COVER SHEET
STANDARD OPERATING PROCEDURE

Operation Title: **GROUNDWATER SAMPLING USING LOW FLOW PURGING AND SAMPLING FOR LONG-TERM MONITORING**

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DISTRIBUTION;

( ) Division of Remediation..........................By:_____________Date:_______

1.0 APPLICABILITY

This Standard Operating Procedure (SOP) applies to all programs in the Maine Department of Environmental Protection's (MEDEP) Division of Remediation (DR). It is also applicable to all parties that may submit data that will be used by the DEP/DR.

This SOP is not a rule and is not intended to have the force of law, nor does it create or affect any legal rights of any individual, all of which are determined by applicable statutes and law. This SOP does not supersede statutes or rules.

2.0 PURPOSE

The purpose of this document is to describe the MEDEP/DR's procedure for collecting groundwater samples from wells utilizing the "Low Flow" purging and sampling procedure. This Standard Operating Procedure (SOP) is similar to SOP# RWM-DR-002 - Groundwater Sample Collection for Site Investigation and Assessment Monitoring. RWM-DR-002 is intended to be used at sites where Data Quality Objectives (DQOs) do not require long-term monitoring of concentration trends. The purpose of this SOP (RWM-DR-003) is to outline the procedure for collecting groundwater samples from existing monitoring wells where DQOs require consistently documented procedures for collecting groundwater samples at regular intervals (quarterly, tri-annual, bi-annual, annual, etc.) to monitor data trends over time. Site specific DQOs should be reviewed to ensure the sampling methods are appropriate.

3.0 RESPONSIBLITIES

All MEDEP/DR Staff must follow this procedure when performing this task. All Managers and Supervisors are responsible for ensuring that their staff are familiar with and adhere to this procedure. MEDEP/DR staff reviewing data by outside parties are responsible for assuring that the procedure (or an equivalent) was utilized appropriately.

4.0 GUIDELINES AND PROCEDURES

4.1 INTRODUCTION

Low flow sampling (LFS) is an appropriate method for long-term monitoring of groundwater at sites. The goal in any groundwater monitoring activity is to collect groundwater samples that are representative of mobile organic and inorganic loads in the vicinity of the selected open well interval. Current research indicates that LFS is the best available technique for: 1) obtaining the most consistently representative samples of groundwater from the formation surrounding the screened interval of a properly installed monitoring well; 2) eliminating variability introduced by sampling technique; and 3) providing a basis for evaluating appropriateness of long-term groundwater sampling data.

LFS includes both a purge and no-purge option. The purge option for LFS involves pumping the well at a rate that minimizes drawdown in a well to reduce mixing of the riser water and groundwater in the aquifer. Field parameters, such as pH, dissolved oxygen, temperature, turbidity and conductivity are monitored during purging until readings have stabilized; at this point, groundwater entering the pump intake represents formation water and the sample is collected.

In low permeability formations or poorly installed monitoring wells it may not be possible to collect groundwater samples using the specified purge techniques. In such instances, the no-purge option should be evaluated (see Attachment A).

Additionally, this procedure is not designed to collect samples from wells containing light or dense nonaqueous phase liquids (LNAPLs or DNAPLS).

LFS is a skill which requires considerable experience and ongoing education and tuning on the part of those who perform it; therefore, at least one experienced person in LFS should always accompany every sampling team.

4.2 EQUIPMENT

The following list of equipment is necessary when performing LFS. Specific brand names indicate equipment owned by either MEDEP/DR and MEDEP/TS, and is available to staff for use equipment with similar performance may be used in place of the specifically identified equipment. (see SOP# RWM-DR-014 - Development of a Sampling and Analysis Plan).

4.2.1 PUMP

The pump selected must have capabilities of adjusting the flow rate without the use of flow restrictors. Types of acceptable pumps include: submersible, bladder and peristaltic pumps. Physical limitations on the use of peristaltic pumps also apply to wells with deeper water levels; wells with water levels greater than approximately 24 feet cannot be sampled with a peristaltic pump. In these instances, a submersible or bladder pump should be used.

The Department recommends the use of dedicated equipment, where possible, for long-term monitoring.

4.2.2 TUBING

Low density polyethylene (LDPE) is recommended for most situations. However, site specific DQOs should be reviewed before selecting the appropriate tubing. For example, sites with low concentrations of certain petroleum related contaminants should consider the use of Teflon lined polyethylene tubing. Peristaltic pumps typically use 1/4-inch or 3/8-inch outside diameter (OD) LDPE tubing together with 3/8-inch OD silicone tubing. Submersible pumps typically have barbed fittings that accommodate 3/8-inch or

1/2-inch inner diameter (ID) LDPE tubing, depending on the pump manufacturer. Note that larger diameter tubing (1/4 inch ID or greater) is generally easier to install in monitoring wells equal to or greater than 2 inches in diameter.

As in the case with pumps the use of dedicated tubing, where possible, is recommended for long-term monitoring programs.

4.3 POWER SUPPLY

The power supply options for the pumps include generators, deep cycle batteries, and compressed gas. If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples. If the operator of the generator has handled gasoline, then he/she should not risk cross-contamination by handling the sampling equipment or sample containers.

4.4 INDICATOR PARAMETER MONITORING INSTRUMENTS

Site specific Data Quality Objectives (DQOs) should be used to select appropriate field parameters. Field parameter options include, but are not limited to:

- pH (EPA Methods 150.1 or 9040),
- turbidity (EPA Method 180.1),
- specific conductance (EPA Methods 120.1 or 9050),
- temperature (EPA Method 170.1),
- oxidation reduction potential (ORP), and
- dissolved oxygen (EPA Method 360.1).

A flow-through cell is required for dissolved oxygen and ORP measurements.

4.5 WATER LEVEL/FLOW MEASURING TOOLS

Water level and flow measurement are required for LFS. Several different water level meters, including Solinist® and Well Wizard®, are available to staff. A graduated cylinder and stopwatch are used for measuring flow in mL/minute.

4.6 DOCUMENTATION SUPPLIES

This includes a field notebook for taking field notes, and the MEDEP LFS data sheet included in Attachment B.

4.7 WELL DOCUMENTATION

A well's location, well construction, previous sampling data, and the Sampling and Analysis Plan (SAP) should accompany samplers in the field.

4.8 MISCELLANEOUS SUPPLIES

Miscellaneous supplies include decontamination equipment and material, sample bottles, preservation supplies, sample tags and labels.

4.9 LFS PURGE AND SAMPLE PROCEDURE

4.9.1 PREPARATION

Prior to conducting an LFS event, information regarding well construction, development, and water level records for each well to be sampled should be obtained and reviewed to determine the appropriate pump to be used, the depth of intake, and the potential groundwater recharge rate of the well. If this information is not available, a reconnaissance should be made prior to the actual sampling event to determine well depth, water level, length of screen, and a pump test to determine the recharge rate of the well. Additionally, wells that have **not been sampled for two years should be redeveloped** prior to conducting the actual sampling event. Redevelopment of Monitoring wells is outlined in SOP RWM-DR-028 – Maintaining and Redevelopment of Inactive Monitoring Wells.

4.9.2 FIELD PROCEDURE

1) Obtain static water level. Measure and record the depth to water (to 0.01 ft) in the well to be sampled before inserting tubing or preparing to purge the well. Care should be taken to minimize suspension of any particulates attached to the sides or at the bottom of the well. If wells to be sampled are arranged in clusters (i.e. shallow/middle/deep), then depth to water readings should be collected from all wells in the cluster before purging.

2) Install sampling pump or tubing. The use of dedicated sample tubing will reduce disturbance and water mixing in the well. In situations where dedicated equipment is not used, field staff will lower equipment (i.e. pump, safety cable, tubing and electrical lines) slowly into the well so that the pump intake is located at the center of the saturated screened interval to avoid disturbing sediments in the bottom of the well.

3) Purge well. Flow rate and water level (drawdown) should stabilize before connecting the flow cell or obtaining any other measurements. Air or gas bubbles trapped in the sample tube can usually be removed by elevating the discharge tube and pump to allow the air to continue rising until discharged with the water. However, some groundwater has high dissolved gas levels and gas can not be completely removed from the sample

tube. Check previous data sheets to assist in well set up, flow rates, and notes regarding gas presence in the sample tube.

Monitor water level and pumping rate frequently during the first five minutes of purging. If the recharge rate of the well is less than minimum capability of the pump, then the water level will not stabilize. If a constant water level can not be maintained at a flow rate of 80 to 100 mL/min., then the no-purge option should be evaluated (see Section 4.12 No-Purge Option). Care should be used to avoid dewatering the screen or lowering the water level to the intake depth.

Once the water level has stabilized during purging, monitor field indicator parameters every three to five minutes. Measurements of dissolved oxygen and ORP must be obtained using a flow-through cell. Purging is complete and sampling may begin when all field indicator parameters have stabilized (variations in values are within ten percent of each other, pH +/- 0.2 units, for three consecutive readings taken at three to five minute intervals).

4) Collect Samples. Collect samples in appropriate containers as indicated by laboratory conducting the analysis. Samples for laboratory analyses must be collected before the flow cell. This can be done by disconnecting the flow cell after reaching stabilization, using a sample port before the flow cell, or by disconnecting the flow cell once parameters have stabilized.

LFS will help reduce turbidity caused by improper purge and sampling techniques. The need for filtering water samples will be reduced by using this method. However, if turbidity values equilibrate above 20 NTUs, one should consider the need to collect both a filtered and an unfiltered sample. An in-line 0.2-0.45 um particulate filter should be pre-rinsed with approximately 25 - 50 mL of groundwater prior to sample collection, or as per filter manufacturers instructions. **Note that filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations representative of total mobile loads.**

After collection of the samples, any tubing used may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

4.10 PROCEDURE EVALUATION

The purpose of the LFS purge option is to sample the groundwater from the surrounding aquifer. If your well is not receiving sufficient recharge from the formation, then the water level in the well will drop as pumping continues. This means that the discharge water could contain a significant percentage of stagnant water from the well casing. As the percentage of casing water increases, the representativeness of the sample decreases. If the percentage of casing water is significant, an alternative sampling technique, such as the no–purge option, should be considered (see Section 4.12). A decision process for implementing low flow/no purge sampling can be found in Attachment B.

The second step in evaluating the viability of LFS for a potential no–purge well is to determine the volume of groundwater needed to fill the laboratory containers. Compare this volume to the volume of groundwater in the screened section of the monitoring well. If the volume of water contained in the screened zone is greater than the volume of sample required to fill the sample containers, then the no-purge option is appropriate for this well.

4.10.1 CALCULATING FORMATION/STAGNANT WATER RATIO

The following calculation will determine how much of the water being pumped is coming from the well, and how much is coming from the aquifer. This is done by comparing the total volume being purged to the drawdown volume in the well. If the equilibrium flow rate is 150 mL/min or lower for a given well, the following evaluation should be followed:

- Calculate the total volume of water discharged for a given time interval.
- Measure the total drawdown of the water level in the well during that time interval.
- Calculate the total drawn down volume in the well (see Attachment B for mL/ft conversions of typical monitoring well sizes)

Compare the total volume of water discharged to the total drawdown volume. If the drawdown volume comprises 60% or more of the discharge volume, then the well construction should be evaluated.

4.10.2 WELL CONSTRUCTION EVALUATION

Evaluate the well construction. Was the appropriate screen slot size selected? Was the appropriate filter sand selected? If the well construction details are not appropriate for the formation, then consideration should be given to installing a replacement well that is properly designed. A poorly designed well will not yield representative samples no matter what purging procedure is utilized.

4.11 PROCEDURE MODIFICATIONS

The LFS procedure can be modified to meet the DQOs for the Sampling Event. In long-term monitoring events it may be possible to reduce the field parameter list after baseline information is obtained over the first year or two. Careful consideration should be given to the purpose of each parameter used in the procedure. Each parameter has importance that extends beyond the measurement for equilibrium. If Low-Flow sampling is not appropriate for a particular site, then SOP RWM-DR-002 – Groundwater Sample Collection for Site Investigation and Assessment Monitoring should be used for the site.

Cold weather considerations must be factored into a low flow sampling plan.

Monitoring wells with recharge rates below 100 mL/min may not be capable of being pumped at a continuous rate. Therefore, low purge or no purge options should be considered.

4.12 NO – PURGE OPTION

The theory of no-purge sampling is that the water in the screened zone is in equilibrium with the aquifer and the water in the riser portion of the well is not. The goal is to sample only the water in the screened zone and to minimize any mixing with the water in the riser.

In certain low permeability formations it may not be possible to maintain a constant drawdown at low flow rates (~80-100 mL/min.). In these formations the only option may be to obtain a groundwater sample without purging.

4.12.1 NO-PURGE PROCEDURE

Dedicated equipment is required to properly complete this procedure (to eliminate any additional mixing of the water in the riser with the water in the screen).

The pump intake must be in the screened zone, at or slightly above the midpoint of the screen.

1) Calculate the volume of water standing in the discharge line.

2) Turn on the pump at the lowest possible flow rate.

3) Purge the volume of water that was standing in the discharge line.

4) Immediately begin sample collection after the discharge line is purged.

4.13 DECONTAMINATION

Dedicated equipment will not need decontaminating. However, non dedicated equipment should be cleaned prior to field work, after each sampling location, and upon return to the office from the field, as outlined in MEDEP/DR SOP# RWM-DR-017 – Equipment Decontamination Protocol, with specific procedures for cleaning submersible pumps outlined below. The pump, including support cable and electrical wires which are in contact with the well will be decontaminated by one of the procedures listed below. Note that if historical data is available for site wells, non-dedicated equipment decontamination in the field can be minimized or even eliminated by sampling monitoring wells in order from cleanest to dirtiest. Non dedicated tubing should be discarded.

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is flushed out. The outside of the pump and the electrical wires must be rinsed with the decontaminating solutions as well. The procedure is as follows:

- Flush the equipment/pump with deionized or tap water. Flush pump by allowing pump to run with water for several minutes in basin filled with water.

- Flush with non-phosphate detergent solution for several minutes.
- Flush with deionized water to remove all of the detergent solution. In some instances of high levels of contamination, it may be appropriate to use isopropyl alcohol in this step. The need for this will be determined in the Site Specific Sampling and Analysis Plan (See SOP# RWM-DR-014)

- Flush one final time with distilled/deionized water. If required (as determined in Site Specific Sampling and Analysis Plan), collect equipment blank after final flushing.

5.0 QUALITY ASSURANCE/ QUALITY CONTROL

DQOs should be stated in the site Sampling and Analysis Plan (SAP). Quality Assurance/Quality Control (QA/QC) samples may be collected if needed to meet your data quality objectives. The following are typical types of QA/QC samples that may be collected as part of the QA/QC program for groundwater sample collection utilizing this SOP, other QA/QC samples may be collected as stated in the SAP. For an additional discussion of QA/QC, please refer to the MEDEP/DR Quality Assurance Plan, Sections 4 and 8. All analytical data should be reviewed and assessed to determine if DQOs have been met. If review indicates DQOs have not been met, corrective action will be recommended by the reviewer.

5.1 TYPICAL QA/QC SAMPLES

5.1.1 Equipment Blanks

If using non dedicated or disposable equipment, equipment blanks should be collected at a rate of 5%, which is equivalent to one equipment blank for every twenty samples collected. The equipment blank will consist of purging de-ionized water through submersible pumps and piping, and/ or rinsing equipment with de-ionized water, and collection for appropriate sample analysis.

5.1.2 Duplicate Samples

It is recommended that duplicate samples be collected at a rate of 5% to assess sample location variability.

5.1.3 Trip Blank

A trip blank may be necessary when sampling for volatile organic compounds (i.e. EPA 8260). The need for a trip blank will be outlined in the SAP.

5.1.4 Background Samples

The need for background groundwater samples will be outlined in the SAP.

6.0 DOCUMENTATION

All site visits, including groundwater sampling events shall be documented as described in the SOP# RWM-DR-013 - Documentation of Field Activities and Development of A Trip Report. A field log must be kept each time ground water monitoring activities are conducted in the field; the LFS Data Sheet in Attachment A is the approved form for use by staff. The field log should document the following:

- Well identification, condition of well
- Static water level
- Pumping rate, or flow rate including units
- Time of all measurements
- Water Level at the specified pumping rate
- Indicator parameters values
- Well sampling sequence and time of sample collection.
- Types of sample bottles used and sample identification numbers.
- Preservatives used.
- Parameters requested for analysis.
- Name of sample collector(s).
- Calibration information of meters.

7.0 REFERENCES

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ATTACHMENT A
DECISION PROCESS FOR IMPLEMENTING LOW FLOW/NO PURGE SAMPLING

Decision Process for Implementing LFS

1) Obtain well construction, development, and water level records for each well being sampled. Compile total depth, screened interval, water level, and available hydraulic conductivity information for field technician(s).
    Continue to 2

2) Review available equipment. Make sure the pump is capable of variable speeds and can pump water at low rates without the use of mechanical flow restrictions. Reducing flow by altering the diameter of the discharge pipe is not acceptable for purposed of LFS. Make sure the chamber being used to collect field parameters is appropriate for the parameters being measured. For ORP and DO measurements with probes, the chamber must be an enclosed chamber that does not allow water to contact the atmosphere and does not impact the water quality. Additionally, the size of the chamber should be appropriate given the expected flow rates.
    Continue to 3

3) The objectives of the sampling event should be reviewed to determine the important stabilization parameters as well as the important field parameters for geochemical analyses.
    Continue to 4

4) Is the well being used as part of a long-term plan to monitor trends in groundwater chemistry?
    Yes … Go to 5
    No … Go to 6

5) Complete Well Performance Evaluation on Well prior to first sampling event.
    Continue to 6

6) Will water level (under pumping conditions) stabilize above the top of the screen?
    Yes … Go to 11
    No … Go to 7

7) Is the static water level above the top of the screen?
    Yes … Go to 9
    No … Go to 8

8) Will the stabilized water level reduce the volume of water in the well by greater than 10%?
    Yes … Go to 12
    No … Go to 11

9) Is there sufficient water in the well to purge and sample the well given the measured drawdown rate without dewatering any part of the screen?
    Yes … Go to 10
    No … Go to 12

10) Is the volume of water attributable to the change in water level greater than 20% of the volume of water being discharged during the same time period?
    Yes … Go to 12
    No … Go to 11

11) Complete the Standard Low Flow Sampling Procedure and collect groundwater samples once the selected stabilization parameters have equilibrated.

12) Evaluate the appropriate application of Reduced Purge Procedures for this well.
    Continue to 13

13) Is the sampling equipment (pump or sample tube) dedicated to the well and/or has it been installed for more than 2 weeks prior to sampling?
    Yes … Go to 15
    No … Go to 14

14) Install the pump or tubing and purge a volume of water equal to 1.5 times the volume required to fill the laboratory containers. Purging must be completed at the lowest setting possible (must be less than 100 mL/min). Then shut-off the pump and allow the well to recharge until the water level returns to the static water level
    Continue to 15

15) Set the pump rate to the lowest possible setting (must be lower than 100 mL/min) and purge a volume of water equal to the volume of water in the sample tube. Then immediately begin collection of laboratory samples at the same rate. Record the water level at the beginning of sample collection and at the end of sample collection. If field parameters are to be collected, they must be collected after laboratory samples are collected.

ATTACHMENT B
LOW FLOW DATA SHEET