

STANDARD OPERATING PROCEDURE SOP-12: MONITORING WELL INSTALLATION AND DEVELOPMENT

Scope and Application

A minimum of two monitoring wells will be installed on the former railroad grade within the Little Squalicum Park boundaries to further delineate a petroleum seep observed near the upper reaches of Little Squalicum Creek. The monitoring wells will be installed using a hollow-stem auger (HSA) drill rig by a well driller licensed in the state of Washington consistent with the regulations listed in Chapter 173-160 of the Washington Administrative Code (WAC).

Supplies and Equipment

A generalized supply and equipment list is provided below. Additional equipment may be required depending on project requirements.

- Hollow-stem auger drill rig and at least two 3-inch diameter Dames & Moore samplers
- Field equipment:
 - Electronic water level meter
 - Well screen, casing, and sump
 - 10-20 Colorado silica sand
 - Bentonite chips and grout
 - Well monument, cap, and lock
 - Concrete
 - Submersible pump, tubing, and power supply for well development
 - 5 gallon plastic buckets
 - 55 gallon drums
 - Plastic sheeting
 - Decontamination supplies (Alconox™ detergent, methanol, hexane, dionized water)
 - Personal protective equipment for field team (rain gear, safety goggles, hard hats, nitrile gloves)

- Photoionization detector (PID) and/or flame ionization detector (FID)
- First Aid kit
- Cell phone
- Camera
- Permanent markers
- Indelible black-ink pens
- Documentation
 - Waterproof field logbook
 - Sampling and Analysis Plan (SAP)
 - Health and Safety Plan (HASP)
 - Well installation and borehole log forms
 - Request for change forms

Methods

Monitoring Well Installation

A track-mounted hollow-stem auger (HSA) drill rig will be used for installation of the monitoring wells. Drilling will be conducted using an 8.25 inch OD hollow-stem auger, which has a 4.25 inch ID—large enough to accommodate the 2-inch monitoring well, plus a 1-inch sand pack around the well (other suitable augers may be used, provided that the 2-inch well can be installed to the desired depth per WAC regulations). The monitoring wells will be constructed in accordance with the design shown in Figure 3 of Addendum 2. Each well will be drilled to the top of the gray clay observed daylighting in the upper portion of the creek bed or 50 ft, whichever comes first. If heaving sands are encountered, the augers will be removed after reaching total depth and a tapered wooden plug will be inserted in the hollow stem at the end of the lead auger to minimize accumulation of drilled material in the augers.

A lithologic log and well construction diagram (Figure 4 of Addendum 2) will be generated for each monitoring well based on the soil samples collected from the borehole and the drilling conditions noted by the drillers (i.e., change in drilling penetration rate).

The monitoring well casings above the water table will be 2-inch diameter schedule-40 PVC with flush-threaded couplings. The well casing below the water will be constructed of Type 316 stainless steel. A 10-ft section of 0.010-in. Type 316 stainless steel well screen with an end plug (i.e., sump) will be placed at the bottom of each well. The casing will

extend from the top of the screen to the ground surface. Stainless-steel centralizers will be attached at the top and bottom of the well screen to keep the well in the center of the filter pack.

Each monitoring well will be assembled and set inside the hollow-stem augers once the target depth has been reached. If a wooden plug is used in the lead auger, the augers will be retracted a few inches and the wooden plug will be knocked out of the bottom of the lead auger with a steel pipe or similar device. The annular space will be backfilled with No. 10–20 Colorado silica sand or equivalent to approximately 2 ft above the top of the screen. The silica sand filter pack material will be added to the augers as they are pulled out, keeping several feet of silica sand in the augers to fill the void created by the augers as they are retracted. The sand will be poured in slowly to avoid bridging. The filter pack will extend approximately 2 ft above the screen. The well will be surged repeatedly with a surge block or similar device to promote settling of the filter pack. Additional silica sand will be added if significant settling has occurred.

A 2-ft-thick bentonite pellet filter pack seal will put on top of the filter pack as the augers are retracted. The bentonite pellets will be added slowly to avoid bridging. The seal will be hydrated with clean, potable water until sufficiently hydrated. Bentonite grout will be mixed according to the manufacture's specifications and pumped into the hole to approximately 2.5 ft bgs. The driller will calculate the volume of the annular space to ensure the proper volume of grout is placed in the annulus. A 0.5-ft-thick layer of bentonite pellets will be placed on top of the grout to create stable surface for the concrete surface seal, which will extend from the ground surface to approximately 2 ft bgs. The surface completion will conform to the State of Washington standards, and will consist of an 8-inch diameter flush-mount traffic-rated watertight monument.

The augers and any other equipment that comes into contact with the well or borehole will be pressure-washed prior to drilling each well. All soil cuttings will be containerized in UN-approved 55 gallon drums for characterization in accordance with applicable local, state, and federal regulations prior to disposal. The drilling contractor will be responsible for supplying drums and transporting filled drums as specified.

Monitoring Well Development

Upon well completion and any waiting time required by the WAC regulations for the filter pack seal to fully hydrate, Integral will develop each monitoring well by over-pumping using a 1.5-in diameter centrifugal pump (i.e., "Whale pump") capable of pumping approximately 1-2 gallons per minute (GPM). The wells will be repeatedly surged and pumped. Turbidity measurements will be collected periodically and over-pumping and surging will continue until the measurements are below 50 NTU. A minimum of 50 well casing volumes will be removed from each well during development.