Washington State Department of Ecology

Environmental Assessment Program

Standard Operating Procedures for Purging and Sampling Water Supply Wells for General Chemistry Parameters

Version 1.0

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SIGNATURES ON FILE

Please note that the Washington State Department of Ecology's Standard Operating Procedures (SOPs) are adapted from published methods, or developed by in-house technical and administrative experts. Their primary purpose is for internal Ecology use, although sampling and administrative SOPs may have a wider utility. Our SOPs do not supplant official published methods. Distribution of these SOPs does not constitute an endorsement of a particular procedure or method.

Any reference to specific equipment, manufacturer, or supplies is for descriptive purposes only and does not constitute an endorsement of a particular product or service by the author or by the Department of Ecology.

Although Ecology follows the SOP in most instances, there may be instances in which the Ecology uses an alternative methodology, procedure, or process.

SOP Revision History

Revision Date	Rev number	Summary of changes	Sections	Reviser(s)

Environmental Assessment Program

Standard Operating Procedure for Purging and Sampling Water Supply Wells for General Chemistry Parameters

1.0 Purpose and Scope

1.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for collecting samples for general chemistry from public and private water supply wells.

1.2 For the purposes of this SOP, general chemistry includes nutrients (nitrogen and phosphorus), total dissolved solids, organic carbon, as well as cations and anions (to evaluate charge balance and describe hydrochemical grouping). Standard cations and anions include carbonate/bicarbonate (alkalinity field analysis), calcium, magnesium, sodium, potassium, sulfate, and chloride. For standard sampling procedures for iron and manganese, see EAP100 (Pitz, 2015) and EAP098 (Pitz, 2014).

1.3 Goals for collecting groundwater samples from water supply wells can include characterizing ambient conditions, defining the nature and extent of groundwater problems, determining trends in contaminant concentrations, and evaluating compliance with groundwater standards.

1.4 Groundwater measurements and samples should be as representative of in situ conditions as possible. Factors that can alter groundwater chemistry during the sampling include changes in temperature, pressure, and exposure to air. This SOP summarizes the general procedures and practices that EAP staff use to collect representative groundwater samples from water supply wells with dedicated in-place pumps. When sampling monitoring wells, see Standard Operating Procedures for Collecting Samples for General Chemistry from Monitoring Wells (Carey, 2016).

2.0 Applicability

2.1 This document is the Environmental Assessment Program (EAP) Standard Operating Procedure (SOP) for collecting samples for general chemistry from private or public water supply wells.

2.2 This SOP provides general information to help guide EAP field staff in proper purging and sampling techniques for general chemistry parameters. Alternative procedures may be used if they provide scientifically valid and legally defensible groundwater data and are documented in the project Quality Assurance Project Plan.

2.3 Field staff should be familiar with additional standard procedures related to activities described in this SOP. If samples are also being collected for organics or metals, see procedures described in separate SOPs, EAP077 for organics and for metals (Pitz, 2014), on Ecology's webpage: http://www.ecy.wa.gov/programs/eap/quality.html.

2.4 Documents such as the USGS National Field Manual for the Collection of Water-Quality Data (USGS, 1997) have additional detailed explanations of factors to consider when sampling water supply wells.

3.0 Definitions

3.1 Aquifer – A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield usable quantities of water to wells and springs.

3.2 Dissolved Oxygen – The concentration of oxygen that is dissolved or carried in water measured in mg/L or percent saturation.

3.3 Data Quality Objectives (DQO's) – Data Quality Objectives are qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

3.4 Depth-to-Water – The distance between an established measuring point at the top of a well casing to the top of the water in the well. Also referred to in this SOP as water level measurement.

3.5 EAP – Environmental Assessment Program

3.6 Ecology – Washington State Department of Ecology

3.7 EIM – Environmental Information Management System. A searchable database of environmental monitoring developed and maintained by the Washington State Department of Ecology.

3.8 Field Data Sheets – Weather resistant sheets (“Rite in the Rain” ® writing paper) used to document all field activities, sample data, methods, and observations for each collection site.

3.9 General Chemistry Parameters—Analytes that require wet chemistry analysis, including alkalinity, total dissolved solids, nutrients (ammonium, nitrate, total nitrogen, ortho-phosphorus and total phosphorus), , organic carbon , chloride, calcium, magnesium, sodium, potassium, chloride, bicarbonate (alkalinity), sulfate, iron, manganese, and sulfate.

3.10 GPS - Global Positioning System

3.11 Oxidation-Reduction Potential (ORP)-The electric potential required to transfer electrons from one compound or element (oxidant) to another compound (reductant). Used as a qualitative measure of the state of oxidation in water.

3.12 pH – A measure of the acidity or alkalinity of water. A pH value of 0 to 7 indicates that an acidic condition is present, while a pH value of 7 to 14 indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

3.13 Quality assurance project plan (QAPP) – A written plan that describes the goals, objectives, and details of how a study will be conducted and the results analyzed.

3.14 Specific Conductance (SC) – A measure of the water’s ability to conduct an electrical current. Specific conductance is related to the concentration and charge of dissolved ions in water.

3.15 Static water level (SWL)—The level to which water in a well naturally rises in the absence of external stresses such as the withdrawal or injection of water within the well or nearby wells.

3.16 Water Level Measuring Point (MP) – An established (fixed) point on a well casing from which depth-to-water/water level measurements are made to ensure data comparability.

3.17 Water table elevation—The elevation of the top water surface of an unconfined aquifer with respect to a standard vertical datum, e.g., the point where the pore water pressure equals atmospheric pressure in an unconfined aquifer.

4.0 Personnel Qualifications/Responsibilities

4.1 Staff new to groundwater sampling should become familiar with the most recent USGS National Field Manual for the Collection of Water-Quality Data (USGS, 1997); The Essential Handbook of Ground-Water Sampling (Nielsen, 2007), or an equivalent, for background information on principles and techniques of groundwater monitoring.

4.2 Monitoring staff should have a detailed working understanding of the groundwater monitoring needs for the project described in the Quality Assurance Project Plan (QAPP).

4.3 This document supplements, but does not replace, the need for on-the-job training. Field staff should be familiar with the sampling equipment and instruments being used. The field lead is responsible for ensuring that all field staff members adhere to prescribed sampling methods when conducting field work.

4.4 Field staff must obtain permission from the well owner or operator to access any public or private well and water distribution system. Discuss with the well owner planned sampling activities that are permitted (e.g. well tagging, water level measurement, potential alterations to the water system, etc.). Perform only activities for which the owner has granted permission.

4.5 EAP staff who sample groundwater are responsible for complying with this SOP and the requirements of the EAP safety manual - particularly Chapter 1 'General Field Work' and the following sections of Chapter 2: 'Groundwater Sampling and Water-Level Measurements' (Ecology, 2015).

5.0 Equipment, Reagents, and Supplies

5.1 <u>Sample Measuring and Collecting Equipment</u>
5.1.1 Sonic water level meter
5.1.2 Field data sheets
5.1.3 Water level measuring equipment (calibrated electric water level meter, graduated steel tape)
5.1.4 Water quality meters, multi-meters, and probes (e.g. temperature, pH, conductivity, dissolved oxygen (DO), and oxidation-reduction potential (ORP))
5.1.5 Probe calibration standards/reagents
5.1.6 Flow cell
5.1.7 Pump (usually in the well already—if not, use a submersible pump)
5.1.8 Power supply (generator, batteries)
5.1.9 Extension cord
5.1.10 Tubing and connectors
5.1.11 Sample containers/bottles (preservatives are added to sample bottles as appropriate by the lab)
5.1.12 Filters (45 µm)
5.1.13 Coolers with ice or ice packs

5.2 <u>Cleaning and Disinfecting Supplies</u>
5.2.1 Deionized water (plenty)
5.2.2 Laboratory grade soap (Liquinox®)
5.2.3 Dilute chlorine bleach solution

5.3 Safety Equipment
5.3.1 Nitrile gloves
5.3.2 Hearing protection
5.3.3 Safety goggles
5.3.4 Hard hat
5.3.5 First aid kit
5.3.6 Orange vest, Ecology issued
5.3.7 Traffic cones/signs, if applicable

5.4 Miscellaneous Equipment
5.4.1 Well location map
5.4.2 All applicable SOPs
5.4.3 Field paper work: property owner contact information, field data sheets, sample bottle labels and tags, chain-of-custody sheets
5.4.4 Pencils, pens, etc.
5.4.5 Permanent marking pen or paint stick (for marking measuring point)
5.4.6 Calculator
5.4.7 Well keys, if applicable
5.4.8 Compass
5.4.9 GPS unit
5.4.10 Digital camera
5.4.11 Paper towels or clean rags
5.4.12 Plastic garbage bags
5.4.13 Plastic sheeting for ground cover
5.4.14 Cart for transporting equipment
5.4.15 Buckets, plastic 5-gallon
5.4.16 1-liter container (to calibrate purge volume/rate)
5.4.17 Stop watch
5.4.18 Field bag (containing rain gear, rubber boots, work gloves, etc.)
5.4.19 Hand cleaner/disinfectant

5.5 Tools
5.5.1 Steel hand measuring tape (engineer scale)
5.5.2 Socket wrench set
5.5.3 Allen wrench set
5.5.4 Pipe wrenches
5.5.5 Crescent wrenches
5.5.6 Set of screwdrivers
5.5.7 File
5.5.8 Knife
5.5.9 Hammer
5.5.10 Pliers
5.5.11 Hack saw
5.5.12 Crow bar/manhole hook
5.5.13 Shovel

5.5.14 Machete
5.5.15 Whiskbroom
5.5.16 Spare well cover bolts/nuts
5.5.17 Spare well caps/plugs
5.5.18 Spare pad locks/keys
5.5.19 Wire brush
5.5.20 WD-40 (to be used away from the well head)
5.5.21 Flashlight
5.5.22 Spare batteries (e.g. electric-tape, GPS, flashlight)
5.5.23 Tape (duct tape/electrical tape)
5.5.24 Well tagging equipment

6.0 Summary of Procedures

6.1 Project Planning

6.1.1 A Quality Assurance Project Plan (QAPP) must be completed and approved before collecting water quality samples for analysis as described in *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies* (Lombard and Kirchmer, 2004). QAPPs may reference SOPs. Non-standard procedures or deviations from SOPs should be described in the QAPP.

6.1.2 Detailed information should be collected for each sampling well location whenever practical, including well construction logs, water level data, pump setting, sample faucet location relative to pressure tank(s) or water treatment systems, site access agreements, and any relevant information about the well.

6.1.3 Well location and construction information for sampled wells should be entered into Ecology's Environmental Information Management (EIM) system database.

6.1.3.1 If the well has not been previously inventoried, use a GPS receiver when visiting the well to define a preliminary latitude and longitude coordinates as described in SOP EAP013, *Determining Coordinates via Hand-Held GPS Receivers* (Janisch, 2010). The field-collected coordinates can be refined using mapping tools in EIM when entering the well into the EIM database.

6.1.3.2 If the well does not have a Department of Ecology unique well ID tag, then it should be tagged as described in EAP SOP081 (Pitz, 2011). Well tags are available from Ecology's Water Resources Program. Securely attach the tag to the well casing, or another permanent, easily-seen fixture of the well. After the well is tagged, complete a well tag form and submit to Ecology's Water Resources Program with a copy of the well log.

6.1.3.3 Factors to consider when sampling water supply wells with permanently installed pumps for general chemistry parameters include: physical characteristics of the well and water delivery system (depth, location of the screened interval, location of sample point relative to pressure tanks, aerators, water softeners, etc.). The effects of these factors on the general chemistry analytes should be considered relative to the project objectives and data quality requirements (U.S.Geological Survey, 1997).

6.2 Field Work Preparation

6.2.1 Inventory consumable field supplies several weeks before sampling to ensure adequate supplies of disposable gloves, calibration standards (pH, conductivity), tubing, filters, etc. Order necessary supplies, allowing ample time for delivery.

6.2.2 Make arrangements with Ecology's Manchester Environmental Laboratory for sample analysis and transport before sampling. The *Manchester Environmental Laboratory (MEL) Laboratory User's Manual* (Ecology, 2008) contains detailed guidance on the planning steps necessary to request, track, ship, and analyze water quality samples collected in the field. Submit a Pre-sampling Notification Form and a Sample Container Request Form at least 2 weeks before sampling. For large projects the lab should be informed 4-6 weeks before sampling. Coordinate with the lab regarding any special arrangements such as contract lab analysis, special courier or sample delivery.

6.2.3 Inventory sample bottles when they arrive to ensure the lab provided the correct type and number.

6.2.4 Establish the order in which the wells will be sampled. Sample order should be based on either logistics or the known or suspected water quality of a sample location. For closely spaced wells, the order should go from lower to higher concentration. This minimizes potential effects of cross-contamination by equipment.

6.2.5 Contact the well owner, operator, or property resident a few days before a planned sampling event to confirm the sampling date and time and to discuss any site access issues.

6.2.6 Prepare field data sheets for each well location before going in the field. It can be helpful to bring previous sample data for each well such as pump rate, total purge time, stabilized field parameter values, etc. Other sample paperwork should also be filled out as much as possible, including: bottle labels and tags and Manchester Labs Chain-of-Custody/Lab Analysis Required Form (LAR). Example field data sheets are provided in Appendix A.

6.2.7 Inspect equipment and verify that water quality field meters are in good working order, calibrate properly, and batteries are fully charged. Calibration procedures are outlined in the user's manual. When using a Hydrolab multimeter, follow SOP EAP033 for field preparation and calibration (Swanson, 2007).

6.2.8 Equipment that is placed in a well and reused at other wells (such as an e-tape) must be properly cleaned, disinfected, or decontaminated prior to and after use in each well. Cleaning procedures depend on the equipment (water level equipment, field parameter probes, down well sample equipment, tubing for pumps). This is especially important when placing equipment in water supply wells. Field equipment that enters a water supply well must be properly disinfected just prior to, and after, use in each well to prevent introduction of pathogens.

6.2.9 Nitrile gloves should be worn when cleaning sample equipment. When not in use, sampling equipment should be placed on a clean surface, such as a clean plastic sheet. If equipment is not reused immediately, it should be wrapped in clean plastic sheeting or plastic bags. Equipment should never be placed on bare ground prior to using it in a well.

6.2.10 If measuring water levels, disinfect water level probe and any potentially submerged tape with dilute chlorine bleach. After cleaning, rinse with deinonized water, and dry with a paper towel or allow to air dry.

6.2.11 Non-dedicated sample equipment such as the Y-split flow controller/Y-fitting (Figure 1) that is attached to the sample faucet/tap should be washed in a laboratory grade soap (e.g. Liquinox) solution after each use and before the start of a sampling event. Use a brush to scrub the sample equipment if needed followed by a deionized water rinse. Note: Thorough rinsing is needed if Liquinox is used before organic carbon samples are collected to avoid bias.

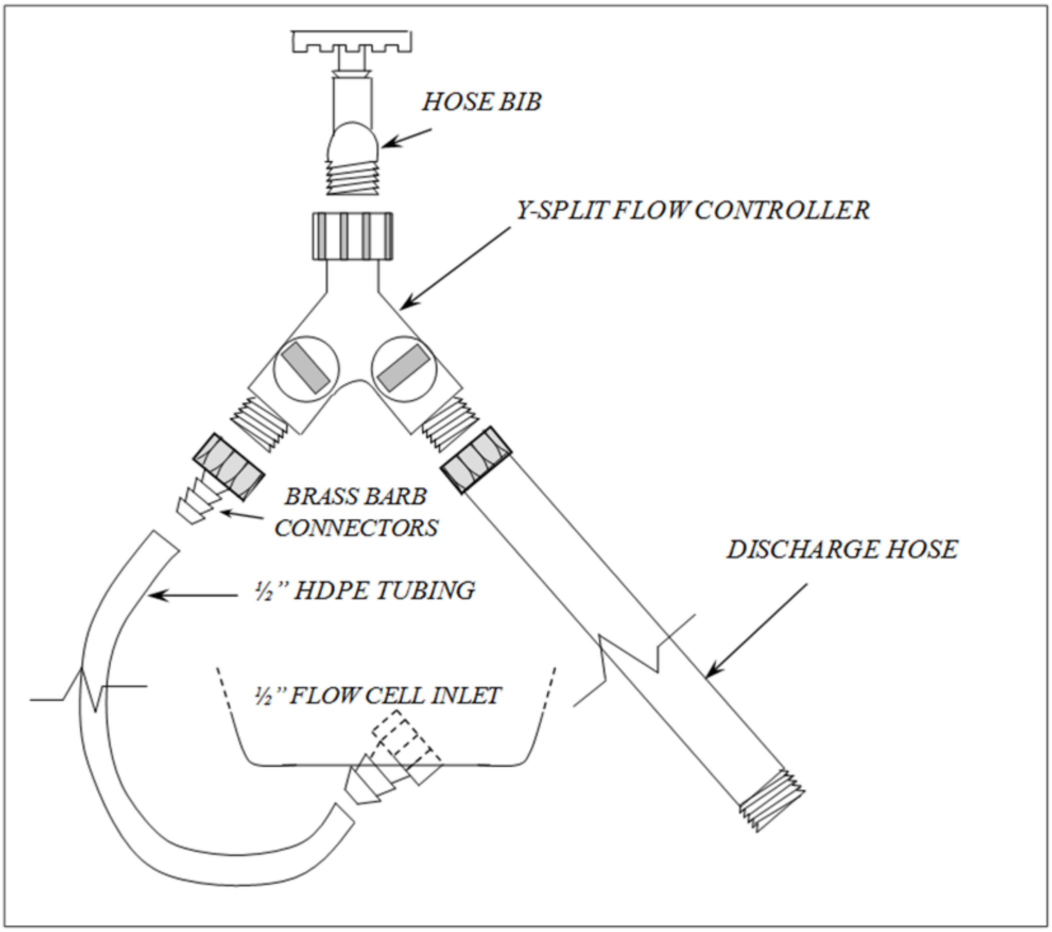

Figure 1. Typical purging apparatus for sampling water supply wells.

6.2.12 Equipment that comes in contact with sample water and is difficult to clean should be replaced between sample locations, such as pump tubing or tube fittings.

6.3 Purging and Sampling Procedures

6.3.1 Most water supply wells are equipped with permanent, higher-capacity pumps. If the well is not equipped with a permanent pump, then follow the purge and sampling guidance in (Carey, in preparation).

6.3.2 Upon arriving at a well, set out safety equipment as needed.

6.3.3 Check the site for hazardous conditions, either physical or chemical.

6.3.4 Clean hands/dirty hands: One person should be designated to keep gloved hands clean for sample handling (clean hands), while the other person opens the well and conducts duties that involve potential contaminants (dirty hands). The dirty hands do not touch the sampling bottles or tubing unless clean gloves are used.

6.3.5 Spread clean plastic sheeting on the ground to keep sample equipment clean (Figure 2). Set up and check equipment: water level meter, field parameter meters, flow cell, etc.

6.3.6 Use a sonic water level meter to measure the depth to water following the manufacturer’s instructions.

6.3.7 If you do not have a sonic water level meter and you have been granted permission by the well owner to collect a water level measurement, remove the well cover, cap, or well instrument access port plug located on the well cover.

6.3.8 If the well has not been sampled before, establish and document a water level measuring point using the procedures described in SOP EAP052, (Marti, 2009).

6.3.9 Measure the water level according to SOP EAP052 (Marti, 2009). Record the water level value, date, and time on the well specific field data sheet (Appendix A). The water level should be measured twice to confirm an accurate measurement. If the water level is not stable due to recent pumping or other influences, wait a few minutes and repeat the measurement. If a stable measurement is not obtained after a few minutes, note this on the field data sheet and qualify the measurement. (See the field data sheet in Appendix A for a list of qualifier codes.) Shutting off the well pump temporarily may help stabilize the water level measurement.

6.3.10 Temperature, pH, conductivity, DO and ORP should be sampled in a closed atmosphere flow cell attached to the pump outflow as shown in Figure 2.

6.3.11 Water samples should be collected as close to the well pump/wellhead as possible. It is preferable to collect samples from a cold water faucet/tap, before the water passes through any storage tanks, pressure tanks, or physical/ chemical treatment systems that may alter the quality of the sample. Document on the field data sheet the location of the sample point.

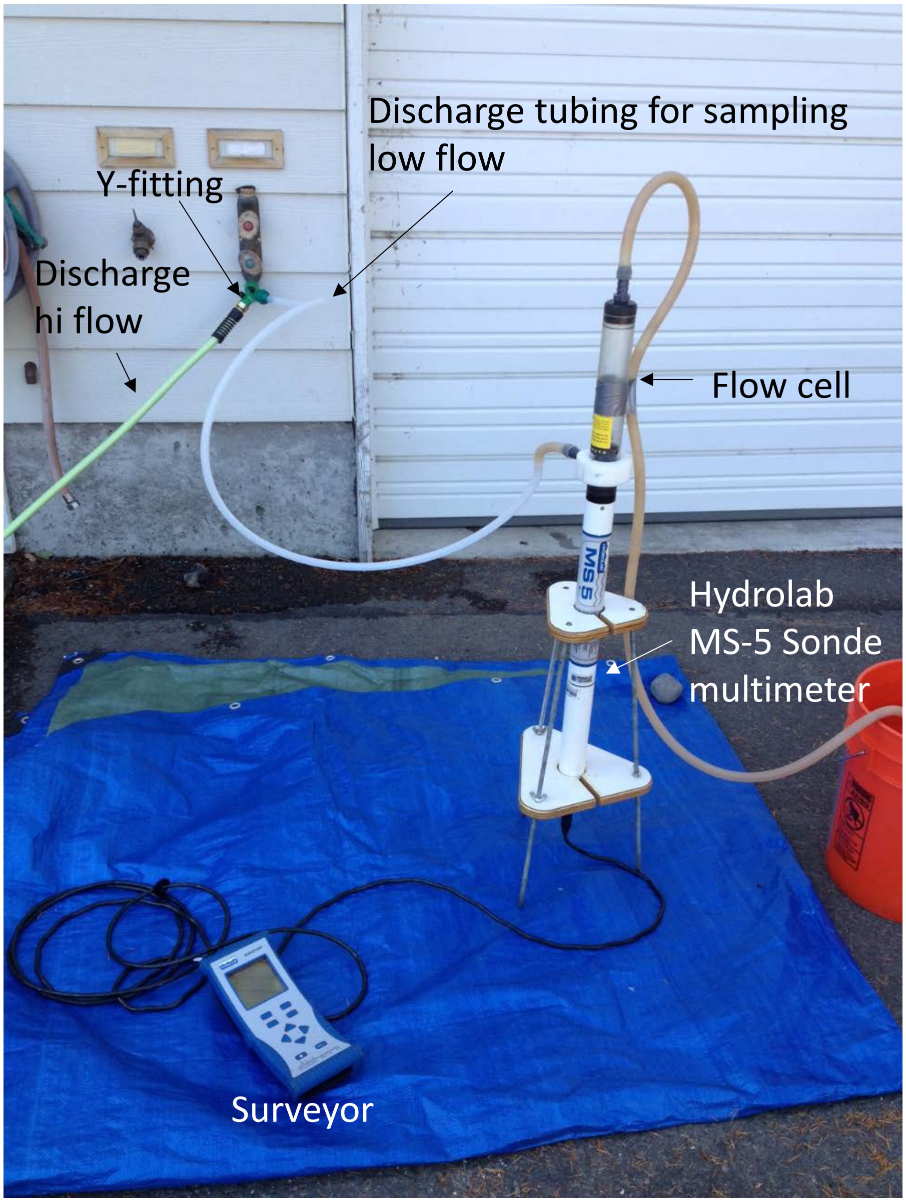

Figure 2. Field equipment set-up for purging a public supply well.

6.3.12 If there is no sample point close to the wellhead, choose a location least affected in the well distribution system. Document the location of the sample point on the field data sheet, the type of system the water passes through, and potential effects on the quality of the sample.

6.3.13 Faucets or taps used to collect water samples should be in good condition. Inspect the faucet for any signs of corrosion, dirt or leakage that might compromise field parameter measurements or sample quality.

6.3.14 If the faucet must be altered prior to sample collection, first obtain permission from the property owner.

6.3.15 Remove any hoses from the faucet. If possible, remove aerators, filters, or other devices from the faucet.

6.3.16 If the faucet is dirty or corroded, use a stiff bristle or wire brush to clean the threads on the faucet. Rinse with deionized water.

6.3.17 If collecting bacteriological samples such as fecal coliform in addition to general chemistry samples, sanitize the inside and outside of the faucet with a butane lighter or propane torch until dry. Do not touch the faucet with your bare hands after sanitizing (**Only clean gloved hands should be used for the remainder of the sampling**.)

6.3.18 Connect a clean apparatus, such as a Y-split flow controller/Y-fitting (Figure 1), to the selected faucet.

6.3.19 Attach a hose or tubing to one arm of the Y-fitting (Figure 3). This will be the main purge water discharge. The flow rate for the purge water discharge hose can be at full capacity for the pump (e.g. 5 gallons/minute) so that the well can be purged quickly. However samples are collected under low-flow conditions via the tubing connected to the non-discharge arm of the Y-fitting. Low-flow sampling procedures should be used at all wells. Sampling rates should be less than 0.5 L/minute to minimize sample alteration by agitation or aeration. Dissolved forms of phosphorus are especially sensitive to aeration, and can convert to particulate forms if transitioning from a low-DO to a high-DO environment. Low-flow sampling also means that purging continues until water quality parameters (temperature, pH, conductivity, DO, ORP) stabilize sufficiently.

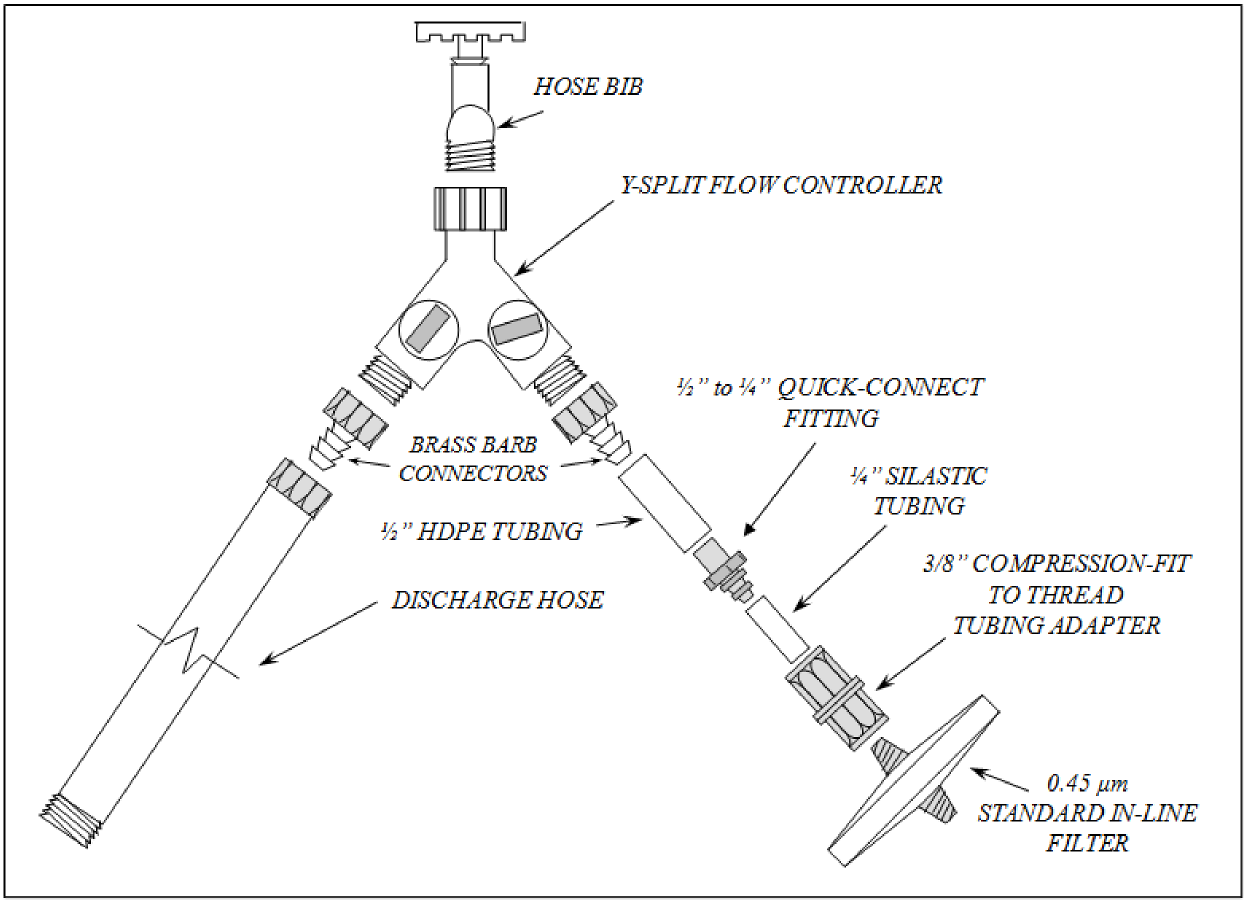

Figure 3. Typical water supply well sampling apparatus.

6.3.20 Connect the other arm of the Y-fitting with the flow cell for field parameter measurements. The flow rate on the sample side should be adjusted to accommodate the flow specifications for the flow cell (e.g. <1 liter/minute). Consult the manufacturer’s guidelines to determine the maximum allowable flow rate for the field parameter probes and flow cell chamber. For the YSI/Hydrolab MS-5A, a flow of ~300-400 ml/minute through the flow cell is recommended.

6.3.21 If the well has been sampled before, review past field data sheets for purge rates, total purge time, and stabilized field parameter values prior to sample collection.

6.3.22 Start purging by opening the faucet and valves on the attached Y-split flow controller. Use the valves on the Y-fitting to regulate the flow rates to both the flow cell and the discharge hose. Use a 5-gallon bucket and a stopwatch to measure the pumping rate from the discharge hose. Record the rate on the field data sheet.

6.3.23 Purge water for most projects may be discharged directly to the ground. Direct the purge water away from the well head and work area.

6.3.24 If the purge water is contaminated it should be disposed of in accordance with Washington State regulations (Chapter 173-303-400 WAC).

6.3.25 The purge volume necessary to achieve water quality parameter stabilization depends on two factors: 1) presence of a storage/pressure tank between the pump and sample point, and 2) frequency of well use.

6.3.26 While purging and collecting samples, the flow should be a smooth, solid stream of water with no air bubbles in the tubing or flow cell. Tap and tilt the tubing or flow cell to remove bubbles and gradually adjust the pumping rate to remove bubbles, if necessary.

6.3.27 Once flow is constant, begin recording field parameter values at regular intervals (e.g. 2 to 5 minutes). The frequency of measurements depends on the pump rate and the estimated time for field parameters to stabilize.

6.3.28 Record the field parameter values, time of measurement, and the amount of purge water discharged. Note and provide qualifying remarks if parameter readings are anomalous or unstable due to instrument problems. Record observations during purging and sampling (e.g. purge water clarity, odor, etc.).

6.3.29 If the faucet is located ***before*** any storage or pressure tanks, purge time should be relatively short. At a minimum, purge the amount of standing water in the well and plumbing (including the tank) AND until field parameters have stabilized.

6.3.30 The volume of standing water in the well can be roughly estimated as follows:

6.3.31 Well volume = $V = 0.041 \times HD^2$ = ____ gallons, where

V is volume of water in the well, in gallons,
H is height of water column (total depth – estimated depth to water = H), in feet, and
D is inside well casing diameter, in inches

6.3.32 If the faucet is located ***after*** a tank, then purging should include the volume of water in the tank in addition to field parameters being stable.

6.3.33 Water supply wells that are in regular service, with the pump routinely running, should purge relatively quickly. Wells used infrequently may require a longer purge period to achieve parameter stabilization.

6.3.34 Continue purging and recording measurements uninterrupted <u>until field parameters stabilize</u>. At a minimum, five sets of field measurements should be recorded. Monitored field parameters for EAP studies include but are not limited to water temperature, pH, specific conductance, dissolved oxygen, and oxidation-reduction potential. Field parameters should be specified in the project QAPP.

6.3.35 Field parameters are considered stable when 3 consecutive readings fall within the following stabilization criteria:

pH	± 0.1 standard units

Specific Conductance	± 10.0 µmhos/cm for values < 1000 µmhos/cm ± 20.0 µmhos/cm for values > 1000 µmhos/cm
Dissolved Oxygen	± 0.05 mg/L for values < 1 mg/L ± 0.2 mg/L for values > 1 mg/L
Temperature	± 0.1° Celsius
ORP	± 10 millivolts

If sampling for organics or metals, in addition to general chemistry parameters, see SOPs EAP077, EAP100, and (Marti, 2014 and Pitz, 2015) for additional steps and considerations for sampling.

6.3.36 Prepare the Y-fitting for end-of-purge parameter analyses, if any, which occur before filtering and sample collection. Maintain the same flow rate through the discharge hose side of the Y-fitting; once the purge and sample process has been started, do not stop pumping the well until all measurements and samples have been collected.

6.3.37 Collect end-of-purge samples, if any (e.g. low dissolved oxygen using a Chemetrics kit).

6.3.38 Using new clean disposable gloves, disconnect the flow cell and connect clean sample tubing to the Y-fitting using clean connectors (Figure 3). Rinse the sample tubing for ~2-3 minutes with discharge water from the well before collecting end-of-purge samples. Then collect non-filtered samples (e.g., bacteria, pathogens, low dissolved oxygen using Chemetirics kit).

6.3.39 After collecting non-filtered samples connect a new disposable 0.45 um in-line filter to the compression-fit connector on the sample arm of the Y-fitting (Figure 3). Flow through the sampling arm can be closed using the valve while connecting the filter, but pumping should continue through the discharge hose. All samples except for bacteria and pathogens should be field-filtered.

6.3.40 Reopen the valve on the sampling arm of the Y-fitting, reestablish a flow rate through the filter of ~0.3 L/min, and discard the first 500 mL of filtrate before filling sample containers.

6.3.41 Samples should be collected in the order specified in the QAPP. Analytes most sensitive to change or most important for the study are usually collected first. Sample order should also take into account cross-contamination from preservatives. For example, sulfate samples should be collected before samples preserved with sulfuric acid (e.g. nitrogen series). This can prevent accidental contamination of an unpreserved sulfate sample with sulfuric acid preservative used for another sample. Likewise, samples for nitrogen compounds should be collected before samples preserved with nitric acid (e.g. total and dissolved metals).

6.3.42 When filtering samples for several parameters, the U.S. Geological Survey (1997) suggests the following sample sequence to account for reduced pore size as filtering progresses: trace metals, major cations, major anions, nutrients/alkalinity, and dissolved organic carbon.

6.3.43 Alkalinity should be analyzed using a field test kit immediately upon sample collection (Chemetrics Titrets Kit is recommended). Total alkalinity and pH values can be used to calculate bicarbonate concentration using the equation below from Standard Methods 4500-CO_2 D (*Standard Methods*, 20th Edition). Most of the total alkalinity will be bicarbonate when the pH is less than 8.3.

$$HCO_3^- \text{ as mg } CaCO_3/L = (T - 5.0 \times 10^{(pH-10)})/(1 + 0.94 \times 10^{(pH-10)})$$

where T = total alkalinity, mg $CaCO_3$/L[1]

6.3.44 Keep sample containers capped until a sample is collected. Hold the cap while filling each sample bottle. If you have to set the cap down during filling, place the inside of the cap facing upward on a clean surface.

6.3.45 Direct the flow from the sample tubing into laboratory-supplied bottles using clean hands. Fill containers directly from the discharge tubing/filter. The discharge tube/filter should be close to, but not touching, the sample container.

6.3.46 Do not stop or significantly change the discharge rate from the faucet during the final phase of purging or while sampling.

6.3.47 Most general chemistry bottles should be filled to the shoulder to allow for complete mixing by the lab analyst and to provide the correct preservative concentration for the sample (bottles from MEL contain preservative).

6.3.48 Attach pre-labeled tags to sample bottles with the sample date and time. All sample bottles from the same well should be stored in the same plastic bag to prevent any mix-up in transport to the lab. If possible, bottles should be immediately stored in an ice chest at 6° C.

6.3.49 Bottles supplied by MEL are to be used for sample collection. Pre-preserved bottle will be supplied for nutrients and dissolved organic carbon.

6.3.50 Bottles for non-preserved general chemistry samples should be rinsed with about 100 ml of water discharging from the pump before collecting an actual sample (e.g., total dissolved solids, cations and anions).

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[1] If lab samples are analyzed for alkalinity, bottles should be completely filled and immediately capped to minimize exposure to air. (Field analysis for alkalinity using a Chemetrics Titrets kit is highly recommended over lab analysis.) All other sample bottles should be filled to the shoulder to allow for complete mixing by the lab analyst, who must understand that the whole sample needs to be analyzed.

6.3.51 If the filter becomes clogged during purging or sampling, which can occur due to high concentrations of fine particulates, replace it with a clean filter. Do not change the pump rate while replacing the filter with a new one.

6.3.52 Attach pre-labeled tags to sample bottles with the sample date and time. All sample bottles from the same well should be stored in the same plastic bag to prevent any mix-up in transport to the lab. If possible bottles should be immediately stored in an ice chest at 6° C.

6.3.53 Collect quality control (QC) samples, such as field replicates, from the well(s) specified in the project QAPP. Field replicate samples are collected by alternating the sample stream between two of the same type sample containers. A filter blank using a factory new filter should be collected for all filtered analytes using deionized water from MEL. A rinsate blank should also be collected once/day if sampling equipment is cleaned between wells.

6.3.54 Follow procedures outlined in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody, sample courier service for special shipping requirements).

6.3.55 When planning for sample transport, take into account analytical holding times as shown in the *Manchester Laboratory Users' Manual*, Table 1, p. 27. Orthophosphate has a 48-hour holding time, the shortest for general chemistry parameters.

6.3.56 When all work at the well site is complete, leave the well as you found it (i.e. replace any removed aerators, filters, or hoses). Properly close and secure the well.

6.3.57 Field parameter sampling equipment must be post-calibrated upon returning from each sampling event. See Appendix A for an example form.

7.0 Records Management

7.1 The location and construction information related to water supply wells sampled must be archived in Ecology's Environmental Information Management (EIM) system and well log imaging databases. EIM help documents list of the well specific metadata required by EIM.

7.2 Station information and monitoring notes should be documented during each site visit on site specific field data sheets. Examples are presented in Appendix A. All field entries should be neat and concise. The field lead is responsible for reviewing the form(s) for completeness before leaving a field site.

7.3 EAP staff has developed a number of data analysis spreadsheets, field forms, and other tools to standardize data collection and processing for groundwater monitoring projects. See the EAP Groundwater Assessment SharePoint site for the most up-to-date version of these tools.

7.4 Field meter pre- and post-calibration must be documented before and after each sampling event for pH, conductivity and DO (EAP SOP033, Swanson, 2007). See Appendix A for an example calibration form.

7.5 Hardcopy documentation, such as well reports and field data sheets, should be maintained by the project lead. At the completion of a project, hardcopies are boxed and moved to EAP archives.

8.0 Quality Control and Quality Assurance Section

8.1 Data collection, review, and analysis will follow the procedures specified in the project QAPP, including following all SOPs, calibrating and maintaining instruments according to manufacturer's recommendations, and documenting all procedures. Field staff should follow these general QA/QC procedures when collecting samples to minimize error.

8.2 Follow the project QAPP and any applicable standard operating procedures (SOP) when collecting and handling samples.

8.3 Calibrate and maintain field water quality meters according to the manufacturer instructions. Document the calibration in the field notes.

8.4 Use equipment to purge and sample that is compatible with the characteristics of the well and analytes being sampled. Operate equipment in accordance with the manufacturer instructions, unless otherwise specified in the project QAPP.

8.5 Properly collect, handle, and store samples.

8.6 Collect appropriate quality control samples. These may include a field replicate, and field blanks (e.g. filter, equipment, rinsate). The types and number of quality control samples should be specified in the project QAPP.

8.7 Follow the procedures in the project QAPP or Manchester Lab Manual for sample handling and management (e.g. chain of custody).

8.8 Document all data, observations, notes, deviations from project QAPP, etc. on the field data sheets and other project paperwork.

8.9 Properly clean, maintain, and store all field equipment after use.

8.10 Use consistent procedures from well to well.

8.11 Conduct a cation/anion charge balance to check the validity of water quality analyses. The sum of the cations should equal the sum of the anions. Cations include calcium, magnesium, sodium, potassium, iron and manganese. Anions include bicarbonate (concentration calculated from alkalinity as shown in Equation 1 where pH is less than 10, (Murray and Wade, 1996)), chloride, and sulfate.

$$\left(\frac{Alkalinity\ (\frac{mg}{L})}{50}\right) = HCO_3\ (mg/L) \qquad \text{Equation 1}$$

(from Murray and Wade, 1996)

The charge for each ion is calculated as:

$$\frac{Charge}{L} = Ion\ concentration\ \left(\frac{mg}{L}\right) \div\ Atomic\ wt\ \left(\frac{mg}{mmole}\right) x \frac{Charge}{L} \qquad \text{Equation 2}$$

Example: Na^{+}: 55.0 mg/L in sample / 23.0 mg/mmole x 1^{+} (charge) = 3.30^{+}

The difference between the sum of the cation charges and the sum of the anion charges divided by the total charges should be +/- 5% (*Standard Methods*, 20^{th} Edition, Method 1030 F).

9.0 Safety

9.1 Field work should follow protocols specified in the Environmental Assessment Program Safety Manual (Ecology, 2006). A working knowledge of sections ‘Groundwater Sampling and Water-Level Measurement’ and ‘Hazardous Waste Sites’ in Chapter 2 is expected for all field staff. These protocols should be used to complement the judgment of experienced field professionals.

9.2 A Field Work Plan Form must be completed for each sampling event that documents field personnel, sampling locations, overnight lodging, planned itinerary, contact person(s), and emergency contacts. If a boat is used to access sites, an Ecology Float Plan must be completed.

9.3 All EAP field staff who works on hazardous waste sites are required to complete and maintain certification in First Aid/CPR and 40-hour Hazardous Materials Safety and Health Training.

10.0 References

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10.5 Lombard, S. and C. Kirchmer, 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. Washington State Department of Ecology, Environmental Assessment Program. https://fortress.wa.gov/ecy/publications/SummaryPages/0403030.html

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10.13 Standard Methods, 1998. *Standard Methods for the Examination of Water and Wastewater* (20th Edition).

10.14 Swanson, T., 2007. Standard operating procedure for Hydrolab DataSonde® and MiniSonde® Multiprobes. Washington State Department of Ecology, Environmental Assessment Program, EAP033, Version 1.0. www.ecy.wa.gov/programs/eap/quality.html

10.15 Revised Code of Washington, Chapter 18.220 RCW, Geologists.

10.16 U.S. EPA, 2006. Guidance on Systematic Planning Using the Data Quality Objective Process. EPA QA/G-4. https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4

10.17 U. S. Geological Survey, 1997 to present, National Field Manual for the Collection of Water-Quality Data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, Chapters A1-A, http://water.usgs.gov/owq/FieldManual/chapter1/Ch1_contents.html

10.18 Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 2004 with updates through 2009, Processing of water samples (version 2.2): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5 http://water.usgs.gov/owq/FieldManual/chapter5/html/Ch5_contents.html

Appendix A. Example field forms.

See SOP EAP077 for field forms and templates available to streamline groundwater data collection. The following form is for pre- and post-calibrating field meters for temperature, pH, conductivity, and dissolved oxygen.

See the EAP Groundwater Assessment SharePoint site for the latest versions of field forms that can be modified to accommodate project needs.

Well Reconnaissance Field Sheet

Date: ______________________ **Time:** ______________________

Field Crew: ______________________

Well ID: ______________________

Well Tag ID: ______________________

Well Owner Name: ______________________

Facility Name: ______________________

Current Phone Number: ______________________

Current Mailing Address: ______________________

____

____

Renter? ☐ **Name:** ______________________

Permission granted to locate well? ☐

Permission granted to collect Water Level? ☐

Permission granted to sample well for Water Quality? ☐

Permission granted to tag well? ☐ **Tagged?** ☐

Call ahead required before site visit? ☐

Recon GPS Well Coordinates:

Recording Datum: **NAD83HARN** ☐ **NAD83** ☐ **NAD27** ☐

DDLAT: ______________________ **DDLONG** ______________________

Wellhead Photo #: ______________________

Comments: ______________________

____

____

____

____

____

____

Add sketch map of well location on back.

Water Level Data Field Sheet Well Tag #: ____________ Well Study Name: ____________

DDLAT: ____________ DDLONG ____________ T: ____________ R: ____________ SEC: ____________

Recording Datum: ________ NAD83HARN: ____________ NAD83: ____________

Well Owner: ____________ Well Address ____________

MP Height: ____________ (ft) MP Date ____ / ____ / ____ Photo ____________

MP Description: ____________

Date	Time (PST or PDT)	Hold (ft)	Cut (ft)	Depth Below MP (ft)	Water Level (below LSD)	Status	Mthd.	Accu.	Remark
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									

Date	Time (PST or PDT)	Hold (ft)	Cut (ft)	Depth Below MP (ft)	Water Level (below LSD)	Status	Mthd.	Accu.	Remark
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									
/ /									

Status Codes

D	E	F	G	H	I	J	N	O	P	R	S	T	V	W	X	Z
Dry	Recently Flowing	Flowing	Nearby Flowing	Nearby Recently Flowing	Injector	Site Monitor	Discon-tinued measuring	Obstruction	Pump-ing	Recently Pumped	Nearby Pumping	Nearby Recently Pumping	Foreign Matter on Water	Well Des-troyed	Affected by Surface Water Site	Other

Method of Measurement Codes

A	B	C	E	G	H	L	M	N	R	S	T	V	Z
Airline	Analog	Cal. Airline	Estimate	Pressure Gage	Cal. Pressure Gage	Geophys Log	Mano-meter	Non-Recording Gage	Reported	Steel Tape	Electric Tape	Calibrated E-tape	Other

Measurement Accuracy Codes

0	1	2
±1 FT	±0.1 FT	±0.01 FT

Well Name: ______________________ **Well Tag ID:** ______________________

Groundwater Quality Sampling Field Sheet

Well Tag ID: ____________________ Well Name:

Well Owner: _______________

Well Address: _______________

Date: ________/_______/________ Sample Time (PST/PDT):

Lab Sample #: _____________________________ Crew:

Pumping Rate: _________________________ Meter:

Duplicate: ☐ Equipment Blank: ☐ **Reference:**

Duplicate Lab Sample #: __________________ Equipment Blank Lab #:

Purge Parameters:

Time	Temperature (ºC)	pH	Conductivity (µS/cm)	DO (mg/L)

Groundwater Quality Sampling Field Sheet (cont.)

Well Tag ID: ______________________ **Well Name:** ______________________

Purge Parameters (cont.):

Time	pH	Temp (°C)	Cond (μS/cm)	DO (mg/L)

Photometric O_2 : **Kit:** ______________ **Conc.** ______________

Photometric O_2 : **Kit:** ______________ **Conc.** ______________

Colormetric O_2 : ______________________

Field Alkalinity : **Kit:** ______________ **Conc.** ______________

ORP: ______________________

Other: ______________________

Comments :

Sample Container Request Form

Please FAX to Leon Weiks: (360) 871-8850

(Phone for Leon Weiks: (360) 871-8825)

Requestor: ______________________________ Project Name: ____________________

Phone: _________________________________ Today's Date: ____________________

Location for Delivery: ____________________ Date Needed by: __________________

Index #	Description	Qty.
1	1 gallon jar *	
2	1/2 gallon jar *	
3	1 liter jar * (wide mouth) (special request only)	
4	1 liter jar (narrow mouth) (oil & grease) **	
5	8 oz short jar *	
6	8 oz short jar **	
8	4 oz short jar *	
9	4 oz short jar **	
11	40 mL vial w/septum *	
13	2 oz short jar w/septum * (Volatiles: solids only)	
14	125 mL amber glass bottle * (carbamate)	
15	1 liter amber bottle * (narrow mouth)	
16	500 mL HDPE bottle (metals)	
17	1 gallon cubitainer	
19	125 mL clear Nalgene (nutrients or COD; bottle contains 1:1 sulfuric acid)	
20	125 mL amber Nalgene (filters and syringe also required for orthophosphate)	
21	125 mL polypropylene bottle (hardness - bottle contains acid) **For Hexachrome, request bottle without acid**	

Index #	Description	Qty.
22	500 mL poly bottle	
23	1000 mL poly bottle	
24	1000 mL amber poly	
25	250 mL amber poly bottle (Cyanide) (contains Sodium Hydroxide)	
26	60 mL poly bottle (TOC/DOC or TP; bottle contains 1:1 hydrochloric acid)	
27	250 mL glass or poly bottle (fecal coli)	
28	500 mL glass bottle or poly (multiple micro tests)	
29	250 mL glass or poly bottle **with thiosulfate** (fecal coliform - chlorinated)	
30	500 mL glass or poly bottle **with thiosulfate** (multiple micro tests - chlorinated)	
31	8 oz plastic jar (grain size only)	
32	1 liter jar ** with **sulfuric acid** (wide mouth, clear; for phenolics)	
33	sterile specimen cup (micro)	
34	2 oz short jar (TOC - NO septum)**	
35	Soil VOA/BTEX Airtight Sampling Capsules (3 per sample)	
36	Soil VOA/BTEX Sampling Handle (1 per sampling event)	
	Other Supplies	

*organic free with Teflon lined lids, with Certificate of Analysis. **same as "*" but does not include Certificate of Analysis.

PRE-Sampling Notification

Fax to Manchester Laboratory: (360) 871-8850

☐ Enforcement
☐ Monitoring
☐ Emergency
☐ Class II
☐ Preliminary Invest.
☐ Special turnaround

Project Name: ________________________________ **SIC:** _______

Requested by: ________________________________ Sampling Date(s): _______

Program: ________________________________ Date to Lab: _______

Phone No.: ________________________________ Sample Pickup Location: _______

QAPP: ☐Yes ☐ No Date results needed by: _________

General Chemistry	W	S	O	Microbiology		W	S	O	Organic Chemistry	W	S	O
Alkalinity				Fecal Coliforms ☐ MF ☐ MPN					Base/Neutral/Acids (BNA)			
Conductivity				E. Coli MF ☐ "MUG" ☐ mTEC2					Polynuclear Aromatics (PAH)			
Hardness				E. Coli MPN								
pH				% Klebsiella					Volatile Organic Analysis (VOA)			
Turbidity									BTEX			
☐ Fluoride ☐ Chloride ☐ Sulfate									Pest/PCB's (Organochlorine)			
Cyanide ☐ Total ☐ Dissociable				**Metals**	**W$_T$**	**W$_D$**	**S**	**O**	Pesticides only (Organochlorine)			
Total Solids				Priority Pollutant Metals (13 elements)					PCB's only			
Total Nonvolatile Solids				TCLP metals					OP - Pests (Organophosphorous)			
Total Suspended Solids				Hardness					Herbicides (Chlorophenoxy)			
Total Nonvolatile Suspended									Nitrogen Pesticides			
Total Dissolved Solids				Mercury (Hg) ☐ Low Level ☐ Regular					PCL Pesticides (8085)			
Chlorophyll ☐ Filtered in field ☐ Filtered at lab				Other: List individual elements:					PBDEs			
% Solids									Hydrocarbon ID (match to source)			
% Volatile Solids (TVS)									TPH-ID (gas/diesel/oil)			
Total Organic Carbon									TPH-G$_X$			
Dissolved Organic Carbon									TPH-D$_X$			
Biochemical Oxygen Demand (BOD) 5 day												
BOD - Inhibited									TCLP-VOA			
BOD - Ultimate									TCLP-BNA			
Ammonia									TCLP-Herbicides			
Nitrate-Nitrite									TCLP-Pesticides			
Orthophosphate												
Total Phosphorous												
☐ TPN ☐ TKN				Asbestos								

Comments: Enter the number of samples in the appropriate box(es) above.

W = water S = soil/sediment O = other (please specify) W$_{TR}$ = water total W$_D$ = water dissolved

Project Name: ______________________________

SIC: ______________ **Program:** ______________________________

☐ Preliminary Investigation ☐ For HW Designation **Date Results needed by:** ________________

Send Results to: ______________________ **Mail Stop:** ______________

☐ Monitoring ☐ For NPDES **Name/Reference # of QAPP for this project:** ______________________

Sampling							General Chemistry																			Micro					Metals					Organic Chemistry														
Date Year: ☐ Mo Day	Time (Military) 0001 - 2400 Hr Min	Field Station Identification	Manchester Lab Sample Number	Matrix Code	Source Code	No. of Containers	Alkalinity	Conductivity	pH	Turbidity	☐ Chloride ☐ Sulfate	Fluoride	Total Suspended Solids	Total Dissolved Solids	☐ Total Solids ☐ % Sol ☐ Vol Sol	TOC	DOC	BOD5	Oil & Grease (HEM)	Ammonia	Nitrite/Nitrate	Total Phosphorus	Orthophosphate	TPN	Chlorophyll ☐ filters	Fecal Coliform ☐ MF ☐ MPN	Total Coliform ☐ MF ☐ MPN	E. Coli ☐ MF ☐ MPN	% Klebsiella	Enterococcus	PP Mets	Mercury (Hg) ☐ low level	Hardness	Individual Elements (please list)	☐ Total ☐ Dissolved	VOA	BTEX	TPHG	TPHD	HCID Only (Hydrocarbon ID)	PCB aroclors	☐ Pest 1 ☐ w/PCB aroclors	☐ Pest 2 ☐ w/PCB aroclors	☐ Pest 3 ☐ w/PCB aroclors	Carbamates	PESTMS	Herbicides	PBDE	BNA	PAH

Project Officer: ______________________

Phone Number: ______________________

Cell Number: ______________________

Samplers: ______________________

Chain of Custody Record

Relinquished By:	Received By:	Yr	Mo	Da	Hr	Mn	Seal I.D.	Condition of Seals	Comments (Temperature, Preserv., etc.)

Recorder: ______________________ Comments: ______________________

Matrix Codes	**Source Codes**	**Code Description**
Code Description 10 Water 11 Field Filtered Water 12 Filter from Water 13 Water to be filtered upon receipt at lab 40 Soil/Sediment 41 Frozen Soil/Sediment (PSEP) 45 Semi-Solid/Sludge 70 Tissue 80 Oil/Solvent 90 Waste 00 Other (Use only if no other apply)	**Code Description** 00 Unspecified Source 01 Unknown Liquid Media (Drum/Tank) 02 Unknown Liquid Media (Spill Area) 03 Unknown Liquid Media (Waste Pond) **10 Water (General)** 12 Ambient Stream/River 13 Lake Reservoir 14 Estuary/Ocean 15 Spring/Seepage 16 Rain 17 Surface Runoff/Pond (general) 18 Irrigation Canal/Return Flow **20 Well (General)** 21 Well (Industrial/Agricultural) 22 Well (Drinking Water Supply) 23 Well (Test/Observation) 24 Drinking Water Intake 25 Drinking Water (At Tap) **30 Effluent Wastewater (General)** 31 Municipal Effluent 32 Municipal Inplant Waters 33 Industrial Surface Runoff/Leachate 34 Industrial Effluent 35 Industrial Inplant Waters 36 Industrial Surface Runoff/Pond 37 Industrial Waste Pond 38 Landfill Runoff/Pond/Leachate **40 Sediment (General)** 42 Bottom Sediment or Deposit 44 Sludge (General) 45 Sludge (Waste Pond) 46 Sludge (Drum/Tank) 48 Soil (General) 49 Soil (Spill/Contaminated Area)	50 Bore Hole Material **60 Air (General)** 61 Ambient Air 62 Source or Effluent Air 63 Industrial or Workroom Air **70 Tissue (General)** 71 Fish Tissue 72 Shellfish Tissue 73 Bird Tissue 74 Mammal Tissue 75 Macroinvertebrate 76 Algae 77 Periphyton 78 Plant/Vegetation **80 Oil/Solvent (General)** 81 Oil (Transformer/Capacitor) 82 Oil/Solvent (Drum Tank) 83 Oil/Solvent (Spill Area) 84 Oil/Solvent (Waste/Pond) **90 Commercial Product Formulation** 95 Well Drill Water 96 Well Drill Mud 97 Well Sealing Material 98 Gravel Pack Material

Field Meter Calibration Record

Project Name:

Recorder:

Calibration date and time__________________________ Post-sampling check date and time________________

Meter Number: Hydrolab, GW

	Pre-use calibration				Post-use calibration check			
	Reference standard	Meter reading	Difference	Accept/ Reject	Reference standard	Meter reading	Difference	Accept/ Reject
pH								
Specific conductance								
Dissolved Oxygen								
	DO reading				DO reading			
	% Saturation				% Saturation			

Pre and Post Use Calibration Acceptance Criteria by Parameter

pH slope and asymmetry acceptance criteria

Slope	Acceptable: -50 to -62 mV/pH
	Ideal: -58 to -60.5 mV/pH
Asymmetry	Acceptable: < ± 30mV
	Ideal: < ± 15 mv

DO relative slope acceptance criteria

Relative slope	Acceptable: 0.6 to 1.25
	Ideal: 0.8 to 1.25

pH post Calibration Standard Checks

less than or equal to ±0.15 = pass
greater than ±0.15 and less than or equal to ±0.5 = "J" qualify
greater than ±0.5 = reject

Conductivity post Calibration Standard Checks

less than or equal to ±5% = pass
greater than ±5% and less than or equal to ±10% = "J" qualify
greater than ±10% = reject

DO% Saturation post Calibration Evaluation Criteria

less than or equal to ±5% = pass
greater than ±5% and less than or equal to ±10% = "J" qualify
greater than ±10% = reject

Append calibration remarks or comments below: