APPENDIX A

List of Lab Equipment and Field Instruments	Quantity Needed
Lab Equipment	
Colilert 18, Enterolert packets	-
Pipettes, 100 mL graduated cylinder (for dilutions)	1
Latex or nitrile gloves	1/person
Black light	1
incubator	1
IDEXX sealer	1
coolers	1
IDEXX trays	-
IDEXX sample bottles	-
25 ml sample vials (cuvettes)	-
colorimeter	1
Scissors	1
Reagents	-
Plastic sample cups	2
Waste container	1
Squeeze bottle, distilled water	2
Data sheet	1
Hydrochloric acid, gloves	1
Phosphate-free soap/scrubber	1
Field Equipment	
100 ml sealed poly bottles (for bacteria)	4
100 ml amber glass bottles (for nutrients, turbidity)	2
500 ml poly bottle (for Total Metals and TSS)	2
1 L amber glass bottle (for TPH and PAH)	2
Ice or frozen blue gel	Fill ½ ice chest
COC forms	1
first aid kit	1/team
clipboard	1/team
backpack	1/team
pH Meters	1
thermometer	1
Electrical conductivity meter	1
Dissolved oxygen meter (with paper towels)	1
Stadia rod	1
Stopwatch	1
Boots (or waders)	1 set /person
Measuring tape	1
Markers (sharpies & pens)	2
bobber	1
Field data sheets	-
latex gloves-	1/person
camera	1
GPS	1

APPENDIX B

Sampling Operation Plans (SOP's)

STANDARD OPERATING PROCEDURE FOR WATER SAMPLE COLLECTION

Scope and Application

This protocol describes the techniques used to collect water samples in the field in a way that neither contaminates, loses, or changes the chemical form of the analytes of interest. The samples are collected in the field into previously cleaned and tested (if necessary) sample bottles of a material appropriate to the analysis to be conducted. Pre-cleaned sampling equipment is used for each site, whenever possible and/or when necessary. Appropriate sampling technique and measuring equipment may vary depending on the location, sample type, sampling objective, and weather. Trade names used in connection with equipment or supplies do not constitute an endorsement of the product.

Summary of Method

Appropriate sample containers and field measurement gear as well as sampling gear are transported to the site where samples are collected according to each sample's protocol. Water velocity, temperature, pH, conductivity, dissolved oxygen as well as other field data are measured and recorded using the appropriate equipment, and recorded using the forms in Appendix C. Samples are put on ice and appropriately shipped to the processing laboratories. [1]

Water Sample Collection

Water chemistry and bacteriological samples, as requested, are collected at the same location. *Water samples are best collected before any other work is done at the site*. If other work (i.e., sediment sample collection, flow measurement or biological/habitat sample collection or assessment) is done prior to the collection of water samples, it might be difficult to collect representative samples for water chemistry and bacteriology from the disturbed stream. Care must be taken, though, to not disturb sediment collection sites when taking water samples.

The following general information applies to all types of water samples, unless noted otherwise:

Sample Collection Depth	**Sub-Surface Grab Sample:** Samples are collected at 0.1m below the water surface. Containers should be opened and re-capped under water in most cases. **Depth-integrated Sample:** If a depth-integrated sample is taken, the sample is pumped from discrete intervals within the

[1] This procedure has been modified from the "Texas Natural Resources Conservation Commission's Procedure Manual for Surface Water Quality Monitoring", with major input from the "USGS NAWQA protocol for collection of stream water samples", for which due credit is herewith given.

entire water column.

Surface Grab Sample: Samples are collected at the surface when water depth is <0.1m.

Where to Collect Samples

Water samples are collected from a location in the stream where the stream visually appears to be completely mixed. Ideally this would be at the centroid of the flow (*Centroid* is defined as the midpoint of that portion of the stream width, which contains 50% of the total flow), but depth and flow etc., do not always allow this. For stream samples, the sampling spot must be accessible for sampling physicochemical parameters, either by bridge, boat or wading. Sampling from the shoreline of any water body (meaning standing on shore and sampling from there) is the least acceptable method, but in some cases is necessary.

In reservoirs, lakes, rivers, and coastal bays, samples are collected from boats at designated locations provided by RWQCB's.

Sampling Order if Multiple Media are Requested to be Collected

The order of events at every site has to be carefully planned. For example, if sediment is to be taken, the substrate can not be disturbed by stepping over or on it; water samples can not be taken where disturbed sediment would lead to a higher content of suspended matter in the sample. *For the most part, water samples are best collected before any other work is done at the site*. This information pertains to walk-in sampling.

Sample Container Labels

Label each container with the station ID, sample code, matrix type, analysis type, project ID, and date and time of collection (in most cases, containers will be pre-labeled). After sampling, secure the label by taping around the bottle with clear packaging tape.

Procedural Notes

For most water samples (not for organics, inorganics or bacteria), prior to collecting sample, rinse the container with ambient water, unless protocol for specific analytical procedure dictates otherwise.

If applicable to the sample and analysis type, the sample container should be opened and re-capped under water.

Sample Short-term Storage and Preservation

Properly store and preserve samples as soon as possible. Usually this is done immediately after returning from the collection by placing the containers on bagged, crushed or cube ice in an ice chest. Sufficient ice will be needed to lower the sample temperature to at least 4°C within 45 minutes after time of collection. Sample temperature will be maintained at 4°C until delivered to the laboratory. Care is taken at all times during sample collection, handling and transport to prevent exposure of the sample to direct sunlight. Samples are preserved in the laboratory, if necessary, according to protocol for specific analysis (acidification in most cases).

Field Safety Issues

Proper gloves must be worn to prevent contamination of the sample and to protect the sampler from environmental hazards (disposable polyethylene, nitrile, or non-talc latex gloves are recommended, **however, metals and mercury sample containers can only be sampled and handled using polyethylene gloves as the outer layer**). Wear at least one layer of gloves, but two layers help protect against leaks. One layer of shoulder high gloves worn as first (inside) layer is recommended to have the best protection for the sampler. Safety precautions are needed when collecting samples, especially samples that are suspected to contain hazardous substances, bacteria, or viruses.

Sample Handling and Shipping

Due to increased shipping restrictions, samples being sent via a freight carrier require additional packing. Although care is taken in sealing the ice chest, leaks can and do occur. Samples and ice should be placed inside a large plastic bag inside the ice chest for shipping. The bag can be sealed by simply twisting the bag closed (while removing excess air) and taping the tail down. Prior to shipping the drain plug of the ice chests have to be taped shut. Leaking ice chests can cause samples to be returned or arrive at the lab beyond the holding time. Although glass containers are acceptable for sample collection, bubble wrap must be used when shipping glass.

Chain of Custody Forms (COC)

Every shipment must contain a complete Chain of Custody Form (see Appendix C) that lists all samples taken and the analyses to be performed on these samples. Make sure you include a COC for every laboratory you ship to, every time you send a shipment. Include region and trip information as well as any special instructions to the laboratory.

The original COC sheet (not the copies) is included with the shipment (insert into zip lock bag); one copy goes to the sampling coordinator; and the sampling crew keeps one copy. Samples collected should have the salinity (in ppt), depth of collection, and date/time collected on every COC. Write a comment on this form, if you want to warn the laboratory personnel about a possibly hazardous sample, or samples, which contain high chlorine or organic levels.

Field QC Samples for Water Analyses

Field duplicates are currently submitted at an annual rate of 5%. Field travel blanks are required for volatile organic compounds at a rate of one per cooler shipped. Field blanks are required for trace metals (including mercury and methyl mercury), DOC, and volatile organic compounds in water at a rate of 5%. See Appendix C for detailed Field QC requirements.

Field Site Data Sheets

Each visited field site requires a completed Field Data Sheet (Station Occupation Data Sheet, Appendix C), even if no samples are collected (i.e. at a site which is found to be dry). If water and/or sediment samples are taken, a Water Quality Data Sheet/Sediment Data Sheet (Appendix C) must be filled out as well.

General Pre-Sampling Procedures

Instruments: All instruments must be in proper working condition. Make sure all calibrations are current. YSI sondes should be calibrated every morning prior to sampling. Conductivity should also be calibrated between stations if there is a significant change in salinity.

Calibration Standards: Pack all needed calibration standards.

Sample Storage Preparations: A sufficient amount of cube ice, blue ice and dry ice as well as enough coolers of the appropriate type/size, must be brought into the field, or sources for purchasing these supplies identified in advance.

Sample Container Preparation: After arriving at the sample station, pack all needed sample containers for carriage to the actual collection site, and label them with a pre-printed label containing Station ID, Sample Code, Matrix info, Analysis Type info, Project ID and blank fields for date and time (if not already pre-labeled).

Safety Gear: Pack all necessary safety gear like waders, protective gloves and safety vests.

Walking To The Site: For longer hikes to reach a sample collection site, large hiking backpacks are recommended for transport of gear, instruments and containers. Tote bins can be used, if the sampling site can be accessed reasonably close to the vehicle.

GPS: At the sampling site, compare/record reconnaissance GPS reading with current site reading and note differences. GPS coordinates should be in Decimal Degrees i.e. 38.12345 -117.12345.

COLLECTION OF WATER SAMPLES FOR ANALYSIS OF CONVENTIONAL CONSTITUENTS

In most streams, near-surface water is representative of the water mass. A water sample for analysis of conventional constituents is collected by the grab method in most cases, immersing the container beneath the water surface to a depth of 0.1 m. Sites accessed by bridge can be sampled with a sample container-suspending device. Extreme care must be taken to avoid contaminating the sample with debris from the rope and bridge. Care must also be taken to rinse the device between stations. If the centroid of the stream cannot be sampled by wading, sampling devices can be attached to an extendable sampling pole.

In some cases, depth-integrated sampling is required, as requested by Regional Boards. This is useful when lakes or rivers are stratified and a sample is wanted that represents the entire water column. Depth-integrated sample collection is explained later in this document.

Conventional Water Constituents, Routinely Requested in SWAMP	Chloride, sulfate, nitrite, nitrate (or nitrate+nitrate), orthophosphate, fluoride, total phosphorus, ammonia, TKN, alkalinity, chlorophyll *a*.
Conventional Water Constituents, Occasionally Requested in SWAMP	Total Suspended Solids (TSS) or Suspended Sediment Concentration (SSC), Total Dissolved Solids (TDS--especially if total metals requested), Total Organic Carbon (TOC), Dissolved Organic Carbon (DOC), hardness (if trace metals analysis is requested).
Conventional Water Constituents Sample Volume	Due to the potential for vastly different arrays of requested analyses for conventional constituents, please refer to table at the end of this document, as well as the Sample Handling Requirements Tables in Appendix C of this QAPP, for information on the proper volume to collect for the various types of analyses.

Conventional Water Constituents Sample Container Type

Due to the potential for vastly different arrays of requested analyses for conventional constituents, please refer to table at the end of this document, as well as the Sample Handling Requirements Tables in Appendix C of this QAPP, for information on the proper type of sample containers.

Field QC Samples

If required, field Duplicates and field blanks are submitted with every twentieth sample. Refer to Appendix C for details on required blanks and duplicates.

Whirl-Pak Bags

Label the bottle as previously described for SWAMP.

Tear off the top of the bag along the perforation above the wire tab just prior to sampling. Avoid touching the inside of the bag. If you accidentally touch the inside of the bag, use another one.

If wading into the stream, try to disturb as little bottom sediment as possible. Be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side, in front of you. You may also tape your bottle to an extension pole to sample from deeper water.

Hold the two white pull-tabs in each hand and lower the bag into the water on your upstream side with the opening facing upstream. Open the bag midway between the surface and the bottom by pulling the white pull-tabs. The bag should begin to fill with water. You may need to "scoop" water into the bag by drawing it through the water upstream and away from you. Fill the bag no more than 3/4 full.

Lift the bag out of the water. Pour out excess water. Pull on the wire tabs to close the bag. Continue holding the wire tabs and flip the bag over at least 4-5 times quickly to seal the bag. Don't try to squeeze the air out of the top of the bag. Fold the ends of the wire tabs together at the top of the bag, being careful not to puncture the bag. Twist them together, forming a loop.

If the samples are to be analyzed in the lab, place them in a cooler with ice or cold packs for transport to the lab.

Summary of Sample Container, Volume, Initial Preservation, and Holding Time Recommendations for Water Samples

Parameters for Analysis in Water Samples	Recommended Containers (all containers pre-cleaned)	Typical Sample Volume (ml)	Initial Field Preservation	Maximum Holding Time (analysis must start by end of max)
Conventional Constituents in Water				
Nitrate + Nitrite ($NO_3 + NO_2$)	Polyethylene bottles[1]	150 ml	Cool to 4°C, dark	48 hours at 4°C, dark
Ammonia (NH_3)	Polyethylene bottles[1]	500 ml	Cool to 4°C, dark	48 hours at 4°C dark; if acidify, 28 days at 4°C, dark
[1] The volume of water necessary to collect in order to analyze for the above constituents is typically combined in four 1-liter polyethylene bottles, which also allows enough volume for possible re-analysis and for conducting lab spike duplicates. This is possible since the same laboratory is conducting all of the above analyses; otherwise, individual volumes apply.				
Total Suspended Solids (TSS)	500 ml amber glass jar	1000 ml (two jars)	Cool to 4°C, dark	7 days at 4°C, dark
Bacteria and Pathogens in Water Samples				
***E. Coli,* Enterococcus**	Factory-sealed, pre-sterilized, disposable Whirl-pak bags or 125 ml sterile plastic (high density polyethylene or polypropylene) container	100 ml volume sufficient for both E. coli and Enterococcus analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	STAT: 6 hours at 4°C, dark if data for regulatory purposes; otherwise, 24 hrs at 4C, dark if non-regulatory purpose.
Total Coliform	Factory-sealed, pre-sterilized, disposable Whirl-pak® bags or 125 ml sterile plastic (high density polyethylene or polypropylene) container	100 ml volume sufficient for both fecal and total coliform analyses	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.	STAT: 6 hours at 4°C, dark if data for regulatory purposes; otherwise, 24 hrs at 4C, dark if non-regulatory purpose.

FIELD OBSERVATIONS

Upon arrival at a sampling site, record visual observations on the appearance of the water and other information related to water quality and water use.

Other Observations

Water Appearance	Color, unusual amount of suspended matter, debris or foam, etc.
Weather	Note recent meteorological events that may have impacted water quality; heavy rains, cold front, very dry, very wet, etc.
Unusual Odors	Note if hydrogen sulfide odor, musty odor, sewage odor, etc. This should be recorded for sediment as well.
Specific Sample Information	Specific comments about the sample itself that may be useful in interpreting the results of the analysis; number of sediment grabs, or type and number of fish in a tissue sample. If the sample was collected for a complaint, or fish kill, make a note of this in the observation section.

Field Measurements

After collecting water samples (see Appendix C), record appropriate field measurements. When field measurements are made with a multiparameter instrument, it is preferable to place the sonde in the body of water to be sampled and allow it to equilibrate in the D.O. mode while water samples are collected. Field measurements are made at the centroid of flow, if the stream visually appears to be completely mixed from shore to shore. *Centroid* is defined as the midpoint of that portion of the stream width which contains 50% of the total flow. For routine field measurements, the date, time and depth are reported as a grab.

Recommended Depths for Conducting Field Data Measurements

Water Depth Less than 5 feet (<1.5m)	If the water depth is less than 5 feet (1.5m), grab samples for water are taken at approximately 0.1m (4 inches), and multi-probe measurements are taken at approximately 0.2m (8 in). This is because all sensors have to be submerged, so 0.1m would not be deep enough. But taking a grab sample at 0.2m is not always feasible, as it is difficult to submerge bottles to that depth, and in many cases the bottle will hit the stream bottom.

Water Temperature (^{O}C)

Water temperature data are recorded for each visit in final form in a Field Data Logbook.

Temperature Measuring Equipment

- Centigrade Thermometer
- Electronic Temperature Sensor

Temperature Sampling Procedures

- Temperature is measured in-stream at the depth(s) specified in Field Measurements above.
- Measuring temperature directly from the stream by immersing a multiprobe instrument or thermometer is preferred.

Hand Held Centigrade Thermometer

- If an electronic meter is not available, the temperature is measured with a hand-held, centigrade thermometer (Rawson, 1982).
- In wadeable streams, stand so that a shadow is cast upon the site for temperature measurement.
- Hold the thermometer by its top and immerse it in the water. Position the thermometer so that the scale can be read.
- Allow the thermometer to stabilize for at least one minute, then without removing the thermometer from the water, read the temperature to the nearest 0.1^{o} C and record.
- Do not read temperature with the thermometer out of the water. Temperature readings made with modern digital instruments are accurate to within $\pm$ 0.1^{o} C.

Temperature Measurement from a Bucket

- When temperature cannot be measured in-stream, it can be measured in a bucket- Nalgene or plastic. Care must be taken to insure a measurement representative of in-stream conditions.
- The bucket must be large enough to allow full immersion of the probe or thermometer.
- The bucket must be brought to the same temperature as the water before it is filled.
- The probe must be placed in the bucket immediately, before the temperature changes.
- The bucket must be shaded from direct sunlight and strong breezes prior to and during temperature measurement.
- The probe is allowed to equilibrate for at least one minute before temperature is recorded.
- After these measurements are made, this water is discarded and another sample is drawn for water samples which are sent to the laboratory.

<u>pH (standard units)</u>

pH data is recorded for each visit in a Field Data Logbook.

pH Sampling Equipment

- The pH meter should be calibrated according to the Recommended Procedures for Calibration and Maintenance of SWAMP Field Equipment, found in Appendix D of the QAMP (http://www.waterboards.ca.gov/swamp/qamp.html).

- The pH function is calibrated each day of use for multiparameter instruments.

pH Sampling Procedure, In-stream Method

- Preferably, pH is measured directly in-stream at the depth(s) specified earlier in this document. Allow the pH probe to equilibrate for at least one minute before pH is recorded to the nearest 0.1 pH unit.

pH Measurement from a Bucket

- When pH cannot be measured in-stream, it can be measured in a bucket-Nalgene or plastic, following precautions outlined under Temperature Measurement from a Bucket above.

Potential Problems

- If the pH meter value does not stabilize in several minutes, out gassing of carbon dioxide or hydrogen sulfide, or the settling of charged clay particle may be occurring (Rawson, 1982).
- If out gassing is suspected as the cause of meter drift, collect a fresh sample, immerse the pH probe and read pH at one minute.
- If suspended clay particles are the suspected cause of meter drift, allow the sample to settle for 10 minutes, then read the pH in the upper layer of sample without agitating the sample.
- With care, pH measurements can be accurately measured to the nearest 0.1 pH unit.

<u>Specific Conductance (μmhos/cm)</u>

Specific conductance should be recorded for each visit in the Field Data Logbook or field form.

Specific Conductance Sampling Equipment

- Conductivity meter
  - <u>Calibration Procedure</u> (from Oakton Conductivity Meter Manual)
    The conductivity meter should be calibrated once each sampling day within twenty-four hours of use. Calibrate the meter by submerging the tip in a standard solution similar to what you will encounter in the field and adjusting the reading using the up or down buttons under the meter battery cap until it reads the same as the standard solution.

Specific Conductance Sampling Procedure

- Preferably, specific conductance is measured directly in-stream at the depth(s) specified in Field Measurements. Allow the conductivity probe to equilibrate for at least one minute before specific conductance is recorded to three significant figures (if the value exceeds 100). The primary physical problem in using a specific conductance meter is entrapment of air in the conductivity probe chambers. The presence of air in the probe is indicated by unstable specific conductance values fluctuating up to $\pm$100 μmhos/cm. The entrainment of air can be minimized by

slowly, carefully placing the probe into the water; and when the probe is completely submerged, quickly move it through the water to release any air bubbles.
- If specific conductance cannot be measured in-stream, it should be measured in the container used for collection of water samples (a bucket) using the precautions outlined on prior pages, Temperature Measurement from a Bucket.

Turbidity

- Nephlometric turbidity can be determined by measuring the amount of scatter when light is passed through a sample using a turbidity meter. The LaMotte 2020 Turbidity meter is a suitable instrument for example.
- Meters should be calibrated using a standard close to the expected sample value.
- For instructions on how to operate the instruments refer to the manufacturer's manual. Turbidity measurements can be executed together with water sampling. The turbidity sample has to be representative for the sampled water mass. Make sure that no gas bubbles are trapped in the vial for the reading and that the outside of the vial is wiped completely clean, meaning free of moisture, lint and fingerprints. Take several measurements to assure an accurate reading. Do not record values that vary greatly. If variations are small, record an average. If settling particles are present, record a reading before and one after settling. The meter might have to be recalibrated with a different standard, if the sample water readings are outside of the calibration standard limits.

Significant Precipitation (days since last)

- Significant precipitation is defined as any amount that visibly influences water quality. Water quality in small to medium streams and in the headwaters of many reservoirs is influenced by runoff during and immediately after rainfall events. This influence is site specific and poorly studied. As part of a new initiative to understand and regulate the adverse effects of runoff, the SWAMP Program would like to associate recent rains or melted snow with ambient water quality, using a parameter defined as "days since last significant precipitation". Record the number of days, rounded to the nearest whole number, since a rain has occurred that, in the best professional judgment of monitoring personnel, may have influenced water quality. If it's raining when the sample is collected, or has rained within the last 24-hours, report a value of <1. If it has been a long time since a significant rain, record this as greater than that particular value, for example >7 days. If confidence about the recent history of precipitation is low, draw a line through the space on the data form.

Flow Severity

- Flow severity should be recorded for each visit to non-tidally influenced flowing streams. It should be recorded even if flow is not measured on that sampling visit. There are no numerical flow guidelines associated with flow severity. This is an observational measurement that is highly dependent on the knowledge of monitoring personnel. It is a simple but useful piece of information when assessing water quality data. For example, a bacteria value of 10,000 with a flow severity of 1 would represent something entirely different than same value with a flow severity of 5.

- Flow information for over 200 USGS sites is available at **http://water.usgs.gov/index.html**. This is useful information in determining flow conditions prior to sampling. This information may be included in general observations.

- The six flow severity values are; 1=No Flow, 2= Low Flow, 3 = Normal Flow, 4 = Flood, 5 = High Flow, and 6 = Dry. The following are detailed descriptions of severity values:

1 **No Flow:** When a flow severity of one (1 = no flow) is recorded for a sampling visit, then a flow value of zero ft^3/s should also be recorded for that sampling visit. A flow severity of one (1) (no flow) describes situations where the stream has water visible in isolated pools. There should be no obvious shallow subsurface flow in sand or gravel beds between isolated pools. Low flow does not only apply to streams with pools. It also applies to long reaches of bayous and streams that have no detectable flow but may have water from bank to bank.

2 **Low Flow:** When stream flow is considered low a flow severity value of two (2) is recorded for the visit and the corresponding flow measurement is also recorded for that visit. In streams to shallow for a flow measurement but water movement is detected, record a value of < 0.10 cfs. Note: Use a stick or other light object to verified the direction of water movement, i.e., movement is downstream and not the affect of wind. What is low for one stream could be high for another.

3 **Normal Flow:** When stream flow is considered normal, a flow severity value of three (3) is recorded for the visit and the corresponding flow measurement is also be recorded for that visit. Normal is highly dependent on the stream. Like low flow, what is normal for one could be high or low for another stream.

4 and 5 **Flood and High Flow:** Flow severity values for high and flood flows have long been established by USEPA and are not sequential. Flood flow is reported as a flow severity of four (4) and high flows are reported as a flow severity of five (5). High flows would be characterized by flows that leave the normal stream channel but stay within the stream banks. Flood flows are those which leave the confines of the normal stream channel and move out on to the flood plain.

6 **Dry:** When the stream is dry a flow severity value of six (6 = dry) is recorded for the sampling visit. In this case the flow is not reported. This will indicate that the stream is completely dry with no visible pools.

The method (or instrument) used to measure flow is noted by reporting a method number. The method numbers are:

1	Flow gage station (USGS/IBWC)
2	Mechanical (e.g., Pigmy meter)
3	Electric (e.g., Marsh-McBirney)
4	Weir/flume
5	Other (e.g., orange peel)

Flow (ft^3/s)

If requested, flow data should be recorded for each monitoring visit to non-tidal, flowing streams. Flow data should be recorded in the Field Data Logbook. The following are two exceptions to the flow reporting requirement:

Flow/ Pools If there is no flow at a stream site and accessible, isolated pools remain in the stream bed, collect and report the required field data and laboratory samples from the pools and report instantaneous flow. Under these conditions, flow (ft^3/s) should be reported as zero. The reported flow severity value should be one. Pools may represent natural low-flow conditions in some streams and the chemistry of these pools will reveal natural background conditions.

Dry If the stream bed holds no water, the sampling visit is finished. Report that the stream was "dry" in the observations and record a value of six (meaning "dry") for flow severity. No value is reported for flow since there is no water.

- If a flow measurement is required at a site, measure and record flow after recording visual observations. The intent of measuring flow first, is to delay collection of chemical and biological water samples with limited holding times. Care must be taken not to collect water samples in the area disturbed during flow measurement. There are several acceptable flow measurement methods that can be used.

Flow Measurement Equipment

Flow meter

One of the following or an equivalent:

- Marsh-McBirney Electronic meter
- Montedoro-Whitney Electronic meter
- Price Pigmy meter (with timer and beeper)
- Price meter, Type AA (with Columbus weight)

Additional Equipment

- Top-setting wading rod (preferably measured in tenths of feet)
- Tape measure (with gradations every tenth of a foot).

Flow Measurement Procedure (USGS, 1969)

Select a stream reach with the following characteristics:

- Straight reach with laminar flow (threads of velocity parallel to each other) and bank to bank. These conditions are typically found immediately upstream of riffle areas or places where the stream channel is constricted.
- The site should have an even streambed free of large rocks, weeds, and protruding obstructions that create turbulence. The site should not have dead water areas near the banks, and a minimum amount of turbulence or back eddies.

Flat Streambed Profile (cross section)

Stretch the measuring tape across the stream at right angles to the direction of flow. When using an electronic flow meter, the tape does not have to be exactly perpendicular to the bank (direction of flow). When using a propeller or pigmy type meter, however, corrections for deviation from perpendicular must be made.

If necessary and possible, modify the measuring cross section to provide acceptable conditions by building dikes to cut off dead water and shallow flows, remove rocks, weeds, and debris in the reach of stream one or two meters upstream from the measurement cross section. After modifying a streambed, allow the flow to stabilize before starting the flow measurement.

Record the following information on the flow measurement form (see example Flow Measurement Forms at end of this document):

- Station Location and Station ID
- Date
- Time measurement is initiated and ended
- Name of person(s) measuring flow
- Note if measurements are in feet or meters
- Total Stream Width and Width of Each Measurement Section
- For each cross section, record the mid-point, section depth and flow velocity

Measuring the Stream Width

- Measure and record the stream width between the points where the tape is stretched (waters edge to waters edge).

Determining the Number of Flow Cross Sections

Determine the spacing and location of flow measurement sections. Some judgement is required depending on the shape of the stream bed. Measurements must be representative of the velocity within the cross-section. If the stream banks are straight and the depth is nearly constant and the bottom is free of large obstructions, fewer measurements are needed, because the flow is homogeneous over a large section. Flow measurement sections do not have to be equal width. However, flow measurement sections should be of equal width, unless an obstacle or other obstruction prevents an accurate velocity measurement at that point. ***No flow measurement section should have greater than 10% of the total flow.***

If the *stream width is less than 5 feet*, use flow sections with a width of 0.5 feet. See Example 1 on page 2-34. If the *stream width is greater than 5 feet*, the minimum number of flow measurements is 10. The preferred number of flow measurement cross sections is 20-30. See Example 2 at the end of this document: The total stream width is 26 feet with 20 measurements, section widths will be 1.3 feet (26/20 = 1.3).

Determining the Mid-Point of the Cross Section

To find the mid-point of a cross section, divide the cross section width in half. Using Example 2 (see forms at end of document);

- The total stream width is 26 feet with 20 cross sections and each cross section width is equal to 1.3 feet.
- Divide 1.3 feet in half and the mid-point of the first section is 0.65 feet. In this example the tape at waters edge is set at zero (0) feet.
- By adding 0.65 to zero the mid-point of the first section is 0.65 feet.
- Each subsequent mid-point is found by adding the section width (1.3 feet) to the previous mid-point. For example; MIDPOINT #1 is 0.65 + 0.0 = 0.65; MIDPOINT #2 is 0.65 + 1.3= 1.95 feet; MIDPOINT #3 is 1.95 + 1.3 = 3.25 feet and ....MIDPOINT # 20 is 24.05 +1.3.
- Place the top setting wading rod at 0.65 feet for the first measurement.
- Using a top setting wading rod, measure the depth at the mid-point of the first flow measurement section and record to the nearest 0.01 feet.
- In cases where the flow is low and falling over an obstruction, it may be possible to measure the flow by timing how long it takes to fill a bucket of known volume.

Calculating Flow

To calculate flow, multiply the width x depth (ft^2) to derive the area of the flow measurement section. The area of the section is then multiplied by the velocity (ft/s) to calculate the flow in cubic feet per second (cfs or ft^3/sec) for that flow measurement section. When flow is calculated for all of the measurement sections, they are added together for the total stream flow.

Q = Total Flow (or discharge), W=Width, D=Depth, V=Velocity.

$Q = (W_1 * D_1 * V_1) + (W_2 * D_2 * V_2) + \ldots\ldots (W_n * D_n * V_n)$

What to Do with Negative Values

Do not treat cross sections with negative flow values as zero. Negative values obtained from areas with back eddies should be subtracted during the summation of the flow for a site.

Flow Estimate (ft^3/s)

Flow estimate data may be recorded for a non-tidally influenced stream when it is not possible to measure flows by one of the methods described above. Flow estimates are subjective measures based on field personnel's experience and ability to estimate distances, depths, and velocities. If flow can not be measured at a routine non-tidal station, a new site should be selected where flow can be measured.

Procedure

- Observe the stream and choose a reach of the stream where it is possible to estimate the stream cross section and velocity.
- Estimate stream width (feet) at that reach and record.
- Estimate average stream depth (feet) at that reach and record. Estimate stream velocity (ft/s) at that reach and record. A good way to do this is to time the travel of a piece of floating debris. If doing this method from a bridge, measure the width of the bridge. Have one person drop a floating object (something that can be distinguished from other floating material) at the upstream side of the bridge and say start. The person on the downstream side of the bridge will stop the clock when the floating object reaches the downstream side of the bridge. Divide the bridge width by the number of seconds to calculate the velocity. The velocity can be measured at multiple locations along the bridge. These velocities are averaged. If this is done alone, watch for road traffic.
- Multiply stream width (feet) times average stream depth (feet) to determine the cross sectional area (in ft^2) which when multiplied by the stream velocity (in ft/s) and a correction constant, gives an estimated flow (ft^3/s).

Example: A stream sampler conducted a sampling visit to a stream while the flow meter was being repaired. The sampler looked at the creek downstream from the bridge and saw a good place to estimate flow. The stream width was around 15 feet. It appeared the average depth on this reach was about 0.75 feet. The sampler timed a piece of floating debris as it moved a distance of ten feet in 25 seconds downstream over the reach. An estimated flow with a smooth bottom was calculated using the following formula.

Width x Depth x Velocity x A (correction factor)= estimated flow
15 ft (width) x 0.75 ft (depth) x 2.5 ft/s (velocity) x A =25 ft^3/s (cfs)

A is a correction constant: 0.8 for rough bottom and 0.9 for smooth bottom

Estimated flow should be reported to one or two significant figures.

Experienced field personnel are able to estimate flow to within 20% of actual flow for total flows less than 50 ft^3/s. The best way to develop this skill is to practice estimating flow before making measurements at all monitoring visits to non-tidally influenced flowing streams and then compare estimated flows with those obtained from USGS gages or from instantaneous flow measurements.

APPENDIX C

FIELD DATA FORMS:

Chain of Custody
SWAMP Sampling Site Information Form
Testing Result Form
Flow Rate Form

SWAMP Station Occupation Results

*Station ID: | | | | | | | | |

*Date: MM / DD / YYYY

PG: OF PGS

Entered Dbase

*Project ID: | | | | | | | |

*Sample Time: (time of first sample)

Arrival Time:

Departure Time:

*Sample Season:

Event Type

Sample Type: FieldObs

SampleDepthCollection: -88

DistanceFromBank: -88

*Crew:

____

____

____

*Habitat
dry
non-wadeable stream
wadeable stream
wadeable concrete channel
standing water
other_______________

Photos (RB & LB are assigned when facing downstream)
RB/LB/BB/US/DS/##
RB/LB/BB/US/DS/##
RB/LB/BB/US/DS/##

*Precipitation
dry
drizzle
rain
thunderstorm

Sea State (if applicable):
Calm
Rough
Choppy

*Sky
clear
partly cloudy
overcast
fog

Wind Direction (from) / no wind = xx :
N
W E
S

Wind Speed (kts) :

*Water Color
clear
green
yellow
brown
other

*Water Clarity
clear
semi-clear
turbid

*Water Odor
hydrogen sulfide
sewage
petroleum
mixed
none

*Sediment Color
black
brown
gray
yellow
mixed
other

* Sediment Composition
course sand
fine sand
silt / clay
cobble
gravel
mixed
other

*Sediment Odor
none
hydrogen sulfide
sewage
petroleum
mixed
other

Station Occupation Comments

Access key required: Yes / No
Contact info:

Gaging Station #:

*Elevation (ft or m) :

* required field; underlined fields used as primary keys in dbase

SWAMP SOFDS 1/02/2003

Sample Collection:				
Sample ID: _	**Time Collected:** _ _	**Collected by:**	**Type:** _	**Container type :** _ _
			Bacteria	
			Nutrient	
			____________	
			____________	
			____________	
			____________	
			____________	
			____________	

Sample Custody:	
Relinquished By:	Received By:
Date /Time:	Date /Time:

	Temp. (°C)	Dissolved Oxygen (mg/L)	Conductivity (uS Low) (mS high)	pH	Nitrate-Nitrogen Test#50	Phosphate Test#79	Turbidity	Ammonia -Nitrogen Test#64
Equip#								
Reagent#								
Result 1								
Result 2								
Result 3								
Blank								
Split								
Duplicate								
Backup Reading								
Meet Objective? Y or N								

Comments:____

____

Data Entered by: ________________________

Data Entry Date: ________________________

UPSTREAM

Wetted Width of Stream _______________(feet, inches)

Cross Sectional Area (measure points at every foot across width of stream, start at opposing side).

Point #	Depth	Point #	Depth	Point #	Depth	Point #	Depth
1		11		21		31	
2		12		22		32	
3		13		23		33	
4		14		24		34	
5		15		25		35	
6		16		26		36	
7		17		27		37	
8		18		28		38	
9		19		29		39	
10		20		30		40	

DOWNSTREAM

Wetted Width of Stream _______________(feet, inches)

Cross Sectional Area (measure points at every foot across width of stream, start at opposing side).

Point #	Depth	Point #	Depth	Point #	Depth	Point #	Depth
1		11		21		31	
2		12		22		32	
3		13		23		33	
4		14		24		34	
5		15		25		35	
6		16		26		36	
7		17		27		37	
8		18		28		38	
9		19		29		39	
10		20		30		40	

VELOCITY FLOAT TRIALS:
Length of reach (distance along stream)__________should be 20ft

Trial #	1	2	3	4	5
Time					

Quality Assurance

Field Supervisor Signature: _________________________________ Date: ______________

Data Entry Completed by: _________________________________ Date: _______________

Notes and Observations : (include any equipment comments/problems or observations such as water color, trash composition, etc...)