PIONEER TECHNICAL SERVICES

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Butte, MT 59701
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November 7, 2025

Mr. William Bergum
Environmental Project Officer
Petroleum Tank Cleanup Section
Montana Department of Environmental Quality
1225 Cedar Street
Helena, MT 59601

RE: **Remedial Investigation Work Plan**
**MDT White Sulphur Springs Maintenance Facility**
**705 3rd Avenue Southwest, White Sulphur Springs, Meagher County, Montana,**
**Facility ID #30-12376 (TID #25004), Release #6522, Work Plan ID #35079**

| | | | |
|---|---|---|---|
| **Owner/ Responsible Party** | Montana Department of Transportation<br>Mr. Kendall Gustafson<br>2701 Prospect Avenue<br>Helena, MT 59620<br>kgustafson@mt.gov | **Consultant/ Work Plan Preparer** | Pioneer Technical Services, Inc.<br>Charles Peterson, P.G.<br>2310 Broadwater Avenue, Suite #1<br>Billings, MT 59102<br>cpeterson@pioneer-technical.com |

Dear Mr. Bergum,

Pioneer Technical Services, Inc. is submitting this Remedial Investigation Work Plan for the Montana Department of Transportation (MDT) White Sulphur Springs Maintenance Facility on behalf of MDT. As requested in correspondence from the Montana Department of Environmental Quality dated August 7, 2025, our scope of work and associated proposed costs are below. Figure 1 provides the location and vicinity of the subject facility, Figure 2 provides the site layout, and Figure 3 proposed borehole locations.

If you have any questions about this project or the proposed scope of work, please call me at (406) 702-2430 or email me at cpeterson@pioneer-technical.com.

Sincerely,

Charles L Peterson, P.G.
Program Manager

Attachment 1 Figures
Attachment 2 Cost Estimate

cc: Kendall Gustafson, Responsible Party Representative
Taylor Bienvenue, Pioneer Technical Services, Inc.

# 1 FACILITY HISTORY AND RELEASE BACKGROUND

Section 1 details the history, background, contact information, petroleum release information, and other relevant information related to the Montana Department of Transportation (MDT) White Sulphur Springs Maintenance Facility (Site).

## 1.1 Contact Information

Table 1 provides the relevant contact information for the Site.

**Table 1. List of Contacts**

| | | |
|---|---|---|
| **Owner/Operator/ Responsible Party** | Montana Department of Transportation<br>Mr. Kendall Gustafson<br>Environmental Scientist<br>Environmental Services Bureau, Remediation and Assessment Section<br>2701 Prospect Avenue<br>Helena, MT 59620<br>406-461-2193<br>kgustafson@mt.gov | |
| **DEQ Contact Person** | Montana Department of Environmental Quality<br>Mr. William Bergum<br>Environmental Project Officer<br>Petroleum Tank Cleanup Section<br>1225 Cedar Street<br>Helena, MT 59601<br>406-444-0216<br>wbergum@mt.gov | |
| **Work Plan Preparation** | Pioneer Technical Services, Inc.<br>Taylor Bienvenue, G.I.T<br>Staff Scientist<br>2310 Broadwater Ave, Suite 1<br>Billings, MT 59102<br>406-723-1931<br>tbienvenue@pioneer-technical.com | Pioneer Technical Services, Inc.<br>Charles L. Peterson, P.G.<br>Program Manager<br>2310 Broadwater Ave, Suite 1<br>Billings, MT 59102<br>406-702-2430<br>cpeterson@pioneer-technical.com |

## 1.2 Facility History

The project Site is located at the intersection of Third Avenue Southwest and Southwest Garfield Street in White Sulphur Springs, Montana. The Site is located within a predominantly residential and light commercial area and is fairly level with an elevation of approximately 5,040 feet above mean sea level. The Site is a rectangular shaped parcel and is bordered by Third Avenue Southwest to the east, East Garfield Street to the south, Fifth Avenue Southwest to the west, and Southwest Hancock Street to the south. This area of White Sulphur Springs is served by public utility city services (e.g., potable water, sanitary sewer, and storm sewer systems). The Site historically operated and currently operates as a MDT maintenance facility.

Prior to April 2023, the Site included the former MDT maintenance building situated near the southeast and east-central portions of the property and consisted of a one-story, slab-on-grade, block and brick building with garage bays, office space and maintenance areas. In April 2023, redevelopment of the Site started and included removal and replacement of the former MDT maintenance building with a new MDT maintenance building. Prior to the construction activities, a subsurface geotechnical soil investigation was performed at the Site and a petroleum release was discovered. It appears that the petroleum release occurred from a former underground storage tank (UST) system that was located at the southeast corner of the facility. Figure 1 in Attachment 1 provides the Site location, Figure 2 provides the general Site layout, and Figure 3 provides the former and proposed borehole locations.

## *1.3 Release Background*

On October 7, 2022, petroleum hydrocarbon-impacted soil was encountered in the subsurface soil near the southwest corner of the former MDT maintenance building during a geotechnical investigation at the facility. Pioneer Technical Services, Inc. (Pioneer) was performing the investigation under contract to Slate Architecture. In response to the discovery of the petroleum impacts, Pioneer was further retained by Slate Architecture to perform an additional Site investigation to determine the magnitude and extent of the petroleum impacts near the southern and southeastern portions of the Site.

Pioneer completed the additional Site assessment between February 16 and 17, 2023, which included the advancement of 15 soil borings (SB-1 through SB-15) to depths ranging from 10 to 15 feet below ground surface (bgs), soil sample collection, and analytical laboratory testing. Following the fieldwork, Pioneer prepared a Site Assessment Report detailing the Site assessment (Pioneer, 2023a). Results of the Site assessment indicates that subsurface soil located near and around the south and southeastern corner of the former maintenance building were impacted with highly weathered gasoline. A review of a historical plat map of the facility, provided by MDT Environmental Services, indicates that the most likely source of the gasoline release is the former underground gasoline tank and dispenser island that was located just east of the southeast corner of the former maintenance building. Based upon the soil sample and field screening results, the impacts appeared to be present from 1 to 12 feet bgs. The impacts likely extend deeper than 12 feet in the former UST basin, but the drilling program scope of work was limited to a total depth of 15 feet and focused on the areas adjacent to the former maintenance building. The additional Site assessment did not fully define the extent and magnitude of the petroleum impacts in soil and potentially groundwater. The results indicate that the release likely extends an unknown distance beneath the former MDT maintenance building.

MDT, utilizing the Site Assessment Investigation completed by Pioneer, reported the release to MT DEQ on February 17, 2023. DEQ sent out a 30-day report request letter on March 16, 2023, and MDT submitted the 30-day report on March 21, 2023. The Facility was designated as an approved release.

Evidence of the release was again encountered during the demolition and reconstruction project, which started in April 2023. Before implementing the Site cleanup activities, three sampling events occurred where soil or groundwater samples were collected from the Site. Two of the sampling events occurred during Pioneer's Site visits, and the third was collected by the construction contractor while excavating prior to the installation of footings. Between April 27, 2023, and May 11, 2023, several test pits were excavated along the perimeter and corners of the new building footprint. During the Site visit, each test pit was examined for the presence of potential petroleum impacts to soil and/or groundwater. No petroleum impacts were observed in the test pits located near the northwest, southwest, and northeast corners of the new building footprint. The test pit located at the southeast corner of the new building footprint and the test pit east of the new building footprint both had standing water, and the contractor noted a petroleum odor when excavating the two test pits. The groundwater sample collected from the southeastern test pit indicated the presence of hydrocarbons from a separate source other than the gasoline and diesel fuel from the UST basin. The water sample exhibited $C_9$ to $C_{18}$ Aliphatics and $C_{11}$ to $C_{22}$ Aromatics concentrations above the Montana Department of Environmental Quality's (DEQ) Risk-Based Screening Levels (RBSLs) (DEQ, 2024) for groundwater. The laboratory results indicate the hydrocarbons present in the groundwater sample are from a more "heavy hydrocarbon," namely oil and grease with traces of diesel. The hydrocarbons are likely leakage over the years from the former maintenance building floor drains and sewer drainpipe system and would explain the existence of the shallow "perched" water within the test pits. Field observations also corroborated this finding as the water had a "sewage" odor. All volatile petroleum hydrocarbon (VPH) constituents were below the DEQ RBSLs for groundwater, further corroborating the second source theory.

Petroleum impacted soil cleanup activities were completed from May through June 2023 at Site. The objective of the cleanup activities was as follows: further define the extent and magnitude of petroleum impacts in soil, determine and address its potential impact to the former MDT maintenance building demolition work, and limit its impact to the new MDT maintenance building during and after construction. Between May 22 and 24, 2023, petroleum-impacted soil was excavated from the south portion of the new building footprint. The soil cleanup activities involved excavation of approximately 1,406 bank cubic yards of petroleum-impacted soil. The final excavation measured approximately 60 feet long by 50 feet wide and was 8 to 12 feet deep.

On May 24, 2023, following petroleum-impacted soil removal, a Pioneer engineer collected 18 confirmation and characterization soil samples from the base and sidewalls of the excavation area and the stockpiled soil. All the VPH and extractable petroleum hydrocarbon (EPH) constituents for the confirmation samples were below their respective Montana DEQ RBSL for Direct Contact (Commercial 2 to 10 feet) and Leaching (0 to 10 feet to groundwater). Characterization samples of the east and south wall, however, had VPH and EPH constituents above the DEQ RBSL Direct Contact (Commercial 2 to 10 feet) and/or DEQ RBSL Leaching (0 to 10 feet to groundwater). The stockpile sample collected to characterize the stockpiled soil for disposal had concentrations of VPH and EPH constituents above the DEQ RBSL Leaching (0 to 10 feet to groundwater) and EPH constituents above the DEQ RBSL Direct Contact

(Commercial 2 to 10 feet). The stockpile characterization sample also had non-detect constituent concentrations for toxicity characteristic leaching procedure metals.

Results of the assessment and cleanup activities indicate that petroleum-impacted soil within the new building footprint has been successfully removed; however, some residual petroleum impacted soil remains to the south and east of the new building footprint location. Based on the findings and conclusions of the Cleanup Report (Pioneer, 2023b), Pioneer recommended a post-removal remedial investigation be performed to further define the extent and magnitude of the remaining petroleum-impacted media (soil and groundwater). The investigation would be designed to define petroleum-impacts to soil and groundwater south and east of the petroleum-impacted soil removal area through soil borings, soil sampling, groundwater monitoring well installation and development, and groundwater monitoring.

As requested by Montana DEQ on February 6, 2024, Pioneer submitted Remedial Investigation Work Plan #34821 dated March 15, 2024, on behalf of MDT to perform additional remedial investigation activities at the Site (Pioneer, 2024). Montana DEQ approved the work plan on April 25, 2024. The work plan included installing soil borings and permanent groundwater monitoring wells, completing soil and groundwater sampling, performing a petroleum vapor intrusion (PVI) desktop analysis, completing a receptor survey, and preparing a remedial investigation report and updated release closure plan (RCP).

Pioneer advanced a total of 22 soil borings to depths ranging from 15 to 25 feet bgs, with 12 of the borings converted to permanent monitoring wells, at the Site in October 2024 and March 2025. The water table was encountered at approximately 6 to 12 feet bgs; however, several monitoring wells were dry or did not exhibit sufficient groundwater to collect a sample. A total of 67 soil samples, including eight duplicate samples, were submitted for laboratory analyses of VPH, EPH screen, and lead scavengers 2-Dichloroethane (DCA) and Ethylene Dibromide (EDB). Of the 67 samples submitted for analyses, only nine soil samples exhibited one or more VPH constituent above the respective RBSLs. The concentrations detected in the soil above the DEQ RBSLs were present at depths ranging from approximately 2 to 8 feet bgs south of the building, and from approximately 4 to 10 feet bgs southeast of the building. Groundwater samples were collected from 7 of the 12 monitoring wells (MW-3, MW-5, MW-6, MW-7, MW-8, MW-11, and MW-12). The remaining monitoring wells were either dry or did not exhibit sufficient groundwater to collect a sample. Contaminant concentrations were also detected above the DEQ RBSLs in the groundwater samples collected from monitoring wells MW-6, MW-11, and MW-12, all located near the southeast corner of the Site, during the groundwater sampling events completed in November 2024 and March 2025 (Pioneer, 2025).

As part of a desktop PVI analysis, Pioneer evaluated the contaminant concentrations in the confirmation soil samples, soil borings, and monitoring wells located within 30 feet of the on-Site building and those in proximity to the on-Site utilities. The main sanitary sewer and water lines are located west of the on-Site building with the Site water lines extending east to connect on the southern side of the existing building. The propane, fiber optic, and electrical utilities also extend from the southern portion of the Site to the southern portion of the on-Site building. The south portion of the building and on-Site utility corridor are located within the location of the soil samples exceeding the Montana DEQ RBSLs at depths shallower than 8 feet bgs. Per DEQ's Vapor Intrusion Guide (DEQ, 2021a), the depth of petroleum contamination near the building may result in PVI to the building. None of the groundwater samples collected from the monitoring wells located within 30 feet of the on-Site building exceeded contaminant concentrations above the regulatory limits. While several VPH constituent concentrations in groundwater on the southern boundary of the Site may exceed the regulatory limits south of the property boundary based on the potentiometric contour maps and the depth to groundwater being greater than 8 feet bgs in the southernmost monitoring well, MW-12, it does not appear that current contaminant concentrations would result in PVI to the adjoining properties and off-Site utilities.

Based on the results of previous investigations and cleanup actions, DEQ composed a work plan request letter dated August 7, 2025 (Work Plan #35079) requesting installation of additional monitoring wells to establish the downgradient and upgradient boundaries of the contamination, replacement of monitoring wells that are providing insufficient groundwater for sampling, groundwater monitoring, and reporting that includes an updated RCP to identify and propose additional work needed to resolve the release. This Remedial Investigation Work Plan is being constructed in response to the work plan request letter dated August 7, 2025.

# 2 REMEDIAL INVESTIGATION WORK PLAN TASKS

The scope of work for this Phase II remedial investigation includes installing seven soil borings to a depth of 20 feet bgs using hollow stem auger drilling techniques, collecting soil samples from each soil boring for laboratory analysis, constructing 2-inch-diameter groundwater monitoring wells, developing, surveying, and performing groundwater monitoring of the existing and newly installed monitoring wells, and proper abandonment of three existing groundwater monitoring wells (MW-1, MW-4, and MW-10). The scope of work will be conducted to further define the extent and magnitude of petroleum impacts at and downgradient of the Site. The work will include the following tasks:

- Task 1 – Project Management and Planning.
- Task 2 – Soil Boring and Well Installation Activities.
- Task 3 – Groundwater Monitoring Well Abandonment.
- Task 4 – Groundwater Monitoring.
- Task 5 – Reporting.

## 2.1 Task 1 – Project Management and Planning

Task 1 includes managing, scheduling, organizing, and planning the work, including the activities below:

- Coordinating Site work.
- Preparing this Work Plan.

- Scheduling personnel.
- Securing access agreements and encroachment permits, as necessary.
- Coordinating activities of owners, regulators, and the analytical testing laboratory.
- Preparing a Job Risk Assessment (JRA) to complete the work.
- Verifying utility location and documentation prior to Site work.
- Conducting planning meetings with owner and DEQ's project manager as deemed necessary by DEQ's project manager.

Pioneer will prepare a JRA to document a safety plan and complete the work as approved by the Montana DEQ. Pioneer we will manage, schedule, and supervise all work to ensure it is completed as proposed and in a timely manner.

## 2.2 Task 2 – Soil Boring and Well Installation Activities

The work includes drilling seven soil borings at the facility and constructing them into 2-inch-diameter groundwater monitoring wells. The soil borings and monitoring wells will be installed in locations that best define the extent and magnitude of the remaining petroleum impacts in and downgradient of the source area and will be based on historical soil boring and soil excavation data. The anticipated total depth of the borings is 20 feet bgs. We will advance the soil borings using hollow stem auger drilling methods to conduct the soil investigation. Figure 3 shows the seven proposed borehole locations, and final borehole locations will be determined in the field after consultation with the MDT and DEQ project managers and will be based on accessibility, underground utilities, the presence of unforeseen impedances, or other factors.

Pioneer will construct the seven borings into 2-inch diameter groundwater monitoring wells. Figure 3 provides Pioneer's proposed monitoring well locations. For the groundwater monitoring well installation phase, the team will use the hollow stem auger drill rig to construct the wells. The monitoring wells will be constructed with 2-inch-diameter, schedule 40 polyvinyl chloride (PVC) pipe. All well screens and piping will be delivered to the Site factory wrapped. Each well will be constructed using a prepack well screen consisting of 0.010-inch, factory-slotted PVC screen. The wells will be screened from 10 to 20 feet bgs. The remainder of the borehole will be completed with PVC riser pipe to grade. The annular space between the prepack well screen and the borehole will have 0.10- to 0.20-inch sand completion to 2 feet above the screen, whereas the remaining annulus space between the well casing and the borehole will have a bentonite seal. The wells will be secured with bolt-down covers set in concrete. The wells will be developed after construction following Pioneer SOP-GW-12: Well Development Using A Modified Over-Pumping Technique (provided in Attachment 3). Initial turbidity will be recorded immediately prior to starting development, and final turbidity will be recorded immediately following completion of well development. Each well will be considered developed once clear of sediment, or the well has been pumped with a submersible pump or trash pump for 1 hour. Following well installation and development, the new wells will be surveyed by a licensed surveyor, and the top of casings will be determined to be within 0.01 feet of mean sea level.

A Pioneer engineer or geologist will supervise drilling operations and be present to collect, screen, and log soil types. Soil samples will be collected in accordance with Pioneer SOP-S-14:

Sampling Soil from a Hollow-Stem Auger Drill (provided in Attachment 3). Soil samples will be collected at continuous intervals and personnel will log the soil type, consistencies, and will document any visible signs of petroleum impacts. Standard headspace readings will be collected using a photoionization detector (PID) meter following Pioneer SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID (provided in Attachment 3). A portion of each soil sample will be placed into an airtight container, labeled, and allowed sufficient time for the hydrocarbons, if present, to volatilize. After the equilibration period, each sample will be scanned with a PID meter by inserting the sampling probe into the headspace of the container. The PID readings from each soil sample collected from each borehole will be reviewed and recorded. The sample with the highest reading, or with other signs indicating petroleum impacts, will be selected for laboratory analysis. The sample collected closest to the water table at the time of drilling will also be submitted for analysis. A maximum of two samples from each boring will be submitted for laboratory analysis. A total of 15 samples, including one duplicate sample will be submitted for laboratory analysis. The selected samples will be placed into a laboratory-supplied container, labeled, stored on ice, and submitted to Energy Laboratories, Inc. (Energy) in Helena, Montana, for VPH, EPH screen and lead scavengers (DCA and EDB) analyses. If the EPH screen result is greater than 200 milligrams per kilogram, the sample will be submitted for EPH fractionation analysis. For this Remedial Investigation Work Plan, we are assuming that half of the samples will require EPH fractionation. Chain of custody documentation will accompany the samples.

## *2.3 Task 3 – Groundwater Monitoring Well Abandonment*

The existing wells MW-1, MW-4, and MW-10 will be abandoned in accordance with Montana Department of Natural Resources and Conservation (DNRC) regulations (Administrative Rules of Montana 36.21.810). This will be completed by removing the manhole covers, concrete collars, and the top 3 to 5 feet of casing, then filling the remaining casing with bentonite chips, and filling the remaining hole with native soil and completing the surface with gravel or asphalt to match the surrounding surface. These forms will be submitted to and filed with DNRC.

## *2.4 Task 4 – Groundwater Monitoring*

Pioneer personnel will collect groundwater samples from the seven newly installed monitoring wells and eight existing wells during one monitoring event. For the event, we will gauge and purge the wells and collect groundwater samples. The monitoring event will occur in early spring of 2026.

Prior to groundwater sample collection, we will gauge each of the seven new and eight existing monitoring wells for the presence of light non-aqueous phase liquid (LNAPL) following Pioneer SOP-GW-03: Depth to Water Level Measurements (provided in Attachment 3). Each well will be gauged using an electronic interface probe capable of detecting water or LNAPL hydrocarbons to within 0.01 feet. If the well does not contain LNAPL, the team will collect groundwater samples. If LNAPL is detected, the team will not collect any samples from wells containing LNAPL, will note the conditions in a logbook, and notify DEQ's project manager.

The groundwater samples will be collected in accordance with low-flow sample techniques outlined in Pioneer SOP-GW-10.2: Purging and Sampling Using the Low Flow Purge Method (provided in Attachment 3). To ensure representative groundwater samples are collected, we will monitor the water quality parameters for the following intrinsic bioremediation indicators and allow them to stabilize during the purging process prior to sample collection: temperature (plus or minus 3%), pH (equal or less than 0.1), dissolved oxygen (plus or minus 10%), specific conductivity (plus or minus 3%), oxidation reduction potential (plus or minus 10 millivolts), and turbidity (plus or minus 10%). To complete groundwater sampling in accordance with DEQ's low-flow sampling guidance (DEQ, 2018), the wells will be gauged at each field parameter monitoring interval with a water level meter to ensure that excessive drawdown (plus or minus 0.3 foot) does not occur prior to sampling.

We will collect the groundwater samples with a peristaltic or submersible bladder pump and disposable tubing and transfer the samples to the appropriate laboratory containers. New, decontaminated containers will be supplied by the laboratory prior to sample collection. Groundwater samples will be submitted for laboratory analysis of VPH, EPH screen and lead scavenger (DCA and EDB) analyses. We will collect one field duplicate during each sampling event. Each sample container will be preserved as directed by the laboratory, labeled, and packaged on ice. The samples will be delivered to Energy. For this Remedial Investigation Work Plan, we assume that half of the samples will require EPH fractionation. Chain of custody documentation will accompany the samples.

Purge water generated during the sampling activities will be infiltrated into the grassy areas available at the Site in accordance with Montana DEQ's standards.

## *2.5 Task 5 – Reporting*

***Remedial Investigation Report and RCP.*** Pioneer will prepare and submit a remedial investigation report and RCP in accordance with *Montana Remedial Investigation Report Work Plan and Report Guidance for Petroleum Releases* (DEQ, 2021b). The remedial investigation report will detail the method and results of the groundwater monitoring event completed under this work plan along with the soil boring activities; well installation, development, well abandonment, and survey. The report will follow Montana DEQ's report format and include the following:

- Updated facility maps illustrating locations of utilities, former fuel systems, Site buildings, locations of petroleum source material areas, receptors including underground utilities, locations of groundwater monitoring wells, and potentiometric surface maps.
- The report will be appended with copies of the DNRC well abandonment report forms that are to be submitted to and filed with DNRC.
- Tables summarizing field data and cumulative laboratory analytical data for soil and groundwater water samples.
- Laboratory analytical reports for the soil and groundwater samples.
- Field sample data sheets and related field data.

- Data interpretation and recommendations relevant for further remediation and/or closure plan for the release.
- Data validation documentation using DEQ's Data Validation Summary Forms.
- A completed RCP.

# 3 COST ESTIMATES

Attachment 2 provides the cost estimate to perform this scope of work.

# 4 SCHEDULE

We can begin work on this project within 15 days following receipt of Montana DEQ's approval, which is expected sometime in the winter of 2026. The soil boring installation and well abandonment is expected to be completed in the early spring of 2026, and the groundwater monitoring is to be completed in the late spring of 2026. The final report will be issued 45 days after the final groundwater monitoring event or no later than June 12, 2026.

# 5 REFERENCES

DEQ, 2018. Groundwater Sampling Guidance. Montana Department of Environmental Quality Contaminated Site Cleanup Bureau. DEQ-WMRD-GWM-1. March 6, 2018. Helena, Montana 59601.

DEQ, 2021. Montana Vapor Intrusion Guide. Montana Department of Environmental Quality. DEQ-WMRD-Vaport-1. September 2021. Available at https://deq.mt.gov/Files/Land/StateSuperFund/Documents/VI_Guide/MontanaVI_Guide_FINAL.pdf.

DEQ, 2021b. Montana Remedial Investigation Report Work Plan and Report Guidance for Petroleum Releases. March 2021.

DEQ, 2024. Montana Risk-Based Corrective Action Guidance for Petroleum Releases. Montana Department of Environmental Quality. February 2024.

Pioneer, 2023a. Environmental Site Assessment Report – Soil Boring and Soil Sampling, MDT Maintenance Facility, 3rd Avenue and Garfield Street, White Sulphur Springs, MT 59645. March 17, 2023.

Pioneer, 2023b. Abbreviated Cleanup Report Revision 1, Montana Department of Transportation White Sulphur Springs Maintenance Facility, 705 3rd Avenue Southwest, White Sulphur Springs, Meagher County, Montana, Facility ID #30-12376, Release #6522. December 19, 2023.

Pioneer, 2024. Remedial Investigation Work Plan: MDT White Sulphur Springs Maintenance Facility, 705 3rd Avenue Southwest, White Sulphur Springs, Meagher County, Montana. Facility ID #30-12376 (TID #25004), Release #6522, WP ID #34821. Prepared by Pioneer Technical Services, Inc. March 2024.

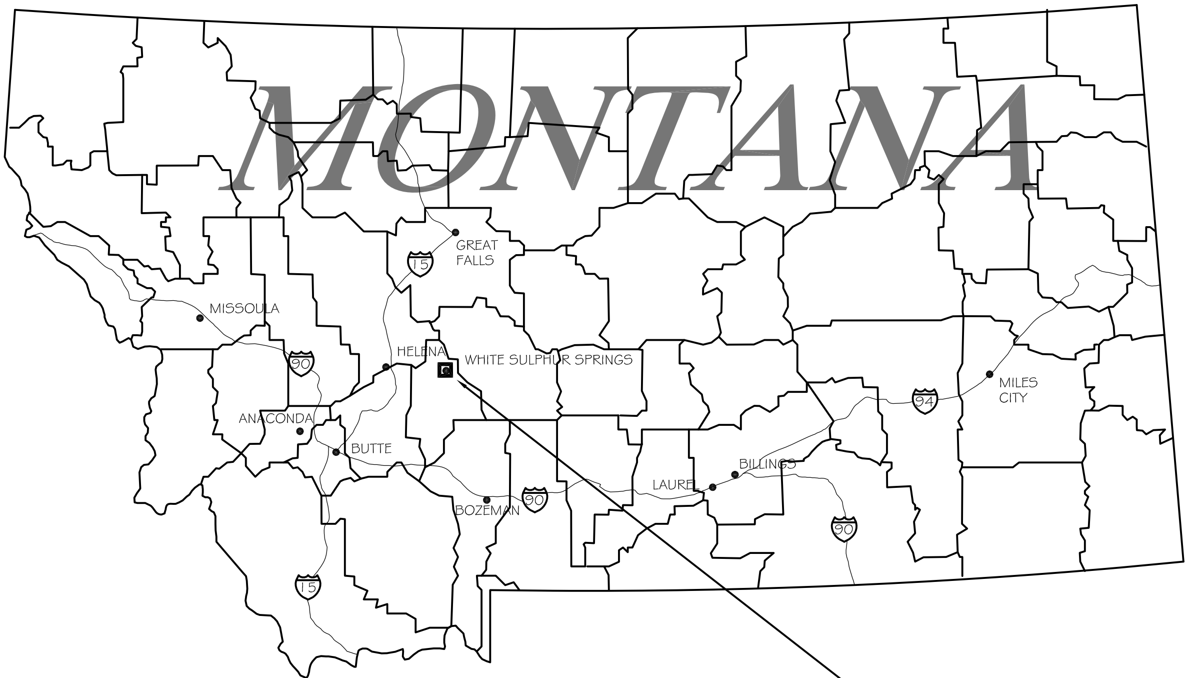
Pioneer, 2025. Remedial Investigation Report: Soil Boring and Groundwater Monitoring at the Montana Department of Transportation White Sulphur Springs Maintenance Facility, 705 3rd Avenue Southwest, White Sulphur Springs, Meagher County, Montana, Facility ID #30-12376, Release #6522. April 25, 2025.

# Attachment 1
# Figures

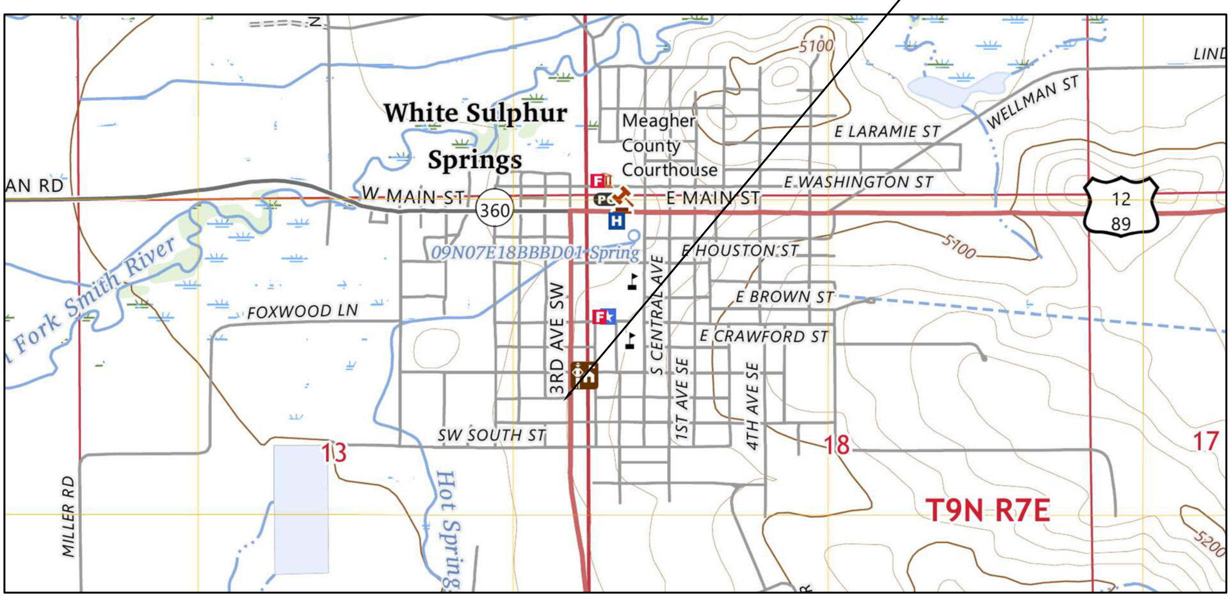
**Figure 1: Location and Vicinity Map**

**Figure 2: Site Map**

**Figure 3: Soil Boring Map**




**PROJECT LOCATION**




## SITE VICINITY MAP

SITE: MDT WHITE SULPHUR SPRINGS MAINTENANCE FACILITY
WHITE SULPHUR SPRINGS, MT
FACILITY ID #30-12376
RELEASE #6522

N

DISPLAYED AS:
COORD SYS/ZONE: NAD83, NAVD88
DATUM: MSP
UNITS: INT. FEET
SOURCE: USGS

SCALE IN FEET
0 1000 2000

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**FIGURE 1**

MDT WSS MAINTENANCE FACILITY LOCATION AND VICINITY MAP

DATE: OCTOBER 2025

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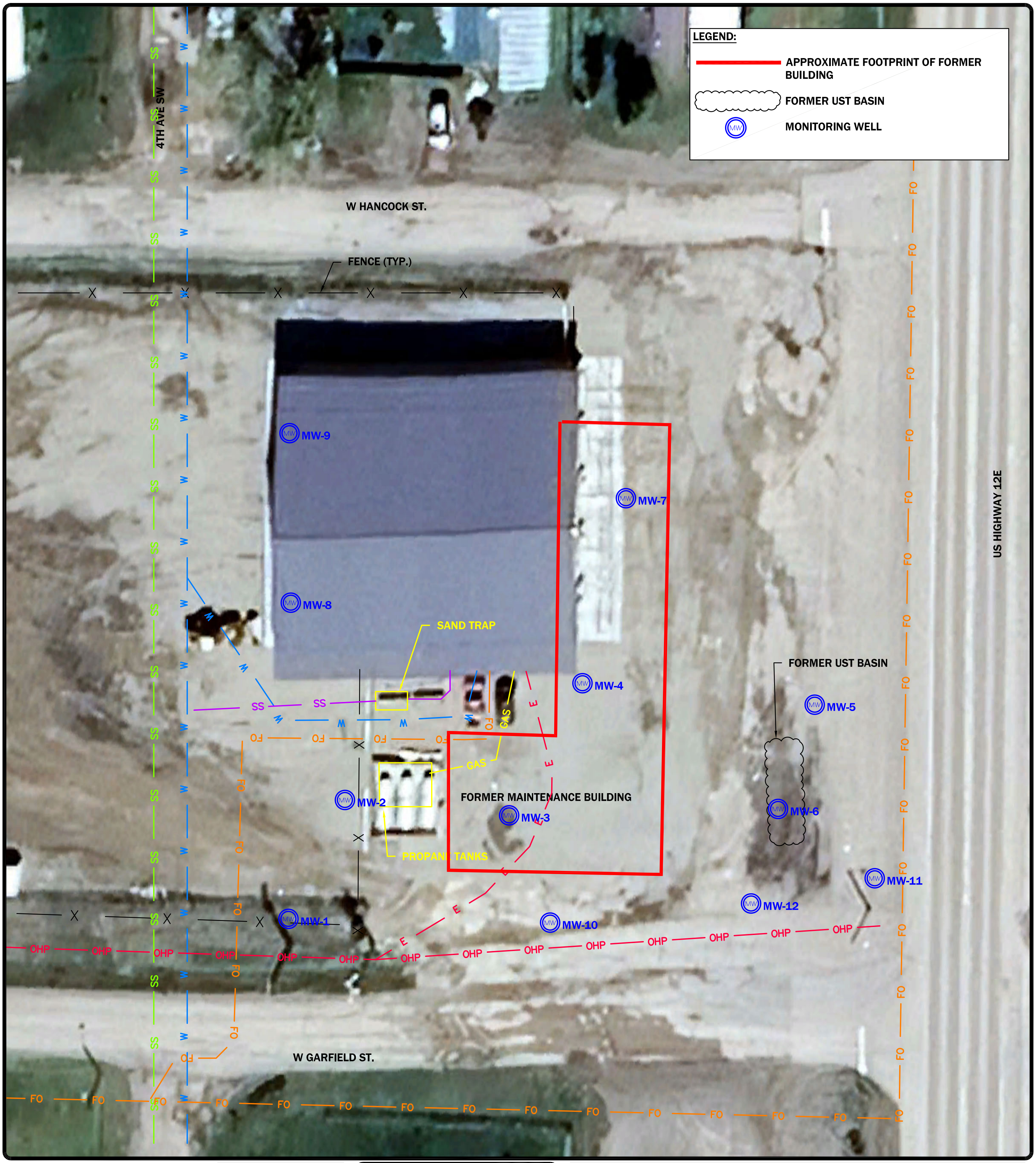


SITE: MDT WHITE SULPHUR SPRINGS
MAINTENANCE FACILITY
WHITE SULPHUR SPRINGS, MT
FID#: 30-12376
RELEASE #:6522

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COORD SYS/ZONE: NAD83, NAVD88
DATUM: MSP
UNITS: INT. FEET
SOURCE: BING

SCALE IN FEET
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**FIGURE 2**

MDT WSS
MAINTENANCE FACILITY
SITE MAP

DATE: OCTOBER 2025

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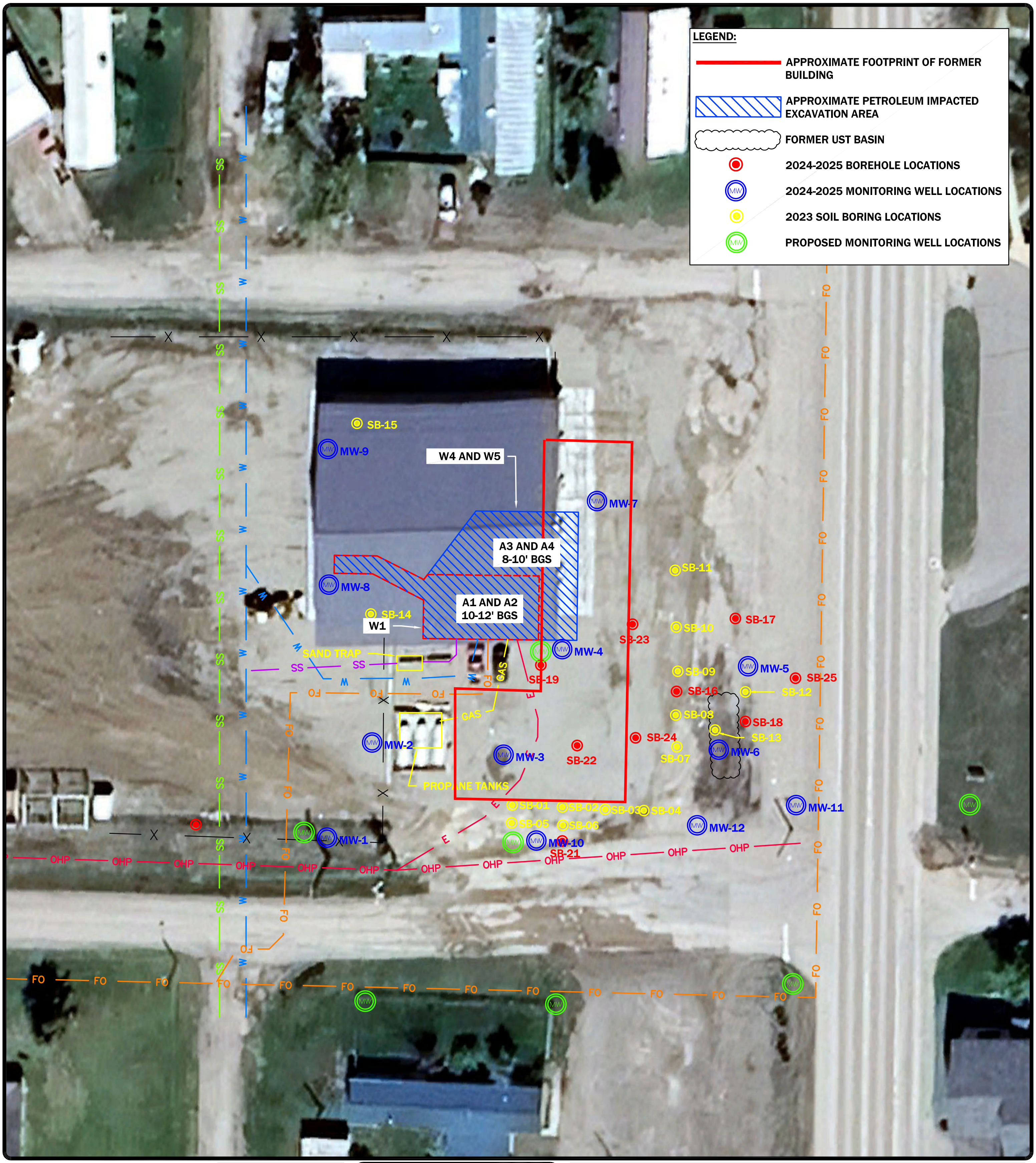


SITE: MDT WHITE SULPHUR SPRINGS MAINTENANCE FACILITY
WHITE SULPHUR SPRINGS, MT
FID#: 30-12376
RELEASE #:6522

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| SOURCE: | BING |

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# FIGURE 3

MDT WSS MAINTENANCE FACILITY SOIL BORING MAP

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10/31/2025 11:51:19 AM Z:\SHARED\ACTIVE PROJECTS\MDT\WHITESULPHURSPRINGSMAINTFACIL\CADD\FIGURES\2025\MDT-WSS-FIG-003_V2.DWG

# Attachment 3
# Pioneer Standard Operating Procedures

**SOP-GW-12: Well Development Using A Modified Over-Pumping Technique**
**SOP-S-14: Sampling Soil from Hollow-Stem Auger Drill**
**SOP-FM-01: Field Headspace Analysis and VOC Measurements with PID**
**SOP-GW-03: Depth to Water Level Measurements**
**SOP-GW-10.2: Purging and Sampling Using the Low Flow Purge Method**

| | |
|---|---|
| **PURPOSE** | To provide standard instructions for well development and the removal of fine grained sediments from the vicinity of the well screen. Well development allows the water to flow freely from the formation into the well and reduces the turbidity of the water during groundwater sampling. Initial well development is critical to ensure that the well has the pumping volume required for future use. |
| **SCOPE** | This practice is for the Pioneer Technical Services, Inc. (Pioneer) workforce and applies to work carried out by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent in the risk-assessed procedure described below.<br><br>This Standard Operating Procedure (SOP) discusses well development using a modified over-pumping technique and can be used with the following pumps: peristaltic, low flow Grundfos, PROACTIVE 12-volt submersible, and Grundfos Redi-Flo II. Less vigorous methods of well development include bailers or manual surge blocks. These methods are addressed in other SOPs. If a well requires more vigorous development than over-pumping (e.g., soil types, chemicals used during installation, large required production volumes, etc.), a well installer or subcontractor may be required to complete the development. |

**WORK INSTRUCTIONS**

The following instructions are intended to provide sufficient guidance to perform the task in a safe, accurate, and reliable manner. Should these instructions present information that is inaccurate or unsafe, operations personnel must bring the issue to the attention of the Project Manager and the appropriate revisions made. All work performed under this Standard Operating Procedure (SOP) will be consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

| TASK | INSTRUCTIONS |
|---|---|
| 1. Select pump. | The table below summarizes the types of pumps Pioneer has readily available for well development. Personnel should select the appropriate pump for the well development required using the table below. |

| Pump/ Development Type | Well Diameter (inches) | Max Well Depth (ft) | Anticipated Production |
|---|---|---|---|
| Bailer[1] | 1 | 100 | Poor to Good |
| | ≥2 | 100 | Poor |
| Manual Surge Block[1] | 1 | 100 | Poor to Good |
| | ≥2 | 100 | Poor |
| Peristaltic Pump | 1 | 25 | Poor to Good |
| | 2 | 25 | Poor |
| Low Flow Grundfos | ≥2 | 200 | Poor to Good |
| PROACTIVE 12-volt Submersible Pump | ≥2 | 80 | Good |
| Grundfos Redi-Flo II | ≥2 | 250 | Good |
| Subcontractor/Well Installer | ≥2 | >250 | Poor to Good |

1. If a bailer or manual surge block is the only alternative, the modified over-pumping technique cannot be used. Instead, personnel should follow the appropriate, alternative SOP.

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| 2. Gather information. | Review the Site Sampling and Analysis Plan (SAP) or Work Plan for purge water containment requirements. Compile the necessary equipment and well installation information (e.g., total depth, screen interval, etc.) prior to traveling to the site. |
| 3. Set up equipment. | Upon arrival at the well/piezometer to be developed, place the containers that will be used to contain purge water (if required) in an accessible location.<br><br>Set up the remainder of the equipment adjacent to the well, within spill containment if required. |
| 4. Take and initial DTW reading. | Open the well/piezometer and take an initial depth to water (DTW) reading following the instructions outlined in SOP-GW-03 Depth to Water Level Measurements. Record the initial DTW in the field logbook and on the well development field data sheet. |
| 5. Check the total depth of the well. | Check the total depth of the well by turning off the buzzer on the DTW meter and lowering probe to the bottom of the well. Record this information in the field logbook and on the well development field data sheet. Remove the DTW probe from the well. Record the screen depth and length (available from the well installation log). |
| 6. Set up pump and tubing. | If needed, attach an appropriate length of disposable or decontaminated tubing to the pump outlet or put tubing in the pump head. Don a new, clean pair of gloves prior to handling the tubing. Lower pump or tubing into the well. The pump intake should be located near the bottom of the screened interval. If the screen extends to the bottom of the well, make sure the intake for the pump is located above any slurry that may be present in the bottom of the well, approximately 1/2 to 1 foot above the bottom if using the submersible pumps. |

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| | If using a peristaltic pump, tubing can be located closer to the bottom of the well as slurry will only clog the tubing and not damage the pump itself.<br><br>If using a submersible 12-volt pump without a controller, put a valve on the discharge end of tubing and securely fasten.<br><br>Record the depth of the pump intake in the field logbook and on the well development field data sheet. |
| 7. Measure DTW with the pump installed. | Put the DTW probe back in the well and make sure it is turned on. Record the DTW with the pump installed. |
| 8. Turn the pump on and adjust water flow. | If using a 12-volt submersible pump, start the pump with the attached discharge valve all the way open. If using a Grundfos pump with a controller or a peristaltic pump, turn the pump on and raise the pumping rate slowly until water starts to flow.<br><br>Monitor the DTW meter; the water elevation should drop until the tubing is full and water is flowing freely. If the water elevation continues to drop after water is flowing smoothly, turn flow down using either the discharge valve or the controller until the water elevation stabilizes.<br><br>Record the time development starts, the stabilized water elevation, and an estimate of volume purged in the field logbook and on the well development field data sheet as "Initial Drawdown." |
| 9. Measure the stabilized water flow rate. | Measure the stabilized water flow rate using an appropriately-sized container (e.g., graduated cylinder, marked beaker, marked bucket, etc.) and a stopwatch to determine the volume of water per minute being purged from the well. Record the water flow rate in the field logbook and on the well development field data sheet. |
| 10. Record the characteristics of the purged water. | Record the color of water, presence of sand or silt, and any odors or sheen. If the water is not extremely dirty, run an initial turbidity measurement and record. |
| 11. Track the volume of water being removed. | Track the volume of water being removed. Volume may be calculated by either multiplying the elapsed time by the water flow rate or multiplying the number of buckets/drums purged by the volume of the bucket/drum. Keep a record of time, water removed, turbidity measurements and DTW readings in the field logbook and on the well development field data sheet. |
| 12. Measure and record the field parameters. | Once the water appears to be clear, begin measuring field parameters. At a minimum, measure temperature, pH, specific conductivity (SC), and turbidity. If required by the SAP or Work Plan, measure and record the oxidation reduction potential (ORP) and dissolved oxygen (DO).<br><br>Depending on the water flow rate field parameter probes can be placed in a 5-gallon bucket, in a ½- to 1-liter beaker or in a flow thru cell. Turnover of water in the container should be quick (e.g., 1 to 2 minutes). As an example, if the water is purging |

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| | at 4 gallons a minute, a 5-gallon bucket could be used, as turnover in the bucket would be about 1 minute. If water is purging at 1 to 2 gallons a minute, a liter beaker may be more appropriate. If the water is fairly clear, a flow through cell with appropriately sized bypass tubing can be used with any flow rate. The flow through cell allows the water in the bypass tubing to be discharged directly into a storage container or to the ground a safe distance downgradient from the well.<br><br>Record parameter measurements every 5 to 10 minutes. Record DTW measurements and estimated volume along with the parameter readings in the field logbook and/or on the well development field data sheet. |
| 13. Purge the well and monitor drawdown. | If possible, when turbidity falls below 50 Nephelometric Turbidity Unit (NTU), increase the flow by adjusting the discharge valve or turning up the controller. Purge the well at about twice the stabilized water flow rate determined in Steps 8 and 9. Monitor drawdown constantly as you do not want to purge the well dry.<br><br>• The water elevation may stabilize at a level lower than the initial DTW reading. If so, record how long it took to stabilize at the lower level, the amount of water purged, and the new DTW elevation in the field logbook and on the well development field data sheet.<br><br>• If the water elevation in the well drops to about 4 to 5 feet above the pump intake (the acceptable drawdown elevation should be adjusted based on the water column, screen length and depth of the well being developed; ideally you want to develop the well along the entire screen length), turn the discharge valve or controller below the starting flow rate and allow the well to “recover.” Record the duration, amount purged, and DTW when done with the initial over-pumping of the well.<br><br>• If the pump is purging at maximum capacity, or if no drawdown occurs at a higher flow, turn the pump off, let the well “recover” for 1 to 5 minutes, and turn the pump back on. Record the duration of the stoppage and the new starting water level in the field logbook and on the well development field data sheet. |
| 14. Continue monitoring turbidity and recording field parameters. | Turbidity may increase after the over-pumping or stopping. Continue recording field parameters unless the turbidity exceeds 1000 NTU. At this point, remove the field parameter probes and wait for the water to clear up before recording field parameters. Note this in the field logbook or on the well development field data sheet.<br><br>Once turbidity measures less than 50 NTU, repeat Steps 12 and 13 until the clarity of water does not change significantly between lower and higher flows. |
| 15. Adjust pump as needed. | If time permits (as designated in the SAP or Work plan) and the stabilized water level allows, raise the pump to the midpoint of the screen and repeat Steps 12 through 14, recording time, field parameters, volume purged, and DTW readings until turbidity readings are less than 50 NTU. |
| 16. Continue monitoring turbidity and | The well is considered developed when 3 consecutive readings for turbidity are below the SAP or Work Plan designated requirements (e.g., the Clark Fork River Superfund Site Investigation SOP [ARCO, 1992] requires readings below 5 NTU, and the U.S. |

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| field parameters to determine if the well is developed. | Environmental Protection Agency [EPA] well development protocol requires readings below 50 NTU) and the remaining required field parameters have stabilized. Water quality parameters are considered stable when three consecutive readings are as follows:<br><br>• Temperature range is no more than +/- 1 degree Celsius (°C);<br>• pH varies by no more than 0.1 pH units; and<br>• SC readings are within 3% of the average. |
| 17. Record the final DTW and calculate the total amount of water purged. | Before turning off the pump, record a final DTW. Calculate the total amount of water purged and record the volume in the field logbook and on the well development field data sheet. |
| 18. Dispose of the purge water and tubing. | Dispose of the purge water and tubing as outlined in the SAP or Work Plan. |

| HSSE CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
|---|---|---|---|---|
| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
| **CHEMICAL** | Potential contact with contaminated soils and water. | During well development. | Inadvertent exposure to contaminated soils and water could lead to adverse health effects. | Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when contact with purge water is possible. Pour purge water from buckets into disposal area/containers used to contain purge water slowly to prevent splashes and skin contact. Keep control of high-flow discharge hoses to prevent water spraying and skin contact. |
| | Carbon monoxide (CO). | Generator. | Potential exposure to CO when working around the generator could result in irritated eyes, headache, nausea, weakness, and dizziness. | Personnel will stay up wind when working around the generator. The generator will not be operated indoors or near openings to any buildings that might be occupied. |
| | Contact with gasoline. | Fueling the generator. | Inadvertent exposure via inhalation and/or skin contact can result in adverse health effects and skin irritation if contact with gasoline occurs. | Personnel will fuel the generator in a well-ventilated area, stand up wind while fueling, and minimize splash hazards so skin contact does not occur. Wear nitrile gloves when removing the fuel cap and filter. |

| **HSSE CONSIDERATIONS**<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
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| **NOISE** | Elevated noise levels. | Using the generator. | Exposure to elevated noise levels from the generator may result in hearing damage. | Personnel will set up the generator away from the well development activities to prevent exposure to elevated noise levels. |
| **ELECTRICAL** | Improper use of the generator. | Sites (during we conditions). | Electrocution, shock, death, or equipment damage could be caused when using a generator during wet conditions. | If personnel must use a generator when it is wet outside, the generator will be protected from moisture and it will be equipped with a Ground Fault Circuit Interrupter (GFCI). Keep extension cord (if used) and connections as dry as possible. Place generator on a surface where water cannot puddle or drain under it.<br><br>Personnel will dry hands, if wet, before touching the generator. Items will be connected to the generator using heavy-duty extension cords that are specifically designed for outdoor use. |
| | Improper use of the 12-volt battery. | Using the battery to power the 12-volt submersible pump. | Personal injuries could result from improper use and maintenance of a 12-volt battery. Example are: shocks, acid burns on skin or eyes, skin burns from electrical charge transfer through a tool and into a metal ring or watch, and battery explosions. | Personnel will remove all jewelry before working with a 12-volt battery. Personnel will disconnect the negative cable first and re-connect it last to prevent getting a shock from current overflow. Personnel will use the battery in well-ventilated areas and inspect the battery before and after each use. Personnel will wear leather gloves and safety glasses when handling the battery. |

| **HSSE CONSIDERATIONS**<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
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| **BODY MECHANICS** | Improper lifting. | During well development. | Back injuries and muscle/back strains could result when using improper techniques to lift and carry tools and equipment. | Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder's height. Two workers will lift/handle heavy items. |
| | Bending, squatting, and kneeling. | During well development. | Bending, squatting, and kneeling during work activities could result in muscle/back strains or other injuries. | Personnel should stretch prior to starting work and they will take breaks when necessary. |
| **GRAVITY** | Falls from slips and trips. | Uneven terrain, slick/muddy/wet surfaces and steep slopes. | Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries. | Personnel will wear work boots with good traction and ankle support. Personnel will be aware of walking/working surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. If conditions are wet or muddy, wear muck boots. |
| **WEATHER** | Cold/heat stress. | Outdoor sites. | Exposure to cold climates may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke. | Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP. |
| | Lightning. | Outdoor sites. | Electrocution, injury, death, or equipment damage could result from lightning strike. | Personnel will follow the 30/30 rule during lightning storms. |

| HSSE CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
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| **RADIATION** | Ultraviolet (UV) radiation. | Outdoor sites. | Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage. | Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary. |
| **BIOLOGICAL** | Plants, insects, and animals. | Outdoors. | Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling. | Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on the site. Personnel with allergies will notify their supervisor. |
| **MECHANICAL** | Pinch points. | Well caps. | Personal injury could result from fingers getting pinched in well caps. | Personnel will wear leather gloves when removing well caps. |
| **PRESSURE** | Not applicable. | | | |
| **THERMAL** | Not applicable. | | | |
| **HUMAN FACTORS** | Inexperienced and improperly trained personnel. | Sites. | Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage. | Personnel will be properly trained in the procedure described above and other applicable procedures. Personnel will follow the stop work policy, if there are any issues. |
| **SIMOPS** | Not applicable. | | | |

| HSSE CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | |
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| **ADDITIONAL HSSE CONSIDERATIONS**<br>This section to be completed with concurrence from the Safety and Health Manager. | |
| **REQUIRED PPE** | **Personal Protective Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and work gloves. |
| **APPLICABLE SDS** | **Safety Data Sheets** (SDSs) will be maintained based on the site characterization and contaminants. |
| **REQUIRED PERMITS/FORMS** | Per site/project requirements. |
| **ADDITIONAL TRAINING** | Per site/project requirements. |

| DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT<br>The following documents should be referenced to assist in completing the associated task. | |
|---|---|
| **DRAWINGS** | |
| **RELATED SOPs/ PROCEDURES /WORK PLANS** | SOP-GW-03 Depth to Water Level Measurements |
| **TOOLS** | DTW meter, pump and tubing (see step 1 for pump selection), turbidity meter, container to measure water flow rate (e.g., graduated cylinder, marked beaker, marked bucket, etc.), stopwatch, field parameter meters, and containers to contain purge water (if required). |
| **FORMS/ CHECKLIST** | Field logbook, well development field data sheet, and well installation log. |

| APPROVALS/CONCURRENCE<br>By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing. | |
|---|---|
| **SOP TECHNICAL AUTHOR** | **DATE** |
| Julie Flammang<br>**Julie Flammang** | **04/10/2018** |
| **SAFETY AND HEALTH MANAGER** | **DATE** |
| Tara Schleeman<br>**Tara Schleeman** | **04/10/2018** |

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| **PURPOSE** | To provide standard instructions for collecting geotechnical soil samples generated during hollow-stem auger drilling. |
| **SCOPE** | Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work. |
| **DISCUSSION** | The steps to collecting soil samples using a hollow-stem auger drill rig are as follows:<br><br>1. Advance a hollow-stem auger flight into undisturbed soil. Auger flights are typically 5 feet.<br>2. Drive a split-spoon sampler 18 inches ahead of the hollow-stem auger flight with a 140-pound hammer falling 30 inches. This is known as a Standard Penetration Test (SPT).<br>3. Remove the split-spoon sampler to the surface and separate the two halves to reveal the sample for lithologic interpretation.<br>4. Place the sample into labeled, sealable plastic bags for transport to the laboratory. |

**WORK INSTRUCTIONS**

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

| TASK | INSTRUCTIONS |
|---|---|
| **Preparation** | |
| **1. Verify utility locates and conduct site walk.** | Confirm that the drilling subcontractor has placed a utility locate ticket that covers the area to be sampled. The confirmation number needs to be provided to Pioneer and put on the Job Risk Assessment or corresponding safety or permit form. Utility locates need to be called in a minimum of 48 business hours prior to the planned drilling activities.<br><br>Conduct a site walk-through and determine any site-specific hazards associated with the sampling area. Discuss these with the sampling crew and note in the field logbook and Job Risk Assessment or corresponding safety form.<br><br>As part of the site hazard assessment, identify possible locations for unidentified, privately installed underground utilities. For example, identify where natural gas pipes enter any structures on the property and confirm that gas lines from the street/alley have been marked. Check on yard lights or streetlights that are present with no overhead lines, underground wiring from a residence to outbuildings, or a possible gas line to a grill or outdoor kitchen. Adjust sample locations based on this information. |

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| | Before drilling activities begin, verify that the ground has been marked with the location of underground utilities listed on the locate ticket from the drilling subcontractor. If needed, adjust sample locations based on identified or potential utility locations. See the Trenching, Excavation, and Ground Disturbance Program information in Pioneer's Corporate HASP to identify safe distances for drilling when adjacent to specific buried utilities. |
| **2. Set up the sample area.** | Designate an area near the drill rig that can be used for sampling and logging the soil from the split-spoon. The location should be out of the way of the drill rig, but close enough to facilitate moving the soil to the area and allowing continued monitoring of the drilling. This is typically done on the tailgate of a pickup truck. Alternative locations include a designated logging trailer (most often used in unfavorable weather), or a folding table (covered with plastic sheeting, as needed) when the site is not conducive for a vehicle. |
| **3. Determine the sampling interval.** | Discuss with the drilling crew the frequency at which they will be performing SPTs. In most cases, this will be every 5 feet. If weak materials are anticipated, a more frequent sampling interval (e.g., 2.5 feet) might be appropriate for the best results. |
| **4. Record information provided by the operator.** | If possible, consult with the drill rig operator for any issues or observations associated with auguring each interval. Potential information they may report:<br>• A section that drilled extremely easy indicating material that was easily compressed such as clay or debris or indicating material that is loose.<br>• The presence of a potential void, large cobbles, etc.<br>• Heaving sands, which could result in overestimation of the width or depth of a layer due to re-coring of the same interval.<br>• Their recognition of slough into the hole prior to drilling the next interval.<br><br>Record any information provided by the operator in the field logbook or on a field data sheet. This information can be referenced when logging the soil. |
| **Standard Penetration Testing using a Split-Spoon Sampler** | |
| **1. Position the split-spoon sampler at the bottom of the auger run.** | The drill crew will remove the center drill rod and drill bit to provide access to undisturbed soil ahead of the hollow-stem auger. The drill crew will then position the split-spoon sampler down hole making sure it rests on top of the undisturbed soil ahead of the auger. The drill crew will place a 140-pound hammer on top of the drill rod attached to the split-spoon sampler and mark 6-inch intervals on the drill rod for discrete "blow count" intervals. |
| **2. Perform the STP.** | Using a 140-pound hammer falling 30 inches, the split-spoon sampler will be driven into the soil 18 inches. Record the number of blows required to drive the sampler 6 inches for 3 discrete intervals. If the blow count exceeds 50 blows before any discrete 6-inch interval is entirely driven, then the test may be terminated, and this should be recorded as refusal. The blow counts for the first 6-inch interval shall be disregarded and the number of blows for the second and third intervals shall be added to calculate the number of blows per foot. |

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| **3. Measure and record material in the split-spoon sampler.** | Measure and record the number of inches of soil in the split-spoon sampler. This will be recorded in the field logbook or on the field data sheet as "length recovered" (e.g., 12 inches from an 18-inch spoon). This measurement should not include any material that appears to have sloughed from an upper interval such as leaves or topsoil present at the top of deeper subsurface samples. If heaving sands are present, the actual measurements of the new interval may be difficult to determine; consult with the driller as to where material from the new interval may start. Record this information in the field logbook or on a field data sheet as specified in the Sampling and Analysis Plan (SAP).<br><br>Photograph the material in the split-spoon sampler, placing a tape measure or ruler next to the sampler for a scale. |
| **4. Log the soil.** | Examine and log the material in the split-spoon. Check the project specific documents for detail or type of information required from the soil log. Pioneer has developed several different field data sheets to aid in collecting the correct information during soil logging.<br><br>Typically, the logger will include a Unified Soil Classification System soil classification, density (determined from blows per foot during SPT), color, moisture, and other descriptive attributes such as gravel angularity or plasticity of the soil. |
| **5. Put sample in container.** | Prepare the appropriate sample containers, typically a gallon-sized resealable bag, with a label as described in the SAP or the Quality Assurance Project Plan. Transfer the contents of the soil in the split-spoon sampler to the sample container. Soil samples may be divided into multiple containers if unique lithologic layers are identified by the logger. After sampling, place the sample bags in a bucket for transport.<br><br>Clean and reassemble the split-spoon sampler for the driller to use on the next SPT. For particularly sticky clays or muddy soil, a bucket of water and a brush may aid in the cleaning process. |
| **6. Repeat this process as needed.** | Repeat this process, Steps 1 – 5 above, for each split-spoon until the drill hole is complete. |
| **Decontamination of Equipment following Sampling, per Project Requirements** | |
| **1. Decontaminate equipment.** | Decontaminate the cutting tool, tape measure, and any other reusable equipment using paper towels wetted with a Liquinox/water mixture and use a deionized (DI) water spray bottle to rinse. If stainless-steel bowls, spoons, and trowels were used, please follow SOP-DE-02. |
| **2. Clean the plastic placed over the sample area.** | If a table is used, sweep or wipe down the plastic sheeting using paper towels wetted with DI water between each sample collection. If a particularly muddy sample was collected, the plastic sheeting may need to be replaced or a new piece placed over the sample area. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
|---|---|---|---|---|
| **CHEMICAL** | Potential contact with contaminated soil and groundwater. | Sites. | Inadvertent exposure to contaminated soil and groundwater could lead to adverse health effects. | Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when contact with soil and groundwater is possible. Sampling will be conducted outdoors or in a trailer with open doors. |
| | Exposure to hydraulic fluids. | Drilling operations. | Exposure to hydraulic fluids could occur while working around the drill due to equipment malfunction/failure resulting in personal injuries. | The operator will inspect the drill and document inspections daily before starting work. The operator will also replace/repair all faulty equipment before starting work. When inspecting equipment, personnel will wear work gloves to prevent possible exposures to hydraulic fluids. Non-essential personnel will maintain a 20-foot buffer zone around the drill. |
| | Liquinox. | Equipment decontamination. | Personnel could be exposed to Liquinox via ingestion and skin/eye contact when decontaminating the equipment resulting in adverse health effects. | Personnel will wear nitrile gloves and eye protection when decontaminating the equipment. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **NOISE** | Elevated noise levels. | Drilling operations. | Personnel could be exposed to elevated noise levels when working near the drilling operations resulting in hearing damage. | Personnel will wear hearing protection (e.g., ear plugs) when working near the drill. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible. Hearing protection will be administered and used according to the policies and procedures outlined in the Pioneer Corporate HASP. |
| **ELECTRICAL** | Not applicable. | | | |
| **BODY MECHANICS** | Bending, squatting, and kneeling. | During fieldwork activities. | Bending, squatting, and kneeling during fieldwork activities could result in muscle/back strains or other injuries. | Personnel should stretch prior to starting work and they will take breaks when necessary. |
| | Improper lifting/ handling of heavy items. | During field work activities. | Back injuries and muscle/back strains could result when using improper techniques to lift/ carry heavy buckets with samples. | Personnel will use proper lifting techniques – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two workers will lift/handle heavy items as needed. |
| | Flying debris. | Drilling operations. | Eye injuries could result from flying debris when working around drilling operations. | Personnel will wear safety glasses when working around drilling operations. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **GRAVITY** | Falls from slips and trips. | Uneven terrain, slick/muddy/wet surfaces, and steep slopes. | Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries. | Personnel will wear work boots with good traction and ankle support. They will plan their path, walk cautiously, and keep work areas as dry as possible. Personnel will wear muck boots, as necessary. |
| **WEATHER** | Cold/heat stress. | Outdoor sites. | Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke. | Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors (e.g., layers and loose clothing). Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in the applicable SSHASP and/or Pioneer Corporate HASP. |
| | Lightning. | Outdoor sites. | Electrocution, injury, death, or equipment damage could be caused by lightning strike. | Personnel will follow the 30/30 rule during lightning storms. |
| **RADIATION** | Ultraviolet (UV) radiation. | Outdoor sites. | Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage. | Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **BIOLOGICAL** | Plants, insects, and animals. | Outdoor sites. | Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling. | Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available in company vehicles. Personnel with allergies will notify their supervisor. |
| **MECHANICAL** | Pinch points/injury from auger. | Auger. | Inadvertent contact with the auger can result in pinch points/injury while performing drilling/sampling. | Personnel will wear Level D personal protective equipment (PPE) when drilling and sampling. Inspect the auger prior to use, wear gloves, and do not touch the auger during drilling. Sampling personnel will not handle the auger. |
| **PRESSURE** | Pressurized hydraulic hoses. | Drilling operations. | Hydraulic hoses could burst/rupture resulting in inadvertent contact with hydraulic fluid or personal injury due to being struck by hoses. | The operator will inspect the drill and document inspections daily before starting work. The operator will also replace/repair all faulty equipment before starting work. When inspecting equipment, personnel will wear work gloves to prevent possible exposures to hydraulic fluids. Non-essential personnel will maintain a 20-foot buffer zone around the drill. |
| **THERMAL** | Not applicable. | | | |
| **HUMAN FACTORS** | Inexperienced and improperly trained personnel. | Sites. | Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage. | Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary. |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
|---|---|---|---|---|
| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
| **SIMOPS (Simultaneous Operations)** | Not applicable. | | | |

| ADDITIONAL HSSE CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | |
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| **REQUIRED PPE** | **Personal Protection Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and work gloves. |
| **APPLICABLE SDSs** | **Safety Data Sheets** (SDSs): Liquinox.<br><br>Safety Data Sheets are available to Pioneer personnel on the internal website under Safety. |
| **REQUIRED PERMITS/ FORMS** | Per site/project requirements. |
| **ADDITIONAL TRAINING** | Per site/project requirements. |

| DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT<br>The following documents should be referenced to assist in completing the associated task. | |
|---|---|
| **DRAWINGS** | Map with site location and sample locations. |
| **RELATED SOPs/ PROCEDURES/ WORK PLANS** | SOP-DE-02 Equipment Decontamination |
| **TOOLS/ EQUIPMENT** | Sample area – plastic sheeting, tape measure, camera, plastic disposable scoops or stainless-steel spoons or spatulas, screwdrivers, DI water spray bottle, Liquinox/water spray bottle, paper towels, foil disposable pans or stainless-steel bowls, cleaning brush, buckets, and sample containers. |
| **FORMS/ CHECKLIST** | Field logbook and field data sheets. |

**APPROVALS/CONCURRENCE**

By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.

| SOP TECHNICAL AUTHOR | DATE |
|---|---|
| Adam Fetherston<br>**Adam Fetherston** | **08/15/2022** |
| **SAFETY AND HEALTH MANAGER** | **DATE** |
| Tara Schleeman<br>**Tara Schleeman** | **08/15/2022** |

| | |
|---|---|
| **PURPOSE** | To provide standard instructions for using a photo-ionization type detector (PID) to estimate the total concentration or presence of volatile organic compounds (VOCs) in groundwater and soils. This is a ***screening*** procedure to help in determining appropriate sample collection and/or required laboratory methods (high or low concentration methods). Actual concentrations of VOCs in samples should be determined by a laboratory. |
| **SCOPE** | Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work. |
| **NOTES** | 1. This SOP specifically discusses the procedures for using a MiniRAE 3000 PID. If another type of PID is being used, the instrument-specific user manual should be reviewed for activities such as calibration and measurement times. However, the safety precautions and general procedures described here should be followed when using any PID.<br><br>2. Static voltage sources such as AC power lines, radio transmissions, or transformers may interfere with measurements. See operating manual for discussion of necessary considerations.<br><br>3. Regular cleaning and maintenance of instrument and accessories will assure representative readings.<br><br>4. As with any field instrument, accurate results depend on the operator being completely familiar with the operator's manual for unit use. |

**WORK INSTRUCTIONS**

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate the appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

| TASK | INSTRUCTIONS |
|---|---|
| **1. Charge battery.** | **Always** fully charge the battery prior to use. Directions on charging the battery and checking battery levels are described in the operating manual. |
| **2. Turn unit on.** | Turn the unit on by pressing and holding the on/off /flashlight button (also known as mode key) on the front of the unit. The display screen should start up and display the RAE system's logo. The instrument is now on and will perform several self-tests. If the detector indicates that any tests have failed, refer to the troubleshooting section of the user manual.<br><br>As part of the startup menu, the display screen will say "Please apply zero gas." At this point, a fresh air calibration can be performed. Start the zero calibration by |

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| | pressing start, the display will read "Zeroing…" and perform a 30-second count down. When the zero calibration is complete you see the message:<br><br>"zeroing is done!<br>Reading = 0.0 ppm"<br><br>If a full calibration is required (see Step 3), skip the zero calibration by pressing the mode key again to quit.<br><br>Once the startup procedure is complete the display screen will show a numerical reading screen with icons, which indicates the instrument is ready for use. You should be able to hear the sampling pump running. |
| **3. Calibrate unit.** | In general, the PID should be calibrated at least once a week while in use, and if the PID has not been used for at least a week it should be calibrated. Calibration information (date, time, type, concentration of gas, and results of calibration) must be recorded in the project logbook or on the project field sheets.<br><br>You should calibrate the unit at the office prior to leaving for the field. If calibrating the PID in the field, it is critical to choose a location where the air is not tainted by automobile, generator, and heavy equipment emissions or other potential contaminants.<br><br>Pioneer generally performs a 2-point calibration consisting of a zero (fresh air) gas and an appropriate span gas. If a volatile other than VOCs are to be measured or monitored, determine the specific compounds to be evaluated, the appropriate calibration (span) gas, and concentrations required so that the calibration can be performed for an appropriate instrument response. Please check with safety personnel on the appropriate type of gas to use for calibration. Isobutylene (100 parts per million [ppm]) is the span gas used for standard hydrocarbon screening and is stored in the PID case.<br><br>Follow the directions for calibration of the PID in the operating manual for a 2-point calibration. Briefly, to perform the calibration:<br><br>1. Press and hold the mode key (the button used to turn the meter on and off) and the [N/-] key simultaneously to start the calibration.<br>2. The password screen will appear, instead of inputting a password, press the mode key again.<br>3. On the calibration screen, **Zero Calib** should be highlighted. Press the [Y/+] key to perform the zero calibration. Pioneer uses fresh air for this calibration. Make sure that you are in an area with "clean" air with an oxygen value of 20.9%.<br>4. Press [Y/+] again to start the calibration.<br>5. The display will read "Zeroing…" and perform a 30-second count down. When the zero calibration is complete you see the message: |

| | |
|---|---|
| | “zeroing is done!<br>Reading = 0.0 ppm”<br>6. The calibration menu will return with the **Span Calib** highlighted. Press [Y+] to enter the Span calibration.<br>7. Put the flow regulator on the span gas and make sure the tubing is securely attached. The flow regulator should be OFF.<br>8. Press [Y+] to select “Change.” Choose the appropriate span gas from the list on the display screen. Isobutylene is the default span gas. Press Save. Refer to Table 1 in Attachment 1 for the required gas correction factor concentration. Enter the corrected value. Press Save.<br>9. Attach the span gas cylinder to the meter probe following the directions in the user manual. Turn on the span gas.<br>10. Immediately press the [Y/+] key to start the calibration.<br>11. The display will read “Calibrating…” and perform a 30-second countdown. When the calibration is complete the display screen shows:<br>“Span 1 is done!<br>Reading = XX ppm.” Reading should be the value entered in Step 8 above.<br>12. This reading should be very close to the span gas value. If it is not, try the calibration sequence again. Check to see if there is gas in the cylinder and confirm the concentration of the gas has been entered correctly prior to restarting the calibration. Refer to the troubleshooting guide in the operating manual if problems persist.<br>13. The instrument will exit the span calibration and show the zero calibration menu on the display. Press the mode key, the instrument will then update its settings and return to the main display.<br><br>Calibration is **required** if:<br>• The user is prompted by the instrument to perform a calibration.<br>• The lamp type is changed so as to detect different VOC ranges.<br>• The sensor has been replaced.<br>• It has been more than 7 days since the instrument was last calibrated.<br>• The calibration gas type is changed. |
| **4. Set up alarms.** | The MiniRAE 3000 PID can be programmed to sound an alarm at different gas concentrations. If the concentration of VOCs exceeds any of the user-programmed alarm limits (low, high, time weighted average [TWA] or short-term exposure level [STEL]), a loud buzzer and red flashing LED are activated. See Table 2 in Attachment 1 for a list of each alarm sequence and meaning. Alarms should be adjusted for the desired contaminant gases. Refer to Table 1 in Attachment 1 for gases or check with the safety department to see which limits and concentrations should be used for the different alarm levels, if necessary. To program the different alarms, refer to the operator’s manual or consult the safety department for assistance. Prior to use, confirm that the alarms are set for the appropriate concentrations. |

The following sections describe the general procedures for using the PID for different monitoring/sampling medias. Prior to any sampling, **make sure that the external filter is clean and is attached to the instrument inlet tube** to prevent dust or particles from being sucked into the sensor and damaging the instrument.

Be aware that VOCs, if present, can show significant losses in concentration with even a short duration (seconds) of exposure to the atmosphere. Take care to begin readings/measurements as soon as the media is exposed to air to ensure measurement of the most volatile compounds. Planning and teamwork is essential to getting the most accurate readings possible.

**5. Screening for organic vapors in a well casing.**

**PID readings are always taken immediately upon opening the well casing.**

To measure VOCs directly in a well without an attachment for the PID tubing, complete these steps:

1. Turn on the PID and allow it to warm up before unlocking and opening the outer casing. If the meter is reading a background level of VOCs prior to opening the outer casing, record that information in the logbook. If machinery is running in the area or the site is adjacent to a road, VOC background readings may be expected.
2. If there is no cap on the inner casing, immediately put the inlet probe into the well as far as you can while still being able to read the screen. If there is an inner cap, remove the inner cap and stick the inlet probe into the well, gently cover as much of the opening with the inner cap as you can to slow down VOC loss as you monitor the readings.
3. Record the highest reading. It may take a while to start getting readings depending on the depth to water, how long the well has sat undisturbed, and the concentrations of organics in the well. Watch the display screen, when the measurement drops significantly from a high reading, remove the PID, record the highest reading, and then begin associated sampling activities, if required.

For well caps with a dedicated attachment, to measure VOCs complete these steps:

1. Prior to leaving for the field, collect any available information on the well to be sampled, including total depth and the most recent depth to water measurements. Information from prior sampling events, the Montana Groundwater Information Center (GWIC) data base, or registered well logs from GWIC, can be used to gather information on the well.
2. Prior to unlocking and opening a well, calculate how long the PID needs to run to purge the air present in the well (refer to the table below). To use the table below, identify the time to purge 1 foot of air column (in either seconds or minutes) based on the diameter of the well in inches, and multiply this number by the most recent depth to water information (i.e., air column). The MiniRAE 3000 sampling pump will purge 450 to 550 cubic centimeters per

minute ($cm^3$/min). Make sure that the tubing and connector for the well are available and can be attached to the inlet tube on the MiniRAE 3000.

**Volume of Air per Foot in Common Well Sizes**

| Diameter of well (inch) | Volume per foot ($in^3$) | Volume per foot ($cm^3$) | Time to purge 1 foot of column at 450 $cm^3$/min (sec) | Time to purge 1 foot of column at 450 $cm^3$/min (min) |
|---|---|---|---|---|
| 0.5 | 2.4 | 38.6 | 5 | 0.09 |
| 1 | 9.4 | 154.4 | 21 | 0.34 |
| 1.5 | 21.2 | 347.4 | 46 | 0.77 |
| 2 | 37.7 | 617.6 | 82 | 1.37 |
| 4 | 150.7 | 2470.3 | 329 | 5.49 |
| 6 | 339.1 | 5558.2 | 741 | 12.35 |

MiniRAE 3000 PID pump purges at 450-550 cubic centimeters per minute ($cm^3$/min).
Equation for calculating volume of cylinder – $\pi * r^2 * Ht$, *where*
$\pi = 3.1416$
r = radius of well
Ht = air column (depth to water measurement)
1 $in^3$ = 16.39 $cm^3$

3. Turn on the PID and allow it to warm up before attaching the MiniRAE 3000 to the well attachment. There may be an outer casing that needs to be opened to access the sampling port.
4. Record the highest reading. It may take a while to start getting readings depending on the depth to water, how long the well has sat undisturbed, and the concentrations of organics in the well. The prior calculations will give you an idea of the maximum amount of time before readings may be detected. Watch the display screen, when the measurement drops significantly from a high reading, remove the PID, record the highest reading, and then begin associated sampling activities, if required.

**6. Screening for volatile organic vapors in drill core or Geoprobe® drill core.**

**PID readings are always taken immediately on opening the core, prior to any other sampling or logging activities. Soil samples can show significant losses in VOC concentration within only seconds of opening soil cores.**

Detailed procedures for sampling soils in core for organics are discussed in SOP-S-12 Sampling Soil from a Geoprobe® Liner and SOP-S-13 Sampling Core from Sonic Drill. Please refer to those SOPs prior to exposing the core to air and starting these sampling activities:

1. Ensure that the driller and/or helper place caps on the end of core liners, tie the plastic ends shut or use duct tape to seal the end of the core immediately after removing the liner from the drill/probe rod so that no VOC escape prior to cutting open the core. Store capped core in the shade or on ice to avoid additional volatilization of VOCs. **Do not** open the core until just before sampling.

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| | 2. Make sure the PID is on, calibrated and warmed up prior to opening the drill/probe core.<br>3. Refer to SOP-S-12 Sampling Soil from a Geoprobe® Liner -Sampling of Soil for Organic Constituents and SOP-S-13 Sampling Core from Sonic Drill – Sampling Soil for Organic Constituents, then prepare for opening the core.<br>4. As soon as possible after opening the core, hold the PID inlet approximately 1-2 inches above the soil surface and **slowly** scan the length of the core, noting or marking where "hits" are shown on the instrument display. If the core is compacted, or there is evidence of "smear" on the outside of the core, use gloved fingers to break up or indent the core to expose additional surface area. Please note that there may be a 1-3 second delayed response on the display as it takes time for the vapor to travel up the inlet and into the detector. After completing the scan of the entire core, go back and check the areas where readings occurred. Make note of the highest reading at these locations. The project-specific Quality Assurance Project Plan (QAPP) will provide guidance on what additional sampling may be required based on the PID screening results (i.e., sample or headspace collection).<br>5. Record results of the PID screening in the field documentation (project logbook or field data sheets) including the highest reading from each interval and the actual location in the core (i.e., 10 inches from the bottom) and the calculated interval depth. Refer to SOP-S-12 Sampling Soil from a Geoprobe® Liner and SOP-S-13 Sampling Core from Sonic Drill information on determining calculated interval depths.<br>6. If required sample following the appropriate SOP directions. |
| **7. Screening for VOCs in hand-dug test pits or machine-excavated test pits.** | **PID readings should be taken as soon as the soils are exposed to air, prior to any other sampling or logging activities. Soil samples can show significant losses in VOC concentration within only seconds of being exposed to air.**<br><br>Detailed procedures for conducting surface and subsurface sampling and test pit sampling for organics are discussed in SOP-S-01 Surface Soil Sampling, SOP-S-02 Subsurface Soil Sampling and SOP-S-06 Test Pit Sampling. Please refer to these SOPs prior to starting sampling activities.<br><br>Make sure the PID is turned on and warmed up and any VOC, volatile petroleum hydrocarbon (VPH) and/or extractable petroleum hydrocarbon (EPH) sampling supplies are ready prior to beginning excavation.<br><br>**For surface soil:**<br><br>Surface soil screening for VOCs can be performed, however expect results only if the release of hydrocarbons is recent. Removing vegetation, debris, or the immediate surface soils may result in detection of VOCs.<br><br>1. With the PID probe pointed downward, walk the sample area to see if there are any readings. |

2. Any areas with "hits," areas of staining, or other indications of organic contamination should be measured carefully by placing the PID input probe 1-2 inches above the soil surface.
3. Record any measurements, location description (staining, debris, etc.), and location as needed in the field logbook or on field data sheets.

**For hand-dug test pits:**

1. Complete any required surface screening prior to digging.
2. As each interval (0-2 inches, 2-6 inches, etc.) is uncovered, complete a scan of exposed surfaces. Hold the input probe 1-2 inches from the wall surface and slowly scan the complete circumference of the new portion of the excavation.
3. Record measurements, location description (staining, moisture content, etc.), and location as needed in the field logbook or on field data sheets. Complete any organic sampling prior to moving to the next sample interval as described in the steps in SOP-S-02 Subsurface Soil Sampling under Volatile Organic Sampling.

**For hand auger sampling:**

1. Complete any required surface screening prior to digging. Following guidance in SOP-S-02 Subsurface Soil Sampling – Hand Auger Sampling for Volatile Organic Compounds, prepare for sampling the site.
2. Once the first sample interval is reached, advance the auger into the sample interval. When the auger is full, remove the head from the hole and empty the auger onto the plastic. Once the soil is on the plastic, immediately begin PID screening. Hold the input probe 1-2 inches from the soils and slowly scan the material. If the soils are mounded, using a newly gloved hand spread the soils so that readings can be taken of the whole sample interval.
3. Complete any organic sampling prior to moving to the next sample interval as described in SOP-S-02 Subsurface Soil Sampling under Hand Auger Sampling for Volatile Organic Compounds. Record measurements, location description (staining, moisture content, etc.), and location as needed in the field logbook or on field data sheets.

**For machine-excavated test pits:**

For excavated areas under 4 feet, the assigned, competent person (as defined by OSHA) at the site will examine the test pit and determine if the test pit is safe prior to entering **for each interval to be tested.**

1. Instruct the operator to dig set depths (i.e., 0.5 foot or 1 foot).
2. Once the appropriate interval is completed by the machine operator and the bucket is resting on the ground, enter the test pit and scan the interval uncovered. Hold the input probe 1-2 inches from the test pit wall surfaces and slowly scan.
3. If there is a "hit," return to that location after completing the overall scan and determine the extent of the higher readings. Pay particular attention to oil-stained areas or wet-looking areas that do not appear to be associated with groundwater.
4. If sampling for organics is required, complete the sampling after the PID scan and prior to digging the next interval as described in SOP-S-06 Test Pit Sampling under Sampling Test Pits for Volatile Organic Compounds.
5. Once the entire interval is scanned, exit the test pit, and have the operator dig to the next interval.
6. If entering the test pit for any interval is not possible (unsafe walls, groundwater entering), the excavated material can be scanned as it is removed from the test pit. Have the machine operator place the material at least 3 feet from the edge of the test pit and spread it out as the bucket empties.
7. As soon as the machine bucket is set on the ground and the spoils pile can be safely approached, scan the newly exposed soils. Holding the PID input probe 1-2 inches above the soils, slowly move the probe over the entire area.
8. If there is a "hit," return to that location after completing the overall scan and determine the extent of the higher readings. Pay particular attention to oil-stained areas or wet-looking areas that do not appear to be associated with groundwater.
9. If sampling for organics is required due to PID measurements, sample depth, or interval location (at groundwater interface), complete the PID measurement at this time.
10. Record the interval examined and the results in the field logbook or field data sheets.
11. Exit the spoils pile area and have the machine operator place the next bucket in the same location. **Coordination and communication between the machine operator and field personnel are key during this type of operation.**

For test pits greater than 4 feet deep:

1. For test pits that are planned to be deeper than 4 feet, scan the test pit as described above until the test pit is just under 4 feet deep.
2. For depths greater than 4 feet, PID scans will need to be taken from the spoils pile as described above. Required sampling should be completed after PID

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| | scans of each bucket or interval as directed in the project Sampling and Analysis Plan (SAP), QAPP, and Work Plan. |
| **8. Field headspace analysis.** | Field headspace analysis is an appropriate technique for approximation of low-level petroleum hydrocarbon concentrations. Use this procedure to estimate gasoline, #2 heating oil, diesel fuel, kerosene, and other chemically and physically similar oil contamination in mineral soil with water contents between dry and saturation. The procedure is not intended for estimating concentrations of heavy oils, lubricating oils, waste oil, and other low volatility hydrocarbon products; estimating those types of concentrations would require laboratory analysis. Field headspace analysis can be used as a screening tool to determine which samples may need to be submitted for organic analysis. It also can be used to evaluate stained or suspicious areas that did not show “hits” during the initial screening with a PID. Refer to the project SAP/QAPP/Work Plan for guidance on when head space analysis is to be used. For field headspace analysis:<br><br>1. Determine the location at which the sample is to be taken.<br>2. Collect up to 250 grams of the material to be sampled into a self-sealing, 1-quart freezer thickness polyethylene bag. If limited soil amounts are available, such as when sampling from Geoprobe® cores, ¼ to ½ cup can be placed in the bag, so that enough soil remains for samples. In so far as possible, samples should be mineral soil free of vegetation and stones larger than ½ inches in diameter. Seal the samples immediately by zipping the bag closed. A sufficient amount of air should be left in the bag so that the instrument can withdraw an adequate headspace sample.<br>3. Knead the bag until the contents are uniform.<br>4. If necessary, adjust sample temperatures to between 15 degrees Celsius (°C) and 25 °C by bringing sample containers into a warm vehicle. In warm weather, samples should be kept in a shaded, ventilated area during headspace development and analysis.<br>5. Allow at least 15 minutes but not more than 1 hour for soil hydrocarbons to reach equilibrium with the headspace.<br>6. If samples are to be taken for laboratory analysis, they should be collected and preserved per laboratory protocols at the time of the headspace sample collection. Refer to the project SAP/QAPP/Work Plan to determine sampling requirements. Any samples with potential for laboratory analysis of organics should be collected at this time and placed immediately in a cooler with ice.<br>7. Prior to the headspace analysis, turn on and let the PID warm up.<br>8. Knead the bags again for 30 seconds.<br>9. Measure the sample’s headspace concentration. Poke a hole in the top corner of the ziplock bag using a pencil or small knife. The hole should be just big enough to insert the intake probe. Alternately, make a small opening using the zip and insert the intake probe. Squeeze the bag tight around the probe. |

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| | 10. Record the highest reading that remains steady for 1-2 seconds in the field logbook or on field data sheets.<br>11. Repeat this step until all samples have been measured.<br><br>Due to the warming of the sample and the removal of VOCs during the PID measurement, the sample that is used for headspace analysis CANNOT be used for laboratory analysis for organics. It may be used for non-organic analysis (except mercury). |
| **9. Evacuate the area if preset alarm sounds.** | Be prepared to evacuate the area if any of the preset alarms sound. Actions required by each alarm are shown in Attachment 1 Table 3 and will be identified in the pre-job meetings and reviewed during daily toolbox meetings. If a preset alarm sounds while taking a core sample, be sure to take a reading within the breathing zone. If the high alarm continues to sound when measuring the breathing zone, proceed with an evacuation. If the low or high alarm sounds only while taking core samples, proceed with caution with frequent breathing zone samples. Operators using supplied air systems may not need to consider this action. |
| **10. Turn the unit off.** | Press and hold the on/off key for 3 seconds. A 5-second countdown to shutoff begins. The on/off key must be held down during the entire shut off process. Once the countdown stops, the unit should say "Unit off…" Release the on/off key. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **CHEMICAL** | Gases and vapors. | During measurements. | Inadvertent exposure to unknown gases and vapors via inhalation could lead to adverse health effects. | Personnel will measure concentrations of gases/vapors in the breathing area, and they will evacuate the area if preset alarm sounds. |
| | Isobutylene. | Equipment calibration. | Inadvertent exposure to Isobutylene gas via inhalation could lead to adverse health effects. | Personnel will wear safety glasses when handling calibration gas. Personnel will make sure the flow regulator is securely attached and turned to OFF when active calibration is not happening. Personnel will make sure tubing is securely attached before turning the flow regulator ON. Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and after equipment calibration. If a volatile other than VOCs are to be measured, a different calibration gas will have to be used. Consult with the safety department to ensure the correct calibration gas is be used for the meter. |
| | Potential contact with contaminated soil samples or water samples. | Sample collection sites. | Inadvertent exposure to contaminated soil samples or water samples could lead to adverse health effects. | Personnel will practice proper personal hygiene – wash hands prior to eating and when leaving the site. Work will be suspended during high wind conditions that may produce large amounts of visible dust. Personnel will wear nitrile gloves and safety glasses when sampling and handling soil. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| | Carbon Monoxide (CO). | Vehicle, equipment, and test pit. | Potential exposure to CO when working around idling vehicles/equipment could result in irritate eyes, headache, nausea, weakness, and dizziness. The CO from idling excavator could also end up in test pits. | Personnel will minimize the time sitting in idling vehicles and will open a window to increase ventilation. Personnel will avoid working around idling vehicles/ equipment and stay up wind. Operator will turn engine off when the excavator is not needed to prevent accumulation of CO in test pits. |
| | Exposure to hydraulic fluids. | Geoprobe® or heavy equipment. | Exposure to hydraulic fluids could occur while working around the Geoprobe® due to equipment malfunction/failure resulting in personal injuries. | The operator will inspect the Geoprobe® or equipment and document inspections daily before starting the work. The operator will also replace/repair all faulty equipment before stating work. When inspecting equipment, personnel will wear work gloves to prevent possible exposures to hydraulic fluids. Non-essential personnel will maintain a 20-foot buffer zone around the Geoprobe® and heavy equipment. |
| | Liquinox. | Equipment decontamination. | Personnel could be exposed to Liquinox via ingestion and skin/eye contact when decontaminating the equipment resulting in adverse health effects. | Personnel will wear nitrile gloves and eye protection when decontaminating the equipment. |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
|---|---|---|---|---|
| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
| | Methanol. | Equipment decontamination. | Personnel could be exposed to methanol via skin/eye contact and ingestion/ inhalation when decontaminating equipment. Exposure could cause irritation of skin/eye. Adverse health effects can also result if methanol is ingested and/or inhaled. Direct contact with methanol during winter months can result in skin discomfort due to rapid evaporative cooling. | Personnel will prevent skin/eye contact with methanol, and they will wear nitrile gloves and safety glasses when handling methanol. Personnel will use methanol in well-ventilated areas. Personnel will also practice proper personal hygiene – wash hands prior to eating/drinking, after decontamination procedures, and when leaving the site. During winter months, personnel will wear a pair of liner gloves underneath nitrile gloves. |
| **NOISE** | Elevated noise levels. | Geoprobe® or heavy equipment. | Personnel collecting samples can be exposed to elevated noise levels from the Geoprobe® or other heavy equipment resulting in hearing damage. | Personnel collecting soil samples will set up the sampling station 20 feet away from the equipment. The equipment operator or helper will bring the plastic liner to the sampling station. Personnel will wear hearing protection according to the Pioneer Corporate HASP if they must collect samples within 20 feet of the equipment. |
| **ELECTRICAL** | Not applicable. | | | |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **BODY MECHANICS** | Bending, squatting, and kneeling. | During sample collection. | Bending, squatting, and kneeling during sample collection and handling could result in muscle/back strains or other injuries. Kneeling on gravel can result in bruises and knee injuries. | Personnel should stretch prior to starting work and they will take breaks when necessary. Personnel will use a foam pad or knee pads, if necessary. |
| | Lifting and carrying tools, equipment, and/or samples. | Testing sites. | Improper lifting and carrying tools, equipment, and/or samples could result in back injuries and muscle/back strains. | Personnel will use proper lifting techniques- get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two people will lift, if necessary. |
| **GRAVITY** | Falls from slips and trips. | Uneven terrain, slick/muddy/wet surfaces and steep slopes. | Walking/working on slick/muddy/wet and uneven terrain could cause slips and trips resulting in falls and injuries. | Personnel will wear work boots with good traction and ankle support. Personnel will also be aware of working/walking surfaces and choose a path to avoid hazards, keep work areas as dry as possible, and wear muck boots as necessary. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| | Falling rocks, debris, and cave-ins. | Test pit. | Personal injuries could occur when collecting samples in test pits. | Personnel will wear Level D PPE. Sloping techniques will be used, if necessary. Competent person (as defined by OSHA) will examine test pits before entry and large rocks will be removed from above sampling locations, or sample locations will be moved to avoid the potential of falling material. Personnel will not enter test pits deeper than 4 feet. For test pits deeper than 4 feet, personnel will sample from the spoil piles once the excavator operator has placed the excavator bucket on the ground. |
| | Entering the test pit. | Test pit. | Personnel could slip or trip when entering the test pit due to slick, muddy, uneven, or wet terrain that could result in falls or injuries. | Personnel will wear sturdy work boots with good traction and ankle support. Personnel will be aware of walking/working surfaces and choose a path that avoids hazards. Personnel will not enter a test pit deeper than 4 feet. If a test pit will be deeper than 4 feet, personnel will sample from the spoil piles once the excavator operator has placed the excavator bucket on the ground and it is safe to approach. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
|---|---|---|---|---|
| **WEATHER** | Cold/heat stress. | Sites. | Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke. | Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors, remain hydrated, and have sufficient caloric intakes during the day. Personnel will also follow procedures outlined in applicable SSHASP and/or Pioneer Corporate HASP. |
| | Lightning. | Sites. | Electrocution, injury, death, or equipment damage could be caused by lightning strike. | Personnel will follow the 30/30 rule during lightning storms. |
| **RADIATION** | Ultraviolet (UV) radiation. | Sites. | Exposure to UV radiation during summer months can cause sun burns, skin damage, and eye damage. | Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary. |
| **BIOLOGICAL** | Plants, insects, and animals. | Sites. | Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling. | Training on the signs and symptoms of exposure to plants, insects, and animals is required. Personnel will avoid contact with plants, insects, and animals. First aid kits will be available on the site. Personnel with allergies will notify their supervisor. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **MECHANICAL** | Pinch points. | Test pits. | Personnel could cut their fingers if debris (e.g., glass, steel) is present in the test pits. Personal injury to the hands could occur when using sampling equipment/tools. | Personnel will wear nitrile gloves when sampling and handling soil. Personnel will wear leather gloves while using sampling tools. |
| | Struck by shovel. | Carrying tools. | Personnel can strike other workers or objects when carrying shovels and augers to/from sampling stations resulting in bodily injuries and/or property damage. | Personnel will be aware of their surroundings and, if needed, use a spotter. When carrying tools, maintain a safe distance (e.g., 4 feet or more depending on side of tool) from other personnel. |
| | Cutting tools and sharp edges. | Liner cutter, cut liner, and well casing. | Personnel could be exposed to hand injuries such as lacerations, punctures, scrapes, and cuts when using the liner cutter, handling the cut liner, and opening well casing. | Personnel will wear work gloves when using the liner cutter. Be cautious of sharp edges when handling plastic core liners after they have been cut open. Personnel will be trained on how to properly use the liner cutter and will inspect the tool before use. Two individuals will cut liners, if needed. Personnel will inspect well casing for sharp edges. If edges are very sharp, personnel will wear leather gloves. |
| | Flying debris. | Drilling operations. | Eye injuries could result from flying debris when working around drilling operations. | Personnel will wear safety glasses when working around drilling operations. Non-essential personnel will maintain a 20-foot buffer zone around the drill when possible. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| | Struck by and/or caught in between the excavator. | Testing sites. | Personnel could be injured if struck by and/or caught in between the excavator. | Personnel will communicate and establish eye contact with the operator before approaching the excavator. The operator will stop the excavator and place the bucket on the ground before ground personnel approach the equipment. Personnel will wear high visibility clothing. When sampling from the excavated material, personnel will not approach the material until the operator has placed the bucket on the ground and it is safe to approach. |
| **PRESSURE** | Pressurized hydraulic hoses. | Geoprobe® or heavy equipment. | Hydraulic hoses could burst/rupture resulting in inadvertent contact with hydraulic fluid or personal injury due to being struck by hoses. | The operator will inspect the Geoprobe® or heavy equipment and document inspections daily before starting work. The operator will also replace/repair all faulty equipment before starting work. When inspecting equipment, personnel will wear work gloves to prevent possible exposures to hydraulic fluids. Non-essential personnel will maintain a 20-foot buffer zone round the Geoprobe® or heavy equipment. |
| **THERMAL** | Not applicable. | | | |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| *SOURCE* | *HAZARDS* | *WHERE* | *HOW, WHEN, RESULT* | *CONTROLS* |
|---|---|---|---|---|
| **HUMAN FACTORS** | Inexperienced and improperly trained personnel. | Sites. | Inexperienced personnel and improper training could cause incidents resulting in injuries and/or property damage. | Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary. |
| | Public entering the work area. | Sites. | Third-party members of the public could enter the work area resulting in an unsafe work environment. | Stop work if members of the public enter the work area. |
| **SIMOPS (Simultaneous Operations)** | Not applicable. | | | |

**ADDITIONAL HSSE CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| | |
|---|---|
| **REQUIRED PPE** | **Personnel Protection Equipment** (PPE)**:** Safety glasses, high-visibility long-sleeve shirt or vest, long pants, and work boots. |
| **APPLICABLE SDSs** | **Safety Data Sheets** (SDSs) will be maintained based on site characterization and contaminants.<br><br>Safety Data Sheets are available to Pioneer personnel at the link below: https://pioneertechnicalservices.sharepoint.com/Safety/SafetyDataSheets |
| **REQUIRED PERMITS/ FORMS** | Per site/project requirements. |
| **ADDITIONAL TRAINING** | Per site/project requirements. |

| DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT<br>The following documents should be referenced to assist in completing the associated task. | |
|---|---|
| **DRAWINGS** | |
| **RELATED SOPs/ PROCEDURES/ WORK PLANS** | SOP-S-01 Surface Soil Sampling<br>SOP-S-02 Subsurface Soil Sampling<br>SOP-S-06 Test Pit Sampling<br>SOP-S-12 Sampling Soil from a Geoprobe® Liner -Sampling of Soil for Organic Constituents<br>SOP-S-13 Sampling Core from Sonic Drill – Sampling Soil for Organic Constituents |
| **TOOLS/ EQUIPMENT** | PID |
| **FORMS/ CHECKLIST** | Field logbook and field data sheets. |

| APPROVALS/CONCURRENCE<br>By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing. | |
|---|---|
| **SOP TECHNICAL AUTHOR** | **DATE** |
| Julie Flammang<br>**Julie Flammang** | **12/09/2020** |
| **SAFETY AND HEALTH MANAGER** | **DATE** |
| Tara Schleeman<br>**Tara Schleeman** | **12/09/2020** |

## Attachment 1

**Table 1.** Frequent Gas of Interest Correction Factors and Alarm Settings

| Compound Name | Calibration Gas (Isobutylene) Concentration | Correction Factor* | Input Calibration Gas Concentration | TWA | Low Alarm Value | High Alarm Value |
|---|---|---|---|---|---|---|
| Diesel Fuel | 100 ppm | 0.9 | 90 ppm | 11 ppm | 6 ppm | 11 ppm |
| Gasoline #1 | 100 ppm | 0.9 | 90 ppm | 300 ppm | 150 ppm | 300 ppm |

*Correction factor for a 10.6 eV lamp.
ppm: Parts per million. TWA: Time weighted average.
Consult Technical Note-106 and the safety department for additional compounds.

**Table 2.** Alarm Signals

| Message | Condition | Alarm Signal |
|---|---|---|
| High | Gas exceeds “High Alarm” limit | 3 beeps/flashes per second |
| Low | Gas exceeds “Low Alarm” limit | 2 beeps/flashes per second |
| TWA | Gas exceeds “TWA” limit | 1 beep/flash per second |
| STEL | Gas exceeds “STEL” limit | 1 beep/flash per second |

TWA: Time weighted average. STEL: Short-term exposure level.

**Table 3.** Alarm Procedures

| Message | Procedure |
|---|---|
| High | Gas has reached an unsafe level. Evacuate the work area to a well-ventilated area. Open the sample trailer doors to allow the work area to ventilate. Move the sample outside of the trailer if it is safe to do so. |
| Low | Gas has reached the action level. Be prepared for rapidly changing conditions. Be prepared to evacuate the work area. |
| TWA | Gas has reached the TWA for the day. |
| STEL | Gas has reached the STEL. Do not come in contact with potentially contaminated samples for at least 1 hour. Do not reach the STEL alarm more than 4 times per day, with at least an hour in between each alarm exposure. |

TWA: Time weighted average. STEL: Short-term exposure level.

| | |
|---|---|
| **PURPOSE** | To provide standard instructions for conducting depth to water level measurements. |
| **SCOPE** | Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed work described below before performing the work. |

**WORK INSTRUCTIONS**

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

| TASK | INSTRUCTIONS |
|---|---|
| **Electric Depth to Water Indicator** | |
| **1. Inspect well casing.** | Inspect well and casing for a marked measuring point (e.g., a line or arrow made with a permanent marker, or an indentation on the well's inner casing). If no measuring point is marked, locate the north side of the well and establish a marking point. Choose the point for ease in accurately reading the measuring tape. Mark the measuring point with a Sharpie© or paint pen. |
| **2. Turn on and test the water level indicator.** | Turn the depth to water meter on. Test that the water level indicator is on and working by pushing the test button on the body of the meter. Check the buzzer sound level and/or check that the indicator light flashes. Before using the meter, clean and decontaminate the meter per SOP-DE-02 Equipment Decontamination. |
| **3. Lower the sensor.** | Lower the sensor probe slowly into the well to minimize disturbance of water when it is encountered.<br><br>As the sensor is lowered down the well, the buzzer and/or flashing light will indicate contact with water. Be aware that the sensor may indicate water prior to actual water level if the probe contacts condensation on the well; in this case the buzzer on the meter will buzz intermittently. |
| **4. Align probe cable.** | Once a solid tone is heard or the indicator light stays on, a depth to water reading can be taken. Align the marked probe cable with the designated marking point and gently raise and lower the probe until the exact mark on the probe cable, when water is encountered, is identified. |
| **5. Record information.** | Record this information in the project logbook as the depth to water (DTW) along with the time the reading was taken. Additionally, record where the marking point was located (e.g., top of casing [TOC], top of steel casing [TOSC], top of polyvinyl |

| | |
|---|---|
| | chloride (PVC) [TOPVC], inner PVC [IPVC], etc.) to help maintain continuity, if subsequent depth to water readings are needed from this well. |
| **6. Reel in equipment.** | Reel in sensor probe. |
| **7. Decontaminate equipment.** | Decontaminate all equipment prior to re-use per SOP-DE-02 Equipment Decontamination. |
| **Chalked Measuring Tape Depth to Water Measurements** | |
| **1. Coat tape with chalk.** | Make sure the equipment is clean and decontaminated per SOP-DE-02 Equipment Decontamination. Coat the lower 3 to 5 feet of tape with chalk and lower into the well. Listen for a slight splash when the weight contacts water or the cable may feel a slight drag or be lighter once it contacts the water, then lower tape an additional 0.5 foot. |
| **2. Record information.** | Record measure point and pull tape carefully from well. Read the wetted chalk mark and record. Subtract the wetted chalk mark from the measure point for true depth to water. |
| **3. Decontaminate equipment.** | Decontaminate all equipment prior to re-use per SOP-DE-02 Equipment Decontamination. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
|---|---|---|---|---|
| **CHEMICAL** | Potential contact with contaminated water. | Sites. | Inadvertent exposure to contaminated soil and water could lead to adverse health effects. | Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when collecting and handling samples. |
| **NOISE** | Not applicable. | | | |
| **ELECTRICAL** | Not applicable. | | | |
| **BODY MECHANICS** | Bending, squatting, and kneeling. | During depth measurements. | Bending, squatting, and kneeling during depth measurements could result in muscle/back strains or other injuries. | Personnel should stretch prior to starting work and take breaks when necessary. |
| **GRAVITY** | Falls from slips and trips. | Uneven terrain, slick / muddy / wet surfaces and steep slopes. | Walking / working on slick / muddy / wet and uneven terrain could cause slips and trips resulting in falls and injuries. | Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary. |
| **WEATHER** | Cold/heat stress. | Sites. | Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke. | Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors. Personnel will remain hydrated and will have sufficient caloric intakes during the day. Personnel will follow procedures outlined in applicable SSHASP and/or Pioneer corporate HASP. |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
|---|---|---|---|---|
| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
| | Lightning. | Outdoor sites. | Electrocution, injury, death, or equipment damage could be caused by lightning strike. | Personnel will follow the 30/30 rule during lightning storms. |
| **RADIATION** | Ultraviolet (UV) radiation. | Outdoors. | Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage. | Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary. |
| **BIOLOGICAL** | Plants, insects, and animals. | Sites and well casings. | Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling. | Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Personnel with allergies will notify their supervisor. |
| **MECHANICAL** | Scrapes and cuts. | Well casing. | Scrapes and cuts could result when taking measurements, from sharp edges in metals or PVC casings. | Personnel will inspect well casing for sharp edges. If edges are very sharp, personnel will wear leather gloves. |
| **PRESSURE** | Not applicable. | | | |
| **THERMAL** | Not applicable. | | | |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
|---|---|---|---|---|
| ***SOURCE*** | ***HAZARDS*** | ***WHERE*** | ***HOW, WHEN, RESULT*** | ***CONTROLS*** |
| **HUMAN FACTORS** | Inexperienced and improperly trained personnel. | Sites. | Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage. | Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary. |
| **SIMOPS (Simultaneous Operations)** | Struck by and/or caught in between heavy equipment or vehicles. | Sites. | Personnel could be injured if struck by and/or caught in between heavy equipment or vehicles while collecting samples. | Personnel will communicate with the contractors on site. Personnel will avoid working near heavy equipment/vehicles, when possible. Personnel will wear high visibility clothing. When possible, personnel will park field vehicles or use traffic cones to prevent third party vehicles from coming into the work area. |

| ADDITIONAL HSSE CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | |
|---|---|
| **REQUIRED PPE** | **Personnel Protection Equipment** (PPE)**:** Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, and nitrile gloves. |
| **APPLICABLE SDSs** | **Safety Data Sheets** (SDSs) will be maintained based on site characterization and contaminants.<br><br>Safety Data Sheets are available to Pioneer personnel on the internal website under Safety. |
| **REQUIRED PERMITS/ FORMS** | Per site/project requirements. |
| **ADDITIONAL TRAINING** | Per site/project requirements. |

| **DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT**<br>The following documents should be referenced to assist in completing the associated task. | |
|---|---|
| **DRAWINGS** | Map with well locations. |
| **RELATED SOPs/PROCEDURES /WORK PLANS** | SOP-DE-02 Equipment Decontamination. |
| **TOOLS/ EQUIPMENT** | Depth to water meter or measuring tape and chalk and field logbook. |
| **FORMS/ CHECKLIST** | |

| **APPROVALS/CONCURRENCE**<br>By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing. | |
|---|---|
| **SOP TECHNICAL AUTHOR** | **DATE** |
| Patricia Olson<br>**Patricia Olson** | **01/18/2022** |
| **SAFETY AND HEALTH MANAGER** | **DATE** |
| Tara Schleeman<br>**Tara Schleeman** | **01/18/2022** |

| | |
|---|---|
| **PURPOSE** | To provide standard instructions for purging and sampling groundwater wells or piezometers using the low flow purge method. This procedure can be used with the following pumps: peristaltic and bladder pumps. |
| **SCOPE** | Pioneer Technical Services, Inc. (Pioneer) prepared this practice for the workforce and this Standard Operating Procedure (SOP) applies to all work performed by and on behalf of Pioneer. All members of the Pioneer workforce who conduct the work shall be trained and competent (as defined by OSHA) in the risk-assessed procedure described below before performing the work. |

**WORK INSTRUCTIONS**

The following instructions provide guidance to perform the task in a safe, accurate, and reliable manner. If these instructions present information that is inaccurate or unsafe, personnel must notify the Project Manager, Safety Manager, and the SOP Technical Author to initiate appropriate revisions. Personnel will perform all work under this SOP in a manner that is consistent with procedures and policies described in the appropriate Operation, Maintenance, and Monitoring (O&M) Plan (where applicable), appropriate Site-Specific Health and Safety Plan (SSHASP), and Pioneer Corporate Health and Safety Plan (HASP).

| TASK | INSTRUCTIONS |
|---|---|
| **Note** | Sampling wells in order of increasing chemical concentrations is always preferred but not required. |
| **Pump Manuals** | The pumps that Pioneer currently uses are listed below. If a pump is necessary for fieldwork and not listed below, please refer to the Sampling Analysis Plan (SAP), Quality Assurance Project Plan (QAPP), Work Plan (WP), Field Sampling Plan (FSP), and/or other project documents (referred to collectively herein as the guidance document) for directions on pump selection and manuals.<br><br>• Peristatic Pump: Geotech Geopump Peristaltic Pump Installation and Operation Manual (geotechenv.com)<br>• Bladder Pump: Geotech Bladder Pumps Installation and Operation Manual (geotechenv.com) |
| **1. Gather information for the sample event.** | Review the guidance document for the following:<br><br>• Sampling/purge method requested for sampling the required wells.<br>• Purge water containment requirements.<br>• Well installation information (e.g., total depth, screen interval, the last depth to water [DTW] level reading if available, etc.) to determine the appropriate pump and approximate purge volumes required.<br>• Depth at which the pump should be installed; the mid-point of the saturated screen is used by convention as the location of the pump intake. Chemical concentrations or permeability considerations may require pump placement in a different zone. Refer to the guidance document to determine the project or analyte requirements. |

- Sample container and preservation requirements; make sure the appropriate bottles and preservatives have been provided by the analytical laboratory.
- Whether samples must be filtered; if so, determine the number and type of filters needed.
- Sample storage requirements such as:
  - Do the samples need to be iced immediately upon their collection?
  - If highly contaminated samples are to be collected, do they need to be stored in a separate cooler/container from other samples?
- Analytes to be analyzed. If low-level analyte analysis is being requested (e.g., mercury or low-level volatile organic compounds [VOCs]), determine if additional precautions and equipment will be required.
- Type of water quality measurements required for either informational or stabilization parameters. Confirm that the appropriate meters or field tests are available.
- Refer to the project-specific requirements in the guidance document for purge volume requirements.

**2. Select pump needed for sampling.**

The table below summarizes the types of pumps Pioneer has available for groundwater sampling. Using the information compiled in Step 1, select the appropriate pump using the table below.

**Table 1. Pumps Available for Groundwater Sampling**

| Pump/Development Type | Well Diameter (inches) | Max Well Depth (feet) | Anticipated Production |
|---|---|---|---|
| Peristaltic Pump | ≥ 0.38 | 25 | Up to 0.25 GPM |
| Bladder Pump (stainless steel) – 3/4" diameter[1] | =1 ½ | <200 | Low Flow Only |
| Bladder Pump (stainless steel) – 1 ¾" or 2" diameter | ≥ 2 | <290 | Low Flow Only |

[1] 3/4" bladder pump can only be used in 1 ½" wells.

GPM: gallons per minute.

Use stainless-steel pumps (bladder pump) when sampling for VOCs, semi-VOCs (SVOCs), pesticides, and polychlorinated biphenyl (PCBs). Peristaltic pumps and bailers are not recommended when volatile organic samples are to be collected as they may introduce air into the sample.

If the purging/sampling requirements from the guidance document cannot be met by the pumps Pioneer has available, talk to the project manager about renting an appropriate pump. This may be particularly necessary for deeper or wider diameter wells requiring large purge volumes.

| | |
|---|---|
| **3. Gather field equipment.** | Based on the type of pump selected, ensure that the proper diameter tubing (inner and outer diameters) and the appropriate disposable or decontaminated tubing type is available for use. Teflon or Teflon-lined tubing is preferred when sampling for VOCs, SVOCs, pesticides, and PCBs. The polyvinyl chloride (PVC), polyethylene, and polypropylene tubing can be used when sampling for inorganics. For other analytes or low-level analysis, specialty tubing may be required.<br><br>**Note**: All down hole and potentially wetted surfaces must also be made of non-contaminating/non-contributing materials. This includes power and suspension cables and compressed gas or sample tubing.<br><br>Gather the remaining required field equipment based on the information Step 1, including containment supplies, decontamination equipment, field measurement devices, personnel protection equipment (PPE), well keys, pumps, tubing, sampling supplies, etc. |
| **4. Calibrate all field measurement devices.** | Following the directions in the specific meter user's manual or corresponding Pioneer SOP, calibrate all the field parameter measurement devices needed for the sample event. General devices used are listed below with the corresponding SOP. The specific guidance document or project may require other measurement devices.<br><br>• Potential hydrogen (pH) probe/meter (SOP-WFM-01).<br>• Oxidation Reduction Potential (ORP) probe/meter (SOP-WFM-02).<br>• Specific Conductivity (SC) probe/meter (SOP-WFM-03).<br>• Dissolved Oxygen (DO) probe/meter (SOP-WFM-07).<br>• Turbidity meter (SOP-WFM-08).<br>• Photoionization detector (PID) (SOP-FM-01).<br><br>Record all calibration information and results in the field logbook. Water quality parameter meters must be calibrated DAILY. |
| **5. Mobilize to site.** | When arriving at the site, take notice of where you park the vehicle. If using the truck battery to power the pump, make sure that the truck is parked with the proper side facing the well. If unloading heavy pumps and generators is required, park the vehicle as close to the well as possible to limit the distance the equipment needs to be carried.<br><br>When sampling for VOCs or extractable petroleum hydrocarbon (EPH), purging, sample collection, sample handling, and containerization should not take place near a running motor or any type of exhaust system. A 12-volt battery can be carried to the well site. If the truck battery needs to be used for sampling, do not have the truck running just before and during sampling. If the truck needs to run during sampling or a generator will be used, make sure that they are located as far downwind of the well as possible so that exhaust will blow away from the well. Note in the logbook and on the field data sheet the presence of a running vehicle or generator when sampling for volatile organics. If there are additional sources of exhaust in the vicinity (site is close to active road, etc.), this should also be noted in the logbook. |

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| | When collecting water quality VOC samples, use a new pair of nitrile gloves to collect the samples. Do not allow the gloves to come into contact with the media being sampled and change them any time during sample collection when their cleanliness has been compromised. If possible, one member of the sampling team should take all the notes and fill out sample tags/identification, while the other member collects the groundwater samples. This will help prevent contamination to the sample being collected. |
| **6. Open well cap and collect PID readings (if required).** | If sampling for VOCs such as volatile petroleum hydrocarbon (VPH), methane, or EPH, the guidance document may require measuring organic vapors immediately upon opening the well casing, prior to determining DTW level or sampling. The procedures for calibrating and using a PID meter are discussed in SOP-FM-01. The section "*Screening organic vapors in a well casing"* in that SOP discusses measuring organic vapors in a groundwater well. |
| **7. Determine the water level in the well.** | Using clean, non-contaminating equipment, such as an electronic DTW level indicator, determine the water level in the well. Refer to SOP-GW-03 for instructions.<br><br>If required, check for the presence of free or floating product with an interface probe. If an interface probe is not available, use a clean, clear bailer. To use a bailer to measure floating product depth:<br><br>• Slowly and gently lower the bailer to just below the surface of the water; try not to agitate the water in any way.<br>• Mark the string at the measuring point on the well head.<br>• Pull the bailer up and measure the width of floating product present in the bailer above the water surface. The bailer may need to set for a few minutes to ensure that any product has risen to the surface.<br>• Calculate the depth to top of product by measuring from the mark on the string to the top of the product in the bailer or by subtracting the width of the product layer in the bailer from the water level measured with the DTW level indicator.<br><br>If there is no existing information available about the total depth of the well, determine the depth to the bottom of the well.<br><br>• Once you have recorded the DTW level measurement in the field logbook and/or on the field data sheet, turn down the volume on the DTW meter.<br>• Slowly lower the probe until it gently touches the bottom. The bottom is easier to identify in narrower wells with hard bottoms. If necessary, because of a "soft" bottom, gently lower and raise the probe to determine when the bottom is encountered. In larger-diameter wells, the probe cable will go slack as the probe hits the bottom and leans over. Be gentle when tapping the bottom as sediment in the bottom of the well will be stirred up each time the bottom is touched. This will make stabilizing water quality readings more difficult. |

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| | Record the total depth of the well from the same measuring point used for the DTW level measurement. |
| **8. Calculate purge volumes.** | Using the Multi-Purge Volume Method (SOP-GW-10.1), purging a monitoring well of 3 well volumes is considered sufficient to obtain a valid sample. A well volume is the amount of water contained initially inside the well casing. The 3 well volumes are part of the stabilization parameter requirements for the Multi-Purge Volume Method. However, the Low Flow Purge Method parameter stabilization does not include well volume requirements. The Low Flow Purge Method is used to reduce stress to the well, meaning having slower purge rates (typically less than 0.5 Liters per minute [L/min]) with minimal drawdown to water level in the well. In general, groundwater samples can be collected after pH, SC, ORP, DO, and turbidity have stabilized (refer to SOP-GW-14 or Step 14 of this SOP for additional information on stabilization parameters), only for the Low Flow Purge Method. Project-specific sampling requirements may require different well volumes for sufficient sampling.<br><br>For all purge methods, if you have purged 5 or more well volumes, you can proceed with sampling. Record all information regarding purging, problems with purging, and decision-making processes in the field logbook and/or on the field data sheet.<br><br>Although purge volumes are not part of the stabilization requirements (unless stated otherwise), the calculation of the fluid volume in the well casing ("casing volume") must be recorded in the logbook and/or on the field data sheet. Refer to Table 2 for constants that may help in calculating gallons required for purging.<br><br>**It may be necessary to follow purge volume requirements. If so, follow the guidance in Table 2 and the procedures following the table. If purge volumes are not required as part of the stabilization parameters, skip to Step 9 of this SOP.** Refer to the guidance document to determine total purge volume. Contact the project manager or quality assurance officer, if necessary. |

**Table 2. Purge Volumes Per Foot of Water Column for Various Well Diameters**

| Well Diameter (inches) | Gallons per foot Constant for purging 1 casing volume | Gallons per foot Constant for purging 3 casing volumes |
|---|---|---|
| 0.5 | 0.01 | 0.03 |
| 0.75 | 0.02 | 0.07 |
| 1 | 0.04 | 0.12 |
| 1.5 | 0.09 | 0.28 |
| 2 | 0.16 | 0.49 |
| 3 | 0.37 | 1.10 |
| 4 | 0.65 | 1.96 |
| 6 | 1.47 | 4.41 |
| 7 | 2.00 | 6.00 |
| 8 | 2.61 | 7.83 |
| 10 | 4.08 | 12.24 |
| 12 | 5.87 | 17.62 |
| 16 | 10.44 | 31.33 |
| 18 | 13.22 | 39.65 |
| 24 | 23.50 | 70.50 |

To determine the gallons required for a 3 well volume purge:

a. Subtract the DTW level from the total depth of the well (water column).
b. Multiply the water column (Step a) by the constant for purging 3 well volumes (Table 2, above) associated with the well diameter. This result is the number of gallons to purge for 3 well volumes.

For example, DTW level on a 2-inch monitoring well was measured at the marking point as 10.5 feet. The total depth of the well is 20 feet to that same marking point. The calculation is then:

$$(20 - 10.5) * 0.49 = 4.7 \text{ gallons.}$$

The resultant 4.7 gallons is the amount that would need to be purged to achieve 3 casing volumes.

Use the constant for purging 1 well volume in Table 2 to determine the number of casing volumes purged if trying to determine how many casings have been purged or to calculate the volume for 5 well casings.

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| **9. Attach tubing to the pump outlet.** | Based on the information collected in Step 1, determine the depth the pump will be set in the well. The mid-point of the saturated screen is used by convention as the location of the pump intake. Chemical concentrations, permeability considerations, or the physical limitations of the pump (pumping depth or tubing length) may require pump placement in a different zone; this should be indicated in the guidance document or recorded in the logbook as a deviation to this SOP.<br><br>Measure and cut the appropriate length of tubing if using disposable tubing. Remember to add enough tubing to reach from the measuring point to the flow cell or the containment system when cutting tubing.<br><br>If using decontaminated or dedicated tubing, depth intervals may already be marked on the tubing, which makes installation at the appropriate depth easier. Make sure that the tubing is marked with the depth the pump needs to be set at from the marking point. Refer to the individual pump operating manual to determine the location of tubing attachments; this is particularly important when installing air and sample tubing on the bladder pumps. |
| **10. Attach pump shroud if needed.** | In larger bore wells (greater than or equal to 4 inches), the stainless-steel electric submersible pumps may need a shroud installed over the pump to force water to flow around the pump and keep it cool. Check the pump user’s manual to determine if a shroud is needed. If the water in the well is fairly warm and the pump will run for an extended time a shroud is recommended. Pioneer owns several PVC shrouds that can be used.<br><br>**To install a shroud:**<br>a. Loosen the hose clamp on the top of the shroud.<br>b. Remove the two top sections.<br>c. Slide the pump into the base, then replace the two top sections.<br>d. Slide the hose clamp into place and tighten the screw. |
| **11. Lower pump and tubing into well.** | Lower the pump and tubing gently into the well to the predetermined sampling zone. If possible, keep the pump at least 2 feet from the bottom of the well to avoid mobilization of particulates in the bottom of the well. The placement of the pump in the well should be such that the well cannot be pumped dry. If, when lowering the pump into the well, the pump touches bottom before the mid-screen depth is reached, the project manager should be contacted about potentially redeveloping the well.<br><br>Using the clamp on the pump reel, large binder clips, or clamps, secure the pump/tubing in the sampling zone. If using clips or clamps make sure that the tubing is not constricted as to reduce flow rates.<br><br>Reinsert the DTW meter probe into the well to monitor drawdown while purging. |

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| **12. Prepare the work area for purging and sample collection.** | Attach the flow cell to the discharge tubing or valve associated with the water parameter meters being used. Refer to the individual SOPs (listed previously under Step 4) for information on using the water parameter meters and the flow cells.<br><br>If necessary, collect/contain purge water. There are several methods to collect/contain purge water if directed to do so in the project guidance document.<br><br>• If a pickup truck with a tank is available, run the discharge hose directly from the well into the tank for containment. Use this tank to transport for disposal. Pioneer has several large plastic tanks available. If hydrocarbon contamination in a well is known or suspected, make sure to use a tank marked for hydrocarbons (hydrocarbon-marked tanks must not be used for non-hydrocarbon purge water containment).<br>• In some cases, tanks may not be available. Consult with the project manager or quality assurance officer for containment and disposal.<br><br>Use a bucket or discharge storage container to collect the discharge water from the flow cell.<br><br>Place the discharge tubing from the flow cell into the bucket or storage container. At this time, the valve to the flow cell should be in the OFF position. The valve to the discharge hose should be open all the way. |
| **13. Start the pump and adjust the pump's speed.** | Place the outlet end of the tubing in a bucket for containment or connect it to a discharge hose prior to starting the pump.<br><br>Using the pump's controller or by attaching the leads of the pump to a 12-volt battery, start the pump. Refer to the individual pump user's manual for specific requirements for each pump.<br><br>Adjust the flow using the controllers or the valve until an appropriate discharge rate is achieved (refer to the paragraph below). Try and set a purge rate that allows the water level to stay above the screened interval to avoid exposing sediments adjacent to the well to oxidize and possibly affect incoming groundwater chemistry.<br><br>**To determine the discharge rate** use a stopwatch and a container of an appropriate size marked with gallons/quarts or liters to measure the flow. Refer to SOP-WFM-09 for methods on calculating flow rates. Record this information in the logbook or on the field data sheet. You will use this information along with time elapsed to determine the volume of water purged from the well. Once you establish a flow rate, turn the valve so water flows through the flow cell.<br><br>**Caution**: Be aware that as a well is pumped, the water level is frequently drawn down causing the efficiency of the pump to decrease. Pump efficiency is decreased because the water has to be lifted higher above the decreasing water level in the well. This causes the flow rate to decrease. Check the discharge rate during the purging process if needed. If you notice a decrease in flow rate, the flow rate or the purging time may need to be adjusted to compensate. |

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| | If the recharge rate of the well appears to be slower than a reasonable extraction rate for the pump used, the well may have become essentially dewatered (e.g., water level falls below the pump intake level). In this case, shut off the pump and allow the well to recover sufficiently to continue sampling and fill all the sample containers. If possible, do not move the pump intake during this process. Once the well recovers, continue to collect samples even though parameters have not stabilized.<br><br>Record and document sampling procedures in the field logbook.<br><br>**Never allow a well to be pumped dry.** Oxidation of sediments at the bottom of the well can alter the incoming water chemistry and provide misleading results.<br><br>If needed, allow the monitoring well to sit for up to 24 hours after purging before sampling to ensure enough water will be available to fill sample containers. Remember that when determining the amount of water in the well after recovery, use the constant for 1 well casing for calculations.<br><br>Record any deviations to the standard sampling protocol in the field logbook and/or on a field data sheet. |
| **14. Monitor and record field parameters and depth to water level measurements.** | During well purging, monitor field parameters including DTW, pH, ORP, SC, temperature, DO, and turbidity (refer to SOP-GW-03, SOP-WFM-01, SOP-WFM-02, SOP-WFM-03, SOP-WFM-04, SOP-WFM-07, and SOP-WFM-08). Depth to water measurements should be less than 0.1 meter (m) (0.3 feet) of drawdown from the time of purge to the time of sampling. If drawdown is greater than 0.1 m (0.3 feet), consult with the project manager and quality assurance officer prior to sample collection. Refer to the guidance document for other field parameters that may need to be monitored.<br><br>As outlined in the *"Groundwater Sampling Guidance"* from the Montana Department of Environmental Quality – Contaminated Site Cleanup Bureau (available at https://deq.mt.gov/files/Land/LUST/Documents/downloadables/GWSamplingGuidance-FINAL.pdf), water quality parameters are considered stable when 3 consecutive readings (generally 2-5 minutes apart) are as follows:<br><br>a. Temperature range is no more than plus or minus 1 degree Celsius (°C).<br>b. pH varies by no more than 0.1 pH units.<br>c. SC readings are within 3% of the average.<br>d. ORP varies by no more than 10 millivolt (mV) units.<br>e. DO readings are within 10% of the average.<br>f. Turbidity readings are within 10% of the average.<br><br>It should also be noted that natural turbidity levels in groundwater may exceed 10 nephelometric turbidity units (NTU); therefore, turbidity can be considered stable when 3 consecutive readings are within 10% for values greater than 5 NTU and if 3 |

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| | turbidity values are less than 5 NTU (Montana Department of Environmental Quality *"Groundwater Sampling Guidance"* – available at https://deq.mt.gov/files/Land/LUST/Documents/downloadables/GWSamplingGuidance-FINAL.pdf). For DO, if 3 consecutive values are less than 0.5 milligrams per Liter (mg/L), consider the values as stabilized.<br><br>Record field parameters in the logbook or on field data sheets.<br><br>As researched and determined in Step 1, the guidance document may require different stabilization ranges. Because groundwater temperature can be subject to rapid changes during stabilization, you may need to cover the discharge tubing and flow cell with a blanket or something similar if the ambient temperature is too cold, too hot, or the tubing/well/flow cell is in sunlight (thermal heating).<br><br>Record the DTW level readings each time water parameters are read to make sure that the well is not becoming dewatered. |
| **15. Label and preserve sample bottles.** | Label the sample bottles with the appropriate label and/or tag. Ensure that the sample bottle is appropriately labeled with field sample identification number, sample date, start time of sample collection, preservative, filtered or non-filtered, and sampler initials.<br><br>Place clear tape over the completed label to ensure that the information is not smeared during sampling or transport.<br><br>Record the sample information in the field logbook and/or on a field data sheet.<br><br>If the sample bottles were not received pre-preserved from the laboratory and need to be preserved, add the appropriate preservatives to the sample bottles as directed by the analytical laboratory. For VOC vials, add the acid prior to collecting the sample and immediately cap the vial making sure that a Teflon liner is present in the cap. |
| **16. Collect samples.** | The guidance document (or project manager) may indicate that sampling can occur if water quality parameters have stabilized. If purge volume requirements are necessary, water quality parameters and purge volume requirements must be met prior to sample collection.<br><br>Once these conditions occur, begin sampling. If VOC analysis is required, collect them first (see VOC analysis below). If the discharge tubing from the pump is connected to anything, such as a hose or flow cell, remove the tubing from the connection. If necessary, make sure to **cut the discharge tubing** above the connection or hose to prevent any contamination of the sample from this connection.<br><br>Always sample from the tubing connected directly to the pump. When filling sample containers prevent dust from blowing into the bottle by blocking any wind with your body while filling the containers or put the lid back on the container |

momentarily if you see dust approaching. If you suspect that dust has gotten into the container, discard the container and fill another sample container.

**Collect VOC samples:** Collect VOC samples first directly into pre-preserved sample containers:

1. If necessary, reduce flow from the discharge tubing to avoid overflowing the vials.
2. Hold each vial at an angle and underneath the discharge.
3. Fill the sample vials by allowing pump discharge to flow gently down the side of the vial with minimal entry turbulence.
4. Cap each bottle as filled. The goal is to have little agitation and avoid introducing air bubbles while filling.
5. When the vial is nearly full, tilt the vial to the vertical position and fill completely. Avoid overfilling as this can "wash" out the preservative.
6. Completely fill the vial and form a meniscus (the curved upper surface of a liquid formed by surface tension) at the top of the vial. If needed, collect a small amount of water in the cap and pour it over the top of the vial to form the meniscus.
7. Screw the cap onto the vial and check for air bubbles.
   a. Turn the VOC bottle upside down, tap it lightly, turn it right side up, and see if any bubbles float to the top. If there is a small bubble, open the lid, fill the cap and pour the water from the lid to form a new meniscus and recap. Check again for bubbles.
   b. If there is still a bubble, or many bubbles were present in the original sample, discard the sample and collect a new sample using a new preserved vial.

   If a sample cannot be obtained without air bubbles due to off-gassing, then note the presence of air bubbles in the field logbook or field data sheet. Also, air bubbles may form during shipment to the laboratory. These bubbles do not necessarily invalidate the sample but may result in qualification of the sample during data validation.

**Collect other samples:** Once you have collected the VOC samples, fill other organic sample bottles, the total metal bottles, the containers for general chemistry analytes, the dissolved metals bottles, and then any other analyte bottles that require filtration.

**Collect filtered sample:** Filtered samples should be collected after all other sample containers are filled as you may need to adjust the flow from the discharge hose to keep appropriate pressure through the filter.

If a filtered sample is required, insert the filter specified in the guidance document, generally an in-line high capacity (0.45 micrometers [µm]), into the discharge hose. There may be a small amount of water dripping from the filter/tubing connection; MAKE SURE that no drops of this unfiltered water get into the filtered samples. If

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| | dust or unfiltered water drops get into the sample container, discard the sample bottle, and fill another bottle with the filtered water.<br><br>If discharge from the pump is not of an adequate flow for the sample collection (for example, no water is discharged from the filter), purge water from discharge hose into an unpreserved container. Then, use a peristaltic pump to filter the sample. Refer to SOP-SW-02.<br><br>As you fill each sample bottle, immediately cap the bottle to prevent dust or debris from getting into the bottle. If the sample vial/bottle overflows and preservative is lost, empty the container, replace the acid or use a new pre-preserved bottle, and collect the sample again. |
| **17. Transport sample bottles.** | Place organic sample containers into a cooler with ice immediately upon collection. Keep samples at 4 °C plus or minus 2 °C or less and under chain of custody protocols until they can be transported to the laboratory for analysis as described in SOP-SA-01.<br><br>Properly preserved metals and general chemistry samples may need to be stored and shipped on ice. Refer to the guidance document or the analytical laboratory submittal requirements to determine storage and transportation requirements. |
| **18. Dispose of purged water and measure purge volume.** | Collect and dispose of purged water according to the requirements in the guidance document or with SOP-DE-03. Empty the bucket or storage container associated with the flow cell appropriately. When finished purging, measure and record the total purge volume in the field logbook and/or on the field data sheet. |
| **19. Decontaminate the pump.** | After each use, thoroughly decontaminate any pump immersed in a well according to SOP-DE-02A. Discard disposable tubing used in peristaltic pumps and the bladder in the bladder pumps after sampling each well. If required by the guidance document, empty any fluids used for decontamination into the purge water container. |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
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| **SOURCE** | **HAZARDS** | **WHERE** | **HOW, WHEN, RESULT** | **CONTROLS** |
| **CHEMICAL** | Potential contact with contaminated water. | Sites. | Inadvertent exposure to contaminated water could lead to adverse health effects. | Personnel will practice proper personal hygiene – wash hands prior to eating/drinking and when leaving the site. Personnel will wear nitrile gloves and safety glasses when collecting and handling samples. Pour water from bucket into disposal area slowly to prevent splashes and skin contact. Keep control of high-flow discharge hoses to prevent water spraying and skin contact. |
| | Preservatives: hydrochloric acid (HCL), nitric acid ($HNO_3$), sulfuric acid ($H_2SO_4$), zinc, acetate, and sodium hydroxide (NaOH). | In bottles or added to bottles through sampling process. | Inadvertent exposure to preservatives could lead to adverse health effects. | Personnel will practice proper personal hygiene – wash hands prior to eating and after handling preservatives and sampling bottles. Personnel will wear nitrile gloves and safety glasses when handling preservatives and sampling bottles. |
| | Carbon monoxide (CO). | Generator. | Potential exposure to CO when working around the generator could result in irritated eyes, headache, nausea, weakness, and dizziness. | Personnel will stay upwind when working around the generator. The generator will not be operated indoors or near openings to any buildings that might be occupied. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| SOURCE | HAZARDS | WHERE | HOW, WHEN, RESULT | CONTROLS |
|---|---|---|---|---|
| | Contact with gasoline. | Fueling generator. | Inadvertent exposure via inhalation and/or skin contact can result in adverse health effects and skin irritation if contact with gasoline occurs. | Fuel generators in well-ventilated area, stand upwind while fueling, and minimize splash hazards so skin contact does not occur. Wear nitrile gloves when removing fuel cap and filter. |
| **NOISE** | Elevated noise levels. | Sites, when using a generator. | Exposure to elevated noise levels when using a generator can result in hearing damage. | Set up the generator away from the working area and use hearing protection (ear plugs) if necessary. |
| **ELECTRICAL** | Improper use of 12-volt battery. | Sites, when using battery to power pump. | Personal injuries could result from improper use and maintenance of a 12-volt battery. Examples include shocks, acid burns on skin or eyes, skin burns from electrical charge transfer through a tool and into a metal ring or watch, and battery explosions. | Personnel will remove all jewelry before working with a 12-volt battery. Personnel will disconnect the negative cable first and re-connect it last to prevent getting a shock from current overflow, use battery in well-ventilated areas, and inspect battery before and after each use. Personnel will wear leather gloves and safety glasses when handling battery. |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
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| **SOURCE** | **HAZARDS** | **WHERE** | **HOW, WHEN, RESULT** | **CONTROLS** |
| | Improper use of generator. | Sites, when using the generator during wet conditions. | Electrocution, shock, death, or equipment damage could be caused when using a generator during wet conditions. | If personnel must use a generator when it is wet outside, the generator should be protected from moisture. The generator should be equipped with a Ground Fault Circuit Interrupter (GFCI). Keep extension cord (if used) and connections as dry as possible. Place generator on a surface where water cannot puddle or drain under it. Personnel should dry hands, if wet, before touching the generator. Items should be connected to the generator using heavy-duty extension cords that are specifically designed for outdoor use. |
| **BODY MECHANICS** | Bending, squatting, and kneeling. | During sampling collection. | Bending, squatting, and kneeling during sample collection could result in muscle/back strains or other injuries. | Personnel should stretch prior to starting work and take breaks when necessary. |
| | Improper lifting and carrying equipment. | Sites. | Back injuries and muscle/back strains could result when using improper techniques to lift and carry equipment, such as 12-volt batteries, generator, and pump. | Personnel will use a proper lifting technique – get a good grip, keep the load close to the body, lift with legs and not with back, and avoid lifting loads above shoulder height. Two workers will lift heavy items, if needed. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**

This section to be completed with concurrence from the Safety and Health Manager.

| SOURCE | HAZARDS | WHERE | HOW, WHEN, RESULT | CONTROLS |
|---|---|---|---|---|
| **GRAVITY** | Falls from slips and trips. | Uneven terrain, slick/ muddy/wet surfaces, and steep slopes. | Walking/working on slick/muddy/ wet and uneven terrain could cause slips and trips resulting in falls and injuries. | Personnel will wear work boots with good traction and ankle support. Personnel will be aware of working/walking surfaces and choose a path to avoid hazards. Keep work areas as dry as possible. Wear muck boots, as necessary. |
| **WEATHER** | Cold/heat stress. | Sites. | Exposure to cold temperatures may result in cold burns, frostbite, and hypothermia. Exposure to high temperatures may result in heat cramps, heat exhaustion, or heat stroke. | Training on signs and symptoms of cold/heat stress is required. Personnel will wear appropriate clothing when working outdoors, remain hydrated, and have sufficient caloric intakes during the day. Personnel will also follow procedures outlined in applicable SSHASP and/or Pioneer Corporate HASP. |
| | Hypothermia/ frostbite. | Sites where air temperature is 35.6 degrees Fahrenheit (°F) (2 °C) or less. | Personnel whose clothing becomes wet during decontamination procedures may be exposed to hypothermia and/or frostbite. | If it becomes wet, personnel will change clothing. |
| | Lightning. | Outdoor sites. | Electrocution, injury, death, or equipment damage could result from lightning strike. | Personnel will follow the 30/30 rule during lightning storms. |

**HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS**
This section to be completed with concurrence from the Safety and Health Manager.

| SOURCE | HAZARDS | WHERE | HOW, WHEN, RESULT | CONTROLS |
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| **RADIATION** | Ultraviolet (UV) radiation. | Outdoors. | Personnel could be exposed to UV radiation during summer months causing sun burns, skin damage, and eye damage. | Personnel will wear safety glasses with tinted lenses, long-sleeve work shirts, and long pants. Personnel should wear sunscreen, if necessary. |
| **BIOLOGICAL** | Plants, insects, and animals. | Sites. | Exposure to plants, insects, and/or animals may cause rashes, blisters, redness, and swelling. | Training on the signs and symptoms of exposure to plants, insects, and animals is required. Avoid contact with plants, insects, and animals. First-aid kits will be available on site. Personnel with allergies will notify their supervisor. |
| **MECHANICAL** | Pinch points. | Well caps. | Personal injury could result from fingers getting pinched in the well cap. | Personnel will wear leather gloves when removing well caps. |
| **PRESSURE** | Not applicable. | | | |
| **THERMAL** | Not applicable. | | | |
| **HUMAN FACTORS** | Inexperienced and improperly trained personnel. | Sites. | Inexperienced personnel and improper training could cause incidents resulting in adverse health effects and/or property damage. | Personnel will be properly trained in this procedure and other applicable procedures. Personnel will implement stop work procedures, if necessary. |
| | Interaction with public. | Sites. | Public can enter the work area and interfere with work activities. | Personnel will stop work if public enters the work area. Work will resume once public has left the area. |

| HEALTH SAFETY SECURITY ENVIRONMENT (HSSE) CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | | | | |
|---|---|---|---|---|
| **SOURCE** | **HAZARDS** | **WHERE** | **HOW, WHEN, RESULT** | **CONTROLS** |
| **SIMOPS (Simultaneous Operations)** | Not applicable. | | | |

| ADDITIONAL HSSE CONSIDERATIONS<br>This section to be completed with concurrence from the Safety and Health Manager. | |
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| **REQUIRED PPE** | **Personnel Protection Equipment** (PPE): Hard hat, safety glasses, high-visibility work shirt or vest, long pants, work boots, nitrile gloves, and leather gloves. |
| **APPLICABLE SDSs** | **Safety Data Sheets** (SDSs): HCL, $HNO_3$, $H_2SO_4$, zinc, acetate, and NaOH.<br><br>Safety Data Sheets are available to Pioneer personnel on the internal website under Safety. |
| **REQUIRED PERMITS/ FORMS** | Per site/project requirements. |
| **ADDITIONAL TRAINING** | Per site/project requirements. |

| DRAWINGS, DOCUMENTS, AND TOOLS/EQUIPMENT<br>The following documents should be referenced to assist in completing the associated task. | |
|---|---|
| **DRAWINGS** | Map with site location and sample locations. |
| **RELATED SOPs/ PROCEDURES/ WORK PLANS** | SOP-DE-02A Equipment Decontamination – Pumps for Well Sampling<br>SOP-DE-03 Investigation Derived Waste Handling<br>SOP-FM-01 Field Headspace Analysis and VOC Measurements with PID<br>SOP-GW-03 Depth to Water Level Measurements<br>SOP-GW-10.1 Purging and Sampling Using the Traditional Multi-Volume Purge Method<br>SOP-GW-14 Field Water Quality Measurements Using the YSI Meter and Flow Cell<br>SOP-SA-01 Soil and Water Sample Packaging and Shipping<br>SOP-SW-02 Field Sample Filtration<br>SOP-WFM-01 Field Measurement of pH in Water<br>SOP-WFM-02 Field Measurement of Oxidation Reduction Potential in Water<br>SOP-WFM-03 Field Measurement of Specific Conductance<br>SOP-WFM-07 Field Measurement of Dissolved Oxygen<br>SOP-WFM-08 Field Turbidity Measurement<br>SOP-WFM-09 Bucket and Stopwatch Method for Measuring Flow |

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| **TOOLS/ EQUIPMENT** | Well keys, sampling supplies, electronic DTW level indicator, required pump, tubing, 12-volt battery (if needed), generator (if needed), sampling bottles, water quality meters, buckets, containment supplies, decontamination equipment, cooler, field logbook, and field data sheets. |
| **FORMS/ CHECKLIST** | |

**APPROVALS/CONCURRENCE**

By signing this document, all parties acknowledge the completeness and applicability of this SOP for its intended purpose. Also, by signing this document, it serves as acknowledgement that I have received training on the procedure and associated competency testing.

| **SOP TECHNICAL AUTHOR** | **DATE** |
|---|---|
| Kendra Overley<br>**Kendra Overley** | **07/06/2022** |
| **SAFETY AND HEALTH MANAGER** | **DATE** |
| Tara Schleeman<br>**Tara Schleeman** | **07/06/2022** |