvent based cleaners with aqueous-based cleaners for decontamination of equipment, reuse of equipment (where it can be properly decontaminated), limitation of traffic between exclusion and support zones, and drilling methods and sampling techniques that minimize the generation of waste. Alternative drilling and subsurface sampling methods may include the use of small diameter boreholes, as well as borehole testing methods such as a core penetrometer or direct push technique instead of coring.

Drum Storage

Drums containing hazardous waste will be stored in accordance with the requirements of 40 CFR 265 Subpart I (for containers) and 265 Subpart DD (for containment buildings). All 55-gallon drums will be stored at a secure, centralized onsite location that is readily accessible for vehicular pick-up. Drums confirmed as, or assumed to contain hazardous waste will be stored over an impervious surface provided with secondary spill containment. The storage location will, for drums containing liquid, have a containment system that can contain at least the larger of 10% of the aggregate volume of staged materials or 100% of the volume of the largest container. Drums will be closed during storage and be in good condition in accordance with the Guide to Management of Investigation-Derived Wastes (USEPA, 1992).

Hazardous Waste Determination

Waste material must be characterized to determine if it meets any of the federal definitions of hazardous waste as required by 40 CFR § 262.11. If the waste does not meet any of the federal definitions, it must then be established if any state-specific or local-specific hazardous waste criteria exist/apply.

Generator Status

Once hazardous waste determination has been made, the generator status will be determined. Large quantity generators (LQG) are generators who generate more than 1,000 kilograms of hazardous waste in a calendar month. Small quantity generators (SQG) of hazardous waste are generators who generate greater than 100 kilograms but less than 1,000 kilograms of hazardous waste in a calendar month. Very small quantity generators (VSQG) are generators who generate less than 100 kilograms of hazardous waste per month. Please note that a generator status may change from month to month and that a notice of this change is usually required by the generator’s state agency.

Accumulation Time for Hazardous Waste

A LQG may accumulate hazardous waste on site for 90 calendar days or less without a permit and without having interim status, provided that such accumulation is in compliance with requirements in 40 CFR § 262.17. A SQG may accumulate hazardous waste on site for 180 calendar days or less without a permit or without having interim status, subject to the requirements of 40 CFR § 262.16. VSQG requirements are found in 40 CFR § 262.14. NOTE: The federal VSQG and SQG provisions may not be recognized by some states (e.g., California and Rhode Island). State-specific and local-specific regulations must be reviewed and understood prior to the generation of hazardous waste.

Satellite Accumulation of Hazardous Waste Satellite accumulation (SAA) will mean the accumulation of as much as fifty-five (55) gallons of hazardous waste, or the accumulation of as much as one quart of acutely hazardous waste, in containers at or near any point of generation where the waste initially accumulates, which is under the control of the operator of the process generating the waste, without a permit or interim status and without complying with the requirements of 40 CFR § 262.15 and without any storage time limit, provided that the generator complies with 40 CFR § 262.15.

Once more than 55 gallons of hazardous waste accumulates in SAA, the generator has three days to move this waste into storage.

Storage recommendations for hazardous waste include:

- Ignitable or reactive hazardous wastes must be >50 feet from the property line per 40 CFR § 265.176 (LQG generators only).
- Hazardous waste should be stored on a concrete slab (asphalt is acceptable if there are no free liquids in the waste).
- Drainage must be directed away from the accumulation area.
- Area must be properly vented.
- Area must be secure.

Drum/Container Labeling

Drums will be labeled on both the side and lid of the drum using a permanent marking pen. Old drum labels must be removed to the extent possible, descriptions crossed out should any information remain, and new labels affixed on top of the old labels. Other containers used to store various types of waste (e.g., polyethylene tanks, roll-off boxes, end-dump trailers, etc.) will be labeled with an appropriate "Waste Container" or “Testing in Progress” label pending characterization. Drums and containers will be labeled as follows:

- Appropriate waste characterization label (Pending Analysis, Hazardous, or Nonhazardous)
- Waste generator's name (e.g., client name)
- Project Name
- Name and telephone number of Arcadis project manager
- Composition of contents (e.g., used oil, acetone 40%, toluene 60%)
- Media (e.g., solid, liquid)
- Accumulation start date

- Drum number of total drums as reconciled with the Drum Inventory maintained in the field log book.

IDW containers will remain closed except when adding or removing waste. Immediately upon beginning to place waste into the drum/container, a “Waste Container” or “Pending Analysis” label will be filled out to include the information specified above, and affixed to the container. Once the contents of the container are identified as either non-hazardous or hazardous, the following additional labels will be applied.

- Containers with waste determined to be non-hazardous will be labeled with a green and white "Nonhazardous Waste" label over the "Waste Container" label.
- Containers with waste determined to be hazardous will be stored in an onsite storage area and will be labeled with the "Hazardous Waste" label and affixed over the "Waste Container" label.

The ACCUMULATION DATE for the hazardous waste is the date the waste is first placed in the container and is the same date as the date on the "Waste Container" label. DOT hazardous class labels must be applied to all hazardous waste containers for shipment offsite to an approved disposal or recycling facility. In addition, a DOT proper shipping name will be included on the hazardous waste label. The transporter should be equipped with the appropriate DOT placards. However, placarding or offering placards to the initial transporter is the responsibility of the generator per 40 CFR § 262.33.

Inspections and Documentation

All IDW will be documented as generated on a Drum Inventory Log maintained in the field log book. The Drum Inventory will record the generation date, type, quantity, matrix and origin (e.g., Boring-1, Test Pit 3, etc.) of materials in every drum, as well as a unique identification number for each drum. The drum inventory will be used during drum pickup to assist with labeling of drums. The drum storage area and any other areas of temporarily staged waste, such as soil/debris piles, will be inspected weekly. The weekly inspections will be recorded in the field notebook or on a Weekly Inspection Log. Digital photographs will be taken upon the initial generation and drumming/staging of waste, and final labeling after characterization to document compliance with labeling and storage protocols, and condition of the container. Evidence of damage, tampering or other discrepancy should be documented photographically.

Emergency Response and Notifications

Specific procedures for responding to site emergencies will be detailed in the HASP. If the generator is designated as a LQG, a Contingency Plan will need to be prepared to include emergency response and notification procedures per 40 CFR § 265 Subpart D. In the event of a fire, explosion, or other release which could threaten human health outside of the site or when Client or Arcadis has knowledge of a spill that has reached surface water, Client or Arcadis must immediately notify the National Response Center (800-424-8802) in accordance with 40 CFR § 262.265. Other notifications to state and/or other local regulatory agencies may also be necessary.

Drilling Soil Cuttings and Muds

Soil cuttings are solid to semi-solid soils generated during trenching activities, subsurface soil sampling, or installation of monitoring wells. Depending on the drilling method, drilling fluids known as "muds" may be used to remove soil cuttings. Drilling fluids flushed from the borehole must be directed into a settling section of a mud pit. This allows reuse of the decanted fluids after removal of the settled sediments. Soil cuttings will be labeled and stored in 55-gallon drums with bolt-sealed lids.

Excavated Solids

Excavated solids may include, but are not limited to: soil, fill, and construction and demolition debris. Prior to permitted treatment or offsite disposal, potentially hazardous excavated solids may be temporarily stockpiled onsite as long as the stockpile remains in the same AOC from where it was excavated. Potentially hazardous excavated solids removed from the AOC must be immediately containerized in labeled drums or closable top roll-offs lined with 9-mil polyvinyl chloride (PVC) sheeting and are subject to LQG storage time limits. Nonhazardous excavated solids can be stockpiled either inside or outside of the AOC, do not have to be containerized and are not subject to hazardous waste regulations. Potentially hazardous excavated solids must not be mixed with nonhazardous excavated solids. All classes of excavated solid stockpiles should be maintained in a secure area onsite. At a minimum, the floor of the stockpile area will be covered with a 20-mil high density polyethylene liner that is supported by a foundation or at least a 60-mil high density polyethylene liner that is not supported by a foundation. The excavated material will not contain free liquids. The owner/operator will provide controls for windblown dispersion, run-on control, and precipitation runoff. The run-on control system will prevent flow onto the active portion of the pile during peak discharge from at least a 25-year storm and the run-off management system will collect and control at least the water volume resulting from a 24-hour, 25-year storm (USEPA, 1992). Additionally, the stockpile area will be inspected on a weekly basis and after storm events. Individual states may require that the stockpile be inspected/certified by a licensed professional engineer. Stockpiled material will be covered with a 6-mil polyvinyl chloride (PVC) liner or sprayed dust control product. The stockpile cover will be secured in place with appropriate material (concrete blocks, weights, etc.) to prevent the movement of the cover.

Decontamination Solutions

Decontamination solutions are generated during the decontamination of personal protective equipment and sampling equipment. Decontamination solutions may range from detergents, organic solvents and acids used to decontaminate small field sampling equipment to steam cleaning rinsate used to wash heavy field equipment. These solutions are to be labeled and stored in closed head drums compatible with the decontamination solution. Decontamination procedures, including personnel and field sampling equipment, must comply with applicable Arcadis procedural documents.

Disposable Equipment

Disposable equipment includes personal protective equipment (e.g., tyvek coveralls, gloves, booties and APR cartridges) and disposable sampling equipment such as trowels or disposable bailers. If the media sampled exhibits hazardous characteristics per results of waste characterization sampling, contaminated disposable equipment will also be disposed of as a hazardous waste. If compatible with the original IDW waste stream (i.e., the IDW is a solid and the disposal equipment is a solid), the disposable equipment can be combined with the IDW. If these materials are not compatible (i.e., the IDW is a liquid and the disposal equipment is a solid), the disposable equipment will be stored onsite in separate labeled 55-gallon drums. Uncontaminated or decontaminated disposable equipment can be considered nonhazardous waste.

Purge Water

Purge water includes groundwater generated during well development, groundwater sampling, or aquifer testing. The volume of groundwater generated will dictate the appropriate storage procedure. Monitoring well development and groundwater sampling may generate three well volumes of groundwater or more. This volume will be stored in labeled 55-gallon drums. Aquifer tests may generate significantly greater volumes of groundwater depending on the well yield and the duration of the test. Therefore, large-volume portable polyethylene tanks will be considered for temporary storage pending groundwater-waste characterization.

Purged Water Storage Tank Decontamination and Removal

The following procedures will be used for inspection, cleaning, and offsite removal of storage tanks used for temporary storage of purge water. These procedures are intended to be used for rented portable tanks such as Baker Tanks or Rain for Rent containers. Storage tanks will be made of inert plastic materials. The major steps for preparing a rented tank for return to a vendor include characterizing the purge water, disposing of the purge water, decontaminating the tank, final tank inspection, and mobilization. Decontamination and inspection procedures are described in further detail below.

- Tank Cleaning: Most vendors require that tanks be free of any visible sediment and water before returning, a professional cleaning service may be required. Each specific vendor should be consulted concerning specific requirements for returning tanks.
- Tank Inspection: After emptying the tank, purged water storage tanks should be inspected for debris, chemical staining, and physical damage. The vendors require that tanks be returned in the original condition (i.e., free of sediment, staining and no physical damage).

8 WASTE MANAGEMENT

Soil/Solids Characterization

Waste characterization will be conducted in accordance with waste hauler, waste handling facility, and local/state/federal requirements. In general, RCRA hazardous wastes are those solid wastes determined by a Toxicity Characteristic Leaching Procedure (TCLP) test or to contain levels of certain toxic metals, pesticides, or other organic chemicals above specific applicable regulatory agency thresholds. If the one or more of 40 toxic compounds listed in Table I of 40 CFR § 261.24 are detected in the sample at levels above the maximum unregulated concentrations, the waste must be characterized as a toxic hazardous waste. Wastes can also be considered “listed” hazardous waste depending on site-specific processes.

Composite soil samples will be collected at a frequency of one sample per 250 cubic yard basis for stockpiled soil or one per 55-gallon drum per different waste stream for containerized. A four-point composite sample will be collected per 250 cubic yards of stockpiled material and for each drum waste stream. Sample and composite frequencies may be adjusted in accordance with the waste handling facility’s requirements and may be reduced for large volumes of waste with consistent properties. Waste characterization samples will be considered valid for consistent waste streams for a period of 1 year. Waste characterization samples may be analyzed for the TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls (PCBs), as well as reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- or local-specific regulations may require a different or additional sampling approaches.

Wastewater Characterization

Waste characterization will be conducted in accordance with the requirements of the waste hauler, waste handling facility, and local/state/federal governments. In general, purge water should be analyzed by methods appropriate for the known contaminants, if any, that have been historically detected in the monitoring wells. Samples will be collected and analyzed in accordance with the requirements of the waste disposal facility. Wastewater characterization samples may be analyzed for TCLP volatile organic compounds (VOCs), TCLP semi-volatile organic compounds (SVOCs), TCLP RCRA metals, and polychlorinated biphenyls, as well as corrosivity (pH), reactivity and flammability (flashpoint). Additional samples may be collected and analyzed by the laboratory on a contingency basis. Site-specific constituents of concern including pesticides may require additional sampling. Please note that state- and/or local-specific regulations may require different or additional sampling approaches.

Sample Handling and Shipping

All samples will be appropriately labeled, packed, and shipped, and the chain-of-custody will be filled out in accordance with current Arcadis sample chain of custody, handling, packing, and shipping procedures and guidance instructions.

It should be noted that additional training is required for packaging and shipping of hazardous and/or dangerous materials. Please refer to the current Arcadis training requirements related to handling and shipping of samples, shipping determinations, and hazardous materials.

Preparing Waste Shipment Documentation (Hazardous and Nonhazardous)

Waste profiles will be prepared by the Arcadis CPM and forwarded, along with laboratory analytical data to the Client for approval/signature. The Client will then return the profile to Arcadis who will then forward to the waste removal contractor for preparation of a manifest. The manifest will be reviewed by Arcadis prior to forwarding to the Client for approval. Upon approval of the manifest, the Client will return the original signed manifest directly to the waste contractor or to the Arcadis CPM for forwarding to the waste contractor. Arcadis personnel may sign waste profiles and/or waste manifests on a case by case basis for clients, provided the appropriate agreement is in place between Arcadis and the client documenting that Arcadis is not the generator, but is acting as an authorized representative of the generator.

Final drum labeling and pickup will be supervised by an Arcadis representative who is trained and experienced with applicable waste labeling procedures. The Arcadis representative will have a copy of the drum inventory maintained in the field book and will reconcile the drum inventory with the profile numbers on the labels and on the manifest. Different profile numbers will be generated for different matrices or materials in the drums. For example, the profile number for drill cuttings will be different than the profile number for purge water. When there are multiple profiles it is critical that the proper label, with the profile number appropriate to a specific material be affixed to the proper drums. A copy of the Arcadis drum inventory will be provided to the waste transporter during drum pickup and to the facility receiving the waste.

9 DATA RECORDING AND MANAGEMENT

Waste characterization sample handling, packing, and shipping procedures will be documented in accordance with relevant Arcadis procedures and guidance instructions as well as applicable client and/or project requirements, such as a Quality Assurance Project Plan or Sampling and Analysis Plan. Copies of the chain-of-custody forms will be maintained in the project file. Arcadis should photograph or maintain a copy of any hazardous waste manifest signed on behalf of Client in the corresponding office DOT record file.

10 QUALITY ASSURANCE

The CPM or APM will review all field documentation once per week for errors or omissions as compared to applicable project requirements including but not limited to: the proposal/scope of work, QAPP, SAP, HASP, etc. Deficiencies will be noted, tracked, and resolved. Upon correction, they will be noted for project documentation.

11 REFERENCES

United States Environmental Protection Agency (USEPA). 1992. Guide to Management of Investigation-Derived Wastes. Office of Remedial and Emergency Response. Hazardous Site Control Division. January 1992.

SOP - SAMPLE CHAIN OF CUSTODY

Rev: #2

Rev Date: April 29, 2020

VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Reviewed by
0	April 19, 2017	All	Re-write to COC only	Richard Murphy
1	May 23, 2017	4 9 7	Add: Guidance on use of previous version of SOP. Add: Info on COCs for multiple shipping containers Modify: Move letter i. to letter m. and change to “when appropriate”	Peter Frederick
2	April 29, 2020	4 11	Remove obsolete link Remove obsolete link	Lyndi Mott

APPROVAL SIGNATURES

Prepared by: 05/23/2017

Peter C. Frederick Date:

Technical Expert Reviewed by: 05/29/2020

Lyndi Mott (Technical Expert) Date:

1 INTRODUCTION

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

2 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) describes the general Chain of Custody (COC) procedures and guidance instructions for samples collected from project sites that are relinquished from Arcadis' possession.

COC is defined as the maintenance of an unbroken record of possession of an item from the time of its collection through some analytical or testing procedure. COC is typically documented by a written record of the collection, possession, and handling of samples collected from a project location. Each sample will be tracked by a documented record that efficiently documents the individuals who were responsible for the sample during each successive transfer of that sample to various recipients beyond Arcadis' possession. This information can be used to legally establish the integrity of the samples and therefore the analytical results derived from the samples. This information can be used in addition to other records and documentation regarding the samples, such as field forms, field logs, and photographs.

A sample is considered under custody if:

- It is in your possession; or
- It is in your view, after being in your possession; or
- It was in your possession and then you then locked it up to prevent tampering; or
- It is in a designated secure area.

Continued use of previous version of SOP:

Although not recommended, Arcadis program-, project-, and client-teams may be able to use the previous version of this SOP provided that it meets all of the quality expectations of Arcadis and client, and meets applicable regulatory requirements. It is up to the program, project, and/or client-team leader to determine whether it is appropriate to adopt the current SOP or to continue using the previous version.

However, all new work not associated with the previous version of this SOP must be performed with the current version of the SOP.

When adopting this new SOP, users of the previous versions must be aware that specific handling, packing, and shipping procedures and guidance has been removed and that those should be addressed within program or project plans (e.g. QAPPs, Work Plans, SAPs, etc.) or in a more detailed SOP or TGI specific to that sampling activity, whether related to media, constituent/analyte, client, state, etc.

In addition, adopting this new SOP will require users to refer to the Arcadis DOT Safety Program for procedures and guidance on the determination and handling, packing, and shipping of samples that are or may be considered hazardous materials.

3 PERSONNEL QUALIFICATIONS

Arcadis personnel performing work under the purview of this SOP will have received appropriate training and have field experience regarding the collection of samples from project locations. Arcadis personnel will have all other applicable and appropriate training relevant to the sampling work and project site.

4 EQUIPMENT LIST

The following list provides materials that may be required for each COC. Project reporting and documentation requirements must be reviewed with the CPM prior to execution of work. Additional materials, tools, equipment, etc. may be required, and project staff are required to verify with the CPM and/or Technical Expert what specific equipment is required to complete the COC.

- Indelible ink pen (preferably either black or blue ink);
- COC form (**Appendix A**) from either Arcadis, laboratory receiving and analyzing the samples, or other applicable and appropriate entity for the work performed;
- When appropriate, such as for litigation or expert testimony work, custody seals or tape.

5 CAUTIONS

One way in which the law tries to ensure the integrity of evidence is by requiring proof of the chain of custody by the party who is seeking to introduce a particular piece of evidence.

A proper chain of custody requires three types of affirmations: (1) affirmation that a sample is what it purports to be (for example, soil collected from a specified location and depth); (2) affirmation of continuous possession by each individual who has had possession of the sample from the time it is collected until the time it is analyzed or held by a laboratory; and (3) affirmation by each person who has had possession that sample remained in substantially the same condition and not contaminated or affected by outside influences from the moment one person took possession until the moment that person released the evidence into the custody of another (for example, affirmation that the sample was stored in a secure location where no one but the person in custody had access to it).

Proving chain of custody is necessary to "lay a foundation" for the samples in question, by showing the absence of alteration, substitution, or change of condition.

Ensure that appropriate sample containers with applicable preservatives, coolers, and packing material are planned for and provided at the site at the time of sample collection.

Understand the offsite transfer requirements of the samples for the facility at which samples are collected.

If overnight courier service is required schedule pick-up or know where the drop-off service center is located and the hours of operation.

An Arcadis employee appropriately trained at the correct level of internal hazardous materials/DOT (Department of Transportation) shipping must complete an Arcadis shipping determination to address applicable DOT and IATA (International Air Transport Association) shipping requirements. Review the applicable Arcadis procedures and guidance instructions for sample packaging, and labeling. Prior to using air transportation, confirm air shipment is acceptable under DOT and IATA regulations.

The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

6 HEALTH AND SAFETY CONSIDERATIONS

Follow the health and safety procedures outlined in the project/site Health and Safety Plan (HASP) as well as other applicable H&S requirements, such as:

- Arcadis Hazardous Material/DOT handling, packaging, and shipping training
- Project site-specific H&S training
- Client-specific H&S training
- Constituent-specific H&S training
- Media-specific H&S training

7 PROCEDURE

Collected samples must be uniquely identified, and properly documented, containerized, labeled with unique identifier, possessed in a secure manner during remainder of sampling event, packaged, and shipped to recipient laboratory.

Sample Identification

The method of sample identification depends on the type of measurement or analyses performed. In some cases, in-situ measurements of existing conditions and/or sample location must be made during sample collection. These data will be recorded directly on field forms, logbooks, or other project record data sheets used to permanently retain this information for the project file. Examples of location identification information includes: latitude/longitudinal measurements, compass directions, well number, building number, floor number, room name, or proximity to a site feature unique to the site. Examples of in-situ measurements are pH, temperature, conductivity, flow measurement, or physical condition of the media being sampled. Physical samples collected are identified by a unique identifying number or code on a sample tag or label. These physical samples are removed from the sample location and transported to a laboratory for analyses.

In some cases, before samples are placed into individual containers and labeled as individual samples, samples may be separated into portions depending upon the analytical methods and required duplicate or triplicate analyses to be performed.

When completing a COC for samples, personnel must complete the following:

1. Written COCs must be completed with indelible ink (preferably either black or blue colored ink).
2. Written COCs must be completed using legible printed writing, and not cursive writing.
3. All entry fields on the COC form must be completed. If information is not applicable for a specific entry field, personnel will either put "N/A" or use a strike-out line or dash like "-----------" to indicate no applicable information is needed for that field.
4. Use of quotation marks or lines/down arrows to represent repetitive/duplicative text in similar fields.
5. Regardless of the type or specific COC form, the following pertinent information must be provided on the COC form:
    a. Arcadis project number
    b. Arcadis project name
    c. Project location, including street address, city, state, building number, providing as much detail as appropriate
    d. Recipient laboratory contact and sample receiving shipping location information
    e. Entities'/persons' contact information for who will be receiving analytical results
    f. Name of sampler, i.e. person collecting sample and relinquishing possession of samples to the next entity in the chain of custody
    g. Date of sample collection

    h. If appropriate for the sample media, contaminant/constituent of concern, or analytical method, document time of sample collection using standard military time
    i. Sample analytical method(s)
    j. Turnaround time required for analyses and/or reporting
    k. Instructions to laboratory regarding handling, timing, analyses, etc. as applicable and appropriate
    l. Printed name and signature of the individual person who collected the samples and relinquishing possession of the samples
    m. If appropriate or when documentation of the specific sample collection method will influence how the laboratory handles, prepares, or analyzes the samples, document the sample collection methodology used for collecting the samples (e.g. ASTM D5755)

6. The following additional specific information will be entered on the COC form, regardless of what type of COC is being used:

    a. <u>Unique Sample Identifier</u> – The sample identifier (ID) must be unique to the individual sample it is applied to. The information in which the sample ID conveys is determined by the CPM, Technical Expert, and/or other project team members in advance of sample collection so that sample identification is consistently applied for the project. The sample nomenclature may be dictated by a specific client, program, or project database and require unique identification for each sample collected for the project. Consult with the CPM and/or Technical Expert for additional information regarding sample identification.

       The sample ID could convey specific information regarding the sample to aid personnel in recognizing what the sample represents, or they may be arbitrary so as to facilitate the anonymity of the sample location, media, constituent of concern, project site, etc.

       Examples of unique identifiers include:

        1. Well locations, grid points, or soil boring identification numbers (e.g., MW-3, X-20, SB-30). When the depth interval is included, the complete sample ID would be “SB-30 (0.5-1.0) where the depth interval is in feet. Please note it is very important that the use of hyphens in sample names and depth units (i.e., feet or inches) remain consistent for all samples entered on the chain of custody form. DO NOT use the apostrophe or quotes in the sample ID.
        2. Sample names may also use the abbreviations “FB,” “TB,” and “DUP” as prefixes or suffixes to indicate that the sample is a field blank, trip blank, or field duplicate, respectively.

    b. List the date of sample collection. All indicated dates must be formatted using either mm/dd/yy (e.g., 03/07/09) or mm/dd/yyyy (e.g. 03/07/2009).
    c. When appropriate for the analytical procedure used, list the local time that the sample was collected. The time value should be presented using military format. For example, 3:15 P.M. should be entered as 15:15.

d. Samples should be indicated to be either “Grab” or “Composite”. Grab samples are collected from only one unique location at one specific point in time.

e. Composite samples are a group of individual samples that are combined for analysis in their totality. Composite samples need to be documented if they are either collected from a number of different locations over a broader area to be representative of the entire area being sampled, or if they are representative of a single location over an extended period of time.

f. If used, preservatives for the individual sample will be noted.

g. The requested analytical method(s) that the samples are being analyzed for must be indicated. As much detail, as necessary, should be presented to allow the analytical laboratory to properly analyze the samples. For example, polychlorinated biphenyl (PCB) analyses may be represented by entering “EPA Method 8082 – PCBs” or “EPA PLM 600-R93-116.” In cases where multiple analytical methods and/or analytical parameters are required for an individual sample, each method should be indicated for the sample (e.g., EPA 8082/8260/8270 or EPA PLM/400-point count).

h. If there are project-specific sample analytes to be reported, they should be specifically listed for each individual sample (e.g., 40 CFR 264 Appendix IX).

i. The total number of containers for each analytical method requested should be documented. This information may be included under the parameter or as a total for the sample.

j. When necessary, note which samples should be used for site specific matrix spikes.

k. Indicate special project-specific requirements pertinent to the handling, shipping, or analyses. These requirements may be on a per sample basis such as “extract and hold sample until notified,” or may be used to inform the laboratory of special reporting requirements for the entire sample delivery group (SDG).

l. Indicate turnaround time (TAT) required for samples on COC. If individual samples have differing TATs, the different TATs for each sample or groups of samples must be clearly indicated.

m. Provide contact name and phone number in the event that problems are encountered when samples are received at the laboratory. The person relinquishing possession of the samples or other member of the project team should contact the final recipient of the samples to confirm receipt and review any special provisions on the COC or questions that they may have.

n. If available, attach the Laboratory Task Order or Work Authorization forms.

o. The “Relinquished By” field must contain the signature of the Arcadis person who relinquished custody of the samples to the next entity in the chain of custody, which may be another person, the shipping courier, or the analytical laboratory.

p. Dates and times must be indicated using the following format:

   1) Date: either mm/dd/yy e.g., 01/01/17 OR mm/dd/yyyy e.g., 01/01/2017

   2) Time: use military format, e.g. 9:30 a.m. is 0930 and 9:30 p.m. is 2130

   q. The "Received By" section is signed by sample courier or laboratory representative who received the samples from the sampler or it is signed upon laboratory receipt from the overnight courier service.

4. When more than one page of the COC form is required to complete the total number of samples, use as many sheets as necessary to accurately and clearly document the samples and information. Some COCs may have a standard first page/cover page, and subsequent pages may not contain all the detailed fields as the first page/cover page. Ensure that any subsequent pages convey all of the necessary and pertinent information for each individual sample as required in this procedure document.
5. Pages of the COC must retain a page count of the total number of pages; e.g., Page 1 of 3, Page 2 of 3, Page 3 of 3.
6. Upon completing the COC forms, forward the original signed COC with the sample package. Ensure that the original COC form is secured with the sample package so that it remains with the physical samples for the duration of transport and handling to its final destination and ensure that the COC form will not be become damaged or rendered unreadable due to sample breakage/leakage if stored inside the sample shipping container or outside influences if COC is stored in an outside plastic pouch to the container.
7. If you've collected enough samples that would require more than one container to ship them all to the same laboratory or location, then each separate/individual container that contains any number of samples must have a separate COC representing only those samples contained within that specific container. For example, if you have 3 total shipping containers for all of your samples, you must have a total of 3 separate, individual COCs for each of the 3 containers representing only those samples in their representative container. Thus, every container holding samples must have its own, individual COC.
8. If electronic chain of custody (eCOC) forms are utilized, ensure that the requirements of this procedure and guidance instructions are followed to the extent possible. Verify that proper signature and COC procedures are maintained with the CPM and/or Technical Expert when using eCOC.

8 WASTE MANAGEMENT

Not Applicable.

9 DATA RECORDING AND MANAGEMENT

The original signed COC shall be submitted with the samples. Copies of COC records will be transmitted to the CPM or designee at the end of each day unless otherwise directed by the CPM. The sampling team leader retains copies of the chain of custody forms for filing in the project file. Record retention shall be in accordance with client- and project-specific requirements and Arcadis policies, the most stringent will apply.

10 QUALITY ASSURANCE

COC forms will be legibly completed in accordance with this procedure and guidance instruction document, as well as other applicable and appropriate project documents such as Sampling and Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan, or other project guidance documents.

COC records will be reviewed by the CPM or their appropriate designee for completeness and accuracy to the applicable requirements. Non-conformances will be noted and corrected in a timely manner on the copies retained by Arcadis as well as contacting the ultimate receiving entity for correction to the originally signed COC in their possession.

11 REFERENCES

Arcadis Client Document Retention Guide

Arcadis Transportation Safety Program requirements, procedures, and guidance instructions

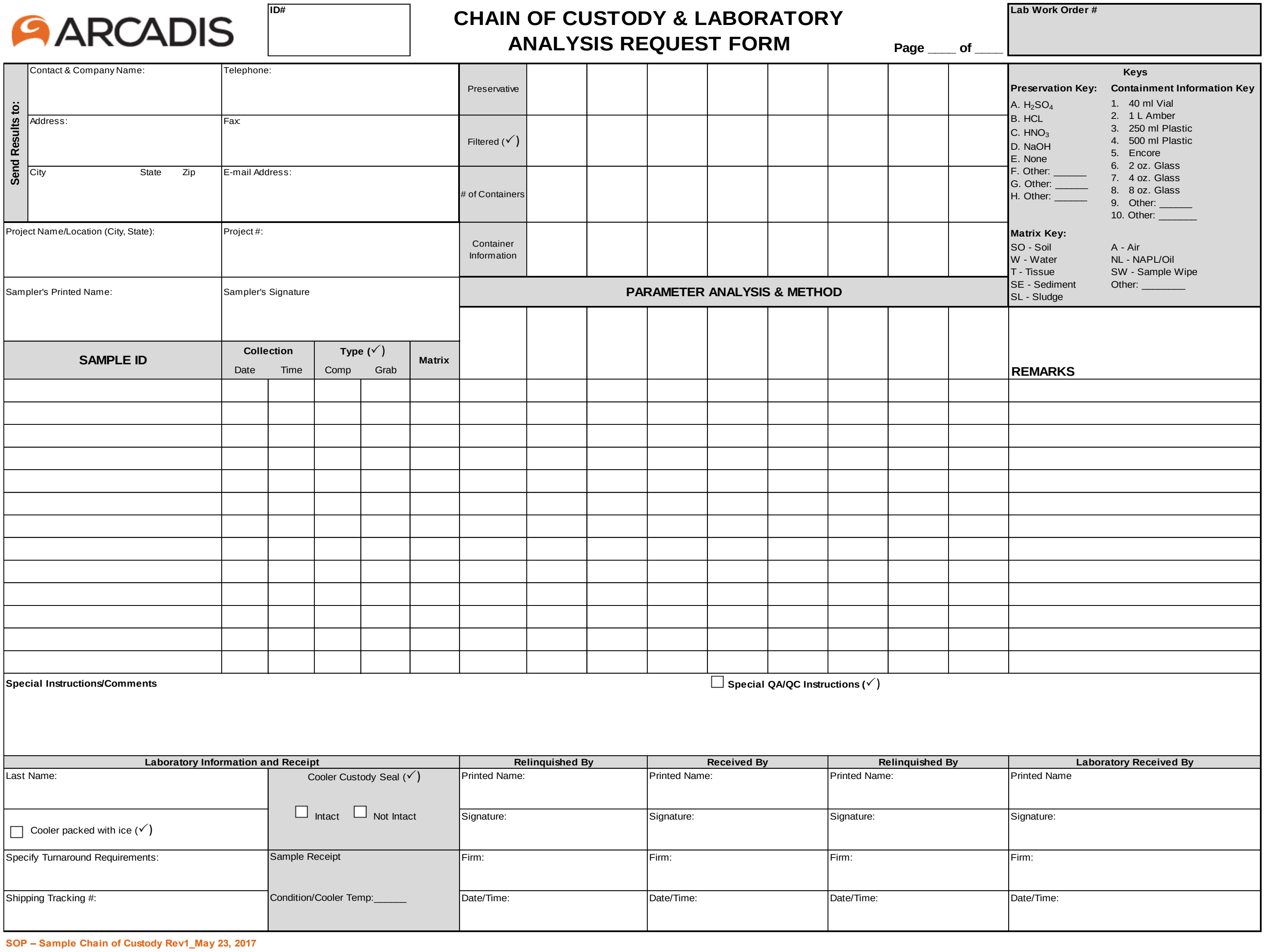
EPA Samplers' Guide – Contract Laboratory Program Guidance for Field Samplers, EPA document EPA-540-R014-013 October 2014

EPA Region III – *Sample Submission Procedures for the Office of Analytical Services and Quality Assurance (OASQA) Laboratory Branch* revision 13.0 January 29, 2014

EPA Region I Office Environmental Measurement and Evaluation – *Standard Operating Procedures for Chain of Custody of Samples* revision 1 March 25, 2002

EPA Region IV Science and Ecosystem Support Division *Operating Procedure for Sample and Evidence Management* January 29, 2013

APPENDIX A
Chain of Custody Form



ARCADIS

ID#

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ____ of ____

Lab Work Order #

Send Results to:

Contact & Company Name:

Telephone:

Address:

Fax:

City State Zip

E-mail Address:

Project Name/Location (City, State):

Project #:

Sampler's Printed Name:

Sampler's Signature

Preservative								
Filtered (✓)								
# of Containers								
Container Information								

PARAMETER ANALYSIS & METHOD

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: ______
G. Other: ______
H. Other: ______

Containment Information Key
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: ______
10. Other: _______

Matrix Key:

SO - Soil	A - Air
W - Water	NL - NAPL/Oil
T - Tissue	SW - Sample Wipe
SE - Sediment	Other: _______
SL - Sludge	

SAMPLE ID	**Collection**		**Type (✓)**		**Matrix**										**REMARKS**
	Date	Time	Comp	Grab											

Special Instructions/Comments

☐ **Special QA/QC Instructions (✓)**

Laboratory Information and Receipt		**Relinquished By**	**Received By**	**Relinquished By**	**Laboratory Received By**
Last Name:	Cooler Custody Seal (✓) ☐ Intact ☐ Not Intact	Printed Name:	Printed Name:	Printed Name:	Printed Name
☐ Cooler packed with ice (✓)		Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt	Firm:	Firm:	Firm:	Firm:
Shipping Tracking #:	Condition/Cooler Temp:______	Date/Time:	Date/Time:	Date/Time:	Date/Time:

SOP – Sample Chain of Custody Rev1_May 23, 2017

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