

MINNESOTA  
MINNESOTA POLLUTION CONTROL AGENCY  
WATER QUALITY DIVISION

SAMPLING PROCEDURES FOR  
GROUND WATER MONITORING WELLS

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Check the Minnesota Pollution Control Agency Internet Web site for the most recent version of this document:  
<http://www.pca.state.mn.us/water/groundwater/sampleguide.html#part2>

This book is not a health and safety manual and should be supplemented with other references on recommended health and safety practices.

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# Sampling Protocol For Ground Water Monitoring Well

## 1.0 INTRODUCTION

This document defines procedures to be used for ground water quality measurements and for collecting and handling ground water samples obtained from monitoring wells. These procedures shall be used for ground water quality measurements taken to meet the requirements of a National Pollutant Discharge Elimination System (NPDES) or State Disposal System (SDS) permit, or where referenced in any other enforceable document. This document shall be referenced as Water Quality Program Sampling Procedures for Ground Water Monitoring Wells, July 1997 by Laura A. Triplett. It is based on the Minnesota Pollution Control Agency Ground Water Sampling Guidance: Development of Sampling Plans, Protocols and Reports, 1995 by Tim Thurnblad, and it replaces Procedures for Ground Water Monitoring: Minnesota Pollution Control Agency Guidelines, December 1986 by Gretchen V. Sabel and Thomas P. Clark. This document takes effect on September 1, 1997.

This document is divided into 4 sections. Section one establishes applicability and provides an overview of the document; section two describes the decisions and preparations that should be addressed before sampling takes place; section three describes each step of the field sampling procedure; and section four contains a brief summary of the field sampling procedures for easy reference. There are five appendices which provide additional information and examples of forms referenced in this document.

Deviations from these procedures may be required by unforeseen circumstances that develop during the sampling event. Such deviations shall be approved by the hydrogeologist or the field crew leader and documented as described in the protocol.

## 2.0 BACKGROUND INFORMATION FOR SAMPLING

This section describes the decisions and preparations that should be addressed well in advance of the actual sampling event. A "sampling event" is a single sampling of all of the permitted wells at a facility, and may stretch over a one to three day period.

## 2.1 Selection Of Analytical Parameters

The selection of analytical parameters, which are generally analyzed in a laboratory, shall be dictated by the individual NPDES/SDS or SDS permit. Specific conductance, temperature, and pH shall be measured in the field for all sampling events to assess well stabilization, as discussed in sections 2.5 and 3.4. Where measurement of trace metal concentration is required, reduction/oxidation potential (Eh) shall be measured in the field.

A state certified laboratory must perform the analysis of samples as required by the permit. The permittee should work closely with the laboratory analyzing the samples to ensure that sample collection and preservation methods meet their quality standards.

## 2.2 Detection Limits

Except where noted, detection limits must be at or below the intervention limits in your permit. *Laboratories must report their practical quantitation limits in order to evaluate their ability to analyze data to meet this requirement.*

## 2.3 Quality Assurance For Field Procedures

### Contamination Prevention

Contamination of samples can occur prior to and during sampling. Good management and quality control can minimize the chances of contamination. Exercise care to avoid the following common ways in which cross-contamination or background contamination can occur:

- storing or transporting sampling equipment improperly
- contaminating equipment or sample bottles on site by setting them on or near potential contamination sources such as uncovered ground, a contaminated vehicle, vehicle exhaust, or blowing dust
- handling bottles or equipment with dirty hands or gloves
- cleaning well purging or sampling devices inadequately

Prevent cross-contamination of sampling equipment, sampling bottles, or anything else that could potentially compromise the integrity of samples. Field personnel should assume that contamination exists on the soil surface and vegetation, near sampling points, in wash water, etc.

Minimize exposure to these media by taking the following precautions:

- minimize the amount of rinse water left on washed materials
- minimize the time sampling containers are exposed to airborne dust or volatile contaminants in the air
- place equipment on clean ground-covering materials instead of on the ground

All field crew shall wear clean gloves made of appropriately inert material. Keep gloves clean while handling sampling-related materials. Replace gloves with a new pair when soiled and between each sampling site.

### Decontamination, Storage, and Transport of Equipment

In order to obtain valid ground water monitoring results, it is important that equipment used for sampling is decontaminated after each use, and stored and transported properly. This section outlines accepted practices for decontamination, storage, and transportation of equipment.

Before mobilizing for field work or performing any decontamination, select and evaluate a source of control water of known chemistry and organic-free reagent grade deionized water. Ten percent nitric or hydrochloric acid solution made from reagent grade acid and deionized water wq-gw1-01

shall be used as the inorganic desorbing agent. The organic desorbing agent shall be hexane, or pesticide grade isopropanol. *{The user is responsible for verifying that the procedures and materials discussed below present no potential health, safety, or materials incompatibility problems for the specific situation. At highly contaminated sites, additional measures may be necessary to minimize the spread of contaminants on site or beyond site boundaries.}*

Decontaminate equipment in the following manner:

1. **Equipment that does not contact sample water or the inside of the well**
  - clean inside and outside where possible, with clean water and a phosphate-free detergent/clean-water solution, applied with a scrub brush, where practical
  - rinse three times with clean control water
  - inspect for remaining particles or surface film and repeat cleaning and rinse procedures if necessary
2. **Equipment that contacts sample water or the inside of the well**
  - clean inside and the outside where possible with a phosphate-free detergent/clean-water solution - applied with a scrub brush made of inert materials.
  - rinse three times with clean control water
  - inspect for remaining particles or surface film and repeat cleaning and rinse procedures if necessary
3. **For sites that require sampling of volatile or semi-volatile organics**
  - rinse with an inorganic desorbing agent in the laboratory
  - rinse with clean control water
  - rinse with an organic desorbing agent: for example, hexane
  - rinse thoroughly with laboratory controlled deionized water
  - shake off remaining water and allow to air dry
  - do NOT reuse equipment such as bailers and tubing when testing for organics

Thoroughly clean equipment used during purging or sampling (including the water elevation meter) prior to use in each individual well. Decontaminate pump bladders by circulating decontamination fluids through the pump after working at each sampling point. After cleaning, inspect the equipment visually to detect sticky residues or other substances that may survive normal cleaning. If inspection reveals that decontamination was insufficient, implement additional measures as necessary and document that activity.

Clean the internal surfaces of pumps and tubing that cannot be adequately cleaned by the above methods alone by circulating decontamination fluids through them. Exercise special care to ensure that the rinse fluids are circulated in sufficient quantities to completely flush out contaminants, detergents and desorbing agents.

Use new pump tubing the first time each well is sampled and then discard. Alternatively, pump tubing may be dedicated to a single well for subsequent sampling events. Between sampling events, decontaminate dedicated tubing in a laboratory setting and store in a sealed, chemically inert plastic bag. Label the bag with the well name and store in a secure, clean location. Sampling pumps and tubing that are permanently installed and dedicated to individual wells are exempt from field decontamination. Handle all equipment in a manner that shall minimize cross-contamination between wells and avoid introducing surface or ambient air contamination into a well.

When transporting or storing equipment after cleaning, protect the equipment in a manner that minimizes the potential for contamination. Enclose sampling pumps totally in a clean case. If used pumps are transported in the case, decontaminate the case as described above before using again. Place tubing in a clean, inert plastic bag. Wrap bailers in inert plastic or aluminum foil.

### **Field Blanks and Replicates**

Field blanks and replicates are used to ensure the accuracy of analytical results and to identify field contamination problems. These are a critical part of the Quality Assurance/Quality Control (QA/QC) for the sampling event.

*{One "set" of samples refers to all of the samples collected at a single well in one sampling event.}*

Assign all QA/QC samples identification aliases on the sample bottle label to avoid alerting laboratories that the sample is a blank or replicate sample.

Record the true identity of the QA/QC samples in the field sampling log.

All facilities are required to take one set of QA/QC samples. When a permitted facility has more than ten wells, take one set of QA/QC samples for every ten wells. The following schedule applies:

### ***Collection Schedule and Analysis of QA/QC Samples:***

⇒ one field methods (equipment) blank for every sampling event, plus one for every additional group of ten wells.

⇒ one replicate (duplicate) sample set for every ten sets of samples collected. Replicates shall be collected and analyzed for each parameter required by the facility's permit.

⇒ one trip blank for every sampling event where VOCs are monitored.

**Field methods (equipment) blank:** These blanks should reflect all of the potential exposures to background contamination and cross-contamination. Collect blanks in the field at the same time the primary samples are collected. Use the same type of container for each blank as for the actual sample.

In the field, clean, organic-free deionized water should be run through all of the same tubes, sample collection devices, filters, etc., that actual samples encounter. All containers shall be pre-cleaned within the laboratory's QA/QC program in the same manner as primary sample bottles. Fill the blank containers in the field.

Use laboratory-controlled, deionized water to fill all organic blank samples. Fill trace metals blanks with laboratory-prepared, triple deionized water. Add the same preservatives to both the methods blank and the primary samples. The field blank water shall contact all the equipment surfaces that the sample water shall contact.

**Replicate (duplicate) sample:** Replicate samples are collected to evaluate variability in analytical methods. Collect field replicate samples of actual ground water for each parameter in the facility's monitoring requirements. Fill the replicate sample bottles as closely as possible to the time the actual samples are taken. All containers shall be filled as close together in time as practical with a sampling stream that is steady and continuous.

Do not sample all replicates together. Collect each replicate sample after the primary sample from each parameter group is collected. For example, after the primary trace metal sample is collected, the replicate trace metal sample is collected, then the VOCs, and so on. All of the replicate samples should be acquired at one well; essentially, two sample sets shall be collected at one of the wells during the sampling event. *{If you are required to sample more than ten wells at your facility, one replicate sample set shall be collected at one in every ten wells.}*

**Trip blank:** A trip blank is used to detect contaminants that might leak into sample containers during transportation, on-site storage, or storage in the laboratory. Clean, organic-free deionized water should be placed in a sample container in the field, and then be treated as a sample during storage and transport. Trip blanks are most important for facilities that monitor trace metals and/or organics.

## 2.4 Sampling Containers And Preservatives

In most cases, laboratories shall supply containers and preservatives needed for sampling. The correct sampling containers and preservatives to be used for each parameter group are identified in Appendix 1. Coordination with the laboratory conducting analyses is necessary to determine whether preservatives are added to bottles in the field or in the laboratory.

## 2.5 Field Water-Quality Measurements

Measure specific conductance, pH, and temperature in the field during purging to determine well stabilization (Section 3.4). When trace metals are monitored, reduction/oxidation potential (Eh) must also be measured. Record the calibration information and all measurements on the Well Purging - Field Water-Quality Measurements Form or approved equivalent form. Note measurement conditions and the steady-state value for each field water-quality parameter on the Sampling Form (forms described in Section 3.1).

### Water Quality Measurements with a Flow Cell

*{For the definition of a flow cell, see Appendix 2.}*

When a pump is used, we recommend that all measurements be taken within a closed flow cell designed to allow measurement of these parameters while minimizing changes in temperature, pressure, and dissolved gases from the in-situ aquifer environment. If a flow cell is not available, steps should be taken to minimize exposure to air and direct sunlight, and measurements should be taken as quickly as possible.

- Maintain a continuous and steady flow of sample water through the flow cell, as practical, throughout the measurement period.
- Keep discharge velocities through the flow cell low to prevent problems of streaming potential with probes.
- Fully immerse all probes without touching the sides of the air tight, non-metallic flow cell.
- Allow all probes to equilibrate with fresh aquifer water for five minutes before beginning to record measurements.

Allow all probes to equilibrate with fresh aquifer water for five minutes before beginning to record measurements

### Water Quality Measurements without a Flow Cell

When a bailer is used, or a flow cell is not available, carefully pour sample water from the bailer (or pump discharge line) into a clean container which minimizes exposure to sunlight and the atmosphere. Probes shall be allowed to equilibrate with fresh aquifer water. When the readings are reasonably stable, measurements shall be recorded. Specific procedural details for measurement of individual field water quality parameters are discussed below. Follow general care, maintenance, calibration procedures, and operation instructions as specified in the instruction/owner's manual for each measurement device.

**Specific Conductance:** Store the conductivity probe according to manufacturer specifications, and inspect it to be sure it is in good condition with no chips in the coating. Calibrate the conductivity meter each day before taking measurements at the first site. Record the reading taken in the calibration standard. Compare this reading with the chart value for the standard reference solution at the temperature of the solution. Follow the measurement procedures in the manufacturer's instructions. Measure and record the specific conductance to the nearest 10  $\mu\text{mhos/cm}$ . The specific conductance, rather than the electrical conductance, shall be used to determine when the well is stabilized.

**Temperature:** At the beginning of each day of field operations, inspect the temperature probe. To ensure that the temperature probe is in good operating condition, immerse the probe and a mercury thermometer capable of being read to the nearest 0.1 degrees Celsius in a water bath, and compare the readings. Measure and record ground water temperature readings to the nearest 0.1 degrees Celsius.

**pH:** Personnel using pH measuring equipment shall read the manufacturer's instruction manual carefully before recording any measurements. This equipment must be handled carefully, including all steps from taking the cap off the electrode to keeping the electrode tip moist between sampling points. Take special care to protect the fragile glass bulb on the end of the pH electrode. Do not touch the electrode, or allow it to freeze.

Before beginning sampling for the day, calibrate the pH meter using a two-point calibration method or according to the manufacturer's specifications (if using manufacturer's specifications disregard the following instructions). If the meter holds its slope well over time, routine calibration later in the day can be accomplished by calibrating the meter with only one buffer. The single buffer calibration shall normally be accomplished using a pH = 7 buffer for natural waters. At a minimum, calibrate the pH meter

using a single-point calibration method before taking measurements at each new sampling point or every two hours, whichever comes first.

For the two-point calibration method, use two buffers with pH values representative of the range of values expected in the field to check the slope of the meter. Typically, a pair of buffers with pH = 4 and 7 or, alternately, of pH = 7 and 10 shall be used for the two-point calibration. Refer to the manufacturer's instructions regarding the variability of the buffers due to temperature, and make adjustments accordingly. Under extreme or variable temperature conditions, place the buffers in a water bath from the well discharge to minimize temperature-correction errors.

Use only fresh buffer solutions. Take precautions to prevent dilution or contamination of the buffer solutions. Discard buffer solutions after the tenth calibration or four weeks after the first use of the solution, whichever occurs first. Measure and record pH to the nearest 0.1 units.

**Reduction/Oxidation Potential (Eh):** Measure the Eh (also called redox potential) only at sites where trace metal samples are taken. The most common way of measuring Eh is to use a pH meter with redox probes attached to it. Carefully pre-treat platinum electrodes according to the manufacturer's instructions, and store them in an oxygen-scavenging solution of 0.2 M sodium sulfide because the probes are sensitive to the presence of oxygen.

Replace the redox probes after each sampling day after exposure to water containing oxygen, as variations of several hundred mV have been observed between used and fresh electrodes. Follow manufacturer recommendations when calibrating the redox probe. During calibration, gently stir the solution. Measure and record Eh to the nearest millivolt (mV).

## 2.6 Purging And Sampling Equipment

Selection of equipment for purging and sampling depends on your sampling objectives and the parameters to be analyzed. For assistance with selection of appropriate equipment for your project, please contact the MPCA hydrogeologist assigned to your facility.

The most common types of well purging and sampling equipment include the following:

- Pumps: for instance, two-inch nominal diameter stainless-steel positive-displacement submersible bladder pumps or low flow variable-speed electric submersible pumps with Teflon<sup>®</sup> bladder
- Pump discharge lines: new or dedicated Teflon<sup>®</sup> tubing
- Regulators and compressed nitrogen or air tanks

- Bailers
- Flow through cells
- Miscellaneous equipment: rope, generators, air compressors with air filter, etc.

Equipment description and specification details, and equipment inspection and maintenance schedules must be available at the facility upon request.

## 2.7 Order Of Sampling

Where water quality data are available, purge and sample the least contaminated wells first, and proceed to increasingly contaminated wells. Where the distribution of contaminants is not known, begin with wells considered to be upgradient from likely sources of contamination and finish with the downgradient wells closest to the suspected contamination. Where application of the term "upgradient" may not be applicable and previous water quality data are not available, purge and sample wells considered to be background wells first. Collect the ground water sample immediately after purging. Complete purging and sample collection at each well before moving on to the next. Keep records of the order in which wells are sampled, and make them available to the Agency upon request.

## 2.8 Selection of Purging Rate

The purpose of purging wells is to remove stagnant water from within the well casing so that samples collected are representative of the ground water at the sampling location. To purge the well, pump or bail to remove this stagnant water. Once the well contains fresh ground water, the well is considered to be stabilized and ready for sample collection.

Because wells recharge with water at different rates, the pumping rate and purging method must be adjusted to avoid conditions in the well which changes the ground water characteristics (for example, aeration). In order to determine the rate of purging which should be used, characterization of the formation recharge rate is needed. This information can be obtained from a variety of sources. If information to determine the recharge rate is not available, the appropriate pumping rate can be determined in the field. The Pumping and Sampling Rate Test Form in Appendix 5 can be used to determine the correct pumping rate. Instructions for completing this test are included on the back of the form.

This document contains methods for purging medium to high yield wells (wells which can be purged at rates between 100 - 200 ml/min) and Low Yield Wells (wells which cannot be purged at rates between 100 - 200 ml/min). See Section 3.4 for information on how to purge these two categories of wells.

## 2.9 Alternatives for Sample Collection

Ground water samples can be collected using pumps or bailers. Pumps **must** be used to collect samples when testing for volatile organic compounds, and are highly recommended for monitoring other parameters as well. This is because there is less chance for sample contamination when using pumps than there is when using bailers. If pumps are not available, Teflon or stainless steel bailers may be used. The use of any other devices for sample collection must be approved by the MPCA hydrogeologist prior to sampling. Note the type of pump or bailer that was used to sample each well on the Sampling Form.

### Sample Collection with a Pump

A two-inch submersible bladder or low flow variable speed submersible pump (e.g. Well Wizard or Grundfos Rediflo) shall be used as the default device for sample collection. Peristaltic pumps are also acceptable, except where trace metals and VOCs are monitored. In most cases, the pump intake setting should be approximately two feet from the top of the static water elevation. Record the approximate depth of the pump intake setting. Pump continuously, and sample immediately following purging using the same pump and the same purging rate for both procedures. If pumping is not continuous, note it on the Sampling Form.

### Sample Collection with a Bailer

Use a thoroughly decontaminated stainless steel or PTFE-coated bailer retrieval line when sampling for metals and semi-volatile organics. If rope is used for the bailer retrieval line, evaluate its potential to interfere with sample integrity. Do not reuse the rope. Follow these guidelines for optimal sample collection:

- Do not allow either the bailer or the retrieval line to touch dirty hands or gloves, the ground, a dirty ground cloth, or any other potentially contaminated surface during the purging or sampling process.
- Keep track of where the top of the water column is and make sure that the bailer enters the water column gently during both purging and sampling.
- Withdraw the bailer gently from the water column.
- Keep check valves clear of sediment and inspect to make sure they are operating effectively to minimize the amount of water that drips back into the well.
- Use the same device for purging and sampling. If this is not possible, regard at least the first two bails of sample water as rinse water and discard.
- When collecting a sample, raise the sample to the surface immediately. After surfacing from the water column, continue to raise the sample slowly and carefully.
- Transfer the sample from the bailer to the sample

vessel quickly while minimizing turbulence and exposure to the atmosphere.

- Use a bottom-emptying device that delivers water from the bottom of the bailer at an appropriately low rate that results in a controlled, non-turbulent flow.

## 3.0 FIELD PROTOCOL

This section describes procedures for sampling of monitoring wells in the field. Field decisions to make minor changes to this protocol can be made by the field crew leader. The project manager shall review field decisions at the end of the day to decide whether or not any wells need to be re-sampled. The project manager shall review any changes to the protocol that may adversely affect results.

Exceptions to this protocol shall be noted on the Ground Water Sampling Information Form and detailed in a report included with the Discharge Monitoring Report (DMR).

The report shall include:

- the reason for the exception
- the identification of all samples and individual parameters that may have been impacted either in terms of the quantitative or legal integrity of their reported values
- the significance of the potential impacts to the integrity of each parameter for each sample
- Significant changes to this protocol require approval obtained in advance from a MPCA hydrogeologist.

## 3.1 Sample Documentation

For each step in this section, one or more of the forms from Appendix 5:

- Ground Water Sampling Information Form (Sampling Form)
- Water-level Data Form
- Well Purging/Field Water Quality Measurements Form
- Purging and Sampling Rate Test Form

The Sampling Form, or another form containing the same information, shall be completed at each sampling point in the field. The other forms may be used as needed. All of the completed forms should be kept at the facility. Monitoring data required by the MPCA should be submitted on pre-printed forms supplied to each facility by the MPCA (for instance, DMRs). Monitoring data may also be submitted via Electronic Data Transfer.



each laboratory

- 6) an alias cross-reference list for QA/QC samples if needed

### **Sample Identification**

All primary and QA/QC samples collected at a given sampling point over a discrete interval of time shall be assigned the same sample event ID. This ID is used to link that set of containers together and associate them with all of the information contained on the Sampling Form or approved equivalent.

Label each sample container with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- ⇒ site name
- ⇒ unique container ID #
- ⇒ sample collection date
- ⇒ sample collection time
- ⇒ initials of person collecting sample
- ⇒ parameter names/groups to be analyzed
- ⇒ preservation method

Label containers at the sampling location and at the time of sample collection, with the following exceptions:

- Containers receiving preservatives in advance, “parameter names” and “preservation method” shall be entered onto labels by laboratory staff.
- Containers receiving preservatives in the field, “preservation method” shall be entered onto labels at the time individual containers are filled.

### **Field Sampling Log**

The leader of the field sampling crew shall keep a daily field log of sampling activities. This record or log shall supplement information entered on the Sampling Form. At a minimum, the log shall contain a record of the following items:

- 1) a list of field personnel present
- 2) field conditions as described below in Section 3.2, “Field Inspection”
- 3) a summary of how samples were transferred/transported to laboratories
- 4) a description of exceptions to this protocol, identifying which samples may have been impacted by the exceptions
- 5) for each well sampled:
  - the unique identifier used to label samples
  - the well name and Minnesota unique well number
  - the date and time of sampling
  - a list of primary and QA/QC samples sent to

## **3.2 STEP 1: Field Inspection**

*FORMS NEEDED: Ground Water Sampling Information Form*

Upon arrival at each monitoring well, inspect the well to verify that the annular seal is intact at the surface. Note missing parts, missing labels, missing locks, well damage, or signs of tampering. Note any relevant information regarding the general physical condition of the well, the surrounding soil and vegetation, or other objects in the immediate vicinity of the well. If you discover any condition that may interfere with obtaining representative analytical results, note the condition and rectify the situation if possible before sampling. Record any unusual condition, including the presence of wind-blown dust or odor in the ambient air.

The sampling summary must include information about any unusual field conditions that had a significant impact on the integrity of results. The field conditions report must include:

- air temperature
- wind speed and direction
- precipitation/moisture
- ambient odors
- airborne dust

Record field conditions on the Ground Water Sampling Information Form. Unlock the well and remove the inner riser cap to a clean storage spot.

## **3.3 STEP 2: Depth and Elevation Measurements**

*FORMS NEEDED: Water Level Data Form (optional) Ground Water Sampling Information Form*

Prior to any well evacuation or sampling, measure initial static water levels to the nearest 0.01 feet and record. This is done to facilitate selection of the proper pump intake depths for purging and sampling, and calculation of the ground water flow direction. We recommend use of an electronic water-level sensor that indicates, with a light or tone, when the sensor contacts water.

The depth to water shall be referenced to the measuring point marked at the top of the innermost well casing. Where a measuring point has not been marked at the top of the innermost casing, the measuring point shall be assumed

to be at the top of the north side of the innermost casing.

When reporting, the absolute water level elevation, not the depth to ground water must be submitted. This can be determined by subtracting the depth to ground water from the surveyed elevation of the inner most casing. Record the water level elevation on the Sampling Form. You may also use the Water Level Data Form to record these measurements.

During initial static water level measurement, measure the water level twice at each well. If there is poor agreement between the first and second static water level measurements (i.e., a difference of more than 0.01 feet), evaluate the data for measurement errors, unsuspected pumping that may have caused transient changes in gradient, or other factors that might have impacted the accuracy of the measurement. If the disagreement cannot be reconciled, take a third static water level measurement at the sampling point in question to assess the water level and verify non-steady state conditions.

Decontaminate water level probes with phosphate-free detergent and rinse twice with deionized water. Begin calibrating field water quality instruments according to manufacturer's instructions.

### 3.4 STEP 3: Well Purging And Stabilization

*FORMS NEEDED: Well Purging - Field Water Quality Measurements Form (optional)  
Ground Water Sampling Information Form  
Purging and Sampling Rate Test Form (optional)*

The first step in purging wells is determining one water column volume. Well depth information is necessary for this calculation. See Appendix 3 for procedures for calculating this value. The instructions on the back of the Well Purging and Sampling Rate Test Form describe how to select the correct purging rate for monitoring wells. Once you have determined whether you have a medium to high yield well, or a low yield well, select the correct purging method below. While the well is being purged, water quality parameters described above in Section 2.5 shall be monitored in a flow cell or container.

If previous sampling indicates the need, or if directed by an MPCA hydrogeologist, collect purge water from contaminated wells for disposal in accordance with Minnesota Rules 7048 and 7060.

### METHOD A. Medium to High Yield Wells (>100-200 ml/min.)

Wells that have recharge rates within this category shall be purged and sampled as described below. If you are sampling for volatile organics, you must use the Purging and Sampling Rate Test Form in Appendix 5 to determine an appropriate pumping rate. If you are not sampling for volatile organics, you may approximate the recharge rate of the aquifer and use that as your purging rate; that is, the well should NOT be "pumped dry". Purging must be conducted in a manner that removes "old" water in the well so it is replaced by fresh formation water.

Set equipment to remove water from a depth approximately two feet below the water surface.

Once pumping begins, vertical adjustment of the purging equipment intake should not be necessary because the pumping rate should approximate the aquifer yield. Collect samples for laboratory analysis only after:

(1) a minimum of three water column volumes has been purged, and (2) stabilization of field water-quality parameters has been demonstrated by meeting the target criteria defined below. If, after five or more water column volumes have been purged, field measurements have not stabilized, you may begin sample collection. Clearly document that stabilization has not been achieved on the Well Purging - Field Water Quality Measurements Form and in a report included with the DMR form.

Following is the purging and stabilization procedure for medium to high yield wells:

- 1) Determine the volume of water in one water column (see Appendix 3).
- 2) Set pump at approximately two feet below the water surface.
- 3) Begin purging. Remove one water column volume. Water should be pumped through a flow cell or placed in a clean container. Record the purging rate used. Avoid any significant amount of cascading or turbulence in the well.
- 4) Measure and record field water quality parameters after purging each water column volume or each partial water column volume, as applicable, to determine stabilization. The following target criteria for three consecutive measurements shall be used to define stabilization:
  - temperature +/- 0.1 degrees Celsius
  - specific conductance +/- 5%
  - pH +/- 0.1 units
- 5) Repeat steps 3 and 4 until the field water quality parameters are stable within the above tolerance limits. If field parameters do not stabilize after approximately five water column volumes, check operator procedures, equipment, and well construction information for potential problems.

- 6) The well is now ready for sampling. Sample immediately after purging. Well evacuation should be continuous between purging and sampling.

**METHOD B. Low Yield Wells with Recovery (Wells that cannot be stabilized at purge rates of 100-200 ml/min.)**

Normal purging may be impractical for a well installed in tight formation materials with an extremely slow recharge rate. In such a case, purge the well until it is nearly dry and allow it to partially recover one time before sampling. This may take up to a few hours. Sample the well as soon as possible after the evacuation. The pump intake setting may require adjustments during sampling in low recovery wells. Note the data and procedures clearly on the Sampling Form.

**3.5 STEP 4: Sample Collection**

*FORMS NEEDED:*

*Ground water Sampling Information Form*

Don protective gloves before collection of samples. Remember that field blanks, trip blanks and replicate samples are required for all sampling events, as described in Section 2.3.

**Sample Filtration**

Appendix 1 identifies which sample containers shall be filled with sample water that has been filtered in the field. Sample filtration shall be completed as follows:

- Flush the new filters with fresh sample water before collecting samples
- Connect the filter directly to the well sampling pump discharge line using positive pressure to force the sample through the filter. If a bailer is used, discharge the sample directly from the bailer into the filter apparatus
- From the filter, route the flow directly into the sample collection container
- Use a 0.45 micron pore size filter unless otherwise specified
- The flow rate shall not exceed 500 ml per minute.
- Minimize agitation and aeration of the sample
- Use Teflon tubing for the pump and filter discharge lines

**Filling Sample Containers**

Appendix 1 summarizes the sample container type, filling method, preservation method and holding time for each analytical parameter set. To clarify and supplement the

summary in Appendix 1, the manner in which containers shall be filled is described in Appendix 4.

Do not open individually prepared bottles until they are to be filled with water samples. Ensure that the sources of contamination listed in Section 2.3 are eliminated. Sampling personnel shall not touch the inside of sampling containers, bottle caps, or rim of sample containers. If contact occurs, replace sample containers.

At the well, field personnel shall label the bottles according to procedures described in Section 3.1. Use laboratory-prepared bottles to ensure quality control. Fill bottles with water to be analyzed in the following order (consult your permit for the parameters which are required for your facility):

- 1 major and minor ions
- 2 nitrogen (nitrate/nitrite, ammonia, Kjeldahl)
- 3 trace metals
- 4 volatile organics
- 5 semi-volatile organics
- 6 coliform bacteria
- 7 total organic carbon
- 8 total phosphorus
- 9 sulfide

Hold the sample water discharge point at the end of the tube as close to the sample container as possible without allowing the sample tubing to contact the container. At a minimum, sampling personnel should use their bodies to shield the sampling container from wind and airborne dust while filling. When strong winds, heavy rain, or dusty conditions are present, take additional precautions to avoid background interference, such as using a portable shelter at the well head.

At wells used for collecting QA/QC samples, those samples should be taken at this time. Refer to Section 2.3 for proper timing and filling of field method blanks, trip blanks, and replicate samples.

Do not rinse any sample bottles in the field or overfill sample bottles. Minimize turbulence during filling.

**3.6 STEP 5: Sample Preservation, Handling and Transport**

This section describes procedures that shall be followed between the time samples are collected and the time they are either shipped or delivered to an analytical laboratory.

**Sample Preservation**

Samples shall be preserved as described in Appendix 1. All chemical preservatives, added to containers in the

laboratory or field shall be produced and controlled within the laboratory's QA/QC program. Field supplies of preservatives and sample containers with pre-dosed preservatives shall be discarded and replaced according to the laboratory's schedule.

Keep all samples cool in the field by placing the samples in an insulated ice chest containing uncontaminated ice immediately after sample collection. Place the ice inside leak-proof plastic containers. Check the ice chest containing volatile organic compound samples for temperature and record. Record the temperature just before transporting samples and upon receipt at the laboratory to verify the sample temperatures.

### **Sample Handling And Transport**

All ice chests shipped shall be labeled, both inside and outside, with a complete address and return address. Keep the samples at approximately 4 degrees C during transport to laboratories. Before transporting samples, field personnel shall perform the following tasks:

- Verify that laboratory personnel shall be present to receive samples when they arrive.
- Check labeling and documentation to ensure sample identity shall be clear to laboratory personnel.
- Hand deliver or ship samples in a manner that ensures samples shall remain cool, about 4 degrees Celsius, until received by laboratory personnel.

### **3.7 STEP 6: Closing the Well**

After field record documentation is completed, the inner riser cap shall be replaced and the well shall be locked.

### **3.8 Reporting Sample Results to the MPCA**

Ground water sampling data shall be submitted to the Minnesota Pollution Control Agency on a DMR or other form provided by the Agency by the 21 st day of the month following sampling, unless otherwise specified in the MPCA permit. Include copies of the following with the form:

- Data sheets completed by the laboratory after analysis of the samples.
- If there are any deviations from this Sampling Protocol, any unusual conditions at the well (such

as odor or free matter in the water), or if stabilization of the well was not reached, then this information should be detailed in a report and included with (NOT attached to) the DMR.

In the future, electronic submission of data may be possible.

All other forms completed during sampling shall remain at the facility for a minimum of five years and made available upon request.

## **4.0 SUMMARY OF SAMPLING PROTOCOL**

This section is a general outline of the chain of events in the field. This section is for general reference only; samples must be taken in accordance with the detailed sampling protocol.

- 1) Inspect the well for damage, missing parts, labeling, and for evidence of tampering; document field conditions
- 2) Review equipment list; prepare area around well for sampling
- 3) Unlock well and remove inner riser cap to clean storage
- 4) Measure static water elevation; calculate water column volume
- 5) Calibrate equipment within specified operating limits; document
- 6) Document field work in the field log book and other appropriate forms such as the well purging form
- 7) Measure field parameters while simultaneously purging the well based on predetermined rates
- 8) Consult parameter list; adequately label sampling containers; don protective gloves
- 9) Collect the sample and field filter as appropriate, add preservatives as specified
- 10) Place the samples in a chilled shipment cooler
- 11) Prepare quality control samples, where applicable
- 12) Perform additional field analyses, if specified
- 13) Complete documentation for the well on sampling form
- 14) Replace inner riser cap and lock well
- 15) Decontaminate any reusable equipment and proceed to the next well
- 16) Initiate chain-of-custody controls, as requested by the individual laboratory
- 17) Ship the samples to the laboratory for analysis

**APPENDIX 1:  
Sample Containers, Filling Method, Preservation and Holding Times**

| <i>PARAMETER GROUP<sup>1</sup></i>   | <i>BOTTLE<sup>2</sup><br/>VOLUME/TY<br/>PE</i> | <i>FILL METHOD<sup>3</sup></i>      | <i>PRESERVATION</i>                            | <i>HOLDING<br/>TIME</i>               |
|--|--|-------------------------------------|--|---------------------------------------|
| MAJOR & MINOR IONS   | 1L P   | No head space                       | Cool   | 28 days                               |
| NITROGEN SERIES  | 250 ml P                                       | Leave head space                    | H <sub>2</sub> SO <sub>4</sub> /pH<2 Lab, Cool | 28 days                               |
| CYANIDE  | 500 ml P                                       | Leave head space                    | NaOH/pH>12 Lab, Cool                           | 14 days                               |
| TRACE METALS (unfiltered)<br>(mercury)   | 500 ml P                                       | Leave head space                    | HNO <sub>3</sub> /pH<2 Lab, Cool               | 6 months<br>28 days                   |
| TRACE METALS (filtered)<br><br>(mercury)   | 500 ml P                                       | Filter 0.45 micron No<br>head space | HNO <sub>3</sub> /pH<2 Lab, Cool               | 6 months<br><br>28 days               |
| CHROMIUM VI (unfiltered)   | 125 ml P                                       | No head space                       | Cool   | 24 hours                              |
| CHROMIUM VI (filtered)   | 125 ml P                                       | Filter 0.45 micron No<br>head space | Cool   | 24 hours                              |
| MISCELLANEOUS  | 1 L P  | No head space                       | Cool   |                                       |
| TDS and TSS  |  |                                     |  | 7 days                                |
| specific conductance-lab   |  |                                     |  | 28 days                               |
| VOLATILE ORGANICS  | 3 x 40 ml P &<br>T                             | Positive meniscus                   | HCl/pH<2 Field, Cool                           | 14 days to<br>analysis                |
| purgeable halocarbons<br>purgeable aromatics non-<br>halogenated volatiles   |  |                                     |  |                                       |
| NON-VOLATILE ORGANICS  | 2 x 1L AG                                      | No head space                       | Cool   | 7 days/extraction<br>40 days/analysis |
| base-neutral/acid extractable<br>organics phthalate esters<br>phenols polynuclear aromatic<br>hydrocarbons chlorinated<br>herbicides organochlorinated<br>pesticides & PCBs<br>organophosphorus pesticide<br>acid herbicides carbamate<br>pesticides |  |                                     |  |                                       |
| DIOXINS AND DIBENZO<br>FURANS  | 1L AG  | No head space                       | Cool   | 7 days/extraction<br>40 days/analysis |

**Table 1: Sample Containers, Filling Method, Preservation and Holding Times**  
(continued)

| <i>PARAMETER<sup>1</sup></i>       | <i>BOTTLE<sup>2</sup><br/>VOLUME/TYPE</i> | <i>FILL METHOD<sup>3</sup> Leave<br/>head space</i> | <i>PRESERVATION<br/>Cool</i>  | <i>HOLDING TIME 6<br/>hours</i> |
|------------------------------------|---|---|---|---------------------------------|
| TOTAL COLIFORM BACTERIA            | 125 ml P                                  |   |   |                                 |
| TOTAL ORGANIC CARBON               | 1 L G                                     | Leave head space                                    | H <sub>2</sub> SO <sub>4</sub> /pH<2 Lab,<br>Cool   | 48 hours                        |
| TOTAL PHOSPHORUS                   | 125 ml P                                  | Leave head space                                    | H <sub>2</sub> SO <sub>4</sub> /pH<2 Lab,<br>Cool   | 28 days                         |
| SULFIDE                            | 250 ml P                                  | Leave head space                                    | Zn(C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> ) <sub>2</sub> *2H <sub>2</sub> O<br>& NaOH/pH>9<br>Lab, Cool | 7 days                          |
| RADIUM, GROSS ALPHA,<br>GROSS BETA | 1 Gallon P                                | Leave head space                                    | HNO <sub>3</sub> /pH<2 Lab  | 6 months                        |

**(1) PARAMETER NAMES/GROUPS**

Some of these parameter names actually represent groups of individual analytes.

**(2) BOTTLE TYPE**

L: liters;  
 ml: milliliters;  
 P: polyethylene;  
 P & T: 40 ml purge and trap vial fitted with a Teflon® septum;  
 G: glass bottle fitted with Teflon®-lined cap  
 GG: glass bottle fitted with glass stopper  
 AG: amber glass bottle fitted with Teflon®-lined cap

**(3) FILL METHOD**

Positive meniscus: fill container completely with zero head space resulting in a positive meniscus with no air bubbles in container, add acid and cap container quickly;  
 No head space: fill container completely; container shall not be rinsed; overfilling shall be minimized.  
 Leave head space: fill container about 90 to 95 % full - do not allow preservative (if present) to be diluted by overfilling container  
 Fill from bottom : fill container completely from the bottom of container using tubing; allow several bottle-volumes of water to overflow before sealing bottle  
 Filter 0.45 micron: filter in-line with positive pressure through a filter with 0.45 micron pore size.

**(4) PRESERVATION**

Cool: place container inside sealed Zip-Lock bag; place in cooler with sufficient ice to quickly bring temperature down to 4 degrees C and hold at approximately 4 degrees C until received by laboratory personnel  
 HNO<sub>3</sub>/pH<2: add a predetermined amount of high-purity HNO<sub>3</sub> to sample to bring the sample pH down to 2 or less;  
 HCl/pH<2: add a predetermined amount of high-purity HCl to sample to bring the sample pH down to 2 or below;  
 NaOH/pH>12: add a predetermined amount of high-purity NaOH to sample to bring the sample pH up to 12 or above;  
 (for Cyanide, use 50% NaOH solution and add ascorbic acid if oxidizing agents are present)  
 Zn(C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>\*2H<sub>2</sub>O: predetermined amount added by laboratory staff to prevent oxidation of sulfide  
 Field: preservative added in the field by field personnel  
 Lab: preservative added to container in laboratory before going into the field

## **APPENDIX 2: FLOW CELLS**

A flow cell has the following characteristics:

- Air tight fittings for installation of all probes.
- Intake is connected directly to the pump discharge line.
- Resides in a water bath kept at a temperature close to the in-situ ground water temperature.
- A discharge line approximately 3 feet long that is connected to the flow cell with an air tight connection.
- A maximum volume of no greater than five times the per minute volumetric rate of inflow to the cell to maintain measurement sensitivity to temporal changes in water quality.
- A minimum volume of 500 ml to provide enough thermal mass to minimize external temperature effects.
- The flow cell and lines shall be shielded from strong winds and from direct sunlight.

### APPENDIX 3: CALCULATING THE WATER COLUMN VOLUME

One water column volume is defined as the amount of water in the well initially, prior to purging. This is equal to the volume of a cylinder with a height (h) inside the well and a diameter (d) equal to the diameter of the well casing and can be calculated as follows:

$$\text{Volume} = \pi \cdot (d/2)^2 \cdot h \cdot 7.48$$

Where:

$$\pi = 3.14$$

d = diameter of well in feet

h = height of water column from bottom of well in feet

7.48 = gallons/cubic foot

Volume = one water column volume in gallons



## APPENDIX 4: PROPER FILLING OF SAMPLE CONTAINERS

**Major and Minor Ions:** Sample containers used for analysis of major and minor ions shall be filled completely with unfiltered sample water.

**Nitrogen Series:** Sample containers for nitrate/nitrite, ammonia and Kjeldahl analyses shall be prepared in advance by the laboratories with H<sub>2</sub>SO<sub>4</sub> as a preservative, if required. [Consult your specific laboratory for its preferred method of nitrogen sample collection.] The containers shall be filled approximately 95% full (up to the neck) with unfiltered water.

**Trace Metals:** Sample containers for general ions and metals analysis shall be prepared in advance by the laboratories with HNO<sub>3</sub> as a preservative. This shall insure that samples shall be acidified as soon as they are collected. Containers shall be filled approximately 95% full.

The sample bottles for dissolved metals analysis shall be clearly labeled as “filtered.” Sample water shall be filtered through a 0.45 micron pore size filter unit before filling the laboratory prepared bottle. New filters shall be used for each sample. Samples shall be collected in a manner that minimizes turbulence and aeration, and then acidified immediately as described above. Plastic containers shall be used for sample collection. The acid shall be produced/controlled within the applicable QA/QC program to ensure that it is pure enough (e.g. Ultrex, or pure acid diluted with triply distilled water) with regard to metals to avoid a false positive analytical result.

**Volatile Organics:** The use of bailers for VOC sampling is strongly discouraged. The 40-ml purge and trap vials shall be filled in a manner that minimizes turbulence, entrapment of air and overfilling. They shall not be rinsed in the field but shall be completely filled in a manner that leaves a positive meniscus at the top of the vial

Hydrochloric acid prepared specifically for volatile organics analysis by the laboratory shall be used to preserve samples. The acid may be added to vials at the laboratory in advance of sampling, with extra caution exercised to minimize overfilling in the field. Alternatively, the acid may be added immediately after filling the vials in the field. Field personnel shall add the number of drops specified by the laboratory to bring the pH to less than or equal to pH = 2, and immediately cap the vials.

**Semi-Volatile Organics:** As defined here, semi-volatile organics include the following sets of parameters: base- neutral/acid extractable organics, phthalate esters, polychlorinated biphenyls (PCBs), phenols, polynuclear aromatic hydrocarbons, chlorinated herbicides, organochlorinated pesticides and PCBs, and organophosphorus pesticides. Containers shall be filled completely.

**General Parameters:** The sample containers for laboratory analysis of general parameters: anions, total dissolved solids, total suspended solids and alkalinity. The containers shall be filled completely and capped promptly.

**Coliform Bacteria:** Unfiltered sample water for coliform bacteria shall be collected in laboratory-supplied sterilized and pre-treated plastic containers. The containers shall be partially filled, leaving a one-inch head space. Nothing but atmospheric air and sample water should touch the inside and rim of the container or the inside and rim of the cap.

**Total Organic Carbon and Total Phosphorus:** Sample containers for TOC analyses are prepared with H<sub>2</sub>SO<sub>4</sub> by the laboratory and shall be filled to about 95% capacity.

## APPENDIX 5: EXAMPLE FORMS

### Forms listed below are available at

<http://www.pca.state.mn.us/water/groundwater/sampleguide.html#part1>

- 1) **Ground Water Sampling Information Form (also referred to as “Sampling Form”)**. This form shall be used to record all field activities, including:
  - General Information
  - Sampling Station (Well) Details
  - Purging Information
  - Field Water-Quality Measurements and Observations
  - Sample Collection Information
- 2) **Water Level Data Form**. This form shall be used to record the water level in the well before purging, as detailed in Section 3.3 of this document.
- 3) **Well Purging - Field Water Quality Measurements Form**. This form shall be used to record the field water quality measurements during purging, as detailed in Section 2.5 and 3.4 of this document.
- 4) **Purging and Sampling Rate Test Form**. This form *may* be used during tests to determine what is an appropriate purging rate for a given well. The object of testing is to find a pumping rate that is:
  - high enough to complete purging and sampling in a reasonable length of time
  - low enough to not bring the water level below the top of the open (screened) interval
  - low enough to not cause so much drawdown that significant cascading (and associated aeration and turbulence) occurs

# GROUND WATER SAMPLING INFORMATION FORM\*

Sheet      of       
Side 1 of 2\*

## General Information

|                                     |  |
|-------------------------------------|--|
| Location (Site/Facility Name) _____ | Sampling Point (common name) _____       |
| Project Name/# _____                | Type (mon. well, spring, etc.) _____     |
| Field Personnel _____               | Field Sample (Event) ID#* _____          |
| Sampling Organization _____         | Facility ID (for IGWIS data entry) _____ |
| Weather  ? _____                    | Station ID (for IGWIS data entry) _____  |

## Sampling Station (Well) Details

Read from left to right

|   |   |  |  |
|---|---|--|--|
| Well Depth (ft. below MP) _____                                     | Casing Diameter (inches) _____                              | Open Interval (depth below GS)  _____          | <small>top -- bottom</small><br>-<br>(0.1 ft.) |
| Static Depth to Water (below MP) _____<br><small>(0.01 ft.)</small> | Static DTW (ft. below GS) _____<br><small>(0.1 ft.)</small> | Date _____                                     | Time _____                                     |
| Water Column Length (L) (ft.) _____                                 | One WC Volume (cu. ft.) _____                               | One WC Volume (gals) _____                     |  |
| Condition: Securely Locked? <u>Y or N</u>                           | Station (Well) Damaged? <u>Y or N</u>                       | Surface Contamination (visible)? <u>Y or N</u> |  |

## Purging

Read from left to right

|  |  |  |  |
|--|--|--|--|
| PID/FID Reading @ Wellhead* _____            | Concentration _____ ppm                  | Background Conc. _____ ppm                       |  |
| Free Product (circle: LNAPL or DNAPL)* _____ | Detected/Sampled? <u>Y or N / Y or N</u> | Appearance  _____                                |  |
| Well Purging Equipment _____                 | Pump, bailer? _____                      | Type* _____                                      |  |
| Purging Date/Time _____                      | Start  _____ / _____                     | Finish  _____ / _____                            |  |
| Pump/Bailer Intake Set at _____              | Feet below MP _____                      | Avg. Purge Rate _____ gpm                        |  |
| Amt. Purged before Sampling _____            | Gals./WC Volumes _____ / _____           | Purge Protocol of _____ WCV's met? <u>Y or N</u> |  |

## Field Water-Quality Measurements and Observations

|   |   |
|---|---|
| Date/Time Measurements Began _____ / _____  | Purge Rate for Measurements (gpm) _____ |
| Submersible Pump with direct line to Flow Cell used for all Field Water Quality Measurements? _____                       | <u>Y or N</u>                           |
| All Field Measurement Instruments Calibrated according to Protocol? _____   | <u>Y or N</u>                           |
| All Field Water Quality Parameters Stabilized according to Protocol Criteria just before filling sample containers? _____ | <u>Y or N</u>                           |
| The Measurements below Represent: (1) stabilization, (2) sample water collected, (3) both 1 and 2, (4) other*: _____      |   |
| Sample Appearance:  _____   | Odor: _____                             |

| Field Measurement       | Value          | Time (24 hour) | Comments*                       |
|-------------------------|----------------|----------------|---------------------------------|
| Temperature             | ° C            |                |                                 |
| Electrical Conductivity | µMhos/cm       |                | = meter reading x magnitude x k |
| Specific Conductance    | µMhos/cm       |                | EC corrected to 25 ° C          |
| pH                      | Standard Units |                |                                 |
| Dissolved Oxygen        | mg/l           |                |                                 |
| Eh                      | mV             |                |                                 |
| Turbidity               | NTU            |                |                                 |
|                         |                |                |                                 |

## Sample Collection

|  |  |
|--|--|
| Sampling Device (type of pump/bailer)* _____       | Sample Medium (well water, LNAPL, etc.)* _____                               |
| Permanently Installed Pump? <u>Y or N</u>          | Dedicated Equipment? <u>Y or N</u> Used Same Equip. for Purge? <u>Y or N</u> |
| Pump Intake/Bailer Set at (ft. below MP) _____     | Interval Samples Represent (ft. below GS) Top = _____ / Bottom = _____       |
| Date/Time Sampling Began _____                     | Date/Time Sampling Finished _____  |
| Depth to Water (ft. below MP) _____                | Depth to Water (ft. below MP) _____  |
| QC Samples Collected? <u>Y or N</u> (see reverse*) | Sample Withdrawal Rate _____ gpm   |

**All Field Protocols were followed with no exceptions (Y, N); Enter Protocol Codes\* 1. \_\_\_\_\_ 2. \_\_\_\_\_**

Remarks (1)\* (include protocol exceptions) \_\_\_\_\_

Form Completed by \_\_\_\_\_ (sign in ink) Date \_\_\_\_\_

\* Side 2 of this form contains definitions of abbreviations, protocol codes, additional room for equipment specification, QC sample description and other comments

Form GWS #4  
Revised 1-12-95



**GROUND WATER SAMPLING INFORMATION FORM\***  
(Reverse side)

Sheet \_\_\_\_\_ of \_\_\_\_\_  
Side 2 of 2

**ABBREVIATIONS**

|     |                             |       |  |         |   |
|-----|-----------------------------|-------|--|---------|---|
| ft. | feet                        | MP    | Measuring Point                          | GS      | Ground Surface                          |
| DTW | Depth to Water              | WC    | Water Column                             | cu. ft. | cubic feet                              |
| Y   | Yes (circle if appropriate) | N     | No (circle if appropriate)               | gals    | gallons                                 |
| PID | Photo Ionization detector   | FID   | Flame Ionization detector                | ppm     | parts per million                       |
| gpm | gallons per minute          | Amt.  | amount                                   | k       | cell constant                           |
| EC  | Electrical Conductivity     | LNAPL | light non-aqueous phase liquid (floater) | DNAPL   | dense non-aqueous phase liquid (sinker) |

**GENERAL INFORMATION**

The "Field Sample (Event) ID#" should be constructed from the date and time that the first sample container of a purposefully associated set of sample containers is filled. This set of samples would normally be collected very closely together in time and include containers for a number of analytical parameters and QC samples. QC samples are normally assigned temporary aliases (see below) For example, if the first of a set of containers is filled at 1:30 PM on December 19, 1992, the Field Sample Event ID# for all containers in the set should be 9212191330.

**WELL INFORMATION**

The water column length (L) is calculated by subtracting the depth to water (DTW) from the well depth.  $L = \text{well depth} - \text{DTW}$ . However, both of these distances must be referenced to the same datum: either from the measuring point (MP) or from ground surface (GS). This form was designed with the assumption that both the well depth and static water level values are referenced to the MP.

For convenience, a blank was included to also enter depth to water below GS in case the well depth referenced to the MP is unknown or cannot be measured directly. In addition, this value will indicate where the static water level is relative to the open (screened) interval which is referenced to GS. For the calculation of L in this case, the "stick up", the distance from the MP to GS, needs to be looked up or measured in the field. If the MP is above GS, then the stick up is a positive number for this calculation. Enter the stick up distance here \_\_\_\_\_ ft. (to the nearest 0.1 ft.).  $\text{DTW (from GS)} = \text{DTW (from MP)} - \text{stick up}$ ;  $L = \text{well depth (from GS)} - \text{DTW (from GS)}$ .

One water column volume =  $\pi r^2 L$ . The units conversion from cubic feet to gallons is as follows:  $\pi r^2 [\text{ft.}^2] L [\text{ft.}] [7.48 \text{ gallons/ft}^3]$ .  $r = \text{well radius in feet}$  (since well specifications are normally given as diameter in inches, the diameter must be converted from inches to feet and then divided by one-half to yield  $r$ , in feet). Examples of well diameter/gallons per ft. of WC: 1"/0.041 gals; 2"/0.163; 4"/0.653; 6"/1.47; 8"/2.61.

**PURGING**

Measure the concentration of organic vapors inside the well immediately after removing the wellhead cap. On the front side of this form, circle whether a PID or a FID was used, then enter wellhead and ambient background readings. Here specify the calibration gas \_\_\_\_\_, lamp voltage \_\_\_\_\_ make & model # of the instrument here \_\_\_\_\_. If free product was detected, describe appearance, thickness, etc. (free product samples collected? { Y , N }): \_\_\_\_\_. Supplemental description of purging equipment: \_\_\_\_\_.

**FIELD WATER QUALITY MEASUREMENTS AND OBSERVATIONS**

If a flow cell was not used, describe how measurements were taken (note whether or not measurements were taken down hole): \_\_\_\_\_  
Other Comments and Observations \_\_\_\_\_.

**SAMPLE COLLECTION**

Sampling equipment details (Mfgr., Model#, tubing, etc.): \_\_\_\_\_.

**Quality Control Samples**

Fictional sampling point name(s) and field sample event ID#(s) (aliases) can be used for QC samples on sample labels and chain of custody sheets to distinguish them from primary samples without tipping off laboratories. List aliases here to document their association with primary sample identifiers on front side of sheet. Name(s)/ID#(s) \_\_\_\_\_.  
Indicate total # of QC samples collected: Replicates \_\_\_\_\_ Splits \_\_\_\_\_ Trip blanks \_\_\_\_\_ Field ambient air blanks \_\_\_\_\_ Field methods blanks \_\_\_\_\_.

**Protocol codes: 1.**

Indicate the type of sampling protocol followed by selecting from codes (A-F) below and entering it on the front of this form. Specify the name of the agency \_\_\_\_\_ and the name of the agency program \_\_\_\_\_ that approved the protocol. If none, write "none."  
A) A slightly modified agency program standard sampling protocol, approved as a site-specific protocol  
B) An unmodified or slightly modified agency program standard sampling protocol, approved as a non site-specific protocol  
C) A non site-specific protocol approved by an agency  
D) A detailed but non agency-approved, site-specific sampling protocol with adequate QA/QC procedures was followed;  
E) A detailed but non agency-approved sampling protocol without adequate QA/QC procedures was followed;  
F) None of the above protocol conditions were known to be met (comment): \_\_\_\_\_.

**Protocol codes: 2**

A) Sampling observed by \_\_\_\_\_ (agency) to meet all field protocols except as noted below: (agency signature) \_\_\_\_\_;  
B) Sampling observed by "neutral" observer (signature) \_\_\_\_\_ approved by \_\_\_\_\_ (agency) to meet all field protocols except as noted below; (list the agency that approved observer)  
C) Neither A or B applies (comment): \_\_\_\_\_.

**PROTOCOL EXCEPTIONS**

List/discuss protocol exceptions for sampling-related field work (attach additional sheets if necessary): \_\_\_\_\_

**OTHER REMARKS(2)**

\_\_\_\_\_  
\_\_\_\_\_

Form GWS #4R

\* Other forms normally used to support this form include GWS #1 for Purging & WQ Measurements, GWS #3 for Sample ID/Chain of Custody, GWS#4 for Water Levels. Revised 09-07-94





## WATER LEVEL DATA FORM

(reverse side)

**Abbreviations:** DTW = Depth to Water, MP = Measuring Point, IGWIS = Integrated Ground Water Information System

**Guidance**

Use the codes listed below for data entry in the applicable columns on the front side of this form.

Note that this form is designed for field data entry only. Furthermore, it is designed for a single 24-hour period. It is not intended for calculation of water level elevations, use as a historical water level data base, etc. Therefore, it has been assumed that information such as measuring point description, measuring point elevation and historical data is recorded elsewhere (e.g., an historical water level data base). However, this form can be customized to your needs by making use of the "user defined field" column, and using the comment column for entry of one or more additional custom fields.

The column headings "hold" and "cut" are intended to receive the two measurements required to determine the depth to water below the MP. These terms come from the metal tape measuring technique. The same terms can also work for other techniques. For example, for an electric sounder, "hold" could be the value of the first demarcation label on the sounding wire above the measuring point. "Cut" could be the distance along the wire from the actual measurement point to the "hold" point (label). The distance from the MP to the top of the water column would then be hold minus cut. The user may want to write in different column headings or take the measurement differently, but caution is in order to ensure that the subtraction is done correctly.

**Measurement Qualifiers**

| <u>Parameter Fields</u>                   | <u>Code</u>   | <u>Code Description</u>  |                    |
|---|---------------|--|--------------------|
| Static Water Level                        | Y             | Assumed to be static   |                    |
|   | N             | Known to not be static   |                    |
|   | U             | Status unknown   |                    |
| Conditions (up to 2 codes can be entered) | A             | Artesian   |                    |
|   | D             | Dry  |                    |
|   | F             | Free Product   |                    |
|   | Z             | Frozen   |                    |
|   | B             | Obstruction  |                    |
|   | P             | Pumped   |                    |
|   | S             | Surface Water Effect   |                    |
|   | O             | Other (specify in Station Remarks)                             |                    |
|   | Method/Device | A  | Airline            |
|   |               | C  | Calibrated Airline |
| D   |               | Pressure (Electrical) Transducer                               |                    |
| E   |               | Estimated  |                    |
| G   |               | Pressure Gauge   |                    |
| H   |               | Calibrated Pressure Gauge                                      |                    |
| L   |               | Geophysical Log  |                    |
| M   |               | Manometer  |                    |
| P   |               | Popper   |                    |
| S   |               | Steel Tape (chalk)   |                    |
| T   |               | Electric Tape  |                    |
| U   |               | Acoustic Water Level Sounder                                   |                    |
| V   |               | Calibrated Electric Tape                                       |                    |
| Measuring Point Verification              | O             | Other (specify in Station Remarks)                             |                    |
|   | U             | Unknown  |                    |
|   | G             | From Ground Surface  |                    |
|   | S             | From Measuring Point Scribed                                   |                    |
|   | P             | From Measuring Point - Top of Protective Casing (outer casing) |                    |
|   | W             | From Measuring Point - Top of Well Casing (inner casing)       |                    |

**Discussion of Protocol Exceptions:** \_\_\_\_\_

**Other Comments:** \_\_\_\_\_





# WELL PURGING - FIELD WATER QUALITY MEASUREMENTS FORM

(Reverse Side)

Location (Site/Facility Name) \_\_\_\_\_  
 Project Name/# \_\_\_\_\_  
 Sampling Point (common name) \_\_\_\_\_

| CALIBRATION          | Temp. (°C) | Electrical Conductivity (µMhos/cm) | Specific Conductance (µMhos/cm) | pH | Eh (mv) | DO (mg/l) | Turbidity (NTU) | GUIDANCE REMARKS  | Comments |
|----------------------|------------|------------------------------------|---------------------------------|----|---------|-----------|-----------------|---|----------|
| DATE                 |            |                                    |                                 |    |         |           |                 |   |          |
| TIME (24 hour clock) |            |                                    |                                 |    |         |           |                 |   |          |
| TYPE OF CALIBRATION  |            |                                    |                                 |    |         |           |                 | e.g., standard KCL solution, Zobels solution, in air/water, etc.  |          |
| LIST 1ST STANDARD    |            |                                    |                                 |    |         |           |                 | e.g., pH = 7.02 @ 25 °C<br>KCL solution = 1000 µMhos/cm           |          |
| INSTRUMENT READING   |            |                                    |                                 |    |         |           |                 | actual reading from instrument                                    |          |
| CALIBRATED TO +/-?   |            |                                    |                                 |    |         |           |                 | difference between calibrated instrument display and standard     |          |
| LIST 2ND STANDARD    |            |                                    |                                 |    |         |           |                 | e.g., repeat calibration with 2nd buffer or by alternate method   |          |
| INSTRUMENT READING   |            |                                    |                                 |    |         |           |                 | "   |          |
| CALIBRATED TO +/-?   |            |                                    |                                 |    |         |           |                 |   |          |
| CORRECTION FACTOR    |            |                                    |                                 |    |         |           |                 | e.g., cell constant, "k"  |          |
| CALIB. SUCCESSFUL?   |            |                                    |                                 |    |         |           |                 | Enter YES or NO   |          |
| SATISFIES PROTOCOL?  |            |                                    |                                 |    |         |           |                 | Did calibration meet criteria in the sampling protocol ? (Y or N) |          |
| CALIBRATION BY       |            |                                    |                                 |    |         |           |                 | Signature or Initials   |          |
| INSTRUMENT ID#       |            |                                    |                                 |    |         |           |                 | serial # or other ID #  |          |
| LOCATION             |            |                                    |                                 |    |         |           |                 | specify "field", "lab", "office", etc.                            |          |

Well Purging Equipment (more details): \_\_\_\_\_

List/Describe Field Instruments: \_\_\_\_\_

Discussion of Protocol Exceptions: \_\_\_\_\_

Other Comments: \_\_\_\_\_

Form completed by \_\_\_\_\_ Date \_\_\_\_\_







# PURGING AND SAMPLING RATE TEST FORM

(reverse side)

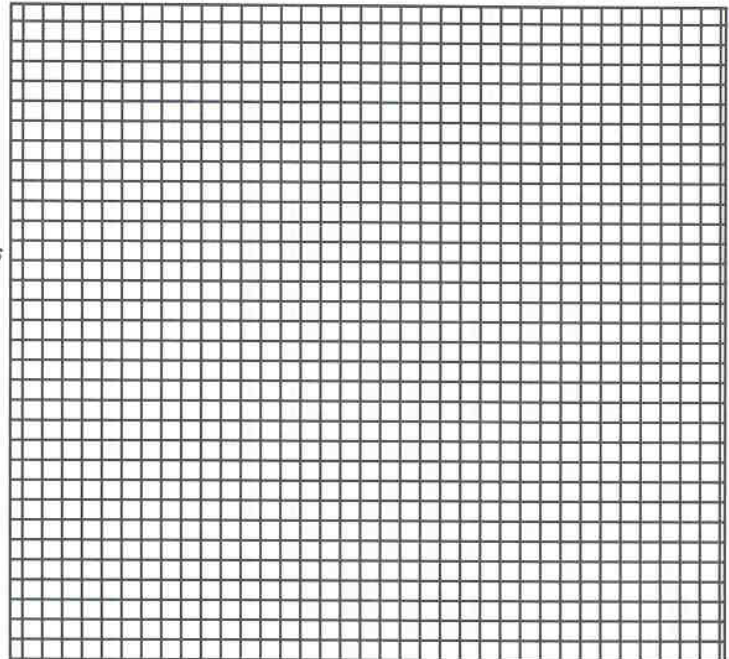
## ABBREVIATIONS

MP = Measuring Point  
GS = Ground Surface  
DTW = Depth to Water  
 $s$  = drawdown  
 $s^1$  = residual drawdown  
gals. = gallons  
WC = water column  
Q = Pumping Rate

## WATER COLUMN VOLUME

| Well Diameter | Gallons per ft. of WC |
|---------------|-----------------------|
| 1"            | 0.041                 |
| 2"            | 0.163                 |
| 4"            | 0.653                 |
| 6"            | 1.47                  |
| 8"            | 2.61                  |

Q/s



Q (gpm)

## OBJECT OF EQUILIBRIUM PUMPING RATE TEST

The object of the test is to find a pumping rate that is

- (1) high enough to complete purging and sampling in a reasonable length of time; and
- (2)a. low enough to not bring the water level below the top of the open (screened) interval if applicable; or
- (2)b. low enough to not cause so much drawdown that significant cascading (and associated aeration and turbulence) occurs

note: sampling protocol criteria may specify a maximum pumping and sampling rate lower than that determined in (2).

## HOW TO PERFORM THE TEST

The following procedure is based on the assumption that the typical sampling event can be completed by purging about 5 water column volumes and then filling sample containers while pumping no more than 5 additional water-column volumes.

Several trial pumping rates should be tested. Start with a very low rate. Pump at this rate until ten water-column volumes have been pumped and then record the maximum drawdown for the trial. In addition to the final drawdown for each trial, it may be useful to record intermediary drawdown values such as at 3, 5, and 7 water-column volumes. These data will help in understanding the well's response to pumping. On side 1 of this sheet, fill in all of the columns that have a "√" at the top. Ideally, you will wait for nearly full recovery to static water level between trials. Increase the pumping rate for each consecutive trial and plot the data (using the above graph) until an informed choice can be made regarding purging and sampling rates. Guidance is given below.

One Water Column Volume =  $\pi r^2 L$ ;  $\pi r^2$  [ft. <sup>2</sup>] L [ft.] [7.48 gallons/ft. <sup>3</sup>] = gallons per water column volume

L = height of water column = depth of well minus depth to static water level measured from the same datum; r = well radius in feet.

## GUIDANCE

For your convenience, the form on the front side of this sheet is designed to allow recording of more information than needed for the objectives given above (see "Other Uses", below). Note that the balance of current researchers and guidance documents recommend that both purging and sampling rates should be very low when sampling for sensitive parameters such as volatile organics or trace metals. According to some authors, the "ideal" rate is 100 to 500 ml/minute when sampling for sensitive parameters. Although these rates may seem impractical for various scenarios, the negative impacts of higher pumping rates on data quality should be considered before exceeding the 500 ml/min. value. In any case, it is recommended that cascading be minimized by not exceeding rates determined by this test.

For each trial, enter a point for Q/s vs. Q and one for s vs. Q. (using two different symbol types) on the above graph. The plot of specific capacity (Q/s) versus Q may show a decreasing specific capacity with greater Q values. A sharp decrease in Q/s probably indicates that turbulent flow to the well has increased significantly compared to lower pumping rates. This is a key indicator to stay below that rate while purging or sampling. On the s versus Q graph, draw a horizontal line that represents the top of the screen or whatever depth you preliminarily choose to keep the pumping level above. As you plot the s and Q data, it will then be immediately apparent when you reach a pumping rate that will exceed the ideal maximum drawdown. After plotting data from an adequate number of trials, fill in the blanks in the two large rectangles at the bottom of side 1 of this sheet.

## OTHER USES OF THIS FORM

Note the columns that are labeled "optional" in the first (very narrow) row. These columns can be used along with the other columns for a short-term, single well constant-rate pumping (and/or recovery) test. Alternatively, they can be used for a slug test. Note that a true static water level is needed to begin these tests as residual drawdown from earlier testing is difficult to factor into the analysis. Slug tests are most appropriate for roughly estimating permeability in the immediate vicinity of the tested well. They are not generally considered reliable for assessing transmissivity or storativity. Single well pumping tests also have significant limitations, especially where storativity values are needed. It is essential to know factors such as % of aquifer thickness screened and whether the aquifer is confined, unconfined, leaky, etc., to determine what type of analytical method is appropriate. The reader is encouraged to consult reference materials on these subjects.