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-SOP-048 Revision: 0

Procedure title: **Groundwater Sampling Using Bladder 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 Name (print)	6/28/04 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
David Rogers
F. Bourque
Steve Rae

Signature	Mike Alexande Name (print)	7/14/04 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 Name (print)	7/14/04 Date

Draft prepared and sent for formal review on: 3/19/04. Comments resolved on: 6/15/04. 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 Name (print)	July 22, 2004 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 Name (print)	7/13/04 Date
Signature	Mike Alexander Name (print)	7/14/04 Date
Signature for DBR	David Rogers Name (print)	7/22/04 Date
Signature	F. Bourque Name (print)	6/29/04 Date
Signature	Steve Rae, Group Leader Name (print)	July 22, 2004 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 BLADDER PUMPS

Purpose

This RRES Water Quality and Hydrology Group (RRES-WQH) procedure describes the process for collection of groundwater samples using bladder pumps.

Scope

This procedure applies to all RRES-WQH staff, contractors, and students assigned to collect groundwater samples from wells using bladder 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: 6/28/04
Approved by: for DBR David Rogers, Environmental Surveillance Team Leader	Date: 6/22/04
Approved by: Mike Alexander, RRES-WQH Operations Team Leader	Date: 6/29/04
Approved by: Robert F. Bourque, Pressure Safety Officer, HSR-5	Date: 6/29/04
Approved by: Steve Rae, RRES-WQH Safety Committee Chair	Date: July 22, 2004
Approved by: Steve Rae, RRES-WQH Group Leader	Date: July 22, 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
4	Pressure sytem diagram	1

History of revisions

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

Revision	Date	Description Of Changes
0	6/04	New document

Who requires training to this procedure

The following personnel require training before implementing this procedure:

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

- RRES-WQH-SOP-002, General Field Work
- RRES-WQH-SOP-043, Pressure System Use for Groundwater Sampling
- RRES-WQH-SOP-020, Custody, Packaging, and Transportation of Samples

General information, continued

Definitions to this procedure

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

References

The following documents are referenced in this procedure:

- LANL-RRES-WQH-SOP-002, General Field Work
- RRES-WQH-SOP-043, Pressure System Use for Groundwater Sampling
- RRES-WQH-SOP-020, Custody, Packaging, and Transportation of Samples
- 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 402-1200-01, Pressure, Vacuum, and Cryogenic Systems
- 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.
- MONOFLEX, Isomega Bladder Pumps, Instruction Manual
- TIMCO, Isomega Bladder Pumps, Instruction Manual

Note

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

Preparations for sampling

Equipment needed

The equipment needed for a sampling activity is given in Attachment 1, "Equipment and Supplies Checklist."

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 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 (MP) to the water table and obtain the total well depth from well construction diagrams. • Measure height of MP above ground surface. • Make sure to adjust well and water depth to the same datum (land surface or MP) 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. 1. Begin pumping at a slow rate and increase rate if drawdown is small. 2. 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. 3. Try not to lower the water level over a large part of the screen or decrease the water column by over 25%. 4. Ideally, pumping rate should be low enough so that drawdown is less than 0.3 ft. 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 requested) 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 requested)
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 of purge 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

Operating pump at well sites

Dedicated bladder pumps at each shallow well

Most shallow alluvial monitoring wells in the RRES-WQH Environmental Surveillance Monitoring Program are equipped with Monoflex Isomega bladder pumps dedicated to each well. The bladder pumps are constructed of Teflon™.

Hazards

Before operating the pressure system for operating the well, review RRES-WQH-SOP-043, *Pressure System Use for Groundwater Sampling*, Attachment 1, for hazards associated with using a pressure system for groundwater monitoring.

System setup

Bladder pumps are used to obtain representative water samples from monitoring wells. During operation, the bladder pump chamber fills with water through a screen inlet and ball valve into the pump chamber collapsing the bladder. The introduction of nitrogen gas into the bladder causes the bladder to expand forcing the water into the sample discharge line. Venting the bladder allows it to collapse permitting the pump to refill. A pressure of 0.45 PSI per foot of depth is required to lift a sample to the surface. A vacuum pump increases the pumping rate and makes it less dependent upon head.

Perform the following steps when preparing the system for use. It is assumed that dedicated pumps have previously been installed.

Step	Action
1	Ensure the nitrogen tank is secured in the vehicle used to conduct the sampling.
2	Install the safety manifold on the nitrogen tank, snug fitting onto tank fill valve with a wrench. Check for leaks. Safety manifold includes: • regulator with two gages, • manual vent valve, • pressure relief valve set to 125 psi (set at 20% over the maximum working pressure) and • "quick connect coupling".

Continued on next page.

Operating pump at well sites, continued

System setup, con't

Step	Action
3	Connect dedicated pressure hose to the quick connect coupling on safety manifold and secure hose with cable whip restraint. Note: Safety manifold, hoses and pump controller, and well assembly have been pre-fabricated. **DO NOT** remove or change coupling, valves, whip restraints, quick connects, or any other components of the pressure system in the field.
4	Connect the other end of the dedicated pressure hose to the quick connect on the Legris shutoff valve.
5	Connect the other end of the Legris shutoff valve to the pump controller and secure hose with cable whip restraint. While making connections, note the direction of flow on the valve.
6	Connect the dedicated coil pressure hose to the pump controller and the other end to the well head assembly.

Pressurizing the system

Perform the following steps to pressurize the system:

Step	Action
1	Ensure that the "T" screw on the pressure regulator is loose, do not unthread all the way out.
2	Tighten the vent valve by hand.
3	Close the pump controller valve.
4	Crack (gently open) the Nitrogen gas cylinder tank valve, listen for leaks, then open all of the way.
5	Adjust the regulator "T" screw to read 100 psi.
6	Leak test all of the fittings, quick connects, and hose connections.
7	Open the Legris shutoff valve.

Operating pump at well sites, continued

Operate the vacuum pump

Perform the following steps to operate the Monoflex IVP Controller:

Step	Action
1	Ensure all tubing and gas cylinder connections are secure and functional.
2	Open the shutoff Legris valve connected to the AIR INLET and note the reading on the SUPPLY PRESSURE GAGE. Note: A minimum of 60 psi is required to operate the controller. The maximum working pressure of the controller is 125 psi and 150 psi for the safety valve.
3	Set the PUMP PRESSURE REGULATOR: • pull up the locking collar on the base of the knob • turn the knob • press the locking collar down to lock once the proper pumping pressure is set
4	Determine proper pump pressure: • multiply the vertical distance to the pump by 0.45 psi (0.03 bar) • add 10 to 20 psi (0.7 – 1.4 bar) to that amount *Example:* Sample to be evacuated at 100 ft (30.5m) 100' x 0.45= 45 psi of lift + 10 PSI= 55 psi total pressure needed.
5	Cycle the pump. (Timers will need adjustment to maximize the pumping rate. Reference Timer Adjustments in this section.) As the pump is cycling and the VACUUM ASSIST SWITCH is in the "ON" position, the PUMP PRESSURE GAUGE will read all the below depending on the step in the sampling process: • the pump pressure manually set, • zero, or • vacuum When the PUMP PRESSURE GAUGE reads "pressure" the pump is pushing the water to the surface. When the gauge reads "vacuum" or zero, the pump chamber is filling with water, or "venting".

Operating pump at well sites, continued

Timer adjustments

Pump pressure timer: Controls the amount of time the pump is allowed to push the water to the surface. Too little time will not allow the pump to empty completely, too much time is unnecessary because the pump has been emptied.

Pump vent timer: Controls the amount of time the pump is allowed to vent, or fill the sample chamber. Too little time will not allow the pump to fill completely, too much time is unnecessary because the pump is full.

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 log
- Well purging worksheets

All hydrological field data will be stored with the Records Coordinator.

Click here to record self study training to this document.

EQUIPMENT AND SUPPLIES CHECKLIST

Equipment for purging wells:

- water level measurement tape
- flow measuring equipment
- nitrogen cylinders
- fluid level measurement record forms
- field log book
- calculator
- thermometer
- specific conductance meter (and extra cup)
- pH meter; electrode and solutions
- standard reference solutions for calibrating specific conductance and pH meters
- Kimwipes
- nitrile gloves
- safety glasses

Equipment and supplies checklist, continued

Equipment for sampling wells:

- Chain-of Custody / Request for Analysis form
- sample containers with preservative, as appropriate
- wide-mouth amber glass bottles with Teflon™-lined caps amber glass vials with Teflon™ septa (precleaned)
- 250 - ml sterile bottle (precleaned)
- wide-mouth polyethelene bottles (precleaned)
- ball-point pen (indelible dark ink)
- felt-tip marker pen (indelible dark ink)
- 1-14 pH indicator paper
- nitrile gloves
- Kimwipes
- safety glasses with side shield
- temperature probe
- deionized water
- Teflon™ tape
- 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
- filtering equipment

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)

Well Purging Worksheet

Initial casing 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 casing 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 casing 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	

Pressure System Diagram