

Ground Water Sampling Using an Electric Submersible Pump
FSOP 2.2.10 (August 31, 2016)
Ohio EPA Division of Environmental Response and Revitalization

1.0 Scope and Applicability

- 1.1 Electric submersible pumps used for ground water sampling include centrifugal submersible pumps and progressive cavity (helical-rotor) pumps. Centrifugal submersible pumps are the more common and operate by using an electric motor to rotate an impeller (or series of impellers) that push ground upward through a discharge line by centrifugal force. Ohio EPA uses variable speed centrifugal submersible pumps specifically designed for collecting ground water samples.
- 1.2 Electric submersible pumps are very versatile for ground water sampling. These devices can be used for low-flow sampling (< 500 ml/min or < 0.1 gpm) and quickly purging large volumes of ground water at higher pumping rates (> 5 gpm). These pumps are effective for purging deep wells (> 100 feet), larger diameter wells (> 2 inches) or wells with large water columns (> 30 feet). The use of an electrical submersible pump to sample a deep well is limited by the length of the electric cord and the amount of hydraulic head the pump is capable of lifting.
- 1.3 The variable speed electrical submersible pumps used by Ohio EPA for ground water sampling are constructed of stainless steel, Teflon® (fluorocarbon polymer) or other inert, non-sorptive materials. These pumps are also equipped with water-cooled motors, i.e., the electric motor is cooled by ground water flow around and through the pump. Either a portable generator or a 12-volt deep-cycle battery is used for power supply. Ohio EPA also uses disposable discharge line composed of Teflon®, polyethylene or similar materials depending on data quality objectives (DQOs).
- 1.4 When operated at low-flow rates (< 500 ml/min), variable-speed electric submersible centrifugal pumps perform similarly to bladder pumps with respect to maintaining sample integrity.
- 1.5 Limitations of electrical submersible pumps include the following:
 - 1.5.1 When operated at flow rates greater than 1 gpm, electrical submersible pumps may cause increased turbulence and pressure changes, which could adversely affect ground water sample quality, e.g., increased turbidity or loss of volatile constituents.
 - 1.5.2 The heat generated by the electric motor may cause increased ground water sample temperature and loss of dissolved gasses and volatile constituents. However, this concern can easily be evaluated by monitoring the ground water temperature, and special devices are available (pump shrouds) to prevent the pump motor from generating excessive heat.
 - 1.5.3 Electric submersible pumps include a number of intricate parts and required more decontamination and maintenance time compared to other ground water sampling devices.

- 1.6 All ground water sampling techniques and associated procedures should be consistent with Ohio EPA's [Technical Guidance Manual \(TGM\) for Hydrogeologic Investigations and Ground Water Monitoring](#), specifically [Chapter 10, Ground Water Sampling](#). In addition, [U.S. EPA 2002 \(Yeskis and Zavala\)](#) provides ground water sampling guidance for RCRA and CERCLA sites. The site-specific work plan (SSWP) will provide project objectives and DQOs. In the event there appears to be inconsistency between the TGM and project objectives or DQOs, please contact the DERR SIFU supervisor and DERR site coordinator for clarification.

2.0 Definitions

Not applicable

3.0 Health and Safety Considerations

- 3.1 Always review the site-specific health and safety plan (HASP) for site-specific hazards before performing work.
- 3.2 Refer to [FSOP 2.2.4, Ground Water Sampling \(General Practices\)](#) for general ground water sampling and health and safety considerations.
- 3.3 Be careful when working with electricity under wet conditions.
- 3.4 If using a generator for power supply, ensure that it is grounded to avoid electrical shock. Handle gasoline carefully. Always wear protective gloves when handling gasoline, and store gasoline containers outside of the work area.
- 3.5 When carrying a 12-volt battery, lift the battery properly. Bend your hips and knees to squat down, grasp the battery, and while keeping it close to your body, straighten your legs to lift it. Do not lift the battery by bending forward, which may cause back injury.

4.0 Procedure Cautions

- 4.1 Refer to [FSOP 2.2.4, Ground Water Sampling \(General Practices\)](#) for general ground water sampling procedure cautions.
- 4.2 If NAPL is encountered in a monitoring well, do not perform ground water sampling. Immediately notify the DERR-SIFU supervisor and DERR site coordinator.
- 4.3 Never lower or lift the pump inside a well using the electrical power cord. The pump may be lowered or lifted using the discharge line provided that it is securely attached to the pump with a hose clamp. When using a hose clamp, don't overtighten the hose clamp screw if the pump is plastic. A safety cord may also be used for lowering and lifting the pump on some pumps. The cord should be composed of an inert material that will not affect ground water quality, and should

be tied to the pump using a non-slip knot such as a bowline. When removing the pump from the well, be sure to pull the safety line, tubing, and electrical line at the same rate. Otherwise, the lines can coil, bind and obstruct the pump removal.

- 4.4 Operating an electrical submersible pump in well with high amounts of suspended solids or turbidity may “sand lock” (seize) or damage the impellers. Carrying one or more impeller replacement kits during ground water sampling is recommended.
- 4.5 When operating the pump, do not allow the water level to fall below the pump intake. Otherwise, the pump will begin surging the water column in the well and may overheat.
- 4.6 If possible, do not operate the pump within the screened interval when purging at rates greater than 1 gpm. This may cause increased sample turbidity.
- 4.7 Never operate the pump at the bottom of a well. Doing so will likely cause increased sample turbidity and may sand lock the pump in the well.
- 4.6 Check the pump periodically to ensure the electrical wires have not loosened from the pump head or become abraded or otherwise damaged.

5.0 Personnel Qualifications

Ohio EPA personnel working at sites that fall under the scope of OSHA’s hazardous waste operations and emergency response standard (29 CFR 1910.120) must meet the training requirements described in that standard.

6.0 Equipment and Supplies

- 6.1 Electric submersible pump and controller box
- 6.2 Generator or 12-volt deep cycle battery
- 6.3 Disposable discharge tubing
- 6.4 Safety cord
- 6.5 Knife or tubing/cord cutter
- 6.6 Other ground water sampling equipment and supplies as needed per FSOP 2.2.4, Ground Water Sampling (General Practices)

7.0 Procedures

- 7.1 Measure the well’s static water level and total depth in accordance with FSOP 2.2.2, Ground Water Level Measurement.
- 7.2 Connect the discharge tubing (and safety cord if applicable) to the pump, taking care to prevent potential cross-contamination (e.g., working over a clean sheet of plastic to prevent direct contact with the ground or other potentially contaminated surfaces).
- 7.3 Calculate the well volume, even if low-flow sampling. (If the well yield is too low to

stabilize the water level for low flow sampling, the volumetric sampling technique will need to be used.)

- 7.4 Using the discharge line tubing (or safety cord), slowly and carefully install the pump in a manner that minimizes disturbance to the water column in the well. The pump should be installed in the approximate center of the screened interval for low-flow sampling, and if possible, above the screened interval for volumetric sampling. Never place the pump at the bottom of the well.
- 7.5 When low-flow sampling, measure the static water level with the pump in the well. Monitor the static water level during sampling to ensure that drawdown is minimized. Follow other low-flow sampling procedures as described in FSOP 2.2.6, Low-Flow Ground Water Sampling.
- 7.6 If using a generator for power supply, the exhaust should be directed away from (downwind of) the wellhead work area where the ground water samples will be collected to avoid cross contaminating the samples.
- 7.7 Connect the power source to the pump controller box and the controller box to the pump.
- 7.8 Start the pump and adjust the flow rate using the pump speed control on the controller box. Refer to the pump's manual as needed for operating instructions.
- 7.9 Monitor the drawdown in the well while purging to avoid drawing the water level below the top of the well screen or to the pump intake. If this situation occurs, immediately reduce the flow rate to allow the water level to rise above the top of the well screen or the pump intake.
- 7.10 Monitor the purge water temperature to evaluate if the pump motor may be heating the ground water. If this situation occurs, the well will likely need to be sampled using a different device. Consult the SSWP or contact the DERR SIFU supervisor and DERR site coordinator for direction regarding alternative sampling procedures.
- 7.11 After purging criteria have been met, collect ground water samples in accordance with FSOP 2.2.4, Ground Water Sampling (General Practices). Handle ground water samples in accordance with FSOP 1.5, Sample Custody and Handling.
- 7.12 Replace the discharge line between each sampling location and decontaminate the pump and electrical cord in accordance with the manufacturer's instructions and FSOP 1.6, Sample Equipment Decontamination.
- 7.13 Dispose of investigation derived waste in accordance with FSOP 1.7, Investigation Derived Wastes.

8.0 Data and Records Management

Refer to FSOP 1.3, Field Documentation.

9.0 Quality Assurance and Quality Control

Refer to the SSWP and FSOP 2.2.4, Ground Water Sampling (General Practices).

10.0 Attachments

None

11.0 References

FSOP 1.3, Field Documentation.

FSOP 1.5, Sample Custody and Sampling

FSOP 1.6, Sampling Equipment Decontamination

FSOP 1.7, Investigation Derived Wastes

FSOP 2.2.2, Ground Water Level Measurement

FSOP 2.2.4, Ground Water Sampling (General Practices)

FSOP 2.2.6, Low-Flow Ground Water Sampling

Ohio EPA, May 2012, Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring, Chapter 10, Ground Water Sampling: Ohio EPA Division of Drinking and Ground Waters

U.S. EPA (D. Yeskis and B. Zavala), May 2002, Ground Water Sampling Guidelines for Superfund and RCRA Project Managers (Ground Water Forum Issue Paper): Office of Solid Waste and Emergency Response, EPA 542-S-02-001