STANDARD OPERATING PROCEDURES (SOP) FOR FIELD SAMPLING EFFORTS OF THE OKLAHOMA WATER RESOURCES BOARD'S BENEFICIAL USE MONITORING PROGRAM (BUMP)

WATER QUALITY PROGRAMS DIVISION

3800 NORTH CLASSEN BOULEVARD

OKLAHOMA CITY, OKLAHOMA 73118

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CHAPTER 1 – BUMP Streams Monitoring Component

The purpose of this document is to provide a simplified, step-by-step outline of the field sampling procedures used by the Beneficial Use Monitoring Program (BUMP) of the Water Quality Programs Division of the Oklahoma Water Resources Board (OWRB). The three basic sampling procedures that will be discussed in this document include:

1. water quality sampling
2. sediment sampling
3. fish sampling

Only the basic techniques for each type of sampling will be discussed in this document. Beneficial Use Monitoring personnel use other, more complex techniques, but these are performed so infrequently that an experienced staff member would conduct training on an as-needed basis. This document is comprised of a number of chapters addressing different aspects of the OWRB Water Quality Programs Division monitoring efforts. The first chapter of this document addresses the OWRB streams sampling program conducted as part of the agencies Beneficial Use Monitoring Program. Chapter 2 is concerned with protocols associated with the lakes sampling program of the BUMP. The OWRB volunteer monitoring program Oklahoma Water Watch (OWW) is not covered under this Standard Operating Procedures (SOP) document. The OWW program maintains a separate document, the OWW Handbook, which outlines their SOPs.

BASIC STREAM WATER QUALITY SAMPLING

INTRODUCTION

The purpose of this document is to provide a simplified, step-by-step outline of the field sampling procedures used by the Water Quality Programs Division of the Oklahoma Water Resources Board (OWRB) for the streams portion of the Beneficial Use Monitoring Program (BUMP). The basic sampling procedures that will be discussed in this document involve water quality sampling, methods and equipment. Only the basic techniques for sampling will be discussed in this document. Other, more complex techniques will be explained by an experienced staff member who will conduct further training on an as-needed basis. APPENDIX A contains all documents needed for streams sampling, including chain of custody forms and laboratory log-in sheets for the Oklahoma Department of Environmental Quality (ODEQ), field data sheets, checklists, and calibration log sheets.

PREPARING FOR THE FIELD

This step of the sampling procedure is often performed in a rushed manner, although this step is extremely important and should be given enough time and attention so that it is done properly. If preparation is not taken seriously, there is a possibility that equipment and supplies may be overlooked and forgotten until reaching the field site (sometimes hours away from the office). Moreover, rescheduling of assessments will be difficult due the large number of stream segments that the BUMP Streams' Team will be monitoring on a monthly basis. A checklist of items needed for stream's water quality (SWQ) sampling is provided in APPENDIX A This list is located on the network as a separate checklist and should be printed out and used prior to each SWQ sampling

event. Field preparation should begin at least two working days before the day of departure as several items must be taken care of in advance. The checklist may be found under the file name: S:\SHARED\BUMP\STREAMS\FORMS\BUMPSWQA.LST. Each team will be responsible for ensuring that their equipment and materials are in working order and in adequate supply, notifying the receiving laboratory of arrival time and number of samples, preparing and printing labels from the trip files, and any other preparation necessary for a sampling trip.

Two working days prior to sampling:
Because most sampling trips are two-day trips, overnight stay is required in order to collect all of the samples and have them to the ODEQ by 3:30 p.m. of the second day of the trip. Remember that the state only reimburses up to $40.00 for a hotel room. It is your responsibility to make reservations at either a state lodge or a hotel for the night before your sampling event. Reservations can be made weeks in advance but it is a good idea to call and confirm your reservation when preparing for each trip. State lodges owned by the state will direct bill the agency. Direct billing from other state lodges and all hotels/motels/inns is not permitted under agency rules. Ask your supervising Full-Time Equivalent (F.T.E) staff person for suggestions on accommodations.

It is important at this point to ensure that all of the necessary supplies are in stock either in the lab or in the storeroom. Walk through the rooms while scanning the checklist (APPENDIX A) to ensure that adequate stocks of sample bottles (½ gallon containers,1 liter bottles and quart bottles), Bacteria (Bac-T) sample containers, glass collection bottles, etc. are in stock. Ensure that there is an adequate supply of calibration standards, sulfuric acid, sharpies, pencils, camera film, etc. Ensure that all rechargeable equipment (e.g., Hydrolab©/Y.S.I. ©, HACH® Portable Turbidimeter, etc.) batteries are fully charged and recharge if needed. The Surveyor 4 units may be "topped off" if less than 100% battery voltage, however, Hydrolab recommends completely draining the battery approximately once per month and then fully charging the battery to 100% voltage. Check the appointment calendar to ensure that a truck is available and checked out for the sampling event (the project officer should have the dates scheduled and trucks checked out in the calendar several weeks in advance). Lastly, notify the ODEQ lab at 702-1113 or 702-1112 of when the samples will arrive and how many samples will be collected. This may be done by the supervising F.T.E.

One Working day prior to sampling:
This is the time to get everything on the checklist together and ready to load. Go through each item on the checklist and stack all of the supplies onto the cart in an out-of-the-way area in the lab. Do not load equipment on the cart until the day before sampling is scheduled. Notice that the first few items on this list are sample containers, and the checklist says "labeled" for each container. It is important to attach the labels at least 24 hrs prior to entering the field so that the labels will set up and stay on the containers. Make sure you also label bottles for QA/QC--either a field blank (deionized water), spike, and/or duplicate taken from churn-splitter (naming these sites will be discussed in the QA/QC section of this document). It is also important to take plenty of extra containers in the event of breakage or loss in the field. Trip forms can be printed by accessing the appropriate trip in the folder S:\shared\bump\streams\forms\at trips. Their will be a file containing the field data sheet, the laboratory chain of custody form and the laboratory log-in sheets and a file with all necessary labels for each trip. The only necessary change should be date and occasionally special sampling events. A sample copy of each form is located in APPENDIX A of this Standard Operating Procedures (SOP) manual.

Ensure that the Hydrolab© and/or Y.S.I.© sonde have been calibrated at least one day before departing. Units should be calibrated before each trip. Calibration of dissolved oxygen (D.O.), pH,

and specific conductivity as well as general maintenance and cleaning will be performed before each trip by the Project Equipment Officer. Record all calibration events in the logbook provided with the instrument. The sonde probes should always be stored in tap water and **NEVER IN DEIONIZED WATER OR SAMPLE WATER**. Do **NOT** touch the pH bulb, even with a Kim-wipe or tissue! This will scratch the bulb and change the accuracy of the probe. An alcohol rinse may be applied, if necessary, to clean the probes. The supervising F.T.E. should perform the initial training on the above procedures and will demonstrate how to operate, maintain, and calibrate the field equipment. Calibration of multiprobe instruments is described in the field sampling section of this document. If problems with calibration occur, consult the supervising F.T.E. before dismantling equipment, removing probes, and/or changing electrolyte solution. Because of high equipment, maintenance, and calibration expense, special care and economy are required when working with these instruments. Notify the Equipment Manager if calibration supplies are low.

The HACH® 2100P portable turbidimeter will be used in the field. The instrument requires both a primary and a secondary calibration. Secondary calibration should be performed at the beginning of each sampling day and results should be recorded in the instrument logbook. Primary calibration is only required at least once every three months or when the instrument battery is changed or if the secondary calibration is significantly different from the previous primary calibration. Check the instrument and the calibration logs before each sampling event to ensure that primary calibration is not necessary. Calibration of the turbidimeter is described in the "Turbidity Sampling Processing" section. On rare occasions, it may be necessary to use the LaMotte 2020 turbidimeter so it would be prudent to become familiar with both the calibration requirements and use of the LaMotte instrument. Calibration for this instrument is described in the same section. As with the multi-probe instruments, the turbidimeters have high equipment, maintenance, and calibration expense so an F.T.E. should provide initial training with the care and maintenance of the instrument.

Depth-integrating (DH-76, DH-81, or DH-81hl) samplers will be used to collect sample water for analysis. After each sampling trip, all samplers and accessories should be washed according to the standard wash procedure described in QA/QC portion of this document and allowed to dry before storing for use. Make sure that no mud or debris is left on the sampler after cleaning. To ensure that samplers will function properly, check all working components including threadings, rubber O-rings, levers, hanger bars, etc. Check all sampler bottles to ensure that they have been properly cleaned and contain no cracks or holes.

Make sure all remaining equipment is in working order and all supply kits are fully stocked. The acid kits should be fully stocked and acid should not be discolored or contaminated. The HACH® alkalinity and hardness kits should be cleaned and restocked. The HACH® turbidimeter should be checked for cleanliness of vials and availability of silicone solution and standards for secondary calibration. Place chain of custody forms for the appropriate lab and extra data sheets in the data notebook. Double and triple check everything on the list to insure that field sampling goes smoothly.

Sampling Day:

Load the field vehicle with all of the supplies/equipment and double-check every item on the checklist again before departing. Equipment should be loaded in the covered bed of the truck, however, if a covered bed is unavailable, load the equipment in the toolbox or in the cab of the truck. In the event that no locked space is available for equipment, store the equipment in the hotel room.

FIELD SAMPLING

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. Please refer to the OWRB safety manual for instructions on how to sample both kinds of sites.

Following is a detailed description of sampling procedures. Sampling sequence is unimportant. However, efficiency is the key, and finding a comfortable sequence of sampling is essential. This will vary from person to person and from sampling team to sampling team. Yet, employing consistent sampling patterns at every site will maximize the number of sites sampled per day and decrease the chance for introduction of sampling error.

Sample Collection:
Physical, biological, and/or chemical parameters are sampled for at each stream site. Methods for sampling will vary depending on the parameter, site dynamics, and QA/QC stringency for the particular parameter. Following is a detailed description of sampling techniques and equipment.

Water samples for determination of chemical composition. Laboratory analysis is used to measure chemical constituents of water. Methods of sample collection have developed and evolved over the years to ensure data quality objectives are met. Whether the stream is a wadable stream or must be sampled from a bridge, the basic methodology remains the same.

Before each sampling event, all collection containers should be cleaned as described in the QA/QC portion of this document and primed with native water at the site. Liquinox© can be used in the field; however, a waste container should be used to maintain the health of the environment.

1. *Sampling Equipment.*
The first determination that must be made is whether sample collection must be made from a bridge or by wading the stream. The determining factors are the accessibility, the depth, and the flow of the stream. Depth-integrating samplers require a minimum sampling depth (MSD). The MSD is roughly defined as "the minimum depth at which the mouth of the nozzle can be fully immersed into the water column while remaining perpendicular to the flow of the water". The DH-76 and DH-81hl samplers are used for bridge sampling and require an ~ 10 inch MSD and 8 inch MSD, respectfully, while the DH-81 is used for wadable sampling and requires an ~ 4 inch MSD. If a site does not meet the MSD for bridge sampling, it must be sampled by wading the stream. A site can be considered wadable if the site is accessible by road or safely by foot and if the sampling personnel feels comfortable entering the stream.

Under certain situations, an alternate sampling method may be used. In a soft substrate during flow above minimal, burrowing at the point of collection can artificially make the MSD. If the MSD is not met for the DH-81, water can be collected using a wide-mouth 1-liter sampling bottle. In those rare cases when wadable sampling is not possible and the MSD for bridge sampling is not met, a bucket can be lowered at each point of the cross-section to obtain the requisite amount of sample. A notation should be made in the "sampler's

comments" portion of the field comment sheet if any of these alternate sampling methods are used.

The DH-81 sampler is composed of 5 separate components -- the DH-81A adapter, the D-77 cap, a 5/16 or 3/16 inch plastic nozzle, a 1-liter plastic bottle, and a 3 foot wading rod. To assemble the unit, follow these steps:

a. Snap the adapter over the D-77 cap,
b. Determine the appropriate nozzle to use and attach it,
c. Screw in the 1 liter bottle,
d. Attach the wading rod. The rod should be maintained at a 90-degree angle to the surface of the water during sample collection. The supervising F.T.E. will initially demonstrate this process. Water should be poured into the churn-splitter by removing the nozzle attachment from the bottle.

The DH-81hl is a hand line sampler that adapts the DH-81 sampler for bridge sampling. The sampler is composed of the following components -- the DH-81 assembly (minus wading rod and adapter), the PVC main body adapter with 8 recesses for weight adjustment, a two piece plastic collar, 4-3/4 inch plastic thumb screws with nuts and washers, 4 recessed hex screw caps, the PVC fin, 1 rubber O-ring, 4-1/4 inch thumb screws with wingnuts, a fore-set hanger bar tightening nut, a mid-set I-bolt and a cable with harness attachment. Also, various sized, plastic-coated steel rods are used to adjust sampler weight to compensate for flow. To assemble the sampler, follow these steps:

a. Mount the fin onto the back of the main body with 4 inserted ¼ inch screws and wingnuts (should be mounted over rubber O-ring),
b. Mount the plastic collar and screws onto the 1-liter sample bottle and insert into the core of the main body,
c. Mount the collar on the main body with the 4-3/4 inch screws, nuts and washers (the other four recesses at the head of the main body should be capped with recessed hex cap screws),
d. Attach the hand line cable and harness and lower the unit into the area of fastest flow. (This will not only prime the nozzle attachment and the 1-liter bottle, but will also help to determine the amount of weight needed to adjust for the flow of the water body.)
e. After returning the sampler to the bridge, needed weight may be added by placing plastic coated steel rods into the recesses of the main body. Remember to always balance the sampler when adding weights. The supervising F.T.E. will initially demonstrate this process. Water should be poured into the churnsplitter by removing the nozzle attachment from the bottle.

The DH-76 sampler is composed of 7 separate components -- the bronze casted main body, the stabilizing spring, o-rings, 5/16 or 1/4 inch plastic nozzle, 1 quart glass or plastic bottle, hangar bar, and hand-line cable. To assemble the sampler, follow these steps:

a. Place one o-ring at the front portion of the main body casting,
b. Engage the stabilizing spring fully and insert the bottle, allowing the spring to firmly hold it in place,

c. Screw in the appropriate sized nozzle,
d. Attach the hangar bar to the unit and clip the hand-line cable to the hangar bar. The supervising F.T.E. will initially demonstrate this process. Water should be poured into the churn-splitter by removing the bottle from the sampler.

2. *Composite sampling*.

A composite sample is collected to represent the cross-section of the entire river or stream at the sampling location. The composite combines water collected at intervals (verticals) across the width of the stream's cross-section. Though several methods can be used, staff will employ the equal width increments (EWI) method and a modified depth-integration (D-I) method under all circumstances except those outlined specifically in this section.

Depth-integration (D-I) allows a flow weighted sample to be collected by continuously collecting from the surface of the water through the water column. The most representative method of D-I involves adjusting the collection rate and weight of the sampler to the velocity at each point of collection. The method is time and equipment intensive, and though beneficial, this level of accuracy is not necessary to meet the data quality objectives of the BUMP. Therefore, a modified method of D-I is employed. This modified method collects water from the surface of the water body through the water column, but does not fully compensate for varying velocities. A consistent rate of transit is used within each vertical and throughout the cross-section (verticals are discussed in the next paragraph). As described above, weight can be added to the DH-81hl sampler to compensate for high and storm-water flows. Furthermore, various sized nozzles are added to the nozzle cap to compensate for flow (nozzle sizes may need to be changed from vertical to vertical depending on the velocity at each vertical). The rule of thumb is:

- for "minimal flows" use no nozzle
- for "light" to "moderate" flows use the 5/16" nozzle
- for "high" to "storm-water" flows use the 3/16" nozzle

By sampling at equal width increments (EWI), a horizontally composite sample is obtained. The first step of the process is to determine the number of verticals, or increments, to be used. The following guidelines should be used for establishing the number of verticals:

- **Determine the inaccessible and accessible portions of the cross-section**. Many things can make a portion of the cross-section inaccessible. These include:
  1) Immovable upstream obstructions such as bridge piers (bridge sampling) and brush piles (bridge and wadable sampling). Bridge piers are permanently marked on the bridge railing in this way " E| |P ".
  2) Immovable instream obstructions such as brush piles (bridge and wadable), rocks (bridge and wadable), and illegally disposed of objects (bridge and wadable).

3) Dangerous flow (bridge and wadable). If bridge sampling is not feasible and 80 percent of the cross section can be safely waded, the sample can be taken in-stream. If this is done, make every reasonable attempt to collect a representative vertical in the area of high flow.
4) Minimal flow (bridge and wadable). These areas only become a problem when sample collection can not be done without inadvertently collecting substrate that is suspended by the act of sampling.
5) Unwadable depth (wadable). If bridge sampling is not feasible and 80 percent of the cross section can be safely waded, the sample can be taken in-stream. If this is done, make every reasonable attempt to collect a representative vertical in the area of unwadable depth.
6) Minimal MSD not met (bridge and wadable). Refer to previous section on sampling equipment.
7) Exposed substrate is always excluded.

Although wadable cross-sections are established and should be used from month to month, they can be temporarily or permanently moved upstream or downstream if one of the above-mentioned situations is applicable. Please, note such a move on the "Sampler's Comments" field sheet. If the cross-section is permanently moved, correct the station description.

- **Determine the width of the of the accessible portion of the cross-section.** This can be done by counting the "blue" OWRB hashlines on the bridge railing or by measuring with a reel when wading. All bridges should be marked with the following hashmarks:

  - 100-foot line—full, single mark with value beside it,
  - 50-foot line—full, double mark,
  - 10-foot line—full, single mark,
  - 5-foot line—half, single mark,
  - 2-foot line—half, single mark (not done on all bridges).

  The areas of the bridge railing that are outside of the normal banks but are in the bank full area of the river are not delineated to 5 and/or 10 feet but only have the 100 and 50 foot marks. When wading, a hash-marked tagline(twine or rope tied off to two stakes) with similar markings to the bridge railing is used.

- Use 5 verticals for streams/rivers that are >1 but < 10 meters wide in the accessible cross-section.

- Use 10 verticals for streams/rivers that are > 10 meters wide in the accessible cross-section.

- Grab samples should be collected if none of the above guidelines are met. Please note in the "Sampler's Comments" field sheet if a grab sample is taken.

To establish the points of collection for each vertical, do the following:

1) Beginning at the near end of the accessible cross-section, mark the inaccessible portions while measuring the width of the accessible of the cross-section. (Two widths should be noted on the field sheet: 'total bank to bank width/accessible width'.)
2) Divide the width of the accessible cross-section by 6 (5 increments) or 11 (10 increments) to determine the width of each increment. This excludes both near shore areas from the sampling cross-section.
3) Starting at the far end of the accessible cross-section, measure out one full increment and place a mark to establish the first vertical. Establish each vertical in the same way until the near end of the accessible cross-section is reached (remember to exclude the inaccessible portions).

To use EWI D-I, follow these steps:

1) Approximate the velocity (none, minimal, light, moderate, heavy, or storm-water) at each vertical. This can be done by visually assessing the displacement of the sampler or wading before sampling. Make notes on amount of weight and/or nozzle size to be used at each vertical.
2) Approximate the transit rate to be used. Collect water for the native rinse at the vertical with the greatest estimated flow (highest velocity and deepest depth). Establish the transit rate as the "time it takes to obtain approximately 1-liter of water at the thalweg." This will ensure that an adequate amount of water is collected. (**NOTE:** Inevitably, there will be occasions when the velocity cannot be compensated for and a representative sample can not be collected. On such occasions, collect as far into the water column a possible, and note that "sampling through the water column was not possible due to..." on the 'sampler's comments' field sheet.) (**NOTE**: Because samples are hand-lined, it is difficult to maintain a consistent transit rate. To be as consistent as possible, establish a count for each overhand pass of the hand-line and always use the same hand-line motion during the entire sampling event.)
3) Attach appropriate nozzle and/or add weight, if necessary.
4) At the approximated transit rate, lower and raise the unit through the water column. Detach the nozzle cap before pouring sample into churn sample splitter.
5) Repeat steps 3-4 until cross-section is completed. When sampling only 5 verticals it may be necessary to sample each vertical more than once so that enough water is collected. **If this is necessary, each vertical must be sampled the same number of times**.

A supervising F.T.E. will demonstrate procedures to all new field personnel.

3. *Collecting samples.*
Once the water is collected, it is equally distributed between 2-1 liter bottles using a churn-splitter (**churn-splitter should always be kept in a plastic bag and bag should always be changed for each new site**). The churn sample splitter, the sample collection bottles, and the tygon delivery tube should be primed with native water before aliquotting the sample water (remember to always churn the sample water before priming). Aliquot the water to the bottles by simply churning the water at a slow rate of speed while dispensing it into the two bottles. To avoid aerating the sample, water should be dispensed through tygon tubing, and the bottle should be completely filled. On occasion, bubbles will form along the walls of the bottles. To ensure that the bottle is completely full, cap the bottle and invert to bring any airspace to the top of the bottle and then top the bottle off with sample water from the churn sample splitter. After the water has been dispensed, one bottle (labeled "ice") can be capped and placed on ice, and one bottle (labeled "acid") will have 2 ml's per liter of concentrated sulfuric acid (in a disposable, single use vial) added to it and be capped and placed on ice. It is also vital that samples be preserved correctly and maintained at 4 °C until the laboratory receives the samples. The acid is hazardous and care should be taken not to touch the acid with clothing or skin. If this occurs, quickly neutralize the contaminated area with sodium bicarbonate and rinse with water.

Occasionally, a 1-liter sample will also be collected for metals analysis. Water is collected in the traditional fashion but is added to a 1-gallon, plastic jar (acid washed). The sample is dispensed by slowly inverting the plastic jar 10 times and filling a 1-liter plastic bottle to the top. Nitric acid is the preservative for metals, but due to the volatile nature of nitric acid, the lab will add the preservative when samples are logged in. Samples should be placed on ice and maintained at 4 °C until delivery to the laboratory.

Occasionally, two 1-quart samples will also be collected for organics analysis. Because of the affinity of organics for certain types of plastics, a Teflon collection bottle, nozzle cap, and nozzle and a 1-gallon glass jar are used throughout the process. The collection bottle can be attached directly to the DH-76 and DH-81 series samplers. If using the DH-81hl sampler, a deeper set, two-piece collar should be used to hold the bottle in the sampler (demonstrated by the supervising F.T.E.). Water is collected in the traditional fashion, but is added to the 1-gallon, glass jar. The sample is dispensed by slowly inverting the glass jar 10 times and filling one 1-quart, glass sample jar to the top. The process is repeated for the second 1-1quart, glass sample jar. Samples are preserved on ice and maintained at 4 °C until delivery to the laboratory.

Other Sample Analysis:
In addition to the samples collected for laboratory chemical analysis, water samples are collected for turbidity, total alkalinity, and total hardness analysis. These samples are collected and dispensed at the same time as the laboratory samples. Each of these tests is described below.

1. Turbidity sample collection and analysis.

Water for use in turbidity analysis is collected using one of the vials in the turbidimeter kit (for immediate analysis) or a clean one pint plastic bottle (for later analysis). Prime the vial or bottle with native water from the churn sample splitter and, while churning, fill the vial above the white line or fill the pint bottle to the top ensuring that the bottle is not aerated. If collecting for later analysis, place the bottle on ice until analysis is made (water must be brought to ambient temperature for an accurate reading to be determined). Analysis must be made in 24 hours, but immediate analysis is preferable. Turbidity is measured using the HACH® 2100P portable turbidimeter or the LaMotte 2020 portable turbidimeter. Remember that dirty glassware and the presence of air bubbles may give false results. Be sure to record all calibration information in the log notebook found in each turbidimeter case.

Calibration for HACH® 2100P PORTABLE Turbidimeter.

There are 2 types of calibration for the HACH® 2100P - primary and secondary calibration. Primary calibration must be completed at least every three months. Primary calibration should also be completed every time batteries are changed or if secondary calibration values are significantly different from the last primary calibration values. To perform a **primary calibration**:

1) Place a drop of silicone on the Stabl. Cal <0.1 NTU ampule (blank) and spread evenly with a chemwipe. Place the ampule in the cell compartment and align the orientation arrow with the orientation mark on the front of the cell compartment. Close the lid. Turn the HACH® 2100P on by pressing **I/O**.
2) Press **CAL** and the “S0" icons will be displayed. The “0" will flash. The 4-digit display will show the value of the SO standard for the previous calibration. If the blank value was forced to 0.0 the display will be blank. Press to get a numerical display.
3) Press **READ**. The instrument will count from 60 to 0 (67 to 0 if the signal average is on), read the blank. The display will automatically increment to the next standard. Remove the sample cell from the compartment.
4) The display will show the “S1" (with the 1 flashing) and the “20 NTU” or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the key until the number that needs editing flashes. Use the key to scroll to the correct number. After editing, insert the 20 NTU Stabl. Cal ampule (coated with silicone) into cell compartment, align orientation marks, close lid and press **READ**. The instrument will count from 60 to 0, measure turbidity, and store value. Remove ampule.
5) The display will show the “S2" and the “100 NTU” or the value of the S2 standard for the previous calibration. If the value is incorrect, edit using previously described procedure. Insert the silicone coated 100 NTU Stabl. Cal ampule, align the orientation marks, close the lid, and press **READ**. The instrument will count from 60 to 0 then

automatically increment to the next standard. Remove the sample ampule from the cell compartment.

6) The display will show the "S3" and "800 NTU". If the numeric value is incorrect edit as described above. Insert the silicone coated 800 NTU Stabl. Cal ampule, align the orientation marks, close the lid, and press **READ**. The instrument will count from 60 to 0 then automatically increment back to the S0 display. Remove the sample ampule from the cell compartment.
7) Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.
8) In the calibration logbook, record the date, your initials, and primary calibration completed.
9) Next, perform a secondary calibration as described below.

To perform a **secondary calibration**:

A secondary calibration must be completed at the beginning of each sampling day. Secondary calibration uses the gelex secondary standards stored in each turbidimeter case.

1) Turn the HACH® 2100P on by pressing **I/O**.
2) Select automatic range mode using the **RANGE** key. This setting should always be set to whole numbers unless changed by the project manager.
3) Thoroughly clean the outside of the gelex vials and apply a thin coating of silicone oil using a **chemwipe (abrasive material will scratch the vial)**.
4) Place the 0-10 NTU Gelex standard in the cell compartment and align orientation marks. Close the lid and press **READ**. Record the value on the calibration log.
5) Repeat steps 3 and 4 for the 10-100 NTU and 100-1000 NTU Gelex standards. If this is the first measurement of Gelex values following primary calibration, these values will be what future readings are compared to for accuracy. If this is not the first measurement following primary calibration, compare to the values collected immediately following primary calibration. If the two sets of values are significantly different, primary calibration is necessary.
6) Once secondary calibration is complete and the results are satisfactory, you are ready to read the turbidity of actual samples.

<u>Calibration for LaMotte© Turbidimeter.</u>

The primary calibration for the LaMotte© 2020 Turbidimeter is performed at the factory prior to shipment of the unit to purchasing entities. Therefore, re-calibration is not required. In order to standardize the calibration of the instrument, a secondary calibration should be performed periodically to obtain the most accurate readings over a narrow range. Three standards (1 NTU, 10 NTU, and 100 NTU) are available but only one is necessary to calibrate the LaMotte© 2020. Select a standard that is in the range of the samples to be tested. To perform calibration follow these steps:

1) Before filling a tube with standard, rinse the inside of the tube with a small amount of standard. Use standards sparingly and only as necessary as these standards are very costly!!

2) Fill a turbidity tube with the standard closest to the value of sample water and immediately cap the standard bottle and tube. Wipe the tube with a Kim-wipe to make sure all marks are removed from the tube.
3) Align the arrow marks on the tube and meter, insert the tube into the chamber, and close the lid.
4) Push **READ**. If the displayed value is not within specification limits of the standard value, then the unit must be calibrated. If the displayed value is within specification limits of the standard value, then the unit is calibrated and ready to read sample water.
5) Push the **CAL** button for 5 seconds until "CAL" is displayed then release the button. Once the display is flashing, adjust the display value with the up/down arrow buttons until the standard value is displayed.
6) Push the **CAL** button again to memorize the calibration and the value should stop flashing. Calibration is complete!

Measuring Sample Turbidity.

Follow these guidelines when measuring turbidity:

1) **Turbidity should be measured at the site**, but on occasion this may not be possible, so it must be read within 24 hours of collection.
2) **Sample should always be well mixed.** Sample vial must be well mixed immediately before reading. If the sample is to be read later, bottles must be well mixed to dislodge any particles that may have settled.
3) **Attempt to use the same sample cell when measuring turbidity.** The glass in each cell is slightly different and therefore reflects light differently. Using separate cells for each sample could introduce additional error to the method and bias results.
4) **It is imperative to clean and prime the glass before each use.** Scratches, fingerprints, and water droplets on the inside of the turbidity tube or inside the light chamber can cause stray light interference, leading to inaccurate results.
5) **Do not let the glass fog while reading the sample.** As stated before, it is important to read samples at the ambient temperature, but this may not be possible if the temperature of the water is too cold. In this case, collect the sample in the vial and allow it to warm before taking the reading. If samples were stored on ice, the sample must be allowed to warm before reading.

To read turbidity with the HACH® 2100P unit, follow these steps:
1) Clean vial with deionized water ensuring that all residue is gone,
2) Prime vial with sample water,
3) While churning, fill vial to the white line (miniscus should sit on the white line),
4) Clean vial with silicone oil by adding a single dropping and spreading with a chemwipe (do not use an abrasive cloth),
5) Invert vial several times and visually ensure that all sample particles have been dislodged,

6) Place vial in cell compartment, align orientation marks, and press **READ** (samples should be read with no decimal),
7) Record reading and visually ensure that the sample did not fog,
8) Repeat steps 4-7 two times (for a total of 3 readings). It will not be necessary to add a drop of silicone oil after each reading. The vial can be cleaned with only the previously used chemwipe.
9) Record the cumulative total and the average (rounded to the nearest whole number) on the field data sheet (e.g., 2 readings of 30 and 1 reading of 31 would be recorded as "3/91 = 30").
10) Turn unit off after each use.
11) The type of turbidity measured should also be recorded on the field data collection sheet as I (inorganic) or O (organic). One duplicate turbidity reading should be made every sampling trip.

2. Alkalinity sample collection and analysis.

Akalinity should be measured at the site; however, on occasion this may not be possible, so it must be read within 24 hours of collection. If analysis will be done later, water is collected using a clean one pint plastic bottle. Prime the bottle with native water from the churn sample splitter and, while churning, completely fill bottle ensuring that the bottle is not aerated. Place on ice until analysis is made. Samples should be brought to ambient temperature before analysis. Do not aerate the sample before testing. Both "phenolphthalein alkalinity" and "total alkalinity" will be measured and recorded. The steps are as follows:

1) Select the sample volume and sulfuric acid titration cartridge responding to the expected alkalinity concentration (this chart is in the Hach© "Digital Titrator Manual" on page 33). The expected concentration can be ascertained from trip notebook.
2) Insert a clean delivery tube into the titration cartridge. Attach the cartridge to the titrator body.
3) Turn the delivery knob to eject a few drops of titrant. Reset the counter to zero and wipe the tip.
4) Use a graduated cylinder to measure the sample volume from table 1 on page 33 in the manual. Dilute with deionized water to the 100-ml mark if necessary. Transfer the sample to a clean 250-ml Erlenmeyer flask. Make sure that all glassware has been rinsed with deionized water and primed with native water before analysis begins.
5) Add the contents of one phenolphthalein indicator powder pillow and swirl to mix. "Thump" the powder pillow before opening to ensure that all of the powder is at the bottom.
6) If the solution turns pink, titrate to a colorless end point. Place the delivery tube tip into the solution and swirl the flask while titrating with sulfuric acid. Record the number or digits required to reach end point.
7) Calculate: Digits required X digit multiplier = mg/L CaCO3 P- Alkalinity.
8) Add the contents of one bromocresol green-methyl red indicator powder pillow to the flask and mix. "Thump" the powder pillow before opening to ensure that all of the powder is at the bottom.
9) Continue the titration with sulfuric acid to a light pink (pH 4.5) color. Record the number of digits required.

10) Calculate: total digits required X digit multiplier = mg/L as CaCO3 Total (T or M) Alkalinity

Report total alkalinity on the field data collection sheet. If the sample measures phenolphthalein alkalinity record the value on the sampler's comment sheet. One duplicate, blank and known sample should be collected for each sampling trip.

3. Hardness sample collection and analysis

Hardness should be measured at the site; however, on occasion this may not be possible, so it must be read within 48 hours of collection. If analysis will be done later, water is collected using a clean one pint plastic bottle. Prime the bottle with native water from the churn sample splitter and, while churning, completely fill bottle ensuring that the bottle is not aerated. Place on ice until analysis is made. Samples should be brought to ambient temperature before analysis. Do not aerate the sample before testing. "Total hardness" will be measured and recorded. The steps are as follows:

1) Select the sample volume and EDTA titration cartridge responding to the expected hardness concentration (this chart is in the Hach© "Digital Titrator Manual" on page 108). The expected concentration can be ascertained from trip notebook.
2) Insert a clean delivery tube into the titration cartridge. Attach the cartridge to the titrator body.
3) Turn the delivery knob to eject a few drops of titrant. Reset the counter to zero and wipe the tip.
4) Use a graduated cylinder to measure the sample volume from table 1 on page 108 in the manual. Dilute with deionized water to the 100-ml mark if necessary. Transfer the sample to a clean 250-ml Erlenmeyer flask. Make sure that all glassware has been rinsed with deionized water and primed with native water before analysis begins.
5) Add 2 ml's of Hardness 1 Bufer Solution and swirl to mix well.
6) Add the contents of one Man Ver 2 Hardness Indicator powder pillow to the flask and mix. "Thump" the powder pillow before opening to ensure that all of the powder is at the bottom.
7) Titrate with appropriate EDTA titrant from red to a pure blue color. Record the number of digits required.
8) Calculate: total digits required X digit multiplier = mg/L as CaCO3 Total Hardness.

Report total hardness on the field data collection sheet. One duplicate, blank and known sample should be collected for each sampling trip.

Quality Assurance/Quality Control:

QA/QC samples will be routinely collected to determine the precision of collection methods and the accuracy of the data. Protocols for the collection and analysis of these samples are contained in APPENDIX E of this document. All protocols will be demonstrated by the supervising F.T.E.

Collection of Bacteriological Specimens:
Occasionally, bacteriological specimens will be collected to determine water quality. Protocols for these collections are contained in APPENDIX C of this document. All protocols will be demonstrated by the supervising F.T.E.

Collection of Biological Specimens:
Occasionally, biological specimens will be collected to determine water quality. Protocols for habitat assessments and biological collections related to biocriteria are contained in Appendix B of this document. Protocols for the collection of fish in non-wadable rivers are in APPENDIX D of this document. All protocols will be demonstrated by the supervising F.T.E.

Collection of Toxicity Samples:
Occasionally, samples will be collected to determine toxicity. Samples will consist of both sediment and water column samples in soft substrates. Samples will consist of only water column samples in hard substrates. Water column samples will be collected in accordance with the above protocols for organics. Sediment samples will be collected using a petite ponar. All protocols will be demonstrated by the supervising FTE.

Determination of Flow:
Occasionally, data will be collected to determine flow. Several methods exist to measure flow, and the method that is employed is dependent upon the application of the data. Flow is discussed in greater detail in later in this section and in **Error! Reference source not found.** of this document. All protocols will be demonstrated by the supervising F.T.E.

Recording Physical/Chemical Parameters using a Multi-Probe Instrument:
A Hydrolab© or Y.S.I.© sonde is used to collect and store information on some of the physical/chemical parameters of the stream being studied. Parameters measured by these sondes include water temperature, dissolved oxygen (D.O.), dissolved oxygen % saturation, pH, specific conductivity, salinity, depth, oxidation-reduction potential (redox), and total dissolved solids. There are many similarities in operating both types of sondes. Some instructions on operating the Hydrolab© are provided in this document but specific training on the operation of each sonde will be provided by the supervising F.T.E. The important thing to remember is to always use the same type of sonde (even the same serial number sonde, when possible) throughout a particular study so that data collected is comparable.

No matter which sonde is used, similar techniques are used to collect data. At each site, data is collected at the thalweg (the major channel). The collection method will be different for bridge sites and wadable sites. For bridge sites, the sonde unit will be connected to the data logger using the 150-foot cable. It is important to ensure that sonde unit is in the water, and depending upon flow, different sized weights may be necessary. If the flow is so high that an accurate reading can not be obtained, the reading may be taken outside of the thalweg in an area of lesser flow (note in the "sampler's comments" portion of the laboratory log-in sheet). After lowering the sonde into the water, allow the unit to equilibrate. Equilibration should take no more than 1 to 2 minutes. The key is to allow all the parameter readings to stabilize before storing the information. Because streams and rivers have a constant mixing zone, the sonde readings can be taken from just below the surface of the water to the midpoint of the water column (sampling near the stream bed may bias certain parameters). The supervising F.T.E. will instruct you on how to operate and store data in the logger

unit and also how to extract data from the surveyor unit for recording on the field sheet. Use a 5-meter cord for wadable streams.

Logging Data into the Hydrolab© in the field. Two Hydrolab© models, the Surveyor 4/ DataSonde 4, and the Surveyor 4/MiniSonde. Following is a detailed description for logging readings with the Hydrolab.

1) **Pre-trip calibration.** Check calibration logs before leaving office to ensure that the pre-trip calibration has occurred. If calibration has not occurred, perform the following pre-trip calibrations (a supervising F.T.E. will demonstrate calibration techniques and the unit's operations manual can be consulted for calibration techniques):
   - *Dissolved Oxygen Percent Saturation (D.O.)*: Check the probe membrane for any cracks, bubbles, or other abnormalities, and change membrane if necessary. Perform an "air" calibration with tap water using the barometric pressure (BP) of the laboratory. The lab and field barometers give BP in units of "inHg", and the unit can only read accept BP in units of "mmHg". A conversion chart is provided in the laboratory and in each field notebook (the conversion is 'inHg x 25.4 = mmHg').
   - *pH*: Check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only change probe after consulting with supervisor). Clean with warm soapy water and Q-tip. Determine the expected range of pH by consulting the Station Dossier(s) in the trip notebook, and perform a two-point calibration based on the pH values. For example, if the ranges on the trip are from 7.5 to 8.1, perform a 7-10 pH calibration, or if the ranges are from 6.6 to 7.1, perform a 7-4 pH calibration. If values vary from station to station, always calibrate to the first station on the trip.
   - *Specific Conductance(SpC)*: Check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only change probe after consulting with supervisor). Clean with warm soapy water and Q-tip. Determine the expected range of SpC by consulting the Station Dossier(s) in the trip notebook, and perform a two-point calibration based on the SpC values. For example, if the ranges on the trip are low range (< 700), perform a 0-500 SpC calibration, or if the ranges are high range (> 700), perform a 0-1413 SpC calibration. If values vary from station to station, always calibrate to the first station on the trip.
   - *Oxidation/Reduction Potential (ORP)*: Should be performed once per month. Consult unit logbook to determine if needed.
   - **ALL CALIBRATIONS AND CLEANINGS MUST BE RECORDED IN THE UNIT'S LOGBOOK.**
2) **Create manual trip file**. Each trip requires a different manual file be created and this only needs to be done at the beginning of the trip. Create the file by doing the following:
   - sequence: I/O ➔ File ➔ Create ➔ Enter file name ➔ Done ➔ select parameters to be measured ➔ Done.
   - File names should be written in the following sequence or some juxtaposition of the sequence: trip number, trip type, month, and year. For example, permanent station trip number 7 taken during November of the year 2000 would be written as "07AT1100".
   - Parameters to be measured should already be entered and be in the correct order. If they need to be entered, do so in the following order:

"date(MMDDYY)/time(HHMMSS)", "depth(meters)", "water temp(°C)", "dissolved oxygen(mg/L)", "dissolved oxygen(%sat.)", pH(units)", "specific conductivity(µS/cm)", "salinity(ppt)", oxidation/reduction potential(mV)", "total dissolved solids(g/L)", "circulator(status)", "IB volts(volts)", "IB percentage(%left)".

3) **Connect sonde to surveyor.**

- The surveyor is connected to the cable at the serial port on the back of the unit. Ensure that pins are fully aligned before tightening screws. Do not force or over-tighten screws.
- The sonde is connected to the cable at the bulkhead. Ensure that the sonde pins are aligned with the bulkhead by matching the raised knot on the bulkhead to the large pin on the sonde. Snap the two ends together and screw the sleeve tight. (**NOTE**: If pins are bent and do not completely connect, the unit will not work properly.
- Use 150-meter cable when working from bridge and 5-meter cable when wading.
- **BEFORE PROCEEDING, ENSURE THAT ALL CONNECTIONS BETWEEN SONDE /CABLE/SURVEYOR ARE SECURED.**

4) **Site specific calibrations or checks.**

- *Depth*: Depth (meters) should be calibrated to 0.1 at each station.
- *Dissolved Oxygen Percent Saturation (D.O.)*: At each station, check the probe membrane for any cracks, bubbles, or other abnormalities, and change membrane if necessary. Dissolved oxygen percent saturation should also be calibrated when the barometric pressure (BP) change is greater than 0.5 inHg in comparison to the previous calibration, when the reading is below the screening, or when the reading is outside the norm for a particular station (refer to the description of lab calibration). Local BP can be obtained from the SHERPA® weather watch or a comparable instrument (an FTE will demonstrate appropriate use and calibration of the watch). Also, the tap water used for calibrating should be changed each time calibration is done. Fresh tap water should be collected in the morning and at least once during the day and should always be kept in the cab of the truck to avoid freezing or over-heating.
- *pH*: At each station, check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only change probe after consulting with supervisor). Clean with warm soapy water and Q-tip. Determine the expected range of pH by consulting the Station Dossier(s) in the trip notebook, and perform a two-point calibration if necessary. Refer to the description of lab calibration. If the initial reading at a site is outside the range of current calibration, the instrument needs to be calibrated to the correct two-point calibration. If the reading is outside the OWQS standard of 6.5 to 9.0 s.u.'s, then the instrument needs to be calibrated at the appropriate range to ensure that the reading is accurate.
- *Specific Conductance(SpC)*: Check the probe bulb for cracks, dirt, scum, or other abnormalities, and change or clean probe if necessary (only change probe after consulting with supervisor). Clean with warm soapy water and Q-tip. Determine the expected range of SpC by consulting the Station Dossier(s) in the trip notebook, and perform a two-point calibration if necessary. Refer to the description of lab calibration. If the initial reading at a site is outside the range of current calibration, the instrument needs to be calibrated to the correct two-point calibration.

- *Oxidation/Reduction Potential (ORP)*: Do not perform in field.
- **ALL CALIBRATIONS AND CLEANINGS MUST BE RECORDED IN THE UNIT'S LOGBOOK.**

5) Measuring and recording readings
   - Each site will be measured at or near the thalweg at a depth of 0.1 to 0.5 meters.
   - Lower the sonde unit to the desired depth and wait for the Hydrolab to equilibrate (especially D.O., temperature, and specific conductivity readings) before selecting the STORE key to save the displayed information.
   - When the readings are stabilized, press **Store**. Now the reading for that site is stored into the manual file of the Hydrolab and is safe from human error. **Before pressing store be sure to read the file that you are storing to. The surveyor unit may bring up another file that is in the unit.**

4. After storing the information, data will need to be recorded to the multi-probe field data sheet. This can be accomplished by using the **Review** option under the **File** menu for the surveyor 4.

Recording Observed Physical Data:

Other physical data are observed and recorded on the appropriate data sheets (APPENDIX A) at each site. Record the range of time spent at the site, air temperature, wind direction, wind speed, percent cloud cover, and flow (estimated or instantaneous flow). Air temperature and wind speed are measured using the SHERPA® weather watch or a comparable instrument (an F.T.E. will demonstrate the appropriate use and calibration of the instrument. Although instantaneous flow will not be collected in the field, many of the BUMP sites are located at bridges with operational gages. Instantaneous flow can be obtained by consulting the data collected from these gages. This data will also be entered into a spreadsheet file on the computer upon returning from the field and the data sheet will be filed appropriately. In the case of data that seems out of the ordinary, the F.T.E. may refer to the physical data recorded on the field data sheet to determine if a storm or windy conditions may have caused noticeable differences between sampling dates or streams.

SAMPLE SUBMISSION TO LAB

Sample Submission to Contract Laboratory for Analysis:

All iced water samples should be recorded on an appropriate "chain-of-custody" sheet (APPENDIX A) before submission to the lab. Make sure that all samples are accounted for and have been assigned lab numbers by the analyzing lab. Have an employee of the lab sign the chain-of-custody form, and obtain a photocopy of the signed form for OWRB records. This form will be filed in the project files until the results of the lab analysis have been forwarded to our office. Before relinquishing all samples to the lab, make sure that all of the information is correct and special information, like location code, has been recorded on your data sheet. Also make sure that any necessary field parameters (e.g., total dissolved solids) are recorded on the laboratory log-in sheet. Only record field parameters specifically designated by the project manager. Someone will instruct you as to where to take the samples during training.

BACK AT THE OFFICE

After all samples have been delivered to the lab, it is important to follow some simple, yet courteous rules. Unload all equipment, and put it back where it was found prior to the field trip. Make sure that the truck is filled up with gas and cleaned up for the next user(s). Notify the supervising staff person of any damaged or faulty equipment (including vehicles). It is a good rule to leave everything in better shape than you found it. After data has been dumped from the data logger, drain the batteries and recharge them or top off the battery to 100% for the next user. On rare occasions, turbidity and/or alkalinity analysis may need to be finished. Try to complete this work immediately. If there is no time to do so, put the pint containers in the refrigerator and process immediately the next morning.

Downloading Data to the OWRB Network:
Upon returning from a sampling trip, data can be downloaded from either the Hydrolab© or Y.S.I.© datalogger to the OWRB network.

1. *Downloading the Hydrolab© to the OWRB Network*. Downloading data from the Hydrolab© unit to a computer is a relatively simple and straightforward process. Data is uploaded into the spreadsheet software package Microsoft Excel® through a few easily understood steps. First, connect the Surveyor unit to your Personal Computer (PC) or some other Water Quality Programs PC. Have the Hydrolab©, Hydrolab© manual, and PC interface cable at the PC being used. Secondly, plug the interface cable into the PC Communication Port. **DO NOT PLUG THE INTERFACE CABLE INTO THE HYDROLAB©, YET!** Now you are ready to load the communications software you will need to transfer the data.

   For Surveyor 4 units: Most WQPD personnel have a Hydrolab© icon that will instantly connect the PC to Hyperterminal. Once connected to Hyperterminal and the PC interface cable is connected to the Surveyor 4 unit, it is time to download the information stored in the Hydrolab© unit. Several things must be addressed on the PC and Surveyor 4 unit before downloading can commence. On the PC, the settings should already be set from the last Hydrolab© "dump", but this is something that may be checked periodically. Choose **Transfer** heading and select **Receive file**. At this point you will be prompted for the location of where to store the file (choose browse if the default location is not the correct place in the network). The receiving protocol should read: **X modem**. The filename must be specified, without an extension, before downloading (for example: "01AT0101"). On the Surveyor 4 unit, choose **File** and then **Transfer**. Highlight the file you wish to download and when prompted, choose **SS importable**. When both the PC and Surveyor unit are ready, press the enter key, and when finished, the **Transfer complete** message will appear on the Surveyor 4 screen. The supervising F.T.E. will give instructions for the remainder of the data transfer to Microsoft Excel®

2. *Downloading the Y.S.I.© to the OWRB Network*. Before beginning the downloading process, ensure that the 50-meter Y.S.I.© cable and the Y.S.I.© manual are at the PC being used. First, attach the cable to both the sonde unit and the PC Communication Port. Secondly, "boot up" the communications software by going to the DOS prompt and typing the following:
   1. C: <CR>
   2. CD PC6000 <CR>
   3. PC6000 <CR>

Now data can be downloaded to Microsoft Excel® by the following process:

1. Choose "**SONDE**" from the top-line menu.
2. At the "#" prompt, type "**MENU**" **<CR>** to get to the sonde main menu (disregard the preceding step if main menu is already present).
3. Choose "File" from the main menu by **pressing 3**.
4. Choose "Upload" from the file menu by **pressing 2.**
5. Choose "Comma & "" Delimited" from the upload menu by **pressing 2** and enter the **number of the file** that you wish to upload and **<CR>**.
6. Press <CR> at both the starting and stopping date & time prompts (i.e., **four carriage returns**).
7. To download more files, follow **steps 4 through 7 again for each file**.
8. When all files have been uploaded, hit **<F10>** to get back to the PC6000 top-line menu and choose "**EXIT**" from the top-line menu. At the "C:\PC6000>" prompt type **DIR <CR>**.

The newly uploaded files should be listed with the names given them at file initiation (in the field) followed by a "*.DAT". Record the drive, path, and file name of each file to be imported to Microsoft Excel® or entered into the Streams Database (Microsoft Access®). Only transfer files into a spreadsheet-formatted file. Also, when importing the uploaded data file(s) into your existing spreadsheet, remember to select "numbers" instead of "text" in the menu.

Cleaning Glassware, Plasticware, Samplers, and Churn-Splitters:

Glassware, plasticware, and equipment must be carefully cleaned after each use to remove any solids or chemicals adhered to the glass/polyethylene. The churn sample splitter is cleaned after each sampling trip. This generally involves some type of acid rinse and non-phosphate detergent (**LIQUINOX**©). When samples are collected for analysis of pesticides, different preparation is required. Glassware preparation for stream's assessment is described below:

Standard Wash: Follow this wash procedure for regular water quality sampling of nutrients, solids, metals, etc.

1. Soak approximately 30 minutes in warm soapy water (non-phosphate detergent, Liquinox© solution should be 2% or less). Alconox© can be used if phosphorus is not a consideration.
2. 2. Scrub equipment with non-metallic brushes; scrub nozzle with foam-tipped swab. Run some Liquinox© solution through the churn spigot.
3. Rinse with deionized water or tap water until all visible soap is removed. Rinse an additional 3 times with warm tap water.
4. Place bottles in a dilute acid solution (approximately 5% hydrochloric acid - Add 5 ml concentrated HCL to 95 ml DI/tap water. **ALWAYS** add acid to water, never water to acid). Do not place the churn-splitter or sampler in acid wash; partially fill the churn-splitter and beta bottles with HCL solution. Let soak for 30 minutes. Use gloves when removing items from the acid rinse.
5. Rinse 3 times with warm tap water. Do not run acid through the spigot! Dump the acid solution out of the churn-splitter and beta bottles.
6. Rinse 3 times with de-ionized (DI) water.
7. For equipment, drain/let dry upside-down, and then store in appropriate place.
8. Rinse with native water twice before use in the field.

STREAM ASSESSMENT METHODOLOGY (HABITAT ASSESSMENT)

INTRODUCTION

The methodology used to perform most stream assessments involves the evaluation of ecological integrity (physical, chemical and biological components) of the water body. In general, Rapid Bioassessment Protocols (RBP's) are used to collect both fish and macroinvertebrates when performing a one-day survey. Intensive surveys are sometimes deemed necessary if additional stream data is required to make a regulatory decision. Criteria for one-day and intensive surveys can be found in Oklahoma's Continuing Planning Process document (1994). One-day and intensive surveys are generally site specific. Site specific assessments involve selection of a reference site above the impact and a site below the impact. Establishment of a site-specific reference condition requires the availability of comparable habitat within the same water body in both the reference location and the impacted area (EPA-440/5-90-004). In some cases, the use of site-specific criteria are inappropriate because of inaccessibility or nonexistence of reference sites. Methods used in one-day surveys are outlined below. A more detailed discussion is included in Appendix B.

SITE SELECTION

Depending on stream length and access availability, one or more sample sites are selected per stream. Prior to selection of sample sites, U.S. Geological Survey topographic maps of the entire watershed are reviewed for watershed characteristics and all potential access points. One (1) too three (3) of these access points are selected as sites for physical, chemical and biological measurements. Length of each site ranges from 100 to 300 meters (m). For site specific assessments, sites are selected upstream and downstream of the observed impact. Potential sample sites are selected based on available information in the office (i.e., maps). Reconnaissance of potential sites prior to sampling allows for selection of most representative sites.

ECOLOGICAL INTEGRITY

Physical Integrity Physical characteristics of a stream is measured and inventoried by incorporating several methods of evaluation as described by Platts et al. (1983), U.S. Environmental Protection Agency (U.S.E.P.A.)(1983), Karr et al. (1986) and U.S.E.P.A. (1989). Physical integrity of a water body is largely determined by watershed characteristics, such as, channel morphology/structure, stream bed composition, banks and riparian vegetative zone, and hydrology. Watershed description is discussed in the following paragraph. Channel morphology/structure and streambed composition is discussed in Habitat Assessment Part 1. Banks and riparian vegetative zone are discussed in Habitat Assessment Part 2. Hydrology is discussed in Habitat Assessment Part 3. The Standard Operating Procedure (SOP) for assessing stream habitat is modified from sections 5.1.1, 5.2.1, 5.2.2 and 5.2.3 of the RBP manual (EPA, 1989). The function of stream habitat assessment is to facilitate an accurate description for the condition of a stream. Raw data for each site are recorded on data sheets for later assessment of Habitat Metrics modified from Section 5.2 of the RBP manual.

Watershed Description Watershed description characteristics include recent precipitation and rural and urban land use descriptions. Some of this data can be entered on-site and some completed with the aid of U.S. Geological Survey topographic maps. Stream size is determined using stream order and link magnitude obtained from 7.5 minute (1:24,000) USES maps including intermittent and ephemeral channels (Strahler, 1957). While stream order is the position a section of a stream

occupies in relation to the tributaries contributing to it (Cole, 1983), link magnitude is the number of first order segments upstream of given point on a channel (Osborne, 1992). Link magnitude is used to account for the addition of tributaries which increase discharge and the magnitude of associated hydrological variables (Osborne, 1992).

HABITAT ASSESSMENT PART 1

Habit Assessment Part 1 consists of semi-quantitative estimates of stream morphology and instream structure. This procedure is used on wadable streams in order to document limiting habitat features. Streams with depths greater than 1.5 meters are too deep for this method. All physical characteristics are recorded on the data sheet titled "Habitat Assessment Part 1" and photographed while at the site. Data sheets should be photocopied on to all-weather paper for use while wading. Sites are divided into segments, depths, stream width, in-stream cover, substrate composition, etc. and combined on a spreadsheet to derive a more objective description of in-stream habitat. These methods were similar to, and partly modified from McCain et al., 1990.

Distance traveled is measured with a Chainman II trailing string distance measurer calibrated in 0.1-meter increments. Stations are established every five (5), ten (10) or 20 meters depending on homogeneity and stream size for a total of 20 to 30 stations. Generally, this was done wading along the center of the stream. At each station, thalweg depth is measured to the nearest 0.1 meter. Stream width is estimated to the nearest meter using a 1.5-meter staff as reference. Habitat type (pool, run, riffle, or dry), percent composition of each substrate type, and in-stream cover (i.e., logs, undercutting, roots and trash) are recorded at each interval. Mean habitat depths, maximum depth, depth distribution, percent habitat types and substrate composition is calculated in a Microsoft Excel spreadsheet. The following SOP for part 1 of the habitat assessment is modified from the Oklahoma Conservation Commission SOP revised in 1994. Numbers correspond with those on the data sheet.

(1) Print the stream name.

(2) Print the names of initials of the person(s) doing the sampling.

(3) Circle appropriate response for direction traveled from site beginning. If you go upstream from the start point, circle upstream.

(4) Print the date (MO. / DAY / YEAR).

(5) Circle the site number of the stream being surveyed.

(6) Enter the amount of flow in Cubic Feet per Second (cfs). (Habitat Assessment Part 3)

(7) Describe starting point. A description, legal or otherwise, of where the assessment begins. Someone else should be able to locate this point from your description.

Repeat the following steps along the length of the site at 5, 10 or 20-meter intervals.

(8) Enter the distance in meters, these are evenly spaced consecutive numbers beginning with 00.

(9) Depth of water is measured in meters to the nearest 0.1 meters. **The left bank of the stream is that on your left as you face downstream**. The left 1/4 (L1/4) is the depth of water midway between the center of the stream and the left bank. The Center (T ½) is the depth of water in the thalweg of the stream. Right 1/4 (R 1/4) is the depth of water midway between the center of the stream and the right bank.

(10) Width WTR & Width BNK are the width of the water in meters to the nearest 0.1-m, and the width of the lower bank in meters to the nearest 0.1-m. The lower bank extends from the water's edge at summer low flow to the top of the normal high water line. The lower bank width is the distance between the tops of the left and right lower banks.

(11) Enter the estimated percent composition of the area of the habitat type that each substrate size class occupies.

CLY	Clay.
SIL	Loose silt.
BLD	Boulder; rocks > 250mm.
GVL	Gravel; rocks from 2mm to 50mm.
CBL	Cobble; rocks from 50mm to 250mm.
BRK	Bedrock or hardpan clay.
SND	Sand or rock particles; 0.1 to 2mm.

(12) Check the box that is most applicable to the habitat type present at the station. A riffle has surface that is definitely broken and usually makes a sound. A pool has a smooth surface, no or very little current and can be deep or shallow. A run has an obvious current, may be slightly broken, but does not make noise. Check dry if the stream has no water at the point being measured.

If there are two obvious habitat types at the cross section you are measuring, check both boxes. An example is when a backwater pool is encountered beside a run or riffle.

(13) In-stream Cover Area of an area attempts to quantify the amount of cover present for fish in the section of stream you walked from the previous station to the present one. For example, if the section was 20 meters long and averaged 6 meters wide, its area would be 120m^2. A submerged log about 3 meters long by 0.5 meters wide would offer 1.5m^2 cover, and you would note that the LWD (large woody debris) category offered 1.5/120 or 1.3 percent cover. Water willow, an emergent aquatic macrophyte, has a 1-meter zone along each side of the stream where it grows. There would be (1 meter) (20 meters) (2 meters) = 40m^2 of EAV (emergent aquatic vegetation) in the 120m^2 section of stream. You would check 40/120 or 33 percent in the EAV column. Note that the totals of the percent cover columns for each row will rarely add up to 100 percent and may often be 0 percent.

The categories are as follows:

a. **UCB** Undercut banks
b. **LWD** Large woody debris--woody debris in the water > 10cm. in diameter.

c. **SWD** Small woody debris-- woody debris in the water <= 10 cm. in diameter.
d. **RTS** Roots -- these are submerged root wads of trees. If single or occasional roots are encountered, count them as woody debris.
e. **BRL** Bedrock ledges--underwater bedrock ledges not forming part of an undercut bank.
f. **SAV** Submerged aquatic vegetation.

g. **EAV** Emergent aquatic vegetation.
h. **TV** Terrestrial vegetation which is currently underwater. An example would be tree branches or grass leaves that are actually hanging down into the stream.

HABITAT ASSESSMENT PART 2

Habitat Assessment Part 2 data sheet is always completed in the field. Part 2 provides a summation of the current in-stream conditions and aids in scoring using stream habitat assessment scoring criteria. This empirically derived habitat assessment score is derived from habitat assessment metrics modified from EPA's guidance on RBP's. (EPA/444/4-89-001). The use of scoring criteria is optional; however, it is a valuable tool for stream classification (i.e., beneficial use designation).

1. **Bottom substrate/instream cover**. Refer to Habitat Assessment Part 1.

2. **Stream bed Composition.**
   CPOM = Coarse particulate organic matter (wood, coarse plants and sticks).
   FPOM = Fine particulate organic matter (fine organic).

3. **Embeddedness - EMB.** This quantifies the amount of silt, clay and sand that have been deposited in riffles. If there is no fine material surrounding the cobble and gravel of riffles, and there is at least some free space under the rocks, the area is 0 percent embedded. If the free space under the rocks is filled but the sides are untouched, percent embeddedness is 5 percent of the total height of the cobbles that is covered sediment. Percent embeddedness is evident as a line on the substrate as you lift the rocks out of the water.

4. **Discharge of pool variability**. Refer to Habitat Assessment Part 3.

5. **Canopy Cover (shading).** Note the general proportion of open to shaded area which best describes the amount of cover at the sampling station.

6. **Channel Alteration.** Circle (M) manmade and/or (N) Natural for type of alteration and describe as thoroughly as possible.

7. **Bottom scouring and/or deposition.** Describe all erosional features that exist in the stream. For example: Point Bar - if a recently formed point bar is present, that is, it has no or little vegetation; Deposition and Scouring - if there is evidence of scouring (smooth, clean bedrock or hardpan play) or deposition (loose, shifting bottoms of fine sand, silt or filled in pools) in the previous segment surveyed.

8. **Pool/riffle, run/bend ratio.** Refer to Habitat Assessment Part 1.

9. **Lower bank channel capacity.** Record the high water mark in meters. The high water mark is often marked by debris drifts or water lines on the banks.

10. **Bank Stability.** Describe bank material composition (i.e., rock, soil, clay, etc.). Estimate the slope (in degrees) of the bank and check the box.

11. **Bank vegetative stability.** List and describe the potential for bank erosion.

12. **Streamside cover.** List or describe streamside vegetative cover and check the appropriate box on the assessment sheet.

13. **Riparian vegetative zone width.** Check appropriate box of vegetative cover and land usage.

HABITAT ASSESSMENT PART 3

Flow measurements from at least one (1) site are recorded on the Habitat Assessment Part 3 data sheet (See Appendix B). Other sites are measured if a perceived difference in flow exists. If possible, any augmentation of flow is noted. An area of laminar flow is chosen for flow measurements. Accurate flow measurements are difficult to obtain from riffle areas, divided channels, and points where stream width or depth is variable. A cross section is established using a measuring tape to record stream width and depth. Velocity measurements are recorded at a minimum of one (1) point per linear foot extending the cross section. Width, depth, and velocity measurements are determined using a Marsh-McBirney Model 201 portable water flow meter and staff. The flow meter uses the Faraday principle that states that as a conductor moves through and cuts the lines of magnetic flux, a voltage is produced. The magnitude of the generated voltage is directly proportional to the velocity at which the conductor moves through the magnetic field (Marsh-McBirney). The following equation represents the average flow between two individual sections in a given cross section of a stream segment:

$$Q = \sum_{i+1}^{n} \left[(w_{i+1} - w_i) \left(\frac{d_i d_{i+1}}{2} \right) \left(\frac{v_i v_{i+1}}{2} \right) \right]$$

Where: n = the total number of individual sections
w_i = horizontal distance from initial point
d_i = water depths for each section
v_i = measured velocity for each section.

CHEMICAL INTEGRITY

Chemical components are measured to obtain existing water quality information primarily to detect natural and man-induced constraints to attaining healthy in-stream conditions. In site specific studies water quality is measured at sites upstream and downstream of the observed impact. Chemical characteristics measured at most sites include: dissolved oxygen (D.O.), temperature, pH, specific conductance, total dissolved solids, salinity, oxidation-reduction potential, alkalinity, total hardness, and total ammonia. These parameters are measured at one (1) to four (4) sites on each stream depending on stream size and number of significant sampling sites. All measurements are made between late morning and late afternoon

BIOLOGICAL INTEGRITY

In order to determine biological integrity of a stream, aquatic macroinvertebrates and fish are sampled at each site. A stream capable of supporting a good diversity of organisms including climax fish and macroinvertebrate communities is assumed to have good habitat and water quality. Fish and macroinvertebrates are generally sampled to determine appropriate beneficial uses of a stream-Habitat Limited Aquatic Community (HLAC) or Warm Water Aquatic Community (WWAC). A stream assigned the WWAC beneficial use has "*Habitat and water quality adequate to support game fishes or other sensitive species whether introduced or native to the biotic province or ecological region. Such communities require specific or narrow ranges of high quality environmental conditions*" (OWQS, 1994). Whereas, a stream assigned the HLAC beneficial use is not capable of supporting a "warm water aquatic community" (OWQS, 1994). For example, part of the procedure to ascertain the

existence of a "warm water aquatic community", fish and macroinvertebrate collections are analyzed determine to community composition.

Fish Sampling Protocol Fish are collected using an electrofisher and/or seine depending on in-stream conditions (i.e., conductivity, snags, etc..). All major types of habitat are sampled (riffle, run, and pool). Fish sampling protocol is discussed further in Rapid Bioassessment Protocols for Use in Streams and Rivers (EPA, 1989).

Electrofisher Method

A Smith-Root Backpack Electrofisher model 115-B POW with a Honda model EX-350 generator is used to collect fish according to manufacturer instructions. This sampling method is especially beneficial where sample sites are difficult to seine due to in-stream obstruction. In general, streams with elevated conductivity do not yield a representative fish collection by electrofishing. In such cases, seining is a more efficient sampling method.

Seining Method

At least two crewmembers are needed to sample fish with an eight (8) foot, 1/8 inch mesh seine. Riffle dwelling species are sampled by holding the lead-line of the seine on the substrate across the lower end of the riffle while one (1) or two (2) crewmembers agitate the substrate with their hands and feet for several square meters upstream of the seine. Pools and runs are sampled by dragging the seine through the water. Undercut banks and other in-stream habitat are sampled by agitating the water around the object or under the bank allowing the fish to swim into the seine.

Easily identified species are recorded on the field data sheet titled “Fish List for Field Collections” and released. Age class, hybridization, and anomalies of the released species are noted either on the field data sheet or in a field notebook. Species more difficult to identify are preserved in 10% formalin solution for identification in the laboratory.

Macroinvertebrate Sampling Protocol Sampling of aquatic macroinvertebrates is performed using a 34cm wide, triangular shaped, fine mesh dip net (D-ring net) and/or 1m by 1m benthic seine. In general, the most productive habitat (usually riffle areas) is sampled because it yields a more representative sample than less productive habitat. Riffle areas are sampled holding the net or seine perpendicular to the substrate at the downstream end of the riffle while the upstream riffle segment is agitated allowing many of the clinging organisms to drift into the net or seine. If riffle habitat is not available, alternative habitat is sampled (woody debris or other submerged objects including aquatic vegetation, and roots) by agitating or hand picking the substrate. Macroinvertebrates should be assessed after each collection to ensure a representative sample. If a representative sample is collected, the organisms are preserved in 90% ethanol. If a representative sample is not collected, additional sampling is necessary. Following collection and preservation in the field, aquatic macroinvertebrates are semi-quantitatively assessed by counting and identifying organisms in the lab to at least order level. Most samples are identified to family level.

In addition to sampling macroinvertebrates with a net or seine, visual observations are beneficial to the overall assessment of a water body. Field personnel should note the presence or absence of indicator organisms not included in the metric calculations. This information is recorded in a field notebook. Indicator organisms commonly observed, but not collected, include Mussels, Oligochaetes (*Tubifex*), and crayfish. The presence or absence of these organisms indicates current instream conditions. For example, freshwater mussels are indicative of water bodies that have limited water quality degradation and good habitat (Pennak, 1989). A large mat of *Tubifex* on the banks of a stream reflects potential organic impacts. The abundance of crayfish indicates a potential

lack of fish predation, although other organisms (i.e., wading birds, frogs, turtles, etc.) Consume appreciable numbers (Pennak, 1989).

Once again, for a more detailed and thorough discussion on the subject please refer to OWRB technical publication 99-3 in Appendix B.

STREAM DISCHARGE MEASUREMENT

Point discharge measurements on streams may be used in the determination of the instantaneous volume of water flowing down a stream. If these measurements are taken at the proper time they may be used to determine the amount of water discharging to or receiving water from groundwater over a particular area. If a stream is "gaining" then the flow of water in the stream is increasing over a distance, while a stream is "losing" if the flow of the stream is decreasing over a distance. The base-flow of the stream is the flow of the stream during periods of time when there has been no significant rainfall within several weeks of time. The base-flow under these conditions is the result of water discharging from the aquifer into the stream. This volume of water is directly related to the amount of recharge the aquifer receives.

Stream point discharge measurements (also known as seepage runs) should be conducted at geologically or lithologically significant contacts or over the reach of the stream that covers the particular area of interest. Point discharge measurements, for the purposes of determining groundwater recharge, should be conducted from November through March when evapotranspiration is at a minimum. For more detail on how to determine stream discharge please refer to **Error! Reference source not found.**

PROCEDURE

The purpose of point discharge measurements is to determine the stream discharges (base-flow) of the trunk stream and its' tributaries. A portable water flowmeter (Marsh-McBirney Model 2000 FLO-MATE) and tape measure are needed to conduct point discharge measurements. The measurements should be completed within a three-day period and no significant rainfall (< 0.5 inches) should have fallen within two weeks prior to the stream discharge measurement.

Stream width and depth must be determined initially. If the stream depth is less than 2.5 feet in depth, then the Marsh-McBirney Model 2000 flowmeter is set at 0.6 of the stream depth, from the surface. If the stream is greater than 2.5 feet in depth, then the meter is used with settings at 0.2 and 0.8 of stream depth, from the surface.

Flows and depths should be determined in an area that is relatively free of pools and riffles. The width of the stream is divided into segments perpendicular to the stream. The segments may vary in length across the stream. Segment width is somewhat dependent on the stream depth and width, generally the segments are 1 or 2 feet in width. The measuring point for the discharge measurement is at the midpoint of each segment across the stream. At each midpoint the depth and velocity are determined.
The segment width and segment depth at the midpoint equals the area of the segment. The Marsh-McBirney Model 2000 flowmeter measures flow using the Faraday Principle which states: as a conductor moves through and cuts the lines of magnetic flux, a voltage is produced. The magnitude of the generated voltage is directly proportional to the velocity at which the conductor moves through the magnetic field. The area of the stream segment times the flow velocity equals the discharge of the segment. The discharge of each segment is added together to obtain the total discharge for the stream at that location.

CHAPTER 2 – BUMP Lakes Monitoring Component

BASIC LAKE WATER QUALITY SAMPLING

INTRODUCTION

The purpose of this document is to provide a simplified, step-by-step outline of the field sampling procedures used by the Water Quality Programs Division of the Oklahoma Water Resources Board (OWRB) for the Lakes section of the Beneficial Use Monitoring Program. Only the basic techniques for sampling will be outlined in this document; other, more complex techniques will be explained by an experienced staff member who will conduct further training on an as-needed basis. All documents pertaining to lakes sampling, including chain of custody forms for Oklahoma Department of Environmental Quality (ODEQ), data sheets, checklists, and calibration log sheets are given a network location so they can be easily accessed. Only checklists are included in APPENDIX A.

PREPARING FOR THE FIELD

This step is extremely important and should be given enough time and attention so that it is done properly. If preparation is not taken seriously, there is a possibility that equipment and supplies may be overlooked and forgotten until reaching the field site (sometimes hours away from the office). A checklist of items needed for water quality (WQ) sampling is provided in APPENDIX A This list is located on the network as a separate checklist and should be printed out and used prior to each WQ sampling event. Field preparation should begin at least two working days before the day of departure as several items must be taken care of in advance. The checklist is found under the file name: S:\SHARED\BUMP\LAKES\CHKLIST\BUMPLAKESCHK.LST

Two working days prior to sampling. It is important to insure that all of the necessary supplies are in stock either in the lab or in the storeroom. Walk through the rooms while scanning the checklist (APPENDIX A) and make sure that plenty of sample bottles (1-liter bottles and quart bottles) are in stock. Verify that there is an adequate amount of calibration standards for calibrating the Hydrolab©, sample bottles, ice chests, acid for preservation, sharpies, pencils, camera film, etc. Make sure that all rechargeable equipment batteries are fully charged and if they are not, plug them in now (i.e., check the Hydrolab to make sure it is charged and ready). The Hydrolab© Surveyor 4 units may be "topped off" if less than 100% battery voltage, however, Hydrolab© suggests completely draining the battery approximately once per month and then fully charging the battery to 100% voltage. Also, make sure that the battery in the boat is charged. Check the appointment calendar to confirm that a truck is available and checked out for the sampling event (the project officer should have the dates scheduled and boats/trucks checked out in the calendar several weeks in advance). It is important to make sure that the lab analyzing the samples (ODEQ) has been notified of approximate time/date of sample collection and transfer and the anticipated number of samples collected. Check with the supervising F.T.E. to confirm that the lab has been contacted.

One working day prior to sampling. This is the time to get everything on the checklist together and ready to load. Go through each item on the checklist and stack all of the supplies in an out-of-the-way area in the lab. Do not load equipment on the cart until the day sampling is scheduled. Don't forget the boat bag (with Sharpies, boat plugs, keys) and depth finder! Notice that the first few items on this list are sample containers, and the checklist says "labeled" for each container. It is important to attach the labels at least 24 hrs prior to entering the field so that the labels will set up and stay on

the containers. Make sure you also label bottles for QA/QC, either a field blank (deionized water) and/or duplicate (taken from churn-splitter). These samples are generally given additional site names, one plus the last site number for the duplicate (location code 2) and one plus the duplicate site number for the blank sample (location code 3). All samples, other than the blank and duplicate samples, are labeled location code 1 on the ODEQ chain of custody sheets. Take plenty of extra containers to guarantee that you have enough if something unexpected happens in the field. A template for printed labels can be found at S:\SHARED\BUMP\LAKES\FORMS\BPLAKES.LBL.

The Hydrolab© sonde should be calibrated before departing. Calibrate depth before each sampling event OR at the first sample site of the day. It is also necessary to calibrate %DO, pH and specific conductance on a weekly basis. Calibration of oxidation-reduction potential (ORP) is done monthly as is the changing of the DO membrane and replacement of DO electrolyte fluid. However, if the DO membrane has any visible wrinkles, bubbles, or appears dirty during the weekly calibration then the membrane should be changed. Hydrolab© suggests letting the sonde soak in tap water for 24 hours prior to sampling if the membrane and electrolyte have been changed. Calibration of pH requires a 2-point calibration, either standards 7 and 10 for more basic waters or 7 and 4 for more acidic waters. The ORP is calibrated using Zobell's standard solution (428 millivolts). The weekly specific conductance calibration is a 2-point calibration using ambient air "0" and a standard close to the value of the sample water (500 µS/cm or 1413 µS/cm). The sonde units should always be stored in sample water or tap water, **NEVER DEIONIZED WATER**. Do **NOT** touch the pH bulb, even with a Kim-wipe or tissue! This will scratch the bulb and change the accuracy of the probe. An alcohol rinse may be applied, if necessary, to clean the probes. The supervising F.T.E. should perform the initial training on the above procedures and will show staff how to operate, maintain, and calibrate the field equipment. If problems with calibration occur, consult the supervising F.T.E. and/or the Equipment Manager. These units are very expensive and costly to maintain so it is of utmost importance to take special care of equipment and not be wasteful with standards and DI water. Notify the Equipment Manager if supplies are low for calibration standards, DO membranes, acid/acetone, chlorophyll vials, sample containers, etc.

Make sure all remaining equipment is in working order and all supply kits are fully stocked (i.e. check acid kits for an adequate supply of non-discolored acid). Place chain of custody forms for ODEQ lab and extra data sheets in the data notebook as well as the maps with marked location sites. Double and triple check everything on the list to insure that all necessary equipment is present and ready for the sampling trip.

Sampling day. Load the field vehicle with all of the supplies/equipment and double-check every item on the checklist again before departing. Make sure all boat motors have plenty of fuel and oil. Fill them up if necessary and take extra containers. Always take the trucks/boats to a station that accepts the Fuelman card, by checking the Fuelman directory found in each field vehicle. Sample equipment should be loaded in the truck, rather than the boat, which reduces the probability of equipment loss and/or boat damage. Be sure to place the life jackets/throw cushions in the cab of the truck (these will be transferred to the boat along with the equipment at the field location). Check the boat for an anchor/rope and battery, check the trailer bearings to be sure they have been greased, and make sure the transom saver and towing straps are secure and that trailer lights are connected as well as the trailer chains with hooks facing the user. Review the checklist, found in APPENDIX A, for hitching and hauling boats before departure. The checklist is located under S:\SHARED\BUMP\LAKES\CHKLISTS\BOATCHEK.WPD.

FIELD SAMPLING

Upon reaching the sampling location, prepare the boat for sampling the lake. It is extremely important to pull the boat and truck out of the way of other users while preparing and loading equipment, ice chests, etc. Don't forget to remove the boat straps, insert the drain plug, tilt the motor up, remove the

transom saver, and unplug the trailer lights from the truck (leave the bow hooked to the trailer crank until the motor is running properly). Load all necessary equipment into the boat. Be sure that each passenger has a life jacket, and load at least one throw cushion.

After everything has been loaded into the boat, and the boat driver is seated at the helm, it is time to back the boat into the water. **Be sure that the boat motor is still tilted all the way up!** Make sure that plenty of room is available on the boat ramp, and don't crowd other boat users. Once the ramp is clear, **slowly** back the boat into the water until the boat driver gives a halt signal. Typically, it is best to stop backing into the water when the water level is flush with the top of the fender wells on the boat trailer. Once the truck has come to a complete stop, lower the motor into the water and start it up. The driver of the truck should use the **emergency brake** when on the ramp. After the boat motor is running, the driver of the truck will release the bow strap and the chain from the boat and the boat will be backed **slowly** off the trailer. Pick up the other passengers, make sure everyone has ready access to a life jacket and is fully seated. It is now time to head out to the first sampling site. To locate a sample site, rely on information from the supervising F.T.E., maps, and landmarks. Once the approximate site is located, it is important to find the thalweg or "old" river channel. Sample sites should be located in the thalweg as this is generally the deepest area of a particular section of the lake and is less influenced by shoreline areas. The thalweg is located by driving across the lake and noting the point on the depth finder where the bottom rapidly drops off and then rises.

Bring the boat to a complete stop at the sampling site, and set the anchor so the boat sits over the thalweg. This is accomplished by lowering the anchor into the water, waiting for it to reach the bottom, then slowly backing the boat along the direction of the thalweg until the anchor is firmly set on the lake bottom. **{HINT: Set the anchor with the bow of the boat facing into the wind so that the boat will be set when the anchor is set}.** Once the anchor is set (usually the anchor line will be at a 45-degree angle), turn the boat off. **After the boat has steadied**, it is time to begin the sampling process. Several procedures are required when collecting an array of environmental data and each will be described individually.

Water sample collection. Water samples are collected at each site to be tested for chemical composition. The number of samples and depths at which samples are to be taken vary between sites, so the supervising F.T.E. must provide specific instructions. It is important to **prime the sample bottles** by rinsing the containers out with sample water before filling (fill the container with a little sample water, shake it, and pour the water out). Surface samples are collected by completely immersing the sample containers (0.5 meters - approximately an elbow length below the surface) and allowing them to fill. Try to avoid aerating the sample (i.e., don't allow water to "bubble" into the container). **It is important to completely fill sample containers leaving no room for air in the container.**

Sub-surface samples are collected using a Van Dorn. The supervising F.T.E. will provide instruction on using this piece of equipment. Water should be transferred from the sampler to the container using a section of chemical-grade Tygon tubing. Rinse the tubing several times with the sampled water, attach one end of the tubing to the release valve on the sampler, and run the other end of the tubing into the sample container. Again, avoid aerating the sample when transferring it to the sample container. Record the depth of the bottom sample taken on the appropriate data sheet. The data sheet is located under the filename: S:\SHARED\BUMP\LAKES\FORMS\DATASHT.WPD

Quality assurance/quality control (QA/QC) samples will also be taken to verify the precision of the analyzing lab and sample collection methods. Split samples will be drawn from the same site depth and location (usually at the surface at the dam site) into the churn sample splitter. The water in the splitter will then be slowly churned while avoiding aeration of the sample. While churning the water at a steady and slow pace, begin transferring water from the splitter into four sample containers. Two containers should be labeled with the appropriate site number and depth while the other two

containers should be labeled with the same depth but an additional site number (one plus the number of sample sites for that lake). Be sure to document on the data sheet the actual location of the samples labeled with the additional site number.

When collecting water samples at any depth, it is important to collect two containers of the same sample, with enough water to analyze all selected parameters. Currently, two 1-liter bottles are collected for each sample. One of the two containers will be preserved with concentrated sulfuric acid (H_2SO_4) and both will be placed on ice. Immediately after returning to the dock, add the pre-measured vial containing 2ml of sulfuric acid into the sample container designated to be preserved with acid (it is best to do this while on land and out of the wind). If the lake has more than 5 sites, be sure to take the acid kit on the boat in order to acidify the samples. The ODEQ laboratory supplies a new stock of the screw-capped 2ml plastic vials of sulfuric acid every month for sample preservation. Once the acid has been added and the acid vials have been discarded in the appropriate container, all samples should be placed on ice for transport to the analyzing lab. It is vital that the samples be stored on ice at approximately 4°C until they reach the lab to insure preservation of the samples.

Other water samples collected. In addition to the samples collected for chemical analysis, water samples are collected for chlorophyll-a and turbidity analysis. For chlorophyll-a and turbidity sample collection, "prime" the one-quart sample bottle with surface water, completely fill the container using the elbow length rule, and don't aerate the sample. These samples should be iced along with the other samples. Be sure to place the sample bottle in the ice chests immediately after collecting sample water. Typically, one chlorophyll-a and turbidity sample is collected per site. One extra sample is also collected at each lake as a QA/QC sample for chlorophyll-a and turbidity comparisons.

Recording physical/chemical parameters. A Hydrolab© data sonde is used to collect and store information on physical/chemical parameters of the lake to be studied. Parameters measured by the multi-probe sondes include temperature, dissolved oxygen (D.O.), pH, conductivity, salinity, depth, oxidation-reduction potential (redox), and total dissolved solids. Some instructions on operating the Hydrolab are provided in this document but specific training on the operation of the sonde will be provided by the supervising F.T.E. It is important to try and always use the same sonde (even the same serial number surveyor, when possible) throughout a particular study so that data collected is comparable. This information should always be recorded on the data sheet.

At the first sampling site on each lake, a file should be created on the Hydrolab© Surveyor 4 labeled with the appropriate lake name. Annotate the lake file at each site as data is collected. These files help keep the information in order so that it can be downloaded and stored appropriately in a Microsoft Excel® spreadsheet at the OWRB office. At each lake site, data is collected at every meter starting at the lake surface (0.1m) and working down to the bottom (1m, 2m, etc); this technique is called "profiling". **Make sure that the boat is steady and the unit is secure before lowering the sonde into the water!** Slowly lower the sonde into the water until it reaches the water and all probes are completely covered with water (0.1m). Don't forget to calibrate the depth at the surface, 0.1 meters. Let the sonde stabilize, (watch dissolved oxygen in mg/L or as percent saturation) then store the reading. Lower the sonde to the first even meter below 0.1m (wait until Logger Active display disappears from screen before moving sonde to next depth) let it stabilize, and store again. Store readings in the same fashion at every whole meter depth down to the bottom. Store one final reading at the site bottom and turn the logger off. The supervising F.T.E. will instruct you on how to operate and store data in the logger unit.

Upon returning from the field, the data stored in the Hydrolab must be extracted from the unit(s) and imported into a spreadsheet file on the computer. This procedure is called "dumping". The supervising F.T.E. will demonstrate this process upon returning to the OWRB office.

Logging Data into the Hydrolab in the field. We have two basic Hydrolab© models, the Surveyor 4 and DataSonde 4, and the Surveyor 4 and MiniSonde. The Surveyor 4 unit requires a separate manual file for each lake. First, select the **File** button on the Surveyor 4 panel. From the display, choose the **Create** option in order to create a new file for each lake. Using the arrow keys, spell out the name of the lake and press **Done**. When the parameter screen appears, press **Done** (unless adding or deleting measurement of a certain parameter is necessary; in most cases the parameters to be measured will be congruent). The screen will display *"File created!".* When the file has been properly created. For each site on the lake, choose the **File** option again, this time select the **Annotate** option and annotate for the appropriate site number. A file should be annotated for each sample site before data collection begins. Lower the sonde unit to the desired depth (0.1 m) and wait for the Hydrolab© to equilibrate (especially D.O. and temp. readings) then select the **Store** key to save the displayed information. Now the sonde is ready to go on to the next depth (one whole meter below the last reading). The depth readings do not have to be exact and will often fluctuate by 0.1m, because of movement of the Hydrolab© and boat. Annotation is only necessary on each new site, not each new depth reading. In summary, the data recording sequence is as follows:

1. Hook up Hydrolab©.
2. <**Create**> file - Name the file using the lake name and then <**Annotate**> site # at each site
3. Check the depth (at 0 or 0.1m) and make sure it has been calibrated.
4. Lower to 0.1m.
5. Wait for readings to equilibrate.
6. <**Store**> (SELECT appropriate file using the arrow keys)
7. Wait 10 - 15 seconds (until Logger Active! Is gone from screen) after storing data and then lower one meter.
8. Wait for readings to equilibrate.
9. <**Store**> (the Surv. 4 unit should highlight the last file in which data was stored)

Recording observed physical data. Other physical data are observed and recorded on the appropriate data sheets at each site. Transparency is measured by using a Secchi disk. This reading should be taken on the shady side of the boat and sunglasses should be removed. Again, an F.T.E staff member will demonstrate this technique. It is important to remember, however, that the same person should measure secchi disk depth at each site on that lake. The time, estimated air temperature, wind direction, estimated wind speed, percent cloud cover, wave condition, and site depth (as measured by the sonde) should be recorded on the data sheet. This data will also be entered into a spreadsheet file on the computer upon returning from the field and the data sheet will be filed appropriately. In the case of data that seems out of the ordinary, the F.T.E. may refer to the physical data recorded on the field data sheet to determine if a storm or windy conditions may have caused noticeable differences between sampling dates, sites and/or lakes. The data sheet is located at: S:\SHARED\BUMP\LAKES\FORMS\DATASHT.WPD

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance/Quality Control sample preparation. Quality control samples should be used as part of every sampling event. Control samples are essential to ensure that 1) laboratory data provided to the OWRB meets each projects' stated data quality objectives 2) field equipment is properly cleaned and calibrated and 3) sample collection techniques are uniform. Before a discussion of quality control sample preparation can begin, simple definitions for some common quality control terms should be presented.

Definitions:

True Values: A theoretically calculated value based upon careful weighing of constituents.

Acceptance Limits: A 99% Confidence Interval calculated from available performance evaluation data of EPA & state laboratories. By definition the analytic results from a laboratory producing valid data should fall within acceptance limits 99 out of 100 times.
Warning Limit: A 95% confidence interval produced in the same way as the acceptance limits. Data falling outside these limits but inside the acceptance limits should be reviewed for possible problems, but such data should not necessarily be considered unacceptable.
Sample label: Label on bottle consists of lake name, site number, date of collection, and preservative. One 'sample' requires two 1000ml bottles with the same information, one labeled 'ice' and the other 'acid'. Thus, sample label consists of label on both bottles and will be considered one sample.

At least one of the following samples needs to be submitted to the analytical laboratory when the other water quality samples are dropped off at the analytical laboratory.

Blank Sample (reagent grade water/DI water) - Submit every sample event (one per sampling day/trip)
Replicate Sample (environmental sample using a "churn-splitter") - Submit every sample event
Spike Sample (known stock solution diluted by environmental sample) - Submit as required
Known Sample (known stock solution diluted in the laboratory with reagent grade water) - Submit as required

The ODEQ can provide ampule stock solutions for: Ammonia (NH3), Nitrate (NO3), Total Kjeldahl Nitrogen (TKN), & Phosphate (PO4). The OWRB also has ampule stock solutions available for parameters listed. Consult with your supervisor to determine if you will be using the ODEQ or OWRB stock solutions. When preparing QC sample checks be sure to **record everything you do**! It is essential that all steps of the process be adequately documented. Samples should be prepared as outlined below.

Sample Preparation Procedures: Rinse all glassware as described in the "cleaning equipment" section.

Blank Sample - Fill sample jugs with laboratory supplied de-ionized water. These bottles are then taken on the sample trip and treated like a routine environmental sample (i.e. sample bottle labeling, preservative, etc.) **RECORD IN THE FIELD NOTES THE SITE # USED FOR THE BLANK SAMPLE.** Notify the Equipment Manager if the DI containers are noticeably low.

Replicate Sample - Using a churn-splitter, divide water from one sample site into two separate samples. Label each sample as an environmental sample and treat appropriately. **RECORD SITE LOCATION AND DESIGNATED SITE # IN THE FIELD NOTES.** Results from analysis of the replicate samples will be compared to one another to determine how accurate the laboratory is in analyzing samples and to verify consistency in sample collection techniques. This QA procedure will be explained by the project supervising F.T.E. or the QA Officer.

Known Sample - Two separate stock solutions will be prepared and combined into one sample for laboratory analysis. Each prepared solution will account for ½ of the sample or for each type of preservative used. To prepare known sample:

1. Fill a clean (acid rinsed) 2000 ml volumetric flask half full of DI water. Add 2 ml of 25 mg P/l and 1 ml of 150 mg NH_3-N/l using two clean volumetric pipettes. Next, dilute the flask to volume with DI water.
2. Pour the prepared solution into a 1 liter sample jug and label the sample (dummy site #, depth, lake, date, and preservative) listing the preservative as "ACID". **RECORD LABELING, AMPULE LABEL AND DILUTION FACTOR IN THE DATA NOTEBOOK.**

3. Acid wash the volumetric flask.
4. Fill the 2000 ml volumetric flask half full of DI water. Decant 2 ml of 250 mg NO_3-N/l. Next, dilute the flask to volume. Pour the prepared solution into a 1-liter sample jug and label the sample jug (dummy site #, depth, lake, date, and preservative). The preservative should be listed as "ICE". **RECORD LABELING, AMPULE LABEL AND DILUTION FACTOR IN THE DATA NOTEBOOK.**

SAMPLE PROCESSING

In-house sample processing. Water collected for chlorophyll-a analysis will be processed immediately upon returning from the field (24-hour holding time). For BUMP lake crews, these steps may be completed before returning to the office in order to satisfy holding time requirements if overnight trips are required. Chlorophyll-a filtration and turbidity measurements **must be completed within 24 hours of sample collection**. Light and heat degrade chlorophyll, so it is imperative to minimize exposure to heat and sunlight and artificial light (i.e. don't process outside in direct sunlight, keep ice chest lids closed tightly). The supervising staff member will demonstrate the appropriate techniques for filtering and "grinding" chlorophyll samples and reading turbidity. Chlorophyll-a must be filtered immediately after exposure to light to avoid degradation, so one bottle at a time should be removed from the refrigerator when ready to process samples. Be sure to leave ample water for turbidity measurements when chlorophyll grinding is the first procedure conducted. Turbidity must be measured once the sample water has warmed to room temperature (the sample water should not "fog" the glass vial). Chlorophyll-a extracts must be frozen immediately after preparation and should be submitted to the lab for analysis within one month of being processed. Record turbidity data on the appropriate data sheet and log chlorophyll information on the appropriate log sheet. The chlorophyll log sheet is located at: S:\SHARED\BUMP\LAKES\FORMS\CHLORACOC. The individual ODEQ lab sheets that accompany each individual vial of extracted chlorophyll is: S:\SHARED\BUMP\LAKES\FORMS\Chlorophyll. If the chlorophyll filtration and grinding supplies are low, be sure to notify the Equipment Manager.

Chlorophyll a Sample Processing. The following procedures should be followed when filtering and grinding chlorophyll *a* samples:

Filtering

1. Assemble the bottom half of the chlorophyll filtering apparatus (everything but the clamp, filter paper, and well). Center a glass fiber or membrane filter (0.45µm porosity, 47-mm diameter) on the filter base using forceps or a spatula. Clamp the well over the filter (make sure filter paper edges are covered by the well base). Dampen the filter paper with DI water and pump a few times to clear the well.
2. Rinse a graduated cylinder with a small amount of sample water. Measure a volume of sample water (start with 200 ml in turbid water, 300 ml in clearer water). **Be sure to shake the sample bottle well before pouring**. You may need to tap the bottom of the container to dislodge any settled particles. Note/record the initial water volume.
3. Filter the sample. The amount of water filtered is related to the turbidity of the sample. The more turbid the sample the less water you will be able to filter. Filter as much water as possible (but less than 1000 ml) until the filter clogs. Maintain hand pump pressure less than 40 psi. Remember to save some sample water for turbidity readings.
4. Record the final volume of water filtered on chlorophyll sample log sheet.
5. Rinse the inside of the well with DI water. Pump the hand pump to clear the well and remove the clamp and well. With forceps or a spatula, fold the filter paper in half (topside in) being careful not to touch filtered material and remove the filter paper from the apparatus.
6. Filter paper may be ground immediately (**must** be ground immediately if in the field) or wrapped in aluminum foil, labeled (with lake name, site number, date, and volume filtered), and frozen until you or someone else has time to perform the grinding. If sample water has a pH > 7, the **filter**

may be stored airtight (protected from light exposure) at 4 degrees Celsius for **three weeks**. Samples from acidic water, pH < 7, must be filtered and processed within 24 hours.

7. Insert new glass fiber filter into apparatus, wet with DI water, and filter next sample.

Grinding

1. Filter papers can be ground either by hand or with the mechanized tissue grinder. Place the folded filter paper in the mortar of the grinder and add approximately 2 cm **buffered** acetone. Chop up filter paper with a spatula, rinse spatula with acetone. Grind completely (no visible pieces of paper remain). Remember that light (sunlight and incandescent lamps) and heat degrade chlorophyll so be sure not to grind in direct sunlight (don't grind outside) and make sure the grinding process does not heat up the acetone mixture. This is especially important when using the mechanized grinder as it can heat up quickly. While grinding, be careful not to spill any of the acetone mixture. Should you spill, start over if possible. If not, make a note on the chlorophyll sample log sheet.
2. Pour acetone mixture into a 13mL screw-cap chlorophyll tube labeled with Lake Name, site number, date collected, and volume filtered. Write on the label in pencil because acetone can wash away ink. Rinse mortar at least once completely with acetone and pour rinse into chlorophyll tube. Fill remainder of tube with buffered acetone, cap and store in the freezer until delivery to the lab. Be sure to copy the information on the label of the test tube onto the sample log sheet and note if a spill or breakage occurs.

Turbidity Sample Processing. Turbidity is measured using the LaMotte© 2020 turbidimeter or the HACH® 2100P portable turbidimeter. Remember that dirty glassware and the presence of air bubbles may give false results. Be sure to record all calibration information in the data notebook found in each turbidimeter case.

Calibration for HACH Turbidimeter: There are 2 types of calibration for the HACH® 2100P - primary and secondary calibration. Primary calibration must be completed at least every six months. Primary calibration should also be completed every time batteries are changed or if secondary calibration values are significantly different from the last primary calibration values. To perform a **primary calibration**:

1. Place a drop of silicone on Stabl-Cal <0.1 NTU ampule (blank) and spread evenly with a chemwipe. Place the ampule in the cell compartment and align the orientation arrow with the orientation mark on the front of the cell compartment. Close the lid. Turn the HACH 2100P on. Press **I/O**.
2. Press **CAL** and the "S0" icons will be displayed. The "0" will flash. The 4-digit display will show the value of the SO standard for the previous calibration. If the blank value was forced to 0.0 the display will be blank. Press → to get a numerical display.
3. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if the signal average is on), read the blank. The display will automatically increment to the next standard. Remove the sample cell from the compartment.
4. The display will show the "S1" (with the 1 flashing) and the "20 NTU" or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, insert the 20 NTU Stabl-Cal ampule (coated with silicone) into cell compartment, align orientation marks, close lid and press **READ**. The instrument will count from 60 to 0, measure turbidity, and store value. Remove ampule.
5. The display will show the "S2" and the "100 NTU" or the value of the S2 standard for the previous calibration. If the value is incorrect, edit using previously described procedure. Insert the silicone coated 100 NTU Stabl-Cal ampule, align the orientation marks, close the lid, and press **READ**. The instrument will count from 60 to 0 then

automatically increment to the next standard. Remove the sample ampule from the cell compartment.

6. The display will show the "S3" and "800 NTU". If the numeric value is incorrect edit as described above. Insert the silicone coated 800 NTU Stabl-Cal ampule, align the orientation marks, close the lid, and press **READ**. The instrument will count from 60 to 0 then automatically increment back to the S0 display. Remove the sample ampule from the cell compartment.
7. Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.
8. Record on the calibration log the date, your initials, and primary calibration completed.
9. Next, perform a secondary calibration as described below.

Secondary Calibration: a secondary calibration must be completed each time you use the HACH® 2100P prior to reading turbidity on actual samples. Secondary calibration uses the gelex secondary standards stored in each turbidimeter case.

1. Turn the HACH® 2100P on: press **I/O**.
2. Select automatic range mode using the **RANGE** key.
3. Thoroughly clean the outside of the gelex vials and apply a thin coating of silicone oil using a chemwipe.
4. Place the 0-10 NTU Gelex standard in the cell compartment and align orientation marks. Close the lid and press **READ**. Record the value on the calibration log.
5. Repeat steps 3 and 4 for the 10-100 NTU and 100-1000 NTU Gelex standards. If this is the first measurement of Gelex values following primary calibration, these values will be what future readings are compared to for accuracy. If this is not the first measurement following primary calibration, compare values collected immediately following primary calibration. If the two sets of values are significantly different, primary calibration is necessary.
6. Once secondary calibration is complete and the results are satisfactory, you are ready to read turbidity of actual samples.

Calibration for LaMotte© Turbidimeter: The primary calibration for the LaMotte© 2020 turbidimeter is performed at the factory prior to shipment of the unit to purchasing entities. Therefore, re-calibration is not required. In order to standardize the calibration of the instrument, a secondary calibration should be performed periodically to obtain the most accurate readings over a narrow range. Three standards (1 NTU, 10 NTU, and 100 NTU) are available but only one is necessary to calibrate the LaMotte© 2020. Select a standard that is in the range of the samples to be tested. To perform calibration, follow these steps:

1. Before filling a tube with standard, rinse the inside of the tube with a small amount of standard. Use standards sparingly and only as necessary as these standards are very costly!
2. Fill a turbidity tube with the standard closest to the value of sample water and immediately cap the standard bottle and tube. Wipe the tube with a Kim-wipe to make sure all marks are removed from the tube.
3. Align the arrow marks on the tube and meter, insert the tube into the chamber, and close the lid.
4. Push **READ**. If the displayed value is not within specification limits of the standard value, then the unit must be calibrated. If the displayed value is within specification limits of the standard value, then the unit is calibrated and ready to read sample water.
5. Push the **CAL** button for 5 seconds until "CAL" is displayed then release the button. Once the display is flashing, adjust the display value with the up/down arrow buttons until the standard value is displayed.
6. Push the **CAL** button again to memorize the calibration and the value should stop flashing. Calibration is complete!

Measuring Sample Turbidity: Turbidity must be read within 24 hours of collection. Bottles must be well shaken to dislodge any particles that may have settled. It is also important to use the same sample cell for each sample from the same lake (i.e. the turbidimeters usually have 2-3 sample cells - stored full of DI water- don't fill each with a sample and read- use the same one for each lake. The glass in each cell is slightly different and therefore reflects light differently. Using separate cells for each sample could introduce additional error to the method and bias results.). Scratches, fingerprints, and water droplets on the inside of the turbidity tube or inside the light chamber can cause stray light interference, leading to inaccurate results. It is also important not to let the glass fog while reading the sample. It may be helpful to let the samples warm to room temperature before measuring turbidity or to fill the cell with sample water and sit in a warm water bath until the water warms up. To read turbidity with the HACH® 2100P unit, simply place clean, dry cell filled with sample water and coated with silicone oil in cell compartment, align orientation marks, and press **READ**. Record value on field data collection sheet. To read turbidity using the LaMotte 2020 unit, simply rinse a sample tube with sample water, shake out excess water, and fill the tube to the neck with sample water. Be sure to wipe the outside of the turbidity with a Kim-wipe before placing the tube, with arrows aligned, in the unit and closing the lid. Push **READ** and record the value displayed. Turn the unit off by pressing the **READ** button and holding it down for several seconds. This unit will automatically turn off two minutes after the last button is pushed.

SAMPLE SUBMISSION TO LABORATORY

Sample submission for out-of-house analysis. All iced water samples should be recorded on an appropriate "chain-of-custody" sheet before submission to the lab. Make sure that all samples are accounted for and have been assigned lab numbers by the analyzing lab. Have an employee of the lab sign the chain-of-custody form, and obtain a photocopy of the signed form for OWRB records. This form will be filed in the project files until the results of the lab analysis have been forwarded to our office. Before relinquishing all samples to the lab, make sure that all of the information is correct and special information, like duplicate sample site number, location codes, etc. has been recorded on your data sheet. The chain of custody form for the DEQ lab is located at: S:\SHARED\BUMP\LAKES\FORMS\DEQCUST.

The frozen chlorophyll extracts will also be submitted to the ODEQ lab for analysis. These should be submitted when any of the samples have been in storage for one month (imperative for chlorophyll-a). The chlorophyll-a log sheet must accompany each individual vial and a chain of custody form is necessary for listing all the samples dropped off at the laboratory for analysis. Signing of the form insures that the OWRB has proof of acceptance by the lab analyst.

BACK AT THE OFFICE

Once all samples have been dropped off to the lab it is important to follow some courteous and important rules. Make sure that the truck and boat are filled up with gas and cleaned up for the next user(s). Make sure the boat has plenty of oil. Unload all equipment and put it back in the same place that it was found prior to the field trip. Notify the supervising staff person of any damaged or faulty equipment (including vehicles and boats/boat trailers). It is a good rule to leave everything in better shape than you found it. After data has been dumped from the Hydrolab© surveyor unit, drain the batteries and charge them back up again or top off the battery to 100% for the next user. Try to complete the chlorophyll grinding and turbidity measurements immediately. If there is no time to do so, put the quart containers in the refrigerator and perform the processing first thing in the morning. Don't forget to enter data from the data sheets into the appropriate spreadsheet files.

Downloading the Hydrolab to the OWRB network. Downloading data from the Hydrolab unit to a computer is a relatively simple and straightforward process. In general, data is uploaded into some spreadsheet software package such as Microsoft Excel®. The specific details and steps of the

process are fairly simple to understand and perform. First, connect the Surveyor unit to your Personal Computer (PC) or some other Water Quality Programs PC. You should have the Hydrolab©, Hydrolab© manual, and PC interface cables at the PC you are using. Next plug the interface cable into the PC Communications Port. **DO NOT PLUG THE INTERFACE CABLE INTO THE HYDROLAB, YET!** Now you are ready to load the communications software you will need to transfer the data.

For Surveyor 4 units: Most WQPD personnel have a Hydrolab© icon which will instantly connect the PC to Hyperterminal. Once connected to Hyperterminal and the PC interface cable is connected to the Surveyor 4 unit, it is time to download the information stored in the Hydrolab© unit. Several things must be addressed on the PC and Surveyor 4 unit before downloading can commence. On the PC, the settings should already be set from the last Hydrolab© "dump", but this is something that may be checked periodically. Choose **Transfer** heading and select **Receive file**. At this point you will be prompted for the location of where to store the file (choose browse if the default location is not the correct place in the network). The receiving protocol should read: **X modem**. The filename must be specified, without an extension, before downloading (for example: hydrolab). On the Surveyor 4 unit, choose **File** and then **Transfer**. Highlight the file you wish to download and when prompted, choose **SS importable**. When both the PC and Surveyor unit are ready, press the enter key and when finished, the **Transfer complete** message will appear on the Surveyor 4 screen. When you are ready to move the data that has been downloaded into the appropriate database, the supervising F.T.E. will give instructions for the remainder of the data transfer.

Cleaning Glassware, Churn-splitters, Van Dorn, and Sigma Bottles. Glassware, sigma bottles and caps, and equipment must be carefully cleaned to remove any solids or chemicals adhered to the glass/polyethylene. This generally involves some type of acid rinse and non-phosphate detergent (**LIQUINOX**©). However, any glassware used in chlorophyll-a sample collection/preparation must **NOT** be acid rinsed. Acid breaks down chlorophyll, so chlorophyll glassware washing should include all steps except the acid rinse. Do not use an acid rinse on the Van Dorn because the equipment has many metal parts that can rust with acid exposure. Occasionally samples are collected for analysis of pesticides and metals. The glassware for pesticides requires different preparation. Glassware preparation for lake sampling is described below:

Standard Wash: Follow this wash procedure for regular water quality sampling of nutrients, solids, chlorophyll, metals, etc.

2. Soak approximately 30 minutes in warm soapy water (non-phosphate detergent, Liquinox© solution should be 2% or less). Alconox© can be used if phosphorus is not a consideration.
3. Scrub equipment with non-metallic brushes; scrub nozzle with foam-tipped swab. Run Liquinox© solution through the churn sample splitter.
4. Rinse with tap water until all visible soap is removed. Rinse an additional 3 times with warm tap water. **For chlorophyll-a glassware and Van Dorn go to step 5.**
5. Place bottles in a dilute acid solution (approximately 5% by volume hydrochloric acid - Add 5 ml concentrated HCL to 95 ml DI/tap water. **ALWAYS add acid to water, never water to acid.** Do not place the churn sample splitter in acid wash basin; partially fill the churn sample splitter with HCl solution. Let the container soak for 30 minutes. Use gloves when removing items from the acid rinse.
6. Rinse 3 times with warm tap water. Do not run acid through the spigot of churn sample splitter! Dump the acid solution out of the churn-splitter.
7. Rinse 3 times with tap water.
8. Drain/let dry upside down, then cover all openings with caps (washed the same way), aluminum foil, or trash bags.

BASIC LAKE FISH SAMPLING

PREPARING FOR THE FIELD

Follow the same procedure for field preparation given in the Basic WQ Sampling section of this document with a few exceptions. The appropriate checklist for fish sampling is located in S:\USERS\WQUALITY\LAKES\SHARED\MISC\CHKLISTS\FISHCHK.LST. This list should be printed out and used prior to each sediment-sampling event. Notice that the equipment used for fish sampling is different from equipment used in other sampling events. Begin preparing two days prior to sampling by ensuring that all equipment on the checklist is in stock and in good condition, all batteries are charged, all gas tanks are full, and appropriate arrangements have been made. Begin packing for the field one working day prior to sampling. Load the vehicle on the day of sampling, and double-check the checklist before departure.

Make sure that the supervising F.T.E. has contacted the regional fish biologist and let him/her know about the sample event. Also make sure that someone on the sampling team has a scientific collector's permit issued by the Oklahoma Department of Wildlife Conservation (ODWC).

FIELD SAMPLING

Follow the same procedures given in the Basic WQ Sampling section for loading the boat with equipment and getting underway (if necessary). In some cases, it may not be necessary to utilize a boat for fish sampling as most sampling is conducted along shorelines and other shallow areas.

Three methods are utilized for capturing fish for submittal to an analyzing laboratory. The fish will then be processed by the lab and analyzed for heavy metals and other contaminants in their flesh. The three methods used include gill netting, shoreline seining, and electrofishing.

Gill netting. Experimental gill nets are set perpendicular to the shoreline at strategic locations within the lake. The supervising F.T.E. will choose these locations and give specific instructions on setting the nets. It is important to record the time that elapses during the set of each net so that catch-per-unit effort can be estimated. The OWRB typically sets the nets at dusk and returns to check the nets at dawn on the next day. Record all necessary information on the appropriate data sheets.

When using a boat to empty the nets, pull the nets into the boat and stack them in separate baskets. Be careful when maneuvering the boat for this task. Otherwise, wade into the water with a floating container to hold the fish. Start at one end of the net and begin pulling fish out and putting them into the container. Be extremely careful to avoid losing any fish. Record all lost fish along with fish captured on the data sheet along with an appropriate comment if the fish was lost. Once all fish have been retrieved from the net, place the container in the shade on land (well away from the water in case any get away) and neatly put the net away. The next step is to process the fish and is explained after the explanations of the other fish capturing techniques.

Shoreline seining. Two individuals at strategic locations within the lake pull a seine along the shoreline. The supervising F.T.E. will again provide guidance on the technique as well as site selection. It is important to record the distance covered by each seine pull in order for catch-per-unit effort to be calculated. It is also important to record the number of fish captured in each separate seine pull. Record all necessary information on the appropriate data sheets. Place all fish captured in a container, and avoid losing any fish. Place the container in the shade until it is time to process the fish. Neatly roll up the seine when finished removing any debris from the seine as it is rolled up.

Electrofishing. This technique is by far the most dangerous technique of the three, but is often times more effective and less time consuming than other techniques. The supervising F.T.E. will outline safety and operating procedures for the shocking equipment and will choose the sites to be shocked. Record the time that elapses during the shocking procedure so that catch-per-unit effort can be estimated. Record all necessary information on the appropriate data sheets.

The OWRB usually shocks along the shoreline and in other areas where wading is possible. It is important that the operator is fully aware of everything that is going on around him/her while using this equipment. Make sure that rubber waders and gloves are used by all crew members while working in the water. At least one person should follow the electrode operator with a dip net and floating container to catch and contain fish as they float to the surface. This person should be insulated against the electricity with rubber waders and gloves and should be extremely attentive to what is happening. **Always** leave at least one person on land to observe the sampling procedure in case an emergency situation arises. Once the sampling is complete, place the container in the shade until ready for processing. Put all shocking equipment away.

Processing the fish captured. Separate all fish captured into groups by species. Label one large, plastic bag with the scientific and common name of each species found in the sampled population. Weigh and measure each fish, and record this data on the appropriate data sheets. Once each fish has been weighed and measured, place it in its appropriate bag. Once a bag becomes approximately half full, tie a knot in it and label a new bag for the remaining fish. After all fish have been measured and bagged, place the bags on ice for transport to the laboratory.

Each species of fish, along with the corresponding number of fish within that species, should be listed on the chain-of-custody sheet before submission to the lab. All requested information should also be recorded on this chain-of-custody along with the parameters to be analyzed by the lab. Make sure that all samples are accounted for and have been assigned lab numbers by the analyzing lab. Have a member of the lab sign the chain-of-custody form, and obtain a photocopy of the signed form for OWRB records. This form will be filed in the project files until our office has received the results of the lab analysis. Offer the lab copies of the field data sheets if they would be helpful to the analysts.

Returning to the office. Follow the "leave it better than it was found" rule. This is particularly important when dealing with fish sampling equipment. Gill nets and seines should be spread out to air out, but never leave them outside without keeping a close eye on them (i.e., never leave them out overnight). All other equipment should be thoroughly cleaned with soap and water, if necessary, to remove all signs of fish. Again, notify the supervisor of any damaged or faulty equipment. Make sure the truck is clean and full of gas, as well.

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APPENDIX A

Data Sheets, Checklists, and Chain of Custody Forms for the Monitoring Program

Check-list for hitching and hauling boats

	Description	Comments
	Check Tires- look for uneven wear, check (bump) for loose bearings- if bearings are loose- take boat to J&I for repairs	
	Check tie-downs front and back- make sure boat is snug against trailer	
	Make sure transome saver is in place	
	Check spare- does it have air?	
	Check battery- "bump" engine to see if it turns over **(Caution- don't start and let run**)	
	Hook up lights and make sure trailer lights & blinkers work	
	Cross chains when hitching	
	Put first aid kit (from truck) and tool box in boat	
	Check oil (should be at least 3/4) and gas - should also have extra oil on-board	
	Test fire extinguishers/shake to mix	

Check-list for unhitching boats

	Description	Comments
	Unplug lights- secure wires on truck and boat where they won't drag or be pinched	
	Block tires (in front of jack-wheel)	
	Put everything (anchor, paddles, battery, life jackets, boat tool box) in portable building. Put first-aid kit back in truck	
	Double check to make sure boat plug has been pulled	
	Leave boats at an angle (especially in winter) to let water run out	
	Cover (during fall and winter or other periods of little use)	
	Put keys, plug, and book back in the bag	

If problems occur, **record** them in the book, fix what you can, and let someone know what has been done. If possible, take a different boat until repairs can be made.

LAKE WATER QUALITY SAMPLING (BUMP)	
	½ gallon sample containers [2/site, and 2 dup, 2 thermocline, 2 blank, 2 bottom for each lake] + extras
	Quart sample containers, 1 per site + extras
	Coolers to ice all samples
	Hydrolab (Calibrated), cord reel, and battery charger, external battery
	Acid kit stocked w/ plenty of sulfuric acid and waste container
	Van Dorn sampler
	Secchi disk
	Churn-splitter
	Data notebook with datasheets, lake map with marked test sites, and lab sheets
	Pencils and sharpies
	Sherpa Atmospheric Data Center
	Keys: truck & boat ignition, lot, trailer locks, etc.
	Record book, pike pass, & gas card for vehicle
	Boat plug (boat bag) and transome-saver
	Life jackets and floating throw cushion
	Depth finder with good batteries (if needed)
	Anchor with plenty of rope
	Charged battery for boat (check day before or take battery charger)
	Extra gas container and funnel
	Tools
	Oars/paddles (just in case)
	Sunscreen
	Camera and film
	Drinking water/cooler
	Chlorophyll grinding kits, pumps, & supplies (overnight)
	Acetone to preserve chlorophyll extract (overnight)
	Vials for chlora extract and small ice chest to store vials (overnight)
	Turbidimeter (overnight)

BUMP STREAM'S WATER QUALITY SAMPLING S:\WATER QUALITY\BUMP\STREAMS\FORMS\BUMPSWQA.LST	
	?-1quart sample containers for each site + extras [2/site, 2 or 4 dup, 2 or 4 blank]
	Pint sample containers, 2 per site + extras (turbidity, hardness and alkalinity measurement)
	Coolers to ice all samples
	Acid kit stocked w/ plenty of sulfuric acid vials (check expiration dates)
	Samplers (DH-81 sampler with rod and adapter and caps, nozzles, and bottles for each site) (DH-81hl adapter with handline rope and caps, nozzles, and bottles for each site) (DH-76 w/ jars for each site, nozzles, hangar bar/pin, hand-line rope, o-rings) (bac-t sampler if necessary—bridge and shoreline sampler)
	Hydrolab (Calibrated), 150 cord reel, 5 meter cord, and battery charger
	Turbidometer with glass vials, calibration standards (o-10, 10-100, and 100-1000) and properly charged
	Alkalinity kit with titrator, adequate number of acid cartridges (0.16 and 1.6 normality), deliver tubes (one for each normality, bmr powder pillows, phenophthalein powder pillows, flask, graduated cylinder; hardness kit
	Churn-splitter with delivery tube
	Waders and rain gear (if needed)
	Work gloves
	1-½ gallon bottle of deionized water per site (plus 2-3 extras)
	Squeeze Bottle with DI water
	1 gallon of Tap water plus squeeze bottle
	Measuring reel with duct tape and 2 rods
	Data notebook with WQ sampling datasheets (field, multiprobe data, comment sheet, and site-specific laboratory), chain of custody forms (bac-t if needed)
	Pencils and sharpies
	Camera and film (optional)
	Sampling trip information (site maps, directions, sampling info, and safety protocols)
	Keys: truck (utility bed), lot
	Record book, pike pass, & gas card for vehicle
	Drinking water/cooler – Igloo
	First Aid Kit, if available
	Safety—signs (narrow bridge, road work, shoulder work, and lane closed), flags for directing traffic, cones (4-6), operational light bar or strobe, and reflective vests
	Mobile Phone, if available
	pH calibration standards (4.0, 7.0, and 10.0 standard units)

BUMP STREAMS FIELD DATA SHEET
OKLAHOMA WATER RESOURCES BOARD

SAMPLING TRIP: AT TRIP 9 COLLECTOR: MP, SH DATE: 04/30/01 INSTRUMENT TYPE & SN : HYDROLAB DATASONDE #S

CLOUD COVER CHOICES: clear 25% 50% 75% 100% rain fog Stream type: pool run riffle mix (denote)

DATE	TIME	STATION NAME	AIR TEMP (°C)	WIND (dir/peed)	CLOUD COVER	STREAM TYPE	FLOW (CFS)	STAGE (M)	TURBIDITY (NTU)	TURBIDITY TYPE (I or O)	HARDNESS (mg/l CaCO3)	ALKALINITY T (mg/l CaCO3)

DUPLICATE ALKILINITY AT STATION _____ VALUE = _____ ALKALINITY BLANK VALUE = _____

ALKALINITY STANDARD VALUE = _____

DUPLICATE HARDNESS AT STATION _____ VALUE = _____ HARDNESS BLANK VALUE = _____

HARDNESS STANDARD VALUE = _____

DUPLICATE TURBIDITY AT STATION _____ VALUE = _____

BUMP STREAMS MULTIPROBE DATA SHEET

OKLAHOMA WATER RESOURCES BOARD

DATE	TIME	STATION NAME	DEPTH (M)	H_2O TEMP (^oC)	D.O. (mg/L)	D.O. (% SAT)	Ph (units)	SPEC. COND. (uM)	SALINITY (ppt)	REDOX (mV)	TDS (mg/L)
00/00/00											

BUMP STREAMS FIELD COMMENT SHEET

OKLAHOMA WATER RESOURCES BOARD

SAMPLING TRIP: _____ COLLECTOR: _____ DATE: _____

DATE	STATION NAME	ACCESS	PICTURES	SAMPLER'S COMMENTS
00/00/00				

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD

PROJECT: BENEFICIAL USE MONITORING—STREAMS

SAMPLERS: Jeff Everett (Signature)

PC	DATE	TIME	STATION NAME (LOCATION CODE)	# OF CONT.	Nitrogen Series	Phosphorus Series	Minerals	Solids	Other (Optional)	Other (Optional)	SEL'S NUMBER
					NO_2 NO_3 NH_3 TKN	Ortho-P Total P	Chloride Sulfate				
AT	03/20/01		Brushy Creek, Off US 270, Haileyville (1)	2	X	X	X				
AT	03/20/01		Kiamichi River, Off US 271, Tuskahoma (1)	2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				
AT				2	X	X	X				

RELINQUISHED BY: (Signature)	DATE 03/21/01	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

REMARKS:

REMARKS:

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD

PROJECT: BENEFICIAL USE MONITORING--STREAMS

SAMPLERS: (Signature)

PC	DATE	TIME	STATION NAME (LOCATION CODE)	# OF CONT.	As Arsenic	Cd Cadmium	Cr Chromium	Cu Copper	Pb Lead	Hg Mercury	Ni Nickel	Se Selenium	Ag Silver	Th Thallium	Zn Zinc	SEL'S NUMBER
AT	03/20/01		Brushy Creek, Off US 270, Haileyville (1)													
AT	03/20/01		Kiamichi River, Off US 271, Tuskahoma (1)													
AT																
AT																
AT																
AT																
AT																

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

REMARKS:

REMARKS:

OKLAHOMA WATER RESOURCES BOARD **ODEQ CHAIN OF CUSTODY RECORD**

HARDNESS DEPENDENT METALS WITH RESTRICTIVE MQL'S (METHOD 200.8)

PROJECT: BENEFICIAL USE MONITORING—STREAMS				# OF CONT.	**Cd**	**Cu**	**Pb**	**Ag**	
SAMPLERS: (Signature)					Cadmium	**Copper**	**Lead**	**Silver**	SEL'S NUMBER
PC	**DATE**	**TIME**	**STATION NAME (LOCATION CODE)**						
ATHD				**1**					
ATHD				**1**					
ATHD				**1**					
ATHD				**1**					
ATHD				**1**					
ATHD				**1**					

RELINQUISHED BY: (Signature)	**DATE** 03/21/01	**TIME**	**RECEIVED FOR LABORATORY BY: (Signature)**	**DATE**	**TIME**

REMARKS:	**REMARKS:**

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY LABORATORY LOG-IN SHEET
OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"

FOR LAB USE ONLY

PROJECT CODE: **WB-AT**

SELS SAMPLE NUMBER:

Collector's Initials: JE **Site ID: AT231600**
Station Name: Brushy Creek, Off US 270, Haileyville **Location Code: 1**
Date Collected: 03/20/01 **Time:**
Sampler's Comments:_____**TDS=**_____

LABORATORY PARAMETERS

Permanent Coverage:

Nitrogen as Ammonia	Phosphorus, Total
Nitrogen as Nitrite	Phosphorus, Ortho
Nitrogen as Nitrate	Sulfate
Nitrogen, Kjeldahl	Chloride

Optional Coverage:

- ☐ Cyanide (00720)
- ☐ Fluoride (00951)
- ☐ Arsenic (90075)
- ☐ Barium (01007)
- ☐ Cadmium (01027)
- ☐ Chromium (01034)
- ☐ Copper (01042)
- ☐ Lead (01051)
- ☐ Mercury (71900)
- ☐ Nickel (01067)
- ☐ Selenium (01147)
- ☐ Silver (01077)
- ☐ Thallium (01059)
- ☐ Zinc (01092)
- ☐ Other
- ☐ Other
- ☐ Other
- ☐ Other
- ☐ Pesticides
- ☐ Other _____

FILE COPY: RETURN TO:

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3800 N. CLASSEN BLVD.
OKLAHOMA CITY, OK 73118

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY LABORATORY LOG-IN SHEET
OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"

FOR LAB USE ONLY

PROJECT CODE: **WB-RS**

SELS SAMPLE NUMBER: _____

Collector's Initials: **Site ID:**

Station Name: **Location Code:**

Date Collected: **Time:**

Sampler's Comments: _____

_____

_____

_____

_____

_____

_____

LABORATORY PARAMETERS

☐ Nitrogen as Ammonia (00610)	☐ COD (00335)	☐ Cyanide (00720)	☐ Nickel (01067)
☐ Nitrogen as Nitrite (00615)	☐ Total Alkalinity)	☐ Fluoride (00951)	☐ Selenium (01147)
☐ Nitrogen as Nitrate (00620)	☐ P- Alkalinity ()	☐ Arsenic (90075)	☐ Silver (01077)
☐ Nitrogen, Organic (00605)	☐ Total Hardness (00900)	☐ Barium (01007)	☐ Thallium (01059)
☐ Nitrogen, Kjeldahl (00625)	☐ Total Solids, Suspended (00530)	☐ Cadmium (01027)	☐ Zinc (01092)
☐ Phosphorus, Total (00665)	☐ Total Solids, Dissolved (00515)	☐ Chromium (01034)	☐ Other _____
☐ Phosphorus, Ortho (70507)	☐ Total Solids, Settleable (50086)	☐ Copper (01042)	☐ Other _____
☐ Sulfate (00945)	☐ Color, Apparent (00080)	☐ Lead (01051)	☐ Other _____
☐ Chloride (00940)	☐ Color, True (00081)	☐ Mercury (71900)	☐ Other _____

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OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY LABORATORY LOG-IN SHEET

OKLAHOMA WATER RESOURCES BOARD - "BENEFICIAL USE MONITORING PROGRAM"
HARDNESS DEPENDENT METALS WITH RESTRICTIVE MQL'S (METHOD 200.8)

FOR LAB USE ONLY

PROJECT CODE: ~~WB-ATHD~~

SELS SAMPLE NUMBER: _____

Collector's Initials: **Site ID: ATHD******

Station Name: **Location Code: 1**

Date Collected: **Time:**

Sampler's Comments:_____TDS=_____mg/L
Spec. Conductivity=____ ____ _____microSiemens
Hardness Average= _____ mg/L
Turbidity= _____ NTU's

Lowest Criterions:
Cadmium Criterion= _____ ug/L
Copper Criterion= _____ ug/L
Lead Criterion= _____ ug/L
Silver Criterion= _____ ug/L

PARAMETERS

Permanent Coverage:

☐ Cadmium (01027)	☐ Other _____	☐ Other _____
☐ Copper (01042)	☐ Other _____	☐ Other _____
☐ Lead (01051)	☐ Other _____	☐ Other _____
☐ Silver (01077)	☐ Other _____	☐ Other _____

FILE COPY

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3800 N. CLASSEN BLVD.
OKLAHOMA CITY, OK 73118

APPENDIX B

OWRB TECHNICAL REPORT 99-3

Standard Operating Procedures for Stream Assessments and Biological Collections Related to Biological Criteria in Oklahoma

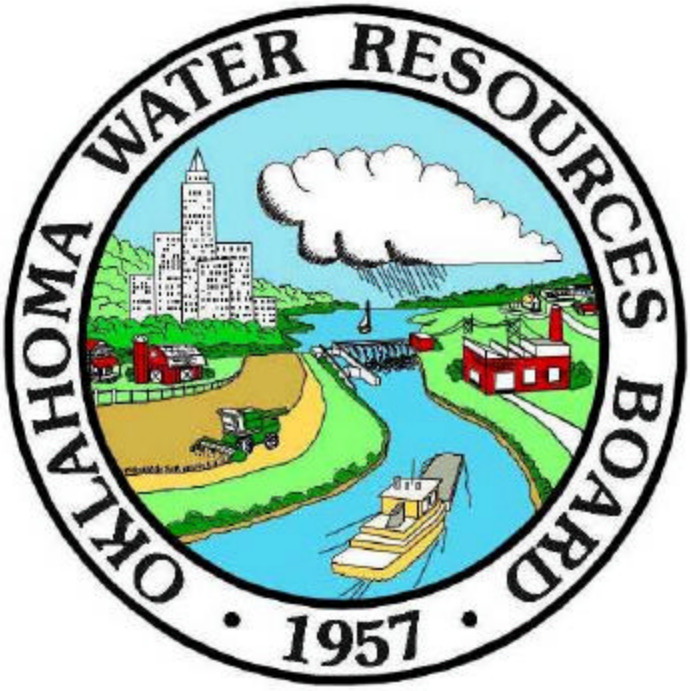
OWRB TECHNICAL REPORT 99-3

Standard Operating Procedures

For Stream Assessments and Biological Collections

Related to Biological Criteria

in Oklahoma



April 5, 1999

Standard Operating Procedures

For Stream Assessments and Biological Collections

Related to Biological Criteria

in Oklahoma

This publication was prepared, issued and printed by the Oklahoma Water Resources Board. One hundred (100) copies have been prepared at a cost of $81.88. Copies have been deposited with the Publications Clearinghouse at the Oklahoma Department of Libraries.

EXECUTIVE SUMMARY OF STANDARD OPERATING PROCEDURES FOR STREAM ASSESSMENTS AND BIOLOGICAL COLLECTIONS RELATED TO BIOLOGICAL CRITERIA IN OKLAHOMA

The thrust of U.S.E.P.A criteria development over the past several years has been to encourage states to develop and adopt, at a minimum, narrative biological criteria. EPA has also encouraged all states to follow the lead of a few states in developing and adopting numeric biological criteria. Biological criteria for Oklahoma have yet to be developed. The development process, however, is continuing and this protocol is another step in that process.

This protocol is the result of the cumulative efforts of numerous representatives from several state agencies and universities. Approximately four years have been invested in the development of these procedures and field tests have repeatedly validated them.

The intended application of this protocol is establishment of a uniform biological assessment through which aquatic communities of similar streams can be compared. Any section of the protocol (physical, chemical or biological) is capable of being used separately. However, a complete picture of the biological condition of any given stream necessitates that each section be applied in conjunction with the others. Agencies, universities, independent entities and individuals are not required to employ these protocols for their own projects unrelated to biological criteria. Separate, project-driven or agency-devised protocols are acceptable for other purposes. Only when results are to be used in biological criteria applications related to Oklahoma's Water Quality Standards will these protocols be required.

_____
Chuck Potts, Oklahoma Water Resources Board

_____
Derek Smithee, Oklahoma Water Resources Board

_____
Phil Moershel, Oklahoma Conservation Commission

_____
Dave Dillon, Oklahoma Department of Environmental Quality

_____
Mark Howery, Oklahoma Department of Wildlife Conservation

_____
Dr. Caryn Vaughn, Oklahoma Biological Survey

_____
Dr. David Bass, University of Central Oklahoma

_____
Dr. Dan Martin, U.S. Fish and Wildlife Service

INTRODUCTION

For the past several years, EPA has been moving toward and encouraging the development of biological criteria (biocriteria) in conjunction with numeric water quality criteria. The use of endemic organisms and communities as indicators of long-term water quality has been recognized by biological researchers for decades. Only recently has the concept begun moving into the regulatory arena. Several states have implemented some form of biocriteria over the past decade and Oklahoma is aggressively moving toward that same goal.

Oklahoma Water Resources Board (OWRB) staff, in conjunction with a Technical Advisory Committee, have developed the following Standard Operating Procedures (SOPs) for assessments involving or relating to biological criteria. This group was comprised of individuals representing several agencies and universities in order to gain as much insight and as many different perspectives as possible. These protocols are the culmination of years of development and testing.

These protocols are required for use during any project where the biological component of a stream is to be compared to reference conditions or other biocriteria results. For biocriteria-related projects, four major classes of parameters must be sampled. These are as follows:

1 Physico-chemical parameters of the water. These include temperature, pH, specific conductivity, dissolved oxygen, percent oxygen saturation, turbidity, instantaneous discharge, hardness, alkalinity, ammonia, phosphates, and nitrates.

2 Habitat Assessment.

3 Macroinvertebrate community structure.

4 Fish community structure.

SOP's for these parameters will be detailed in the following pages. These SOP's are designed and intended to be used outside of the mixing zone of the receiving stream. **ALL ASSESSMENTS AND BIOLOGICAL COLLECTIONS SHOULD ONLY OCCUR AFTER 13 STREAM WIDTHS DOWNSTREAM OF THE POINT OF DISCHARGE.**

STANDARD OPERATING PROCEDURES

CHEMICAL PARAMETERS

All chemical testing follows protocols from the 18th edition of Standard Methods for the Examination of Water and Wastewater (American Public Health Association et al., 1992). Any modifications to these protocols must comply with USEPA regulations and approval.

Parameters to be tested during any sampling event, and associated requirements, will include:

-temperature (°C thermometer)
-pH (standard units)
    pH meter or standard titration
-specific conductivity (µS)
    conductivity meter or calibrated instrument such as Hydrolab or YSI
-dissolved oxygen (mg/L)
    modified Winkler titration or calibrated DO meter
-percent oxygen saturation (%)
    calibrated instrument such as YSI or Hydrolab or conversion from solubility chart (such as from Benson and Krause, 1980 or Hach, 1992 as attached)
-turbidity (NTU's)
    calibrated instrument such as YSI, turbidimeter or colorimeter
-instantaneous discharge(flow measured as CFS)
    calibrated instrument such as Marsh-McBirney Flomate model 2000 and appropriate calculation
-total hardness (mg/L equivalent $CaCO_3$)
    EDTA titration or colorimeter
-alkalinity (mg/L equivalent $CaCO_3$)
    sulfuric acid titration or colorimeter
-ammonia (mg/L)
    Nesslers' titration, colorimeter or colorimetric kit
-phosphates (mg/L total orthophosphate)
    ascorbic acid colorimetric method or colorimetric kit
-nitrate (mg/L)
    cadmium reduction colorimetric method or colorimetric kit

All references to colorimeter or colorimetric methods should be interpreted as meaning following manufacturers instructions for each parameter being tested with the colorimeter or spectrophotometer.

All references to equipment such as Hydrolab or YSI refers to the multi-parameter recording dataloggers available from both companies. All manufacturer's instructions should be followed for calibration and maintenance of the equipment.

All references to colorimetric kits refer to those kits from reputable companies such as LaMotte. These kits have proven reliable through prolonged use by volunteer monitors.

All references to collection equipment manufacturers such as Smith-Root are for reference and comparison only. Mesh sizes in nets, seines and sieves are the only required specifications for equipment intended to be used.

SITE SELECTION

The site chosen for chemical testing should be one that is free of obvious trash and surface materials (e.g. scums, oil sheens, foams, etc.). A site which is close to the road may be preferable for convenience but may not be representative of conditions in the stream as a whole. Select a site that has sufficient depth to submerge the Hydrolab or YSI monitor, lacks excessive turbulence and appears to be similar to most of the visible stream reach to be assessed.

SAMPLE COLLECTION

When collecting a water sample for laboratory analysis, how the sample is taken can be as important to the results as the chemical composition of the water. In most cases, a simple grab sample is sufficient for chemical analyses. It is recommended that all grab samples be taken **BELOW** the surface to prevent contamination by surface materials that may be present. Submerge the sample container inverted and turn it upright once the container is fully submerged. When collecting D.O. samples for titration, **DO NOT** allow bubbles to interfere with the analysis. This can be prevented by submerging the D.O. bottle on its side allowing the water to enter the bottle gradually without causing bubbles to form. Submerge the bottle completely so that the neck of the bottle is full and water will be expelled when putting the cap on. This prevents additional oxygen from being dissolved into the sample from the space at the top of the bottle. This procedure is not necessary if the Hydrolab or YSI is equipped with a D.O. sensor.

Samples transported to the lab must be preserved. In most cases, samples can be preserved using ice and a covered ice chest if analysis is to occur within 24 hours. The dark and cold will prevent algal and chemical activity and possible alteration of chemical composition of the sample. The sample container should be covered at least to the lid by ice to ensure rapid and continuous cooling. If taking more than one sample during any particular trip, ensure that each sample container is labeled with the date, collectors names and appropriate site identification information (e.g. stream name, legal location, county name, etc.).

Some types of analysis (nitrate and ammonia) require that samples be preserved with acid if analysis cannot be performed within approximately 24 hours. In these cases, using approximately 2ml sulfuric acid per liter of sample will reduce the pH of the sample sufficiently to allow storage for up to 14 days (for nitrate) and 28 days (for ammonia) **in refrigeration** ($<4^{o}$ C). Samples will still need to be iced when transporting from the field after preservation and in the laboratory until analysis is completed.

Using the form in Figure 1 will help ensure consistent record keeping. The table found in Figure 2 could be used to approximate oxygen saturation percentage by dividing the D.O. results of the sample by the saturation concentration found in the table. Be sure to know the temperature and barometric pressure at the time of sampling.

STREAM_____

COUNTY_____

LEGAL_____

DATE_____ ANALYZERS_____

	SITE 1 (A)	SITE 2 (B)	SITE 3 (C)	SITE 4 (D)
water temp (^{o}C)				
dissolved oxygen (mg/L)				
oxygen saturation (%)				
carbon dioxide (mg/L)				
pH				
turbidity (NTU)				
specific conductance (µS)				
ammonia (mg/L)				
nitrate (mg/L)				
phosphates (mg/L)				
hardness (mg/L)				
alkalinity (mg/L)				
flow (CFS)				

SITE DESCRIPTIONS

(A)

(B)

(C)

(D)

• Figure 1: Water chemistry data sheet used in OWRB biocriteria assessments.

	Pressure in Millimeters and Inches Hg								
	775	760	750	725	700	675	650	625	mm
TEMP (C°)	30.51	29.92	29.53	28.54	27.56	26.57	25.50	24.61	inches
0	14.9	14.6	14.4	13.9	13.5	12.9	12.5	12.0	
1	14.5	14.2	14.1	13.6	13.1	12.6	12.2	11.7	
2	14.1	13.9	13.7	13.2	12.9	12.3	11.8	11.4	
3	13.8	13.5	13.3	12.9	12.4	12.0	11.5	11.1	
4	13.4	13.2	13.0	125.5	12.1	11.7	11.2	10.8	
5	13.1	12.8	12.6	12.2	11.8	11.4	10.9	10.5	
6	12.7	12.5	12.3	11.9	11.5	11.1	10.7	10.3	
7	12.4	12.2	12.0	11.6	11.2	10.8	10.4	10.0	
8	12.1	11.9	1.7	11.3	10.9	10.5	10.1	9.8	
9	11.8	11.6	11.5	11.1	10.7	10.3	9.9	9.5	
10	11.6	11.3	11.2	10.8	10.4	10.1	9.7	9.3	
11	11.3	11.1	10.9	10.6	10.2	9.8	9.5	9.1	
12	11.1	10.8	10.7	10.3	10.0	9.6	9.2	8.9	
13	10.8	10.6	10.5	10.1	9.8	9.4	9.1	8.7	
14	10.6	10.4	10.2	9.9	9.5	9.2	8.9	8.5	
15	10.4	10.2	10.0	9.7	9.3	9.0	8.7	8.3	
16	10.1	9.9	9.8	9.5	9.1	8.8	8.5	8.1	
17	9.9	9.7	9.6	9.3	9.0	8.6	8.3	8.0	
18	9.7	9.5	9.4	9.1	8.8	8.4	8.1	7.8	
19	9.5	9.3	9.2	8.9	8.6	8.3	8.0	7.6	
20	9.3	9.2	9.1	8.7	8.4	8.1	7.8	7.5	
21	9.2	9.0	8.9	8.6	8.3	8.0	7.7	7.4	
23	9.0	8.8	8.7	8.4	8.1	7.8	7.5	7.2	
22	8.8	8.7	8.5	8.2	8.0	7.7	7.4	7.1	
24	8.7	8.5	8.4	8.1	7.8	7.5	7.2	7.0	
25	8.5	8.4	8.3	8.0	7.7	7.4	7.1	6.8	
26	8.4	8.2	8.1	7.8	7.6	7.3	7.0	6.7	
27	8.2	8.1	8.0	7.7	7.4	7.1	6.9	6.6	
28	8.1	7.9	7.8	7.6	7.3	7.0	6.7	6.5	
29	7.9	7.8	7.7	7.4	7.2	6.9	6.6	6.4	
30	7.8	7.7	7.6	7.3	7.0	6.8	6.5	6.2	
31	7.7	7.5	7.4	7.2	6.9	6.7	6.4	6.1	
32	7.6	7.4	7.3	7.0	6.8	6.6	6.3	6.0	
33	7.4	7.3	7.2	6.9	6.7	6.4	6.2	5.9	
34	7.3	7.2	7.1	6.8	6.6	6.3	6.1	5.8	
35	7.2	7.1	7.0	6.7	6.5	6.2	6.0	5.7	
36	7.1	7.0	6.9	6.6	6.4	6.1	5.9	5.6	
37	7.0	6.8	6.7	6.5	6.3	6.0	5.8	5.6	

• Figure 2: Oxygen saturation table from Hach (1992). All measurements are reported in mg/L.

STANDARD OPERATING PROCEDURE

Macroinvertebrate Collection

Macroinvertebrate collections made for purposes of stream assessment are made from the community which requires or prefers flowing water. Reasons why this community is sampled rather than various lentic communities include:

1. The flowing water community is routinely exposed to the average water quality of the stream.

2. The metrics designed to analyze the macroinvertebrate community of streams were designed for the flowing water community. There is no evidence that they work when applied to lentic communities.

3. The database of pollution tolerance of macroinvertebrates found in Oklahoma is much larger for lotic communities.

Lotic communities in streams require a substrate of some type to attach to. The most common substrates of this type which are encountered are rocky riffles, streamside rootmasses, and woody debris. Where possible, a rocky riffle should be sampled, but if it is not present, or is of dubious quality, or rocky riffles cannot be found in all streams of a given ecoregion, both of the other two alternate habitats should be sampled. At present, it appears that the streamside rootmasses are superior to woody debris but until that is definitely established, both should be sampled.

Collection of Benthic Macroinvertebrates from Rocky Riffles

When sampling the invertebrate communities within a lotic environment, the investigator must remember that the organisms have adapted to moving water and will not be easily dislodged. Care must be taken to thoroughly examine any and all material that is being sampled but not taken back to the lab (large rock, large woody debris, etc). Large debris and rock in the sampling zone can be scrubbed and thrown aside. After completing the sampling event, replace the debris in the riffle.

I. **Suitable Substrates** - A riffle is defined as any sudden change in the level of the streambed such that the surface of the water becomes disrupted by small waves. For this collection method the substrate of the riffle must be composed of gravel, or cobble from 2cm-30cm in the longest dimension. Riffles with substrates of bedrock or tight clay are not suitable.

II. **Method of collecting the sample** - Support a $1m^2$ kicknet (number 30 mesh (650 µm)) in such a way that any organisms dislodged from the substrate will be carried into it by the current. The bottom of the net should be tight against the bottom of the stream and the current must be sufficient to insure that dense organisms such as small mollusks will be carried into the net from the sampling area. It is usually best to lean the net backward (downstream) so that currents caused by the presence of the net will not carry organisms around the sides of the net.

Beginning at the farthest downstream point of the riffle, vigorously agitate the substrate of a $1m^2$ area of the bed of the riffle immediately upstream of the net until all rocks and sediment to a depth of at least ten centimeters have been thoroughly scraped against each other and

the organisms living between and upon the rocks have been dislodged and carried into the net by the current. Continue agitation until it can be seen that the area being sampled is producing no new detritus, organisms, or fine sediment.
At this point, rinse leaves, sticks and other large debris caught in the net in the current so that organisms on them are carried into the net. When the volume of the sample is reduced enough that three such samples will fill a 1 liter sample jar three fourths full or less, remove all of the material from the net and place it in the sample jar. If there is still too much debris to fit into the jar with 2 more samples, remove a portion of the debris and record the estimated percentage of the sample that went into the jar. Care should be exercised in removing the organisms from the net. Dislodge as much material as possible from the sides of the net by splashing stream water up the sides of the net and allowing the water to wash material down to the bottom. Continue this process until the debris and organism sample is collected into a small region. Seine samples can then be carefully picked up and transferred into the jar.

ALWAYS THOROUGHLY RINSE ALL EQUIPMENT AND HANDS BETWEEN SAMPLINGS TO AVOID CROSS-CONTAMINATION OF SAMPLES!

III. **Where to sample the riffle** - Three 1 m^2 areas of the riffle must be sampled. They can be square, rectangular or trapezoidal so long as each area equals 1 m^2 in area. One should be in the fastest part of the riffle where the largest rocks and the smallest amount of interstitial sediment will generally be found. The second should be in the slowest part of the riffle, often near the edge of the stream where the smallest rocks and the greatest amount of interstitial sediment will be found. The third sample should be in an area intermediate between the first two.

IV. **When to sample**- All sampling should occur when the stream has a relatively constant flow **at or near base flow**. This will usually require knowing the hydrologic history of the stream but a safe estimate of base flow will be limiting sampling events to periods between late May and mid-October. **Do not sample within a week of a substantial rain event (>0.5 inch).**

V. **Preservation**- All sample containers should have approximately 3-5 cm of space at the top of the container. All samples should be preserved in 90% ethanol until identification can occur. Insure that ethanol covers all sample material.

VI. **Processing of the Sample** - The sample should be processed and picked according to the USEPA Rapid Bioassessment Protocol (RBP 5).

Collection of Macroinvertebrates from streamside and emergent vegetation

I. **Suitable substrates** - Any streamside or emergent vegetation which offers structure for invertebrates to dwell within or upon is suitable. The vegetation being sampled must include materials in the current so that it offers suitable habitat for organisms which collect drifting particles or which need flowing water for other reasons. This habitat will often be found along the undercut banks of runs and bends where the fine roots of grasses, sedges, and trees, such as willow and sycamore, hang in the water.

II. **Method of collecting the sample** - This type of sample should be collected with a dip net made of #30 size mesh material. The net should be placed around or immediately downstream of the vegetation being sampled. The organisms can be dislodged from the roots either by vigorously shaking the net around the roots or by shaking the roots with your hand while the roots and your hand are inside the net.

ALWAYS THOROUGHLY RINSE ALL EQUIPMENT AND HANDS BETWEEN SAMPLINGS TO AVOID CROSS-CONTAMINATION OF SAMPLES!

III. **Where to sample** - Sampling should continue for five minutes of actual collection time. Do not count the time while you are walking between areas you sample.

IV. **When to sample**- All sampling should occur when the stream has a relatively constant flow **at or near base flow**. This will usually require knowing the hydrologic history of the stream but a safe estimate of base flow will be limiting sampling events to periods between late May and mid-October. **Do not sample within a week of a substantial rain event (>0.5 inch).**

V. **Preservation**- All sample containers should have approximately 3-5cm of space at the top of the container. All samples should be preserved in 90% ethanol until identification can occur.

VI. Insure that ethanol covers all sample material.

VII. **Processing of the samples** -The sample should be processed and picked according to the USEPA Rapid Bioassessment Protocol (RBP 5). Follow identification protocols found at the end of this section.

Collection of macroinvertebrates from woody debris

I. **Suitable substrates** - Any dead wood with or without bark in the stream is suitable as long as it is in current fast enough to offer suitable habitat for organisms which collect drifting particles or which need flowing water for other reasons. The final sample should consist of organisms collected from an even mixture of wood of all sizes and in all stages of decay.

II. **Method of collecting sample** - This type of sample should be collected with a dip net made of #30 mesh material. The net should be placed around or immediately downstream of the debris being sampled. The organisms can be dislodged from the debris either by vigorously shaking the net around the woody debris or by shaking the debris with your hand while the debris and your hand are inside the net. Large logs that are too big to shake should be brushed or rubbed vigorously by hand while the net is held immediately downstream.

ALWAYS THOROUGHLY RINSE ALL EQUIPMENT AND HANDS BETWEEN SAMPLINGS TO AVOID CROSS-CONTAMINATION OF SAMPLES!

III. **Where to sample** - Sample for a total of five minutes counting only the time that debris is actually being agitated. Include as many types of debris in the sample as possible. These types often include wood which is very rotten and spongy with bark, wood which is fairly solid which has loose and rotten bark, and wood that is solid with firmly attached bark. They should range in size from 1cm to about 20cm in diameter.

IV. **When to sample**- All sampling should occur when the stream has a relatively constant flow **at or near base flow**. This will usually require knowing the hydrologic history of the stream but a safe estimate of base flow will be limiting sampling events to periods between late May and mid-October. **Do not sample within a week of a substantial rain event (>0.5 inch).**

V. **Preservation**- All sample containers should have approximately 3-5cm of space at the top of the container. All samples should be preserved in 90% ethanol until identification can occur.

VI. Insure that ethanol covers all sample material.

VII. **Processing the sample** -The sample should be processed and picked according to the USEPA Rapid Bioassessment Protocol (RBP 5). Follow identification protocols found at the end of this section.

VIII. **Identification of organisms**- Once the samples have been returned to the lab, picked, and sorted, identification can proceed at the convenience of the investigator. It is recommended that only personnel appropriately trained in invertebrate taxonomy be involved in the identification phase of the assessment. Recommended taxonomic keys include Merritt and Cummins' *"Introduction to the Aquatic Insects of North America"* (no earlier than 2nd ed., 1988) and Pennack's *"Freshwater Invertebrates of North America"* (2nd ed., 1984). The second edition of Pennack's publication is preferable to the third edition for use with insects because the insects have been eliminated from the third edition. Pennack's third edition possesses updated taxonomy for use with non-insect taxa. Use of multiple editions of the same work should be approached with care as revisions and corrections to taxonomy may produce conflicting results.

IX. All identifications should be taken to as restrictive a level as possible but all organisms should be identified to at least family level.

X. **Archiving samples**- Each individual agency and/or school generally employs a method of archiving that involves saving and cataloging data and samples or individual specimens of both fish and macroinvertebrates. In some cases, arrangements can be made with local universities to store specimens. Many already have some form of museum collection and will be open to such arrangements. It is recommended that entities undertaking biocriteria sampling develop a location and a procedure whereby collections can be archived for future reference. Data archiving will involve either hardcopy or electronic version. Each individual stream that is assessed and sampled for the purposes of biocriteria must be documented and archived for future reference.

STANDARD OPERATING PROCEDURE - Fish Collection in Streams

Variations of habitat, types of fish, and water chemistry dictate the use of different collection techniques both within and among streams. For purposes of conducting a statewide assessment that allows for the comparison of one stream to another, we use a combination of seines and a backpack shocker in every stream. The width and length of the seine being used will vary according to the stream width and the depth of pools. **All seines used are to be no larger than 1/4" mesh**.

Specific techniques for, and relative advantages of seining and electrofishing vary considerably according to stream type, and conductivity and are discussed in detail in Fisheries Techniques (edited by B.R. Murphy and D.W. Willis and published by the American Fisheries Society, 1996).

The following procedure is recommended for collecting fish in streams for biocriteria-related projects.

A. Training Procedures

If you have not already done so, read the chapters in Fisheries Techniques that deal with streams, seines, and electroshockers.

B. Field Collection Methods

1. Distance of stream to be sampled. Distance should be no less than 200 meters up to 400 meters until, using the best professional judgement of the sampling team, all types of available habitat have been sufficiently sampled and the team leader feels that additional sampling will not significantly affect the results of the survey.

2. Collection Procedures

   THE SEGMENT SAMPLED MUST BE INCLUDED IN THE SEGMENT ASSESSED FOR HABITAT QUALITY!

   a. Seining. A stream should be seined before it is shocked since fish that utilize cover in the stream will generally not leave the area when disturbed. These fish are most efficiently collected by shocking and will still be there when electroshocking commences.

      Seine sizes may range from 3 to 6 foot seines in 10, 20, and 30-foot lengths. Seine height is dictated by water depth, and length is determined by width of the water being sampled. If possible the seine should be 15-25% longer than the width of the waterbody being sampled and about 25% higher than the depth of the water. This will allow the center of the net to form a bag behind the operators where the fish are more likely to stay in the net. **REMEMBER that the longer the seine is, the more difficult it will be to control in stream currents.**

      The leadline should be kept on the bottom, and in front of the float line. If there are many obstructions on the bottom, the leadline will become caught or bounce, and most fish will escape underneath the bottom of the net. If this happens use a smaller net that allows you to avoid obstructions, roll up the ends of the existing net to make it more manageable, or go to electroshocking.

The brailles of the net should be used to disturb the area under any undercut banks or beds of macrophytes near the edge in order to scare fish hiding in cover out towards the middle of the net.

Under ideal conditions the net should be pulled through the water in the manner described above for about 10 meters and dragged out of the water on a gradually sloping pre-selected beach. The person pulling the seine on the side of the stream opposite the beach should swing ahead of the other person so that the seine is pulled out on the beach stretched over the same distance it was stretched in the stream.

If the stream doesn't have gradually sloping banks, the dip method should be used. This method consists of sweeping around and through the area to be sampled, keeping a wide bag and moving the lead line as much under the undercut bank as possible. Use the brailles to probe repeatedly as far as possible into the undercut area working towards each other until the brailles overlap. The seine should then be swiftly stretched and lifted vertically from the water. An alternative method of retrieving fish under these conditions is to slowly turn the brailles to wind the net up once they have overlapped to form an enclosure. This may wind up the fish with the net and allow them to be lifted out of the water with the rolled up net. **RECORD THE TIME SPENT SEINING AND SEINE MESH SIZE ON THE FIELD DATA SHEETS.**

b. Electroshocking. A Smith-Root Backpack Electrofisher model 115-B POW with a Honda model EX-350 generator is recommended for use in collecting fish. Always use this equipment in accordance with manufacturer instructions.

[**BEFORE OPERATING OR ASSISTING** with the shocker, **READ** and **UNDERSTAND** the manuals for the generator and the shocker. Starting procedures, safety procedures and troubleshooting are well documented in these manuals and are not detailed here. The manuals can be obtained from the manufacturer.

The shocker consists of a trailing stainless steel cable electrode and a ring electrode mounted on the end of a PVC pole.

The shocking team must consist of at least two people. One will carry and operate the shocker while the other(s) will net stunned fish. The shocker is most useful where a seine cannot be used effectively in areas such as brushpiles, rootwads and cobble substrates. The forward electrode should be gradually passed back and forth over and in these areas as the team walks upstream. As fish are stunned, they will usually roll over and become more visible, allowing the netters to see and capture them.
In very dense brush or root cover, fish often sense the presence of the team before they are close enough to be stunned and then retreat so deeply into cover that it is impossible to net them when they are stunned. It is often better in situations such as these to insert the electrode into the brush before it is turned on, give the fish a minute or so to get used to the new situation and then turn the current on. Many fish will be much closer to the edge of brushpile when they are stunned in this manner. **RECORD THE TIME SPENT ELECTROSHOCKING ON THE FIELD DATA SHEET.**

c. Preservation and Field I.D.

Currently, there is discussion concerning the ethical treatment of the fish specimens collected for any reason. In the future, amendments to this protocol may require an anesthetizing agent be added to the formalin prior to introduction to the fish sample. There is no current requirement for the use of or agreement on the necessity of such an agent.

In general all fish should be placed in 10% formalin immediately after capture and returned to the lab for identification. There are a few exceptions made for large (>100 g) fish which can be positively identified in the field. If all team members agree on the identification of such a fish, it can be returned to the water far enough away that recapture is unlikely. However, if the specimen is unusual or rare (e.g. eels, bowfins, obvious or gross abnormalities, etc.), it too should be preserved regardless of size.

Fish much larger than 0.3 to 0.4 Kg, which cannot be identified in the field, should be sliced open along the ribs when preserved in order to allow the formalin to penetrate the body cavity fast enough to prevent decay.

Formalin is a carcinogen and can also cause permanent damage to mucous membranes and eyes. Care must be taken when placing fish in formalin so that the fish does not flop around and splash formalin onto people near the jar. The fish should be put into the jar with the lid tilted open away from the operator so that the lid shields the face and body of the operator. Flood any skin exposed to formalin with plenty of water as soon as possible. Safety glasses should be worn by those handling formalin. If it gets in your eyes, flood the eyes with water immediately and go to the doctor immediately after that.

d. Sample Identification

Write date, stream name, type of sample (seine or electrofishing), time spent sampling, seine mesh size and legal location on the front of each jar using a wax pencil or an indelible marking pen (e.g. Sharpie). All specimens can identified using a reputable taxonomic reference such as “Fishes of Arkansas” (Robinson and Buchanan, 1988). Attempts are currently underway to update and republish “The Fishes of Oklahoma” which has not been in print since the 1960's.

e. Field Data

At all sites where fish are collected, a stream habitat evaluation **must** be performed. It does not have to be done on the same day as the fish are collected, but should be done before major floods change the habitat.

f. Safety

5 Primary responsibility for safety while electroshocking rests with the team leader. All crewmembers should receive training in First Aid and CPR. Electro-fishing units have a high voltage output and may deliver dangerous electrical shock. While electrofishing,

avoid contact with water unless sufficiently insulated against electric shock. Use chest waders with non-slip soles and water-tight rubber (or electrician's) gloves. **Avoid contact with anode at all times. At no time while electrofishing should a crewmember reach into the water for any reason.** The electrofishing equipment is equipped with a 45-degree tilt switch that interrupts the current. Do not make any modifications to the electrofishing unit that would make it impossible to turn off the electricity.

6 General safety guidelines should be observed. If waders or gloves develop leaks, leave the water immediately. Avoid operating electrofishing equipment near people, pets or livestock. Discontinue any activity in streams during thunderstorms or heavy rain. Rest if crew becomes fatigued.

7 Gasoline is extremely volatile and flammable. Its vapors readily ignite on contact with heat, spark or flame. Never attempt to refill the generator while it is running. **Always allow the generator to cool before refilling.** Keep gasoline out of direct sunlight to reduce volatilization and vapor release. Always wear gloves and safety glasses when handling gasoline. Keep gasoline only in approved containers.

8 Decision to use electrofishing equipment will depend on size of site, flow, conductivity and turbidity. If conductivity is below 10 or over 1200 µS, if flow is too high, site too deep or water is too turbid to assure safe footing or locate stunned fish, the team leader may consider use of seine only or determine that site is "Unsampleable". THIS IS A SAFETY DECISION.

STANDARD OPERATING PROCEDURE

STREAM HABITAT ASSESSMENT

THE SEGMENT SAMPLED FOR BIOTA MUST BE INCLUDED IN THE SEGMENT ASSESSED FOR HABITAT QUALITY!

In the past we have used two separate assessments for streams and riparian areas. Because of the importance of intact riparian areas to stream habitat and water quality there is really no reason to separate these two assessments. We are now merging them, and this SOP describes the correct method of filling out the new assessment form.
Record all measurement data in meters. This includes height of eroded bank, width of riparian zone, depth of pools, size of cobbles or boulders, width of stream and anything else you measure **except flow**. All measurements used to calculate instantaneous discharge are in feet.

If you use feet or inches in any measurement except flow, you will be responsible for converting it to meters before can be compared to other sites or historic data.

1. **Name of stream on USGS 7-1/2 minute map**. If the county map, soil map, or other map has a different name, the USGS 7-1/2' map takes precedence. If a stream is unnamed on the USGS map, but named on another map, use that name, but write the name of the map in parentheses beside the stream name.

2. **Names of people doing assessment**. [Don't use initials.]

3. **Direction--circle the appropriate word**. If you go upstream from the start point, circle upstream.

4. **Date the assessment is done.**

5. **Water Body number**. If the stream has site letters assigned to it, use the site designation of the start point also.

6. **Flow--enter the flow in CFS.** Flow should be taken during base flow conditions or as close as possible. **Never measure within a week of a significant rain event (>0.5 in)**

7. **Start Point**. A description, legal or otherwise, of where the assessment is started. Someone else should be able to locate this point from your description.

8. **Legal description of the portion of stream assessed** to the nearest 1/4 section.

9. **Latitude/Longitude of the start point in the format 00"00"00"/00"00"00".**

10. **Channel sinuosity**. This measurement must be completed in the office using a planimeter. When the assessment is completed, you will know exactly how far up or downstream you have walked. In the office, using the planimeter, measure that distance on a USGS 7-1/2 minute map along the portion of the stream you walked,

starting at the point you started at in the stream. For example, if you started the assessment at a bridge on the east boundary of section 9 T9N R8W and walked upstream for 200 meters, you get out the 7-1/2 minute map containing section 9 T9N R8W and set your planimeter wheel on the bridge from which you started. Being very careful to keep the planimeter wheel on the stream, follow the stream upstream from the bridge until you reach the point on the map where the planimeter reads 200 meters. **Mark this point.**

11. Next, draw a straight line (using a ruler) from the point where you ended the survey to the point from which you started the survey, and measure this distance using the planimeter.

12. Channel Sinuosity is the ratio of in-stream channel length divided by the straight line distance. It will always be ∃1.

13. **Distance**. **The distance from the start point as measured by the hip chain**. A stream must be assessed a minimum of 200 meters. Parameters 12 through 37 should all be measured at the start point and recorded to the right of the start (0) point. Generally we assess streams in conjunction with a bioassessment. For this purpose, **parameters 12-37 will be measured and recorded every 10 meters along the stream**. Instruction for their measurement follow.

14. **Depth**. Depth of water is measured in meters to the nearest 0.1 meter. **The left bank of the stream is that on your left as you face downstream**. The left ? (L?) is the depth of water midway between the center of the stream and the left bank. Center (C) is the depth of water in the center of the streambed . Right ? (R?) is the depth of water midway between the center of the stream and the right bank.

15. **Width WTR & Width BNK** are the width of the water in meters to the nearest 1 m, and the width of the lower bank in meters to the nearest 1 m. The lower bank extends from the water's edge at summer low flow to the top of the normal high water line. The normal high water line is usually marked by the beginning of well-established perennial vegetation. Below this line will be gravel and bare soil. There may be a sparse covering of annual vegetation below this line. The lower bank width is the distance between the tops of the left and right lower banks.

16. **Substrate**. This is an estimate of the substrate of the stream at the point where measurements are taken from the edge of the water on one side to the edge on the other side. The total of all substrate components should add up to 100 percent. The categories include the following:

    a. **S.& C** Loose silt and clay.
    b. **SND** Sand or rock particles; 0.1 to 2mm.
    c. **GVL** Gravel; rocks from 2 mm to 50 mm.
    d. **CBL** Cobble; rocks from 50 mm to 250 mm.
    e. **BLD** Boulder; rocks > 250mm.
    f. **BRK** Bedrock or hardpan clay.
    g. **POM** Particulate organic matter--rotten leaves and fragments of stick and logs.
    h. **HPC** Hardpan clay

17. **Habitat Type**. 0 Check the box that is most applicable to the habitat type present at the station. A **riffle** has surface which is definitely broken and usually makes a sound. A **pool** has a smooth surface, no or very little current and can be deep or shallow. A **run** has an obvious current, may be deep or shallow and often has a surface which may be slightly broken, but doesn't make any noise. Check **dry** if the stream has no water in it at the point being measured.

    i. If there are two obvious habitat types at the cross section you are measuring, check both boxes. An example is when a backwater pool is encountered beside a run or riffle.

18. **Instream Cover Area**. This category attempts to quantify the amount of cover present for fish in the section of stream from the previous station to the present one. For example, if the section was 20 meters long and averaged 6 meters wide, its area would be 120m^2. A submerged log about 3 meters long by 0.5 meters wide would offer 1.5m^2 cover, and you would note that the LWD (large woody debris) category offered 1.5/120 or 1.3 percent cover. Waterwillow, an emergent aquatic macrophyte, might be growing in shallow water along the edge of the stream. If both edges had a zone about 1 meter wide where it grows, there would be (1 meter) (20 meters) (2 sides)=40m^2 of EAV (emergent aquatic vegetation in the 120m^2 section of stream and you would check 40/120 or 33 percent in the EAV column. **Note that the totals of the "percent cover" columns for each row will rarely add up to 100 percent and may often be 0 percent**.

The categories are:

a. **UCB** Undercut banks
b. **LWD** Large woody debris--woody debris in the water > 10 cm. in diameter.
c. **SWD** Small woody debris-- woody debris in the water <= 10 cm. in diameter.
d. **RTS** Roots--these are submerged root wads of trees. If single or occasional roots are encountered, count them in one of the woody debris categories.
e. **BRL** Bedrock ledges--underwater bedrock ledges not forming part of an undercut bank.
f. **SAV** Submerged aquatic vegetation.
g. **EAV** Emergent aquatic vegetation.
h. **TV** Terrestrial vegetation which is currently underwater. An example would be tree branches or grass leaves that are actually hanging down into the stream.
I. **CBG** Cobble, Boulder and Growth. This is an estimate of the percent coverage of cobble and boulder in the 20 meter section. It may not be the same number as the percent composition of cobble and boulder in the cross section where you estimated substrate since they represent different areas.

19. **EMB - Embeddedness**. This quantifies the amount of silt, clay and sand which has been **DEPOSITED**. If there is no fine material surrounding the cobble and gravel, and there is at least some free space under the rocks, that is 0 percent embedded. If the free space under the rocks is filled but the sides are untouched, count that as 5

percent embedded. As the level of fines rises up the cobble sides, estimate the percentage of the total height of the cobbles that is covered. This is your embeddedness estimate. You can often see this line quite distinctly if you lift the rocks out of the water.

20. **CAN - Percent Canopy Cover**. At each measuring station, estimate the percent canopy cover in the previous segment. It can range from 0 to 100 percent, but if you can see any sky directly overhead, that part is not covered and your estimates should be less than 100 percent.

21. **PTB - Point Bar**. If a recently formed point bar is present, that is, it has no or little vegetation, put a check in this box.

22. **D&S - Deposition and Scouring**. If there is evidence of scouring (smooth, clean bedrock or
23. hardpan clay) or deposition (loose, shifting bottoms of fine sand or silt or filled in pools) in the previous segment surveyed, check this box.

24. **BVC - Bank Vegetative Cover**. Record an estimate of the total area on both banks that is protected from erosion by well established **perennial** vegetation. Soil doesn't have to be covered as long as it's stable. If banks are covered with rip-rap or large gravel, they can still be stable. Remember to note this in the "Comments" section.

25. **DV - Dominant Vegetation**. Place an S (shrub), T (tree), or G (grasses and forbs) in the box indicating which type of vegetation is most dominant **ON THE BANKS** in terms of percent of ground protected. For our purposes, shrubs are any woody plant whose trunk and branches are <= 10 cm in diameter. If the vegetation is mixed but each of the three groups contribute at least 20% of the total put an M in the box.

26. At each measurement point **record the average % of streambank that is actively eroding** for both the left bank and the right bank of the stream segment you just walked. Measure from the edge of the lower bank to the edge of the upper bank. [The upper bank is usually the edge of the flood plain.]

27. **REMEMBER THAT THE LEFT BANK IS THE BANK TOWARDS THE LEFT AS YOU FACE DOWNSTREAM** so if you are walking upstream the left bank will be the one on your right side.

28. Record the **average height of the eroding banks** on either side of the stream segment you just walked. Measure from the lower edge of the bank to the upper edge of the bank.

29. Record the average % slope of the banks in degrees. Measure from the lower edge of the bank to the upper edge of the bank.

30. Record the **typical substrate of each bank**, use the same substrate abbreviations that are used in the stream assessment form.

31. Record the **average width of the riparian vegetation** for each side of the segment you just walked. The riparian zone for our purposes extends from the top of the

upper bank outwards from the stream. (Remember that you have already described the size and vegetative state of the banks in columns 21, 22, 24, & 25.) For our purposes, the riparian zone ends where the unmanaged (i.e. not plowed or mowed) portion of land ends. Riparian vegetation is typically bottomland hardwood forest when in a natural state, but mixtures of trees and herbaceous plants are frequently encountered. These will grade from a fairly dense forest with sparse grasses to land that is mostly pasture with a few scattered trees.

32. If WOODY SHRUB AND SAPLING GROWTH CAN BE CONTROLLED USING A 6' BRUSHHOG AND A MEDIUM SIZE TRACTOR IN BETWEEN THE LARGER TREES, THE LAND WILL BE LABELED PASTURE AND MAY OR MAY NOT BE INCLUDED IN THE RIPARIAN ZONE. IF THE LARGE TREES ARE SO DENSE THAT A TRACTOR AND MOWER OF THIS SIZE CAN'T BE USED FOR BRUSH CONTROL, THE LAND SHOULD BE LABELED AS FOREST AND INCLUDED IN THE RIPARIAN ZONE. Remember that the riparian zone stops where pasture or crop management begins.

33. As stated earlier, natural riparian vegetation is typically bottomland hardwood forest, but when disturbances have been or are present there will be varying amounts of herbaceous plants and bare soil also. In these two columns you are asked to decide whether the majority of the land in the riparian zone on either side of the stream is grassland or forest. USE THE CRITERIA FROM CATEGORY 27 FOR THIS DETERMINATION. You are also called upon to decide how much bare soil is exposed. In grassy areas, this is a straight forward determination and is done by estimating the average % of bare soil you see as you walk the 10 meter riparian zone in question. Forest, while not expected to have grasses & forbs covering the ground, is expected to have a layer of spongy duff composed of organic matter in various states of decay covering the soil. This layer is usually covered by a layer of recently fallen leaves or annual herbaceous vegetation that haven't yet started to decay, so you will have to move these leaves or vegetation out of the way to determine if the duff layer is present. Soil not covered by duff should be counted as bare. Estimate the % bare soil exposed in forest as you walk the area in question.

34. THE RIPARIAN ZONE ON BOTH SIDES OF THE STREAM SHOULD BE PLACED IN ONE OF THE FOLLOWING CATEGORIES. Write "W" after the condition class if at least 5 meters of riparian area depth appear to be wetland based on the presence of standing water or saturated soil after at least a week of dry conditions, or dominance by sedges, rushes, button bush or willow.

1A	STABLE FOREST	<1% bare soil exposed
1B	MODERATELY USED FOREST	1-10% of surface is bare soil
1C	HEAVILY USED FOREST	>10% of surface is bare soil
2A	GOOD CONDITION GRASSLAND	<1% bare soil exposed
2B	FAIR CONDITION GRASSLAND	1-5% bare soil exposed
2C	POOR CONDITION GRASSLAND	>5 <20% bare soil exposed
2D	BAD CONDITION GRASSLAND	>20% bare soil exposed

35. **Cattle excluded from the stream.** Put a check mark in the box if this statement is true for the last 10 meters.

36. **% of land trampled.** This is an estimate of land where livestock trampling is evident within one meter either way of the transect. In other words, you are looking at a 2 meter wide strip that runs from the top of the right upper bank across the stream to the top of the left upper bank.

37. **# cow pies.** This is the number of cow pies in the 2 meters wide transect of column 30.

38. **# trails.** This is the number of livestock trails on both banks that reach the stream over the entire 10 meter transect. A single trail that crosses the stream and goes up the other side counts as two trails.

39. **Class of cow trails.** Each cow trail should be placed in one of the following classes and the class of each trail recorded in this column.

    g. < .75m wide
    h. ∃ .75 < 1.5m wide
    i. ∃ 1.5 < 2.5m wide
    j. ∃ 2.5m wide

40. There should be as many numbers listed here as there were cow trails in column 38. Separate each number by a comma.

41. If a road is contributing excess sediment to the stream, or a pipe is discharging to the stream or there is a dump present or any other thing, which you deem significant, is present, record it in the comment block at the end of the page.

OWRB STREAM HABITAT ASSESSMENT FORM

PAGE 1 OF 2

1. STREAM: _____

2. INVESTIGATORS:_____

3. DIRECTION: UPSTREAM DOWNSTREAM _____

4. DATE: _____

5. WBNUMBER:_____

6. FLOW:_____

7. START POINT: _____

8. LEGAL: _____

9. LAT/LONG:_____

10. CHANNEL SINUOSITY:_____

11. DIST	12. DEPTH			13. WIDTH		14. SUBSTRATE								15. HABITAT TYPE				16. INSTREAM COVER % AREA									17	18	19	202122
	L1/4	C	R1/4	WTR	BNK	Si & C	SND	GVL	CBL	BLD	BRK	POM	HPC	RIF	PL	RN	DRY	UCB	LWD	SWD	RTS	BRL	SAV	EAV	TV	CB&G	EMB	CAN	PtB	D+SBVCDV
10																														
20																														
30																														
40																														
50																														
60																														
70																														
80																														
90																														
100																														
110																														
120																														
130																														
140																														
150																														
160																														
170																														
180																														
190																														
200																														

STREAM HABITAT ASSESSMENT

PAGE 2 OF 2

1. STREAM: _____

4. DATE: _____

5. WB NUMBER:_____

	23. % ERODED BK		24. HT. ERODED BK		25. SLOPE BK		26. SUBSTRATE BK		27. RIP. WIDTH		28. RIP. COND.		CATTLE					
	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	29. EXCL	30. %TRAM	31. # CP	32. TRAILS	33. CLASS TRAILS	COMMENTS
10																		
20																		
30																		
40																		
50																		
60																		
70																		
80																		
90																		
100																		
110																		
120																		
130																		
140																		
150																		
160																		
170																		
180																		
190																		
200																		

STREAM HABITAT ASSESSMENT

#		OPTIMAL	ADEQUATE	FAIR	POOR
1	Instream Cover	Greater than 50% mix of stable habitat. Includes rubble, gravel, boulder and cobble, submerged logs, undercut banks, submerged appliance and autos, etc., etc. 100% 50% 20 points 16 pts	30% to 50% mix of stable habitat. 49% 30% 15 points 11 pts	10% to 30% mix of stable habitat. 29% 10% 10 points 6 pts	Less than 10% stable habitat. 9% 0% 5 points 0 pts
2	Pool Bottom Substrate Score by % Si&C and presence of, but not percent of desirable substrate	Mixture of desirable substrates with gravel and firm sand prevalent; root mats, CPOM and submerged aquatic vegetation common, cobble, gravel, firm sand, submerged aquatic vegetation, root mat, and CPOM all present and ∃ 80% of pool bottom. Mud and loose sand and bedrock may make up to 19% of bottom. 0% silt, clay & bedrock 19% 20 pts 16 pts	Firm sand, gravel, CPOM root mat and aquatic vegetation present. Mud, bedrock and loose sand, make up 20% TO 50% of bottom 20% silt, clay & bedrock 49% 15 points 11 pts	Any three types of stable substrate present. Mud, loose, sand and bedrock make up 51% to 80% of pool bottom. 50% silt, clay & bedrock 79% 10 points 6 pts	1 or 0 types of stable habitat present. Mud, loose sand and bedrock make up 81 to 100% of pool bottom. 80% silt, clay & bedrock 100% 5 points 0 pts
3	Pool Variability deep= ∃ .5 meter shallow= <.5 meter	Even mix of deep and shallow pool present. deep pools ∃40% and shallow pools ∃40% deep pools ∃30% and shallow pools ∃ 30% 20 points 16 pts	Majority of pools large and deep very few shallow. deep pools ∃ 71% deep pools = 100% 15 points 11 pts	Shallow pools much more prevalent than deep pools. deep pools # 29% deep pools ∃ 10 % 10 points 6 pts	Majority of pools shallow or pools absent. deep pools < 10% deep pools = 0% 5 points 0 pts
4	Canopy Cover Shading	Mixture of conditions where some areas of water surface fully shaded, some fully exposed and others receiving various degrees of filtered light. Avg % canopy cover Avg % canopy cover 45 to 55 or 55-60 40-45 or 60-65 35-40 or 65-70 30-35 or 70-75 25-30 20 pts 19 pts 18 pts 17 pts 16 pts	Covered by sparse canopy Avg canopy < 25% Avg canopy ∃ 10% 15 points 11 pts	Covered by dense canopy Average Canopy Cover > 75% = 100% 10 points 6 pts	Lack of canopy. Average Canopy Cover < 10% =0 % 5 points 0 pts
5	Presence of Rocky runs or riffles. Don't count gravel # 2 cm screen. At least 50%	Rocky riffles or runs dominant and make up at least 60% of stream	Rocky riffles and runs common.	Rocky riffles and runs infrequent.	Rocky riffles and runs rare or absent.

#		OPTIMAL	ADEQUATE	FAIR	POOR
	of substrate in riffles and runs must be gravel, cobble, boulder or bedrock to count as a rock riffle or run.	∃ 80% ∃60% 20 points 16 pts	59% 30% 15 points 11 pts	29% 6% 10 points 6 pts	5% 0% 5 points 0 pts
6	Flow at representative low flow	∃ .6 cms > .15 cms (20 cfs) (5 cfs) 20 points 16 pts	# .15 cms > .05 cms (5 cf) (2 cfs) 15 points 11 pts	# .05 cms >.03 cms (2 cfs) (1 cfs) 10 points 6 pts	# .03 cms ∃ 0 cms (1 cfs) (0 cfs) 5 points 0 pts
7	Channel alteration	Little or no enlargement of islands or point bars. 5% pt bars 20% pt bars or islands or islands 15 points 12 pts	Some increase in new bar or island formation, 21% pt bars 40% pt bars or islands or islands 11 points 8 pts	Moderate deposition of new gravel and sand on old and new bars. Pools partially filled with silt. 41% pt bars 60% pt bars or islands or islands 7 points 4 pts	Heavy deposition of fine material most pools filled with silt 61% 100% 3 points 0 pts
8	Channel sinuosity	Instream channel length 3 to 4 times straight line distance 4 3 15 points 12 pts	Instream channel length 2 to 3 times straight line distance. < 3 2 11 points 8 pts	Instream channel length 1.2 to 2 times straight line distance. < 2 1.2 7 points 4 pts	Channel almost straight to straight < 1.2 = 1 3 points 0 pts

#		OPTIMAL	ADEQUATE	FAIR	POOR
9	Bank stability a _____ (b)(c)(d) where a= avg. water width b= avg. bank slope % c= avg eroded bank ht. d= % of stream with eroded banks up to 200% for both left and right banks	Bank erosion absent or infrequent 0% to 19% of bank eroded. Avg bank slope 5-20%, avg height of eroded banks 5-19% of water width. bank stabilization score 400 126 10 points 8 pts	Erosion quite evident but not the dominant feature of the banks. 20% to 49% of bank eroded with average bank slope of 20 to 39%, and avg height of eroded banks 20 to 49% of water width. bank stabilization score 125 10 8 points 6 pts	Moderate amount of bank erosion (50-100%) of stream with slope of 40-59% whose avg height is 50% to 79% water width. bank stabilization score 10 2.1 5 points 3 pts	Nearly all of stream has at least one eroded bank (100-200%) that is ∃ 60% slope, whose avg height is 80% of avg water width. bank stabilization score 2 1 2 points 0 pts
10	Bank vegetation stability. Don't count bedrock or concrete - soil doesn't have to be covered as long as it's stable. % right bnk stable + % lft bnk unstable	0% unstable 10% unstable 10 points 9 pts	11% unstable 20% unstable 8 points 6 pts	21% unstable 40% unstable 5 points 3 pts	41% unst. >100% unst. 2 points 0 pts
11	Streamside cover count only vegetation within 10 ft of waters edge. shrub = woody stemmed plants # 10 cm dbh	Dominant vegetation is shrub 100% shrub 34% shrub 10 points 9 pts	Dominant vegetation is tree. 100% 34% 8 points 6 pts	Dominant vegetation is grass and forbs. 100% 34% 5 points 3 pts	Dominant cover is rock, concrete, bridge material, etc. 34% 100% 2 points 0 pts

STANDARD OPERATING PROCEDURE - MEASUREMENT OF STREAM FLOW WITH MARSH-MCBIRNEY MODEL 2000

I. General Information.

This SOP will provide a general discussion of flow measurement practices and detailed information concerning operation of the Model 2000 flowmeter. Before the meter is taken into the field, each operator should read the instrument manual as it contains much more information concerning such topics as error messages and those unusual situations that you might run into. Play special attention to the correction page in the beginning as it corrects some mistakes, especially in regard to instrument calibration. Another very good source of information is the USGS manual on "Discharge Measurements at Gaging Stations". This manual will help to better explain flow calculations if you find them confusing.

Flowmeters, such as the model 2000, measure velocity through changes in the magnetic field about the sensor as caused by water flow. Although the sensor does not have moving parts, it should be protected from bumps as it does contain electronic sensors. The sensor should be kept clean, especially of oils or grease. The probe should be cleaned with soap and water.

The meter operates on two D-cell batteries and will run for about 20 hours. The meter will indicate when the batteries are low. The meter will shut off automatically when it is out of the current for five minutes.

The obtainment of accurate flow measurements is more a matter of physical technique than it is of instrument operation. Each stream will present you with a unique physical situation; therefore, it is not possible to describe to you what to do under any situation. The following instructions are presented as guidelines but you will have to exercise considerable judgement in the field to obtain good results.

II. Operation.

a. Sensor Mounting

The sensor attaches to the wading rod by means of a thumbscrew. The thumbscrew must be placed over the recessed portion of the sensor mount. **THE SCREW THREADS CAN BE EASILY STRIPPED - DO NOT OVER-TIGHTEN**. (The sensor does not need to be tightly attached and, since the sensor should be removed during transport, it will be put on and taken off frequently.)

b. Wading Rod

The wading rod is a top adjusting model that makes it much easier to use. To move the rod up or down, press the metal tab at the top of the rod handle and slide the smaller of the two rods up or down.

The rod is divided into feet and tenths of feet (not inches). Velocity should be measured at different depths, dependent upon the depth of the water column. The velocity should be measured at 60% of the depth from the surface. To calculate 60% of depth from the top:

Determine depth of segment to be measured (ex. 1.4 feet). Slide smaller rod up until the "1" on the rod lines up with the four on the rod handle moving the sensor to 0.6 feet.

c. Stream site locations

The portion of the stream where flow is to be measured should be as uniform as possible. The ideal shape is a rectangle that can be found under some cement bridges. Avoid stagnant areas or those with irregular bottoms, turbulent flow, standing waves, or strongly sloping bottoms. For small streams, the narrowest portions are generally best as velocities will be higher and fewer measurements will be required.

The stream should be divided into a number of segments. The more segments, the more accurate the results. The ideal to shoot for is to divide the stream so that each segment accounts for 5% of the flow. Using this method, if one measure is inaccurate it will not significantly affect the results. In any case, an attempt should be made to measure flow at least every foot, when the width is $\leq$20 feet with a minimum of twenty measurements. If the stream is extremely narrow, the flow should not be measured at increments less than 0.5 feet.

In many streams, the first foot or so of stream is very shallow and stagnant. There are two approaches to dealing with this problem. The first is to ignore the shallow portion while the second involves averaging the depth and velocity between the bank and the first sample point. The best approach is to take the first measurement at the closest point where depth and flow are adequate. Any stream area closer to the shore than one-half the segment width from this point is ignored.

Stretch a measuring tape from bank to bank on the stream cross section to be sampled. Measure velocity at the first point where measurement is possible and then at some regular distance from the first measurement at the prescribed depth. Point the head of the sensor directly into the current and hold steady. Stand to the side and away from the wading rod.

III. Meter operation

a. Calibration

Before each sampling trip, the meter should be checked to see if it is reading ?0.0" under zero discharge. To do this, first clean sensor with soap and water. Place sensor (attached to wading rod for stability) in a five-gallon bucket as near center as possible and at least three inches from any side or bottom. Wait ten minutes to insure that the water is absolutely still before starting measurement. Turn meter on by pressing ON/C button. Press the STO and RCL keys at the same time and a 3 will appear on the display. Reduce this figure to zero with the down arrow key (You must press the arrow key within five seconds of the time that the 3 is displayed or you will get an error message. If this occurs, press the OFF key and start over.) After you have reduced the value to zero, a 32 will be displayed which will automatically drop to zero, at which time the meter is zeroed.

b. Measurement

Turn meter on by pressing ON/C key.

In order to dampen the meter's reading tendency to fluctuate, the meter can be adjusted to either filter the reading (time constant filtering - rC) or average the reading (fixed point averaging - FPA). By filtering the reading, the meter only reads every so many seconds, as specified by the user. The other setting averages the signal over some period, as specified by the user. Either method can be

used; however, for the greatest accuracy, the averaged reading method is best. The rC filter period can be set from 2-30 seconds while the averaging period (FPA) can be set from 2-120 seconds. The period can be changed using the up and down arrow keys. For the FPA setting an average of 15 seconds should be adequate.

The meter will store up to 19 data points. To store a reading, press the STO key. The meter will indicate which store reading that you are on. To recall a reading, press the RCL key and scroll through the readings with the up and down arrows. To clear the memory, press the ON/C and STO keys at the same time.

c. Instructions for completing field sheet

1. In the first row, mark EOS (Edge of Stream) in the width square.

2. Write down the corresponding depth and velocity in the rest of the line. These will often be 0, but if your stream has rock ledge banks or you're under a bridge abutment the edge of the stream will have a depth and possibly a velocity.

3. Proceed measuring flow as you have been until you have recorded your last measurement that falls on a whole distance interval.

4. The final measurement should be marked EOS in the left margin. This width may be less than all the other intervals and the depth and velocity may be 0 or >0. Record the depth and velocity of the edge of the stream no matter whether they are zero or not, and in the width column, record the distance to the edge of the stream from the last measurement point. Please use decimal increments of feet for this distance.

Field sheet is shown on the following page.

The following formula is to be used in determining flow (average discharge).

$$Q = \sum_{i=1}^{n} (w_{i+1} - w_i) \frac{d_i + d_{i+1}}{2} \frac{v_i + v_{i+1}}{2}$$

where "w" is the distance from the previous point, "d" is the depth measurement and "v" is the velocity measurement.

Stream _____ Legal

W.B. # _____ Lat/Long _____ Date
Time _____ G.H. _____ Name

FLOW MEASUREMENT				
DISTANT FROM INITIAL POINT	WIDTH	TOTAL DEPTH	VELOCITY	DISCHARGE

APPENDIX C

Field Sampling Protocol for Bacteria Collection

FIELD SAMPLING PROTOCOL

Bacteria Collection

Draft Copy

OKLAHOMA WATER RESOURCES BOARD

WATER QUALITY PROGRAMS DIVISION

3800 NORTH CLASSEN

OKLAHOMA CITY, OKLAHOMA 73118

31 AUGUST 2000

BASIC STREAM WATER QUALITY SAMPLING

INTRODUCTION

The purpose of this document is to provide a simplified, step-by-step outline of the field sampling procedures used by the Water Quality Programs Division of the Oklahoma Water Resources Board (OWRB) to collect bacterial (Bac-T) data for the streams portion of the Beneficial Use Monitoring Program (BUMP). It is an outtake of the more comprehensive BUMP streams Standard Operating Procedures (SOP) manual. The basic sampling procedures that will be discussed in this document involve sampling, methods and equipment. An experienced staff member on an as-needed basis will provide more in-depth training. Appendix A contains all documents needed for streams Bac-T sampling, including chain of custody forms and laboratory log-in sheets for the Oklahoma Department of Environmental Quality (ODEQ), field data sheets, and checklists.

PREPARING FOR THE FIELD

This step of the sampling procedure is often performed in a rushed manner, although this step is extremely important and should be given enough time and attention so that it is done properly. If preparation is not taken seriously, there is a possibility that equipment and supplies may be overlooked and forgotten until reaching the field site (sometimes hours away from the office). Moreover, rescheduling of assessments will be difficult due the large number of stream segments that the BUMP Streams' Team will be monitoring on a monthly basis. A checklist of items needed for stream's Bac-T water quality (SBWQ) sampling is provided in Appendix A. This list is located on the network as a separate checklist and should be printed out and used prior to each SBWQ sampling event. The checklist may be found under the file name: S:\SHARED\BUMP\STREAMS\FORMS\BUMPSBWQA.LST. Field preparation should begin at least two working days before the day of departure as several items must be taken care of in advance.. Each team will be responsible for ensuring that their equipment and materials are in working order and in adequate supply, notifying the receiving laboratory of arrival time and number of samples, preparing and printing labels from the trip files, and any other preparation necessary for a sampling trip.

Two working days prior to sampling. Because the ODEQ requires that the laboratory receive samples no later than 3:30 p.m., most trips require stay overnight stay. Remember that the

state only reimburses up to $40.00 for a hotel room. It is your responsibility to make reservations at either a state lodge or a hotel for the night before your sampling event. Reservations can be made weeks in advance but it is a good idea to call and confirm your reservation when preparing for each trip. Many hotels and all state lodges will direct bill the agency, but it is your responsibility to arrange the direct bill with the hotel. If direct billing is not available, you can be reimbursed up to the $40.00 maximum. Ask your supervising F.T.E for suggestions on accommodations.

It is important at this point to ensure that all of the necessary supplies are in stock either in the lab or in the storeroom. Walk through the rooms while scanning the checklist (Appendix A) to ensure that adequate stocks of Bac-T sample bottles (100 mL) and 1-Liter bottles are in stock. Check the appointment calendar to ensure that a truck is available and checked out for the sampling event (the project officer should have the dates scheduled and trucks checked out in the calendar several weeks in advance). Lastly, notify the ODEQ lab at 702-9193 of when the samples will arrive and how many samples will be collected. This may be done by the supervising F.T.E.

One working day prior to sampling. This is the time to get everything on the checklist together and ready to load. Go through each item on the checklist and stack all of the supplies onto the cart in an out-of-the-way area in the lab. Do not load equipment on the cart until the day before sampling is scheduled. Notice that the first few items on this list are sample containers, and the checklist says "labeled" for each container. It is important to attach the labels at least 24 hrs prior to entering the field so that the labels will set up and stay on the containers. Make sure you also label bottles for QA/QC--either a field blank (deionized water), spike, and/or duplicate (naming these sites will be discussed in the QA/QC section of this document). It is also important to take plenty of extra containers in the event of breakage or loss in the field. Trip forms can be printed by accessing the appropriate trip in the folder S:\shared\bump\streams\forms\bacteria. There will be a file containing the field data sheet, the laboratory chain of custody form and the laboratory log-in sheets and a file with all necessary labels for each trip. The only necessary change should be date and occasionally special sampling events. A sample copy of each form is located in Appendix A of this manual.

Make sure all equipment is in working order. The suspended "hand-dip" sampler will be used to collect sample water from bridges. After each sampling trip, the sampler and accessories should be washed according to the standard wash procedure described in QA/QC portion of this document and allowed to dry before storing for use. Make sure that no mud or debris is left on the sampler after cleaning. To ensure that samplers will function properly, check all working components including I-bolts, suspension chains, etc. Ensure that a pair of hip or chest waders, a small igloo ice chest, and several zip-lock baggies are available. Test all safety equipment to ensure that is operational.

Place chain of custody forms for the appropriate lab and extra data sheets in the data notebook. Double and triple check everything on the list to insure that field sampling goes smoothly.
Load the field vehicle with all of the supplies/equipment and double-check every item on the checklist again before departing. Equipment should be loaded in a secured place in the vehicle. In the event that no locked space is available for equipment, store the equipment in the hotel room.

FIELD SAMPLING

Upon reaching the sampling location, site safety determinations should be made before proceeding. These will be different for wadable and bridge sites. For wadable sites, several precautions should be taken. Primarily, ensure that the access road is travelworthy. Secondly, be constantly aware of any safety hazards such as snakes, animals, debris, etc. Lastly, visually gauge the flow and depth of the stream. Depending upon recent weather conditions, these parameters can change dramatically from the previous month's visit. If either flow or depth is determined to be hazardous, sample the site from a bridge location. For bridge sites, the following safety precautions should be taken before

sampling begins. First of all, turn on the amber strobe light mounted on the vehicle as well as the vehicle's hazard lights. Secondly, place the "SHOULDER WORK AHEAD" sign approximately ½ mile down-road from the downstream lane of the road. An experienced staff member will demonstrate the setup, appropriate placement, and takedown of the sign. Lastly, determine where the vehicle can be parked. Because of safety rules governing lane closures or impediments, sampling crews should only park on a bridge if adequate shoulder space is available to park the truck clear of both lanes of traffic. If adequate space is available, park the truck parallel to the downstream bridge guardrail and perpendicular to the far stream-bank. Place three cones in a straight line along traffic side of the truck at the front and rear of the truck and perpendicular to the near stream bank. If adequate space is not available, park the truck parallel on the downstream shoulder of the road ensuring that the truck is clear of traffic. Place three cones in a straight line along traffic side of the truck at the front and rear of the truck and at least 30 feet behind the truck. Also, follow this rule when parking along a shoulder for a wadable stream. Check the bridge railing for any damage. While sampling, be constantly alert to traffic and always be aware of the movement of traffic in both lanes. If a dangerous situation does arise, safety of personnel is paramount to the safety of any equipment.

Following is a detailed description of sampling procedures. Remember, efficiency is the key, and finding a comfortable sequence of sampling is essential. This will vary from person to person and from sampling team to sampling team. Yet, employing consistent sampling patterns at every site will maximize the number of sites sampled per day and decrease the chance for introduction of sampling error.

Sample Collection.

Composite sampling. A composite sample is representative of the entire river or stream at the collection site. It is accomplished by employing the equal width increments (EWI) method. By sampling at equal width increments (EWI) across the stream, a horizontally representative composite is obtained. Ideally, no less than 5 and no more than 10 equal increments should be established across the width of the stream. For example, EWI for 5 points of collection can be done by: 1) laying a transect across the stream and measuring the width, 2) dividing the width by 6 (5 increments) or 11 (ten increments), and 3) taking a sample at each increment. It is important not to sample the shoreline of any body of water. The shorelines can be excluded by starting at an increment away from the starting shoreline. By doing this, the far shoreline will also be excluded. If sampling is performed from a bridge, the bridge railing can be permanently marked with hashlines so that laying a transect is not necessary each time the site is sampled. Composite sampling will be possible on all rivers and streams unless the water body does not meet the minimum sampling depth (MSD) for the sampler or is too narrow. The MSD for Bac-t samplers is two (2) inches. If the stream is less than 2 inches deep over the entire cross section, attempt to access the stream to take a "hand-dip" sample. If the stream is not accessible, a sample can not be collected (this will only happen on the rarest of occasions). If a stream is less than 10 feet wide, a composite sample is not necessary. Remember, whenever prescribed protocols are not followed due to special event(s), note this in the 'sampler's comments' portion of the log-in sheet and the field sheet. A supervising F.T.E. will demonstrate composite sampling to all new field personnel.

Collecting samples. Bac-T samples are collected using the dip method. Before collecting water, rinse the "collection" bottle (100 mL) and the "splitting" bottle (1-liter) with native water (do not place the 1-liter bottle into the stream but rinse with water from the collection bottle). At wadable sites, samples are collected using the "hand-dip" method. While standing downstream from the point of collection, plunge the "collection" bottle below the surface of the water and allow it to fill towards the flow. Pour the collected water into the "splitting" bottle. Repeat at the five equal increments established across the cross-section. At bridge collection sites, a suspended "hand-dip" sampler is used. The sampler

is composed of five parts: weight (1), I-bolts with clamping ends (2), suspension chain (1), "collection" bottle (1), and suspension rope. To assemble the sampler follow these steps: 1) screw I-bolts into holes on each side of weight, 2) attach clamping ends to threaded part of I-bolts, 3) hook ends of suspension chain through "eyes" of I-bolts, 4) hook suspension rope to middle of suspension chain, and 5) clamp "collection" bottle to sampler by tightening clamping ends of I-bolts under the lip of the bottle. . While standing at the downstream rail of the bridge, plunge the "collection" bottle below the surface of the water and allow it to fill towards the flow. Pour the collected water into the "splitting" bottle. Repeat at the five equal increments established across the cross-section. After the composite sample has been collected to the "splitting" bottle, two sample bottles (one for fecal coliform/*E.coli* and one for enterococci) will be filled. Before filling, label each bottle with the current time using a black sharpie pen (bottles should stay closed until they are filled. To aliquot the samples, repeat the following steps for each bottle: 1) slowly invert the "splitting" bottle ten times to mix the water (**do not mix quickly or shake the bottle because this will kill bacterial cells**), 2) remove the cap of the bottle being careful not to touch the lip of the bottle or the inside of the cap, 3) open the cap of the sample bottle (being careful not to touch the lip of the bottle or the inside of the cap) and dump the de-chlorinating pill, 4) slowly fill the sample bottle without touching the lips of the two bottles, 5) snap the sample bottle shut, 6) close the "splitting bottle, and 7) "tie-off" the cap of the sample bottle and place on ice immediately. "Collection" and "splitting bottles should be used only once and disposed of in the recycling box upon returning to the laboratory.

Quality assurance/quality control(QA/QC). Various types of QA/QC samples will be taken at a rate of 1 sample in 20. First of all, duplicate samples will be taken. To obtain a duplicate sample, aliquot sample water from the 1-liter "collection" bottle to 4 100-mL bottles (two for fecal coliform/*E.coli* and two for enterococci). Be sure to repeat the steps for splitting samples for each bottle. One set of samples (one fecal coliform/*E.coli* and one enterococci) will be labeled with a location code "1" (the location code which goes on all regular environmental samples) and the other set with a location code "2" (the location signifying a duplicate sample). These samples will verify precision of field techniques. Secondly, certain samples will be labeled for a laboratory split that will verify laboratory precision. These samples will be designated by writing in the comment section of both the laboratory log-in form and the field sheet "LABORATORY SPLIT". These samples will be collected like a regular field duplicate, but the sample to be used for the split will not contain a location code. Thirdly, blank samples will be collected to verify laboratory accuracy and to gauge possible contamination from the "splitting" bottles. To collect this sample, add millipore deionized water to an unused 1-liter bottle. Aliquot this water as a normal sample would be aliquotted. Label the sample bottles with a location code "3" signifying a blank sample. Lastly, five enterococci samples per month will be fully verified for enterococci. These samples must be taken on a Monday to allow adequate time to fully process the sample. To designate these samples, write in the comment section of both the laboratory log-in form and the field sheet "ENTEROCOCCI VERIFICATION".

Paperwork.

Field Data Sheet. Other physical data are observed and recorded on the field data sheet at each site. Again, an F.T.E. staff member will demonstrate this technique. Record the time, estimated air temperature, wind direction, estimated wind speed and percent cloud cover, and access point (bridge or wadable) on the data sheet. This data will also be entered into a spreadsheet file on the network upon returning from the field and the data sheet will be filed appropriately. In the case of data that seems out of the ordinary, the F.T.E. may refer to the physical data recorded on the field data sheet to determine if a storm or windy conditions may have caused noticeable differences between sampling dates and sites. A template for Bac-T field data sheet is at s:shared/bump/streams/forms/fecal.dat. Also, record appropriate observances and pertinent

comments (concerning QA, etc.) in the comment section of this form. Be sure to give all maps and data sheets to the supervising F.T.E upon returning to the OWRB.

Laboratory Log-In Form. Each station will have one laboratory log-in sheet for its sample set (one fecal coliform/*E.coli* and one enterococci). Ensure that all information including station name, location code, date taken, time, sampler, and county is printed on the sheet. These forms will be available on the network with all the information except date and time included. Also, record appropriate observances and pertinent comments (concerning QA, etc.) in the comment section of this form.

Chain of Custody Form. Although the ODEQ laboratory does not require a chain of custody for Bac-T samples, one will be kept for inhouse verification of sample receipt. The chain of custody should contain each sample turned into the lab and the parameters being monitored. There will be a place for both the sampler and the receiver to sign, date, and time the receipt of the samples. It is extremely important that this is done. Because Bac-T samples have such a stringent "holding time", it is necessary that the receipt of samples is adequately documented. These forms will be available on the network with all the information except date and time included.

Bac-T SAMPLING (BUMP)	
	100 milliliter Bac-T sample bottles labeled (two for each site, + four extra) + extra for QA/QC samples
	100 milliliter Bac-T "collection" bottles (one for each site, + four extra)
	1-liter Bac-T "splitting bottles (one for each site, + four extra)
	Suspended "hand-dip" sampler (weight, for I-bolts w/clamp ends, suspension chain and rope)
	Coolers to ice all samples
	Data notebook with Bac-T sampling data sheets (field, lab, and chain of custody)
	Pencils and sharpies
	Site maps with marked test sites
	Rain Gear
	Baggies
	Hip Boots or Chest Waders
	Cellular phone
	Truck keys, record book, pike pass, & gas card for vehicle
	Sunscreen
	Tools
	Drinking water/cooler
	Safety vests, 3 cones, "SHOULDER WORK AHEAD" sign, and flashing amber strobe
	Notify lab which will analyze the samples
	Room reserved

MONITORING PROGRAM BACTERIA FIELD DATA SHEET

OKLAHOMA WATER RESOURCES BOARD

TRIP NAME & NUMBER: _____ DATE: _____ STATION TYPE: lake stream

INSTRUMENT NUMBER: _____ INSTRUMENT TYPE:

COLLECTORS:

TIME (24 hr)	SITE #	STATION NAME	AIR TEMP	WIND (direction/speed)	CLOUD COVER	METHOD USED	NOTES

OKLAHOMA WATER RESOURCES BOARD ODEQ CHAIN OF CUSTODY RECORD

PROJECT: BENEFICIAL USE MONITORING--STREAMS				# OF CONT.				
SAMPLERS: (Signature)					FECAL COLIFORM	E. coli	ENTERO COCCI	SELS NUMBER
PC	DATE	TIME	STATION NAME (LOCATION CODE)					
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	
AT				2	X	X	X	

RELINQUISHED BY: (Signature)	DATE	TIME	RECEIVED FOR LABORATORY BY: (Signature)	DATE	TIME

REMARKS:	REMARKS:

STATE ENVIRONMENTAL LABORATORY
OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY
PO BOX 24104
OKLAHOMA CITY, OK 73124-0104

BACTERIOLOGICAL WATER ANALYSIS

SAMPLE NUMBER:

OWRB

COUNTY _____

TIME COLLECTED _____ DATE COLLECTED _____

COLLECTED AT _____ COLLECTORS INITIALS _____

SITE ID _____

MAILING ADDRESS:

NAME Bill Cauthron PHONE 530-8800

ADDRESS 3800 N. Classen

CITY Oklahoma City STATE OK ZIP 73118

SAMPLER'S REMARKS _____

NOTE: PLEASE DO NOT USE TAPE TO SEAL LID, USE A WIDE RUBBER BAND INSTEAD.

FOR LAB USE ONLY

ANALYSIS DATE _____ TIME _____ REJ CODE _____

E COLI	TEST:	MPN	TOTAL/100 ML	
FECAL COLIFORM	TEST:	MF	TOTAL/100 ML	
FECAL STREPTOCOCCI	TEST:	MF	TOTAL/100 ML	
FECAL STREPTOCOCCI CONFIRMATION	TEST:	MF	TOTAL/100 ML	
ENTEROCOCCI	TEST:	MF	TOTAL/100 ML	
ENTEROCOCCI CONFIRMATION	TEST:	MF	TOTAL/100 ML	
SALMONELLA	TEST:	MPN	TOTAL/100 ML	
SALMONELLA	TEST:	PA	TOTAL/100 ML	

ANALYST COMMENTS _____

MF _____ LTB _____ BGB _____ EC _____ PA _____ UV _____ INITIALS _____

APPENDIX D

Field Sampling Protocol for Collection of Biological Specimens (Fish) in Lakes and Non-wadable Streams

FIELD SAMPLING PROTOCOL

Collection of Biological Specimens (Fish) in Lakes and Non-wadable Streams

Draft Copy

OKLAHOMA WATER RESOURCES BOARD

WATER QUALITY PROGRAMS DIVISION

3800 NORTH CLASSEN

OKLAHOMA CITY, OKLAHOMA 73118

31 August 2000

Standard Operating Procedures - Deployment & Retrieval of Gill Nets

Gill Net Specifications - foam-core float line and lead-core lead line.

Site Recommendations - Gill nets are most effective in waters free of obstructions, snags, floating debris and little or no current.

Sample Collection Materials List

1 2 or more large floats - 5 gallon size
2 Gill nets of desired mesh and length
3 Wash tub for holding gill net
4 2 or more 16" concrete blocks
5 Numerous small floats - 1/2 to gallon size

Selection of mesh size and length is Best Professional Judgement - based upon size of fish needed and number of target species present and required.

Deployment (Lake/Non-wadable stream)

1. Tie concrete block to large float, tie net tub to life vest
2. Wade out to desired location & depth (5') or boat to location
3. Tie lead line of gill net to concrete block, also tie net float to block
4. Tie float line of gill net to net float
5. Set net parallel to shore maintaining desired depth, playing the net out of the tub by handling the float line and shaking the float line to remove tangles.
6. At end of set tie lead line to concrete block and float line to float as done at the beginning of deployment.
7. Tie addition small floats to nets float line to increase visibility of net to others.
8. Walk back to the mid-point of net just deployed and set a turn net (a net of smaller mesh deployed to turn passing target fish into the gill net).
9. Tie turn nets float and lead lines to the float and lead lines of the main net.
10. Deploy turn net back to shore and anchor.

Retrieval

1. Start retrieving gill net at the downwind end, pulling the net over the side of the tub.
2. Stack the gill net into the wash tub in coils or figure eight.

APPENDIX E

Quality Assurance/Quality Control Protocol

For Water Quality Assessment of Streams and Rivers

QUALITY ASSURANCE/QUALITY CONTROL PROTOCOL

Water Quality Assessment of Streams and Rivers

Draft Copy

OKLAHOMA WATER RESOURCES BOARD
WATER QUALITY PROGRAMS DIVISION
3800 NORTH CLASSEN
OKLAHOMA CITY, OKLAHOMA 73118

15 May 2001

INTRODUCTION

When sampling BUMP streams, Quality Assurance/Quality Control (QA/QC) samples will be routinely collected to assure that environmental samples meet the Data Quality Objectives (DQO's) that are outlined in the BUMP Quality Assurance Project Plan (QAPP). QA/QC sampling is designed to control each step of the sampling process. Blanks are collected to ensure that BUMP and ODEQ staffs are properly cleaning the plastics and glassware used in field sampling, and duplicate samples are collected to ensure that BUMP and ODEQ staffs are properly processing environmental samples. Furthermore, equipment used in the sampling process is periodically calibrated and/or tested to ensure that readings are correct. Immediately following is a general discussion of QA/QC procedures. Afterward is a more specific discussion of the BUMP QA/QC protocols.

QA/QC SAMPLE PREPARATION

Quality control samples should be used as part of every sampling event. Before a discussion of quality control sample preparation can begin, simple definitions for some common quality control terms should be presented.

Definitions:

True Values:	A theoretically calculated value based upon careful weighing of constituents.
Acceptance Limits:	A 99% Confidence Interval calculated from available performance evaluation data of EPA & state laboratories. By definition the analytic results from a laboratory producing valid data should fall within acceptance limits 99 out of 100 times.
Warning Limit:	A 95% confidence interval produced in the same way as the acceptance limits. Data falling outside the acceptance limits but inside these limits should be reviewed for possible problems, but such data should not necessarily be considered unacceptable.
Sample label:	Label on bottle consists of project code, stream name, site location, date of collection, and preservative. Each bottle of a particular sample should contain a label with the same information except 'preservative used'.
QA/QC Sample:	A QA/QC sample is made up of each bottle containing the same sample label information (excepting preservative used). An 'environmental sample' requires one or two ½ - gallon bottles with one labeled 'ICE' and the other 'H_2SO_4'. A 'metals sample' requires one 1 - liter bottle labeled 'HNO_3'. An 'organics' requires two 1 – quart bottles labeled 'ICE'.

Kinds of Samples. Samples are collected to test both field and laboratory procedures. Following is a short description of each kind of sample. Samples are submitted to the analytical laboratory with other "trip" samples.

Lab Blank Sample:	A laboratory blank sample is collected to ensure that laboratory cleaning methods are adequate and are not contaminating samples. Reagent grade water should always be used to collect these samples. Submitted on a regular schedule.
Field Blank Sample:	A field blank sample is collected to ensure that field cleaning methods are adequate and are not cross-contaminating samples. Reagent grade water should always be used to collect these samples. Submitted on a regular schedule.

Analy. Blank Sample: An analytical blank sample is submitted to control the methods of the analytical laboratory. Reagent grade water should always be used to collect these samples. Submitted on a regular schedule.

Duplicate Sample: A replicate sample is collected to control the methods of the analytical laboratory. These samples also ensure that composite samples are being collected appropriately. Submitted on a regular schedule.

Spike Sample: A spike sample is a known stock solution diluted by environmental sample. - Submit as required

Known Sample: A known sample is a known stock solution diluted in the laboratory with reagent grade water. - Submit as required

The Oklahoma Department of Environmental Quality (ODEQ) can provide ampule stock solutions for: Alkalinity (total and phosphate), Total Hardness, Ammonia (NH_3), Nitrate (NO_3), Total Kjeldahl Nitrogen (TKN), & Phosphate (PO_4). The OWRB also has ampule stock solutions available for parameters listed. Consult with your supervisor to determine if you will be using the ODEQ or OWRB stock solutions. When preparing QC sample checks be sure to **record everything you do**! It is essential that all steps of the process be adequately documented. Samples should be prepared as outlined below.

Preparation Procedures for Inorganic and Organic Chemistry QA/QC Samples (including field parameters turbidity, hardness, and alkalinity): Rinse all plastic and glassware as described in the "cleaning equipment" section.

1) Laboratory Blank Sample –
   - One sample is collected for each "sampling week".
   - The sample is collected by running reagent grade water through all plastic ware that will be used in the field during a particular sampling week.
   - The sample will include a 1-liter bottle for ice preservation, sulfuric acid preservation, and metals. Other bottles should be collected for parameters as necessary.
   - Label with a "3" (blank water quality sample) in the location code.
   - Field Parameters—process a turbidity, hardness, and alkalinity sample from the collected water.
2) Field Blank Sample
   - One sample is collected for each "sampling day".
   - The sample is collected by running reagent grade water through the splitter churn. Water should be aliquotted in a manner that is consistent with normal sampling procedures.
   - The sample will include a 1-liter bottle for ice preservation, sulfuric acid preservation, and metals. Other bottles should be collected for parameters as necessary.
   - Label with a "3" (blank water quality sample) in the location code.
   - Field Parameters—process a turbidity, hardness, and alkalinity sample from the collected water.
3) Analytical Blank Sample
   - One sample is collected for each "sampling week".
   - The sample is collected from reagent grade water provided by the analytical laboratory.
   - The sample will include a 1-liter bottle for ice preservation, sulfuric acid preservation, and metals. Other bottles should be collected for parameters as necessary.
   - Label with a "3" (blank water quality sample) in the location code.

- Field Parameters—process a weekly turbidity, hardness, and alkalinity sample from the water that will be used for field dilutions.

4) Duplicate Sample
   - One sample is collected for each "sampling trip".
   - The sample is collected by using a "churn sample splitter" to divide water from one sample site into two separate samples.
   - The sample will include a 1-liter bottle for ice preservation, sulfuric acid preservation, and metals. Other bottles should be collected for parameters as necessary.
   - Label one sample with a "1" and the other sample with a "2" (duplicate water quality sample) in the location code.
   - Field Parameters—process a duplicate turbidity, hardness, and alkalinity sample at the same station.
5) Known and Spike Samples
   - Samples are collected as needed.
   - Known samples are measured for alkalinity and hardness for each sampling trip. Use known sample water prepared by the analytical laboratory. Samples should be processed consistent with normal sampling procedures.
   - Two separate stock solutions will be prepared and combined into one sample for laboratory analysis. Each prepared solution will account for ½ of the sample or for each type of preservative used.
   - To prepare sample:
     1) Fill a clean (acid rinsed) 2000 ml volumetric flask half full of DI water.
     2) Add 2 ml of 25 mg P/l and 1 ml of 150 mg NH_3-N/l using two clean volumetric pipettes.
     3) Next, dilute the flask to volume with DI water.
     4) Pour the prepared solution into a ½ gallon sample jug and label the sample (dummy site #, depth, lake, date, and preservative) listing the preservative as "ACID".
     5) RECORD LABELING, AMPULE LABEL AND DILUTION FACTOR IN THE DATA NOTEBOOK.

Preparation Procedures for Bacteriological QA/QC Samples:

1) Analytical Blank Sample
   - One sample is collected for each "sampling week".
   - The sample is collected by filling sample bottles with reagent grade water.
   - The sample will include a 100 mL bacteriological bottle for each separate group. Other bottles should be collected for parameters as necessary.
   - Label with a "3" (blank water quality sample) in the location code.
2) Field Blank Sample
   - One sample is collected for each "sampling week".
   - The sample is collected by running reagent grade water through the sampling method. Water should be aliquotted in a manner that is consistent with normal sampling procedures.
   - The sample will include a 100 mL bacteriological bottle for each separate group. Other bottles should be collected for parameters as necessary.
   - Label with a "3" (blank water quality sample) in the location code.
3) Laboratory Duplicate Sample
   - One sample is collected for each "sampling week".

- The sample is collected by splitting the collected water into two separate samples.
- The sample will include a 100 mL bacteriological bottle for each separate group. Other bottles should be collected for parameters as necessary.
- Label one sample with a "1" and the other sample with a "2" (duplicate water quality sample) in the location code.

4) Field Duplicate Sample
   - One sample is collected for each "sampling trip".
   - The sample is collected by repeating the entire sample collection method.
   - The sample will include a 100 mL bacteriological bottle for each separate group. Other bottles should be collected for parameters as necessary.
   - Label one sample with a "1" and the other sample with a "2" (duplicate water quality sample) in the location code.
5) Enterococci Confirmation
   - One sample is collected for each "sampling trip". All samples should be collected on a Monday.
   - The sample is collected by normal sampling procedures. Is a laboratory procedure.
   - The sample will include a 100 mL bacteriological bottle for each separate group. Other bottles should be collected for parameters as necessary.
   - In the "sampler's comments" portion of the laboratory log-in sheet put "ENTEROCOCCI CONFIRMATION".

Unless otherwise specified, QA/QC samples should be processed from the field to the laboratory to the office in accordance with procedures outlined for environmental samples in the main portion of this document and "Appendix C—Collection of Bacteriological Samples". Deviation from these normal procedures may result in biased results that will compromise the effectiveness of the QA/QC program.

ANALYSIS OF QA/QC SAMPLES

Blank Samples.
Blank samples serve two distinct functions in controlling the quality of samples—the accuracy of the analytical laboratory and the monitoring of potential cross-contamination due to sampling methodology.

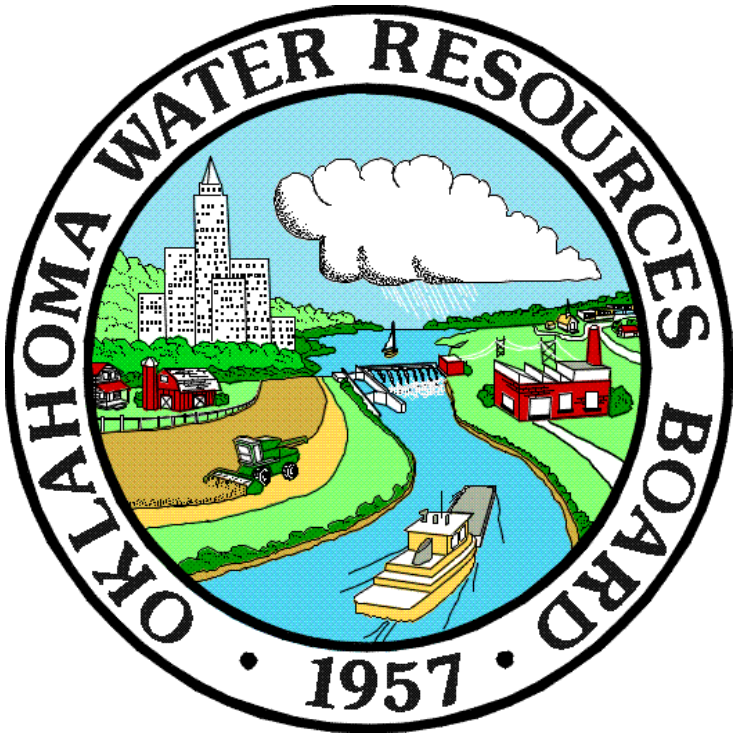
1) Accuracy of the Analytical Laboratory

   - ♦ Analytical blanks test the accuracy of the analytical laboratory. These samples are comprised of reagent grade water that does not go through any portion of the sample collection process.
   - ♦ Expected results are non-detects for all parameters.
   - ♦ If expected results are not meant:

     1) Determine relative contribution to each site related to blank sample.
     2) If relative contribution is greater than 5%, sample is considered questionable.

2) Potential Cross-Contamination due to Cleaning and Sampling Methodology

APPENDIX F
FIELD SAMPLING PROTOCOL
Determination of Flow
WATER QUALITY PROGRAMS DIVISION
OKLAHOMA WATER RESOURCES BOARD
Draft Copy



OKLAHOMA WATER RESOURCES BOARD
WATER QUALITY PROGRAMS DIVISION
3800 NORTH CLASSEN
OKLAHOMA CITY, OKLAHOMA 73118
15 May 2001

STANDARD OPERATING PROCEDURE

DETERMINATION OF PERIPHYTON LINE

For most stream monitoring situations, it's desirable to know whether or not the stage of the stream is rising, falling or stable. Additionally, for biological collections, or physical/chemical collections that are to be interpreted within a biological context, knowledge of the length of time the stream has been at a particular stage is needed. This is because almost all stream life is adapted for life under fairly stable conditions of flow and stage. This isn't meant to imply that organisms can't deal with increased flows, it's just saying that most organisms have optimal conditions of flow under which they reproduce, feed, rest and carry out the day to day business of their lives. During times of elevated flows and the elevated or decreased conditions of dissolved and suspended mineral and chemical compounds that accompany elevated flows, most organisms are simply surviving until flow returns to more normal conditions. The periphyton line is often a quick and easy indicator of how stable stream stage is.

Periphyton is, strictly, the attached algae that grow on underwater substrates. More generally, the word is also used to describe the entire microscopic community that grows attached to underwater substrates. Usually this community is dominated by algae, and the color, texture and thickness of the community is a reflection of the dominant algae.

Because the growth rate of algae is such that it takes several days for a visible layer to accumulate, and elevated stream flows tend to reduce or eliminate the periphyton mat, a visible accumulation of periphyton extending to the water's edge indicates the water has been stable at that level for several days. This makes the periphyton line a useful indicator of stable stage, i.e. seasonal base flow.

Depending on which organisms dominate the periphyton community, it can be any color and texture. Periphyton dominated by filamentous green algae and or non-filamentous green algae is easy to recognize and won't be discussed further. It looks green and is obviously some type of plant. Descriptions of other types of periphyton are listed below.

Tan to olive-brown fuzzy hair-like covering 0.5 to 5 mm long on submerged objects. When rubbed between fingers, it breaks up into microscopic particles.

Yellowish green to yellowish brown fuzzy filaments that don't disintegrate when rubbed between fingers.

Slimy layer on the surface of silt or sand substrate. This is usually recognized by breaking through the surface layer and observing that sediment 5 or more mm below the surface is a different color and not quite as cohesive as the surface layer. Sometimes, the surface layer is obviously green to blue-green to very dark blackish green or golden-brown to brown to black. Often there is enough silt mixed with the algal layer that that it's only slightly more olive-brown to olive-green colored than the sediment itself. Periphyton growing on loose substrates is best recognized by the slight to large change in substrate cohesion and a slight to large change in color of the top millimeter or so of sediment.

Colored layer of almost any color on the surface of rocks or other underwater large submerged objects. Usually this will be either a golden-brown grading to blackish-brown or an olive-green to blue-green grading to blackish-green color. This is often best observed by lifting a larger rock from the stream and observing the contrast in color between the part that was buried under sediment and

the part that was exposed to light. If the substrate is composed of gravel, look for color differences between undisturbed gravel and gravel that is 10 or 12 centimeters below the substrate surface.

Gelatinous layer of almost any color on the substrate & underwater objects. It can be 1 to 10 mm thick.

Recognition of the periphyton line is best taught in the field by observing different types of periphyton under the guidance of an experienced phycologist. Much can be learned by reading, but it's no substitute for direct experience. Consult with the QA officer or the monitoring coordinator before attempting this on your own.

STANDARD OPERATING PROCEDURE

MEASUREMENT OF STREAM FLOW WITH MARSH-MCBIRNEY MODEL 2000

I. General Information.

This SOP will provide a general discussion of flow measurement practices and detailed information concerning operation of the Model 2000 flowmeter. Before the meter is taken into the field, each operator should read the instrument manual as it contains much more information concerning such topics as error messages and those unusual situations that you might run into. Play special attention to the correction page in the beginning as it corrects some mistakes, especially in regard to instrument calibration. Another very good source of information is the USGS manual on "Discharge Measurements at Gaging Stations". This manual will help to better explain flow calculations if you find them confusing.

The Model 2000 is a flowmeter that measures velocity through changes in the magnetic field about the sensor as caused by water flow. Although the sensor does not have moving parts, it should be protected from bumps as it does contain electronic sensors. The sensor should be kept clean, especially of oils or grease. The probe should be cleaned with soap and water.

The meter operates on two D-cell batteries and will run for about 20 hours. The meter will indicate when the batteries are low. The meter will shut off automatically when it is out of the current for five minutes.

The obtainment of accurate flow measurements is more a matter of physical technique than it is of instrument operation. Each stream will present you with a unique physical situation; therefore, it is not possible to describe to you what to do under any situation. The following instructions are presented as guidelines but you will have to exercise considerable judgement in the field to obtain good results.

II. Operation.

a. Sensor Mounting

The sensor attaches to the wading rod by means of a thumbscrew. The thumbscrew must be placed over the recessed portion of the sensor mount. **THE SCREW THREADS CAN BE EASILY STRIPPED - DO NOT OVER-TIGHTEN**. (The sensor does not need to be tightly attached and, since the sensor should be removed during transport, it will be put on and taken off frequently.)

b. Wading Rod

The wading rod is a top adjusting model, which makes it much easier to use. To move the rod up or down, press the small rubber mount at the top of the rod handle and slide the smaller of the two rods up or down.

The rod is divided into feet and tenths of feet (not inches). Velocity should be measured at different depths, dependent upon the depth of the water column. If the depth is less than 1.5 feet, the velocity should be measured at 60% of the depth from the surface. If the depth is greater than 1.5 feet, the velocity should be measured at 20% and 80% of the depth from the surface and averaged. The wading rod is designed to facilitate the determination of the correct sensor depth as shown in the following examples:

To calculate 60% of depth from the top:

Determine depth of segment to be measured - 1.4 feet
Slide smaller rod up until the "1" on the rod lines up with the four on the rod handle - ~0.6 feet.

To calculate 80% of depth from the top:

Determine depth of segment to be measured - 2.5 feet
Divide depth by 2 = 1.25
Slide small rod until "1" on the rod lines up with the 2.5 on the rod handle - 0.5 feet.

To calculate 20% of the depth from the top:

Determine depth of segment to be measured - 2.5 feet
Multiply depth by 2 = 5.0 feet
Slide small rod until "5" on the rod lines up with the zero on the rod handle - 2.0 feet.

c. Stream site locations

The portion of the stream where flow is to be measured should be as uniform as possible. The ideal shape is a rectangle, which can be found under some cement bridges. Avoid stagnant areas or those with irregular bottoms, turbulent flow, standing waves, or strongly sloping bottoms. For small streams, the narrowest portions are generally best as velocities will be higher and fewer measurements will be required.

The stream should be divided into a number of segments. The more segments, the more accurate the results. The ideal to shoot for is to divide the stream so that each segment accounts for 5% of the flow. Using this method, if one measure is inaccurate it will not significantly affect the results. In any case, an attempt should be made to measure flow at least every foot, when the width is $\leq$20 feet with a minimum of twenty measurements. If the stream is extremely narrow, the flow should not be measured at increments less than 0.5 feet.

In many streams, the first foot or so of stream is very shallow and stagnant. There are two approaches to dealing with this problem. The first is to ignore the shallow portion while the second involves averaging the depth and velocity between the bank and the first sample point. The best approach is to take the first measurement at the closest point where depth and flow are adequate. Any stream area closer to the shore than one-half the segment width from this point is ignored. See the following illustration.

Stretch a graduated string from bank to bank on the stream cross section to be sampled. Measure velocity at the first point where measurement is possible and then at some regular distance from the first measurement at the prescribed depth. Point the head of the sensor directly into the current and hold steady. Stand to the side and away from the wading rod.

III. Meter operation

a. Calibration

Before each sampling trip, the meter should be checked to see if it is reading 0.0 under zero discharge. To do this, first clean sensor with soap and water. Place sensor (attached to wading rod for stability) in a five-gallon bucket as near center as possible and at least three inches from any side or bottom. Wait ten minutes to insure that the water is absolutely still before starting measurement. Turn meter on by pressing ON/C button. Press the STO and RCL keys at the same time and a 3 will appear on the display. Reduce this figure to zero with the down arrow key (You must press the arrow key within five seconds of the time that the 3 is displayed or you will get an error message. If this occurs, press the OFF key and start over.) After you have reduced the value to zero, a 32 will be displayed which will automatically drop to zero, at which time the meter is zeroed.

b. Measurement

The meter can measure velocity in a number of ways; however, we will be using feet per second.

Turn meter on by pressing ON/C key.

The flow around a sensor is not stable and will jump around a bit. In order to dampen this tendency the meter can be adjusted to either filter the reading (time constant filtering - rC) or average the reading (fixed point averaging - FPA). By filtering the reading, the meter only reads every so many seconds, as specified by the user. The other setting averages the signal over some period, as specified by the user. Either method can be used; however, for the greatest accuracy, the averaged reading method is best. To move between these two measurement modes press the up and down arrow keys at the same time. The rC filter period can be set from 2-30 seconds while the averaging period (FPA) can be set from 2-120 seconds. The period can be changed using the up and down arrow keys. For the FPA setting an average of 15 seconds should be adequate.

The meter will store up to 19 data points. To store a reading, press the STO key. The meter will indicate which store reading that you are on. To recall a reading, press the RCL key and scroll through the readings with the up and down arrows. To clear the memory, press the ON/C and STO keys at the same time.

c. Instructions for completing field sheet

1. In the first row, mark EOS (Edge of Stream) in the width square.

2. Write down the corresponding depth and velocity in the rest of the line. These will often be 0, but if your stream has rock ledge banks or you're under a bridge abutment the edge of the stream will have a depth and possibly a velocity.

3. Proceed measuring flow as you have been until you have recorded your last measurement that falls on a whole distance interval.

4. The final measurement should be marked EOS in the left margin. This width may be less than all the other intervals and the depth and velocity may be 0 or >0. Record the depth and velocity of the edge of the stream no matter whether they are zero or not, and in the width column, record the distance to the edge of the stream from the last measurement point. Please use decimal increments of feet for this distance.

Field sheet is shown on the following page.

Stream _____ Legal

W.B. # _____ Lat/Long _____ Date
Time _____ G.H. _____ Name

FLOW MEASUREMENT

DISTANT FROM INITIAL POINT	WIDTH	TOTAL DEPTH	OBS. DEPTH	VELOCITY	AVERAGE VELOCITY	AREA	DISCHARGE