FLOYD | SNIDER
strategy ▪ science ▪ engineering

Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel: 206.292.2078 fax: 206.682.7867

# Memorandum

**To:** Sunny Becker, Washington State Department of Ecology

**Copies:** City of Bothell

**From:** Kristin Anderson, Floyd|Snider

**Date:** December 30, 2022

**Project No:** City of Bothell- Ultra

**Re:** Pre-Remedial Design Investigation Work Plan, Ultra Custom Care Cleaners Site

This Pre-Remedial Design Investigation Work Plan (PDI Work Plan) has been prepared for the City of Bothell (City) for the Ultra Custom Care Cleaners Site (Site). The Site includes a source property located on the northeast corner of Bothell Way NE and NE 183rd Street and adjacent downgradient properties and rights-of-way (ROWs) within the downtown corridor of Bothell, Washington. This PDI Work Plan presents proposed additional sample collection to inform the design of the cleanup action for the Site in accordance with the Washington State Department of Ecology (Ecology) Cleanup Action Plan (CAP; Floyd|Snider 2022), which was issued in November 2022.

The results of the pre-design investigation described herein will be used to finalize the design for the cleanup action and will be included in the Engineering Design Report (EDR). The EDR will be submitted within 90 days of receipt of final pre-remedial design investigation data.

**BACKGROUND**

The source property for Site contaminants is the location of the former dry-cleaning operations conducted by Raincheck Cleaners and Laundry, NuLife Cleaners, and Ultra Custom Care Cleaners. The dry-cleaning operations took place from the 1950s until February 2012 when the City acquired the property and demolished the existing building, leaving the property vacant. The Site, which is defined by the extent of contamination resulting from the former dry-cleaning operations, includes areas of the source property, five downgradient private or City-owned properties, and three City ROWs.

The cleanup action selected by Ecology and presented in the CAP consists of multiple technologies to address the contaminants of concern (COCs) present in soil and groundwater at concentrations greater than cleanup levels (CULs) within the identified areas of concern (AOCs) The COCs include tetrachloroethene (PCE) in soil and arsenic, PCE, trichloroethene (TCE), *cis*-1,2-dichloroethene (DCE), and vinyl chloride in groundwater.

As shown in Figure 1, the following is a summary of the cleanup action for the Site:

- Excavation and off-site disposal of soil with PCE contamination greater than the CULs in soil within the source property; this includes three distinct areas as shown in Figure 1. Excavated areas will be backfilled with clean imported fill and restored with an asphalt or gravel surface. Removal of contaminated soil that exceeds Site CULs will eliminate potential ongoing sources of contamination to groundwater via leaching.
- In situ groundwater treatment, including zero-valent iron (ZVI) placement at the bottom of the deepest excavation area near the southern boundary of the source property prior to backfill, and proprietary PlumeStop direct push injections of liquid-activated carbon and sulfidated micro-ZVI (S-MZVI) along five downgradient treatment barriers. The target treatment barrier zone is expected to be 10 to 20 feet below ground surface (bgs) in shallow groundwater (barriers 1 and 2), 15 to 25 feet bgs in the shallow to deep transition zone (barrier 3), and 25 to 35 feet bgs in deep groundwater (barriers 4 and 5). The colloidal matrix will coat soil particles to increase the adsorption of groundwater contaminants and act as a passive treatment zone to immobilize contaminants and passively treat groundwater as it flows downgradient.
- Monitored natural attenuation (MNA) and groundwater monitoring will begin after removal of the soil source of contamination. As part of MNA, post-remedy groundwater monitoring throughout the plume and downgradient of in situ groundwater treatment barriers will be required after cleanup action implementation.
- Institutional controls including the soil and groundwater contamination protocols in place for the City-owned ROW will be implemented, if necessary, to address the remaining soil contamination in the ROW.

**PURPOSE**

This PDI Work Plan was developed to provide details for additional soil and groundwater data collection that will inform the engineering design of the cleanup action prior to remedy implementation for selected AOCs. The following additional data collection have been identified and will be detailed in this PDI Work Plan:

- **Excavation Design:** Current excavation design has been determined based on previous soil sampling within the source property area. The excavation design consists of three main excavation areas within the source property. The three excavation areas are shown in Figure 2 and described as follows.
    - **Area A:** Area A is located at the northwest corner of the source property and is estimated to require a final excavation depth of approximately 5.5 feet bgs within the 570-square-foot delineated area.

- **Area B:** Area B is located along the east property line of the source property and is estimated to require a final excavation depth of approximately 5 feet bgs within the 150-square-foot delineated area.
- **Area C**: Area C is located at the south end of the source property and extends from the west property line to the east property line. Area C is estimated to require a final excavation depth of approximately 9 feet bgs within the 950-square-foot delineated area.

Additional soil sampling and laboratory analyses are proposed to define the perimeter and depth of each excavation area more accurately to refine excavation design, support construction planning, and minimize field changes during construction.

- **Sidewall and base samples:** Additional sidewall and base samples will be collected around the estimated perimeter and base of each of the three intended excavation areas. Direct push drilling methods will be used for sample collection to verify the extent of contaminated soil at varying depths along the perimeter (based on the interval of contaminated soil in existing samples) and at the base of each of the intended excavation areas.
- **Samples to support a Contained-in Determination (CID):** Representative samples of PCE-contaminated soil will be collected from within the planned excavation areas to supplement existing data in a request for CID to be submitted to Ecology prior to cleanup action construction. The CID will allow excavated soil to be disposed of at a Subtitle D landfill. Samples to support a CID will be collected via direct push drilling concurrently with sidewall and base sample collection.

- **PlumeStop Design:** Additional soil and groundwater testing is needed to verify the design parameters of the PlumeStop barrier treatment zone injections. Regenesis Remediation Services (Regenesis), the PlumeStop design and application vendor, recommends deploying Passive Flux Meter (PFM) samplers at well locations along the groundwater plume to measure contaminant mass flux and Darcy flux in situ. PFMs provide high resolution mass flux data and groundwater seepage velocity data. Mass flux data and groundwater seepage velocity are key input values for remediation design. Regenesis additionally recommends collecting samples from within the groundwater treatment zone depth interval for grain size analysis to inform PlumeStop injection rates.

The additional data collection proposed in this PDI Work Plan will be conducted in accordance with the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) provided in the Data Gaps Investigation Work Plan (Floyd|Snider 2020a). The SAP provides details regarding sampling and analysis methods and field procedures, and the QAPP provides details about the organization, objectives, and quality assurance (QA) and quality control (QC) procedures for field and laboratory activities developed for the Site. Supplemental SAP and QAPP sections are included in this PDI Work Plan to provide details specific to the pre-remedial design investigation that were not previously included in the Data Gaps Investigation Work Plan SAP/QAPP.

The results of the data collected in accordance with this PDI Work Plan will be provided in the EDR.

**EXCAVATION PRE-DESIGN INVESTIGATION**

Additional characterization of PCE is proposed to refine excavation extents of each of the three excavation areas. A total of eight sidewall samples and three base samples are proposed for collection. Soil samples will be collected to delineate the excavation base and sidewalls prior to excavation. Sidewall and base samples will be collected to the extent possible using direct push drilling to minimize construction delays due to iterative sampling and better understand the need for potential safety requirements caused by open excavation near public ROWs.

Excavation base samples will be collected at an approximate frequency of one sample per 400 square feet of excavation area to determine the depth of excavation. Excavation sidewall samples will be collected at an approximate frequency of one sample per 20 linear feet of sidewall and will be collected from the interval of soil where PCE was previously detected in existing samples. Several existing remedial investigation soil data collection points are located within the target area and depth interval of recommended sidewall and base samples. Where available, suitable existing data will be used as excavation confirmation samples. The following bullets summarize the sidewall and base sample needs for each excavation area (A through C) as labeled in Figure 2.

- **Excavation Area A:**
    - One base sample at a target depth interval of 5 to 6 feet bgs (proposed)
    - Four sidewall samples at a target depth interval of 2.5 to 3.5 feet bgs (includes two existing samples and two proposed samples)
- **Excavation Area B:**
    - One base sample at a target depth interval of 4.5 to 5.5 feet bgs (proposed)
    - Two sidewall samples at a target depth interval of 2 to 3 feet bgs (proposed)
- **Excavation Area C**:
    - Three base samples at a target depth interval of 9 to 10 feet bgs (includes two existing samples and one proposed sample)
    - Six sidewall samples at a target depth interval of 4.5 to 5.5 feet bgs (includes one existing sample and four proposed samples)

Although the above presents the target depth for base and sidewall samples, field indicators such as odor or elevated volatiles screening results using a photoionization detector (PID) will also be used to determine the appropriate sidewall sample depth.

Additional characterization of PCE and its breakdown products (TCE, *cis*-1,2-DCE, *trans*-1,2-DCE, and vinyl chloride) is also proposed to supplement data previously collected during remedial investigations where PCE exceeding the CUL was detected in soil. These samples will provide recent characterization data to support a CID request to Ecology. A CID is necessary to support off-site disposal of PCE-contaminated soil, which is a hazardous waste per the Resource Conservation and Recovery Act (40 CFR Section 261.31), to a Subtitle D landfill instead of at a Subtitle C landfill. One soil sample will be collected from the overlying contaminated soil at each proposed excavation base sample location (three samples total). Consistent with proposed sidewall sampling, depths corresponding to existing samples with CUL exceedances will be targeted for characterization samples, and field indicators such as odor or elevated volatiles concentrations measured with a PID will be used to determine the most contaminated interval.

Nomenclature, sampling methodology, and analytical methods are described in more detail in the supplemental SAP/QAPP in the following sections.

## IN SITU TREATMENT BARRIER PRE-DESIGN INVESTIGATION

Additional investigation will be performed to verify the final design parameters for injection of the PlumeStop and S-MZVI in situ treatment barriers. These tests include measurement of the contaminant mass flux, groundwater mass characterization, and soil grain size.

### Passive Flux Meter Installation and Retrieval

PFMs are devices installed in monitoring wells to measure the vertical profile of horizontal contaminant flux through the groundwater table. PFMs are constructed from a long outer mesh liner filled with a mixture of sorbent and tracer material that are placed into monitoring wells and later retrieved for analysis after a set amount of time. The chosen sorbent material in the PFM, typically activated carbon for measurement of chlorinated volatile organic compounds (cVOCs), adsorbs to the passing contaminants in groundwater while the tracer chemicals are leached away at a steady rate based on the groundwater flow. After the PFM is retrieved and tested for the cumulative concentration of cVOCs adsorbed and the concentration of tracer chemical remaining, the time-averaged flux of cVOCs through the vertical profile of the groundwater table can be calculated.

PFMs will be installed in monitoring wells UCCMW-29 (shallow barrier 2), UCCMW-34D (deep barrier 5), and BB-2 (shallow to deep transition barrier 3), shown on Figure 3, with samples taken at every 2 feet of the saturated screen interval and analyzed for PCE, TCE, *cis*-1,2-DCE, vinyl chloride, and Darcy flux. These wells were selected based on their location relative to the proposed PlumeStop barrier locations and the elevated concentrations of cVOCs measured in groundwater at these locations. The selected wells are constructed with 10-foot or 15-foot screened intervals, and the screens are generally situated below the groundwater table; therefore, two or three 5-foot PFM sections will be installed per location to sample the full groundwater vertical profile. PFMs will be left in these wells for 2 to 3 weeks then retrieved for collection and analyses of sorbent media samples.

**Groundwater Sample Collection**

Groundwater samples will also be collected from monitoring wells UCCMW-29, UCCMW-34D, and BB-2 (refer to Figure 3) to analyze groundwater geochemical parameters that can impact the effectiveness of the PlumeStop and S-MZVI materials to adsorb and break down cVOCs. The natural groundwater chemistry also impacts the rate at which the PlumeStop polymer transitions from being mobile at the injection point to stabilizing as it adheres to the surrounding soil. Therefore, measurement of groundwater hardness characteristics, including calcium concentrations, is also important for design. The following constituents will be analyzed in groundwater to support design:

- Total arsenic, calcium, iron, and magnesium by USEPA Method 200.7/6010D
- Dissolved calcium, iron, and magnesium by USEPA Method 200.7/6010D
- Sulfate by ASTM D516-11
- Nitrate by USEPA Method 353.2

In addition, the following parameters will be measured using a water quality meter and documented prior to sample collection:

- Temperature
- Total dissolved solids
- pH
- Oxidation–reduction potential
- Dissolved oxygen
- Conductivity
- Turbidity

**Soil Sample Collection and Grain Size Analysis**

Soil samples will be collected from three proposed soil borings along the PlumeStop barrier installation locations as shown on Figure 3. The soil data collection is targeted within the zone for PlumeStop injection (approximately 10 to 20 feet bgs for shallow injections and up to 25 to 35 bgs for deep injections) to provide information about grain size distribution that will inform PlumeStop injection design. Due to access considerations, soil samples will additionally be taken at barrier 4 from 15 to 25 feet bgs, in addition to the samples taken from 25 to 35 feet bgs, to characterize grain size distribution in the shallow-to-deep injection zone. Soil borings will be advanced to a maximum depth of 35 feet bgs using direct push drilling methods.

Starting at the top of the target PlumeStop injection zone, soil samples will be field screened using a PID. Soil samples will be analyzed for grain size in 1-foot increments by filling 40-milliliter vials one-third full of soil, topping with water leaving 0.25-inch air pocket, agitating, and allowing the samples to sit overnight. Photographs of each vial will be taken before and after analysis for documentation purposes.

In addition to the field analysis described above, one additional sample will be taken every 5 feet within the targeted injection interval from each soil boring and will be analyzed for sieve analysis using ASTM D422 to correlate the field-measured versus lab-measured samples.

## SUPPLEMENTAL SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

Sample collection, analysis, and data validation for the pre-remedial design investigation will be performed in accordance with the SAP/QAPP presented in the Data Gaps Investigation Work Plan (Floyd|Snider 2020a), with supplemental information for additional data collection procedures and additional and updated analytical methods as described in the following sections.

### Field Sampling Methodology

All soil samples will be photographed and logged according to the Unified Soil Classification System prior to sampling. Samples for volatiles analysis will be collected using a dedicated plunger and placed in airtight vials prior to disturbing the sample material for additional observation or analysis. Floyd|Snider standard guidelines for soil logging, soil sampling, and low-flow groundwater sample collection are presented in Attachment 1. Procedures for installing, retrieving, and sampling the PFMs is included in the manufacturer's PFM Protocol Manual (Attachment 2). During ground-disturbing field activities, personnel will follow the monitoring protocols specified in the Inadvertent Discovery Plan for the Site (Floyd|Snider 2020b). Health and safety protocols will be implemented as specified in the Site Health and Safety Plan, provided as Appendix C to the Data Gaps Investigation Work Plan (Floyd|Snider 2020a).

### Sample Identification and Labeling

Samples will be placed into laboratory-provided containers and preserved for transmittal to the appropriate laboratory. Samples collected as part of this investigation will be identified and labeled as followed:

- Excavation Area Sidewall Samples: Excavation area - "S" sample number - depth interval. For example, the third sidewall sample collected at Area A from 3 to 4 feet bgs would be labeled "Area A-S3-3-4." Sample collectors should use a GPS or mark approximate locations of samples on a map as they collect to track sample numbers and locations. Samples numbers should start with 1 at the northwest corner and working around the extent in a clockwise manner as possible.
- Excavation Area Base Samples: Excavation area - "B" sample number - depth interval. For example, the first base sample collected at Area B from 4 to 5 feet bgs would be labeled "Area B-B1-4-5." Sample collectors should use a GPS or mark approximate locations of samples on a map as they collect to track sample numbers and locations.

- PlumeStop Design Media Samples: Well ID number - depth interval. For example, the media sample collected from UCCMW-18 from 11 to 12 feet bgs would be labeled "UCCMW-18-11-12."
- PlumeStop Design Soil Samples: Barrier number - depth interval. For example, the soil sample collected from the midpoint of Barrier 2 from 10 to 15 feet bgs would be labeled "Barrier 2-10-15."
- Groundwater Samples: Monitoring well number - month/day/year of collection. For example, a groundwater sample collected from UCCMW-18 on January 15, 2023, would be labeled "UCCMW-18-011523."

**Laboratory Methods, Quality Assurance, and Quality Control**

Soil and groundwater samples will be submitted under chain-of-custody protocol to OnSite Environmental in Redmond, Washington, for laboratory analyses as described in previous sections of this PDI Work Plan. PFM media samples will be submitted under chain-of-custody protocol to EnviroFlux in Gainesville, Florida, for Darcy flux analysis. Grain size samples will be submitted under chain-of-custody protocol for visual analysis by Regenesis. Supplemental QAPP details, including additional analytes, are included in as follows:

- Table 1 includes sample container and preservation requirements for all analyses.
- Table 2 includes analytical methods and quantitation limits for OnSite Environmental.
- Table 3 presents data QA and QC criteria for OnSite Environmental.

**REFERENCES**

Floyd|Snider. 2020a. *Ultra Custom Care Cleaners Site Data Gaps Investigation Work Plan.* Prepared for City of Bothell. March.

_____. 2020b. *Ultra Custom Care Cleaners Site Inadvertent Discover Plan.* Prepared for City of Bothell. April.

_____. 2022. *Ultra Custom Care Cleaners Site Cleanup Action Plan.* Prepared for City of Bothell. November.

**LIST OF ATTACHMENTS**

# Tables

# Table 1
## Analytical Requirements, Methods, Preservation, Bottle Type, and Holding Times

| Chemical | Analytical Method | Bottle Type | Preservative | Holding Time |
|---|---|---|---|---|
| **Soil** | | | | |
| Volatile organic compounds (tetrachloroethene, trichloroethene, *cis* -1,2-dichloroethene, *trans*- 1,2-dichloroethene, vinyl chloride) | USEPA Method 8260D | 4-oz WMG, three 40-mL pre-weighted VOA vials: 2 with stir bar, 1 without | Cool to <4 °C | 48 hours to freeze or preserve VOA vials, 14 days to analyze |
| Grain size | ASTM D422 | 16-oz WM HDPE | Cool to <4 °C | 6 months |
| Grain size | Visual Method | One 40-mL vial with 2/3 of volume water and headspace air | None | None |
| **Groundwater** | | | | |
| Total metals (arsenic, calcium, iron, magnesium) | USEPA Method 200.7/6010D | One 250-mL HDPE | HDPE: $HNO_3$ to pH<2 Cool to <4 °C | 6 months |
| Dissolved metals (calcium, iron, magnesium) - field filtered | USEPA Method 200.7/6010D | One 250-mL HDPE | HDPE: $HNO_3$ to pH<2 Cool to <4 °C | 6 months |
| Sulfate | ASTM D516-11 | 250-mL HDPE | Cool to <4 °C | 28 days |
| Nitrate | USEPA Method 353.2 | 500-mL HDPE | Cool to <4 °C | 48 hours |

Abbreviations:

°C Degrees Celsius
HDPE High-density polyethylene
mL Milliliters
oz Ounces
VOA Volatile organic analysis
WM Wide-mouth
WMG Wide-mouth glass jar

# Table 2
## Analytical Methods, Detection Limits, and Reporting Limits

| Chemical | Units | Analytical Method | Method Detection Limit | Practical Quantitation Limit |
|---|---|---|---|---|
| **Soil** | | | | |
| **Volatile Organic Compounds** | | | | |
| Tetrachloroethene | mg/kg | USEPA 8260D | 0.00036 | 0.0010 |
| Trichloroethene | | | 0.00038 | 0.0010 |
| *cis* -1,2-Dichloroethene | | | 0.00031 | 0.0010 |
| *trans* -1,2-Dichloroethene | | | 0.00042 | 0.0010 |
| Vinyl chloride | | | 0.00045 | 0.0010 |
| **Groundwater** | | | | |
| **Metals** | | | | |
| Total arsenic | µg/L | USEPA 200.7/6010D | 0.36 | 3.3 |
| Total calcuim | | | 45 | 100 |
| Dissolved calcium | | | 90 | 110 |
| Total iron | | | 32 | 50 |
| Dissolved iron | | | 22 | 56 |
| Total magnesium | | | 86 | 100 |
| Dissolved magnesium | | | 33 | 110 |
| **Conventionals** | | | | |
| Sulfate | mg/L | ASTM D516-11 | 1.8 | 5.0 |
| Nitrate | | USEPA 353.2 | 0.042 | 0.050 |

Abbreviations:
µg/L Micrograms per liter
mg/kg Milligrams per kilogram
mg/L Milligrams per liter

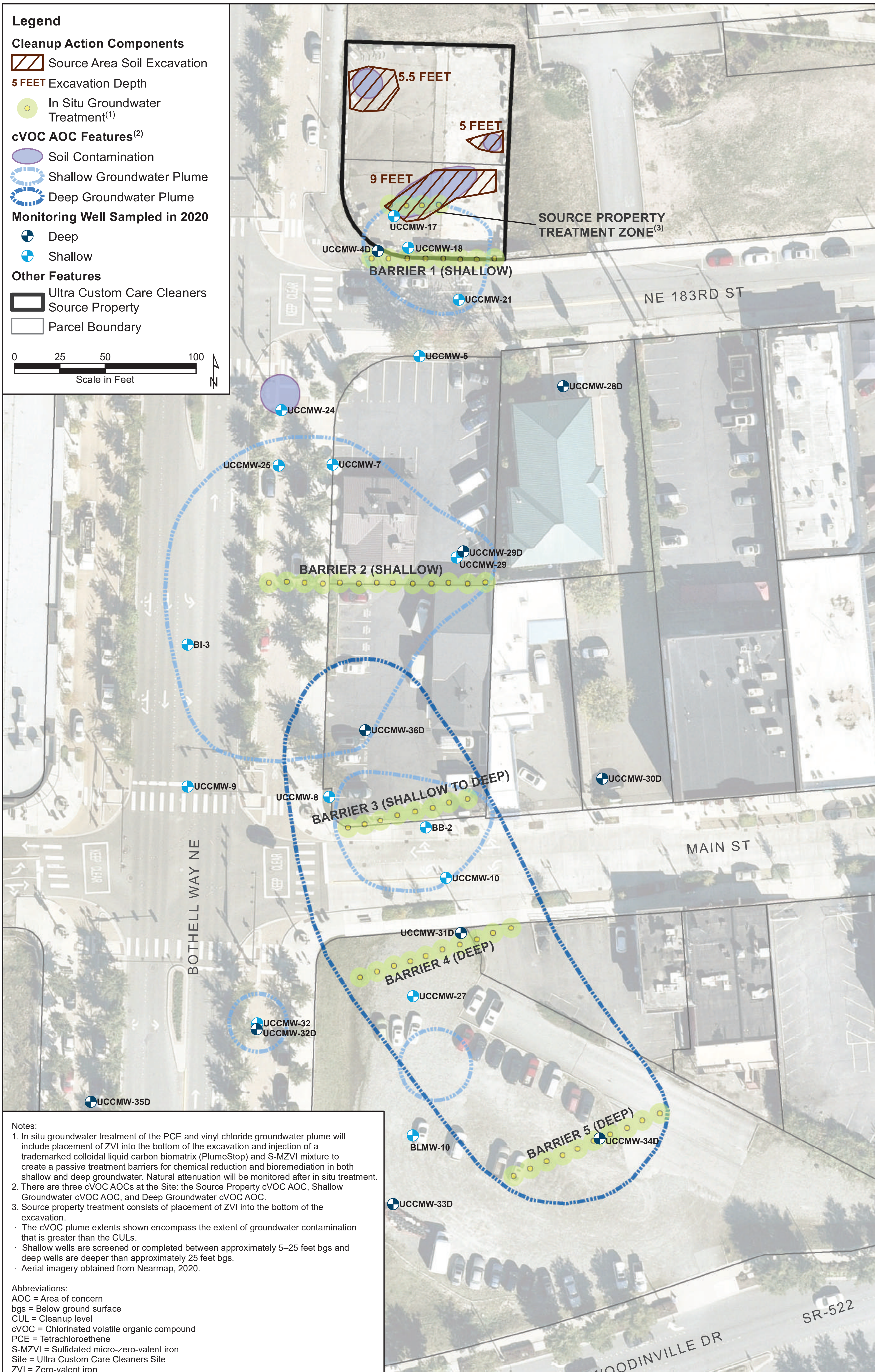
**Table 3**
**Data Quality Assurance Criteria**

| Chemical | Precision [1] | Accuracy | Completeness | Reference |
|---|---|---|---|---|
| **Soil** | | | | |
| Volatile organic compounds (tetrachloroethene, trichloroethene, *cis* -1,2-dichloroethene, *trans* -1,2-dichloroethene, vinyl chloride) | ±20% RPD | 60–140% | 95% | USEPA 8260D |
| **Groundwater** | | | | |
| Metals (total arsenic, calcium, iron and magnesium; dissolved calcium, iron and magnesium) | ±20% RPD | 75–125% | 95% | USEPA 200.7/6010D |
| Sulfate | ≤10% RPD | 72–128% | 95% | ASTM D516-11 |
| Nitrate | ≤10% RPD | 88–125% | 95% | USEPA 353.2 |

Note:
1 Precision criteria apply to analytical precision only. Field duplicate precision will be screened against an RPD of 75%.

Abbreviations:
RPD Relative percent difference

# Figures




Notes:
1. In situ groundwater treatment of the PCE and vinyl chloride groundwater plume will include placement of ZVI into the bottom of the excavation and injection of a trademarked colloidal liquid carbon biomatrix (PlumeStop) and S-MZVI mixture to create a passive treatment barriers for chemical reduction and bioremediation in both shallow and deep groundwater. Natural attenuation will be monitored after in situ treatment.
2. There are three cVOC AOCs at the Site: the Source Property cVOC AOC, Shallow Groundwater cVOC AOC, and Deep Groundwater cVOC AOC.
3. Source property treatment consists of placement of ZVI into the bottom of the excavation.

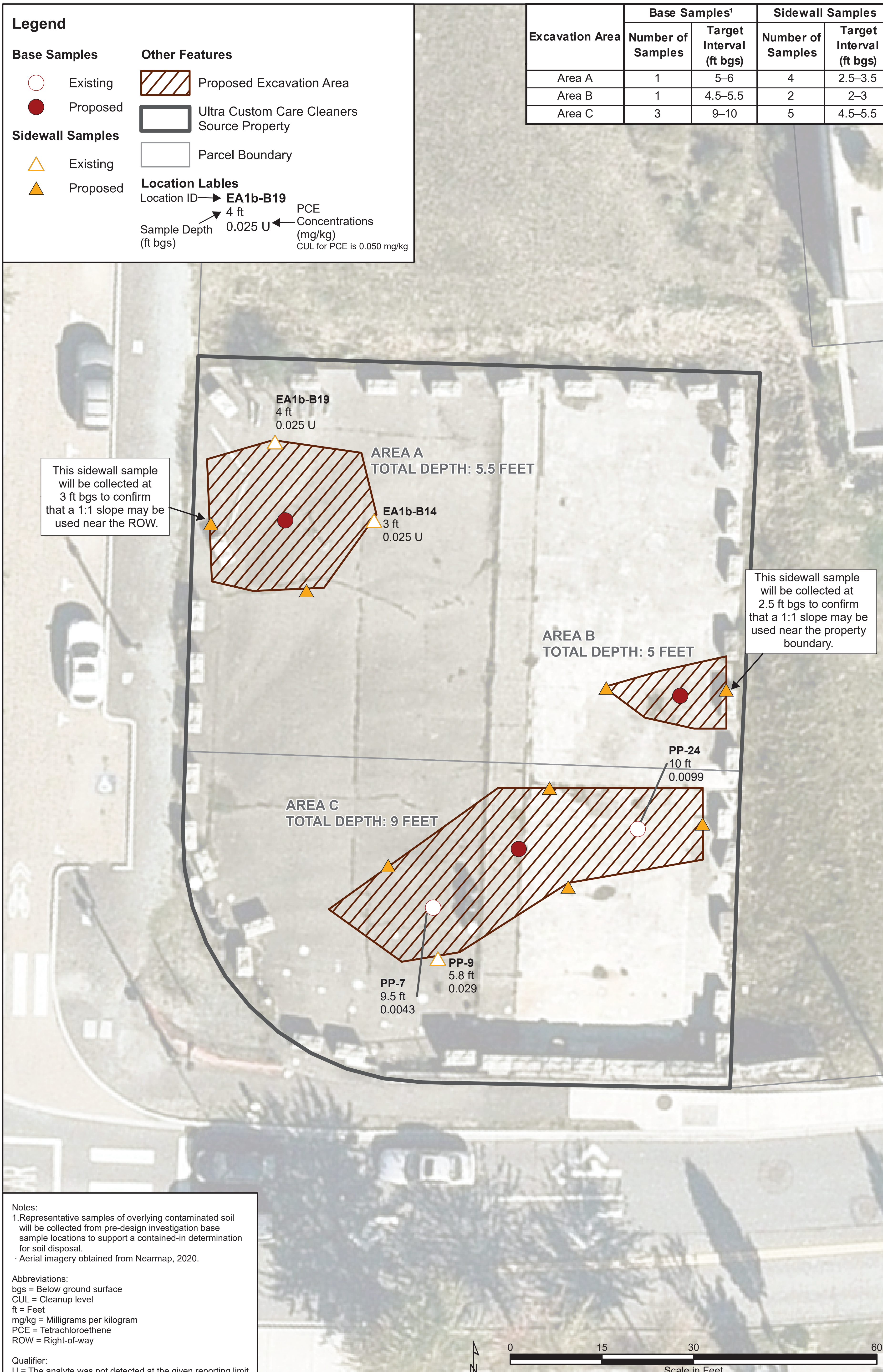
· The cVOC plume extents shown encompass the extent of groundwater contamination that is greater than the CULs.
· Shallow wells are screened or completed between approximately 5–25 feet bgs and deep wells are deeper than approximately 25 feet bgs.
· Aerial imagery obtained from Nearmap, 2020.

Abbreviations:
AOC = Area of concern
bgs = Below ground surface
CUL = Cleanup level
cVOC = Chlorinated volatile organic compound
PCE = Tetrachloroethene
S-MZVI = Sulfidated micro-zero-valent iron
Site = Ultra Custom Care Cleaners Site
ZVI = Zero-valent iron

| | | |
|---|---|---|
| FLOYD \| SNIDER<br>strategy ▪ science ▪ engineering | **Pre-Remedial Design Investigation Work Plan<br>Ultra Custom Care Cleaners Site<br>Bothell, Washington** | Figure 1<br>Cleanup Action Components |

I:\GIS\Projects\COBothell-Ultra\MXD\PDI Work Plan\Pre Remedial Work Plan\Figure 1 Cleanup Action Components.mxd
12/28/2022

DRAFT




| Excavation Area | Base Samples[1] | | Sidewall Samples | |
|---|---|---|---|---|
| | Number of Samples | Target Interval (ft bgs) | Number of Samples | Target Interval (ft bgs) |
| Area A | 1 | 5–6 | 4 | 2.5–3.5 |
| Area B | 1 | 4.5–5.5 | 2 | 2–3 |
| Area C | 3 | 9–10 | 5 | 4.5–5.5 |

Notes:
1. Representative samples of overlying contaminated soil will be collected from pre-design investigation base sample locations to support a contained-in determination for soil disposal.
· Aerial imagery obtained from Nearmap, 2020.

Abbreviations:
bgs = Below ground surface
CUL = Cleanup level
ft = Feet
mg/kg = Milligrams per kilogram
PCE = Tetrachloroethene
ROW = Right-of-way

Qualifier:
U = The analyte was not detected at the given reporting limit.

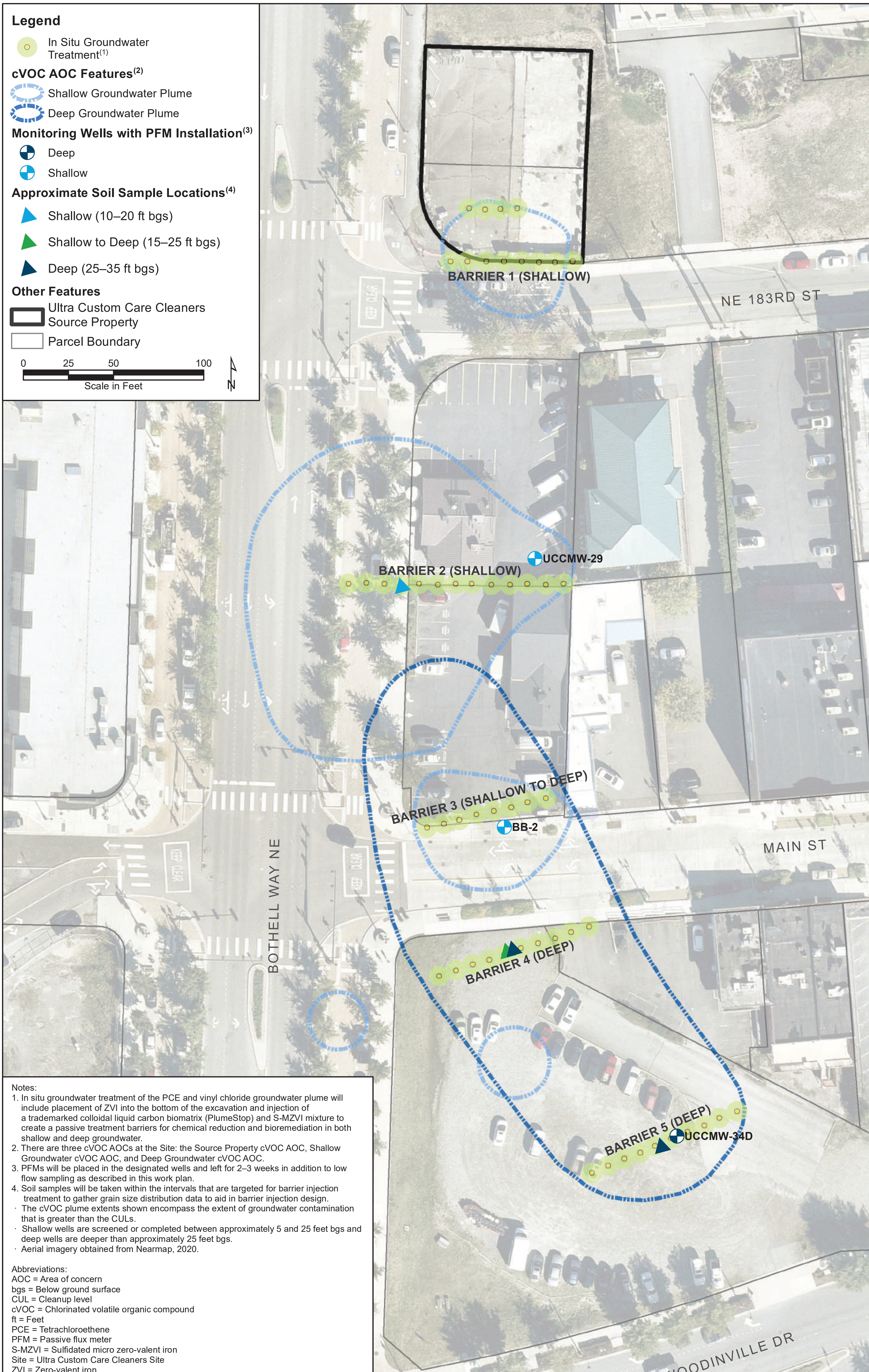
FLOYD | SNIDER
strategy ▪ science ▪ engineering

**Pre-Remedial Design Investigation Work Plan**
**Ultra Custom Care Cleaners Site**
**Bothell, Washington**

Figure 2
Excavation Pre-Design Investigation Sample Plan

I:\GIS\Projects\COBothell-Ultra\MXD\PDI Work Plan\Pre Remedial Work Plan\Figure 2 Excavation Design Investigation Sample Plan.mxd
12/28/2022

DRAFT




Notes:
1. In situ groundwater treatment of the PCE and vinyl chloride groundwater plume will include placement of ZVI into the bottom of the excavation and injection of a trademarked colloidal liquid carbon biomatrix (PlumeStop) and S-MZVI mixture to create a passive treatment barriers for chemical reduction and bioremediation in both shallow and deep groundwater.
2. There are three cVOC AOCs at the Site: the Source Property cVOC AOC, Shallow Groundwater cVOC AOC, and Deep Groundwater cVOC AOC.
3. PFMs will be placed in the designated wells and left for 2–3 weeks in addition to low flow sampling as described in this work plan.
4. Soil samples will be taken within the intervals that are targeted for barrier injection treatment to gather grain size distribution data to aid in barrier injection design.
- The cVOC plume extents shown encompass the extent of groundwater contamination that is greater than the CULs.
- Shallow wells are screened or completed between approximately 5 and 25 feet bgs and deep wells are deeper than approximately 25 feet bgs.
- Aerial imagery obtained from Nearmap, 2020.

Abbreviations:
AOC = Area of concern
bgs = Below ground surface
CUL = Cleanup level
cVOC = Chlorinated volatile organic compound
ft = Feet
PCE = Tetrachloroethene
PFM = Passive flux meter
S-MZVI = Sulfidated micro zero-valent iron
Site = Ultra Custom Care Cleaners Site
ZVI = Zero-valent iron

FLOYD | SNIDER
strategy • science • engineering

**Pre-Remedial Design Investigation Work Plan**
**Ultra Custom Care Cleaners Site**
**Bothell, Washington**

Figure 3
In Situ Treatment Barrier Pre-Design Sample Plan

I:\GIS\Projects\COBothell-Ultra\MXD\PDI Work Plan\Pre Remedial Work Plan\Figure 3 In Situ Treatment Barrier Pre Design Investigation Plan.mxd
12/28/2022

DRAFT

# Attachment 1
# Field Standard Guidelines

Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel: 206.292.2078 fax: 206.682.7867

# F|S STANDARD GUIDELINE

# Soil Logging

DATE/LAST UPDATE: October 2019

*These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field, but are not intended to be step by step procedures, as some steps may not be applicable to all projects.*

*All field staff should be sufficiently trained in the standard guidelines and should review and understand these procedures prior to going in the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.*

## 1.0 Scope and Purpose

These soil logging standard guidelines should be used by the field staff performing subsurface investigations, such as a direct push or roto-sonic soil boring, installation of a monitoring well via hollow stem auger, or roto-sonic or mud rotary drilling. While many projects will not necessarily have a Licensed Geologist (LG) or Hydrogeologist (LHG) who reviews and stamps every boring log, it is important that the field staff discusses the soil logging needs for a particular investigation with the project geologist, the project manager, or whoever will ultimately be responsible for interpreting the findings of the field investigation. This discussion is in addition to field training and general knowledge about soil logging, and should happen prior to entering the field, with additional follow-up before drafting a final set of electronic logs, after the investigation is complete.

## 2.0 Equipment and Supplies

**Logging Equipment and Tools:**

- 100-foot tape measure or measuring wheel
- Handheld Global Positioning System (GPS; optional)
- Unified Soil Classification System (USCS) Soil Classification Field Guide
- Soil logging kit containing:

  - Stainless steel spoons
  - Paint scraper or trowel
  - Small Ziploc bags
  - Small stainless steel bowls or black mining pans for sheen testing
  - Spray bottle filled with water
  - Paper towels (preferably white)
  - Engineers tape
  - Note cards
  - Optional items include:
    - Empty VOA vials or small glass jars
    - Munsell color chart
    - Sieves
    - White and grayscale color cards for photographs
- Plastic sheeting and duct tape or clamps to cover the sampling table
- Camera
- Trash bags
- Coolers
- Jars
- Labels
- Ice

**Paperwork:**

- Work Plan and/or Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP)
- Health and Safety Plan (HASP)
- Copies of figures showing previous boring locations and boring logs from previous investigations, if available
- Boring log forms (enclosed) appropriate for drilling method, printed in Rite in the Rain paper and/or bound field notebook
- Permanent markers and pencils

**Personal Equipment:**

- Steel-toed boots
- Hard hat
- Safety vest

- Safety glasses
- Nitrile gloves
- Ear plugs
- Rain gear
- Work gloves

# 3.0 Standard Procedures

## 3.1 OFFICE PREPARATION

First, meet with the project manager or field manager to identify the key information and goals of the soil boring investigation. These may include fill history, known or suspected sources of contamination and potential field indications of these contaminants, identification of specific units, or important geotechnical measurements. If possible, select a boring log template that is appropriate for the project needs.

Next, review the work plan and all available existing materials such as cross-sections or boring logs from previous investigations to familiarize yourself with the site geology. In addition (or alternatively if other information is not available), you may also review a geologic map of the area from a reputable source such as United States Geological Survey (USGS).

Finally, check the area of the site where drilling will occur for underground objects. At minimum, a OneCall locate request should be made at least one week in advance of drilling in order to give public utility locators time to mark known buried utility lines. All planned boring locations should be marked on the ground with white spray paint prior to making a locate request. In almost all cases, a private utility locator should also clear the area of drilling any underground objects using electromagnetic techniques. If drilling is to occur in close proximity to buried utilities, the work plan may specify use of an air knife or vacuum to clear the borehole to a depth below the utility lines.

## 3.2 COLLECTING SOIL SAMPLES FOR CLASSIFICATION

1. Before beginning drilling, record the following information on each log:
    a. Operator’s name and company, equipment make/model, equipment measurements (i.e., sampler length and diameter, hammer weight and stroke if using hollow stem auger, boring diameter)
    b. Your name, date, project, boring name and approximate descriptive location (i.e., where is the soil boring relative to known site features). Include a description of the ground surface and whether or not coring was necessary, if coring was necessary, include core diameter, concrete thickness, and subcontractor information.

   c. A small hand drawn map showing your location with measurements to a stationary reference point, or GPS coordinates (ideally, both). This is also a good place to note if you have had to move a boring location because of underground utilities, access issues, etc. It is important to note the reason for relocation and the direction and distance moved (i.e., moved 10 feet to the north due to presence of subsurface water line).

2. If you are using a hollow stem auger drilling method, it is important to communicate to the driller how often you would like a split spoon sample collected. Typically this would be continuous or every 5 feet but may be different depending on the project needs.
3. Note any feedback from the driller about the drilling conditions. This may include difficult drilling or rig chatter (usually caused by hard materials), heaving sands (usually caused by hydrostatic pressure on the borehole), caving, or hole instability.
4. For split spoon samples, record the number of hammer blows (blow counts) necessary to drive the sampler each 6-inch increment, as reported by the driller. If more than 50 blows are needed, record the distance that the sampler was driven in 50 blows (i.e., 2-inches in 50 blows). This is referred to as the standard penetration test.
5. Cover the sampling table with plastic sheeting. Lay an engineer's tape lengthwise across the sampling table. Once a sample has been collected, orient it on the table so that the top is aligned with the 0-foot mark on the tape.
6. Split open the sampler, core barrel liner, or sample collection bag. Record the depth interval that the sampler was driven and the depth interval of soil that was recovered. For split spoons or single-cased core barrels, such as Geoprobe direct-push rods, determine whether any loose 'slough' soil has been dislodged by the drilling equipment and deposited at the top of your core (AMS direct push rods are double cased and do not create slough). Do not include slough in the measurement of the soil recovered. Often the core will be filled with an uninterrupted column of soil that is shorter in length than the total drive interval. In such cases, record the recovery interval as it is situated in the core unless you are able to determine the actual depth where the soil sample originated. For the purposes of recording soil observations and collecting samples for analysis, assume that the recovered column of soil has been evenly compressed unless you are able to determine the interval(s) in which compression has occurred. Decompress the recovered soil when making further observations (e.g., if the recovered soil column is 80 percent of the length of the drive interval, assume 0.8 feet of recovered soil represent 1 foot of soil in situ).
7. Before further disturbing the soil, take volatile organic compound (VOC) measurements with a photoionization detector (PID), if using. Take measurements by making crevices in the soil with a spoon or scraper and inserting the PID probe into these openings. Alternatively, collect small spoonfuls of soil into Ziploc bag(s), seal the bag(s), gently shake the bag(s), and insert the PID probe through the top of the bag(s) and into the headspace once the soil vapor has been allowed to equilibrate with the

surrounding air (headspace method). The bag headspace screening method is typically more accurate and is useful at sites with low concentrations of VOCs, whereas the in-situ method is a faster and more qualitative method, best used at sites with higher VOC concentrations. If sampling for VOCs by the U.S. Environmental Protection Agency (USEPA) Method 5035, these soil samples should also be collected prior to disturbing the core. Soil sampling procedures using USEPA Method 5035 are described in detail in the Soil Sample Collection Standard Guideline.

8. Use a straight edge to scrape the soil level and expose the center of the core. Photograph the core alongside the measuring tape and an index card displaying the soil boring location/ID and depth interval.

### 3.3 SOIL CLASSIFICATION

Soils are described using the following characteristics: Color, consistency, MAJOR CONSTITUENT, minor constituent, geotechnical properties, moisture content, other observations (e.g. visual or olfactory indications of contamination). The USCS field guide is included in this guidance for reference. The steps below should help guide the logger in classifying soils according to the USCS.

1. Record the color of the soil. A descriptive color (i.e., light brown) or a color identified using the Munsell color chart are both valid.
2. Determine whether organic matter influences the properties of the material. If so, record as an organic soil.
3. If the soil is predominantly inorganic, identify whether the major constituent is coarse- or fine-grained. Coarse-grained soils include sands and gravels; fine-grained soils include silts and clays.
    a. For coarse grained soils, determine:
        i. Grain size(s) present including fine, medium, or coarse, and grain size distribution including well-graded (a mixture of fine to coarse grains) or poorly-graded (uniform in size). The USCS guide is helpful for determining grain sizes. If the major constituent is gravel, note its angularity using “rounded,” “sub-angular” or “angular.”
        ii. Minor constituent(s). If a minor constituent represents less than approximately 15% of the sample, note this as “with [minor constituent]” and optionally, whether it is “trace” (<5%) or “few” (5-15%). If a minor constituent represents more than 15% of the sample, use “[minor constituent]-y.” For example, a sand with 5% silt would be classified as a “SAND with trace silt” and sand with 30% silt would be classified as a “SILTY SAND.” For coarse-grained soils with fines between 5% and 15%, the USCS includes several dashed classifications, such as SW-SM. It is often helpful to record an estimated percentage for soil constituents to aid in classification according to the USCS.

b. For fine-grained soils, determine:

   i. Major constituent. To determine whether a material is silt or clay, a simple settling test may be performed in a glass vial or gloved hand by spraying a small amount of the sample with water. Silt particles will settle out of suspension in water within a few minutes, whereas clay particles will remain suspended for a longer period of time.

   ii. Minor constituent(s). As described above, determine the approximate percentage and record as "with [minor constituent]" or "[minor constituent]-y" as appropriate. It is often helpful to record an estimated percentage to aid in classification according to the USCS.

   iii. Geotechnical properties. Depending on project data needs, geotechnical properties may be optional but often provide helpful information. Geotechnical properties include plasticity (ranging from "non-plastic" to "highly plastic" as determined by a thread test) and consistency (ranging from "loose" to "very dense" for coarse-grained soils and "soft" to "hard" for fine-grained soils). When using split spoon samplers, blow counts recorded during the standard penetration test (also referred to as N-values) are used to determine consistency; when using direct-push or sonic drilling, consistency is described qualitatively.

4. Using the USCS guide and the description of the soil, determine the appropriate USCS symbol and record it on the log. If it is difficult to distinguish the major constituent of a soil, a borderline "/" symbol may be used to denote the two potential major constituents present. This is not the same as the USCS classifications that utilize a dash, such as SW-SM.

5. Determine whether contacts between stratigraphic units are abrupt, or gradational. Note abrupt contacts using a solid line and gradational contacts using a dotted line. If the contact between units is not visible and was missed between sample depths, a dashed line is used.

6. If the site or area geology is known, and you are confident in your identification of a specific stratum, note the geologic unit. At a site where the geology is uncertain, you may make some more general notes about the depositional environment, such as identifying probable estuarine deposits, colluvium, glacial till, etc.

7. Note the moisture content of the soil, using "dry," "moist," "wet," or "saturated." Mark the water table at the time of drilling on the log at the depth where saturated soil is first observed.

### 3.4 OTHER OBSERVATIONS

1. Record other materials observed in the sample. These may include minor amounts of rootlets or other plant matter, evidence of organisms such as shell fragments, and/or anthropogenic debris such as brick fragments, plastic, or metal debris.
2. Record potential indications of contamination. These may include odors, colored or black staining on soils, colored crystals, hydrocarbon sheens, or non-aqueous phase liquid (NAPL) product.
   a. To test for hydrocarbon sheen, put a small amount of soil in a bowl, saturate with water and swirl, noting whether a rainbow sheen appears on the surface of the water. Alternatively, place a small amount of water in the bottom of the bowl and a small amount of soil along the side, then tilt the bowl so that the water slowly touches the soil. If observed, note the color of the sheen and describe as slight (discontinuous on the water surface), moderate (continuous but spreading slowly) or high (rainbow sheen covering entire surface water).
   b. To test for the presence of NAPL, use a clean paper towel to blot the surface of the core and note the proportion of the towel that is saturated with oil (be sure to allow the towel to dry when blotting moist to wet soils to distinguish between saturation due to NAPL and due to water).
3. Note the final depth of the boring and any reasons for early termination of the boring (i.e., refusal).
4. If monitoring wells will be installed, follow the Standard Guidelines for monitoring well construction and well development.

## 4.0 Decontamination

All reusable equipment that comes into contact with soil should be decontaminated as follows prior to moving to the next sampling location.

Split spoons, stainless steel bowls and spoons, and any other tools used for soil classification must be decontaminated between boring locations. If collecting soil samples for chemical analysis, split spoons and any tools used for sample processing must be decontaminated between each sample; alternatively, disposable bowls and spoons may be used. Equipment decontamination will consist of a tap water rinse to remove soil particles, followed by scrubbing with brushes and an alconox (or similar)/clean water solution and a final rinse with distilled or deionized water.

## 5.0 Investigation-Derived Waste

Unless otherwise specified in the project work plan, waste soils and other drilling materials generated during soil boring activities will be contained, transported, disposed of in accordance with applicable laws, and stored in a designated area until transported off-site for disposal.

The approach to handling and disposal of these materials is as follows. For investigation-derived waste (IDW) that is contained, such as waste soils, 55-gallon drums approved by the Washington State Department of Transportation (WSDOT) will be supplied by the driller and used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., "soil cuttings"), the dates on which the wastes were placed in the container, the owner's name, contact information for the field person who generated the waste, and the site name.

Whenever possible, IDW contained within drums will be characterized relative to applicable waste criteria using data from the sampling locations. Material that is designated for off-site disposal will be transported to an off-site facility that is permitted to accept the waste. Manifests will be used as appropriate for disposal.

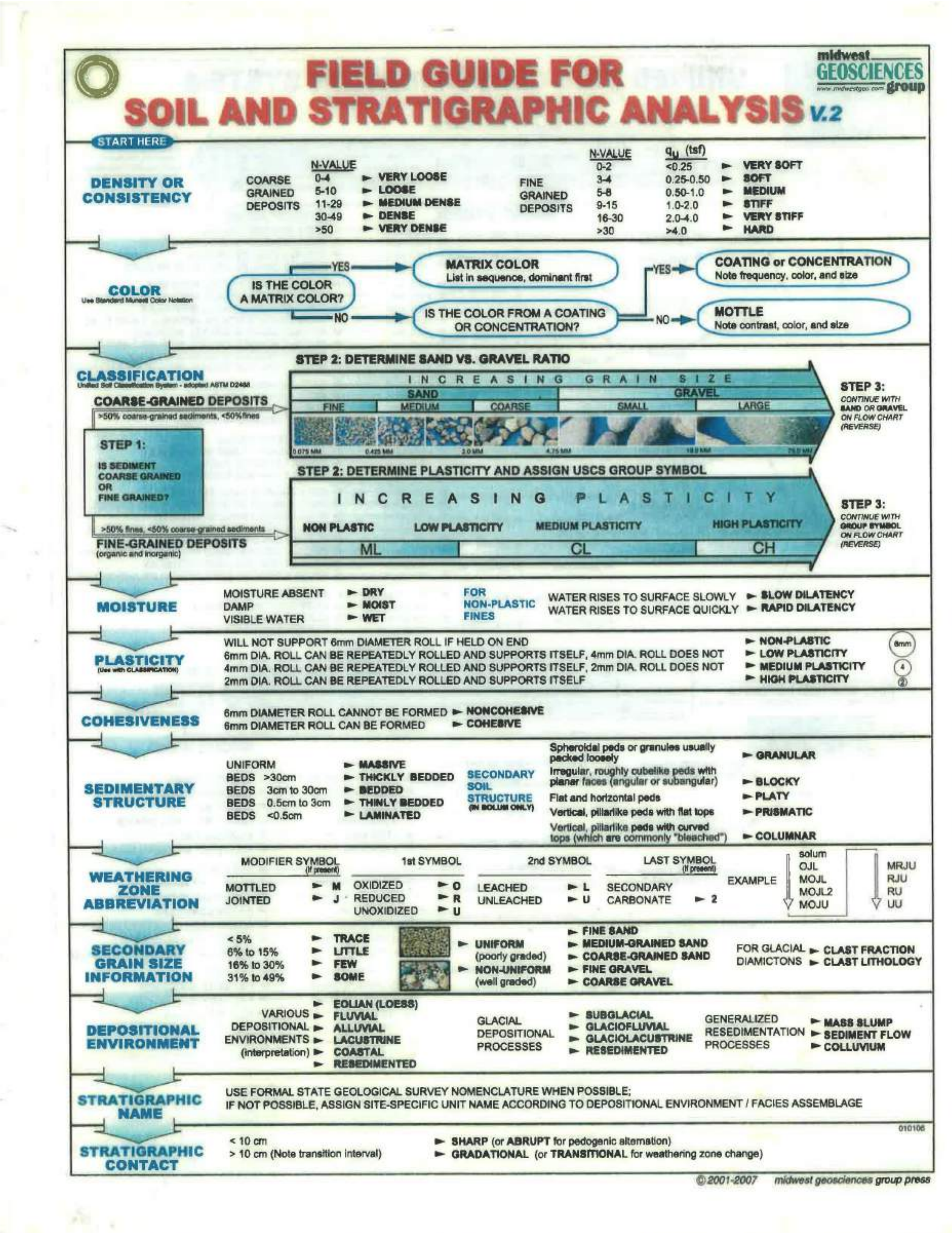
Disposable sampling materials and incidental trash such as paper towels and personal protective equipment (PPE) used in sample processing will be placed in heavy duty garbage bags or other appropriate containers and disposed of as solid waste in the municipal collection system (i.e., site dumpster).

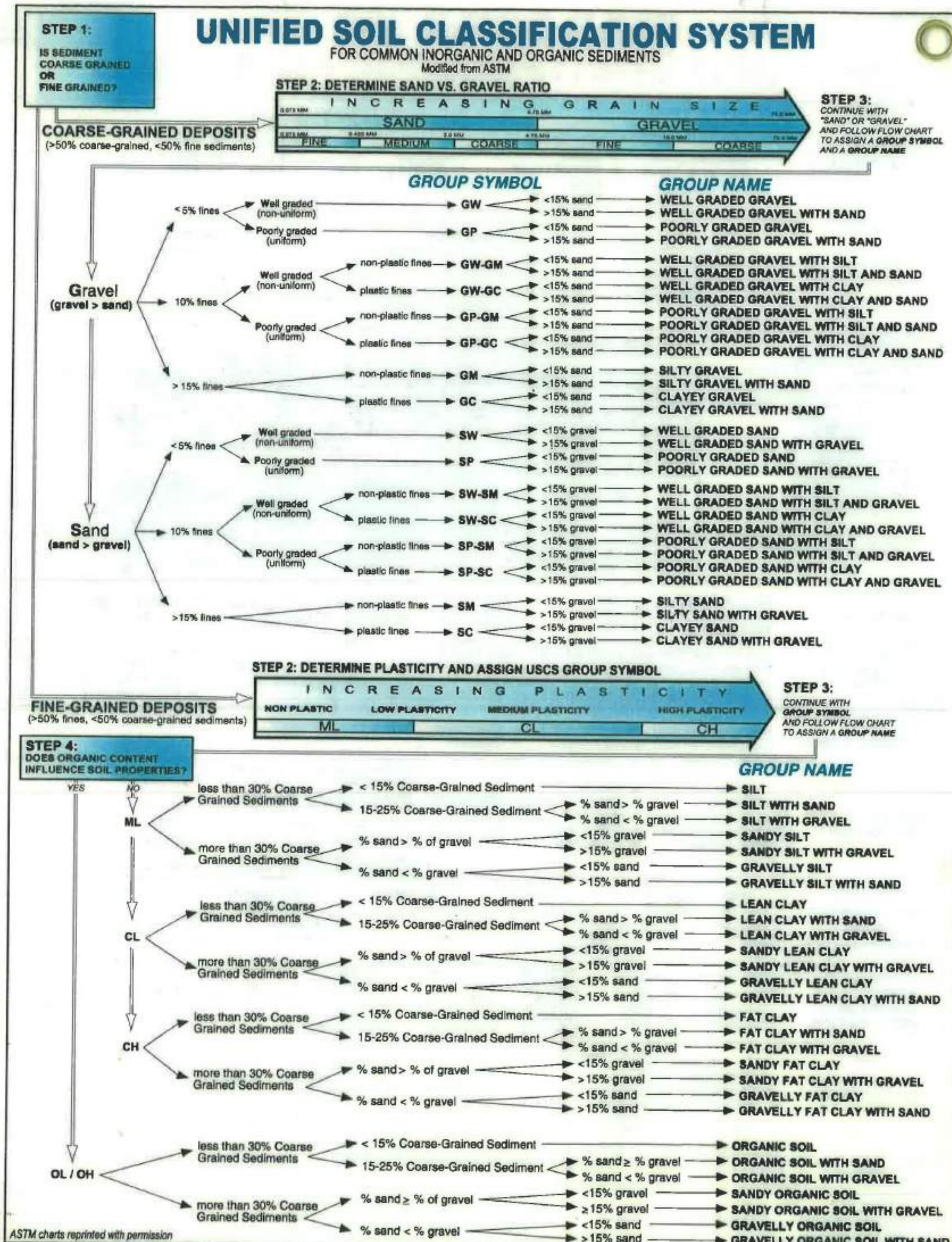
## 6.0 Field Documentation

All observations should be recorded on a soil boring form appropriate for the drilling method or in a bound field notebook. Field staff should make an effort to record as much detail as possible in the field log. After the field work is complete, a set of final logs (usually electronic) that serve as the record for the project will be completed in consultation with the project manager or field manager.

**Enclosure:** USCS Soil Classification Field Guide
Boring Log

## USCS SOIL CLASSIFICATION FIELD GUIDE





UNIFIED SOIL CLASSIFICATION SYSTEM
FOR COMMON INORGANIC AND ORGANIC SEDIMENTS
Modified from ASTM
STEP 1:
IS SEDIMENT COARSE GRAINED OR FINE GRAINED?
STEP 2: DETERMINE SAND VS. GRAVEL RATIO
INCREASING GRAIN SIZE
SAND
GRAVEL
FINE
MEDIUM
COARSE
FINE
COARSE
STEP 3:
CONTINUE WITH "SAND" OR "GRAVEL" AND FOLLOW FLOW CHART TO ASSIGN A GROUP SYMBOL AND A GROUP NAME
COARSE-GRAINED DEPOSITS
(>50% coarse-grained, <50% fine sediments)
GROUP SYMBOL
GROUP NAME
Gravel
(gravel > sand)
<5% fines
10% fines
> 15% fines
Well graded (non-uniform)
Poorly graded (uniform)
non-plastic fines
plastic fines
GW
GP
GW-GM
GW-GC
GP-GM
GP-GC
GM
GC
<15% sand
>15% sand
WELL GRADED GRAVEL
WELL GRADED GRAVEL WITH SAND
POORLY GRADED GRAVEL
POORLY GRADED GRAVEL WITH SAND
WELL GRADED GRAVEL WITH SILT
WELL GRADED GRAVEL WITH SILT AND SAND
WELL GRADED GRAVEL WITH CLAY
WELL GRADED GRAVEL WITH CLAY AND SAND
POORLY GRADED GRAVEL WITH SILT
POORLY GRADED GRAVEL WITH SILT AND SAND
POORLY GRADED GRAVEL WITH CLAY
POORLY GRADED GRAVEL WITH CLAY AND SAND
SILTY GRAVEL
SILTY GRAVEL WITH SAND
CLAYEY GRAVEL
CLAYEY GRAVEL WITH SAND
Sand
(sand > gravel)
SW
SP
SW-SM
SW-SC
SP-SM
SP-SC
SM
SC
<15% gravel
>15% gravel
WELL GRADED SAND
WELL GRADED SAND WITH GRAVEL
POORLY GRADED SAND
POORLY GRADED SAND WITH GRAVEL
WELL GRADED SAND WITH SILT
WELL GRADED SAND WITH SILT AND GRAVEL
WELL GRADED SAND WITH CLAY
WELL GRADED SAND WITH CLAY AND GRAVEL
POORLY GRADED SAND WITH SILT
POORLY GRADED SAND WITH SILT AND GRAVEL
POORLY GRADED SAND WITH CLAY
POORLY GRADED SAND WITH CLAY AND GRAVEL
SILTY SAND
SILTY SAND WITH GRAVEL
CLAYEY SAND
CLAYEY SAND WITH GRAVEL
STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL
INCREASING PLASTICITY
NON PLASTIC
LOW PLASTICITY
MEDIUM PLASTICITY
HIGH PLASTICITY
ML
CL
CH
STEP 3:
CONTINUE WITH GROUP SYMBOL AND FOLLOW FLOW CHART TO ASSIGN A GROUP NAME
FINE-GRAINED DEPOSITS
(>50% fines, <50% coarse-grained sediments)
STEP 4:
DOES ORGANIC CONTENT INFLUENCE SOIL PROPERTIES?
YES
NO
GROUP NAME
less than 30% Coarse Grained Sediments
more than 30% Coarse Grained Sediments
< 15% Coarse-Grained Sediment
15-25% Coarse-Grained Sediment
% sand > % gravel
% sand < % gravel
% sand > % of gravel
<15% gravel
>15% gravel
<15% sand
>15% sand
SILT
SILT WITH SAND
SILT WITH GRAVEL
SANDY SILT
SANDY SILT WITH GRAVEL
GRAVELLY SILT
GRAVELLY SILT WITH SAND
LEAN CLAY
LEAN CLAY WITH SAND
LEAN CLAY WITH GRAVEL
SANDY LEAN CLAY
SANDY LEAN CLAY WITH GRAVEL
GRAVELLY LEAN CLAY
GRAVELLY LEAN CLAY WITH SAND
FAT CLAY
FAT CLAY WITH SAND
FAT CLAY WITH GRAVEL
SANDY FAT CLAY
SANDY FAT CLAY WITH GRAVEL
GRAVELLY FAT CLAY
GRAVELLY FAT CLAY WITH SAND
OL / OH
% sand ≥ % gravel
% sand ≥ % of gravel
≥15% gravel
≥15% sand
ORGANIC SOIL
ORGANIC SOIL WITH SAND
ORGANIC SOIL WITH GRAVEL
SANDY ORGANIC SOIL
SANDY ORGANIC SOIL WITH GRAVEL
GRAVELLY ORGANIC SOIL
GRAVELLY ORGANIC SOIL WITH SAND
ASTM charts reprinted with permission

FLOYD | SNIDER
strategy ▪ science ▪ engineering

| | | | |
|---|---|---|---|
| | PROJECT: | LOCATION: | BORING ID: |
| | LOGGED BY: | COORDINATE SYSTEM: | |
| DRILLED BY: | | NORTHING: | EASTING: |
| DRILLING EQUIPMENT: | | GROUND SURFACE ELEVATION: | |
| DRILLING METHOD: | | TOTAL DEPTH (ft bgs): | DEPTH TO WATER (ft bgs): |
| SAMPLING METHOD: | | BORING DIAMETER: | DRILL DATE: |

| Depth (feet) | USCS | Description | Drive | Recovery | # of Blows | PID (ppm) | Sample ID |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

ABBREVIATIONS:
ft bgs = feet below ground surface USCS = Unified Soil Classification System
ppm = parts per million ▼ = denotes groundwater table

NOTES:

FLOYD | SNIDER
strategy ▪ science ▪ engineering

| | | | |
|---|---|---|---|
| PROJECT: | | LOCATION: | BORING ID: |
| LOGGED BY: | | COORDINATE SYSTEM: | |
| DRILLED BY: | | NORTHING: | EASTING: |
| DRILLING EQUIPMENT: | | GROUND SURFACE ELEVATION: | |
| DRILLING METHOD: | | TOTAL DEPTH (ft bgs): | DEPTH TO WATER (ft bgs): |
| SAMPLING METHOD: | | BORING DIAMETER: | DRILL DATE: |

| Depth (feet) | USCS | Description | Drive | Recovery | # of Blows | PID (ppm) | Sample ID |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

NOTES:

Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel: 206.292.2078 fax: 206.682.7867

# F|S STANDARD GUIDELINE

# Soil Sample Collection

DATE/LAST UPDATE: December 2022

*These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field but are not intended to be step by step procedures, as some steps may not be applicable to all projects.*

*All field staff should be sufficiently trained in the standard guidelines for the sampling method they intend to use and should review and understand these procedures prior to going into the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.*

## 1.0 Scope and Purpose

This standard guideline presents commonly used procedures for collection of soil samples for characterization and laboratory analysis. The methods presented in this guideline apply to the collection of soil samples during the following characterization activities: soil borings via drilling, manual collection of shallow soil samples, test pit excavation, excavation confirmation, and stockpile characterization. Specific details regarding the collection of discrete and composite samples, and special sampling techniques for volatile organic compounds (VOCs) are also included. The guideline is intended to be used by staff who collect soil samples in the field.

It is important that the field staff completing the soil sample collection discusses the specific needs for a particular investigation with the project geologist, the project manager, or whoever will ultimately be responsible for interpreting the findings of the field investigation. This discussion is in addition to field training and general knowledge about soil sampling, and should happen prior to entering the field, with additional follow-up before finalizing the field forms, after the investigation is complete.

## 2.0 Equipment and Supplies

**Soil Sampling Equipment and Tools:**

- Tape measure or measuring wheel
- Stainless steel bowls and spoons
- Trowel, hand auger, or shovel (if needed)
- Table and disposable sheeting, tape or clamps to hold down sheeting (if needed).
- White board and dry erase pen
- Graduated plunger and collection tubes for VOC samples (if needed)
- Photoionization detector (PID) (if needed)
- Ziploc bags (sandwich and gallon sizes)
- Trash bags
- Decontamination tools including:
  - Paper towels or shop towels
  - Spray bottles of Alconox (or similar) solution
  - Deionized or distilled water
  - Scrubbing brush and bucket
- Adhesive drum labels, and paint or grease pen
- Washington State Department of Transportation- (WSDOT) approved drums for investigation-derived waste (IDW) disposal, if needed (if drilling, to be provided by driller)
- Camera
- Hand-held global position system (GPS; if needed)
- Coolers, sample jars, labels, ice

**Paperwork:**

- Work Plan and/or Sampling and Analysis Plan/Quality Assurance Project Plan (SAP/QAPP)
- Field map printed on Rite in the Rain paper
- Site-specific Health and Safety Plan (HASP)
  - Tailgate meeting form (for each day you expect to be on Site)
  - Safety Data Sheets
- Floyd|Snider's Accident Prevention Plan (APP)

- Sample collection forms printed in Rite in the Rain paper
- Boring Logs
- Rite in the Rain field notebook
- Chain of custody forms
- Emergency contact numbers for utilities, property owner/manager, etc. (as needed)

**Safety Equipment:**

- Steel-toed boots
- Safety vest
- Safety glasses
- Nitrile gloves
- Rain gear
- Work gloves
- Hard hat
- Ear protection
- Traffic barricades or cones
- Vehicle emergency kit (road flares, fire extinguisher, first aid kit, etc.)
- Sunscreen if needed
- Hand and foot warmers, if needed
- Mosquito repellent, Hornet Spray, if needed
- Drinking water
- Rain or sun shelter, if needed
- Cell phone and charger cables

# 3.0 Standard Procedures

## 3.1 OFFICE PREPARATION

Prior to going into the field, review the SAP and QAPP to become familiar with the sampling goals, data quality objectives, desired sample intervals and nomenclature, field Quality Assurance (QA) samples (i.e., frequency of field duplicates, MS/MSDs) to be collected, analytes, sample containers, and holding times for each analytical method.

At least one week prior to sampling, coordinate with the laboratory specified in the SAP/QAPP to receive coolers and appropriate sample containers (including additional containers for

QA samples). Familiarize yourself with the volume requirements and container types, preservation methods, and holding times for each class of analytes.

If drilling or digging test pits, mark the sample area and sample locations with white spray paint prior to sampling, then submit an 811 public utility locate request at least 3 business days prior to work. Hire a private utility locator and schedule to locate utilities on private property and ensure proposed boring and/or excavation locations are free of utilities (Note: not all locators are equipped to mark non-conductible utilities).

### 3.2 TAILGATE SAFETY MEETING

Conduct a tailgate safety meeting prior to beginning work at the Site. Include any subcontractors working with you at the Site in this meeting. The safety meeting should cover the hazards specific to soil sampling. Typical hazards include:

- Heavy machinery/drill rig awareness (overhead hazards, pinch points, noise, uncontrolled release of energy). Always make eye contact before approaching an operator.
- Physical hazards (heavy lifting, uneven ground/trip hazards)
- Chemical hazards (dust, site-specific contaminants of concern, lab preservatives)
  - Refer to HASP for specific air monitoring requirements, permissible exposure limits (PELs), and actions if PELs are exceeded.

Additional hazards that may be present at any job site include traffic, adverse weather, slips, trips, falls, biological hazards (such as insects, plants, animals), and worksite distractions (such as pedestrians or other onsite activities).

Record the meeting attendees and topics discussed on the front page of the tailgate safety meeting form. All attendees should sign the form.

### 3.3 OTHER HEALTH AND SAFETY GUIDELINES

The following are additional health and safety guidelines that should be followed in the field. These guidelines are intended to supplement the guidelines and requirements identified in the HASP and are not intended to replace the HASP.

- Review and sign the HASP prior to going out into the field.
- Conduct a tailgate safety meeting prior to beginning work at the site as discussed in Section 3.2.
- If conditions change (e.g., weather or personnel) or when moving between sampling locations/switching to different sampling tasks, assess any additional hazards that may be associated with the new condition or location/task. Record additional hazards noted and corrective actions to address those hazards on the second page of tailgate safety meeting form.

Record near misses and incidents on the Near Miss and Incident Reporting Form (included as an attachment to the HASP) and conduct management/client notifications according to the protocols detailed in the HASP.

### 3.4 GENERAL SOIL SAMPLE COLLECTION PROCEDURES

1. Locate the desired sample location and depth interval using a handheld GPS or by taking field measurements from known site features. Record the soil type and any other observations or indications of contamination on a soil boring log (enclosed), soil sample collection form, or field notebook, as described in the Soil Logging Standard Guideline. Note the location and depth of the sample on the whiteboard or notecard and take a photograph with a scale (e.g., tape measure), if possible.
2. Refer to Sections 3.4.1 through 3.4.4 for the appropriate soil collection procedures for drilling, shallow soil, test pit excavation, excavation confirmation, and stockpiles. If collecting samples for VOC analysis by the U.S. Environmental Protection Agency (USEPA) Method 5035, refer to Section 3.5 for specific sample collection procedures for this method. If composite soil sampling is recommended, refer to Section 3.6 for details.
3. Once soil has been collected from the desired depth or interval, mix thoroughly in a disposable or decontaminated stainless-steel bowl until the sample is homogenous in color, texture, and moisture.
4. Fill the required laboratory-provided jars, taking care not to overfill. If large gravels (diameter greater than ~ 1 inch) are encountered, these should be discarded to ensure that an adequate soil volume is collected for analysis. If necessary, use a clean paper towel to remove soil particles from the threaded mouth of the jar before securing lids to ensure a good seal. Remove any soil or dirt from the outside of the jar with a clean paper or shop towel.
5. Label each jar with the sample name, date, time, field staff initials and required analyses. If collecting a field duplicate, use the sample nomenclature specified in the SAP\QAPP and note the field duplicate name and sample time in the sample log and/or field notebook. If extra volume for matrix spike/matrix spike duplicate (MS/MSD) analysis is required, use the same name on all jars. Soil samples should be protected from moisture by placing the filled sample jars into separate sealed Ziploc bags before placing them into a cooler.
6. Upon completion of each day of sampling, complete a chain-of-custody form for all samples, including sample names, date and time of collection, number of containers, and required analyses and methods. Write neatly and make sure information on the chain is legible. If you need to correct an entry, strike the incorrect entry out once, and add your initials next to the strike out. Samples collected for waste characterization purposes should be recorded on a separate chain-of-custody. Keep samples on ice (unless otherwise specified in the SAP/QAPP) to maintain

temperatures of 4-6 degrees Celsius (°C) and transport to the laboratory under chain-of-custody procedures.

### 3.4.1 Soil Sample Collection via Drilling

These procedures should be used for drilling via direct-push, hollow stem auger, or roto-sonic methods where a pre-designated sample interval (i.e., 0 to 5 feet below ground surface [bgs]) is retrieved from the subsurface using a split spoon sampling device, lined core, or bag sampler.

1. Ensure that reusable sampling equipment has been thoroughly decontaminated prior to sampling.
2. Collect PID measurements and other field tests, if necessary. PID measurements should be collected using the head-space method: put a small amount of soil from the selected interval into a sandwich bag and seal the bag. Label the bag with the soil interval. After at least 10 seconds, insert the tip of the PID into the bag and record the PID reading on the boring log or field collection form. If a sheen test is necessary, place a small amount of soil into a disposable or decontaminated stainless steel bowl, spray it with tap water or deionized water and observe whether a sheen appears on the water. Record results on the boring log or sample collection form.
3. Prior to sample collection, log soil on the boring log or sample collection form following the Soil Logging Standard Guideline.
4. Use a stainless-steel spoon or trowel, or disposable scoop to remove an equal volume of soil across the targeted depth interval from the sampler.
   a. If using a split spoon sampler or other reusable sampler, avoid collecting the soil that is touching the sides of the sampler to the extent practical.
   b. If the soil touching a reusable sampler must be collected to obtain adequate volume for analysis, notify the PM and record in the field logbook.

### 3.4.2 Manual Collection of Shallow Soil Samples

These procedures should be used for shallow soil sampling via scoop, trowel, shovel, or hand auger.

1. Dig or auger to the bottom depth of the shallowest sample to be collected, using a tool that has been thoroughly decontaminated. Verify that the target depth has been reached using a measuring tape.
2. If using a scoop or trowel, collect the soil directly into a decontaminated stainless-steel bowl.
3. If using a shovel, the soil may either be collected in bowls or set as aside on plastic sheeting in favor of collecting the sample from the sidewall of the hole. If sampling the sidewall, use a decontaminated or disposable scoop or trowel to collect soil from the target depth, or scrape along the sidewall to collect soil across a target depth

interval. Transfer soil to a disposable or decontaminated stainless-steel bowl, repeating until a sufficient volume has been collected.

4. If using a hand auger, empty the cylinder of the auger directly into a disposable or decontaminated stainless-steel bowl. It may be necessary to empty the hand auger onto plastic sheeting or into a bowl to reach the target depth without overflowing the sampler.
5. Any soil from depth intervals that are not targeted for sampling should be set aside on plastic sheeting and returned to the hole after sampling.
6. Collect PID measurements and other field tests as described in Section 3.4.1.

### 3.4.3 Sample Collection from Test Pits or Limited Soil Excavations

These procedures should be used for collecting samples from test pit explorations excavated using a backhoe or excavator. These same general procedures should also be followed for post-excavation soil samples used to confirm that an excavation has removed contaminated material or to document post-excavation conditions after target excavation limits have been reached.

1. Measure the length, width, and depth of the test pit or excavation area to verify that the target extents have been reached. The lateral spacing of the test pit or excavation confirmation samples, or exact location of samples should be specified in the work plan and typically depend on the size of the excavation area but can vary significantly by project.
2. If not specified in the work plan, sidewall samples may be collected either midway between the ground surface and base of the excavation, or incrementally along the entire height of the sidewall. Both sidewall and base (bottom) samples should penetrate a minimum of 6 inches into the excavated surface.
3. If the test pit or excavation is less than 4 feet deep, or has been benched to accommodate safe entry, a sample may be collected directly from the sidewall(s). Do not enter an excavation before reviewing and verifying the necessary safety requirements. Most excavations can be sampled without entering, which is preferred. If entering is safe, based on the depth or accommodations to support entry, to collect soil from a sidewall, use a decontaminated or disposable scoop, trowel, or shovel to obtain soil from the desired depth or depth interval directly into a decontaminated stainless-steel bowl.
4. If a test pit or excavation cannot be safely entered, instruct the excavator operator to scoop sidewall material from the target depth or depth interval. Collect the soil sample from the excavator bucket using a decontaminated stainless-steel spoon, trowel, or disposal scoop, avoiding material that has come into contact with the teeth or sides of the bucket. Place an adequate volume of soil into a decontaminated stainless-steel bowl. If necessary, follow the compositing procedures in Section 3.6.

#### 3.4.4 Stockpile Sampling

These procedures should be used for classifying stockpiled soil, including excavated soil and imported backfill material.

1. Where potentially contaminated soils have been previously excavated and stockpiled on site, Washington State Department of Ecology (Ecology) guidance recommends using a decontaminated or disposable scoop or trowel, penetrating 6 to 12 inches beneath the surface of the pile at several locations until sufficient volume for analysis is achieved. A decontaminated shovel may also be used to facilitate collection of soil from large piles. The locations for soil collection should be where contamination is most likely to be present based on field screening (i.e., staining, odor, sheen, or elevated photoionization detector [PID] readings). If there are not field indications of contamination, the locations should be distributed evenly around the stockpile.
2. The stockpile may need to be broken up into sections for sample collection depending on the size of the pile (i.e., segregate the pile in half or quarters). If this is necessary, it is important to document where each set of samples were collected from (i.e., north quadrant) and create a field sketch in the project notebook of the pile for reference and mark sample locations with flags.
3. If a sampling frequency is not specified in the work plan, the general rule of thumb for contaminated soil stockpile profiling is to collect and submit 3 analytical samples (these samples can be multi-point composites or grabs) for stockpiles less than 100 cubic yards (CY), 5 samples for stockpiles between 100 and 500 CY, 7 samples for stockpiles 500 to 1,000 CY, 10 samples for stockpiles 1,000 to 2,000 CY, and 10 samples for stockpiles larger than 2,000 CY with an additional sample collected for every 500 CY of material. This rule of thumb is consistent with the Washington State Guidance for Remediation of Petroleum Contaminated Site (Ecology 2016).
4. Samples for characterization of stockpiles of imported backfill or other presumed clean material should also be collected as described under 3. If not described in the work plan, the typical sample frequency for imported or clean material characterization is one sample per 500 CY.

### 3.5 SOIL SAMPLE COLLECTION FOR VOC ANALYSIS

If collecting soil samples for VOC analysis by USEPA Method 5035, collect these samples first before disturbing the soil. This method uses a soil volume gauge fitted with a disposable soil sampling plunger tube to collect a soil plug that can be discharged directly to a VOA vial, limiting the loss of volatiles during sampling. The collection of VOC samples using the 5035 method specifies use of an airtight VOA vial with a septum lid. Ecology’s interpretation of the USEPA 5035 method allows for field preservation of the sample with methanol or sodium bisulfate, or laboratory preservation (i.e., field collection into an un-preserved vial). It is important to note that if laboratory preservation is the selected method, samples must be received at the laboratory within 48-hours of sample collection. The method of sample preservation for the 5035 method will vary for each site and is dependent on site-specific conditions. Preservation method selection should be coordinated with the laboratory and specified in the sampling plan. Note that not all labs use the soil volume gauge as described below (some use syringes or Terra Core samplers) and that it is important to verify the sampling process with the lab.

1. Note the volume of soil needed for analysis as specified by the laboratory (commonly 5 or 10 grams). Raise the handle of the soil volume gauge to the slot in the gauge body corresponding to the desired volume and turn clockwise until the tabs in the handle lock into the slot.
2. Insert a sample tube at the open end of the gauge body and turn clockwise until the tabs on the tube lock into the "0 gram" slot. Remove the cap from the sample tube and press directly (where possible) into the shallow soil, soil core/sampler, excavation base or sidewall, or stockpile.
3. Continue pressing the sample tube until the plunger is stopped by the sample volume gauge. If a depth interval (for example 9 to10 feet) is targeted for VOC sampling, collect small volumes of soil across this interval until the sample tube is filled
4. Twist counterclockwise to disengage the sample tube, then depress the plunger to eject the soil plug directly into a laboratory-provided VOA vial. Wipe off any soil particles on the VOA vial threads before tightening the lid. Grit on the VOA vial threads can cause a poor seal and interfere with the laboratory analyses. If multiple vials per sample are required, the same plunger may be re-used to fill the remaining vials.

### 3.6 COMPOSITE SAMPLE COLLECTION

For this guideline, composites are considered samples that are collected across more than one location, or multiple depth intervals at a single location. Samples collected over continuous depth intervals within a sampling device (i.e., split spoon) are addressed for each sampling method in Section 3.4 above.

Compositing of sample material may be performed in the field or by the analytical laboratory. To collect a field composite sample, identify the locations and depth(s) that will comprise the composite. Collect soil from the first target sub-sample depth or depth interval and hold in a decontaminated stainless-steel bowl, covered with aluminum foil to prevent cross contamination and label with the location and depth. Continue to collect and hold individual sub-samples until all components of the composite have been collected, then transfer an equal amount of each sub-sample to a clean bowl and homogenize. Fill necessary sample jars from homogenized composite. In some cases, project plans may require that each individual sample that comprised the composite be collected in jars and submitted to the laboratory if individual sample analysis is desired, or if laboratory compositing is requested in addition to field compositing as a field quality control measure. In this case, label each individual jar, but indicate HOLD on the chain-of-custody, and note that the sample is part of composite XYZ.

To collect a laboratory composite sample, collect, and label each sub-sample using the procedures described above in Section 3.4. Record each sub-sample on the chain-of-custody form, and indicate on this form which samples should be composited by the laboratory and the desired name of the composite sample. It is important to communicate to the laboratory if discrete samples will also require analysis (in some cases) or only the composite sample. It is helpful to send a follow up email to the laboratory PM with laboratory compositing details.

## 4.0 Decontamination

All reusable equipment that contacts soil or dust should be decontaminated prior to moving to the next sampling location.

Stainless-steel bowls and spoons, and any tools used for sample processing will be decontaminated between each sample; alternatively, disposable bowls and spoons may be used. Equipment decontamination will consist of a tap water rinse to remove soil particles, followed by scrubbing with brushes and an Alconox (or other soap)/tap water solution, and a final rinse with distilled or deionized water.

## 5.0 Investigation-Derived Waste

Unless otherwise specified in the project work plan, waste soils accumulated as investigation derived waste (IDW) will be contained, transported, disposed of in accordance with applicable laws, and stored in designated drums in a designated area until transported off-site for disposal.

The approach to handling and disposal of these materials is as follows. For IDW that is containerized, such as waste soils, 55-gallon drums approved by WSDOT (or the applicable stage agency) will be used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., “soil”), the dates on which the soil was accumulated, the site owner’s name (i.e., the generator), Floyd|Snider name, and the Floyd|Snider field person contact information or front desk telephone number.

Refer to the IDW Special Conditions SOP for further information on IDW storage, sampling, profiling, and handling.

Disposable sampling materials and incidental trash such as paper towels and personal protective equipment (PPE) used in sample processing will be placed in heavy duty garbage bags or other appropriate containers and disposed of as solid waste in the municipal collection system (i.e., site dumpster).

## 6.0 Field Documentation

All observations including sample collection locations, soil descriptions, sample depths, collection times, analyses, and field QC samples should be recorded on a boring log, soil sample collection form, and/or bound field notebook. Information recorded should additionally include personnel present (including subcontractors), purpose of field event, weather conditions, sample collection date and times, sample analytes, and any deviations from the SAP.

At the end of the day, complete and review the second page of the tailgate safety meeting form detailing additional hazards, corrective actions, near-misses or incidents. Any incidents that result in field staff injuries or have the potential to result in staff injuries (such as hitting buried utility lines when drilling) should be reported immediately to the PM.

## 7.0 Demobilization

Upon returning to the office, ensure that all equipment is property cleaned and put away in the field room. Equipment with rechargeable batteries should be plugged in as appropriate so it is ready for use by the next person. It is preferable to dispose of trash at the project site, but any trash left in the field vehicle should be brought upstairs, labeled, and placed in the front production room for building staff to dispose of.

If equipment or sample coolers will be placed at the front desk for pickup, clearly label each item with the company picking it up, anticipated pickup time frame, and your contact information so front desk staff can contact you if there are any questions. Notify front desk staff if any items require a signature at pickup.

Within one week of returning from the field, the field lead for the event should review field notes, sampling forms and tailgate safety meeting forms with the PM. Following PM review and approval, field notes will be scanned and saved to the project folder. Hard copies should be filed. The PM will provide copies of near miss and incident reports to the Health and Safety Administrator.

**Enclosures:** Boring Log
Test Pit Log and Sample Collection Form

**Record of Revisions:**

| **Revisions** | **Date** |
|---|---|
| Added H&S information and line edits for clarity. | 7/22/2022 |
| Reviewed with minor updates | SD 12/9/2022 |
| | |
| | |
| | |

FLOYD | SNIDER
strategy ▪ science ▪ engineering

| | | | |
|---|---|---|---|
| PROJECT: | | LOCATION: | BORING ID: |
| LOGGED BY: | | COORDINATE SYSTEM: | |
| DRILLED BY: | | NORTHING: | EASTING: |
| DRILLING EQUIPMENT: | | GROUND SURFACE ELEVATION: | |
| DRILLING METHOD: | | TOTAL DEPTH (ft bgs): | DEPTH TO WATER (ft bgs): |
| SAMPLING METHOD: | | BORING DIAMETER: | DRILL DATE: |

| Depth (feet) | USCS | Description | Drive | Recovery | # of Blows | PID (ppm) | Sample ID |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
| | | | | | | | |
| 1 | | | | | | | |
| | | | | | | | |
| 2 | | | | | | | |
| | | | | | | | |
| 3 | | | | | | | |
| | | | | | | | |
| 4 | | | | | | | |
| | | | | | | | |
| 5 | | | | | | | |
| | | | | | | | |
| 6 | | | | | | | |
| | | | | | | | |
| 7 | | | | | | | |
| | | | | | | | |
| 8 | | | | | | | |
| | | | | | | | |
| 9 | | | | | | | |
| | | | | | | | |
| 10 | | | | | | | |

ABBREVIATIONS:
ft bgs = feet below ground surface
USCS = Unified Soil Classification System
ppm = parts per million
▼ = denotes groundwater table

NOTES:

FLOYD | SNIDER
strategy ▪ science ▪ engineering

| | | | |
|---|---|---|---|
| | PROJECT: | LOCATION: | BORING ID: |
| | LOGGED BY: | COORDINATE SYSTEM: | |
| DRILLED BY: | | NORTHING: | EASTING: |
| DRILLING EQUIPMENT: | | GROUND SURFACE ELEVATION: | |
| DRILLING METHOD: | | TOTAL DEPTH (ft bgs): | DEPTH TO WATER (ft bgs): |
| SAMPLING METHOD: | | BORING DIAMETER: | DRILL DATE: |

| Depth (feet) | USCS | Description | Drive | Recovery | # of Blows | PID (ppm) | Sample ID |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| 11 | | | | | | | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | | | | | |
| 16 | | | | | | | |
| 17 | | | | | | | |
| 18 | | | | | | | |
| 19 | | | | | | | |
| 20 | | | | | | | |

ABBREVIATIONS:
ft bgs = feet below ground surface
ppm = parts per million
USCS = Unified Soil Classification System
▼ = denotes groundwater table

NOTES:

Test Pit Log and Sample Collection Form

| | |
|---|---|
| Project: | Date: |
| Field Personnel: | |
| Test Pit # | |
| Pit Dimensions | Depth:_______________ Length:______________ Width:___________ Units:____________ |
| Soil Description: (note depth to native, presence of debris, odor, sheen) | |
| Sketch | |
| GPS coordinates | |
| Other Notes or Observations: | |

| | Sample ID | Depth | Time | Analysis |
|---|---|---|---|---|
| Samples Details | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Two Union Square
601 Union Street, Suite 600
Seattle, WA 98101
tel: 206.292.2078 fax: 206.682.7867

# F|S STANDARD GUIDELINE

# Low-Flow Groundwater Sample Collection

DATE/LAST UPDATE: December 2022

*These procedures should be considered standard guidelines and are intended to provide useful guidance when in the field but are not intended to be step-by-step procedures, as some steps may not be applicable to all projects.*

*All field staff should be sufficiently trained in the standard guidelines for the sampling method they intend to use and should review and understand these procedures prior to going into the field. It is the responsibility of the field staff to review the standard guidelines with the field manager or project manager and identify any deviations from these guidelines prior to field work. When possible, the project-specific Sampling and Analysis Plan should contain any expected deviations and should be referenced in conjunction with these standard guidelines.*

## 1.0 Scope and Purpose

This standard guideline provides details necessary for collecting representative groundwater samples from monitoring wells using low-flow methods. These guidelines are designed to meet or exceed guidelines set forth by the Washington State Department of Ecology (Ecology). Low-Flow sampling provides a method to minimize the volume of water that is purged and disposed from a monitoring well, and minimizes the impact that purging has on groundwater chemistry during sample collection.

## 2.0 Equipment and Supplies

**Groundwater Sampling Equipment and Tools**

- For wells with head less than 25 feet:
  - Peristaltic pump with fully charged internal battery or standalone battery and appropriate connectors
- For wells with head greater than 25 feet:
  - Bladder pump and controller, as well as an air cylinder, or air compressor (with extension cord if near an electrical outlet; with battery and appropriate connectors or generator if not near an outlet)

    **OR**

  - Low-flow submersible pump and controller (with extension cord if near an electrical outlet; with battery and appropriate connectors or generator if not near an outlet)
- Multi-parameter water quality meter
- Water level meter
- Polyethylene tubing, Teflon tubing, or similar (assume polyethylene unless otherwise specified in SAP) and tubing weights (for wells deeper than approximately 10 feet)
- Silicone tubing
- Filters (if field filtering)
- Tools for opening wells and drums (1/2-inch, 9/16-inch, 5/8  and 15/16-inch sockets ratchet, screwdriver, hammer/rubber mallet, bung wrench; any other necessary tools if non-standard monuments have been used)
- Well keys
- Tube cutters, razor blade, or scissors
- 5-gallon buckets, lids, and clamp
- Decontamination supplies: Alconox (or similar), distilled or deionized water, spray bottles, and paper towels
- Bailer or hand pump to drain well box if full of stormwater
- Trash bags

**Lab Equipment**

- Sample jars/bottles
- Coolers
- Chain-of-Custody Forms
- Labels
- Ice
- Ziploc bags

**Paperwork**

- Field notebook with site maps
- Table of well construction details and/or well logs, if available
- Sampling forms (enclosed)
- Purge water plan
- Rite-in-the-Rain pens, paper, and permanent markers

- Site-Specific Health and Safety Plan (HASP) and F|S Accident Prevention Plan (APP)
- List of emergency contacts for the Site or facility
- Safety Data Sheets (SDS) binder
- Sampling and Analysis Plan (SAP) and/or Quality Assurance Project Plan (QAPP) (including tables of analytes and bottle types)

**Safety Equipment**

- PPE:
  - Waterproof boots (safety toed, depending on site)
  - Safety vest
  - Safety glasses
  - Rain gear
  - Nitrile gloves
  - Work gloves
- First Aid kit
- Emergency kit (fire extinguisher, road flares)
- Traffic barricades or cones

# 3.0 Standard Procedures

Low-flow groundwater sampling consists of purging groundwater within the well casing at a rate equal to or less than the flow rate of representative groundwater from the surrounding aquifer into the well screen. The flow rate will depend on the hydraulic conductivity of the aquifer and the drawdown, with the goal of minimizing drawdown within the monitoring well. Field parameters are monitored during purging and groundwater samples are collected after field parameters have stabilized. Deviations from these procedures should be approved by the Project Manager and fully documented.

## 3.1 OFFICE PREPARATION

First, meet with the PM to identify the key objectives of the groundwater sampling effort. This may include the order of wells to be sampled (e.g., if using non-dedicated equipment, wells may need to be sampled in order of least contaminated to most contaminated), whether any wells require redevelopment at least 24-hours prior to sampling, and/or key stabilization parameters (e.g., elevated turbidity may require purging beyond 30 minutes, even if the readings are within 10%).

Conduct a kick-off meeting with the sampling team to discuss site health and safety protocols, data quality objectives, and any site-specific special considerations or sampling procedures.

## 3.2 TAILGATE SAFETY MEETING

Conduct a tailgate safety meeting prior to beginning work at the site. Emergency evacuation procedures, rally points, and onsite communication protocols should be discussed at the first tailgate meeting and repeated if new personnel join the field team onsite.

The safety meeting should cover the hazards specific to groundwater sampling. Typical hazards include the following:

- Chemical hazards (refer to HASP for site chemical exposure hazards)
- Site hazards
  - Traffic hazards onsite (e.g., truck traffic, heavy machinery)
  - Biological hazards (e.g., spiders or wasps within well monuments)
- Physical hazards associated with lifting and carrying heavy equipment and repeated bending while sampling
- Cuts and abrasions associated with using blades and tools
- Electrical hazards (make sure all wires/cables are in good condition and connections to battery or outlet are secure)
- Heat stress and cold stress

Record the meeting attendees and topics discussed on the front page of the tailgate safety meeting form (included as an attachment to the HASP). All attendees should sign the form.

## 3.3 OTHER HEALTH AND SAFETY GUIDELINES

The following are additional health and safety guidelines that should be followed in the field. These guidelines are intended to supplement the guidelines and requirements identified in the HASP and are not intended to replace the HASP.

- Review and sign the HASP prior to going into the field.
- Conduct a tailgate safety meeting prior to beginning work at the site as discussed in Section 3.2
- When moving between monitoring wells or switching to different tasks (e.g., transitioning from sampling to cooler QC prior to lab pickup), assess any additional hazards that may be associated with the new location or task. Record additional hazards noted and corrective actions to address those hazards on the Daily Tailgate Safety Meeting and Debrief Form (included as an attachment to the HASP).
- Record near misses and incidents on the Near Miss and Incident Reporting Form (included as an attachment to the HASP) and conduct management/client notifications according to the protocols detailed in the HASP.

### 3.4 CALIBRATION OF WATER QUALITY METERS

All multi-parameter water quality meters to be used will be calibrated prior to each sampling event. Calibration procedures are outlined in each instrument's specific user manual.

### 3.5 MONITORING, MAINTENANCE, AND SECURITY

Prior to sampling, depth to water and total depth measurements will be collected and recorded for accessible monitoring wells onsite (or an appropriate subset for larger sites). Check for an existing measuring point (notch or visible mark on top of casing). If a measuring point is not observed, a measuring point should be established on the north side of the casing. The conditions of the well box and bolts will also be observed, and deficiencies will be recorded on the sampling forms or logbook (i.e., missing or stripped bolt). The following should also be recorded:

- Condition of the well box, lid, bolts, locks, and gripper cap, if deficiencies
- Condition of gasket if deficient and if water is present in the well box
- Note any obstructions or kinks in the well casing
- Note any equipment in the well casing, such as transducers, bailers, or tubing
- Condition of general area surrounding the well, such as subsidence, potholes, or if the well is submerged within a puddle.

Replace any missing or stripped bolts and redevelop wells if needed.

### 3.6 LOW-FLOW PURGING METHOD AND SAMPLING PROCEDURES

Groundwater samples will be collected using low-flow purging and sampling procedures consistent with Ecology guidelines and the U.S. Environmental Protection Agency (USEPA) standard operating procedures (USEPA 1996). The following describes the Low-Flow purging and sampling procedures for collecting groundwater samples using a peristaltic pump. If the water level is greater than approximately 20 to 25 feet below ground surface (bgs), Grundfos or Geotech submersible pumps or bladder pumps can be used since their pumping rates can be adjusted to low-flow levels. Submersible pumps are preferable to bladder pumps in situations where less than 5 feet of water column are present in the well casing.

- Place the peristaltic pump and water quality equipment near the wellhead. Slowly lower new poly tubing down into the well casing approximately to the middle of the well screen. When sampling wells with a bottom screen depth greater than approximately 10 feet, it is important to measure the length of tubing prior to placement as longer lengths of tubing are more likely to get caught or otherwise obstructed and feel like it has reached the well bottom; this issue can be mitigated by using decontaminated stainless steel tubing weights. If the depth of the well screen is not known, lower the appropriate length of tubing to the bottom of the well, making sure that the tubing has not been caught on the slotted well casing, and then raise the tubing 3 to 5 feet off the bottom of the casing (limit this distance to 2 feet for wells with total depth less than 10 feet). Document the estimated depth of the tubing placement within the well. Connect the tubing to the peristaltic pump using new flex tubing and connect the discharge line to the flow-through cell of the water quality meter. The discharge line from the flow cell should be directed to a bucket to contain the purged water.

- If using a low-flow submersible pump, connect the pump head to dedicated or disposable tubing. If using a bladder pump, connect both the air intake and water discharge ports to decontaminated or disposable tubing, using the manufacturer's instructions to ensure a secure connection. Lower the pump with tubing into the well as described above and connect the water discharge tubing directly to the flow-through cell.
- Measure the depth to water to the nearest 0.01 foot with a decontaminated water level meter and record the information on a sampling form.
- Start pumping the well at a purge rate of 0.1 to 0.2 liters per minute and slowly increase the rate. Purge rate is adjusted using a speed control knob or arrows on peristaltic and low-flow submersible pumps. The purge rate for bladder pumps is controlled by the air compressor, which first pressurizes the pump chamber in order to compress the flexible bladder and force water through the discharge line, and then vents the chamber in order to allow the bladder to refill with water.
    - A good rule of thumb is to pressurize to 10 psi + 0.5 psi/foot of tubing depth and begin with 4 discharge/refill cycles per minute; using greater air pressure and accelerating the pump cycles will increase the purge rate.
- Check the water level. If the water level is dropping, lower the purge rate. Maintain a steady flow with no or minimal drawdown (less than 0.33 feet according to USEPA 2002). Maintaining a drawdown of less than 0.33 feet may not be feasible depending on hydrogeological conditions. If possible, measure the discharge rate of the pump with a graduated cylinder or use a stopwatch when filling sampling jars (500 milliliters [mL] polyethylene or glass ambers) to estimate the rate. When purging water through a flow cell, the maximum flow rate for accurate water quality readings is about 0.5 liters per minute (L/minute).
- The discharge tubing should be connected to the flow cell immediately upon initial water discharge, unless the discharge water is visibly turbid or flocculant is observed. Monitor and record water quality parameters every three to five minutes after one tubing volume (including the volume of water in the flow cell) has been purged.
    - One foot of ¼-inch interior diameter tubing holds about 10 mL of water, and flow-through cells typically hold less than 200 mL of water; one volume should be purged after about 5 minutes at a flow rate of 0.1 L/minute.
- Water-quality indicator parameters that will be monitored and recorded during purging include:
    - pH
    - Specific conductivity

  - Dissolved oxygen
  - Temperature
  - Turbidity
  - Oxidation reduction potential (ORP)

- Continue purging until temperature, pH, turbidity, and specific conductivity are approximately stable (when measurements are within 10 percent) for three consecutive readings, or 30 minutes have elapsed. Because these field parameters (especially dissolved oxygen and ORP) may not reach the stabilization criteria, collection of the groundwater sample will be based on the professional judgment of field personnel at the time of sampling. A minimum of 5 water quality readings should be collected prior to sampling.
- The water sample can be collected once the criteria above have been met.
- If drawdown in the well cannot be maintained at 0.33 feet or less, reduce the flow or turn off the pump for 15 minutes and allow for recovery. If the water quality parameters have stabilized, and if at least two tubing volumes and the flow cell volume have been purged, then sample collection can proceed when the water level has recovered, and the pump is turned back on. This should be noted on the sampling form.
- To collect the water sample, maintain the same pumping rate. After the well has been purged and the sample bottles have been labeled, the groundwater sample will be collected by directly filling the laboratory-provided bottles from the pump discharge line prior to passing through the flow cell. All sample containers should be filled with minimum disturbance by allowing the water to flow down the inside of the bottle or vial. When collecting a volatile organic compound (VOC) sample, fill to the top to form a meniscus over the mouth of the vial prior to placing the cap to eliminate air bubbles. Be careful not to overflow preserved bottles/pre-cleaned Volatile Organic Analyte (VOA) vials.
- If sampling for filtered metals, collect these samples last and fit an in-line filter at the end of the discharge line. Take note of the flow direction arrow on the filter prior to fitting, invert filter to eliminate air bubbles, and allow minimum of 0.5 to 1 liter of groundwater to pass through the filter prior to collecting the sample.
- Sample labels will clearly identify the project name, sampler's initials, sample location and unique sample ID, analysis to be performed, date, and time. After collection, place samples a cooler maintained at a temperature of approximately 4 to 6 degrees Celsius (°C) using ice (if required). Complete the chain-of-Custody forms. Upon transfer of the samples to the laboratory, the Chain-of-Custody Form will be signed by the persons transferring custody of the sample containers to document change in possession.
- When sample collection is complete at a designated location, remove and properly dispose of the non-dedicated tubing. In most cases, this waste is considered solid waste and can be disposed of as refuse. Close and lock the well.

## 4.0 Decontamination

All reusable equipment that comes into contact with groundwater should be decontaminated using the processes described in this section prior to moving to the next sampling location.

**Water Level Meter:** The water level indicator and tape will be decontaminated between sampling locations and at the end the day by spraying the entire length of tape that came in contact with groundwater with an Alconox (or similar)/clean water solution followed by a thorough rinse with distilled or deionized water.

**Water Quality Sensors and Flow-Through Cell:** Distilled water or deionized water will be used to rinse the water quality sensors and flow-through cell. No other decontamination procedures are recommended since they are sensitive equipment. After the sampling event, the water quality meters will be cleaned and maintained according to the specific manual.

**Submersible Pump (if applicable):** Decontaminating the pump requires running the pump in three progressively cleaner grades of water.

1. Fill a bucket with approximately 4 gallons of an Alconox (or similar)/clean water solution to sufficiently cover the pump. Place the pump and the length of the power cord (if applicable) that was in contact with water into the bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.
2. Fill a second bucket containing approximately 4 gallons of clean water to sufficiently cover the pump. Place the pump and cord into this bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.
3. Fill a third bucket with approximately 4 gallons of distilled or deionized water to sufficiently cover the pump. Place the pump and cord into this bucket and run the pump for approximately two minutes or until the volume of water in the bucket has been exhausted.

The soap/water solution may be reused; however, rinse water should be collected for disposal as described in Section 5.0 below. When done for the day, dry the exterior of the pump and cord with clean towels to the extent practical prior to storage.

**Bladder Pump:** Clean the inside and outside of the pump body with an Alconox (or similar)/clean water solution, followed by a thorough rinse with distilled or deionized water. The outside of the air supply line that came in contact with groundwater may also be cleaned with Alconox (or similar) solution and re-used; bladders and water discharge lines must be replaced after each sample is collected.

## 5.0 Investigation-Derived Waste (IDW)

Unless otherwise specified in the project work plan, water generated during groundwater sampling activities will be contained, transported, disposed of in accordance with applicable laws, and stored in a designated area until transported off-site for disposal. This includes purge water and decontamination waste water.

The approach to handling and disposal of these materials for a typical cleanup site is as follows.

For IDW that is containerized, such as purge water, 55-gallon drums (or other smaller sized drums) approved by the Washington State Department of Transportation will be used for temporary storage pending profiling and disposal. Each container holding IDW will be sealed and labeled as to its contents (e.g., "purge water"), the dates on which the wastes were placed in the container, the owner's name and contact information for the field person who generated the waste, and the site name.

IDW containerized within drums will be characterized relative to applicable waste criteria using data from the sampling locations whenever possible. Material that is designated for off-site disposal will be transported to an off-site facility permitted to accept the waste. Manifests will be used, as appropriate for disposal. Refer to the FS Special Condition Standard Guideline for Investigation Derived Waste for additional information regarding proper profiling and disposal of wastewater generated by groundwater sampling.

Disposable sampling materials and incidental trash such as tubing, paper towels and gloves/other disposable used in sample processing will be placed in heavy-duty garbage bags or other appropriate containers and disposed of as trash in the municipal collection system unless otherwise specified in the SAP.

## 6.0 Field Documentation

Groundwater sampling activities will be documented in field sampling forms and/or field notebooks, and Chain-of-Custody Forms. Information recorded will, at a minimum, include personnel present (including subcontractors or client representatives), purpose of field event, weather conditions, sample collection date and times, sample analytes, depths to water, water quality parameters, well box/lid conditions, amount of purged water generated, and any deviations from the SAP. Photographs of damaged well casings or well boxes should be taken.

At the end of the day, complete and review the second page of the tailgate safety meeting form detailing additional hazards, corrective actions, near-misses or incidents. Any incidents that result in equipment damage or field staff injuries should be reported immediately to the PM.

## 7.0 Demobilization

Upon returning to the office, ensure that all equipment is property cleaned and put away in the field room. Equipment with rechargeable batteries should be plugged in as appropriate. It is preferable to dispose of trash on-site, but any trash left in the field vehicle should be disposed as regular trash at Two Union Square.

If rented equipment or sample coolers will be placed at the front desk for pickup, clearly label each item with the company picking it up, anticipated pickup time frame, and your contact information so front desk staff can contact you if there are any questions. Notify front desk staff if any items require a signature at pickup.

Within one week of returning from the field, the field lead for the event should review field notes, sampling forms and tailgate safety meeting forms with the PM. Following PM review and approval, field notes will be scanned and saved to the project folder. Hard copies should be filed. The PM will provide copies of near miss and incident reports to the Safety Program Manager.

## 8.0 References

U.S. Environmental Protection Agency (USEPA). 1996. Low-Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells, Revision 2. Region 1. July 30, 1996.

_____. 2002. Groundwater Sampling Guidelines for Superfund and CAR Project Managers. Office of Solid Waste and Emergency Response. EPA 542.S-02-001. May 2002.

**Enclosures:** Groundwater or Surface Water Sample Collection Form

**Record of Revisions:**

| Revisions | Date |
|---|---|
| Added health and safety information, reviewed EPA guidance, and added revisions table. | 12/9/2022 |

# GROUNDWATER OR SURFACE WATER SAMPLE COLLECTION FORM

Project:________________________________ Date of Collection: ____________________________________

Task:__________________________________ Field Personnel: ____________________________________

## Purge Data

Well ID: ____________ Secure: ☐ Yes ☐ No Ecology Tag #: ____________ Casing Type/Diameter/Screened Interval ________________________

Replacement Required: ☐ Monument ☐ Lid ☐ Lock ☐ Bolts: Missing (#) _____ Stripped (#) _____ Other Damage: ______________________________

Depth Sounder decontaminated Prior to Placement in Well: ☐ Yes ☐ No One Casing Volume (gal): ________________________________________

Depth of water (from TOC):__________________Time: ______________

Total Depth (from log or field measurement): ______________________

After 5 minutes of purging (from top of casing): ______________________

Begin purge (time): ______________End purge (time): ______________

Volume purged:___________ Purge water disposal method____________

**Volume of Schedule 40 PVC Pipe**

| Diameter | O.D. | I.D. | Volume (Gal/Linear Ft.) | Weight of Water (Lbs/Lineal Ft.) |
|---|---|---|---|---|
| 1 ¼" | 1.660" | 1.380" | 0.08 | 0.64 |
| 2" | 2.375" | 2.067" | 0.17 | 1.45 |
| 3" | 3.500" | 3.068" | 0.38 | 3.2 |
| 4" | 4.500" | 4.026" | 0.66 | 5.51 |
| 6" | 6.625" | 6.065" | 1.5 | 12.5 |

| Time | Depth to Water (ft) | Vol. Purged (_____) | pH (s.u.) | DO (mg/L) | Specific Conductivity (µs/cm) | Turbidity (NTU) | Temp (°C) | ORP (mV) | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

## Sampling Data

Sample No: ________________________________________________ Location and Depth: ________________________________________________

Date Collected (mo/dy/yr):____________________ Time Collected: ____________ Weather:____________________________________

Type: ☐ Ground Water ☐ Surface Water Other: __________________________ Sample: ☐ Filtered ☐ Unfiltered Filter Type: ______________________

Sample Collected with: ☐ Bailer ☐ Pump Other: _____________ Type: ☐ Peristaltic ☐ Bladder ☐ Submersible Other: ______________________

Water Quality Instrument Data Collected with: Type: ☐ YSI ProDSS ☐ Tudbidity Meter ☐ Other: ________________________________________________

Sample Decon Procedure: Sample collected with: ☐ decontaminated <u>all</u> tubing; ☐ disposable tubing ☐ dedicated silicon and poly tubing; ☐ dedicated tubing replaced

Sample Description (Color, Turbidity, Odor, Other): ____________________________________________________________________

## Sample Analyses

| Analyte | Analysis Method | Sample Container | Quantity | Preservative | Notes |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

## QC samples

Duplicate Sample No: ______________________ Duplicate Time: _________ MS/MSD: ☐ Yes ☐ No

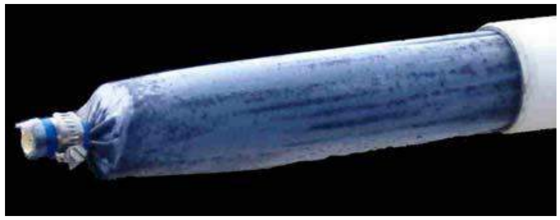
**Signature:** ______________________________________________________ **Date:** __________________________

**Attachment 2**

**Passive Flux Meter Protocol Manual**

# Passive Flux Meter Protocol Manual

**EnviroFlux, LLC**



The following documents current methods for construction, storage, transport, deployment, sampling and analysis of passive flux meters for site assessment.

## PFM CONSTRUCTION

**PFM Storage:** If the PFMs are constructed for transport to the field site, the PFMs will be stored in tubes and cooled. PFM storage tubes are constructed using PVC pipe the same diameter as the packing tube. The bottom of storage tube is sealed by a gas tight mechanical plug. The PFM is then extruded from the packing tube into the storage tube. A section of threaded rod or PVC pipe is used to push the PFM out of the packing tube and into the storage tube. The top of the storage tube is then sealed. The PFM are then placed in cold storage (4 C) until transport.

**PFM Transport:** The PFMs are transported in cardboard boxes to the site for FedEx shipments.

## INSTALLATION PROCEDURES

**PFM Deployment:** At the field site the PFM in the packing tube or storage tube is prepared for PFM insertion into the well casing. A rope (or in some cased a steel cable) is attached to the top of the PFM using a safety carabineer. The tube is lined up with the top of the well casing and a section of push rod is used to push the PFM from the tube into the top section of well casing. Additional push rods are attached to continue pushing the PFM to the screen interval. If multiple PFMs are deployed on a single line, short sections of cable (about 5.5ft long) are thread through the upper PFM to link the PFMs together well. When inserting the PFM some back pressure may build since the water in the well casing must flow through the center tube as the PFM is inserted. Proceed slowly as pressure builds. The PFM rope (or steel cable) attached to the sock assembly is then secured to the well lid or others to ensure that it will not be lost to the well head.

1) PFMs are shipped to the site via FedEx Overnight.

2) Lay the PFMs for the first well onto saw horse legs.

3) Remove end caps from PVC transport tubes.

4) Remove well lid and cap.


5) Attach retrieval rope (or wires) to the top of each PFM using a carabineer connector.

6) Install PFMs by setting transport tube over monitoring well and using Geoprobe rods to push PFM out of the transport tube and into the well.

7) Push PFM into position in the well using Geoprobe rods while holding retrieval wire tight.

8) Repeat steps 5 through 7 for each PFM that is to be installed in the well.

9) Replace well lid and cap (wire ropes are cut to a length such that two feet of each retrieval wire will remain outside the well).

10) Repeat steps 2 through 9 for each well.

## RETRIEVAL AND SAMPLING PROCEDURES

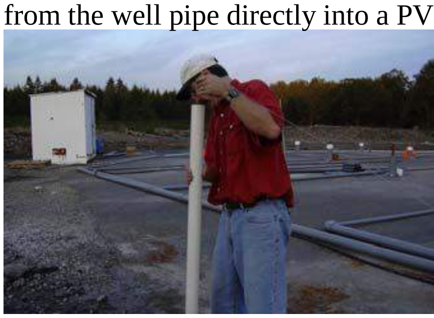
**Preparation of Sampling Vials:** 120 ml jars are used for AC sampling. Jars are filled with activated carbon making sure to seal tightly with no carbon grains on the lip of the jar.

**PFM Retrieval:** PFMs are retrieved using the rope. The top PFM in the well is extracted first by gently pulling up on the rope (heavy work gloves should be worn when pull on rope or stainless wire cable). The PFM should be pulled to the top of the well casing. When the PFM is at the top of the well casing untangle any rope (or wires) that are twisted at the well head. Thread the retrieval cable through a 5ft storage (or transport) PVC pipe and place the pipe over the well to guide and contain the extruded PFM. Move the PFM to the sampling work station.

**PFM Sampling:** A tarpaulin acts as a 'protective flooring' for the work zone. A portable table is used as a work zone for sampling the PFMs. Nitrile protective gloves and necessary other protective clothing will be worn by all samplers. A lined bucket (5gal) is placed under the work area to capture un-sampled residual activated carbon from the retrieved PFM. The sock is extruded from the PVC pipe to the sampling interval extent. The flexible mesh packing material is cut and the sorbent (activated carbon) captured in plastic or stainless steel mixing bowls for homogenization using a stainless steel spatula. A sub-sample is then transferred into 120 mL jars. The jars are stored in a cooler for transport back to the laboratory for analysis. The center tube and viton washers are measured to obtain the sample interval lengths in the PFM. Sampling materials, spatula, scissors, mixing bowls are wiped clean to remove carbon particles prior to retrieving the next PFM.

**Transportation and Storage:** Sorbent (GAC) samples are stored on-site in coolers then shipped via overnight air express (e.g., FedEx) to the EnviroFlux laboratory. Samples are stored in a cold storage room or refrigerator at $4^{o}$C until extraction and analysis.

1) Retrieve PFM from well by pulling up on the attached rope (or wire). The PFM is pulled from the well pipe directly into a PVC tube of the same diameter.



2) Place tube on table and expose the first segment by pulling on the bottom end of the PFM.

3) Using scissors, cut open the nylon socks and flexible red mesh covering the first segment and pour the exposed sorbent(GAC) mixture into a mixing bowl.

4) Stir the mixture vigorously in the bowl to homogenize

5) Sub-sample the mixture and place into 120mL jar and seal tightly (make sure no carbon particles are on the lip of the jar).

6) Measure the interval length of the PFM segment

7) Repeat for steps 3-8 for remaining segments of PFM

8) After all PFMs are sampled, place 120 mL jars into cooler(s) and ship back for analysis

9) Excess sorbent is collected in a plastic-lined container for proper hazardous waste disposal.