Water Quality & Hydrology Group

PROCEDURE TRAVELER

This form is from RRES/WQH-QP-023

Part 1 (completed by any group employee)

Procedure number: RRES-WQH-HCP-049 Revision: 0

Procedure title: **Groundwater Sampling Using Submersible Pumps**

Action Requested: ☒ New procedure ☐ Major revision of existing procedure ☐ Deletion of existing procedure

Description of and reason for action: ☐ Quick-change revision of existing procedure (parts 3 and 5 N/A)

Signature	Jeff Walterscheid	7/21/04
	Name (print)	Date

Part 2 (completed by appropriate manager)

I agree with the action requested: ☐ Yes ☐ No If No, enter reasons below.

If Yes, assigned preparer: Jeff Walterscheid. Affected teams, programs, groups, or individuals required to review this procedure and others who should review it (see procedure page 5):

Required reviewers: Optional reviewers:

Jeff Walterscheid
Mike Alexander
Steve Rae

Signature	Mike Alexander	7/22/04
	Name (print)	Date

Part 3 (completed by preparer or other qualified safety reviewer)

I have evaluated, according to RRES/WQH-QP-023 and LIR300-00-01.0, the risks inherent in performing this procedure and have documented them on the Hazard Control Plan form, or referred to a plan that covers this type of work.

Preparer	Mike Alexander	7/22/04
	Name (print)	Date

Draft prepared and sent for formal review on: 3/19/04. Comments resolved on: 03/23/04. After comments have been resolved with each reviewer, obtain signatures of the reviewers in part 5.

Part 4 (signed by safety officer or group leader)

I agree that the appropriate safety-related activities and appropriate risk level were identified during the hazard evaluation.

Safety officer or group leader	Steve Rae	July 21, 2004
	Name (print)	Date

Part 5 (signed by required reviewers: NA for quick-change revisions)

I attest that all my comments and concerns have been satisfactorily discussed, resolved, and/or incorporated into the final version of the procedure.

Signature	Jeff Walterscheid	7/21/04
	Name (print)	Date
Signature	Mike Alexander	7/22/04
	Name (print)	Date
Signature	Steve Rae, Group Leader	July 21, 2004
	Name (print)	Date
Signature	Name (print)	Date

Preparer: After all reviewers have signed above section, submit this form with copy of draft and final procedure to records coordinator.

GROUNDWATER SAMPLING USING SUBMERSIBLE PUMPS

Purpose

This RRES Water Quality and Hydrology Group (RRES-WQH) procedure describes the process for collecting, documenting, and submitting groundwater samples that are collected from wells using submersible pumps.

Scope

This procedure applies to the RRES-WQH staff, contractors, and students assigned to collect groundwater samples from wells using submersible pumps.

In this procedure

This procedure addresses the following major topics:

Hazard Control Plan

The hazard evaluation associated with this work is documented in RRES-WQH-SOP-002, Attachment 1, and RRES-WQH-SOP-043, Attachment 1.

Initial risk = medium. Residual risk = Low. Work permits required: none.

Signatures

First authorization review date is one year from group leader signature below; subsequent authorizations are on file in group office.

Prepared by: Jeff Walterscheid, RRES-WQH	Date: July 21, 2004
Approved by: Bruce Gallaher for DBR David Rogers, Environmental Surveillance Team Leader	Date: July 22, 2004
Approved by: Mike Alexander, RRES-WQH Operations Team Leader	Date: July 21, 2004
Approved by: Steve Rae, RRES-WQH Safety Committee Chair	Date: July 21, 2004
Approved by: Steve Rae, RRES-WQH Group Leader	Date: July 21, 2004

General information about this procedure

Attachments

This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Equipment and Supplies Checklist	2
2	Groundwater sampling log	1
3	Well purging worksheet	1

History of revisions

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	7/04	New document

Who requires training to this procedure

The following personnel require training before implementing this procedure:

- RRES-WQH staff and contractors assigned to collect groundwater samples from wells using submersible pumps.
- Those who participate and assist in the field collection of groundwater samples from wells using submersible pumps.

Training method

The training method for this procedure is **on-the-job** training by a previously trained individual and is documented in accordance with the procedure for training (RRES-WQH-QP-024).

Prerequisites

In addition to training to this procedure, the following training is also required prior to performing this procedure:

- Training as specified in RRES-WQH-SOP-002, General Field Work, and RRES-WQH-SOP-014, Large Generator Use for Pumping.

Definitions to this procedure

Groundwater: Subsurface water in the saturated zone from which wells and springs are supplied

General information, continued

References

The following documents are referenced in this procedure:

- LANL-RRES-WQH-SOP-002, General Field Work
- LANL RRES-WQH-SOP-014, Large Generator Use for Pumping
- LANL-EM-8-TP-003, RO, *Chain-of-Custody for Environmental Samples*
- USEPA SW-846, *Test Methods for Evaluating Solid Waste*, 3rd edition, U.S. Environmental Protection Agency, November 1986 p11.4.3
- USEPA/530-R-93-001, *RCRA Ground-water Monitoring: Draft Technical Guidance*, November 1992
- LIR 404-00-02, General Waste Management Requirements
- LIR 404-50-01, Water Pollution Control
- LIR 405-10-01, Packaging and Transport
- New Mexico Environment Department, Hazardous Waste Bureau Position Paper, October 30, 2001, "Use of Low-flow and Other Non-Traditional Sampling Techniques for RCRA Compliant Groundwater Monitoring", 15 pp.
- Puls, R.W., and M.J. Barcelona, April 1996, "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures", U.S. Environmental Protection Agency, Office of Research and Development, EPA Groundwater Issue, EPA/504/S-95/504, 12 pp.
- Riebsomer, E., Chemistry Variation during Purging of Alluvial Wells at Los Alamos National Laboratory, Los Alamos National Laboratory Report LA-UR-02-7605, May 2003.

Note

All directives in RRES-WQH-SOP-002, *General Field Work*, and its addendums are explicitly included in this procedure.

Actions specified within this procedure, unless preceded with "should" or "may," are to be considered mandatory guidance (i.e., "shall").

Preparations for sampling

Presampling reviews	Prior to the day of sampling, review sampling plans and Analytical Requests with the Environmental Surveillance Team Leader or his designee. • Ensure that proper samples will be collected according to the sampling plan. • Discuss any issues related to sample collection or the sampling site. • Document this meeting by having the Environmental Surveillance Team Leader or his designee sign initial the Analytical Requests. Alternatively, discuss blocks of stations and document the review by an email from the Environmental Surveillance Team Leader or his designee.
Unexpected issues or conditions	If any unexpected issues arise in the field that cause a significant variation in sample collection protocol, contact the Environmental Surveillance Team Leader or his designee to resolve these issues prior to continuing with sampling. If unusual conditions at the sampling site might affect the sampling, discuss these with the Environmental Surveillance Team Leader or his designee after sampling to provide this information.
Equipment needed	The equipment needed for a sampling activity is given in Attachment 1, Equipment and Supplies Checklist.

Preparations for water supply sampling

Presampling notifications

All municipalities and accord pueblos shall be contacted at least one week (7days) prior to sampling to obtain approval for the sampling event and schedule an escort. After obtaining approval from the appropriate municipality or pueblo representative, the NMED-OB shall also be notified of the sampling event at least 7 days prior. FMU-2 shall be contacted at least 24-hours prior to sampling at Fenton Hill. No escort is required for sampling at the Fenton Hill water system with the exception of wellhead sampling (sample collection in the well house).

Notifications and check-ins

Before conducting any drinking water sampling, the sampler shall contact the utilities department at the municipality or the environment department at the accord pueblo to arrange for an escort. No sampling at any water supply system, with the exception of Fenton Hill, shall be conducted without an escort. An escort is only required at Fenton Hill when the sampling is being conducted at the well house.

Water Supply Sample Collection

Before entering sample location

Once accompanied by a representative from the municipality, accord pueblo, or FMU-2, the sampler shall survey the facility's environment, for any potential hazards.

The sampler shall take notice of all electrical, mechanical, biological, and chemical systems.

If the sampler observes any unusual or potentially hazardous condition, then the sampler shall:

- stop all sampling activity
- leave the area immediately
- contact the appropriate representative

Water supply well preparation

Water supply wells are purged prior to sampling, as some of the wells are operated infrequently (for example, O-1 and G-5A).

Prior to sampling, each water supply well shall be run for a minimum of 1 hour before sample collection. This will purge water in the well and piping so that samples collected are representative of the water in the formation.

To collect the sample, install a brass nipple on hose bib. Turn on the hose bib and allow the water to run freely from the sample tap for a minimum of 3 minutes before collecting samples.

Disposal of water purged from wells

Prior to sampling, ensure that there is a process for disposing purged water. An NOI for disposal of purge water is in place for many wells. Verify that this is the case for wells you are sampling.

Water Supply Sample Collection, continued

Sampling process

If the facility has been determined to be safe for entry, then the sampler shall proceed with sample collection by performing the following steps:

Step	Action
1	Wear noise protection in well houses and booster stations whenever the pump motors are in operation.
2	Don chemical resistant gloves.
3	Where appropriate, install brass nipple on the sample tap to facilitate sample collection. Turn on the sample tap and allow the water to run freely for a minimum of 3 minutes before collecting samples.
4	Collect sample using correct size and type of container for the analytical method.
5	Preserve the sample using the correct type and quantity of preservative as required by the analytical method. Safety glasses shall be worn during preservation.
6	Dry sample containers and apply chain of custody tape.
7	Record all sampling information in a sampling log book and on the Laboratory's sample Chain of Custody form.
8	Collect the following field parameters and record all results: • EC • pH • Temperature • Turbidity
9	Store the sample in an ice chest during transport and maintain sample at 4 degrees Celsius. Use "Blue" ice or equal; do not use ice cubes or block ice. Protect glass containers from breakage with packing material.

Purging wells for a representative groundwater sample

Why are wells purged?

Groundwater that remains in the well casing is subject to chemical reactions over time that may alter its composition. This water may not be representative of the water in the aquifer.

Upon exposure to atmospheric pressure and oxygen, the groundwater's oxidation-reduction potential (ORP or Eh) and hydrogen ion activity (pH) may change. The solubility of some chemical constituents may then change, resulting in water chemistry different from that in the aquifer. Reactions of the water with casing material and bacterial activity may also affect its composition.

Low flow purging

The type of pump (or other sampling device such as a bailer) used for sampling and the pumping rate affect turbidity of water in the well casing and may introduce oxygen into the water samples. Pumping at lower rates and with little drawdown produces more representative groundwater samples and may allow sample collection after purging less than three casing volumes (Puls and Barcelona 1996).

Ideally, a well should be purged at a low flow rate and with little drawdown until the dissolved oxygen and turbidity stabilize. Other parameters - water temperature, specific conductance, and pH, are less sensitive indicators of formation water. Three casing volumes is a usual target for purging. Low-flow purging methods may also be used to ensure that the sample is representative of the aquifer being sampled. Such sampling methods shall comply with NMED guidance (NMED 2001) to the extent practicable.

Purging wells for a representative groundwater sample, continued

Low flow purging, con't

The following NMED stabilization and purging guidelines apply to the variation between three parameter values taken five minutes apart (from Riebsomer 2003):

Purging guidelines and stabilization criteria for the field parameters (NMED, 2001)

Purging Characteristic	**Purging Guideline**
Purge rate	< 1 liter per minute
Drawdown*	Not more than 0.3 ft
Field Parameter (measured every five minutes)	**Stabilization Criteria**
Turbidity*	< 5 NTU ± 10%
Dissolved Oxygen	± 10%
pH	± 0.5 pH units
Specific Conductance	± 10%
Temperature	± 10%

* Turbidity < 5 NTU and drawdown of less than 0.3 ft are ideal, but may vary based on site conditions.

Turbidity measurements are often noisy (about ± 0.5 NTU between measurements), and a variation of less than 10% over three readings below 5 NTU is unlikely to be met. Consider that turbidity has stabilized if three readings taken five minutes (or more) apart show a variation of:

- No more than 10% if turbidity is above 10 NTU,
- No more than 1 NTU if between 5 and 10 NTU, or
- No more than 0.5 NTU if turbidity is below 5 NTU.

Purging wells for a representative groundwater sample, continued

Steps to purge a well

Wells sampled with submersible pumps will generally be sampled after purging of three casing volumes because these pumps have high flow rates.

To purge a well, perform the following steps:

Step	Action
1	Measure and record on the Groundwater Sampling Log (Attachment 2) the depth from the top of casing (TOC) to the water table and obtain the total well depth from well construction diagrams. • Measure height of TOC above ground surface. • Make sure to adjust well and water depth to the same datum (land surface or TOC) to determine water column height. • Fill out Groundwater Sampling Log and casing volume calculation on the Well Purging Worksheet (Attachment 3).
2	Calculate the volume of standing water by multiplying the height of fluid in feet by the factor in the table at the end of this section. Record calculations on the Well Purging worksheet for this purpose. **Example**: If a casing has a diameter of 4 inches, a total depth of 55 ft., and a depth to water level of 15 ft., then the total casing volume would be: • 55-15 = 40 ft. of water column in well • 40 ft. × 0.65 gallons/ft. = 26 gallons Ideally, 3 casing volumes need to be purged, therefore • 26 × 3 = 78 total gallons need to be purged before collecting a sample.
3	Assess pumping rate. • Begin pumping at a slow rate and increase rate if drawdown is small. • Never decrease pumping rate after observing that drawdown is too great; the well will not recover and turbidity will not be reduced by decreasing pumping rate. • Try not to lower the water level over a large part of the screen or decrease the water column by over 25%. • Ideally, pumping rate should be low enough so that drawdown is less than 0.3 ft in a shallow well and little in a deeper well. This may not be possible for all wells.

Continued on next page.

Purging wells for a representative groundwater sample, continued

Steps to purge a well, con't

Step	Action
4	Calculate discharge rate: • Fill a one-gallon bucket • Record the time required to fill the bucket • Repeat three times and average the gallons pumped per minute OR • Use an in line flow meter.
5	Calculate time required to pump total required volume: purge time (minutes) = casing volume (gallons) ÷ discharge rate (gallons per minute).
6	Periodically monitor water level during pumping (about every 5 minutes for the first half hour and every 10-15 minutes thereafter).
7	Periodically measure and record turbidity, temperature, specific conductance, pH, and dissolved oxygen (if possible) about every 5 minutes for the first half hour and every 10-15 minutes thereafter, as well as during purging.
8	Periodically (about every casing volume) redetermine discharge rate as described in step 4 to see whether it has changed. Reference Well Purging Worksheet (Attachment 3). If purge rate has changed more than about 20%: • Determine quantity of water purged to that point by averaging old and new discharge rates • Redetermine time to pump total required volume • Record all calculations on field sheet or log book present purge volume (gallons) = [previous discharge rate + present discharge rate] (gallons per minute) × ½ × elapsed purge time (minutes). remaining purge time (minutes) = [purge volume – present purge volume] (gallons) ÷ present discharge rate (gallons per minute).

Continued on next page.

Purging wells for a representative groundwater sample, continued

Steps to purge a well, con't

Step	Action
9	The well is ready to sample when: • A minimum of three casing volumes of water have been extracted at a low flow rate, or • After purging one casing volume at a low flow rate, drawdown, turbidity (and dissolved oxygen, if measured) have stabilized. Turbidity has stabilized when three readings show a total range of: • No more than 10% if turbidity is above 10 NTU, • No more than 1 NTU if between 5 and 10 NTU, or • No more than 0.5 NTU if turbidity is below 5 NTU.
10	Record on Groundwater Sampling Log (Attachment 2): • Final, stable readings of turbidity • Temperature • Specific conductance • pH • Dissolved oxygen (if measured)
11	Record on Well Purging Worksheet (Attachment 3): • Total volume purged (the number of casing volumes purged)

Disposal of water purged from wells

Prior to sampling, ensure that there is a process for disposing purged water. An NOI for disposal of purge water is in place for many wells. Verify that this is the case for wells you are sampling.

Calculating water volume in well

To determine casing volumes, use the following factors in the equation in step 2 above:

Well Diameter, inches	Gallons per linear foot	Well Diameter, inches	Gallons per linear foot
1	0.04	6	1.47
2	0.16	8	2.61
3	0.37	10	4.08
4	0.65	12	5.88

Records resulting from this procedure

Records

The following records generated as a result of this procedure are to be submitted as records to the Records Coordinator:

- Analytical Request Forms
- Field Forms
- Groundwater Sampling Logs
- Well Purging Worksheets

Click here to record self-study training to this document.

EQUIPMENT AND SUPPLIES CHECKLIST

Equipment for purging wells:

- water level measurement device (See RRES-WQH-SOP-045, *Water Level Measurements)*
- portable generator
- flow measuring equipment
- calculator
- fluid level measurement record forms
- field forms
- nitrile gloves
- keys
- thermometer
- specific conductance meter (and extra cup)
- standard reference solutions for calibrating specific conductance and pH meters
- Kimwipes
- pH meter (and extra probe) and solutions
- safety glasses

Equipment and supplies checklist, continued

Equipment for sampling wells:

- Chain-of Custody / Request for Analysis form
- filtering equipment
- meters for measuring pH, temperature, electrical conductance, and turbidity
- sample containers with preservative, as appropriate
- 250 - ml sterile bottle
- ball-point pen (indelible dark ink)
- felt-tip marker pen (indelible dark ink)
- 1-14 pH indicator paper
- nitrile gloves
- Kimwipes
- safety glasses
- deionized water
- blue ice or equivalent
- insulated coolers
- padding for packaging of samples
- zip lock bags
- sample labels
- custody seals or custody tape
- other equipment specified in EPA Methods, as needed

Groundwater Sampling Log

Project:	Site:	Well No:	Date:
Well Depth:	Screen Length:	Well Diameter:	Casing Type:
Sampling Device:		Tubing Type:	Water Level:
Measuring Point:	Other Info:		
Sampling Personnel:			

Time	pH	Temp	Cond	Dis.O_2	Turb.	Water Level	Discharge Rate	Notes

PULS AND BARCELONA (1996)

Initial purge volume calculation

Well depth (ft)	
- Depth to water (ft)	
= Height of water (ft)	
× Factor (gal/ft)	
= Casing volume (gal)	
× 3 = Total purge volume (gal)	
÷ Discharge rate (gpm)	
= Purge time (min)	

Intermediate purge volume and remaining purge time calculation

Previous discharge rate (gpm)	
+ Present discharge rate (gpm)	
× Elapsed purge time (minutes)	
× ½ = Present purge volume (gal)	
Total purge volume (gal)	
- Present purge volume (gal)	
÷ Present discharge rate (gpm)	
= Remaining purge time (min)	

Intermediate purge volume and remaining purge time calculation

Previous discharge rate (gpm)	
+ Present discharge rate (gpm)	
× Elapsed purge time (minutes)	
× ½ = Present purge volume (gal)	
Total purge volume (gal)	
- Present purge volume (gal)	
÷ Present discharge rate (gpm)	
= Remaining purge time (min)	

Total purge volume

Total purge volume (gal)	
Total number of casing volumes purged	