2010-2011 Pilot Test Work Plan Addendum, Quality Assurance Project Plan for Field Sampling

Aquifer Storage and Recovery Project Boise White Paper LLC Plant
Wallula, Washington

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2010-2011 Pilot Test Work Plan Addendum, Quality Assurance Project Plan (QAPP) for Field Sampling, Aquifer Storage and Recovery Project, Wallula, Washington

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September 2010

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Table of Contents

List of Tables

List of Figures

Appendices

Section 1 Introduction and Background

This document presents the Pilot Test Work Plan Addendum (Work Plan) to the approved Quality Assurance Project Plan (QAPP) related to the Aquifer Storage and Recovery (ASR) project at the Boise White Paper LLC plant (Boise) located in Wallula, Washington.

This QAPP addendum was prepared by GSI Water Solutions, Inc. (GSI) and HDR Inc. on behalf of Boise White Paper LLC. This QAPP addendum, which is the first of several planned for the Project, focuses on the collection of hydrogeologic, and geochemical data during limited scale pilot testing to be used in developing the full scale ASR Project. This Work Plan was prepared in general accordance with the guidelines presented in Ecology Publication No. 04-03-030 (Ecology, 2004).

The tasks covered by this Work Plan involve collection of additional data during limited scale pilot testing of the ASR-5 well to characterize the chemical and hydraulic characteristics of the targeted CRBG aquifer, the chemical characteristics of the treated ASR source water derived from the Columbia River, the chemical compatibility of the ASR source water and the native groundwater, and the hydraulic response within the aquifer to ASR injection and pumping.

Phase 1 of the ASR project focused on initial aquifer hydrologic evalaution, geologic and hydrogeologic characterization, geochemical modeling, thermal modeling and aquifer (pump) testing, and was conducted in 2009. The results of Phase 1 were presented in ASR-5 Well Report, Boise Paper, LLC Wallula Mill Thermal ASR Project (GSI Water Solutions and HDR Inc., 2010). The results can be summarized as follows:

1. The ASR target horizon has high transmissivity (>240,000 feet^2 per day [ft^2/d]), but is of limited lateral extent. It potentially covers several tens of square miles in the immediate vicinity of the Mill.
2. The targeted horizon has flow-limited boundaries. Based on GSI interpretations of area geology, these include a transition from pillow basalt to normal interflow zones to the north and east, and potential fault systems to the west and south.
3. There is some suggestion of other wells pumping water from this horizon, although a well inventory suggests these wells are more than 2 to 3 miles away.
4. The target zone may have some hydraulic connection to deeper water sources, but its connection to shallow basalt water-bearing intervals and the Columbia River at and near the Mill is limited.
5. River water geochemistry is different than the groundwater geochemistry in the target zone. Mixing of the two waters in the aquifer could result in precipitation of iron hydroxides and dissolution of iron pyrite that could result in possible

mobilization of trace metals and arsenic.

6. Pollutants are not present in treated Columbia River water at concentrations of concern.

7. If the ASR source water is chlorinated prior to injection, chlorine and disinfection by-products are the only constituents that potentially would negatively impact groundwater quality as a result of proposed ASR activity.
8. Even with the relatively high ambient groundwater temperature (80 degrees F), the target basalt aquifer appears to be capable of retaining the cold characteristics of the injected water, based on thermal modeling results.
9. Injection should occur only during months when the influent Columbia River water temperature is less than about 48 degrees F to maximize the benefits of the cold water storage. Based on historical data, this would occur typically between December and April 15of each year.

On the basis of those results, Ecology and Boise have decided to procede with a limited scale ASR cycle testing rather than proceed directly to Phase 2, full scale ASR. Phase 2 was originally focused on construction and operation of a full-scale injection and extraction system authorized under an ASR permit. The reason for going forward with a pilot rather than full scale project at this time is because of three basic sets of uncertainties identified in the ASR-5 Test Well Report: (1) those associated with the ASR and water rights permitting pathway and (2) those associated with the nature of the hydrologic boundaries (is the storage zone large enough) and 3) those associated with water quality. Water quality related uncertainties include the aquifers ability to retain and later produce cool injected water, and source water–groundwater geochemical interactions that could result in precipitation of minerals that would be unacceptable for plant operations.

Elements of the previously approved QAPP (the revised version that was approved in 2009 for both Phase 1 and Phase 2 of the proposed project) include methods and procedures for the following:

- Collecting water samples from wells (Sections 5.4, 5.5, 6.2 and 6.3),
- Collecting geologic samples from boreholes (Section 6.5),
- Collecting hydrogeologic information (Sections 5.4, 5.5, and 6.1,)
- Performing aquifer tests (Sections 5.3), and
- Performing ASR cycle tests (Sections 5.7 and 5.9).

Elements described in this Work Plan include some of the activities and methods described in the original QAPP, thus this Work Plan Addendum will reference the original QAPP where applicable and provide supplemental detail or revisions to the original QAPP as needed. However, this Work Plan is structured to be a standalone document for reference for field personnel, so where applicable, details from the original QAPP are included. The Work Plan is intended to support the objectives of Phase 2 of the ASR Project which include the following:

- Confirm feasibility of injecting, storing and recovering cold Columbia River water
- Confirm treatment system performance and suitability for process water
- Evaluate aquifer storage capacity and recovery percentage
- Confirm water quality compatibility (in the aquifer)
- Confirm thermal and recovered water quality characteristics and compatibility with plant operations
- Assess full-scale ASR operational parameters (injection/pumping rate, storage volume, injection timing)
- Assess potential for impacts
- Prepare detailed scope and cost estimate for full-scale project

This Work Plan is organized into the following sections:

1. Introduction and Background
2. Project Schedule and Milestones
3. Pilot Test Program Equipment and Infrastructure
4. Pilot Test Program Overview
5. Water Level Monitoring
6. Water Quality Monitoring
7. System Operation, Monitoring and Maintenance
8. Reporting

Sections 1 through 4 outline the project understanding, system design and required tasks prior to the limited scale ASR testing program. A description of field sampling and monitoring procedures, water quality testing and quality control (QC), and laboratory test procedures and QC prior to and during ASR pilot testing are presented beginning in Section 5 through 7. Data management and reporting are included in Section 8. Tables and Figures are presented at the end of the Work Plan.

Section 2 Proposed Project Team, Schedule and Milestones

This section presents the project team and roles, the proposed schedule and milestones for the pilot test program.

2.1 Project Team

Boise White Paper LLC is the owner for the project. Mr. David Tobin is the primary Boise White Paper LLC representative with overall fiscal oversight and contract management responsibility. Mr. Ray Lam of Silk Road Environmental will provide project management and permitting support to Boise White Paper LLC. HDR, Inc. is the Engineer and Prime Design-Build Contractor for the project. HDR, in collaboration with Boise White Paper LLC will provide engineering and construction services. Mr. Paul Smith is the project manager for HDR. GSI is a subcontractor to HDR and will act as the principal investigators for the hydraulic testing, water quality sampling, and ASR cycle testing elements of the Project. Mr. Kevin Lindsey is the GSI lead on the project with support from Mr. Jeff Barry and Mr. Chris Augustine. The Washington State Department of Ecology Office of Columbia River funds the project. At Ecology, Guy Gregory is primary contact and overall project manager, Al Josephy manages the grant monies administered by Ecology's Office of Columbia River, and Taylor Horne is the primary permit manager. Contact information for these and other staff working on the project are presented in Table 1.

Table 1. Contact Information

Name	Affiliation (Role)	Address	Phone Number	Email
David Tobin	Boise White Paper LLC Project Manager	31831 W Hwy 12 PO BOX 500 Wallula, WA 99363	(509) 546-3415	DavidTobin@BoisePaper.com
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2.2 Proposed Schedule and Milestones.

The proposed project schedule is to perform the scaled-down pilot testing phase between January 2011 and September 2011. Implementation of the Pilot Test program includes several activities that must be accomplished in 2010, prior to performing the actual limited scale testing in 2011. These activities include permitting, design, and construction. Ecology will have several opportunities for review and input prior to initiating ASR pilot testing.

Given the probable permitting timeline, the sequence of the proposed schedule based on current project understanding is:

1. Apply for Water Use Authorization, which includes pilot project work plan (QAPP Addendum), revised QAPP submitted to Ecology, and UIC Registration. (July 2010)
2. Obtain Ecology approval for water use authorization (September 2010)
3. Prepare preliminary pilot system design, equipment list, engineering specifications as required and 30% construction cost estimate (August – September 2010)

4. MILESTONE: Obtain Ecology approval (30% Design)
5. Detail Design pilot project elements
6. MILESTONE: Obtain Ecology approval for Bid Documents Design (October 2010)
7. Solicit bids for contracted work (October 2010)
8. Construct pilot project elements (November 2010 – January 2011)
9. Conduct pilot testing and monitoring (January 2011 – September 2011)
10. Analyze and Report Cycle 1 Testing (January-February 2011)
11. Analyze Cycle 2 test data (July 2011 – October 2011)
12. Submit Pilot Test Report (November 2011)

Design of the system can be performed in parallel with the regulatory tasks but will also require Ecology and Boise approval prior to moving forward. Construction, in turn, likely would not begin until late 2010, such that infrastructure would not be completed in time to take advantage of cold water in the Columbia River until early 2011. As with any construction program, the schedule is subject to change due to a number of factors including contractor availability, unforeseen subsurface conditions, equipment failure, and issuance of needed permits. We will attempt to minimize impacts from schedule delays through effective communication, forecasting of milestones and effective project management.

Once the ASR injection and pumping system is constructed, the project will consist of the following field activities:

- Establish the water level monitoring program at key wells.
- Collect baseline groundwater samples, raw and treated Columbia River water samples
- Conduct ASR cycle tests, monitor water levels and collect water samples during injection, storage and recovery

A description of the proposed Cycle 1 and Cycle 2 testing programs, field sampling and monitoring procedures, water quality testing and quality control (QC), and laboratory test procedures and QC are presented beginning in Section 4.

2.3 Budget and Funding

Funding for this project is provided by Grant G09000172 from the Washington Department of Ecology Columbia River Basin Water Management Program. The project funding is being distributed to Boise White Paper LLC in Phases. Phase 1 of the project, including PNNL test well data collection, permitting, and ASR test well construction has been authorized and completed. Funding for the Work Plan preparation and initial pilot project permitting was done by amending the contract between Ecology and Boise Paper (Amendment 1, dated August 12, 2010. Funding for the design and pilot testing activities will be authorized after the work plan is approved. Approval is expected before September 2010.

Section 3 Pilot Testing Equipment and Infrastructure

This section describes the conceptual design of the treatment system, injection and pumping system, pump to waste system, PLC and distribution system. The actual specifications for the treatment system will be provided in subsequent design refinements prior to construction of the facilities.

3.1 Treatment System

The raw source water for ASR injection will be diverted from Boise White Papers LLC existing diversion system located on the Columbia River. The raw source water will be will first enter the caisson (intake compound for river channel water) supplied by either the floc former supply pump header or the Evap 3 supply pump. Pre-treatment with a polymer may be required to reduce influent turbidity. The polymer chemical name is Diallyldimethylammonium Chloride and is commonly called Poly DADMAC with the molecular formula $(C_8H_{16}NCl)_n$. At this time, we do not intend to disinfect the water prior to injection in order to avoid introduction of chlorine disinfectant, which would produce disinfection byproducts.

Final treatment of the source water for injection will include membrane filtration. The Pilot project treatment system will be modular skid consisting of 4 pressure media vessels capable of filtering 500 to 800 gpm. The skid mounted system will be capable of reducing turbidity to the target effluent turbidity of 0.5 nephelometric turbidity units (NTU) at the anticipated injection rate. A booster pump may be needed to accommodate system head losses. The pilot system will have inline water quality instrumentation installed to gather temperature, pH, turbidity, specific conductance, and dissolved oxygen. The water quality instrumentation will record and store the treated water quality data continuously in the mills data collection system. Systems would be purchased and sized so that they could be reused for the full-scale project where practical.

3.2 Injection System

Water will be conveyed through temporary piping from the treatment unit to the ASR well. A recharge loop will be installed on the discharge of a line shaft turbine pump to allow injection and pumping at the wellhead. The wellhead will have a flow control valve, air relief valve, bi-directional flow meter, pump to waste system, water level access tube, transducer access tube, and sample port. Water will be injected under positive pressure into the well through the recharge loop and into the pump column of the line shaft turbine pump. Injection rate will be controlled by a downhole injection control valve. Systems will be sized so that they could be reused for the full-scale project where practical.

3.3 Pumping System

A purchased line shaft turbine pump that also serves as part of the injection system will be used to recover stored water. Pumped water will be directed to the back wash sump (if use is allowed) or to the wastewater ponds as was done during the pumping test. Temporary discharge piping will be used.

Section 4 Pilot Test Program Overview

The primary objective of this study is to collect representative data for the ASR Project so that decisions can be made regarding the feasibility of full-scale ASR operations to meet Boise White Paper LLC and Ecology objectives.

The pilot testing program consists of two components:

- **Baseline Monitoring** – Includes a water level monitoring program initiated before the start of ASR testing. GSI has had electronic pressure transducers continuously recording water levels in the groundwater as part of the feasibility study. A step rate aquifer test will be conducted at the ASR well to document pre-ASR well performance.

- **ASR Pilot Testing** – Divided into yearly cycle testing programs. One ASR pilot testing cycle includes an injection period, a storage period, and a recovery period.

    - ***Year 1*** – Includes a shakedown test, one short-duration pilot testing cycle, and a longer-duration, limited-scale pilot testing cycle.

    - ***Years 2 and Beyond*** – Injection, storage, and recovery rates and duration for subsequent ASR testing cycles will be determined on the basis of previous year operations. Because all of the stored water may not be recovered each year, the subsequent year's injection volume may be reduced. Additional ASR wells may be installed on the basis of the results collected during the initial well pilot testing.

The planned injection and recovery rates and schedule for cycle 1 and 2 pilot testing are presented in Tables 4, 5 and 6, respectively. Tables 4, 5 and 6 also present the planned water quality monitoring program and schedule for sampling and monitoring field parameters, source water prior to injection, stored water, and recovered water for Cycle 1 and Cycle 2, respectively. The pilot testing and sampling schedule presented in Tables 4, 5 and 6 are preliminary and may be modified as needed depending on results observed as the project progresses and review of the sampling or hydraulic response results indicates additional sampling may be required.

4.1 Baseline Monitoring and Sampling

A network of observation wells will be used to monitor groundwater levels in the shallow and deep basalt aquifer before the start of ASR pilot testing. In addition, the Columbia River stage will be monitored to evaluate the relationship between the river and shallow groundwater levels. The purpose of the baseline monitoring is to identify water level trends that could affect interpretation of the ASR pilot test results. Manual water level monitoring will be conducted for a period of 6 weeks before the start of pilot testing.

The proposed ASR program monitoring network to be used during pilot testing will include the following (refer to Figure 1):

- ASR-5 test well
- OBS -2 – a deep basalt observation well completed at the same elevation as ASR-5 within the Pomona Member, Saddle Mountains Basalt, 100 feet from ASR-5.
- OBS -1 - a shallow basalt observation well completed within the interflow zone between the Ice Harbor and Elephant Mountain Members, Saddle Mountains Basalt.
- Columbia River stage

The presently identified observation well locations are shown in Figure 1. Modifications to the network of observation wells may be made during subsequent years of ASR pilot testing as additional ASR wells are added or observation wells identified. Ecology will be notified and this QAPP and Workplan will be amended if additional wells are identified or if any changes are made to the monitoring network or analyte list. Measuring point elevations at any other identified suitable observation wells will be surveyed before initiation of the ASR pilot testing.

Groundwater quality sampling will be performed using a dedicated pump installed at both ASR-5 and OBS-2. Surface water and source water grab samples will be collected at locations to provide the most representative water quality sample results. No water quality samples are currently proposed to be collected from the shallow aquifer. Specific details for water level monitoring and water quality sampling are presented in Section 5 and Section 6 respectively.

4.2 Shakedown Testing

Before initiating the first pilot testing cycle, a shakedown test will be performed that will consist of turning on injection to check the operation of the injection system and to check well pump operation. Shakedown testing of the installed source water treatment system, distribution system and wellhead controls, inline water quality meters and data recording system will be performed prior to the start of injection. Testing of each system will be performed to determine that each individual component of the system is operating as designed and that reported flow rates, water level and water quality monitoring values are within acceptable limits.

Adjustments to the system will be made as necessary. After the shakedown period, a short-duration injection and recovery cycle (Cycle 1) will be performed.

4.3 Cycle 1 Testing

The objective of Cycle 1 is to evaluate the injection system/well performance and briefly examine the response of the aquifer system to injection. The data collected during this short cycle will provide the basis for predicting system performance during larger-scale ASR tests.

During Cycle 1, water levels will be monitored at the same network of observation wells used during the baseline monitoring program (see section 4.1). At wells instrumented with transducer and data logging equipment, electronic water level measurements will be taken at least every minute during injection and recovery. Specific intervals of data collection for water levels are presented in Section 5.3. All well locations will be monitored periodically using a water level sounder. Water quality monitoring, sampling, and analysis procedures and frequency are described in Section 7 and in Table 4.

Cycle 1 pilot testing will consist of a 3-day injection-extraction cycle. Water will be injected into the well at a rate estimated to be 500 to 800 gpm for approximately 1 day. . The injected water will be stored for approximately 1 day and then recovered at 1000 gpm during a 19-hour period (potential recovery of up to 110 percent of injected volume). The recovered water will be discharged to the Boise wastewater clarifier as shown on Figure 1.

4.4 Cycle 2 Testing

The objective of Cycle 2 is to evaluate the long-term aquifer hydraulic response, well performance, thermal retention characteristics, and water quality conditions under operational-scale ASR conditions.

Cycle 2 of the pilot testing will consist of the following:

- A 105-day injection period (76-121 MG) at an estimated injection rate of 500 to 800 gpm)
- A 30 to 60 day storage period
- A step-rate pumping test followed by a 110-135 day recovery period at an estimated recovery rate of 800 to 1000 gpm.

Potentially more water than was injected may be recovered (up to 110 percent of the injection volume allowed under the Temporary Water Use Authorization) to provide data to support assessments of the mixing zone size, temperature changes, and geochemical interactions that may occur.

The long-term injection phase of Cycle 2 will be used to assess head buildup in the aquifer, potential for loss of stored water, and injection well efficiency changes over time. The storage phase will be used to determine if the temperature and quality of the stored water changes substantially during storage and the degree to which the head buildup is maintained. A step-rate pumping test will be performed at the start of the recovery phase. Results of the step test will be compared to the baseline step-rate test conducted as part of the ASR Feasibility Study to assess changes in well efficiency following ASR.

During Cycle 2, water levels will be monitored at the same network of observation wells used during Cycle 1 testing. The frequency of water level measurements will be similar to that prescribed for Cycle 1, except that wells not instrumented with transducer and data logging equipment will be manually monitored on a bi-weekly schedule. Water quality monitoring, sampling, and analysis procedures and frequency are described in Section 6 and Table 5 of this work plan.

The recovery portion of Cycle 2 will be used to estimate the amount of mixing and to identify changes in well performance and aquifer characteristics relative to the initial baseline pumping tests. Field water quality parameters will be measured during pumping to characterize the mixing zone during the end of the target recovery volume (using criteria developed during baseline monitoring and Cycle 1 testing).

If approved by Ecology, the recovered water will be put into the Boise White Paper filtered water distribution system, if water quality sampling conducted during the storage phase indicates that the water quality is acceptable for this purpose. Acceptability of the recovered water for use in the Mill will be decided by Boise White Paper. Acceptability will be evaluated using a number of parameters and observations including corrosivity (pH), potential to cause significant scaling, potential to mobilize metals or other constituents that would violate the plants NPDES discharge limitations, potential to produce gases, and potential to precipitate significant amounts of iron or manganese minerals on the inside of pipes. Boise will evaluate these conditions during the pilot testing period and does not have specific criteria at this time. In the event that the quality of the water being injected becomes impaired or the recovered water is unacceptable, all of the water injected into the aquifer will need to be recovered and pumped to waste. The Boise White Paper LLC clarifier and wastewater system will be capable of handling the flow produced by the ASR well.

Section 5 Water Level Monitoring

Observation wells will be used to assess the head buildup during injection and drawdown during pumping and to assess aquifer boundary conditions, including possible interconnection between the storage zone and the Columbia River. This section describes the equipment, data collection, data management and objectives of the water level monitoring performed during the pilot test program.

5.1 Equipment

Electronic water level sounders and electronic pressure transducers with data loggers will be used to measure and record water levels at the ASR-5 well and monitoring wells. The electronic pressure transducers will be selected to maximize the water level accuracy for the anticipated range of water level response in accordance with sampling procedures outlined in Section 6.1 of the QAPP. We intend to use either Solinst or Insitu dataloggers. Both of the proposed manufacturers pressure transducers are factory calibrated and have sensor accuracy to one-tenth percent (0.1%) of the full range scale of the pressure rating. Based on the anticipated water level fluctuations, a 30 psi pressure range should be sufficient at each monitoring location. Manual water level data and real-time barometric pressure data will be used to evaluate accuracy in the field. Plots of raw pressure data versus manual water level data will be used to identify failure of pressure transducer or electronic drift.

While most electronic pressure transducers have the capability to measure temperature, temperature of injection and recovery water will be monitored using the in-line water quality sensors installed in the ASR-5 piping system and the multi-parameter meter during water quality sampling (Section 6). Electronic and manual water level data will be measured with a precision of 0.01 feet.

Vented pressure transducers will be used to monitor the Columbia River stage and water levels at OBS-1. A stilling well consisting of a PVC pipe will be installed in the Columbia River at the Boise barge slip so that a data logger and transducer can be used to record river stage fluctuations. Non-vented pressure transducers will be used to monitor barometric pressure changes at ASR-5 and OBS-2 well. This will be done so that barometric efficiency can be evaluated and water level data corrected, if necessary. The pressure transducers will be installed with downhole communication cables for ease of data collection and checking data logger function.

The logging frequency will be set to once per hour except during aquifer testing or ASR testing. During these dynamic tests, the logging frequency will be logarithmic or once every minute. If a transducer fails during testing, the test may be terminated and transducer replaced if the failure occurs early in the test. If the failure occurs later in the test, the test will continue and a replacement transducer will be installed as soon as possible. During this time, the frequency of manual measurements will be increased. Information regarding the dedicated transducer set times, PSI rating, sensor type, serial numbers, depth settings, and corresponding depth to water measurements will be recorded on field data collection forms. All manual water level measurements will be recorded in a field notebook or field data collection form (Appendix A).

5.2 Water Level Monitoring Locations

Baseline water level monitoring of the target aquifer, the shallow aquifer and the Columbia River stage will be performed prior to the installation of the ASR injection system.

The objectives of the baseline water level monitoring are to:

- Evaluate antecedent aquifer trends
- Evaluate the potential influence of nearby wells
- Identify additional observation well locations that would be likely penetrate the target aquifer

Water level monitoring will be performed by installing dedicated electronic pressure transducers in the OBS-1, OBS-2 and Columbia River. A dedicated pressure transducer will be installed at ASR-5 once the sounding tube, injection and pumping system installation is completed. The final ASR-5 well head measurement reference point will be surveyed in accordance with Section 4.5 of the original QAPP.
Baseline water level monitoring will be conducted during a 6-week period before the start of the ASR pilot testing. Water levels will be monitored with electronic data loggers and pressure transducers in ASR-5, OBS-1 and OBS-2, depending upon access and permission other wells may be electronically monitored. Water level measurements at the each observation well will be collected manually using an electronic water level sounder, as access permits. Manual water level measurements will be made and recorded to an accuracy of 0.01 foot.

5.3 Data Collection

Water level monitoring data will be collected at the same general intervals described in Sections 5.3 of the original QAPP. The recommended time intervals for automated water level measurements during start of injection and recovery are:

0 to 10 minutes	– every 0.1 minute (6 seconds)
10 to 100 minutes	– every 1 minute
100 to cessation of pumping	– every 10 minutes
1,000 minutes to cessation of pumping	– every 60 minutes

After the initial start up of Cycle 2, manual water level measurements will be made on a daily basis for the a minimum of two weeks at the start of injection and recovery phases. Weekly manual water level measurements will be collected once stabilization of the injection and recovery pumping levels is observed.

Following shut-down of the pump at the end of injection and recovery pumping, water level readings during recovery will continue to be made in the well network at intervals matching those required for the injection and recovery phase of the test (both automated and manual) until water levels have recovered to 95% of the pre-test water level. In the event of rapid recovery, or recharge, water level measurements will be collected for at least a minimum of two weeks following the end of the test. Field information will be recorded on the field forms provided in Appendix A. Field data and electronic data will be transferred to and stored in Excel spreadsheets that will be provided to Ecology upon submittal of the report.

5.4 Data Evaluation Methods

Drawdown, drawup and recovery data will be analyzed and aquifer parameters estimated using standard curve matching and analytical techniques that are appropriate for the observed response in the data. Head buildup due to plugging will be evaluated using standard approaches such as effective hydraulic area analysis or comparison of the observed hydraulic response at observation well OBS-2 with the injection well ASR-5 (Pyne, 2005).

Section 6 Water Quality Monitoring and Sampling

This section describes the required monitoring and sampling during the pilot test program. The section is meant to supplement the 2009 QAPP Sections 4 through 11. The objectives of the water quality monitoring program include the following:

- Confirm that the injected water does not degrade native groundwater quality.
- Confirm that recovered water quality is acceptable for use in the Boise plant:
    - Temperature
    - pH
    - Alkalinity
    - Corrosion potential
    - Turbidity

- Assess thermal retention characteristics of the target aquifer
- Assess bacterial and virus viability and inactiviation rates in the target aquifer
- Assess water quality compatibility with respect to:
    - Injection well clogging caused by particulates (turbidity), air, biological activity, and chemical reactions
    - Mineral dissolution reactions in the aquifer that could affect recovered water quality
    - ASR well redevelopment criteria
    - Recovery efficiencies

Samples of ASR source water and recovered groundwater will be tested for the analytes listed in Table 3. The parameters on the list will be used to determine whether there are constituents or organisms present in the ASR source water that would degrade native groundwater quality, and if recovered groundwater is of sufficient quality to be used in the Boise plant. Selected parameters including cations, anions, metals, and redox parameters will be input into PHREEQC to model saturation indices of common minerals, model precipitation and dissolution reactions, and assess the potential to mobilize of trace minerals (i.e. arsenic) in order to assess water quality compatibility between native groundwater and ASR source water (GSI and HDR, 2010).

Water quality monitoring, sampling, and analysis procedures were previously described in Section 6 of the original QAPP. However, because the injected water will be filtered but not disinfected, additional biological parameters will be monitored to determine bacterial and viral inactivitation rates during injection, storage and recovery phases of the Cycle 2 testing. Sampling methodology and procedures for the additional microbiological sampling are provided here.

6.1 Bacteriological and Viral Water Quality Sampling Methodology

Bacteriological and viral inactivation rates in groundwater were evaluated by GSI in the memorandum *Bacteria and Virus Survival during ASR at the Boise White Paper Site, May 18, 2010*, **t**he major conclusions of that study and available literature indicate the following:

- Temperature is the dominant factor in controlling the inactivation rate for bacteria and viruses within the basalt aquifer.

- The mean inactivation rate for bacteria varies from 0.063/day at a temperature range of 0 - 10°C to 0.092/day at 10-15°C.

- The mean inactivation rate for viruses varies from 0.015/day at a temperature range of 0 - 10°C to 0.097/day at 10-15°C.

- The temperature of the stored and recovered water will vary from 7.8 to 14.4°C (46 to 58°F).

- The travel time for the injected source water to reach the Boise property boundary, assuming a gradient toward the property boundary will be present during injection, is at least 150 days.

- Inactivation of 99.99% of bacteria in the aquifer will occur in less than 150 days at all reasonable temperatures.

- Inactivation of 99.99% of viruses in the aquifer may require more than 150 days at temperatures <10°C.

The review indicates that the likelihood of degrading groundwater quality is very low based on the site groundwater conditions and inactivation rates anticipated from available literature. Additionally, as presented in the treatment system description, the granular media treatment system is expected to have a 0.5 to 1 log deactivation rate for bacteria. However, the granular filtration media will likely not remove the much smaller viral organisms and as a rule the viruses persist longer than bacteria in an aqueous environment. To be consistent with EPA's LT2 rule, which requires a 4-log removal/inactivation rate, both indicator bacteria and enteric viruses will be evaluated. Water quality samples of raw source water, filtered source water and groundwater will be collected for microbiological testing under ambient conditions, during injection, during storage and during recovery.

Water quality samples collected for bacteriological detection of total and fecal coliform will be analyzed in accordance with standard method 1103.1 described by the EPA (1985) WDOH guidance. Virus samples will be analyzed using the standard total culturable virus method EPA 600/R-75/178.

Sample collection procedures described in the document *Information Collection Requirements (ICR) Rule –Protozoa and Enteric Virus Sample Collection Procedures (EPA/814-B-95-001)* will be used to collect the viral samples (Appendix B). In general, this method requires that large volumes of water (50 to 80 gallons) be allowed to pass through a positively charged 1-MDS Zetapor Virosorb filter (or similar filter provided by the analytical lab). If necessary, the pH of the sample will be adjusted so that it is in the range of 6.5 to 7. This will increase the potential for any viruses present to be sorbed to the filter.

The sampling program will be coordinated with the general water quality sampling and will include sample collection at both ASR-5 and OBS-2 during injection, storage and recovery during Cycle 2. This will allow both temporal and spatial determination of bacteriological and viral inactivation. Table 5 presents the preliminary bacteriological and virus sampling program for Cycle 2. Virus sampling will not be performed for Cycle 1 because this has a very short (1 day) injection period and all injected water will be recovered. In general, the samples will be collected in coordination with the other water quality sampling activities as shown in Table 5.

The recovery sampling program may be scaled back depending on the results observed during the preceding sampling. For example, if virus and bacteriological organisms are not detected during injection sampling, or samples collected during storage indicate sufficient (4-log) inactivation rates near the well (i.e. the water with the lowest residence time in the aquifer), then only a confirmation sample will be collected at the start of recovery. A flow chart for sample collection frequency for the ASR-5 and OBS-2 wells is shown in Figure 2. Any variation from the sample collection frequency described in Figure 2 and Table 6 will be proposed and approved in writing by Ecology.

6.2 Water Quality Sampling of ASR-5 Well and OBS-2 Well

Water quality monitoring, sampling, and analysis procedures were previously described in Section 6 of the original QAPP. A description of the sampling frequency at each proposed monitoring well in the target aquifer is provided below. Additional monitoring locations, if identified and approved by Ecology, will be monitored in a similar manner to the existing monitoring wells.

Pre-injection Sampling

A dedicated submersible pump will be installed at monitoring well OBS-2 to collect water quality samples prior to injection and throughout the pilot test program. Disinfection of ASR-5 and OBS -2 will be performed in accordance with AWWA and WDOH standards after installation of the pumping systems in ASR-5 and OBS-2. Both wells will be purged so that there is no residual disinfectant in the well. Bacterial samples will be collected after the wells are disinfected and purged. No additional groundwater quality samples are proposed to be collected at ASR-5 prior to injection.

Baseline native groundwater quality for the target aquifer will be collected from OBS-2 for the analytes listed in Table 3. Additionally, an enteric virus sample will be collected at OBS-2 after disinfection of the well.

Cycle 1 and Cycle 2 Water Quality Sampling

Field parameter monitoring, sampling locations and frequencies, and the planned laboratory testing program are outlined in Tables 4, 5 and 6. This water quality sampling and testing program is consistent with what has been performed for other ASR projects in the Northwest and will provide adequate data for meeting both Ecology and Boise objectives for the project. The sampling frequency during recovery for bacteria and viruses may be reduced based on results during injection and storage. For example, if samples collected during the storage period indicate that bacteria and viruses have not survived then only a verification sample will be collected during the later portion of the recovery phase.

6.3 Source Water Quality Samples

The planned ASR source water will be Columbia River water that has been treated at the Boise Mill site. The water treatment system during pilot testing at the Boise Mill and will consist of multi-media filtration units containing anthracite, garnet, and sand. The filtered water will have a target turbidity of less than 0.5 NTU. The raw water will be coagulated prior to filtration using Diallyldimethylammonium Chloride (Poly DADMAC), a cationic polymer flocculent. This will assist with removing dissolved substances and will condition the water and particulates for better filtration performance. Source water quality sampling will include evaluation of both the raw water quality and the filtered water quality.

Raw Source Water Quality Sampling

Samples of raw and treated Columbia River water will be collected and analyzed for the constituents listed in Table 3. Tables 4 and 5 present the sampling frequencies and analyte groups for Cycle 1 and 2, respectively. Boise will continue to monitor turbidity and temperature of the treated water periodically throughout the year to help us understand variability. Field and laboratory sampling and QA/QC procedures described in Sections 6, 7 and 8 of the original QAPP will be followed.

Filtered Source Water Quality Sampling

Water quality samples of the filtered source water that will be injected into the target aquifer will be collected at the ASR-5 wellhead. The treated water will be sampled for the analytes listed in Table 3. Tables 4 and 5 present the sampling frequencies and analyte groups for Cycle 1 and 2, respectively.

Poly DADMAC is a flocculation polymer used by Boise White Paper, LLC as part of the water treatment process (Appendix C) . Residual polymer concentrations will be evaluated in the filtered source water during testing. Sampling procedures, laboratory information and methods were described in a technical memorandum, *Laboratory Test Method for Water Treatment Polymer, November 2, 2009*. Initial testing conducted during piloting of the Wallula Mill treatment system and treated water quality in 2009 indicates that the polymer concentration will be less than 10 ppb.

6.4 Water Quality Measurement and Sampling Procedures

Wells will be purged prior to sampling using existing pumps and plumbing. Samples will be obtained from a tap as close to the wellhead as possible. Samples of treated ASR source water will be collected as close as practicable to the ASR well.

Temperature, specific conductance, pH, turbidity, oxidation-reduction potential (ORP) and dissolved oxygen will be recorded at intervals during well purging by using a YSI Multi Meter (Model 556). Dissolved oxygen and ORP will be measured using a closed-atmosphere flow cell. During purging, water from the sampling tap will be routed by a clean "Y" fitting directly to the flow cell using a short section of tubing. Wells will be purged for a minimum of 10 minutes and until all field parameters have stabilized. Table 6 presents the criteria for purge stabilization.

Once stabilized parameter values have been recorded in a field notebook, water will be re-directed to the second outlet of the "Y" fitting for sample collection. Water samples designated for laboratory analysis will be collected directly into the appropriate containers using sampling procedures appropriate for the analyte(s) being sought, e.g., volatile vs. nonvolatile. Samples requiring filtration will be collected using a clean, dedicated, in-line 0.45 micron capsule filter, attached to the appropriate "Y" outlet using clean tubing and fittings. The first 200 ml of filtrate will be discarded prior to collecting samples. As appropriate, preservatives will be added to the sample bottle immediately after collection, or alternatively, samples will be collected in pre-preserved bottles. The number and types of containers to be filled for each analysis, as well as holding times and any special sample handling or preservation requirements are listed in Table 7.

Clean latex (powder-free) gloves will be worn by sampling personnel during sampling and replaced between wells. The sampler will record the location of the sampling point relative to any treatment units or other in-line hydraulic components such as surge/pressure tanks or cisterns. Upon collection, samples will be labeled and immediately placed on ice in a cooler or otherwise stored as specified in Table 7 until delivery to the laboratory.

Bacteria sampling methods will follow WDOH publication No. 331-225. The sampling port will be disinfected prior to sampling using a 5% chlorine bleach mixture and then the sampling port will be flushed to dissipate any residual chlorine. The samples will be delivered to the analytical lab immediately after collection. Virus samples will be collected after bacterial sampling is complete. The sampling apparatus provided by the lab will be attached to the sample port and water flushed through the apparatus. After 50-80 gallons have been flushed through the apparatus the sampling filter will be installed. The sample filter will be shipped to the laboratory per the laboratory sampling protocol (see Appendix B).

6.5 Water Sample Identification, Labeling and Documentation

Sample identification will be based on the 7 or 8-character alphanumeric code identifiers assigned to wells. The format will be as follows: ASRWELL5 (ASR Test Well 5), OBS-1 (ASR Observation Well 1). Samples selected for QC purposes will end with a letter designating the particular QC purpose (e.g., B=field blank, D=field duplicate, M=matrix spike).

For each sampling location/date, the following information will be recorded in a field log:

- Sample number
- Sample location
- Sampling date and time
- Sampler's name
- Well purging information (flow rate, duration, total volume purged)
- Field parameter readings during purging
- Final (stabilized) field parameter readings
- Analytes sampled for and number of bottles collected for each analysis
- QA samples collected
- Any other relevant information (field conditions, details of how sample was collected).

Sample bottles will be labeled using self-adhesive labels, which will be completed in indelible ink and include:

- Sample identification number
- Analysis requested
- Preservatives added
- Sample date and time
- Sampler's name

Following completion of each sampling trip, the principal investigator will review the field logs recorded by the samplers for completeness, accuracy, and clarity. The principal investigator will retain a copy of completed and verified forms.

6.6 Sample Shipping

A Chain-of-Custody form will be completed by field samplers and included with every shipment of samples to the laboratories. An example form containing fields for all required information is provided in Appendix A. The form will be reviewed by field personnel to check that sample identification numbers exactly match those on the sample bottles and field logs. Following review of the forms, field sampling personnel will ship samples to the appropriate laboratories for analysis, in accordance with the following requirements:

- Samples will be shipped so that they arrive at the laboratory within the holding time for the requested analyses.
- Bacteriological and virus samples will be collected early in the business day to allow timely drop-off of the bacteria sample(s) at a local WDOH approved laboratory to meet the holding time criteria. Any additional coordination with the lab(s) to provide rapid sample processing or analysis over a weekend will be done prior to sample drop-off. Virus samples will be shipped per the laboratory provided requirements.
- Sample coolers will be shipped overnight Monday through Thursday. Samples will not be shipped on Friday.
- PolyDADMAC samples will be collected in a 500 mL plastic Nalgene bottle.
- If needed, sufficient blue ice should be added to coolers to ensure samples are maintained at or below 4 degrees centigrade during transport.
- Bubble wrap will be used to package the samples and COCs will be enclosed in a waterproof re-sealable plastic bag.
- Coolers will be sealed with tape.

The laboratory shipping addresses are as follows:

General water quality parameters

Anatek Labs, Inc.
1282 Alturas Drive
Moscow, ID 83843
(208) 883-2839
Attn. John W. Coddington, Ph.D. [john@anateklabs.com]
Laboratory Manager

PolyDADMAC

Nalco Company
Attn: Shipping and Receiving
1601 W Diehl Road
Naperville, IL 60563
(630-305-2055)
Attn: Bill Swanson (WSwanson@nalco.com)

Bacteriological

Test America Richland Laboratory
2800 George Washington Way
Richland, WA 99354
509.375.3131 Fax: 509.375.5590

Enteric Virus

BioVir Laboratories, Inc.
685 Stone Road, Unit 6
Benicia, California 94510 -1126
707 - 747 - 5906

6.7 Data Evaluation Methods

Collection of samples and associated field QC samples will follow accepted procedures. The principal investigator will ensure all field sampling personnel will be appropriately trained and thoroughly familiar with these procedures. Compilation and evaluation of existing water quality data is described in Section 5.5 of the original QAPP. The following additional methods will be used:

- Temperature data will be evaluated and used to calibrate the thermal model developed by GSI (2009) if an increase in temperature greater than 5 degrees Celsius from the anticipated recovered water temperature is observed.

- Bacteriological and viral inactivation rates will be calculated using the methods described by GSI (2009).

- Regulated water quality analytes will be compared to the appropriate regulatory standard listed in Table 3.

Data evaluation will include review of quality control procedures, data verification and validation procedures, and a data quality and usability assessment as outlined in the Sections 8, 11 and 12 of the original QAPP.

Section 7 System Operation, Monitoring, and Maintenance

7.1 Source Water Treatment System

The treatment system operation will be evaluated by monitoring process water flow rate, discharge pressure, treatment vessel differential pressure. In addition, automated in-line meters will monitor raw water and treated water temperature, pH, turbidity, specific conductance and dissolved oxygen. System operation will be modified if the target turbidity of 0.5 NTU cannot be achieved. If the system is not operating within normal tolerances recommended by the manufacturer, the manufacturer will be contacted for recommendations on maintenance

7.2 ASR-5 Wellhead

The injection and pumping system will be tested after it is installed using filtered water from the treatment system to ensure the downhole control valve is functioning properly. The pump and downhole flow control valve will be controlled by an automated logic control system that monitors system pressure, injection flow, recovery flow, water level in the well, and valve position (anywhere between open and closed). The logic control system will operate the system using pre-determined set points. If any of the system set points are not achieved or are exceeded then the system will be automatically shut down until the problem is rectified. The system set points will be adjusted during the shakedown phase of the testing.

The criteria for evaluating system operation will be determined during the final build out of the ASR well head based on vendor supplied specifications. However the following general criteria are provided to evaluate the ASR system performance:

- A 4-20 milliamp pressure transducer installed to monitor water levels in the well. The pressure transducer will be non-vented and capable of monitoring water levels continuouslyto 0.1 % of the full range scale of the transducer.

- System back pressure will be monitored at the well head to the nearest tenth of a psi to evaluate pump performance relative to total dynamic head during recovery pumping

- Meters used to measure flow during aquifer tests and ASR cycle tests will be accurate to within +/- 0.5 percent.

- In-line water quality and flow meters will be evaluated for accuracy in the field using either duplicate meters or other redundant flow monitoring methods or devices

- The design flow rate for valve position of the downhole control valve will be compared to the flow observed at the inline flow meter. Adjustments, if needed, will be made per the manufacturer's recommendations to the hydraulic or pneumatic controls.

7.3 System Maintenance

Backflush Treatment System

The treatment system will be backflushed when treatment vessel differential pressure between the inlet and outlet indicates that the filter is becoming clogged based on the manufacturers specifications and operations and maintenance plan for the system. Injection will be temporarily discontinued during these episodes. The system control logic will be programmed to control injection shutdown and startup automatically. Treatment system backflush water will discharge to the on-site effluent ponds.

Backflush ASR Well

During ASR operations, decreases in well performance due to physical plugging is likely to occur. Typically, this can be addressed by periodically interrupting injection operations and pumping or backflushing the well. The frequency and duration of backflushing will depend on the total suspended solids in the recharge water, injection rates, well performance and the plugging rate of the aquifer.

The initial backflushing frequency and duration will be evaluated periodically during the early stages of Cycle 2. The backflushing frequency for ASR projects in other parts of the country are on weekly or monthly intervals, but in the basalt aquifers in the Pacific Northwest, frequencies are typically less. Typical backflush durations range from 10 minutes to an hour. Backflushing will be performed until the initial injection and pumping specific capacity is achieved or until the turbidity of the backflush water has decreased to acceptable levels. The backflush water will be pumped to waste at a rate exceeding the injection rate. A recommendation for future backflushing and redevelopment program will be included in the Pilot Test Report.

7.4 Contingency Plan

In the event that the quality of the water being injected becomes impaired or the recovered water is unacceptable, all of the water injected into the aquifer will need to be recovered and pumped to waste. The Boise White Paper LLC clarifier and wastewater system will be capable of handling the flow produced by the ASR well.

Section 8 Reporting and Data Management

This section describes data management, interim data sharing, and reporting to Ecology and Boise during the Pilot Test Program.

8.1 Data Management

Field data will be recorded by field personnel at the time of measurement or sampling in a field notebook (log). Data to be entered into field notebooks include names of field personnel, station identification, dates and times of measurement or sampling, appropriate field measurement values and units of measure, laboratory sample numbers, and detailed notes on any deviations from prescribed procedures.

SCADA data collected at the ASR wellhead for injection flow rates, volumes, water levels, system pressure and any inline water quality monitoring will be delivered to the principal investigator in an electronic format. System failures or any deviations from prescribed procedures will be provided with the SCADA data deliverable.
System modifications, operation records, maintenance and backflushing intervals, volumes and frequency will be provided in a paper and electronic copies.

Laboratory generated data will be managed by each laboratory's respective Laboratory Information Management Systems (LIMS) and delivered to the principal investigator in electronic and paper format. In addition to sample results, the laboratory data package will include all relevant QC results needed for data validation. Electronic data will be delivered to the principal investigator in Excel spreadsheet format by electronic mail.

Following evaluation of the analytical data against the project data quality objectives (Table 2), the investigators will incorporate the results into a master Excel spreadsheet database. For each sample, the spreadsheet database will record station identification, coordinates, sampling date, and associated field and laboratory analytical data. A backup copy of the spreadsheet database will be generated for safe storage.

The documentation for each sampling location will include the completed field notebook (log) entry, the completed Chain-of-Custody form, a copy of the analytical results, as well as analytical results for associated field and laboratory QC samples. Full documentation for all samples will be compiled and stored at the investigator's office, and at the Boise White Paper LLC office.

8.2 Interim Reporting

As described in Section 10 of the original QAPP, brief monthly reports will be provided to Ecology summarizing the activities completed during the previous month.

After the completion of system shakedown testing and Cycle 1 testing a brief technical memorandum describing the results and preliminary interpretations of the system operation, hydraulic response (water level time series plots) and field parameter data will be presented. Laboratory generated data for water quality samples will be provided after evaluating the data against the project data quality objectives.

At the completion of Cycle 2 injection, a brief technical memorandum summarizing the hydraulic response, water quality results, system operation, system performance and any proposed modifications to the monitoring program will be presented to Ecology. The interpretations at the end of Cycle 2 injection will be preliminary, but will be provided to allow discussion among the project team and Ecology.

8.3 Final Report

A draft and final report will be prepared summarizing the results from baseline monitoring and Pilot testing. The report will include a description of the pilot ASR system, treatment system and controls, a summary of the ASR operations in 2011, interpretation of the hydraulic response, water quality interpretation, interpretation of the thermal response, and if necessary, reanalysis of the aquifer temperature response using the thermal model.

The results of the Year 1 pilot testing at the pilot test well will be evaluated and used to optimize the ASR operation after the first year. Not all of the water may be recovered from an ASR well in any given year if there is insufficient demand for the water. Target ASR volumes, rates, durations and schedules will be developed on the basis of the previous years results. The proposed ASR operations plan for the following year will be submitted with each annual report. Any modifications to the sampling and monitoring plan will be submitted to Ecology for review and approval.

If funding allows, it is envisioned that additional ASR wells may be incrementally added to the ASR system during the pilot test period if results are favorable and it is determined that additional capacity is needed. Boise White Paper LLC anticipates that up to two additional ASR wells may be installed and developed. Build-out of additional ASR wells will be conducted using the pilot testing framework presented above and the methodology in the approved QAPP. Specific conditions associated with future ASR wells that are different from this pilot testing program (such as, observation well network additions, water chemistry evaluations, etc.) will be provide to Ecology as a separate QAPP addendum, similar to this ASR Pilot Testing Work Plan, prior to initiating pilot testing at the additional ASR wells.

Section 9 References

Ecology, 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies: Washington Department of Ecology Publication No. 04-03-030.

GSI Water Solutions (GS), and HDR, Inc., 2009. Quality Assurance Project Plan for Field Sampling Aquifer Storage and Recovery Project Boise White Paper LLC Plant, Wallula Washington. Prepared for Boise White Paper LLC, July 2009.

GSI and HDR, Inc., 2010. ASR-5 Well Report, Boise White Paper LLC Wallula Mill Thermal ASR Project. Prepare for Boise White Paper LLC, June 2010.

HDR, Inc and GSI Water Solutions., 2010a. DRAFT ASR Injection Water Treatment Criteria, Prepared for Washington Department of Ecology, May 19, 2010.

Pyne, R. David G., 2005. Aquifer Storage and Recovery, A Guide to the Groundwater Recharge through Wells, 2nd edition. ASR Systems Publications, Gainesville, Florida. 608 pp.

United States Environmental Protection Agency (USEPA), 1985. *Test methods for Escherichia coli and enterococci in water by the membrane filter procedure (Method #1103.1).* EPA 600/4-85-076. U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, OH.

United States Environmental Protection Agency (USEPA), 1995. Information Collection Requirements Rule – Protozoa and Enteric Virus Sample Collection Procedures. EPA/814-B-95-001, 63 pp.

Williams, F. P., R. E. Stetler, and R. S. Safferman, 2001. USEPA Manual of Methods for Virology. USEPA, Washington, DC, EPA/600/4-84/013 (N16), 2001.

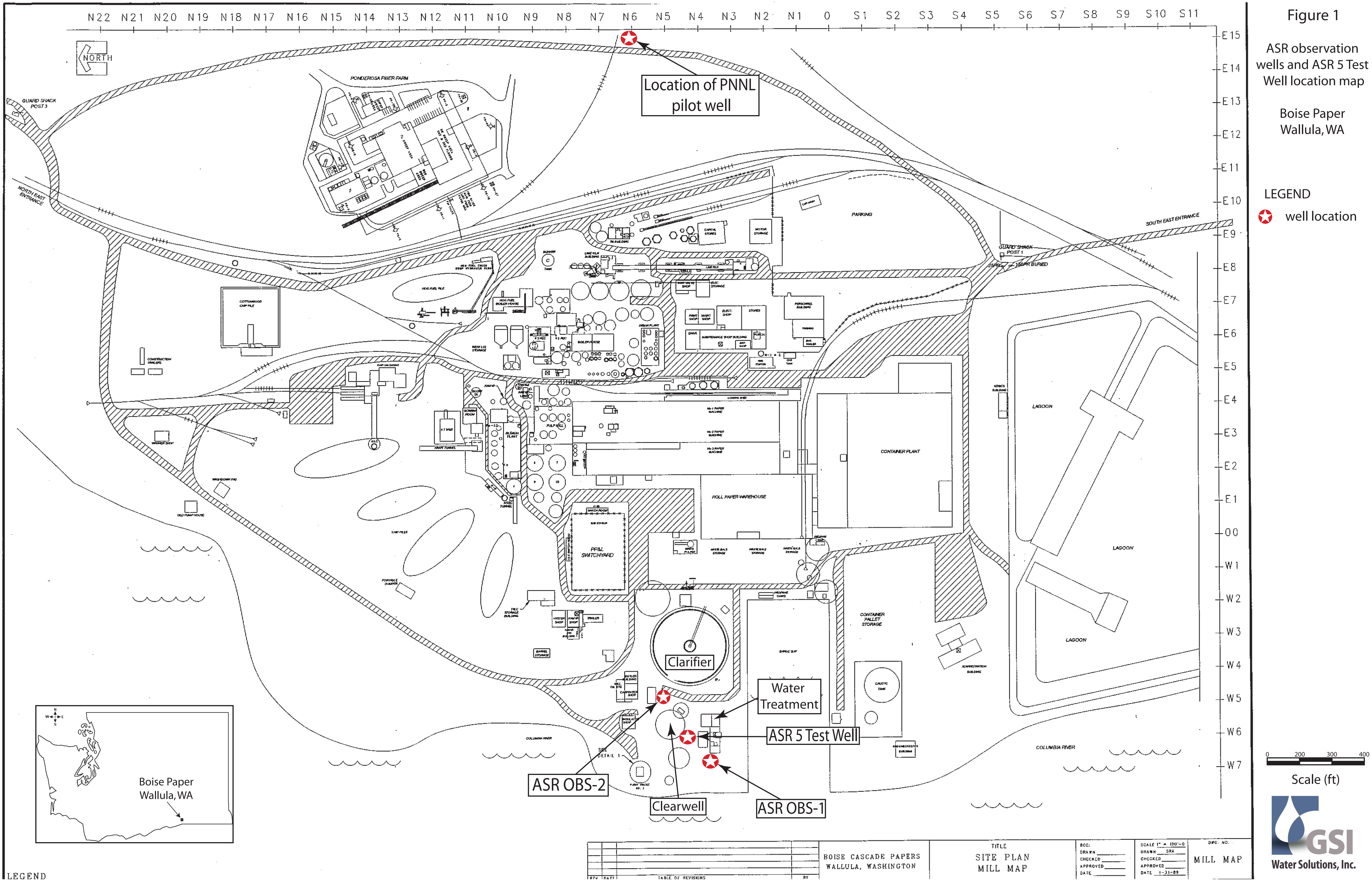


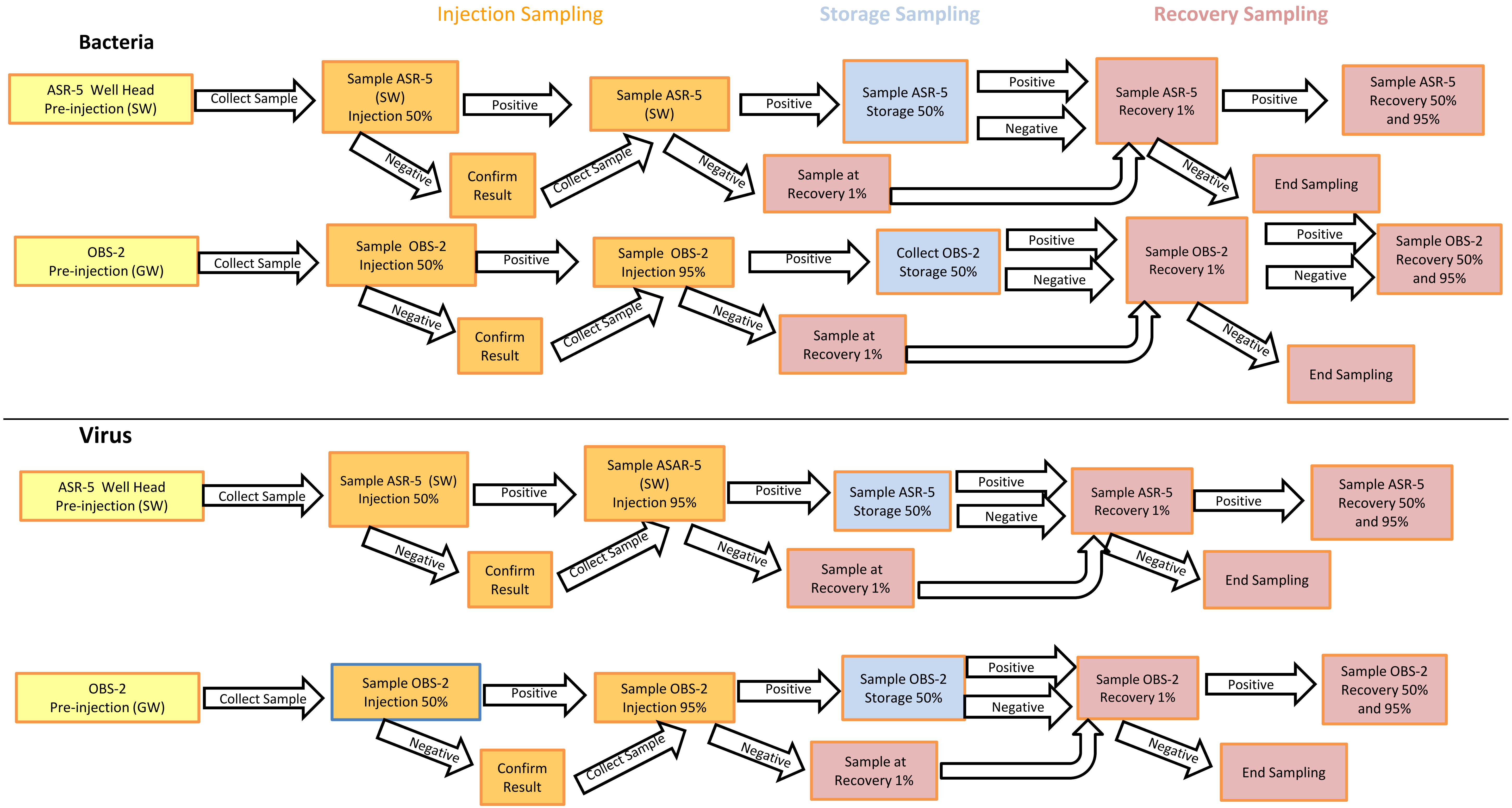
Figure 1

ASR observation wells and ASR 5 Test Well location map

Boise Paper
Wallula, WA

GSI Water Solutions, Inc.

Figure 2. Bacterial and Virus Sampling Flow Chart for Cycle 2 Pilot Testing



Note: Bacteria samples in both groundwater wells will be collected after disinfection in accordance with WAC 173-160-365 prior to injection
Samples during injection at ASR-5 will represent filtered source water from the Columbia River.

Table 2. Measurement Quality Objectives for Water Samples

Boise Paper ASR Project

Analyte		Lowest Regulatory Standard	Units	Regulatory Criteria	MRL	Analysis Method	QA/QC Frequency and Limits										
							Surrogate	Laboratory Duplicate		Matrix Spike		Matrix Spike Duplicate		Lab. Control Sample		Lab. Control Sample Duplicate	
							Limits (%Rec.)	Frequency	Limits (RPD)	Frequency	Limits (%Rec.)	Frequency	Limits (RPD)	Frequency	Limits (%Rec.)	Frequency	Limits (RPD)
Bacteriological	Fecal Coliforms/E.Coli	None	None	None													
	Total Coliform	1	CFU/100 ml	GQC													
	Enteric Viruses	1	Pos/Neg	MCLG													
Field Parameters	Temperature	None	Celsius	None													
	Conductivity	None	mS/cm	None													
	Dissolved Oxygen	None	mg/L	None													
	pH	6 - 8.5	Units	GQC, SMCL													
	Turbidity	1	NTU	GQC													
	ORP	None	mV	None													
Geochemical	Bicarbonate	None	mg/L	None	5	SM 2320B	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Calcium	None	mg/L	None	0.1	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Carbonate	None	mg/L	None	5	SM 2320B	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Chloride	250	mg/L	GQC, SMCL	0.1	EPA 300.0	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Hardness (as CaCO3)	None	mg/L	None	10	SM 2340B	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Magnesium	None	mg/L	None	0.1	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Nitrate as N	10	mg/L	GQC, MCL	0.1	EPA 300.0	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Nitrite as N	1	mg/L	MCL	0.1	EPA 300.0	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Total Nitrate-Nitrite	10	mg/L	GQC, MCL	0.1	EPA 300.0	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Potassium	None	mg/L	None	0.1	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Silica	None	mg/L	None	0.1	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Sodium	None	mg/L	None	0.1	SM 3111B	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Sulfate	250	mg/L	GQC, SMCL	0.1	EPA 300.0	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Fluoride	2	mg/L	SMCL	0.1	EPA 300.0	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Total Alkalinity	None	mg/L	None	5	SM 2320B	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Total Dissolved Solid	500	mg/L	GQC, SMCL	10	EPA 160.1	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Total Organic Carbon	None	mg/L	None	0.5	SM 5310C	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
	Total Suspended Solids (TSS)	None	mg/L	None	1	EPA 160.2	N/A	1:20	20	1:20	80-120	1:20	20	1:20	90-110	N/A	N/A
Metals	Aluminum	0.05 - 0.2	mg/L	SMCL	0.01	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Antimony	0.006	mg/L	MCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Arsenic	0.00005	mg/L	GQC	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Barium	1	mg/L	GQC	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Beryllium	0.004	mg/L	MCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Cadmium	0.005	mg/L	MCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Chromium	0.05	mg/L	GQC	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Copper	1	mg/L	GQC, SMCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Iron (Total)	None	mg/L	None	0.01	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Iron (Dissolved)	0.3	mg/L	GQC, SMCL	0.01	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Lead	0.015	mg/L	MCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Manganese (Total)	None	mg/L	None	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Manganese (Dissolved)	0.05	mg/L	GQC, SMCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Mercury	0.002	mg/L	GQC, MCL	0.0001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Nickel	None	mg/L	None	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Selenium	0.01	mg/L	GQC	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Silver	0.05	mg/L	GQC	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Thallium	0.002	mg/L	MCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
	Zinc	5	mg/L	GQC, SMCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	85-115	N/A	N/A
Radionuclides	Combined Radium 226/228 [1]	5	pCi/L	GQC, MCL	1	EPA 904.0	N/A	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Uranium [1]	0.03	mg.L	MCL	0.001	EPA 200.8	N/A	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Gross Alpha	15	pCi/L	GQC	1	EPA 900.0	N/A	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Beta/Photon emitters [1]	4	mrem/yr	MCL	1	EPA 900.0	N/A	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Gross Beta	50	pCi/L	GQC	1	EPA 900.0	N/A	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Radon [1]	None	pCi/L	None	1	SM #20 7500-RN B	N/A	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
Synthetic Organic Compounds (SOCs)																	
Regulated SOCs	2,4,5-TP (Silvex)	0.01	mg/L	GQC	0.0001	EPA 515.3	70-130	1:20	25	1:20	70-130	1:20	25	1:20	70-130	N/A	N/A

Table 2. Measurement Quality Objectives for Water Samples

Boise Paper ASR Project

	Analyte	Lowest Regulatory Standard	Units	Regulatory Criteria	MRL	Analysis Method	QA/QC Frequency and Limits										
							Surrogate	Laboratory Duplicate		Matrix Spike		Matrix Spike Duplicate		Lab. Control Sample		Lab. Control Sample Duplicate	
							Limits (%Rec.)	Frequency	Limits (RPD)	Frequency	Limits (%Rec.)	Frequency	Limits (RPD)	Frequency	Limits (%Rec.)	Frequency	Limits (RPD)
and Pesticides	2,4-D	0.07	mg/L	MCL	0.0001	EPA 515.3	70-130	1:20	25	1:20	70-130	1:20	25	1:20	70-130	N/A	N/A
	Chlordane	0.00006	mg/L	GQC	0.0004	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	4,4,4 DDT	None	mg/L	None	0.00001	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	4,4,4 -DDE	None	mg/L	None	0.0001	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	4,4,4 DDD	None	mg/L	None	0.0001	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	t-DDT	None	mg/L	None	0.0001	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	Ethylene Dibromide (EDB)	0.000001	mg/L	GQC	0.000001	EPA 504.1	70-130	1:20	25	1:20	70-130	1:20	25	1:20	70-130	N/A	N/A
	Endrin	0.0002	mg/L	GQC	0.00002	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	Dieldrin	0.000005	mg/L	GQC	0.0002	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	Heptachlor Epoxide	0.000009	mg/L	GQC	0.00004	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	Hexachlorobenzene (HCB)	0.00005	mg/L	GQC	0.0002	EPA 525.2	70-130	1:20	25	1:20	30-95	1:20	25	1:20	30-95	N/A	N/A
	Total Polychlorinated Biphenyls (PCBs)	0.00001	mg/L	GQC	0.0005	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
	Toxaphene	0.00008	mg/L	GQC	0.002	EPA 505	70-130	1:20	30	1:20	70-130	1:20	30	1:20	70-130	N/A	N/A
Volatile Organic Compounds (VOCs)																	
Regulated VOCs	1,1,1-Trichloroethane	0.2	mg/L	GQC, MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,1,2-Trichloroethane	0.005	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,1-Dichloroethylene	0.007	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,2,4-Trichlorobenzene	0.07	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,2-Dichlorobenzene (o)	0.6	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,2-Dichloroethane (EDC)	0.0005	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,2-Dichloropropane	0.0006	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	1,4-Dichlorobenzene (p)	0.004	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Benzene	0.001	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Carbon Tetrachloride	0.0003	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Chlorobenzene (monochlorobenzene)	0.1	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	cis-1,2-Dichloroethylene	0.07	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Ethylbenzene	0.7	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Dichloromethane (methylene chloride)	0.005	mg/L	GQC, MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Styrene	0.1	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Tetrachloroethylene	0.0008	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Toluene	1	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	trans-1,2-Dichloroethylene	0.1	mg/L	MCL	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Trichloroethylene	0.003	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Vinyl chloride	0.0002	mg/L	GQC	0.0005	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
	Total Xylenes	10	mg/L	MCL	0.01	EPA 524.2	70-130	1:20	20	1:20	70-130	1:20	20	1:20	80-120	N/A	N/A
Treatment Polymer	Diallyldimethylammonium Chloride	None	mg/L	None	TBD												

NOTE

mg/L = milligram per liter
MRL = Method Reporting Limit from Anetek Laboratories
ND = Not detected at concentrations greater than the MDL
NT = Analyte not tested
MCL = Federal maximum contmainant level for drinking water
SMCL = Federal secondary maximum contaminant levels for drinking water
GQC = Washington Groundwater Quality Criteria (WAC 173-200-040)
Samples are unfiltered unless noted (i.e., dissolved)
1 = These compounds would be analyzed if Gross Alpha or Beta exceed an MCL.
Matrix spike duplicates generally fill lab duplicate requirements
N/A = Not Applicable
TBD = To be determined

Table 3
ASR Water Quality Analyte List
Boise Paper ASR Project

Group	Analyte	Lowest Regulatory Standard	Units	Regulatory Criteria	MRL
A = Bacteriological	Fecal Coliforms/E.Coli	None	None	None	
	Total Coliform	1	CFU/100 ml	GQC	
	Viruses (enteric)	0	pos/neg	MCLG	
B = Field Parameters	Temperature	None	Celsius	None	
	Conductivity	None	mS/cm	None	
	Dissolved Oxygen	None	mg/L	None	
	pH	6 - 8.5	Units	GQC, SMCL	
	Turbidity	1	NTU	GQC	
	ORP	None	mV	None	
C = Geochemical	Bicarbonate	None	mg/L	None	5
	Calcium	None	mg/L	None	0.1
	Carbonate	None	mg/L	None	5
	Chloride	250	mg/L	GQC, SMCL	0.1
	Hardness (as CaCO3)	None	mg/L	None	10
	Magnesium	None	mg/L	None	0.1
	Nitrate as N	10	mg/L	GQC, MCL	0.1
	Nitrite as N	1	mg/L	MCL	0.1
	Total Nitrate-Nitrite	10	mg/L	GQC, MCL	0.1
	Potassium	None	mg/L	None	0.1
	Silica	None	mg/L	None	0.1
	Sodium	None	mg/L	None	0.1
	Sulfate	250	mg/L	GQC, SMCL	0.1
	Fluoride	2	mg/L	SMCL	0.1
	Total Alkalinity	None	mg/L	None	5
	Total Dissolved Solid	500	mg/L	GQC, SMCL	10
	Total Organic Carbon	None	mg/L	None	0.5
	Total Suspended Solids (TSS)	None	mg/L	None	1
D = Metals	Aluminum	0.05 - 0.2	mg/L	SMCL	0.01
	Antimony	0.006	mg/L	MCL	0.001
	Arsenic	0.00005	mg/L	GQC	0.001
	Barium	1	mg/L	GQC	0.001
	Beryllium	0.004	mg/L	MCL	0.001
	Cadmium	0.005	mg/L	MCL	0.001
	Chromium	0.05	mg/L	GQC	0.001
	Copper	1	mg/L	GQC, SMCL	0.001
	Iron (Total)	None	mg/L	None	0.01
	Iron (Dissolved)	0.3	mg/L	GQC, SMCL	0.01
	Lead	0.015	mg/L	MCL	0.001
	Manganese (Total)	None	mg/L	None	0.001
	Manganese (Dissolved)	0.05	mg/L	GQC, SMCL	0.001
	Mercury	0.002	mg/L	GQC, MCL	0.0001
	Nickel	None	mg/L	None	0.001
	Selenium	0.01	mg/L	GQC	0.001
	Silver	0.05	mg/L	GQC	0.001
	Thallium	0.002	mg/L	MCL	0.001
	Zinc	5	mg/L	GQC, SMCL	0.001
D = Radionuclides	Combined Radium 226/228 [1]	5	pCi/L	GQC, MCL	1
	Uranium [1]	0.03	mg.L	MCL	0.001
	Gross Alpha	15	pCi/L	GQC	1
	Beta/Photon emitters [1]	4	mrem/yr	MCL	1
	Gross Beta	50	pCi/L	GQC	1
	Radon [1]	None	pCi/L	None	1
D = Regulated Synthetic Organic Compounds (SOCs) and Pestcides					
	2,4,5-TP (Silvex)	0.01	mg/L	GQC	0.0001
	2,4-D	0.07	mg/L	MCL	0.0001
	Chlordane	0.00006	mg/L	GQC	0.0004
	4,4,4 DDT	None	mg/L	None	0.00001
	4,4,4 -DDE	None	mg/L	None	0.0001
	4,4,4 DDD	None	mg/L	None	0.0001
	t-DDT	None	mg/L	None	0.0001
	Ethylene Dibromide (EDB)	0.000001	mg/L	GQC	0.000001
	Endrin	0.0002	mg/L	GQC	0.00002
	Dieldrin	0.000005	mg/L	GQC	0.0002

Table 3
ASR Water Quality Analyte List
Boise Paper ASR Project

Group	Analyte	Lowest Regulatory Standard	Units	Regulatory Criteria	MRL
	Heptachlor Epoxide	0.000009	mg/L	GQC	0.00004
	Hexachlorobenzene (HCB)	0.00005	mg/L	GQC	0.0002
	Total Polychlorinated Biphenyls (PCBs	0.00001	mg/L	GQC	0.0005
	Toxaphene	0.00008	mg/L	GQC	0.002
D = Volatile Organic Compounds (VOCs)					
	1,1,1-Trichloroethane	0.2	mg/L	GQC, MCL	0.0005
	1,1,2-Trichloroethane	0.005	mg/L	MCL	0.0005
	1,1-Dichloroethylene	0.007	mg/L	MCL	0.0005
	1,2,4-Trichlorobenzene	0.07	mg/L	MCL	0.0005
	1,2-Dichlorobenzene (o)	0.6	mg/L	MCL	0.0005
	1,2-Dichloroethane (EDC)	0.0005	mg/L	GQC	0.0005
	1,2-Dichloropropane	0.0006	mg/L	GQC	0.0005
	1,4-Dichlorobenzene (p)	0.004	mg/L	GQC	0.0005
	Benzene	0.001	mg/L	GQC	0.0005
	Carbon Tetrachloride	0.0003	mg/L	GQC	0.0005
	Chlorobenzene (monochlorobenzene)	0.1	mg/L	MCL	0.0005
	cis-1,2-Dichloroethylene	0.07	mg/L	MCL	0.0005
	Ethylbenzene	0.7	mg/L	MCL	0.0005
	Dichloromethane (methylene	0.005	mg/L	GQC, MCL	0.0005
	Styrene	0.1	mg/L	MCL	0.0005
	Tetrachloroethylene	0.0008	mg/L	GQC	0.0005
	Toluene	1	mg/L	MCL	0.0005
	trans-1,2-Dichloroethylene	0.1	mg/L	MCL	0.0005
	Trichloroethylene	0.003	mg/L	GQC	0.0005
	Vinyl chloride	0.0002	mg/L	GQC	0.0005
	Total Xylenes	10	mg/L	MCL	0.01
E = Treatment Polyme	Diallyldimethylammonium Chloride	None	ug/L	None	<10, 10-100, >1000

NOTE
mg/L = milligram per liter
MRL = Method Reporting Limit from Anetek Laboratories
ND = Not detected at concentrations greater than the MDL
NT = Analyte not tested
MCL = Federal maximum contmainant level for drinking water
SMCL = Federal secondary maximum contaminant levels for drinking water
GQC = Washington Groundwater Quality Criteria (WAC 173-200-040)
Samples are unfiltered unless noted (i.e., dissolved)
1 = These compounds would be analyzed if Gross Alpha or Beta exceed an MCL.

Table 4

Preliminary Boise Paper ASR Pilot Project Testing and Sampling Schedule - Cycle 1

Modified 9/3/2010 CA

Input Values in Yellow Cells

Estimated -- QA needed

AVERAGE Injection Rate:	**800**	(gpm)			**Previous Year Carrryover**
AVERAGE Recovery Rate:	**1000**	(gpm)		gallons	**0**
Injection Start Date	**Monday 1/3/2011 12:00 PM**				
Injection End Date	**Tuesday 1/4/11 12:00 PM**				
Elapsed Injection Days		**1.0**	days		
Elapsed Injection Hours		**24**	hours		
		1,152,000	gallons injected at injection rate		
Total Planned Injection Volume (gals)		**1,152,000**	Total with carryover (gals)		
Storage Start Date	**Tuesday 1/4/11 12:00 PM**				
Storage End Date	**Wednesday 1/5/11 12:00 PM**				
Elapsed Storage Days		**1.0**			
Elapsed Storage Hours		**24**			
Total Planned Recovery Volume (gals)			**1,036,800**	Assume 90%	Recovered
Recovery Start Date	**Wednesday 1/5/11 12:00 PM**				
Days Required to Recover 100% of Injection Volume	**Thursday 1/6/11 7:12 AM**	**0.8**			
Days Required to Recover Planned Volume	**Thursday 1/6/11 5:16 AM**	**0.7**	Assumes single-batch recovery		

Water Quality Monitoring Program - Cycle 1

Water Type	Progress Point	Estimated Date	Elapsed Days	Analyte Group	Sample Location(s)	Sample ID	Date Collected	Bottles Verified?	Bottle Order Code
Baseline Period									
Source	--	December 2010	--	A	Treatment System				
ASR-5	--	December 2010	--	A	Dedicated Pump				
OBS-2	--	December 2010	--	A, B, C, D, E	Dedicated Pump				
Injection Period									
Source	1%	Monday 1/3/11 12:00 PM	0	A, B, C, D, E,	Treatment System				
Source	50%	Tuesday 1/4/11 12:00 AM	1	B	Treatment System				
Source	100%	Tuesday 1/4/11 12:00 PM	1	B	Treatment System				
Storage Period*									
Stored	50%	Wednesday 1/5/11 12:00 AM	0	--					
Recovery Period									
Recovered	1%	Wednesday 1/5/11 12:00 PM	0	B	ASR-5, OBS-2				
Recovered	50%	Wednesday 1/5/11 9:36 PM	0	B	ASR-5, OBS-2				
Recovered	95%	Thursday 1/6/11 6:14 AM	1	A, B, C, D, E	ASR-5				

Notes: * Storage period may not be sufficient length to collect samples, if short or no storage period, disregard storage samples and begin recovery sampling after pumping begins

Analyte Group (refer to Table 3 for complete list)

A= Bacterialogical (virus sampling frequency is shown in Table 6 and Figure 2)

B = Field Parameters (temp, pH, conductivity, Oxidation reduction potential, dissolved oxygen, turbidity) at time of sample collection

C = Geochemical Parameters

D = Regulated Consituents. Only analyze full radionuclide list if Gross Alpha or Beta exceed MCL.

E = Other analytes (Treatment polymer)

* Includes carryover from previous year

gals = gallons

gpm = gallons per minute

Table 5

Preliminary Boise Paper ASR Pilot Project Testing and Sampling Schedule - Cycle 2

Modified 9/3/2010 CA

Estimated -- QA needed

Input Values in Yellow Cells				
AVERAGE Injection Rate:	**800**	(gpm)		
AVERAGE Recovery Rate:	**1000**	(gpm)		
Injection Start Date	**Friday 1/7/2011 12:00 PM**			
Injection End Date	**Friday 4/22/11 12:50 PM**			
Elapsed Injection Days		**105.0**	days	
Elapsed Injection Hours		**2521**	hours	
	Target	**121,000,000**	gallons injected at injection rate	
Total Planned Injection Volume (gals)		**121,000,000**	Total with Carryover (gals)	
Storage Start Date	**Friday 4/22/11 12:50 PM**			
Storage End Date	**Tuesday 6/21/11 12:50 PM**			
Elapsed Storage Days		**60.0**		
Elapsed Storage Hours		**1440**		
Total Planned Recovery Volume (gals)		**108,900,000**		Assume 90% Recovered
Recovery Start Date	**Tuesday 6/21/11 12:50 PM**			
Days Required to Recover 100% of Injection Volume	**Tuesday 9/13/11 1:30 PM**	**84.0**		
Days Required to Recover Planned Volume	**Monday 9/5/11 3:50 AM**	**75.6**	Assumes single-batch recovery	

gallons	Previous Year Carrryover
	0

Table 5 (cont.) Water Quality Monitoring Program and Tentative Schedule - Cycle 2

Water Type	Progress Point	Estimated Date	Elapsed Days	Analyte Group	Sample Location(s)	Sample ID	Date Collected	Bottles Verified?	Bottle Order Code
Injection Period									
Source	1%	Friday 1/7/11 12:00 PM	0	A, B, C	Raw and treated water				
Source	50%	Tuesday 3/1/11 12:25 AM	53	A, B, C, D, E	Raw and treated water				
Source	100%	Friday 4/22/11 12:50 PM	105	A,B,C	Raw and treated water				
Storage Period*									
Stored	50%	Sunday 5/22/11 12:50 PM	30	A, B,C	ASR-5, OBS-2				
Recovery Period									
Recovered	1%	Tuesday 6/21/11 12:50 PM	0	A,B,C	ASR-5, OBS-2				
Recovered	50%	Tuesday 8/2/11 1:10 PM	42	A,B, C, D, E	ASR-5, OBS-2				
Recovered	75%	Tuesday 8/23/11 1:20 PM	63	A,B, C	ASR-5, OBS-2				
Recovered	95%	Friday 9/9/11 8:40 AM	80	A,B,C	ASR-5, OBS-2				

Notes: * Storage period may not be sufficient length to collect samples, if short or no storage period, disregard storage samples and begin recovery sampling after pumping begins
Analyte Group (refer to Table 3 for complete list)
A= Bacteriological (virus sampling frequency is shown in Table 6 and Figure 2)
B = Field Parameters (temp, pH, conductivity, Oxidation reduction potential, dissolved oxygen, turbidity) at time of sample collection
C = Geochemical Parameters
D = Regulated Consituents. Only analyze full radionuclide list if Gross Alpha or Beta exceed MCL.
E = Other analytes (Treatment polymer)
* Includes carryover from previous year
gals = gallons
gpm = gallons per minute

Appendix A

BioVir LABORATORIES®

TOTAL CULTURABLE VIRUS
ENTERIC VIRUS ASSAY
SAMPLE DATA SHEET

LAB USE ONLY:

LIMS #: ____________
Client #: ____________
Date Rec'd: _________
Time Rec'd: _________
Temp Rec'd: ________

(Please fill out completely and return white copy to BioVir with the sample.)
Phone: 1-800-GIARDIA Fax: 707-747-1751 WEB: www.biovir.com

Note: Please print clearly using waterproof ink

NAME AND ADDRESS OF WATER COMPANY OR UTILITY:	SAMPLE DATE:	
	SAMPLE TIME:	
NAME OF SAMPLER:	pH: pH (adjusted):	Water Temp (C):
SAMPLE SOURCE:	TREATMENT CHARACTERISTICS (Check One): Raw Drinking Water ☐ Treated Drinking Water ☐ Wastewater ☐ Filtered Wastewater ☐	
SAMPLE LOCATION:		
SAMPLE VOLUME: (Meter #) Meter Start: Meter Stop:	DECHLORINATION/ DISINFECTANT NEUTRALIZATION (If Treated Water): Yes No	
Total Volume: __________Gallons __________ Liters	TURBIDITY (NTU): Turbidity Begin: Turbidity End:	

Client ID:	P.O. #:

ASSAY REQUESTED: Please check one of the following	
	Total Culturable Virus Assay, MPN - (EPA, ICR 600/R-95/178)
	Pre Filter Cartridge - M19R10A
	Enteric Virus Assay, PFU - (SM 18th; 9510 - BioVir Modification)

COMMENTS:

RELINQUISHED BY:	DATE / TIME:
RECEIVED BY:	DATE / TIME:

SHIPPING ADDRESS: BIOVIR LABORATORIES, INC., 685 STONE ROAD, UNIT 6, BENICIA, CALIFORNIA 94510
WHITE = BIOVIR COPY YELLOW = CUSTOMER COPY

Richland
2800 George Washington Way

Richland, WA 99354
phone 509.375.3131 fax 509.375.5590

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**	COC No:
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**	_______ of ______ COCs
Address	**Analysis Turnaround Time**			Job No.
City/State/Zip	Calendar (C) or Work Days (W) __________			
(xxx) xxx-xxxx Phone	TAT if different from Below _________			SDG No.
(xxx) xxx-xxxx FAX	☐ 2 weeks			
Project Name:	☐ 1 week			
Site:	☐ 2 days			
P O #	☐ 1 day			

Sample Identification	**Sample Date**	**Sample Time**	**Sample Type**	**Matrix**	**# of Cont.**	**Filtered Sample**																		Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* *Poison B* ☐ *Unknown* ☐

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For __________ Months*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:

Appendix B

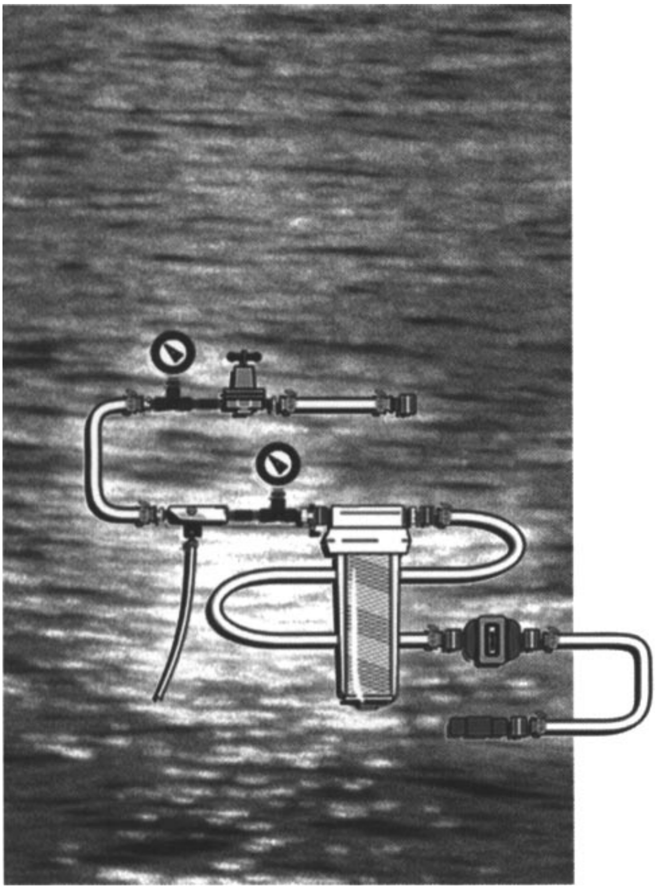
United States
Environmental
Protection Agency

Office of Ground Water
and Drinking Water
Washington, DC 20460

EPA/814-B-95-001
June 1995

EPA

Information Collection Requirements Rule— Protozoa and Enteric Virus Sample Collection Procedures



ABOUT THIS MANUAL

This manual is designed to be brought into the field by drinking water utility personnel when collecting source and finished water samples for protozoa and viruses. The sample collection steps in this manual are consistent with those demonstrated in the accompanying video. To further associate the steps in this manual with the sampling demonstration on the video, the photos for each step are taken directly from the video.

Several graphic conventions are used throughout the manual to differentiate steps or denote special actions:

2 A step icon is used at the beginning of each step. These steps are parallel to those in the accompanying video.

! Actions denoted by this icon are critical to ensuring that the sample will be valid and uncontaminated, such as putting on fresh latex gloves before handling the filter.

Text denoted by this icon provides additional information to the samplers, but may not be part of the actual collection procedure.

Collecting protozoan and virus samples correctly under the Information Collection Requirements Rule can be challenging. Please watch the demonstration video before collecting the samples, and be sure to follow each step in this manual when in the field.

CONTENTS

Protozoan and Enteric Virus Sample Collection Procedures as Defined by the Information Collection Requirements Rule

This manual describes the procedures for collecting source water and finished water samples for protozoan and enteric virus monitoring under the Information Collection Requirements (ICR) rule. This manual and the accompanying video comprise a two-part set of instructional materials that provide public water supply systems with the information needed to properly collect samples for protozoan and virus monitoring. All water utility personnel involved with ICR monitoring should watch the video and review this manual before collecting any samples.

The protozoan collection procedures described in this manual and in the video are based on the procedures in the ICR Protozoan Method for Detecting *Giardia* cysts and *Cryptosporidium* Oocysts in Water by a Fluorescent Antibody Procedure. The total culturable virus collection procedures described in this manual and in the video are based on the procedures in the Virus Monitoring Protocol for the Information Collection Rule. Both of these methods can be requested by calling the Safe Drinking Water Hotline, at (800) 426-4791.

Questions Commonly Asked by Drinking Water Utilities

What is the purpose of the ICR rule?

The ICR rule was developed by EPA to collect occurrence, exposure, and treatment data on drinking water pathogens and disinfectant by-products. The pathogen data are needed to determine whether current Surface Water Treatment Regulations should be revised to include new or more stringent treatment levels for some microbes. The disinfectant by-product data are needed to determine whether to regulate the chemical by-products that form when disinfectants react with organic chemicals in source water.

Although drinking water utilities will be involved in collecting both disinfectant by-product and waterborne pathogen data under the ICR rule, this manual describes the utility's role in collecting data on drinking water pathogen occurrence.

What pathogens are monitored under the ICR rule?

The ICR rule requires public water supply systems to monitor source water (and finished water in some cases) for the following pathogens:

- *Giardia* cysts
- *Cryptosporidium* oocysts
- Total culturable viruses
- Fecal coliform or *Escherichia coli* bacteria
- Total coliform bacteria

EPA is considering revising the current Surface Water Treatment Regulations because existing treatment levels for *Giardia* and viruses may not be adequate to protect public health for systems supplied by poor-quality source water and because of the new threat posed by *Cryptosporidium*.

Giardia cysts in drinking water cause more reported waterborne disease outbreaks than any other single known pathogen. They also are more resistant to environmental stresses and disinfection than almost all other known waterborne pathogens.

Cryptosporidium oocysts in drinking water have caused major waterborne disease outbreaks in the U.S. and other countries and are even more resistant to disinfection than *Giardia*.

Several enteric viruses have caused waterborne disease and may be responsible for many, if not most, of the outbreaks where a causative agent was not identified (about half of all reported outbreaks). Adequate analytical methodology is not yet available for routine analysis for many enteric viruses, so EPA has required monitoring of total culturable viruses. Total culturable viruses are a group of enteric viruses commonly found in poor-quality waters and which EPA believes are at least somewhat representative of other pathogenic viruses. Monitoring for total culturable viruses is useful because this group contains pathogens and is a potential indicator of other viral pathogens.

Fecal coliforms, *E. coli*, and total coliforms have been used for decades to assess source water quality. Coliform bacteria are much more susceptible to environmental stress and disinfection than protozoa and viruses, and would be eliminated by any system that eliminated more resistant pathogens. However, the ICR rule requires drinking water utilities to submit coliform monitoring data as general indicators of water quality. Monitoring procedures for fecal coliform, *E. coli*, and total coliform densities have been established and are not addressed by this manual.

Which drinking water utilities have to collect protozoan and virus samples?

Public water supply systems that serve between 10,000 and 100,000 people and use surface water (or groundwater under the influence of surface water) are required to monitor their source water for *Giardia* cysts and *Cryptosporidium* oocysts.

Public water supply systems that serve more than 100,000 people and use surface water (or groundwater under the influence of surface water) are required to monitor their source water for *Giardia* cysts, *Cryptosporidium* oocysts, and total culturable viruses. If pathogen densities in the source water exceed 1 pathogen per liter during the first 12 months of monitoring, then public water supply systems also must sample finished water for the remaining months.

How often must samples be taken?

Public water supply systems that serve between 10,000 and 100,000 people must collect samples every two months for 12 months.

Systems that serve more than 100,000 people must take samples every month for 18 months.

However, these systems may discontinue monitoring if:

- Viruses are not detected in the source water during the first 12 months of monitoring, or
- Source water has been tested for either total coliforms or fecal coliforms at least five times per week for four months before and two months after the effective date of the ICR and the total coliform density is less than 100 colonies/100 mL or the fecal coliform density in 90 percent of all samples is less than 20 colonies/100 mL.

Where should samples be collected?

Samples must be taken at the intake of each treatment plant. If a plant has several sources of water, the system must sample the blended water from all sources. If this is not possible, the source with the highest expected pathogen concentration should be sampled.

Who will analyze the samples?

EPA has approved several laboratories to analyze the protozoan and virus samples. Before collecting samples, you must arrange to have them analyzed by an EPA-approved laboratory.

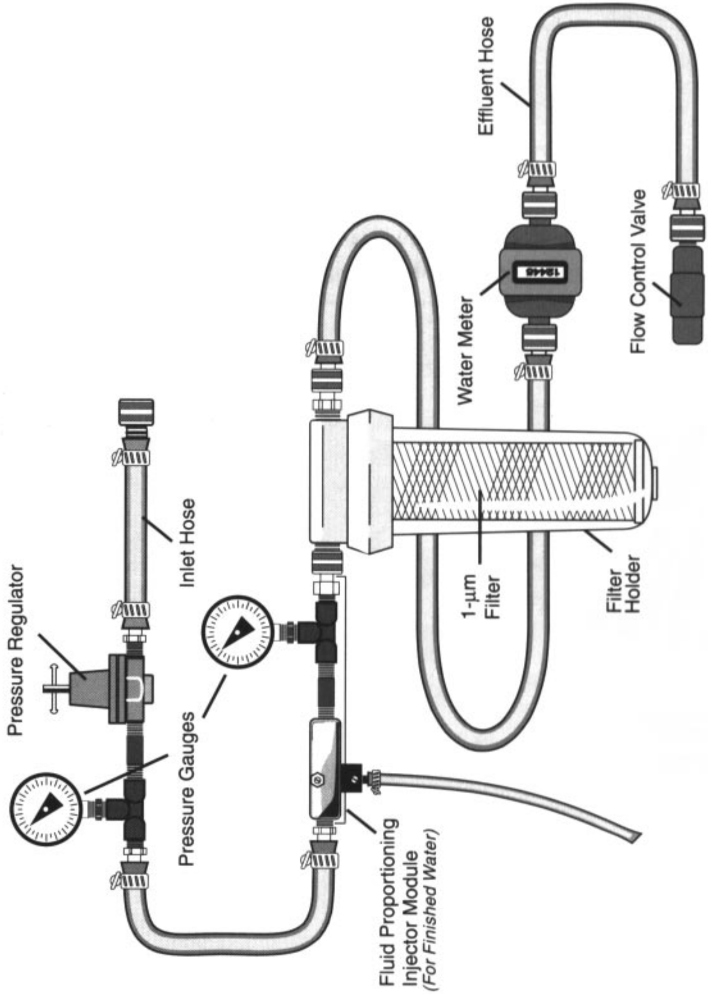
If you have not already located an approved laboratory, notify:

ICR Laboratory Coordinator
EPA Office of Ground Water & Drinking Water
26 West Martin Luther King Drive
Cincinnati, Ohio 45268.

EPA will provide you with a list of approved laboratories or other appropriate guidance.

Sample Collection Procedures for Detecting Protozoa in Water

Sampling Train for Collecting Protozoa



STEP 1 Each month, your laboratory will send you all of the equipment needed to collect samples for *Giardia* cyst and *Cryptosporidium* oocyst analyses. When you receive the sampling kit, check the contents of the carton. The sampling kit should contain the following items:

- ❑ Sampling train for collecting protozoa (left):
  - Inlet hose
  - Pressure regulator with pressure gauge
  - Fluid proportioning injector module, including an injector and pressure gauge*
  - 1-µm nominal porosity filter and holder made by Parker Hannifan or Filterite
  - Water meter
  - Effluent hose and flow control valve

*Needed for finished water sample collection only

- ❑ Plastic sample bags
- ❑ Ice packs for shipping the collected samples
- ❑ Sample labels

If you are missing any items, contact your laboratory immediately. Do not attempt to collect the samples without a complete sampling kit.

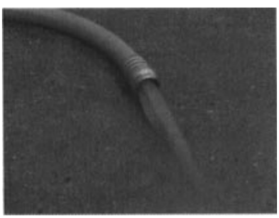
STEP 2 Once you have verified the contents of the sampling kit, place the ice packs in the freezer and repack the box for later use.

Collecting Source Water Samples

When you are ready to collect your protozoa sample, bring the following items with you to the sampling location:

- ❑ Shipping container sent by the laboratory
- ❑ Sampling apparatus
- ❑ Plastic sample bags
- ❑ Sample labels
- ❑ Frozen ice packs
- ❑ Several pairs of new latex gloves
- ❑ pH meter
- ❑ Thermometer
- ❑ Turbidimeter

! If you will be collecting samples from both source water and finished water on the same day, perform the finished water sampling first. Using the sampling apparatus on source water first may cause false positives for finished water sample analyses.

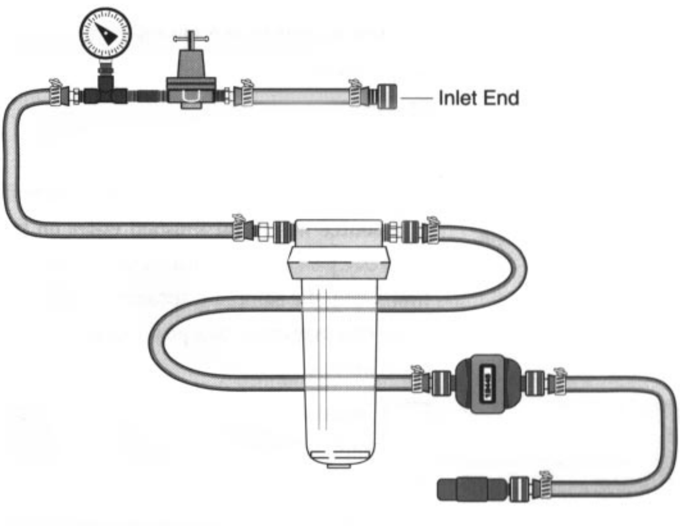


Step 3 Turn on the water at the tap and allow the water to flow for 2 to 3 minutes or until any debris that has accumulated in the sampling line has cleared or the turbidity in the water becomes uniform.

Turn off the water at the tap.

STEP 4 Put on new latex gloves to prevent contamination from outside sources. Sterile technique must be used when sampling for *Giardia* and *Cryptosporidium*. Any contamination of the sampling apparatus may bias the final results.

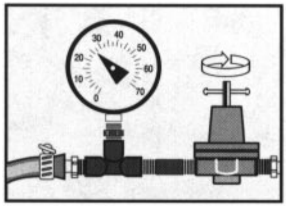
Assemble the sampling apparatus as shown below and connect the inlet end of the sampling apparatus to the sampling tap or to an extension hose connected to the tap.



! Be sure that the filter housing does *not* contain the filter.

Note the water meter reading, then slowly turn on the water.

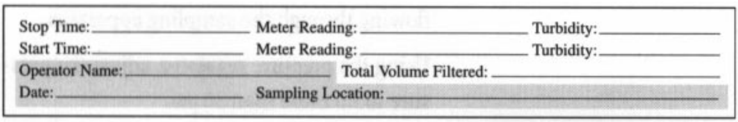
5 Using the pressure regulator, adjust the water pressure to no more than 30 psi. Flush the sampling apparatus with 20 gallons/ 76 liters of water by allowing the water to flow through the system and out the effluent hose.



Sampling Step	Volume In GALLONS	Volume In LITERS	Volume In FT^3
System Flush	20	76	2.7

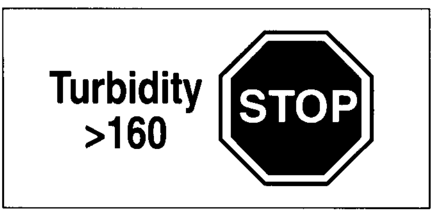
While the water is flushing the sampling apparatus, begin completing your sample label. Record the following information:

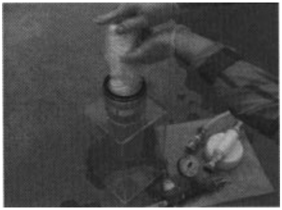
- Sampler's name
- Date
- Sample location



Stop Time:________ Meter Reading:________ Turbidity:________
Start Time:________ Meter Reading:________ Turbidity:________
Operator Name:________ Total Volume Filtered:________
Date:________ Sampling Location:________

6 Measure the turbidity of the source water flowing from the effluent hose. Record the readings on the sample label. If the turbidity is greater than 160 Nephelometric Turbidity Units (NTU), sampling should be rescheduled for a day when the turbidity is lower.





STEP 7 After the system has been flushed with 20 gallons / 76 liters of water, turn off the tap and disconnect the inlet and outlet hoses from the filter housing.

Using the filter wrench, open and drain the filter housing.

Open the filter packaging as aseptically as possible and carefully drop the filter into the filter housing.

! Be sure to hold the loose gasket in place using aseptic technique.

Reassemble the filter housing, and reconnect the inlet and outlet hoses. Place the filter housing in an upright position.

Slowly, turn on the tap and start the water flowing through the sampling apparatus.

Using the pressure regulator, adjust the pressure to no more than 30 psi.

Record the following information on the sample label:

- Time sampling started
- Initial water meter reading (including units)
- Turbidity

Stop Time: ________	Meter Reading: ________	Turbidity: ________
Start Time: ________	Meter Reading: ________	Turbidity: ________
Operator Name: ________	Total Volume Filtered: ________	
Date: ________	Sampling Location: ________	

Monitor the water meter to ensure that the flow rate does not exceed 1 gallon/min (approximately 4 liters/min).

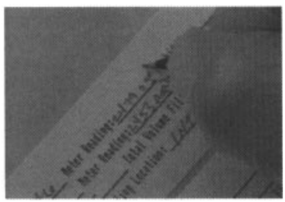
8 Allow at least 26 gallons/100 liters of water to pass through the filter. At a flow rate of approximately 1 gallon/minute, this will require about 30 minutes.

Sampling Step	Volume In GALLONS	Volume In LITERS	Volume In FT^3
Protozoa Flow Rate	1 per minute	4 per minute	.13 per minute
Protozoa Source Water Sample	26	100	3.5

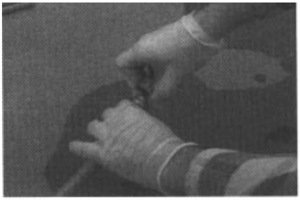
9 When the water meter indicates that 26 gallons/100 liters of water have passed through the filter, turn off the water at the tap.

Record the following information on the sample label:

- Time sampling stopped
- Final water meter reading (including units)
- Final turbidity
- Total volume filtered



Stop Time: ______ Meter Reading: ______ Turbidity: ______
Start Time: ______ Meter Reading: ______ Turbidity: ______
Operator Name: ______ Total Volume Filtered: ______
Date: ______ Sampling Location: ______

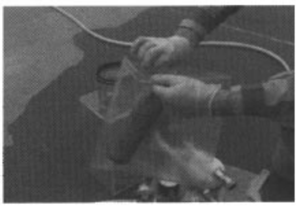


STEP 10 Disconnect the sampling apparatus from the water tap.

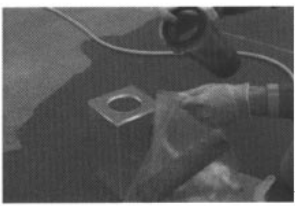
! Be sure to hold the inlet hose *above the level of the outlet hose opening* while the water drains from the housing. This will prevent backwash and loss of particulate matter from the filter.

Disconnect the inlet and outlet hoses from the filter housing.

! Put on fresh latex gloves.



STEP 11 As aseptically as possible, remove the filter from the housing and put it into a plastic sample bag.

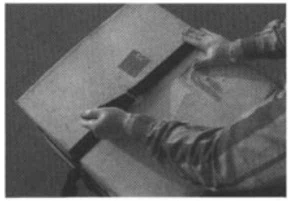


STEP 12 Pour all of the water remaining in the filter housing into the same plastic bag.

STEP 13 Seal the plastic sample bag and place it inside the second plastic sample bag. Transfer the label or label information to the outside of the outer bag.

14 Put the bags containing the filter into the shipping container. Place the ice packs around, but not on, the sample bag to prevent freezing the sample. You may want to insert several inflated, empty sample bags between the sample and the ice packs.

15 Seal the container and follow the laboratory's instructions related to the cleaning, storage, and return of sampling equipment.



16 Ship the container by overnight courier to the laboratory. Call the laboratory and notify them of the sample shipment.

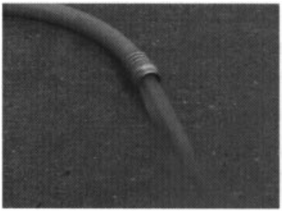
Collecting Finished Water Samples

If *Giardia* or *Cryptosporidium* concentrations in your source water samples exceed 1 per liter during the first 12 months of sampling, then you must monitor finished water as well as source water. If you are required to collect samples from both, collect the finished water sample first, then the source water sample.

Receiving and verifying the contents of your sampling kit are addressed in **Steps 1** and **2** of the source water sampling section.

When you are ready to collect your finished water protozoa sample, bring the following items with you to the sampling location:

- ❑ Shipping container sent by the laboratory
- ❑ Sampling apparatus
- ❑ Fluid proportioning injector (for adding 2% thiosulfate solution to neutralize effects of chlorination or other disinfectant treatments)
- ❑ Plastic sample bags
- ❑ Sample labels
- ❑ Frozen ice packs
- ❑ Several pairs of new latex gloves
- ❑ Approximately 2 gal (4 L) of 2% sodium thiosulfate solution
- ❑ Sterile, 250- or 500-mL graduated cylinder
- ❑ Thermometer

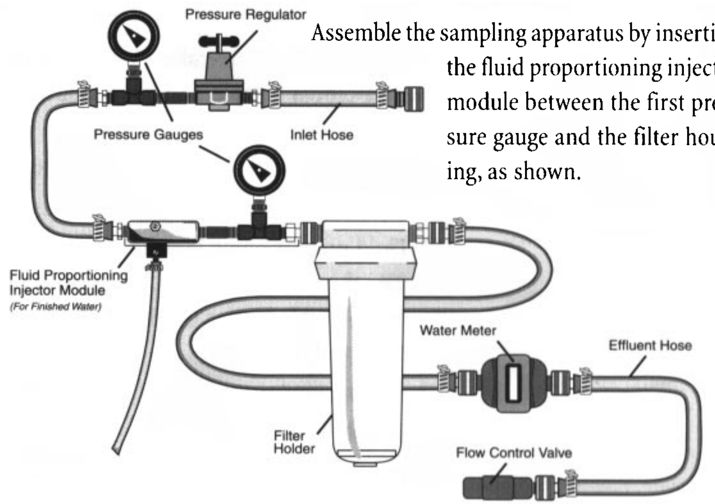


STEP 3 Turn on the water at the tap and allow the water to flow for 2 to 3 minutes or until any debris that has accumulated in the sampling line has cleared or the turbidity in the water becomes uniform.

Turn the water off at the tap

STEP 4 Put on new latex gloves to prevent contamination from outside sources. Sterile technique must be used when sampling for *Giardia* and *Cryptosporidium*. Any contamination of the sampling apparatus may bias the final results.

Assemble the sampling apparatus by inserting the fluid proportioning injector module between the first pressure gauge and the filter housing, as shown.

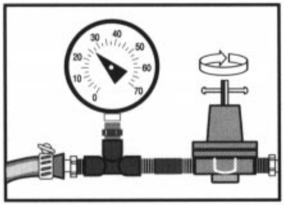


Connect the inlet end of the sampling apparatus to the sampling tap or to an extension hose connected to the tap.

! Be sure that the filter housing does NOT contain the filter.

Note the water meter reading, then slowly turn on the water.

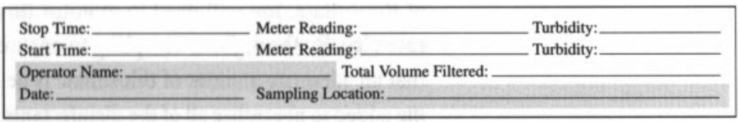
STEP 5 Using the pressure regulator, adjust the water pressure on the first pressure gauge to no more than 30 psi.



Flush the sampling apparatus with 20 gallons/ 76 liters of water by allowing the water to flow through the system and out the effluent hose.

While the water is flushing the sampling apparatus, begin completing your sample label. Record the following information:

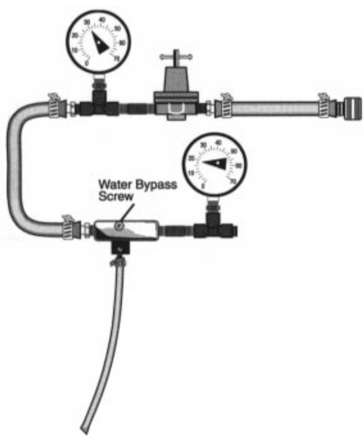
- Sampler's name
- Date
- Sample location



Stop Time: ____ Meter Reading: ____ Turbidity: ____
Start Time: ____ Meter Reading: ____ Turbidity: ____
Operator Name: ____ Total Volume Filtered: ____
Date: ____ Sampling Location: ____

STEP 6 Now, you must adjust the thiosulf injector.

First, using the water bypass screw, the larger top screw in the injector, adjust the pressure on the downstream pressure gauge to be at least 35% less than the pressure shown on the upstream gauge. For ample, if the upstream gauge reads 30p then the second gauge should read no m than 19psi.



Pour the 2% sodium thiosulfate solution into a graduated cylinder. Place the injector tube in the thiosulfate solution, and adjust the smaller injector screw, located on the bottom of the injector, so that the flow rate of the 2% thiosulfate solution is approximately 10 milliliters per minute.

! If there is no suction visibly drawing down the thiosulfate solution, or if too much is flowing, adjust the water bypass screw further to increase or decrease the pressure differential between the two gauges. A greater differential between the upstream and downstream gauges increases the flow rate; a smaller differential decreases the flow rate.

After the thiosulfate flow rate is adjusted properly, transfer the injector tube to a carboy of thiosulfate. You will need to monitor this rate visually throughout sampling to ensure that an adequate amount of thiosulfate is being added to neutralize all of the disinfectants.

Turn off the water at the tap and empty the water in the filter housing.

7 Open the filter packaging as aseptically as possible and carefully drop the filter into the filter housing.

! Hold the loose gasket in place.

Reassemble the filter housing, and reconnect the inlet and outlet hoses.

Slowly, start the water flowing through the sampling apparatus.

Using the pressure regulator, adjust the pressure on the upstream pressure gauge to no more than 30 psi. Using the water bypass screw, readjust the downstream pressure gauge to read 35% less than the upstream gauge, if necessary.

Record the following information on the sample label:

- Time sampling started
- Initial water meter reading (including units)
- Turbidity

Stop Time: ______	Meter Reading: ______	Turbidity: ______
Start Time: ______	Meter Reading: ______	Turbidity: ______
Operator Name: ______	Total Volume Filtered: ______	
Date: ______	Sampling Location: ______	

Place the filter housing in an upright position.

Monitor the water meter to ensure that the flow rate does not exceed 1 gallon/min (approximately 4 liters/min).

STEP 8 Allow at least 264 gallons/1000 liters of water to pass through the filter. At a flow rate of approximately 1 gallon/minute, this will require about 4 hours and 45 minutes.

Sampling Step	Volume In GALLONS	Volume In LITERS	Volume In FT^3
Protozoa Flow Rate	1 per minute	4 per minute	.13 per minute
Protozoa Finished Water Sample	264	1000	36

STEP 9 When the water meter indicates that 264 gallons/1000 liters of water have passed through the filter, turn off the water at the tap.

Record the following information on the sample label:

- Time sampling stopped
- Final water meter reading (including units)
- Final turbidity
- Total volume filtered

Stop Time: ______ Meter Reading: ______ Turbidity: ______
Start Time: ______ Meter Reading: ______ Turbidity: ______
Operator Name: ______ Total Volume Filtered: ______
Date: ______ Sampling Location: ______

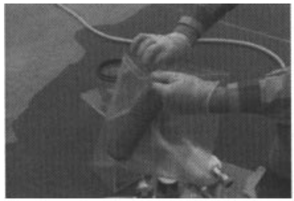
STEP 10 Disconnect the sampling apparatus from the water tap.

! Be sure to hold the inlet hose *above the level of the outlet hose opening* while the water drains from the housing. This will prevent backwash and loss of particulate matter from the filter.

Disconnect the inlet and outlet hoses from the filter housing.

! Put on fresh latex gloves.

11 As aseptically as possible, remove the filter from the housing and put it into a plastic sample bag.



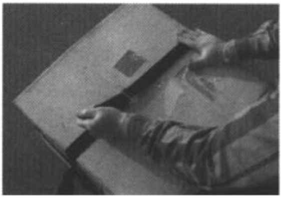
12 Pour all of the water remaining in the filter housing into the same plastic bag.

13 Seal the plastic sample bag and place it inside the second plastic sample bag.

Transfer the label or label information to the outside of the outer bag.

14 Put the bags containing the filter into the shipping container.

Place the ice packs around, but not on, the sample bag to prevent freezing the sample. You may want to insert several inflated, empty sample bags between the sample and the ice packs.



15 Seal the container and follow the laboratory's instructions related to the cleaning, storage, and return of sampling equipment.

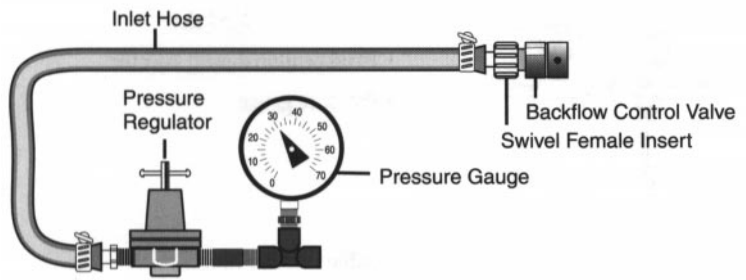
16 Ship the container by overnight courier to the laboratory.

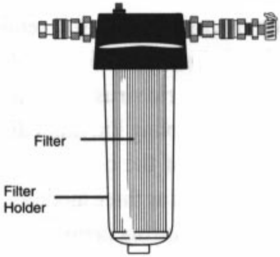
Call the laboratory and notify them of the sample shipment.

Sample Collection Procedures for Detecting Enteric Viruses in Water

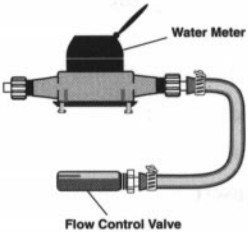
STEP 1 Each month, your laboratory will send you all of the equipment needed to collect samples for enteric virus analyses. When you receive the sampling kit, immediately check the contents of the carton. The sampling kit will be shipped as three modules, and should contain the following items:

- ❑ Plastic sample bags
- ❑ Ice packs for shipping the collected samples
- ❑ Sample data sheet
- ❑ Regulator Module (below):
  - Backflow control valve
  - Swivel female insert
  - Inlet hose
  - Pressure regulator with pressure gauge



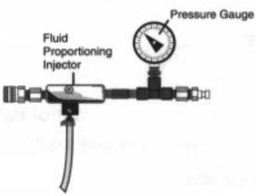


- ❑ Cartridge Housing Module:
  - 1-MDS Zetapor Virosorb filter inside a filter holder

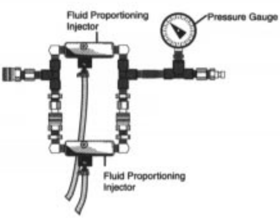


- ❑ Discharge Module:
  - Water meter
  - Flow control valve

The laboratory will also ship three additional modular sections, as required by your facility. These may include:



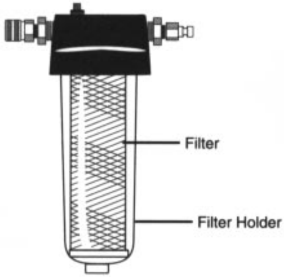
- ❑ Single Injector Module:
  - Fluid proportioning injector
  - Pressure gauge



- ❑ Double Injector Module:
  - Two fluid proportioning injectors, in parallel
  - Pressure gauge

❑ Prefilter Module:

- 10 µm polypropylene filter inside a filter holder



The ends of each module should be wrapped in foil to ensure that the equipment remains free of contamination. If your modules are unprotected or compromised, please contact your laboratory immediately for further instructions.

If you are missing any items, contact your laboratory immediately. Do not attempt to collect the samples without a complete sampling kit.

Once you have verified the contents of the sampling kit, place the ice packs in the freezer and repack the box.

COLLECTING SOURCE WATER SAMPLES

When you are ready to collect your virus sample, bring the following items with you to the sampling location:

- ❑ Shipping container sent by the laboratory
- ❑ Regulator Module
- ❑ Cartridge Housing Module
- ❑ Discharge Module
- ❑ Single Injector Module (for adding 0.1-molar hydrochloric acid to adjust pH, if necessary)
- ❑ Prefilter Module (for filtering sediment from highly turbid water, if necessary)
- ❑ Approximately 2 gal (4 L) of 0.1-molar hydrochloric acid solution (for adjusting pH, if necessary)
- ❑ Sterile, 250- or 500-mL graduated cylinder
- ❑ Plastic sample bags
- ❑ Sample data sheet
- ❑ Frozen ice packs
- ❑ Several pairs of new latex gloves
- ❑ pH meter
- ❑ Thermometer
- ❑ Turbidimeter

2 Turn on the water at the tap and allow the water to flow for 2 to 3 minutes or until any debris that has accumulated in the sampling line has cleared or the turbidity in the water becomes uniform.

3 Put on new latex gloves to prevent contamination from outside sources. Sterile technique must be used when sampling for enteric viruses. Any contamination of the sampling apparatus may bias the final results.

Turn off the water at the tap.

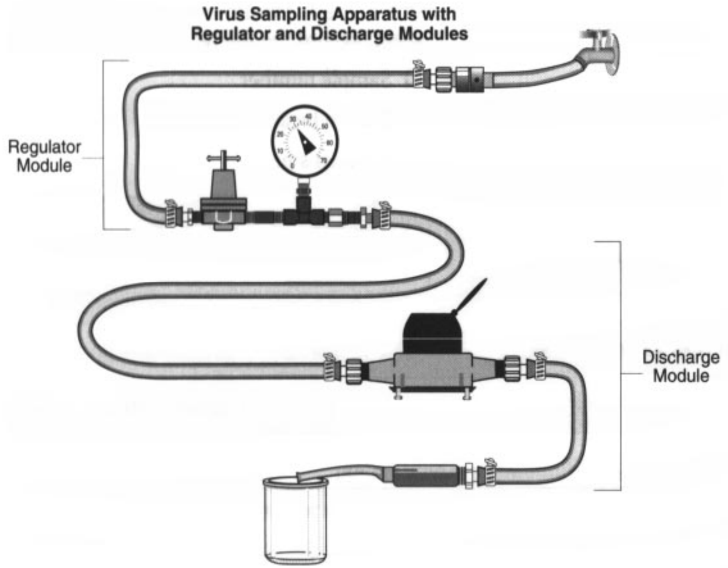
Remove the foil from the backflow regulator on the Regulator Module and connect it to the water tap or to an extension hose connected to the tap.

Remove the foil from the other end of the Regulator Module and from the Discharge Module. Connect the Discharge Module to the Regulator Module.

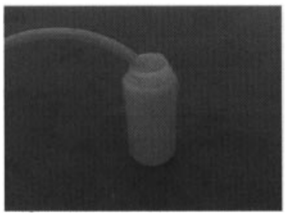
Place the end of the Discharge Module, or an extension hose connected to the Discharge Module, into a 1-liter plastic bottle.

Note the water meter reading, then slowly turn on the water.

Using the pressure regulator, adjust the water pressure to no more than 30 psi.



4 Flush the sampling apparatus with 20 gallons / 76 liters of water by allowing the water to flow through the system, out the effluent hose into the 1-liter plastic bottle.



Sampling Step	Volume In GALLONS	Volume In LITERS	Volume In FT^3
System Flush	20	76	2.7

While the water is flushing the sampling apparatus, begin completing your sample data sheet. Record the following information:

- ❑ Sample number
- ❑ System location
- ❑ Sampler's name

SAMPLE DATA SHEET				
SAMPLE NUMBER:				
SYSTEM LOCATION:				
SAMPLER'S NAME:				
WATER pH:	**WATER TEMPERATURE:**	**°C**	**TURBIDITY:**	**NTU**
INIT. METER READING: **date:**	**time:**	**(CHECK UNITS)**	**__ft³**	**__gallons**
FINAL METER READING: **date:**	**time:**	**(CHECK UNITS)**	**__ft³**	**__gallons**
TOTAL SAMPLE VOLUME:	(Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))		**liters**	
CONDITION ON ARRIVAL:				
COMMENTS:				

5 Measure the pH, temperature, and turbidity of the source water flowing from the effluent hose. Record the readings on the sample data sheet.

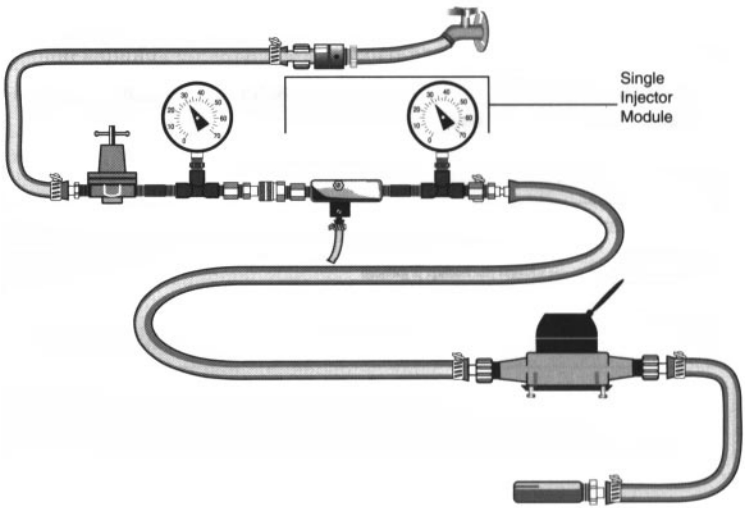
SAMPLE DATA SHEET				
SAMPLE NUMBER:				
SYSTEM LOCATION:				
SAMPLER'S NAME:				
WATER pH:	WATER TEMPERATURE: °C		TURBIDITY: NTU	
INIT. METER READING: date:	time:	(CHECK UNITS)	__ft³	__gallons
FINAL METER READING: date:	time:	(CHECK UNITS)	__ft³	__gallons
TOTAL SAMPLE VOLUME:	(Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))		liters	
CONDITION ON ARRIVAL:				
COMMENTS:				

6 Turn off the water at the tap and decide whether you need to insert additional modules into the sampling train.

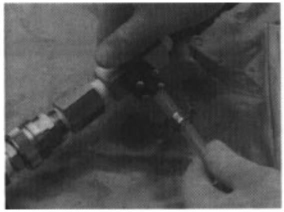
For source water sampling, you may need to use the Single Injector Module and/or the Pre-filter Module.

First, determine if you need to use the Single Injector Module.

If your pH value is greater than 8.0, you need to insert the Single Injector Module between the Regulator and Discharge Modules before proceeding.

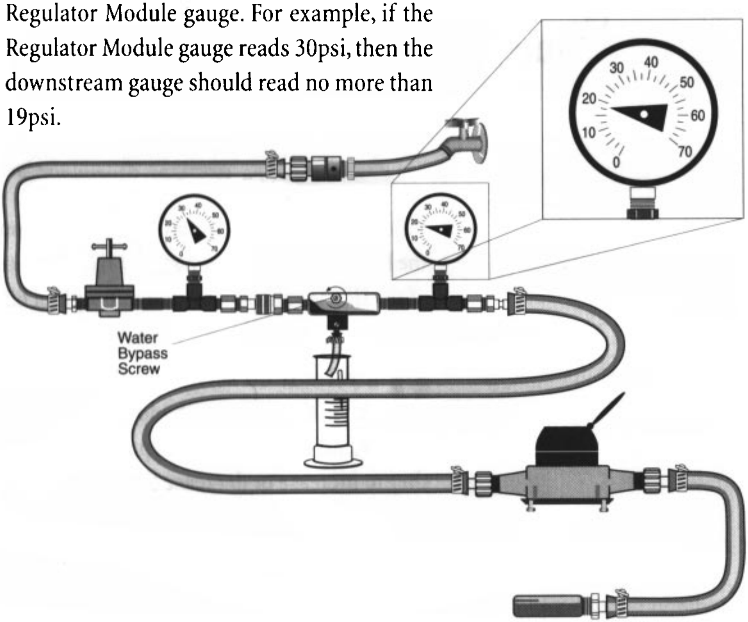


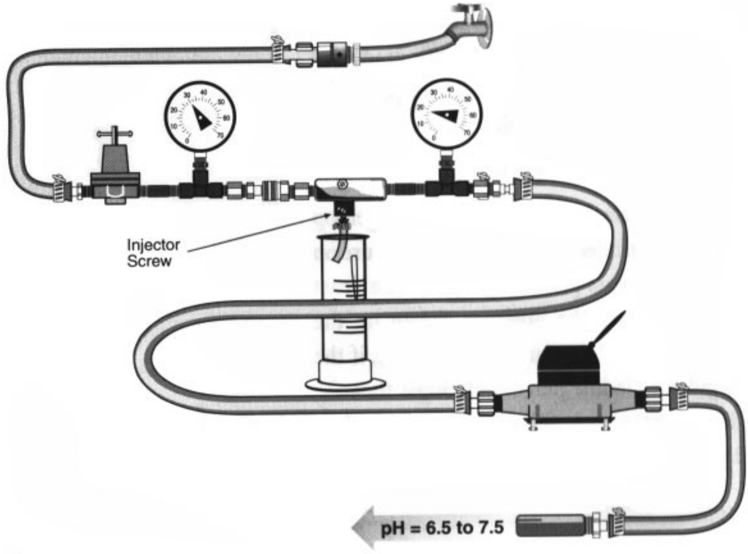
Using aseptic technique, connect the sterile tubing to the injector. Fill the sterile graduated cylinder with 0.1-molar HCl and place the tube in the graduated cylinder.



Turn on the water at the tap.

Using the water bypass screw—the larger top screw in the injector—adjust the pressure on the downstream pressure gauge to be at least 35% less than the pressure shown on the Regulator Module gauge. For example, if the Regulator Module gauge reads 30psi, then the downstream gauge should read no more than 19psi.





Adjust the smaller injector screw, located on the bottom of the injector, so that the flow rate of the HCl is sufficient to maintain a pH of 6.5 to 7.5.

If there is no suction visibly drawing down the HCl, or if too much HCl is flowing, adjust the water bypass screw further to increase or decrease the pressure differential between the two gauges. A greater differential between the upstream gauges increases the flow rate; a smaller differential decreases the flow rate.

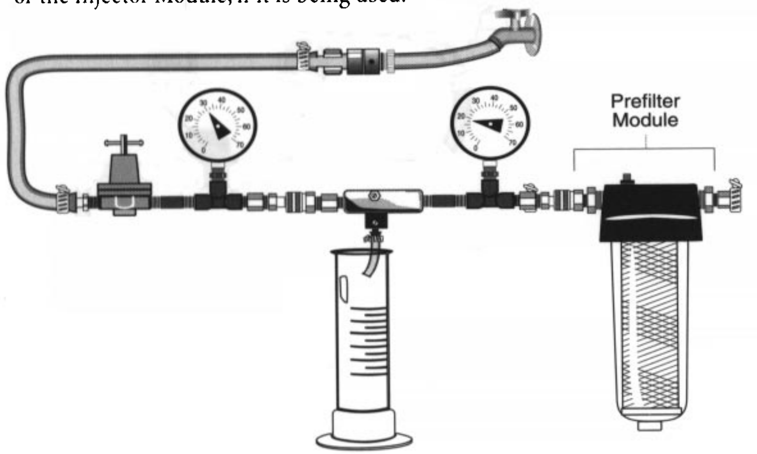
After the HCl flow rate is adjusted properly, transfer the injector tube to a carboy of HCl. Periodically check the pH to ensure that sufficient HCl is being added to maintain a pH of 6.5 to 7.5.

Record the adjusted pH on the Sample Data Sheet.

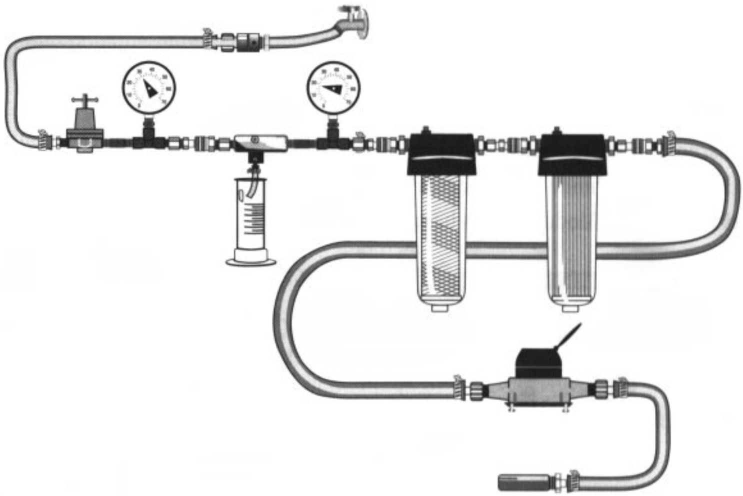
Next, determine if you need to use the Prefilter Module.

Turn off the water at the tap, and note the turbidity. If the turbidity is greater than 75 NTU, or for conditions where the 1-MDS filter is expected to clog before sampling is completed, you will need to use the Prefilter Module.

Disconnect the Discharge Module and connect the Prefilter Module to the Regulator Module or the Injector Module, if it is being used.



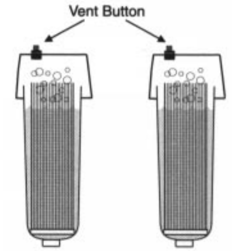
7 Connect the Cartridge Housing Module containing the 1-MDS filter to the Prefilter Module. Then, reconnect the Discharge Module to the outlet end of the Cartridge Housing Module.



Record the following information on the Sample Data Sheet:

- ❑ Date sampling started
- ❑ Time sampling started
- ❑ Initial water meter reading (including units)

SAMPLE DATA SHEET			
SAMPLE NUMBER:			
SYSTEM LOCATION:			
SAMPLER'S NAME:			
WATER pH:	WATER TEMPERATURE: °C	TURBIDITY: NTU	
INIT. METER READING: date:	time:	(CHECK UNITS)	__ft³ __gallons
FINAL METER READING: date:	time:	(CHECK UNITS)	__ft³ __gallons
TOTAL SAMPLE VOLUME:	(Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))	liters	
CONDITION ON ARRIVAL:			
COMMENTS:			



STEP 8 Slowly, start the water flowing through the sampling apparatus.

Push the red vent buttons on top of the filter housings to expel air in the filters. When the air is totally expelled from the filters, release the button and open the water tap completely.

Using the pressure regulator on the Regulator Module, adjust the pressure regulator to no more than 30 psi.

Using the water bypass screw on the injector, adjust the pressure regulator on the Single Injector Module to be at least 35% less than the pressure shown on the Regulator Module gauge.

Allow 53 - 80 gallons / 200 - 300 liters of water to pass through the filter.

Sampling Step	**Volume In GALLONS**	**Volume In LITERS**	**Volume In FT^3**
Sampling Source Water	53 - 80	200 - 300	7 - 11

! If the virus filter clogs before 53 gallons/ 100 liters are collected, contact the approved analyst at your laboratory for further instructions.

STEP 9 When the water meter indicates that 53 - 80 gallons / 200 - 300 liters of water have passed through the filter, turn off the water at the tap.

Record the following information on the Sample Data Sheet:

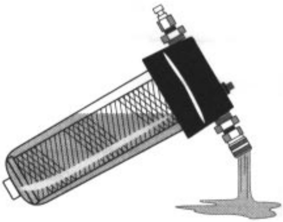
- ❑ Date sampling ended
- ❑ Time sampling ended
- ❑ Final water meter reading (including units)

SAMPLE DATA SHEET			
SAMPLE NUMBER:			
SYSTEM LOCATION:			
SAMPLER'S NAME:			
WATER pH:	**WATER TEMPERATURE:** °C	**TURBIDITY:** NTU	
INIT. METER READING: date:	time: **(CHECK UNITS)**	__ft³	__gallons
FINAL METER READING: date:	time: **(CHECK UNITS)**	__ft³	__gallons
TOTAL SAMPLE VOLUME: (Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))		**liters**	
CONDITION ON ARRIVAL:			
COMMENTS:			

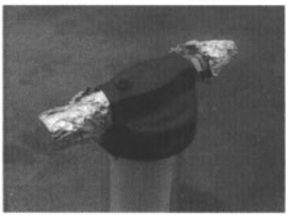
Put on fresh latex gloves.

Carefully, disconnect the sampling apparatus from the water tap.

Disconnect the Cartridge Housing Module from the sampling train.



Turn the filter housing upside down and allow excess water to flow out as waste water.



Turn the housing upright, and cover the module ends with sterile foil.

Do not attempt to open the filter housing.

If you are using the Prefilter Module, disconnect it from the sampling train, repeat the draining procedure, and cover the module ends with sterile foil.

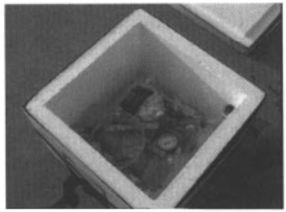
The filters and filter housings are shipped to the laboratory intact. The Discharge Module may be retained at the utility and reused.

Place the filter housings into an insulated shipping box.

Set the ice packs around the housings.

Return the Regulator Module and the Injector Module to the laboratory for cleaning and sterilization.

Place the Sample Data Sheet in a plastic bag and pack it on top of the sampling apparatus.



You may need to use additional packing material to ensure that the contents of the box will not shift during transport.

11 Seal the container and ship it by overnight courier to the laboratory. Call the laboratory and notify them of the sample shipment.

COLLECTING FINISHED WATER SAMPLES

STEP 1 If the concentration of any pathogen in your source water samples exceeds 1 per liter during the first 12 months of sampling, then you must monitor finished water as well as source water.

Sampling of finished water begins in the same manner as sampling of source water described previously, as follows:

When you are ready to collect your finished water virus sample, bring the following items with you to the sampling location:

- ❑ Shipping container sent by the laboratory
- ❑ Regulator Module
- ❑ Cartridge Housing Module
- ❑ Discharge Module
- ❑ Single Injector Module (for adding 2% thiosulfate solution to neutralize effects of chlorination or other disinfectant treatments)
- ❑ Double Injector Module (for adding 2% thiosulfate solution to neutralize effects of chlorination or other disinfectant treatments while adding 0.1-molar hydrochloric acid to adjust pH, if necessary)

- ❏ Approximately 2 gal (4 L) of 2% sodium thiosulfate solution
- ❏ Approximately 2 gal (4 L) of 0.1-molar hydrochloric acid solution (for adjusting pH, if necessary)
- ❏ 2 sterile, 250- or 500-mL graduated cylinders
- ❏ Plastic sample bags
- ❏ Sample data sheet
- ❏ Frozen ice packs
- ❏ Several pairs of new latex gloves
- ❏ pH meter
- ❏ Thermometer

2 Turn on the water at the tap and allow the water to flow for 2 to 3 minutes or until any debris that has accumulated in the sampling line has cleared or the turbidity in the water becomes uniform.

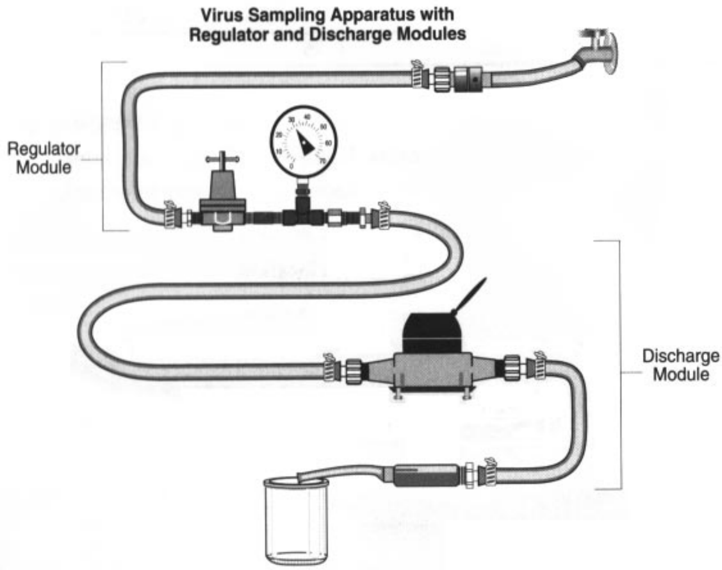
Turn off the water at the tap.

3 Put on new latex gloves to prevent contamination from outside sources. Sterile technique must be used when sampling for enteric viruses. Any contamination of the sampling apparatus may bias the final results.

Remove the foil from the backflow regulator on the Regulator Module and connect the module to the water tap or to an extension hose connected to the tap.

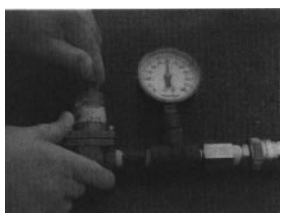
Remove the foil from the other end of the Regulator Module and from the Discharge Module and connect the Discharge Module to the Regulator Module.

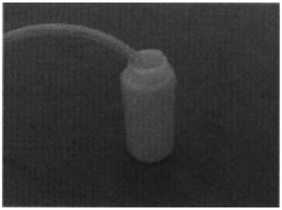
Place the end of the Discharge Module, or an extension hose connected to the Discharge Module, into a 1-liter plastic bottle.



Note the water meter reading, then slowly turn on the water.

Using the pressure regulator, adjust the water pressure to no more than 30 psi.





STEP 4 Flush the sampling apparatus with 20 gallons / 76 liters of water by allowing the water to flow through the system, out the effluent hose into the 1-liter plastic bottle.

Sampling Step	Volume In GALLONS	Volume In LITERS	Volume In FT^3
System Flush	20	76	2.7

While the water is flushing the sampling apparatus, begin completing your sample data sheet. Record the following information:

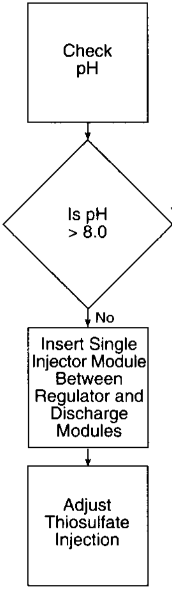
- ❏ Sample number
- ❏ System location
- ❏ Sampler's name

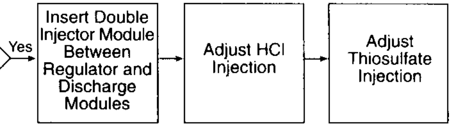
SAMPLE DATA SHEET			
SAMPLE NUMBER:			
SYSTEM LOCATION:			
SAMPLER'S NAME:			
WATER pH:	WATER TEMPERATURE: °C	TURBIDITY:	NTU
INIT. METER READING: date:	time:	(CHECK UNITS)	__ft³ __gallons
FINAL METER READING: date:	time:	(CHECK UNITS)	__ft³ __gallons
TOTAL SAMPLE VOLUME:	(Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))	liters	

5 Measure the pH, temperature, and turbidity of the source water flowing from the effluent hose. Record the readings on the sample data sheet.

SAMPLE DATA SHEET			
SAMPLE NUMBER:			
SYSTEM LOCATION:			
SAMPLER'S NAME:			
WATER pH:	**WATER TEMPERATURE:** °C		**TURBIDITY:** NTU
INIT. METER READING: date:	time:	**(CHECK UNITS)**	__ft³ __gallons
FINAL METER READING: date:	time:	**(CHECK UNITS)**	__ft³ __gallons
TOTAL SAMPLE VOLUME:	(Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))		**liters**
CONDITION ON ARRIVAL:			
COMMENTS:			

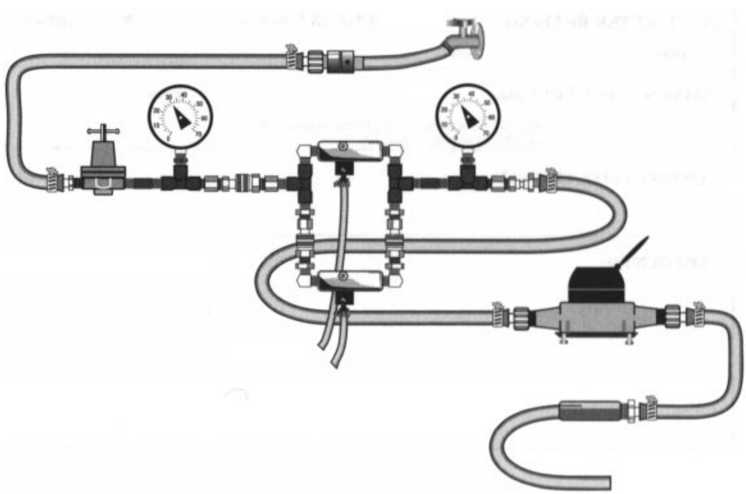
STEP 6 Turn off the water at the tap and decide whether you need to use the Single Injector or Double Injector Module.





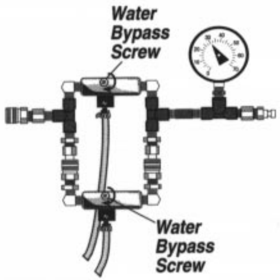
If your pH value is greater than 8.0, you need to inject the hydrochloric acid and 2% thiosulfate solution simultaneously. If your pH value is less than 8.0, you need to inject only the 2% thiosulfate solution.

Disregard the next two pages and proceed to page 57 if your pH value is less than 8.0.



pH > 8.0

Insert the Double Injector Module between the Regulator and Discharge Modules before proceeding.



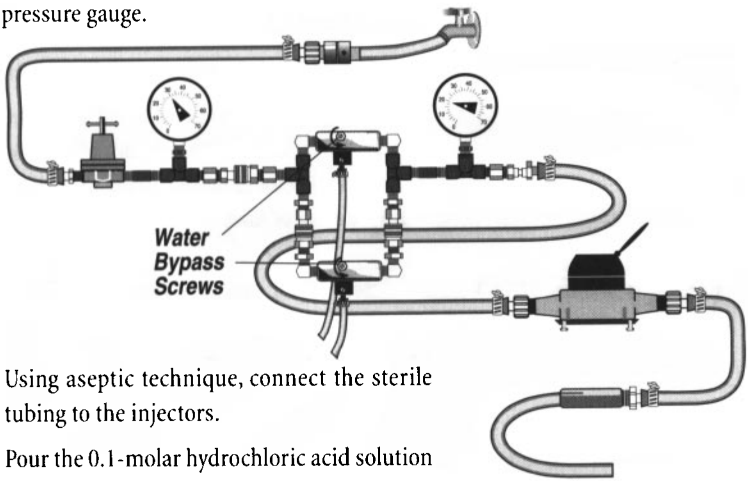
! Ensure that both injectors are completely closed before proceeding.

Adjust the water bypass screws on each injector clockwise as far as possible.

Turn on the water.

Next, turn each of the screws one half turn counterclockwise.

Continue opening the water bypass screws in half-turn increments until the reading on the second pressure gauge is approximately 35% less than that shown on the Regulator Module pressure gauge.



Using aseptic technique, connect the sterile tubing to the injectors.

Pour the 0.1-molar hydrochloric acid solution into a sterile graduated cylinder and place one of the injector tubes into it.

Pour the 2% thiosulfate solution into a second, sterile graduated container. Place the tube from the second injector into the thiosulfate solution.

If there is no suction visibly drawing down the 2% thiosulfate or the HCl, or if too much is flowing, adjust the water bypass screws further to increase or decrease the pressure differential between the two gauges, until the flow is regulated properly.

Adjust the smaller injector screw on the hydrochloric acid injector to add sufficient hydrochloric acid to maintain a pH of 6.5 to 7.5.

After adjusting the injector, transfer the injector tube to the carboy of 0.1-molar hydrochloric acid. As sampling proceeds, periodically check the pH to ensure that it remains between 6.5 and 7.5.

Record the adjusted pH on the Sample Data Sheet.

Next, using the formula below, calculate the rate of thiosulfate injection and adjust the thiosulfate injector to deliver 10 mL of thiosulfate per gallon of flow.

$$\begin{pmatrix}\text{Water}\\ \text{Flow}\\ \text{Rate}\end{pmatrix} \frac{\text{gallons}}{\text{minute}} \times \frac{\text{10 ml Thiosulfate}}{\text{1 gallon water}} = \begin{pmatrix}\text{Thiosulfate}\\ \text{Injection Rate}\end{pmatrix} \frac{\text{ml}}{\text{minute}}$$

After the thiosulfate flow rate is adjusted, transfer the injector tube to the carboy of thiosulfate.

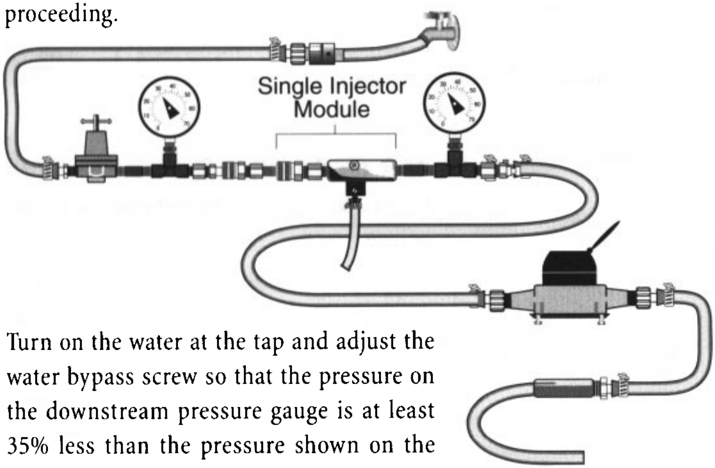
Monitor the thiosulfate flow rate visually throughout sampling.

Disregard the next section and proceed to step 7 (page 58).

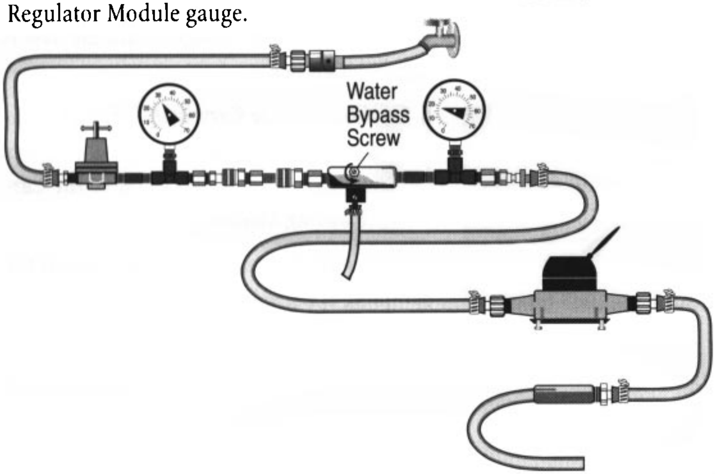
pH < 8.0

If your pH value is less than 8.0, it does not need to be adjusted, and you can use the Single Injector Module to inject the 2% sodium thiosulfate solution.

Insert the Single Injector Module between the Regulator and Discharge Modules before proceeding.



Turn on the water at the tap and adjust the water bypass screw so that the pressure on the downstream pressure gauge is at least 35% less than the pressure shown on the Regulator Module gauge.



Pour the 2% thiosulfate into a graduated cylinder.

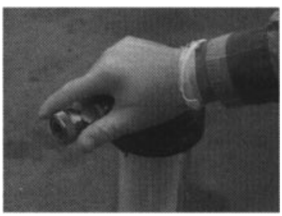
Next, using the formula below, calculate the rate of thiosulfate injection and adjust the thiosulfate injector to deliver 10 mL of thiosulfate per gallon of flow.

$$\left(\begin{matrix}\text{Water}\\ \text{Flow}\\ \text{Rate}\end{matrix}\right)\frac{\text{gallons}}{\text{minute}} \times \frac{\text{10 ml Thiosulfate}}{\text{1 gallon water}} = \left(\begin{matrix}\text{Thiosulfate}\\ \text{Injection Rate}\end{matrix}\right)\frac{\text{ml}}{\text{minute}}$$

After the thiosulfate flow rate is adjusted, transfer the injector tube to the carboy of thiosulfate.

Monitor the thiosulfate flow rate visually throughout sampling.

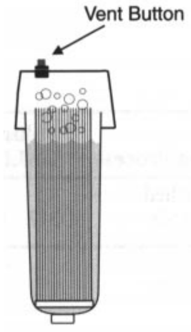
! If there is no suction visibly drawing down the thiosulfate, or if too much is flowing, adjust the water bypass screw further to increase or decrease the pressure differential between the two gauges, until the flow is regulated properly.



STEP 7 Connect the Cartridge Housing Module. Then reconnect the Discharge Module to the outlet end of the Cartridge Housing Module.

Slowly, start the water flowing through the sampling apparatus.

Push the red vent button on top of the filter housing to expel air in the filter. When the air is totally expelled from the filter, release the button and open the water tap completely.



Using the pressure regulator on the Regulator Module, adjust the pressure to no more than 30 psi.

Using the water bypass screw on the injector, adjust the pressure gauge on the Single Injector Module to be at least 35% less than the pressure shown on the Regulator Module gauge .

Record the following information on the Sample Data Sheet:

- ❑ Date sampling started
- ❑ Time sampling started
- ❑ Initial water meter reading (including units)

SAMPLE DATA SHEET			
SAMPLE NUMBER:			
SYSTEM LOCATION:			
SAMPLER'S NAME:			
WATER pH:	WATER TEMPERATURE: °C	TURBIDITY: NTU	
INIT. METER READING: date:	time:	(CHECK UNITS)	__ft³ __gallons
FINAL METER READING: date:	time:	(CHECK UNITS)	__ft³ __gallons
TOTAL SAMPLE VOLUME: (Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))		liters	
CONDITION ON ARRIVAL:			

STEP 8 Collect 317 - 396 gallons or 1200 to 1500 liters of finished water.

Sampling Process	Volume In GALLONS	Volume In LITERS	Volume In FT^3
Virus Finished Water Sample	317 - 396	1200 - 1500	43 - 53

STEP 9 When the water meter indicates that 317 - 396 gallons / 1200 - 1500 liters of water have passed through the filter, turn off the water at the tap.

Record the following information on the Sample Data Sheet:

- ❑ Date sampling ended
- ❑ Time sampling ended
- ❑ Final water meter reading (including units)

SAMPLE DATA SHEET

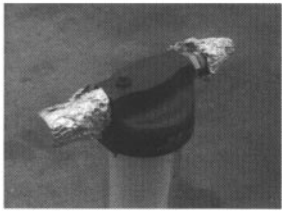
SAMPLE NUMBER:			
SYSTEM LOCATION:			
SAMPLER'S NAME:			
WATER pH:	**WATER TEMPERATURE:** °C	**TURBIDITY:**	**NTU**
INIT. METER READING: date:	time:	**(CHECK UNITS)**	__ft³ __gallons
FINAL METER READING: date:	time:	**(CHECK UNITS)**	__ft³ __gallons
TOTAL SAMPLE VOLUME:	(Final-Initial meter readings x 28.316 (for readings in ft³) or x 3.7854 (for readings in gallons))	**liters**	

Put on fresh latex gloves.

Carefully, disconnect the sampling apparatus from the water tap.

Disconnect the Cartridge Housing Module from the sampling train. Turn the filter housing upside down and allow excess water to flow out as waste water.

Turn the housing upright, and cover the module ends with sterile foil.



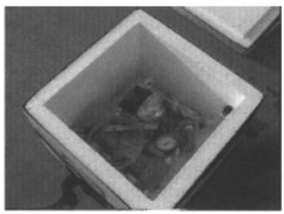
Do not attempt to open the filter housing.

The filter and filter housing are shipped to the laboratory intact. The Discharge Module may be retained at the utility and reused.

STEP 10

Place the filter housing into an insulated shipping box.

Set the ice packs around the housing.



Return the Regulator Module and the Injector Module to the laboratory for cleaning and sterilization.

Place the Sample Data Sheet in a plastic bag and pack it on top of the sampling apparatus. Seal the container.

You may need to use additional packing material to ensure that the contents of the box will not shift during transport.

11 Ship the container by overnight courier to the laboratory. Call the laboratory and notify them of the sample shipment.

Credits and Acknowledgments

The use of Manufacturer Trade Names in the production does not constitute endorsement by the U.S. Environmental Protection Agency.

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Special thanks to the management and staff of the Fairfax County Water Authority.

Appendix C

SAFETY DATA SHEET

PRODUCT

CAT-FLOC(R) CFTL

EMERGENCY TELEPHONE NUMBER(S)
(800) 424-9300 (24 Hours) CHEMTREC

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME : **CAT-FLOC(R) CFTL**

APPLICATION : COAGULANT

COMPANY IDENTIFICATION : Nalco Company
1601 W. Diehl Road
Naperville, Illinois
60563-1198

EMERGENCY TELEPHONE NUMBER(S) : (800) 424-9300 (24 Hours) CHEMTREC

NFPA 704M/HMIS RATING
HEALTH : 0 / 1 FLAMMABILITY : 1 / 1 INSTABILITY : 0 / 0 OTHER :
0 = Insignificant 1 = Slight 2 = Moderate 3 = High 4 = Extreme

2. COMPOSITION/INFORMATION ON INGREDIENTS

Based on our hazard evaluation, none of the substances in this product are hazardous.

3. HAZARDS IDENTIFICATION

****EMERGENCY OVERVIEW****

CAUTION
May cause irritation with prolonged contact.
Do not get in eyes, on skin, on clothing. Do not take internally. Use with adequate ventilation. In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. After contact with skin, wash immediately with plenty of water.
Wear suitable protective clothing.
May evolve oxides of carbon (COx) under fire conditions.

PRIMARY ROUTES OF EXPOSURE :
Eye, Skin

HUMAN HEALTH HAZARDS - ACUTE :

EYE CONTACT :
May cause irritation with prolonged contact.

SKIN CONTACT :
May cause irritation with prolonged contact.

INGESTION :
Not a likely route of exposure. No adverse effects expected.

INHALATION :
Not a likely route of exposure. No adverse effects expected.

SYMPTOMS OF EXPOSURE :
Acute :
A review of available data does not identify any symptoms from exposure not previously mentioned.
Chronic :
A review of available data does not identify any symptoms from exposure not previously mentioned.

AGGRAVATION OF EXISTING CONDITIONS :
A review of available data does not identify any worsening of existing conditions.

4. FIRST AID MEASURES

EYE CONTACT :
Flush affected area with water. If symptoms develop, seek medical advice.

SKIN CONTACT :
Remove contaminated clothing. Wash off affected area immediately with plenty of water. If symptoms develop, seek medical advice.

INGESTION :
Do not induce vomiting without medical advice. If conscious, washout mouth and give water to drink. If symptoms develop, seek medical advice.

INHALATION :
Remove to fresh air, treat symptomatically. If symptoms develop, seek medical advice.

If Swallowed: Do not induce vomiting. Drink large quantities of water. Never give anything by mouth to an unconscious or convulsing person.

If in Eyes: Flood eyes with water for at least 15 minutes

If on Skin: Wash thoroughly soap and water.

NOTE TO PHYSICIAN :
Based on the individual reactions of the patient, the physician's judgement should be used to control symptoms and clinical condition.

5. FIRE FIGHTING MEASURES

FLASH POINT : None

EXTINGUISHING MEDIA :
This product would not be expected to burn unless all the water is boiled away. The remaining organics may be ignitable. Use extinguishing media appropriate for surrounding fire. Water mist may be used to cool closed containers.

FIRE AND EXPLOSION HAZARD :
May evolve oxides of carbon (COx) under fire conditions.

SPECIAL PROTECTIVE EQUIPMENT FOR FIRE FIGHTING :
In case of fire, wear a full face positive-pressure self contained breathing apparatus and protective suit.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS :
Notify appropriate government, occupational health and safety and environmental authorities. Do not touch spilled material. Stop or reduce any leaks if it is safe to do so. Use personal protective equipment recommended in Section 8 (Exposure Controls/Personal Protection).

METHODS FOR CLEANING UP :
SMALL SPILLS: Soak up spill with absorbent material. Place residues in a suitable, covered, properly labeled container. Wash affected area. LARGE SPILLS: Contain liquid using absorbent material, by digging trenches or by diking. Reclaim into recovery or salvage drums or tank truck for proper disposal. Contact an approved waste hauler for disposal of contaminated recovered material. Dispose of material in compliance with regulations indicated in Section 13 (Disposal Considerations).

ENVIRONMENTAL PRECAUTIONS :
This product is toxic to fish. It should not be directly discharged into lakes, ponds, streams, waterways or public water supplies.

7. HANDLING AND STORAGE

HANDLING :
Do not take internally. Have emergency equipment (for fires, spills, leaks, etc.) readily available. Ensure all containers are labeled. Avoid eye and skin contact.

STORAGE CONDITIONS :
Store separately from oxidizers. Store the containers tightly closed.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

OCCUPATIONAL EXPOSURE LIMITS :
This product does not contain any substance that has an established exposure limit.

ENGINEERING MEASURES :
General ventilation is recommended.

RESPIRATORY PROTECTION :
Respiratory protection is not normally needed.

HAND PROTECTION :
Nitrile gloves, PVC gloves

SKIN PROTECTION :
Wear standard protective clothing.

EYE PROTECTION :
Wear chemical splash goggles.

HYGIENE RECOMMENDATIONS :
Keep an eye wash fountain available. Keep a safety shower available.

9. PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL STATE Liquid

APPEARANCE Colorless Light Gold

ODOR None

SPECIFIC GRAVITY	1.02 - 1.06
DENSITY	8.5 - 8.8 lb/gal
SOLUBILITY IN WATER	Complete
pH (100 %)	5 - 8
FREEZING POINT	/ -3 °C
BOILING POINT	212 °F / 100 °C Minimum
VAPOR PRESSURE	Same as water
VOC CONTENT	0.00 % EPA Method 24

Note: These physical properties are typical values for this product and are subject to change.

10. STABILITY AND REACTIVITY

STABILITY :
Stable under normal conditions.

HAZARDOUS POLYMERIZATION :
Hazardous polymerization will not occur.

CONDITIONS TO AVOID :
Freezing temperatures.

MATERIALS TO AVOID :
Contact with strong oxidizers (e.g. chlorine, peroxides, chromates, nitric acid, perchlorate, concentrated oxygen, permanganate) may generate heat, fires, explosions and/or toxic vapors.

HAZARDOUS DECOMPOSITION PRODUCTS :
Under fire conditions: Oxides of carbon, Oxides of nitrogen

11. TOXICOLOGICAL INFORMATION

The following results are for the product.

ACUTE ORAL TOXICITY :

Species	LD50	Test Descriptor
Rat	14,600 mg/kg	Product

Rating : Non-Hazardous

ACUTE DERMAL TOXICITY :

Species	LD50	Test Descriptor
Rabbit	> 20,000 mg/kg	40% Active Ingredient Poly(DADMAC)

Rating : Non-Hazardous

PRIMARY SKIN IRRITATION :

Draize Score	Test Descriptor
1 / 8.0	40% Active Ingredient (Poly(DADMAC))

Rating : Minimally irritating

PRIMARY EYE IRRITATION :

Draize Score	Test Descriptor
8 / 110.0	40% Active Ingredient (Poly(DADMAC))

Rating : Practically non-irritating

SENSITIZATION :
This product is not expected to be a sensitizer.

CARCINOGENICITY :
None of the substances in this product are listed as carcinogens by the International Agency for Research on Cancer (IARC), the National Toxicology Program (NTP) or the American Conference of Governmental Industrial Hygienists (ACGIH).

HUMAN HAZARD CHARACTERIZATION :
Based on our hazard characterization, the potential human hazard is: Low

12. ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL EFFECTS :

The tests for (products or similar products) were performed in clean water as set forth by USEPA (EPA/600/4-90/027). In order to evaluate the potential toxicity mitigation, the tests for (representative polymers) were performed in environmentally relevant water with dissolved organic carbon (DOC: 4.5 mg/l). The toxicity of this product is due to an external mode of action, e.g., suffocation or immobilization. In the presence of suspended material, e.g., DOC, the polymers are bound to suspended material and the bioavailability is substantially reduced. As a result, the toxicity is expected to be lower. Under normal use and discharge conditions, the LC50 values of the representative polymers tested in the presence of DOC are expected to apply to this product. However, for large spills, the clean water data is more applicable.

ACUTE FISH RESULTS :

Species	Exposure	LC50	Test Descriptor
Rainbow Trout	96 hrs	0.74 mg/l	Product tested in clean water
Zebra Danio	96 hrs	10 - 100 mg/l	Representative polymer tested in water with DOC

ACUTE INVERTEBRATE RESULTS :

Species	Exposure	LC50	EC50	Test Descriptor
Daphnia magna	48 hrs	1.8 mg/l		Product tested in clean water
Daphnia magna	48 hrs	10 - 100 mg/l		Representative polymer tested in water with DOC

ADDITIONAL ECOLOGICAL DATA
AOX information: Product contains no organic halogens.

MOBILITY :
The environmental fate was estimated using a level III fugacity model embedded in the EPI (estimation program interface) Suite TM, provided by the US EPA. The model assumes a steady state condition between the total input and output. The level III model does not require equilibrium between the defined media. The information provided is intended to give the user a general estimate of the environmental fate of this product under the defined conditions of the models.
If released into the environment this material is expected to distribute to the air, water and soil/sediment in the approximate respective percentages;

Air	Water	Soil/Sediment
<5%	30 - 50%	50 - 70%

The portion in water is expected to be soluble or dispersible.

BIOACCUMULATION POTENTIAL
This preparation or material is not expected to bioaccumulate.

ENVIRONMENTAL HAZARD AND EXPOSURE CHARACTERIZATION
Based on our hazard characterization, the potential environmental hazard is: High

OTHER INFORMATION
The hazard characterization is based on the tests or potential hazard in the clean water.

If released into the environment, see CERCLA/SUPERFUND in Section 15.

13. DISPOSAL CONSIDERATIONS

If this product becomes a waste, it is not a hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA) 40 CFR 261, since it does not have the characteristics of Subpart C, nor is it listed under Subpart D.

As a non-hazardous waste, it is not subject to federal regulation. Consult state or local regulation for any additional handling, treatment or disposal requirements. For disposal, contact a properly licensed waste treatment, storage, disposal or recycling facility.

14. TRANSPORT INFORMATION

The information in this section is for reference only and should not take the place of a shipping paper (bill of lading) specific to an order. Please note that the proper Shipping Name / Hazard Class may vary by packaging, properties, and mode of transportation. Typical Proper Shipping Names for this product are as follows.

LAND TRANSPORT :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

AIR TRANSPORT (ICAO/IATA) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

MARINE TRANSPORT (IMDG/IMO) :

Proper Shipping Name : PRODUCT IS NOT REGULATED DURING TRANSPORTATION

15. REGULATORY INFORMATION

This section contains additional information that may have relevance to regulatory compliance. The information in this section is for reference only. It is not exhaustive, and should not be relied upon to take the place of an individualized compliance or hazard assessment. Nalco accepts no liability for the use of this information.

NATIONAL REGULATIONS, USA :

OSHA HAZARD COMMUNICATION RULE, 29 CFR 1910.1200 :
Based on our hazard evaluation, none of the substances in this product are hazardous.

CERCLA/SUPERFUND, 40 CFR 117, 302 :
Notification of spills of this product is not required.

SARA/SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 (TITLE III) - SECTIONS 302, 311, 312, AND 313 :

SECTION 302 - EXTREMELY HAZARDOUS SUBSTANCES (40 CFR 355) :
This product does not contain substances listed in Appendix A and B as an Extremely Hazardous Substance.

SECTIONS 311 AND 312 - MATERIAL SAFETY DATA SHEET REQUIREMENTS (40 CFR 370) :
Our hazard evaluation has found that this product is not hazardous under 29 CFR 1910.1200.

Under SARA 311 and 312, the EPA has established threshold quantities for the reporting of hazardous chemicals. The current thresholds are: 500 pounds or the threshold planning quantity (TPQ), whichever is lower, for extremely hazardous substances and 10,000 pounds for all other hazardous chemicals.

SECTION 313 - LIST OF TOXIC CHEMICALS (40 CFR 372) :
This product does not contain substances on the List of Toxic Chemicals.

TOXIC SUBSTANCES CONTROL ACT (TSCA) :
The substances in this preparation are included on or exempted from the TSCA 8(b) Inventory (40 CFR 710)

This product has been certified as KOSHER/PAREVE for year-round use INCLUDING THE PASSOVER SEASON by the CHICAGO RABBINICAL COUNCIL.

NSF INTERNATIONAL :
This product has received NSF/International certification under NSF/ANSI Standard 60 in the coagulation and flocculation category. The official name is "Poly (Diallyldimethylammonium Chloride) (pDADMAC)." Maximum product application dosage is : 50 mg/l.

FEDERAL WATER POLLUTION CONTROL ACT, CLEAN WATER ACT, 40 CFR 401.15 / formerly Sec. 307, 40 CFR 116.4 / formerly Sec. 311 :
None of the substances are specifically listed in the regulation.

CLEAN AIR ACT, Sec. 112 (40 CFR 61, Hazardous Air Pollutants), Sec. 602 (40 CFR 82, Class I and II Ozone Depleting Substances) :
None of the substances are specifically listed in the regulation.

CALIFORNIA PROPOSITION 65 :
This product does not contain substances which require warning under California Proposition 65.

MICHIGAN CRITICAL MATERIALS :
None of the substances are specifically listed in the regulation.

STATE RIGHT TO KNOW LAWS :
The following substances are disclosed for compliance with State Right to Know Laws:

Water	7732-18-5
Polyquaternary Amine	Proprietary

NATIONAL REGULATIONS, CANADA :

WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM (WHMIS) :
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

WHMIS CLASSIFICATION :
Not considered a WHMIS controlled product.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA) :
The substance(s) in this preparation are included in or exempted from the Domestic Substance List (DSL).

AUSTRALIA
All substances in this product comply with the National Industrial Chemicals Notification & Assessment Scheme (NICNAS).

CHINA
All substances in this product comply with the Chemical Control Law and are listed on the Inventory of Existing Chemical Substances China (IECSC).

EUROPE
The substance(s) in this preparation are included in or exempted from the EINECS or ELINCS inventories

JAPAN
All substances in this product comply with the Law Regulating the Manufacture and Importation Of Chemical Substances and are listed on the Ministry of International Trade & industry List (MITI).

KOREA
All substances in this product comply with the Toxic Chemical Control Law (TCCL) and are listed on the Existing Chemicals List (ECL)

PHILIPPINES
All substances in this product comply with the Republic Act 6969 (RA 6969) and are listed on the Philippines Inventory of Chemicals & Chemical Substances (PICCS).

16. OTHER INFORMATION

This product material safety data sheet provides health and safety information. The product is to be used in applications consistent with our product literature. Individuals handling this product should be informed of the recommended safety precautions and should have access to this information. For any other uses, exposures should be evaluated so that appropriate handling practices and training programs can be established to insure safe workplace operations. Please consult your local sales representative for any further information.

REFERENCES

Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices, American Conference of Governmental Industrial Hygienists, OH., (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Hazardous Substances Data Bank, National Library of Medicine, Bethesda, Maryland (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man, Geneva: World Health Organization, International Agency for Research on Cancer.

Integrated Risk Information System, U.S. Environmental Protection Agency, Washington, D.C. (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

Annual Report on Carcinogens, National Toxicology Program, U.S. Department of Health and Human Services, Public Health Service.

Title 29 Code of Federal Regulations, Part 1910, Subpart Z, Toxic and Hazardous Substances, Occupational Safety and Health Administration (OSHA), (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

Registry of Toxic Effects of Chemical Substances, National Institute for Occupational Safety and Health, Cincinnati, OH, (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

Ariel Insight (An integrated guide to industrial chemicals covered under major regulatory and advisory programs), North American Module, Western European Module, Chemical Inventories Module and the Generics Module (Ariel Insight CD-ROM Version), Ariel Research Corp., Bethesda, MD.

The Teratogen Information System, University of Washington, Seattle, WA (TOMES CPS CD-ROM Version), Micromedex, Inc., Englewood, CO.

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