Identifier: **SOP-5232** **(Supersedes RRES-WQH-SOP-048, R0 and RRES-WQH-SOP-049, R0)**	Revision: **0**	
Effective Date: 02/24/2009	Next Review Date: February 4, 2014	

Environmental Programs Directorate

Standard Operating Procedure

For **GROUNDWATER SAMPLING**

APPROVAL SIGNATURES:

Author:	**Organization**	**Signature**	**Date**
Tim Goering	WES-RS	Signature on File	2/20/2009
Responsible Line Manager:	**Organization**	**Signature**	**Date**
Dwain Farley	WES-RS	Signature on File	2/20/2009

1. PURPOSE AND SCOPE

This standard operating procedure (SOP) describes the process for setting up/breaking down equipment, purging, collecting, documenting, and submitting groundwater samples obtained from wells using submersible, bladder, Bennett, Baski, and QED pumping systems. This procedure applies to all personnel assigned to collect groundwater samples using the methods discussed. Groundwater sampling utilizing the Westbay MP System is covered under SOP 5225, Groundwater Sampling Using the Westbay MP System.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

Water that remains in a monitoring well for a period of time may not be representative of formation water because of physical, chemical, or biological changes that may occur as the water remains in contact with the well casing, dedicated sampling equipment, and the air space in the upper casing. This stagnant water may not represent formation water at the time of sampling. To ensure that samples collected from a monitoring well are representative of formation water, stagnant water in the casing must either be removed (full purge) or isolated from the sampling zone within the well before sampling is conducted. It is preferred to use low-flow purge and sampling techniques when performing these activities. However, in many cases, wells completed in higher-yield formations are sampled using traditional sampling techniques.

Ideally, a well should be purged with minimal drawdown until field water-quality indicator parameters stabilize. Once the parameters stabilize, it is presumed that all stagnant water has been removed from the well and that fresh formation water is available for sampling. The most sensitive indicator parameters are dissolved oxygen (DO) and turbidity. Other parameters, such as water temperature, specific conductance, pH, and oxidation-reduction potential (ORP) are also monitored, but are less sensitive indicators of formation water. Water-quality indicator parameters are monitored at 5- to 15-min intervals until stability has been achieved. The criteria for defining stability are discussed in section 4.3, Purging Operations. ORP is monitored during purging but is not used to define stability.

Personnel performing this procedure shall be trained in accordance with the Environmental Program (EP) Directorates' personnel training and qualification process (EP-DIR-SOP-2011, Personnel Training and Qualification). The training method for this procedure is on-the-job training.

This procedure has been developed to be consistent with the requirements of the March 1, 2005, Compliance Order on Consent and with the Interim Facility-Wide Groundwater Monitoring Plan (the Interim Plan).

2.2 Precautions

2.2.1 Decontaminate all equipment that will be placed inside the well in accordance with the provisions of EP-ERSS-SOP-5061, Field Decontamination of Drilling and Sampling Equipment.

2.2.2 Before sampling, ensure that a process is in place for storing and disposing of purged water and that proper storage capacity is available for any purge water generated.

2.2.3 To minimize the potential for cross-contamination, use dedicated sampling equipment whenever possible. Wells that are sampled by use of a portable pump should be sampled in the order of the least contaminated wells first and progressing to the most contaminated wells. Equipment blanks should be taken before use of nondedicated equipment in accordance with the quality assurance/quality control requirements specified in the Interim Plan.

3. EQUIPMENT AND TOOLS

Refer to Attachment 1, Equipment and Supplies Checklist for Groundwater Sampling.

4. STEP-BY-STEP PROCESS DESCRIPTION

4.1 Sampling Preparation

Field Team Leader	1.	Print out the applicable analytical request/chain-of-custody form(s) from the Sample Management Office (SMO) database before leaving for the field (see EP-ERSS-SOP-5110, Creating and Maintaining Chain-of-Custody).
	2.	Review the sampling plan for the current sampling activity to ensure that samples are collected as specified and discuss any purging, sample collection, or site issues with the facility-wide monitoring project leader or operations manager.
	3.	Obtain and review pertinent information, such as the well construction diagrams or the well completion report (available on the Los Alamos National Laboratory [Laboratory] server), and enter in the appropriate information on the Groundwater-Sampling Log (Attachment 2). This will include information such as the following: • well location • total well depth • well diameter • screen length • the referenced measuring point used to determine well and water-level depth • casing type
	4.	Contact the waste coordinator for instructions on containerization or other waste handling measures. Samplers will use the appropriate waste disposal path for all other generated wastes.
	5.	Ensure that work activities are on an approved plan of the day for the appropriate facility in which work will be performed before starting any field or laboratory activities.
	6.	Notify the appropriate facility personnel before working in restricted areas to ensure your names are included in the plan of the week/plan of the day for that location.
	7.	Assemble the required equipment and supplies for the particular pumping method according to the Equipment and Supplies Checklist for Groundwater Sampling (Attachment 1).
Field Team Leader (continued)	8.	Verify field instruments to be used for water-quality readings are calibrated in accordance with ENV-DO-203, Field Water-Quality Analysis.

4.2 System Setup for Sampling

Field Team Member	1.	Mobilize the support equipment required for purging and sampling the well.
	2.	If a large generator is required, follow the guidance contained in ENV-WQH-SOP-014, Large Generator Use for Pumping.
	3.	Follow the appropriate attachment for setup of the pumping system to be used: • Attachment 3—Electric Submersible Pumping Systems • Attachment 4—Bladder Pumping Systems • Attachment 5—Bennett Pump System • Attachment 6—Baski Pump Systems • Attachment 7—QED Portable Bladder Pumping Systems
	4.	Set up the flow-through cell system and field parameter instruments to be used during the purging operation.

4.3 Purging Operations

Field Team Member	1.	Determine the depth of the water table utilizing one of the methods below and record on the Groundwater-Sampling Log (Attachment 2). • If the well has a water-level transducer installed, record the water-level elevation on the Groundwater-Sampling Log (Attachment 2). • If a water-level transducer is not present, determine the water level using one of the methods described in EP-ERSS-SOP-5105, Water-Level Measurements, and record the water-level elevation on the Groundwater-Sampling Log (Attachment 2).
	2.	Determine the volume of water in the casing and the target purge volume as follows: • Determine the linear feet of water column by the difference between the total depth of well and the water elevation determined in step 1 above. • Calculate the casing volume using the formulas provided in Attachment 2. • If the well has a dedicated pump, calculate the volume of water in the drop pipe or tubing by determining the water column height by subtracting the water-level elevation from the top of casing elevation and using the appropriate formula provided in Attachment 2.

Field Team Member (continued)

2.
- Determine the total minimum required purge volume based on whether the well is completed in an alluvial aquifer or in an intermediate perched or the regional aquifer.
    - Alluvial wells are to be purged a minimum of 1 casing volume (CV) plus the volume of the drop pipe and purged until water-quality parameters stabilize as defined in section 10 below.
    - Intermediate and regional wells are to be purged a minimum of 3 CVs plus the volume of the drop pipe and purged until water-quality parameters stabilize as defined in section 10 below.
- Record the calculated minimum purge volume on the Groundwater-Sampling Log in Attachment 2.

3. Start up the pump following the steps in the appropriate attachment for the pump being operated:
- Attachment 3—Electric Submersible Pumping Systems
- Attachment 4—Bladder Pumping Systems
- Attachment 5—Bennett Pump System
- Attachment 6—Baski Pump Systems
- Attachment 7—QED Portable Bladder Pumping Systems

4. The pumping rate should be adjusted during purging so that excessive drawdown does not occur. A table will be provided for each well in a sampling group/watershed that provides guidance for pumping rates during purging and sampling. The guidance will be based on the following criteria:
- Drawdown within alluvial wells should be limited to no more than 0.5 ft, where possible.
- Drawdown within intermediate and regional monitoring wells screened across the water table should be limited to less than 2 ft, where possible, and preferably to no more than 0.5 ft.
- Drawdown in wells screened below the water table should be limited so water levels are not drawn below the top of the screened interval, where possible.
- Pumping rates should not exceed 5 gpm, unless otherwise directed, and flow should be solid with no air bubbles.
- In low-flow applications, the pumping rate should be in the range of 0.1 to 1 L/min.

5. Determine the discharge rate using one of the following methods and record in Attachment 2:
- If an in-line flow meter is installed, record the flow rate.
- Calculate the discharge rate by filling a bucket or bottle of known volume and record the fill time. Repeat this process three times and calculate the average value.

6. Calculate the time required to pump the minimum required volume utilizing the following formula:

   Minimum purge time (min) = minimum purge volume (gal.) ÷ discharge rate (gal./min)

   - Record the calculated minimum purge time on the Groundwater-Sampling Log in Attachment 2.

7. Monitor the water level during pumping every 5 min for the first 0.5 h and every 10–15 min thereafter. Record the water-level data in the Groundwater-Sampling Log (Attachment 2).

8. Measure the parameters indicated below every 5 min (or as identified in the sampling plan) for the first 0.5 h and every 10–15 min thereafter and record the following data in the Groundwater-Sampling Log (Attachment 2):

   - pH
   - temperature
   - specific conductance
   - dissolved oxygen
   - turbidity
   - oxidation-reduction potential (ORP)
   - water level
   - observations of water clarity, color tinting, and odors

9. Review the parameters being monitored periodically (about every casing volume) and recalculate the discharge rate as described in step 5 above.

Field Team Member (continued)

10. Sampling depends on the purge requirements in the Interim Plan. In general, the well is ready to sample when the water-level drawdown has stabilized within the well's allowable limits per section 4.3-4 of this SOP and when the following criteria have been met.

- The drop pipe/tubing has been purged and a minimum of one casing volume (plus drop pipe volume) have been removed for wells completed in alluvial systems, and a minimum of three casing volumes (plus drop pipe) have been removed for wells completed in intermediate perched systems or the regional aquifer.
- The field indicator parameters have stabilized within their allowable ranges for at least three consecutive measurements a minimum of 5 min apart.

Field Parameter	Stabilization Criteria
Turbidity	<5 nephelometric turbidity units (NTUs), if possible; If turbidity remains >5 NTUs, ± 10% of the reading
Dissolved Oxygen	± 10% of the reading, or ± 0.2 mg/L, whichever is greater
pH	± 0.2 pH units
Specific Conductance	± 10% of the reading
Temperature	± 0.2^{o}C

- The well has been purged to the requirements in the Interim Plan.
- Low-producing monitoring wells that purge dry at low pumping rates may be sampled once one casing volume has been purged and the well has recovered. Under these conditions, sampling personnel should communicate with the groundwater-monitoring project leader to assess whether an abbreviated analytical suite should be collected or if the sample may be omitted. In some situations, additional purging may be required if the well purges dry but recovers fairly quickly.

(Note: ORP should be monitored during purging but is not a criterion used to define stability.)

11. Record the final indicator parameters and final water level in the Groundwater-Sampling Log (Attachment 2).

12. Record total purge volume and calculate the number of casing volumes purged in the Groundwater-Sampling Log (Attachment 2).

13. Record the total waste volume generated, including total volume of purge water and contact waste.

4.4 Sampling

Field Team Member	1.	Remove any flow-through system-monitoring instruments that may come into contact with groundwater to be collected for sample analysis.
Field Team Member (continued)	2.	Observe the following general precautions for beginning sampling operations. • The rate at which a well is sampled should not exceed the rate at which it was purged. • If possible, pumps should be operated in a continuous, nonpulsating manner so samples are not aerated. • Decontaminated sampling equipment should not come into contact with the ground. • Groundwater samples should be collected as soon as possible after the well is purged. Water that has remained in the well casing for more than 2 h has had the opportunity to exchange gases with the atmosphere and to interact with the casing material.
	3.	Collect water samples in the order of priority as stated in the Interim Plan or as otherwise directed. Refer to ENV-DO-203, Field Water-Quality Analyses, for specific guidance for the samples to be obtained. If specific guidance is not available, the preferred collection order for some of the more common groundwater analytes is as follows: • volatile organics (VOAs or VOCs) and total organic halogens (TOX) • dissolved gases and total organic carbon (TOC) • semivolatile organics (SVOCs) • metals and cyanide • major water-quality cations and anions • Radionuclides
	4.	Record the final water level during sampling on the Groundwater-Sampling Log (Attachment 2) and field notebook.
	5.	Preserve the samples with the appropriate preservatives as identified on the chain of custody. Refer to ENV-DO-206, Sample Containers and Preservation; and ENV-WQH-SOP-066, Filtering and Chemical preservation of Water Samples, for specific guidance. Filtration should be performed in the field or as soon after sample collection as possible.
	6.	Seal the lid of every sample container with a custody seal (i.e., custody tape) in accordance with EP-ERSS-SOP-5110 to ensure samples are not tampered with.
	7.	Handle, package, and transport samples in accordance with EP-ERSS-SOP-5057, Handling, Packaging, and Transporting Field Samples.
	8.	Transport all sealed sample containers directly to the SMO.
	9.	Complete the chain-of-custody form (refer to EP-ERSS-SOP-5110) for each sample set collected.

4.5 System Disassembly/Breakdown

Field Team Member	1.	Remove and rinse any equipment that has been in contact with the groundwater stream, such as the well-depth measuring tape, in-line flow-through cell, all monitoring parameter probes, and any dedicated discharge/sample apparatus using deionized (DI) water, and wipe dry with a paper towel. Refer to EP-ERSS-SOP-5061 and the applicable attachment for specific guidance.
	2.	Secure contact waste/investigation-derived waste in a labeled drum.
	3.	Secure the purge water drum(s).
	4.	Secure all field equipment.
	5.	Secure and lock well.

4.6 Records Management

Field Team Member	1.	Maintain and submit records and/or documents generated to the Records Processing Facility according to EP-DIR-SOP-4004, Records Transmittal and Retrieval Process.

5. DEFINITIONS

None

6. PROCESS FLOW CHART

Not applicable

7. ATTACHMENTS

Attachment 1	Equipment and Supplies Checklist for Groundwater Sampling
Attachment 2	Groundwater-Sampling Log
Attachment 3	Electric Submersible Pumping Systems
Attachment 4	Bladder Pumping Systems
Attachment 5	Bennett Pumping Systems
Attachment 6	Baski Pumping System
Attachment 7	QED Portable Bladder Pumping Systems

8. REVISION HISTORY

Revision No. *(Enter current revision number, beginning with Rev.0)*	Effective Date *(DCC inserts effective date for revision)*	Description of Changes *(List specific changes made since the previous revision)*	Type of Change *(Technical [T] or Editorial [E])*
0	02/24/2009	Replaces procedures RRES-WQH-SOP-048 and RRES-WQH-SOP-049. Incorporates New Mexico Environment Department (NMED) purging requirements specified in the NMED "Notice of Approval with Modifications for 2008 Interim Facility-Wide Groundwater Monitoring Plan," NMED November 12, 2008. Incorporates revised indicator parameter stability criteria and restrictions on excessive drawdown and pumping rates.	All

Using a CRYPTOCard, click here to receive "Required Read" credit.

If you do not possess a CRYPTOCard or encounter problems, contact the EP training specialist.

ATTACHMENT 1

SOP-5232-1

Records Use Only

EQUIPMENT AND SUPPLIES CHECKLIST FOR GROUNDWATER SAMPLING

Section 1: General Checklist Specific to All Ground Water Sampling

- ☐ Groundwater-Sampling Log Sheets (see Attachment B)
- ☐ Chain-of-custody forms
- ☐ Sample labels
- ☐ Custody seals
- ☐ Sample collection log forms
- ☐ Personnel protection equipment (e.g., leather gloves, safety glasses, steel-toed shoes)
- ☐ Flow-through cell equipment
- ☐ 5-gal. buckets or carboy
- ☐ Well specific attachments (e.g., tubing, discharge line)—refer to other sections
- ☐ Tool kit
- ☐ Portable computer and RS-232 direct-cable connection
- ☐ Calculator
- ☐ Nitrile gloves
- ☐ Kimwipes
- ☐ DI water
- ☐ Alconox
- ☐ Paper towels
- ☐ Eyewash
- ☐ Well key
- ☐ Ball point pen (permanent dark ink; Rite in the Rain brand or equivalent)
- ☐ Felt-tip permanent marker
- ☐ Monitoring equipment (specific conductance meter, pH/temperature meter, ORP meter, turbidity)
- ☐ Large Ziplock bag for contact waste
- ☐ Regular plastic/garbage bag for noncontact waste
- ☐ Trip blanks (if required)
- ☐ Preservatives

- ☐ Roll-up table
- ☐ Coolers with blue ice
- ☐ Filters (0.45 µ)
- ☐ Teflon thread tape

Section 2: Checklist for Bladder Pump Systems

- ☐ Two-stage regulator and safety manifold assembly
- ☐ High-pressure hose
- ☐ Controller box with well attachment hose
- ☐ Shutoff valve
- ☐ Flow measuring equipment
- ☐ Discharge tubing

Section 3: Checklist for Bennett Pumping Systems

- ☐ Black plastic hose with in-line regulator
- ☐ 140 psi regulator
- ☐ Nitrogen tank(s)
- ☐ Well specific Swagelok sampling tee
- ☐ Portable 5-kw, 25-amp generator

Section 4: Checklist for Baski Pumping System

- ☐ Clear high-pressure airline
- ☐ Baski high-pressure safety manifold
- ☐ Baski high-pressure regulator
- ☐ Nitrogen tank(s)
- ☐ 460-volt, 3-phase portable generator

ATTACHMENT 2

SOP-5232-2

Records Use Only

GROUNDWATER-SAMPLING LOG

Groundwater-Sampling Log

Project: Groundwater Monitoring	**LSD:**	**Well Diameter:**	**Date:**
Watershed:	**Water Level:**	**Casing Type:**	
Well No:	**TD:**	**Tubing Type(**Alluvials**):**	
Pump Type or Sampling Device:	**DTW:**	**Water Column:**	
Measuring Point:	**Screen Length:**	**1CV:** **1CV + Drop Pipe:**	
Completion Depth:	**Drop Pipe/gal:**	**3CV:** **3CV + Drop Pipe:**	
Sampling Personnel:			

DTW = (LSD - Water Level)……**Water Column =** (TD - DTW)…..**Drop Pipe =** (DTW x Appropriate Drop Pipe Multiplier)

1CV = (Water Column x Appropriate Well Diameter Multiplier)….. **3 CV =** (1CV x 3)

TIME	pH	TEMP	COND	DO	Turb	ORP	Water	Discharge	NOTES
MST	SU	˚C	µs/cm	mg/l	ntu	mV	**Level**	**Rate (gpm)**	

Example

WASTE

		Contact: **gal.**	**Drum#**
		Purge Water (Minus Drop Pipe Vol**):** **gal.**	**Drum#'s**
		Total Waste Volume: **gal.**	

ATTACHMENT 3	
SOP-5232-3 **ELECTRIC SUBMERSIBLE PUMPING SYSTEMS**	Records Use Only Los Alamos NATIONAL LABORATORY EST.1943

1. PURPOSE AND SCOPE

This attachment describes the process for setting up, operating, and securing submersible pumping systems used in groundwater-sampling activities.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

Some Laboratory groundwater-monitoring wells are sampled using one of the following two types of electrical submersible pumping systems. Many of the deep regional wells are equipped with an electrical geared submersible pump, which is operated with either a 240- or 480-volt portable generator, depending on the specific model. Some shallow alluvial wells are sampled using a portable "QED SamplePro" portable pump, which can be operated with the QED MP15 Micropurge backpack or QED MP10 control box (refer to Attachment 7, QED Portable Bladder Pumping Systems).

2.2 Precautions

Review any special electrical, mechanical, biological, or chemical conditions that are present for the well being sampled. These should be reviewed with the facility operations directorate representative before starting the sampling event.

3. STEP-BY-STEP PROCESS DESCRIPTION

3.1 System Startup and Operation of a Dedicated Gear Driven Submersible Electrical Pump

Field Team Member	1.	Determine the voltage needed for pump operation.
	2.	Connect the trailer-mounted large generator to the well control box, using the appropriate power cord.
	3.	Start the large generator (refer to ENV-WQH-SOP-014, Large Generator Use for Pumping). Allow generator to run for several minutes to warm up before starting the pump.
	4.	Ensure the valve on the discharge line is open.
Field Team Member (continued)	5.	Start the pump by flipping the breaker to ON, turning the dial on the control box to RUN, and pushing the START button.

	6.	Adjust the flow rate using the valve in the discharge line. Flow rate should be adjusted so that excessive drawdown does not occur. Drawdown within wells completed across the water table should be limited to not more than 2 ft, where possible. Flow should not exceed 5 gpm, unless otherwise directed.

3.2 System Shutdown of a Dedicated Gear-Driven Submersible Electric Pump

Field Team Member	1.	Stop the pump by turning the control switch to stop.
	2.	Flip the power breaker to OFF.
	3.	Ensure the valve in the discharge line is open so that water can drain from the drop pipe. The pump and pump drop pipes have check valves, and the water drains slowly through a weep hole.
	4.	Disconnect power cord and discharge pipes.
	5.	Lock and secure well.

3.3 System Startup and Operation of a Nondedicated Portable Submersible Electric Pump in a Shallow Alluvial Well

Field Team Member	1.	Run 5 gal. of DI water through the pump and discharge tubing. Wipe the outside of the pump and discharge tubing with a clean paper towel that has been moistened with DI water.
	2.	If the pressure transducer must be removed before pump installation, stop the transducer data logging and remove the transducer in accordance with SOP-5227, Pressure Transducer Installation, Removal, and Maintenance. Ensure that a manual water-level measurement is taken before removing the transducer and disturbing the water column. If the transducer does not need to be removed before pump installation, go to step 3.
	3.	Lower the pump into the well to the depth just above the bottom of the screen. (NOTE: Be sure the water level taken for calculating the purge volume has been taken before installing the pump and disturbing the water column.)
	4.	Connect the CO_2 or nitrogen tank to the pump and control box or to the backpack unit.
	5.	Start pump using a slow speed.
	6.	Monitor the water level and adjust the pump speed to control drawdown.

3.4 System Shutdown of a Nondedicated Portable Submersible Electric Pump in a Shallow Alluvial Well

Field Team	1.	Stop the pump by turning the control switch to stop.

Member		
	2.	Pull the pump out of the well, wiping the outside of the discharge tubing and the pump with a paper towel moistened with DI water.
	3.	Run 5 gal. of DI water through the pump and discharge tubing. Be sure to collect equipment rinsate in accordance with the waste requirements for the site.
	4.	Disconnect CO_2 or nitrogen.
	5.	Place pump in a protective case.
	6.	If the pressure transducer was removed for sampling, reinstall the transducer in accordance with SOP-5227 and ensure the data file is transferred to the water-level data steward.
	7.	Lock and secure well.

ATTACHMENT 4	
SOP-5232-4 **BLADDER PUMPING SYSTEMS**	Records Use Only

1. PURPOSE AND SCOPE

This attachment describes the process for setting up and operating bladder pumping systems used in groundwater sampling activities.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

Most shallow alluvial monitoring wells in the EP–Environmental Surveillance Program (ESP) are equipped with Monoflex Isomega bladder pumps dedicated to each well. The bladder pumps are constructed of Teflon.

Bladder pumps are used to collect 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/ft 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.

Personnel performing this procedure shall be trained in accordance with the provisions of the EP Directorate training program (EP-ERSS-SOP-2011, Personnel Training and Qualification). The training method for this procedure is on-the-job training. Personnel performing this procedure shall have completed the following courses:

- Pressure System Orientation, Course #769
- Gas Cylinder Safety, Course #9518

2.2 Precautions

2.2.1 Operation of a bladder pump requires the use of pressurized gas cylinders. Operators should be familiar with Laboratory implementation requirement (LIR) 402-1200 Pressure, Vacuum, and Cryogenic Systems, and Laboratory implementation guideline (LIG) 402-1200, Compressed Gases, to be aware of hazards and recommended safety practices before setting up and operating a pressure system for the bladder pump system.

2.2.2 When working on or around pressure systems, operators must adhere to the following safe work practices:

- Wear safety glasses with side shields or use a face shield.
- Wear safety shoes and leather gloves.
- Use warning signs and mark or label pressure vessels and systems to identify the operating pressure and contents.
- Handle and store gas cylinders safely.

- Avoid temperature extremes, which can cause pressure changes and component failure.
- Store cylinders that are not necessary for the current work in a safe location outside the work area.
- Never work on a pressure system under pressure; depressurize the system and use lockout/tagout, if appropriate.
- Release of inert gases displaces breathable air and can result in unconsciousness. In the event of an accidental or uncontrolled release of gas cylinder contents, evacuate the area and notify your supervisor.

3. STEP-BY-STEP PROCESS DESCRIPTION

3.1 System Setup

Field Team Member	1.	Ensure the nitrogen tank is secured in the vehicle.
	2.	Install the safety manifold on the nitrogen tank. The safety manifold includes the following: • regulator with two gauges • manual vent valve • pressure relief valve set to 125 psi (set at 20% over the maximum working pressure) • quick connect coupling (NOTE: Safety manifold, hoses, pump controller, and well assembly have been prefabricated. DO NOT remove or change coupling, valves, whip restraints, quick connects, or any other components of the pressure system in the field.)
	3.	Connect dedicated pressure hose to the quick connect coupling on the safety manifold and secure hose with cable whip restraint.
	4.	Connect the other end of the dedicated pressure hose to the quick connect shutoff valve.
	5.	Connect the shutoff valve to the pump controller and secure the hose with the cable whip restraint. While making this connection, note the direction of flow on the valve.
	6.	Connect the pump controller to the well head assembly.

3.2 System Pressurization

Field Team Member	1.	Ensure the “T” screw on the pressure regulator is loose but do not unthread all the way out.
	2.	Ensure the vent valve is closed.
	3.	Close the pump controller valve.

	4.	Check the shutoff valve is closed.
	5.	Gently open the nitrogen gas cylinder tank valve and check for leaks.
	6.	Fully open the nitrogen gas cylinder tank valve.
	7.	Adjust the regulator Tscrew until the regulator pressure reads at the proper pump operating pressure, as defined in section 3.3, item 3, below. The regulator pressure will be between 30 psi (the minimum pressure required to operate the controller) and 100 psi.
	8.	Leak test all of the fittings, quick connects, and hose connections. The leak test should be conducted at the proper pump operating pressure, as defined in section 3.3, item 3, below.
	9.	Open the shutoff valve.

3.3 System Operation

Field Team Member	1.	Ensure all hose and gas cylinder connections are secure and functional. (NOTE: A minimum of 30 psi is required to operate the controller. The maximum working pressure of the controller is 125 psi and the safety valve pressure is 150 psi.)
	2.	Open the shutoff valve and note the reading on the supply pressure gauge.
	3.	Determine the proper pump operating pressure as follows: • Multiply the vertical distance of the pump in feet by 0.45 psi (0.03 bar) • Add 10–20 psi (0.7–1.4 bar) to obtain the operating pressure. For example sample to be evacuated at 100 ft: 100 ft × 0.45 = 45 psi lift + 10 psi = 55 psi operating pressure
	4.	Set the pump pressure to calculated value.
Field Team Member (continued)	5.	Cycle the pump and observe its operation. As the pump is cycling and the vacuum-assist switch is in the ON position, the pump pressure regulator will read the set operating pressure, zero, or a vacuum, depending on the step in the operating sequence. When the pump pressure regulator gauge reads the operating pressure, the pump is pushing water to the surface. When the gauge reads zero or a vacuum, the pump chamber is filling with water or venting.

	6.	Adjust the timers, as necessary to maximize the pumping rate. • The pump pressure timer controls the amount of time the pump is pressurized and pumping water to the surface. If the time setting is too short, the pump will not have sufficient time to empty. • The pump vent timer controls the amount of time the pump is allowed to vent. If the time setting is too short, the pump will not have sufficient time to completely fill

3.4 System Shutdown

Field Team Member	1.	Close the shutoff valve.
	2.	Shut the gas cylinder tank valve.
	3.	Vent the system to the atmosphere.
	4.	Disconnect all hoses.
	5.	Lock and secure well.

ATTACHMENT 5	
SOP-5232-5 **BENNETT PUMPING SYSTEMS**	Records Use Only

1. PURPOSE AND SCOPE

This attachment describes the process for setting up, co-operating, and securing Bennett pumping systems used in groundwater sampling activities.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

The Bennett sampling pump system is pressure-actuated. The system can provide depth-discrete groundwater samples from a single subsurface stratigraphic horizon from a converted borehole or well. The Bennett pump consists of a piston activated with pressurized gas through a Teflon tube, a second Teflon tube that returns groundwater to the surface, and a third Teflon tube for gas exhaust. The wellhead is set up to facilitate installation of a pressure transducer and obtain water levels without disturbing the dedicated components of the Bennett Pump system. Refer to Figure C-1, Well Plate Schematic, at the end of this attachment.

The Bennett pump operates by pressurized gas (anticipated to be nitrogen), which does not come in contact with the groundwater sample. Components of the pump that make contact with the sample fluids are composed of inert materials, namely, stainless steel and Teflon.

Personnel performing this procedure shall be trained in accordance with the provisions of the EP Directorate training program (EP-ERSS-SOP-2011, Personnel Training and Qualification). The training method for this procedure is on-the-job training. Personnel performing this procedure shall have completed the following courses:

- Pressure System Orientation, Course #769
- Gas Cylinder Safety, Course #9518

2.2 Precautions

2.2.1 Operation of a Bennett pump requires using pressurized gas cylinders. Operators should be familiar with LIR 402-1200, Pressure, Vacuum, and Cryogenic Systems, and LIG 402-1200, Compressed Gases, to be aware of hazards and recommended safety practices before setting up and operating a pressure system for operating the Bennett pump system.

2.2.2 When working on or around pressure systems, operators should adhere to the following safe work practices.

- Wear safety glasses with side shields or use a face shield.
- Wear safety shoes and leather gloves while handling pressurized gas tanks.
- Handle and store gas cylinders safely.
- Avoid temperature extremes, which can cause pressure changes and component failure.

- Store cylinders that are not necessary for the current work in a safe location outside the work area.
- Never work on a pressure system under pressure. Depressurize the system and use lockout/tagout when appropriate.
- Release of inert gases displaces breathable air and can result in unconsciousness. In the event of an accidental or uncontrolled release of gas cylinder contents, evacuate the area and notify supervisor.

3. STEP-BY-STEP PROCESS DESCRIPTION

3.1 System Setup – Portable Pump

Field Team Member	1.	Load a portable 5-kw, 25-amp generator onto the transport vehicle and tow the portable Bennett pump trailer to the well sampling site.
	2.	Collect a water-level reading by taking a manual measurement in accordance with SOP-5223, Manual Groundwater Level Measurements, or by taking a reading from the pressure transducer.
	3.	Once the water level has been measured, remove the water-level meter from the well to prevent damage to the meter while installing the pump. If a pressure transducer is installed, remove the transducer in accordance with SOP-5227, Pressure Transducer Installation, Removal and Maintenance.
	4.	Back up the trailer until it is within 5 ft of the well casing and open up the adjustable gooseneck on the back of the trailer. A cotter pin at the bottom of the gooseneck can be pulled out to allow the gooseneck to move up and down and in and out but NOT side to side.
	5.	Move the trailer back toward the well casing until the gooseneck is lined up with the center of the casing. The pulleys on the tip of the gooseneck will be lined up with the center of the well casing to allow the pump to enter the casing exactly in the middle. (NOTE: It is very important to ensure the pump is properly aligned over the center of the well to ensure the pump does not get hung up or damaged while being lowered or raised within the well housing.)
	6.	Fine-tune the gooseneck distance from the back of the trailer by placing a bolt through the holes in the gooseneck. The holes can be found every 6 in. along the shaft.
	7.	Turn on the portable generator and plug in the motor for lowering and raising the pump.
	8.	Turn on the water-level meter located on the top of the pump unit. The switch to operate the water-level meter is located on the control box in the front of the Bennett pump.
Field Team Member (continued)	9.	Lower the pump into the well; an up and down switch is attached to the motor and the switch is clearly marked as to which way is up and which way is down. Keeping one hand on the switch and one hand on the pump, guide the pump over to the well so that it slides easily into the top of the well and the tubing bundle rests between the pulleys at the tip of the gooseneck.

	10.	Lower the pump unit until the water-level meter alarms indicating when the top of the pump is under water.
	11.	If possible, continue lowering the pumping unit until it is submerged at least 10 ft below the water-table level.
	12.	Turn off the generator after the pump is set at the desired depth.
	13.	Ensure the nitrogen tank is secured in the vehicle used to conduct the sampling evolution.
	14.	Install the pressure regulator assembly on the nitrogen tank, snuggly fitting onto the tank fill valve with a wrench. The assembly includes the following: • regulator with two gauges • manual vent valve • pressure relief valve set to 150 psi (set at 20% over the maximum working pressure) • quick connect coupling
	15.	Connect the black regulator hose assembly to the pressure manifold (nitrogen gas cylinder).
	16.	Connect the female quick-disconnect fitting of the black gas supply assembly to the male quick disconnect fitting at the landing plate.
	17.	Remove the protective stainless cap from the water discharge line and set the cap aside where it will not be misplaced.
	18.	Take the 5-ft Teflon sample elbow from its cover bag and push the stainless-steel end snuggly together with the water discharge outlet at the landing plate.
	19.	Tighten the stainless-steel cap.

3.2 System Setup—Dedicated Pump

Field Team Member	1.	Ensure the nitrogen tank is secured in the vehicle or a stanchion.
Field Team Member (continued)	2.	Install the pressure regulator assembly on the nitrogen tank, snuggly fitting onto the tank fill valve with a wrench. The assembly includes the following: • regulator with two gauges • manual vent valve • pressure relief valve set to 150 psi (set at 20% over the maximum working pressure) • quick connect coupling
	3.	Connect dedicated pressure hose to the quick connect coupling on the pressure regulator and secure hose with cable whip restraint.

	4.	Connect the other end of the dedicated pressure hose to the quick connect on the pump isolation valve.
	5.	Remove the protective stainless cap from the water discharge line and set the cap aside where it will not be misplaced.
	6.	Take the 5-ft Teflon sample elbow from its cover bag and push the stainless-steel end snuggly together with the water-discharge outlet at the landing plate.
	7.	Tighten the stainless-steel cap.

3.3 System Pressurization

Field Team Member	1.	Ensure the T screw on the pressure regulator is loose but do not unthread all the way out.
	2.	Check the vent valve is closed by hand.
	3.	Close the pump controller valve.
	4.	Check the pump shutoff valve is closed.
	5.	Gently crack open the nitrogen gas cylinder tank valve and check for leaks.
	6.	Fully open the nitrogen gas cylinder tank valve.
	7.	Adjust the regulator T screw until the regulator pressure reads 100 psi.
	8.	Leak test all of the fittings, quick connects, and hose connections.
	9.	Push the cap on the black regulator hose assembly inwards to lock it.

3.4 System Operation—Portable Pump

Field Team Member	1.	Ensure all hose and gas cylinder connections are secure and functional.
	2.	Open the pump shutoff valve connected to the air inlet and note the reading on the supply pressure gauge.
	3.	Set the pump pressure regulator as follows. • Pull up on the locking collar at the base of the adjusting knob. • Turn the adjusting knob to an operating pressure of 90 to 100 psi. • Press the locking collar down to lock in the pressure setting.

	4.	Adjust the pressure from the gas cylinder going into the pump to adjust the pumping speed using one of the methods noted below. A pressure of 90 to 110 psi is usually sufficient to run the Bennett pump at any depth. • Adjust the small black valve on the control box located on the front of the Bennett pump just below the water level on/off switch. This valve is used to fine-tune the pressure going into the pump and is the preferred method. • Adjust the regulator valve on the gas cylinder. This will give a coarse adjustment to the operating pressure and should be used if the method above will not give the required operation. On the left-hand side of the front of the Bennett pump is a discharge hose about 3 ft long. Once the pressure has been turned on, water will begin to come out of this hose almost immediately unless there is air buildup inside the tubing bundle.
	5.	Determine if the pump has started cycling by placing the discharge end of the water tubing into a container of water. Bubbles will occur as rising water pushes air out of the tubing. A slight gas flow exiting the gas exhaust also indicates that the pump is cycling.
	6.	If the pump is determined not to be cycling, the pressure should be gently increased until the pump starts cycling using the methods in step 4.

3.5 System Operation—Dedicated Pump

Field Team Member	1.	Ensure all hose and gas cylinder connections are secure and functional.
	2.	Open the pump shutoff valve connected to the air inlet and note the reading on the supply pressure gauge.
Field Team Member (continued)	3.	Adjust the pressure from the gas cylinder going into the pump to adjust the pumping speed using one of the methods noted below. A pressure of 90 to 110 psi is usually sufficient to run the Bennett pump at any depth. • Adjust the small black valve on the control box located on the front of the Bennett pump just below the water level on/off switch. This valve is used to fine-tune the pressure going into the pump and is the preferred method. • Adjust the regulator valve on the gas cylinder. This will give a coarse adjustment to the operating pressure and should be used if the method above will not give the required operation. On the left-hand side of the front of the Bennett pump is a discharge hose about 3 ft long. Once the pressure has been turned on, water will begin to come out of this hose almost immediately unless there is air buildup inside the tubing bundle.
	4.	Determine if the pump has started cycling by placing the discharge end of the water tubing into a container of water. Bubbles will occur as rising water pushes air out of the tubing. A slight gas flow exiting the gas exhaust also indicates that the pump is cycling.
	5.	If the pump is determined not to be cycling, the pressure should be gently increased until the pump starts cycling using the methods in step 3.

3.6 System Shutdown

Field Team Member	1.	Turn off the gas supply valve at the top of the nitrogen cylinder.
	2.	Open the bleeder valve on the pressure manifold and slowly drain the nitrogen gas from the line until the pressure on the black regulator reads around 60 psi.
	3.	Disconnect the black regulator hose assembly from the pump by removing the quick-disconnect fittings at the gas inlet on the landing plate. Disconnect the pressure manifold.
	4.	Disconnect the sample elbow from the water discharge connection at the landing plate and place the sample elbow back into its storage bag.
	5.	Complete the disassembly of the system and remove the Bennett pump, if a portable pump is used.
	6.	Replace the stainless-steel cap on the water discharge outlet at the landing plate and tighten.
	7.	Lower the water level in the water discharge tubing to a depth that is sufficient to prevent freezing of this tube by using the provided 20 ft of ¼-in.-outside-diameter (O.D.) nylon freeze prevention line as follows: • Insert the ¼-in.-O.D. nylon freeze prevention line into the water discharge tubing to the stop at the end of the freeze prevention line. • Remove the freeze prevention line from the water discharge tubing. • The displaced water will lower the water level in the water-discharge tubing sufficiently below the frost line

3.7 Removal of Portable Pump

Field Team Member	1.	Remove portable pump from the well.
	2.	Unthread and remove water intake from bottom of Bennett pump.
	3.	Attach brass quick-connect fitting to pump where water intake was removed.
	4.	Attach black airline to regulator and quick connect fitting on bottom of pump.
	5.	Raise air pressure slowly to displace water from the pump discharge lines, collecting formation water as required to comply with waste characterization strategy form for the site.
	6.	Raise air pressure slowly up to 60 psi until all water has been removed from the discharge line.

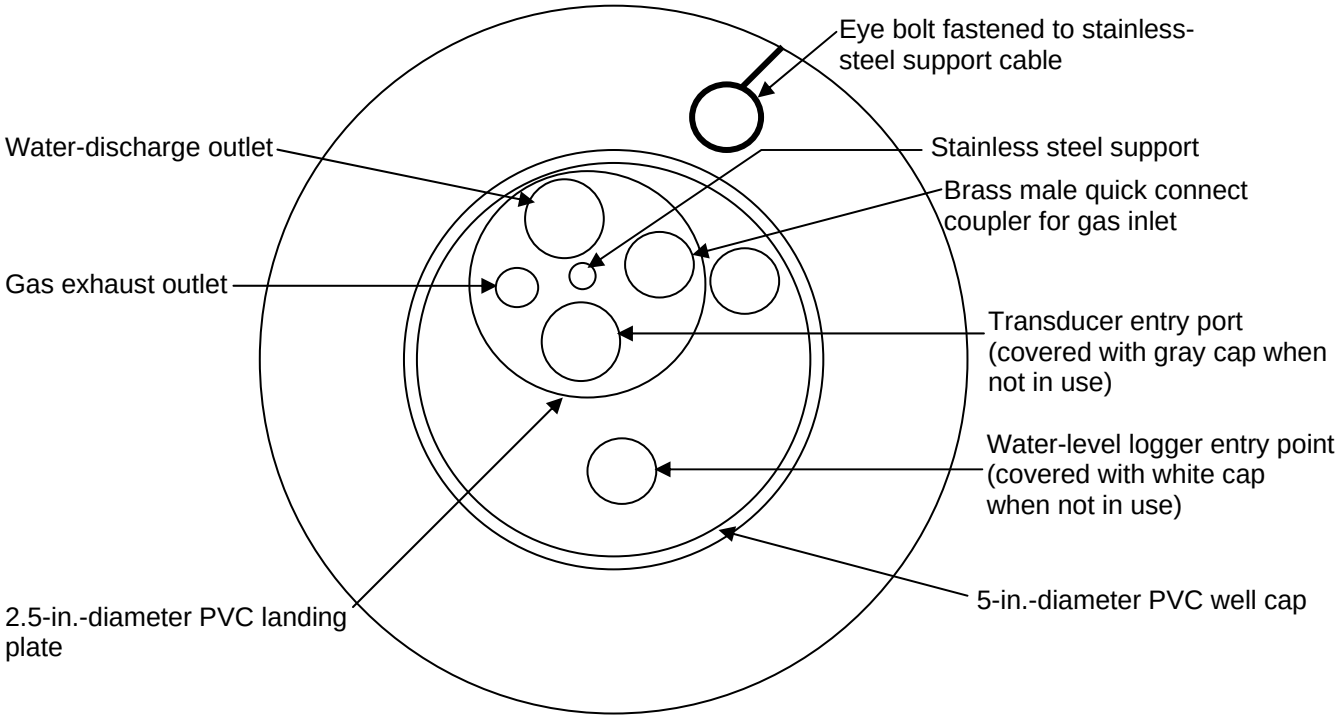

Figure C-1 Well plate schematic

ATTACHMENT 6	
SOP-5232-6 **BASKI PUMPING SYSTEMS**	Records Use Only

1. PURPOSE AND SCOPE

This attachment describes the process for groundwater sampling using Baski pumping systems.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

The Baski dual-screen sampling system relies on two access port valves (APV) to sample two screened intervals in a well using a single submersible pump. The APVs are pneumatic valves that are opened and closed based on differential pressure. Each APV remains closed as a result of pressure from the inflated packer that separates the screened intervals. The APV is opened from the surface by overcoming this pressure using nitrogen gas pumped in through a ¼-in. nylon tube. The submersible pump is isolated from the regional groundwater at its installed depth by a sealed shroud. When either APV is opened, hydrostatic pressure causes the shroud to fill through the drop pipe from the selected screened interval.

Personnel performing this procedure shall be trained in accordance with the provisions of the EP Directorate training program (EP-ERSS-SOP-2011, Personnel Training and Qualification). The training method for this procedure is on-the-job training. Personnel performing this procedure shall have completed the following courses:

- Pressure System Orientation, Course #769
- Gas Cylinder Safety, Course #9518

2.2 Precautions

2.2.1 Operation of a Baski pumping system requires the use of pressurized gas cylinders. Operators should eview LIR 402-1200, Pressure, Vacuum, and Cryogenic Systems, and LIG 402-1200, Compressed Gases, to be aware of hazards and recommended safety practices before setting up and operating a pressure system for operating the bladder pump system.

2.2.2 When working on or around pressure systems, operators must adhere to the following safe work practices:

- Wear safety glasses with side shields or use a face shield.
- Wear safety shoes and leather gloves when moving nitrogen cylinders.
- Use warning signs and mark or label pressure vessels and systems to identify the operating pressure and contents.
- Restrict access to high-pressure areas.
- Handle and store gas cylinders safely.
- Avoid temperature extremes, which can cause pressure changes and component failure.

- Store cylinders that are not necessary for the current work in a safe location outside the work area.
- Never work on a pressure system under pressure. Depressurize the system and use lockout/tagout when appropriate
- Release of inert gases displaces breathable air and can result in unconsciousness. In the event of an accidental or uncontrolled release of gas cylinder contents, evacuate the area and notify your supervisor.

2.2.3 Operation of the Baski pumping system requires the use of a large generator. Ensure the precautions in ENV-WQH-SOP-014, Large Generator Use for Pumping, are observed.

3. STEP-BY-STEP PROCESS DESCRIPTION

3.1 System Setup

Field Team Member	1.	Determine from which screened interval the sample will be taken.
	2.	Connect computer to transducer for zone to be sampled.
	3.	Install the inflation manifold to the regulator on the nitrogen tank. The regulator must be able to handle up to 450 psi. The inflation manifold includes the following: • a Swagelok series QC4 stainless-steel male quick connect fitting • pressure bleed valve • pressure gauge • fill valve • connection to nitrogen tank regulator
	4.	Connect a pressure hose from the inflation manifold to the appropriate female quick disconnect fitting (upper or lower APV) on top of the landing plate (refer to Figure D-1, Landing Plate Schematic).
	5.	Connect the discharge assembly (consisting of a 90-degree elbow, flow meter, valve, spigot, male cam-lock or threaded fitting) to the drop pipe.
	6.	Connect a hose from the outlet of the discharge assembly to the collection container.
Field Team Member (continued)	7.	Mobilize a 480-volt, 3-phase portable generator to the well site in accordance with ENV-WQH-SOP-014.
	8.	Connect the electrical cable from the control box to the generator.

3.2 System Pressurization

Field Team Member	1.	Ensure the T screw on the pressure regulator is loose but do not unthread all the way out.
	2.	Check the pressure bleed valve is closed.
	3.	Check the fill valve is closed.
	4.	Gently crack open the nitrogen gas cylinder tank valve and check for leaks.
	5.	Fully open the nitrogen gas cylinder tank valve.
	6.	Adjust the regulator T screw until the regulator pressure reads approximately 430 psi.
	7.	Leak test all the fittings, quick connects, and hose connections.
	8.	Begin pressurization of the APV by slowly opening the fill valve while monitoring the pressure gauge. The APV should open when the pressure reaches 400 psi. **(WARNING: To avoid damage to the APV, do not exceed the actuation pressure by more than 15 to 20 psi. If necessary, pressure can be reduced by closing the fill valve and slowly opening the pressure bleed valve on the inflation manifold until the proper pressure is achieved.)**
	9.	Once 400 psi is reached on the inflation gauge, wait a minimum of 10 min for the APV to open completely in order for the drop pipe and pump shroud to fill with groundwater before turning on the pump. It may be possible to hear air escaping form the vent hole in the landing plate, indicating the valve is open and shroud is filling. Leave the fill valve open during pumping.

3.3 System Operation

(NOTE: After pressurizing the selected APV, it is critical to allow sufficient time for the APV to open completely in order for the drop pipe and pump shroud to fill with groundwater before turning on the pump.)

Field Team Member	1.	Place the circuit breaker switch on the control box in the ON position.
	2.	Turn the three position (Off-Auto-Hand) control switch to the HAND position.
	3.	Depress the black START button. An audible “click” should be heard indicating the closure of the solenoid allowing startup of the pump.
	4.	Note the time the pump was started and monitor the discharge line for flow.

	5.	If water is flowing within 1 min, proceed with the required operations in the main body of this procedure.
	6.	If water has not started flowing from the discharge line after 1 min, turn off the pump and perform the following. • Release pressure on the APV by slowly opening the pressure bleed valve. • Reinflate to reopen the APV in accordance with section 3.2 above ensuring sufficient pressure is applied to open the APV.

3.4 System Shutdown

Field Team Member	1.	Turn the three position (Off-Auto-Hand) control switch to the OFF position.
	2.	Place the circuit breaker switch on the control box in the OFF position. **(WARNING: The pump must be turned off before closing the APV valve to prevent a vacuum forming at the inlet.)**
	3.	Open the bleed valve to relieve all pressure from the APV.
	4.	Monitor pressure on the packer gauge inside the well monument to ensure the packer inflation pressure does not change.
	5.	Disconnect the airline from the quick connect fitting on the landing plate.
	6.	If the other screened interval is to be sampled, return to section 3.1.
	7.	Shut the nitrogen gas cylinder tank valve and relieve pressure from the inflation manifold.
	8.	Turn off the generator in accordance with ENV-WQH-SOP-014.
	9.	Disconnect the power cable.
Field Team Member (continued)	10.	Remove the inflation manifold from the nitrogen tank.
	11.	Disconnect the discharge line from the discharge line from the discharge assembly.
	12.	Remove the discharge assembly form the landing plate and ensure the polyvinyl chloride (PVC) crossover nipple is left in place on the landing plate.
	13.	Ensure that all gauges and fittings that remain inside the well monument are below the top of the monument and close and lock the cover.
	14.	Lock and secure the well.

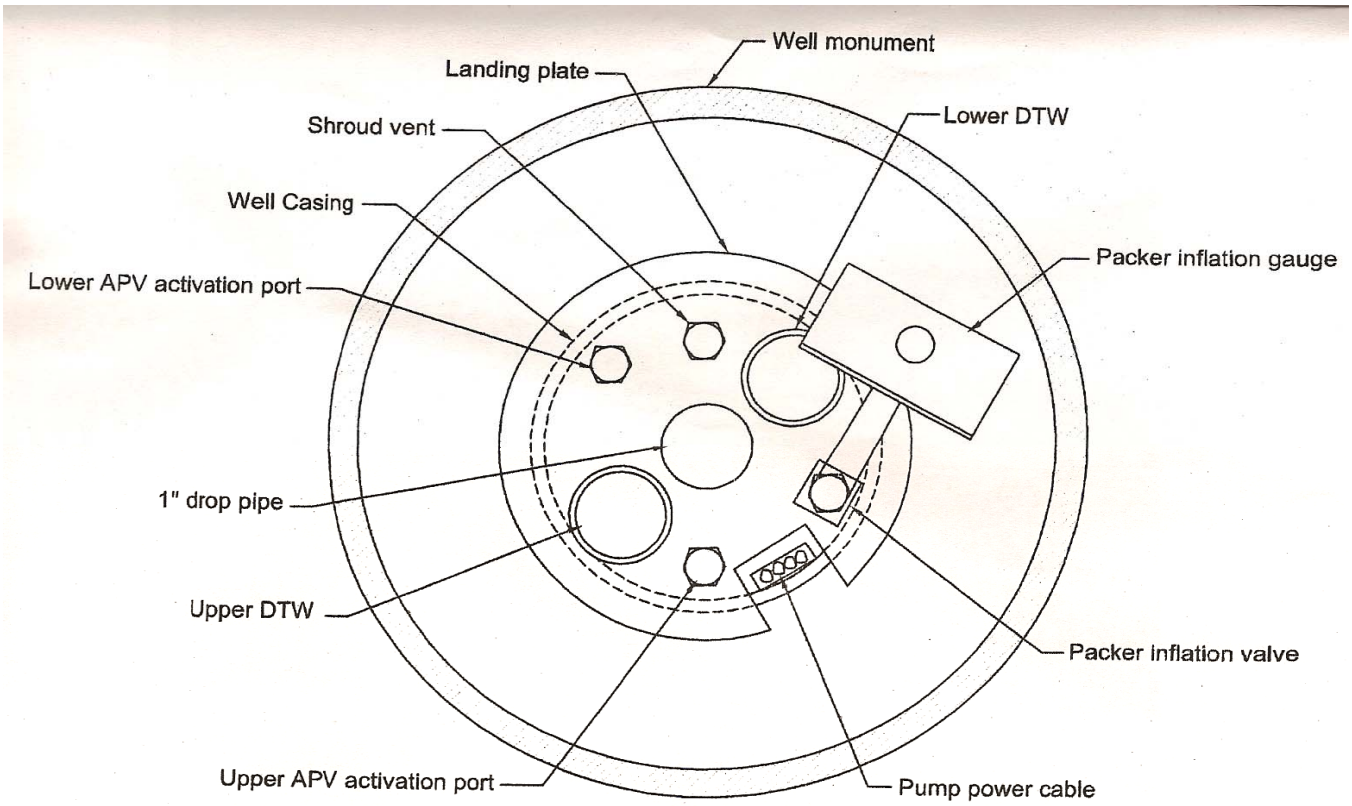

Figure D-1 Landing plate schematic

ATTACHMENT 7	
SOP-5232-7 **QED PORTABLE BLADDER PUMPING SYSTEMS**	Records Use Only Los Alamos NATIONAL LABORATORY EST.1943

1. PURPOSE AND SCOPE

This attachment describes the process for groundwater sampling using QED portable bladder pumping systems. The specific systems pertaining to this appendix are the QED SamplePro 1.75-in. bladder pump, the MP15 control and power pack, and the MP10 controller.

2. BACKGROUND AND PRECAUTIONS

2.1 Background

Most shallow alluvial monitoring wells in the EP-ESP are equipped with dedicated Monoflex Isomega bladder pumps constructed of Teflon. Alluvial wells that are farther than several hundred meters from vehicle access or that do not have dedicated pumps in place are sampled using the QED SamplePro bladder pump. Bladder pumps are used to collect 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 carbon dioxide or 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/ft 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.

Personnel performing this procedure shall be trained in accordance with the provisions of the EP Directorate training program (EP-ERSS-SOP-2011, Personnel Training and Qualification). The training method for this procedure is on-the-job training. Personnel performing this procedure shall have completed the following courses:

- Pressure System Orientation, Course #769
- Gas Cylinder Safety, Course #9518

2.2 Precautions

2.2.1 Operation of a bladder pump requires the use of pressurized gas cylinders. The operator must review Laboratory implementation requirement 402-1200 Pressure, Vacuum, and Cryogenic Systems, and Laboratory implementation guideline 402-1200, Compressed Gases, to be aware of hazards and recommended safety practices before setting up and operating a pressure system for the bladder pump system.

2.2.2 When working on or around pressure systems, the operator must adhere to the following safe work practices.

- Wear safety glasses with side shields or use a face shield.
- Wear safety shoes and leather gloves.

- Use warning signs and mark or label pressure vessels and systems to identify the operating pressure and contents.
- Handle and store gas cylinders safely.
- Avoid temperature extremes, which can cause pressure changes and component failure.
- Store cylinders that are not necessary for the current work in a safe location outside the work area.
- Never work on a pressure system under pressure; depressurize the system and use lockout/tagout when appropriate.
- Release of inert gases displaces breathable air and can result in unconsciousness. In the event of an accidental or uncontrolled release of gas cylinder contents, evacuate the area and notify your supervisor.

3. STEP-BY-STEP PROCESS DESCRIPTION

3.1 System Setup

Field Team Member	1.	Ensure that a sufficient number of carbon dioxide or nitrogen tanks are secured in the vehicle.
	2.	Install the safety manifold on the carbon dioxide or nitrogen tank. The safety manifold includes the following: • regulator with two gauges • manual vent valve (not equipped with carbon dioxide manifold) • pressure relief valve set to 125 psi (set at 20% over the maximum working pressure) • quick connect coupling or air roving coupling (NOTE: Safety manifold, hoses, pump controller, and well assembly have been prefabricated. DO NOT remove or change coupling, valves, whip restraints, quick connects, or any other components of the pressure system in the field.)
	3.	Connect dedicated pressure hose to the quick connect coupling on the safety manifold and secure hose with cable whip restraint (nitrogen use only).
	4.	Connect the other end of the dedicated pressure hose to MP10 or the MP15 controller (nitrogen use only).

Field Team Member (continued)	5.	Set up/prepare SamplePro bladder pump by performing the following steps: (NOTE: Wear nitrile gloves during pump setup/preparation.) • Remove pump from protective case. • Inspect O-rings and check valves on pump head to ensure functional integrity, replace if necessary. • Install new Teflon bladder onto barb. Wells greater than 75 ft need bladder connector fitting attached. • Install new grab plate into head assembly. • Based on measured depth to water and known total depth of well, cut the corresponding lengths of Swagelok air tubing and Teflon-lined polyethylene tubing. • Set both tubing and pump in a clean place free of potential contamination until ready to deploy.
	6.	Connect the pump controller to the SamplePro bladder pump via quick connect air fitting and Swagelok air tubing cut to the length needed to purge and sample the well.
	7.	Insert precut tubing ends into pump head and grab plate until firmly seated against O-rings. “W” indicates water line and “A” indicates airline.
	8.	Attach stainless-steel security cable to pump head.
	9.	Deploy pump, with noted corresponding components, slowly down the well. While lowering the pump into the water decontaminate the cable and tubing with a Kimwipe and DI water.
	10.	When pump has been submerged, set a clamp on the steel cable to ensure no further movement down the well due to gravity. Pump should be set above sump with pump intake in middle of screen interval.

3.2 System Pressurization

Field Team Member	1.	Ensure the T screw on the pressure regulator is loose but do not unthread all the way out (nitrogen use only).
	2.	Ensure the vent valve is closed (nitrogen use only).
	3.	Gently open the nitrogen or carbon dioxide gas cylinder tank valve and check for leaks.
	4.	Fully open the nitrogen or carbon dioxide gas cylinder tank valve.
	5.	Adjust the regulator T screw until the desired pressure is read on the regulator (nitrogen use only).
Field Team Member (continued)	6.	Leak test all of the fittings, quick connects, and hose connections.

3.3 System Operation

Field Team Member	1.	Ensure all hose and gas cylinder connections are secure and functional.
	2.	Determine the proper pump operating pressure as follows: • Multiply the vertical distance of the pump in feet by 0.45 psi (0.03 bar) for nitrogen and 0.42 psi for carbon dioxide. Add 10–20 psi (0.7–1.4 bar) to obtain the operating pressure for nitrogen and 10–15 psi for carbon dioxide. For example: Sample to be evacuated at 100 ft: 100 ft × 0.45 = 45 psi lift + 10 psi = 55 psi operating pressure 100 ft × 0.42 = 42 psi lift + 10 psi = 52 psi operating pressure
	3.	Set the pump pressure to calculated value.
	4.	Cycle the pump and observe its operation. Start at four cycles per minute and put discharge line in a calibrated 1-L bottle to determine a flow rate.
	5.	Adjust the timers, as necessary, to maximize the pumping rate. 6. If needed, increase/decrease pressure on controller or at the tank. 7. If flow rate is still far below 1 L/min, then increase the number of cycles per minute.

3.4 System Shutdown

Field Team Member	1.	Press STOP button on controller.
	2.	Shut off the gas cylinder tank valve.
	3.	Vent the system to the atmosphere (nitrogen use only).
	4.	Disconnect all hoses and whipping chains.
	5.	Carefully pull pump out of well while wiping water off of steel cable with DI water and Kimwipe.
	6.	Separate cable and tubing from SamplePro portable pump.
Field Team Member (continued)	7.	Remove tubing from grab plate and add to the contact waste for that sampling event.
	8.	Disassemble pump and add grab plate and bladder to contact waste. Empty bladder into purge water before disconnecting.
	9.	Decontaminate the pump and all of its components before returning it to the protective case. Decontaminate pump using DI water, cleaning brushes, and Kimwipes.

10. Lock and secure well.