Standard Operating Procedures for Surface Water Quality Sampling

Prepared by the

ADEQ Arizona Department of Environmental Quality

Surface Water Section

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Standard Operating Procedures for Surface Water Quality Sampling

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The Arizona Department of Environmental Quality
shall preserve, protect and enhance the environment
and public health, and shall be a leader in the develop-
ment of public policy to maintain and improve
the quality of Arizona's air, land and water resources

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PREFACE

"Standard Operating Procedures for Water Quality Sampling" is a presentation of surface water sampling procedures and related activities by the Arizona Department of Environmental Quality's Surface Water Section (SWS). ADEQ has two main groups that conduct surface water monitoring. The Monitoring Unit conducts ambient monitoring of Arizona's lakes and streams while the Total Maximum Daily Load (TMDL) Unit collects data to support development of TMDLs for impaired surface waters in Arizona.

This document is meant to be a reference document for surface water monitoring staff. Its main purpose is to maintain consistency among staff over time. It will also serve as a training manual and an information source for agencies, contractors, organizations, and educators for sampling surface waters.

DOCUMENT ORGANIZATION

The SWS Standard Operating Procedures (hereafter referred to as SOPs) is organized in a sequential manner and is meant to outline all the activities before, during and after a sampling trip. It is divided into the following chapters:

Chapter 1) Pre-Trip Administrative Activities
Chapter 2) General Field Procedures
Chapter 3) Chemistry Procedures
Chapter 4) Bacteria Collection
Chapter 5) Measuring Flow
Chapter 6) Automated Sampling Equipment
Chapter 7) Stream Ecosystem Monitoring
Chapter 8) Geomorphology Procedures
Chapter 9) Post-Trip Procedures
Chapter 10) Data Management

The appendixes cover reference information that is important for water quality sampling.

The SOP's have been designed to allow staff to jump the particular chapter that is needed for a particular project. The following icons are used throughout the text to draw the reader's attention to important procedures.

This symbol is meant to draw the reader's attention to a particular point.

This symbol is meant to alert the reader that this is a critical point that cannot be missed.

This manual, or portions of it, will be updated whenever available technologies, procedures, or quality assurance protocols change. The SOPs are posted on the ADEQ website and is available in

printed form at the ADEQ library at 1110 W. Washington Street, Phoenix, Arizona. Updates to the SOPs will be posted in a timely manner on the website.

Any reference to specific brand names or model numbers is intended for the sake of clarification purposes and in no way represents an endorsement of such product.

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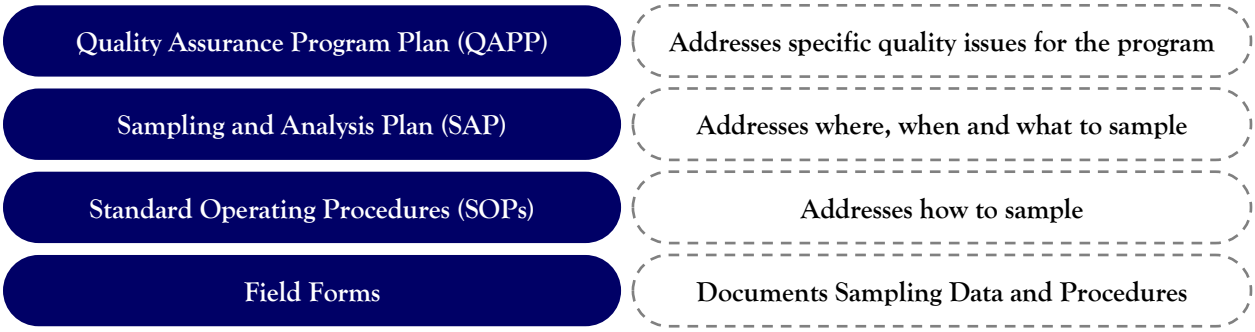
CHAPTER 1 PRE-TRIP ACTIVITIES

Preparation is the key to a successful monitoring trip. Monitoring staff are responsible for remembering numerous items before they even leave the office. This chapter is designed to help staff prepare for trips by using checklists, calibrating equipment, and considering site safety before they leave the office.

1.1 IMPORTANT DOCUMENTS AND FORMS

This document is used in conjunction with several other documents, each of which answers basic questions related to water quality sampling as indicated below.



Staff should be familiar with each of these documents before attempting to sample.

1.2 FIELD TRIP EQUIPMENT LISTS

Check lists are very important tools to ensure that all the needed equipment is accounted for before going out into the field. Appendix A has checklists sorted by program (lakes, ambient streams, TMDL, etc.). The checklists may not be complete for all projects. Certain projects don't need all of the equipment listed for every trip.

1.3 ORDERING SUPPLIES

It is the responsibility of the lab coordinator and staff to make sure that all supplies are fully stocked in the lab. Staff should contact the lab coordinator if bottles, acid, batteries, bags or any other supplies need to be ordered.

1.4 EQUIPMENT CALIBRATION

1.4.1 GENERAL CARE OF THE MULTIMETER

ADEQ currently uses Insitu, Hydrolab and YSI multimeters. The multimeter measures field parameters such as temperature, pH, and conductivity. They consist of two main parts; the surveyor readout unit and the sonde. The surveyor is the computer while the sonde contains the various probes.

The calibration procedures listed in this document are just a subset of the YSI and Hydrolab manuals. Always consult the respective equipment manual if additional information is needed.

The sonde and surveyor must be transported and stored in the hard plastic Pelican cases. Proper care of the probes is essential for accurate readings. An occasional pre-calibration cleaning and rinse with isopropyl alcohol and a very soft brush or cotton ball is recommended. Repeated use of

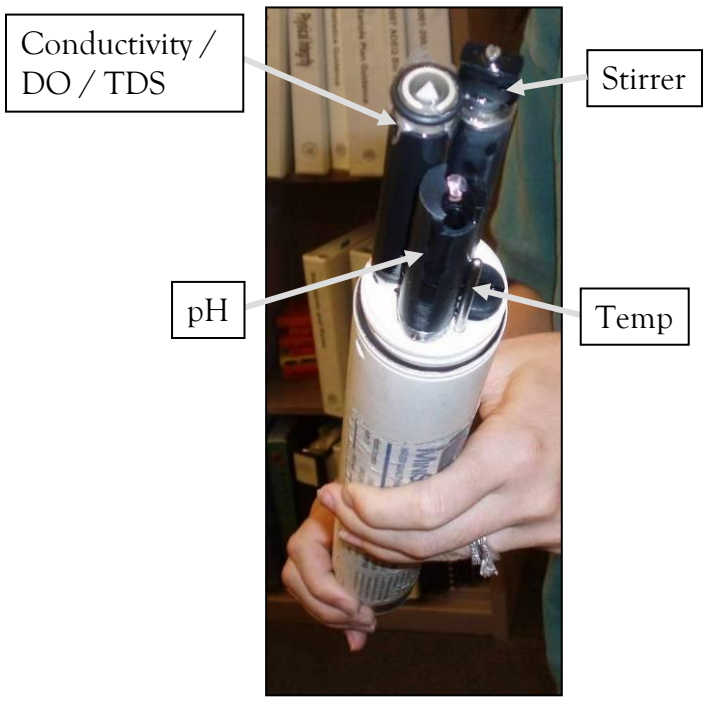


FIGURE 1.1. Minisonde sensor placement.

FIGURE 1.2. Hydrolab calibration.

the meter can accumulate iron filings on the Hydrolab's magnetic dissolved oxygen stirrer. Regular cleaning will keep the build-up from becoming an operational problem. FIGURE 1.1 shows the location of the sensors on the Hydrolab Minisonde unit. FIGURE 1.2 shows the calibration of the Hydrolab.

Maintain about 1/8 to 1/4 inch of tap water (or pH 4 buffer) in the probe protective cup at all times. Do not let the probes dry out because they will be permanently damaged and will have to be replaced.

Never store deionized water in the probe protective cup.

The connectors on the cable, probe and transmitter should be cleared of debris. Do not let the cable ends fall into the dirt or water. Keep protector caps on the sensor connectors and cable connectors whenever they are not in use.

Always check the battery reading before taking the unit into the field. The Hydrolab Surveyor 4 read-out units are equipped with a rechargeable nickel metal hydride battery (FIGURE 1.3).

The fully charged battery holds a charge of 8.5 volts and should be recharged when the level reaches 6.5 volts. Nickel metal hydride batteries can be charged to full voltage at any time, no matter how low the voltage.

FIGURE 1.3. Surveyor

Turn the unit off immediately after use to preserve the battery charge. The stirrer unit is the largest draw on the battery, so use it sparingly. Some models will allow the observer to disable the stirrer when not needed.

Carefully coil the cable after use into a 6" to 12" diameter coil. Do not step on the cable or allow it to become kinked. If the pin connector to the probe or stirrer becomes difficult to slip on, lubricate the connector sleeve with the clear petroleum lubricant provided in the maintenance kit. The male connector pins should occasionally be cleaned with a weak solvent and a soft brush. After cleaning, always apply a thin coating of petroleum lubricant.

Protect units from temperatures greater than 122° F (50 °C). Units will automatically shut down at this temperature. The read-out units utilize a liquid crystal display and very cold or very hot temperatures will adversely affect the display read-out; therefore, do not subject units to extreme hot and cold temperatures.

1.4.2 HYDROLAB CALIBRATION PROTOCOLS

All equipment should be calibrated before and after each use in the field and recorded in the equipment log book, which is kept with the unit. This allows the sampler to determine the accuracy of the field parameters taken at the site and ensures that the instrument is ready for the next user. Some individuals may chose to calibrate at each site depending on the requirements of their sample plan. Each time the instrument is pre-calibrated and post -calibrated, the results must be noted in the log book along with the name of the user and the intended use of the equipment. Any problems with the unit should also be noted. As a general rule, the temperature and other parameter readings should be monitored for approximately a minute to ensure that the values stabilize before the readings are recorded in the unit's log book. There may be some drift between the two calibration values, depending on the amount of elapsed time between the pre-calibration and post-calibration.

When calibrating the units, use the function and cursor keys on the Surveyor 4 read-out units (FIGURE 1.3) to navigate through the procedure.

Try running through the calibration procedure again if the readout states "**calibration out of range**". If the problem occurs again, it may be that the probe in question needs the reference solution replaced. Use fresh reference solution (be sure it hasn't expired) and replace the probes old solution. If the probe will still not calibrate, make notes in the calibration book regarding the

problem and have it shipped back to the manufacturer for repair. Do not put the faulty unit back into the cabinet.

1.4.2.1 Specific Electrical Conductance Calibration

There are normally three conductivity standards found in the lab area, 0.1 Molar (M), 0.01 M and 0.001 M potassium chloride (KCl) solutions. Use the 0.01 M KCl unless your site has low or high conductivity. These three standards are typically sufficient for most conditions encountered in the field. The ranges and values assigned to the standards are in most cases given in micro Siemens per centimeter (µS/cm).

When calibrating with the KCl standards, ensure that the solutions have not exceeded the expiration date.

Standard solutions can be disposed of in the lab sink, using tap water to dilute and rinse equipment.

1. Rinse the sensors three times with a half full calibration cup of deionized water to clear the probes of contaminants.
2. Use a paper towel or other non-abrasive absorbent material and dry the electrodes of the Electrical Conductivity (EC) probe. When the electrodes are dry, use the calibration menu on the readout unit to set the EC value to **zero** and push **enter** to save. This is the 1st point of the 2 point calibration. Rinse the sensors one additional time with DI water.
3. Rinse the sensors two times with a small amount of KCl standard solution. Try to use a solution that has a conductivity range somewhere near the conditions expected to be seen in the field.
4. Pour in the same KCl standard that was used when rinsing, until the conductivity electrodes are covered with the solution. Make sure there are no bubbles attached to the EC chamber; if bubbles are present, gently tap the cup to dislodge them.
5. Check the EC readings and look for stabilization of the value before continuing. EC readings are corrected to 25° C, regardless of the ambient temperature of the solution.
6. Use the calibration button on the readout unit to adjust the EC value to the conductance value of the KCl solution; press **Enter**. This saves the calibration reading.
7. If other probes need calibrating, discard the KCl solution and rinse the cup and sensors 2 times with deionized water. When the EC calibration is completed, discard the KCl solution into the sink and flush with tap water. When storing the unit, add a small amount of tap water in the cup to keep the probes moist.

1.4.2.2 pH Calibration

When performing a pH calibration, always check the buffer solutions being used and make sure that they are still within the expiration period specified on the container. pH calibration is performed by measuring two buffer solutions of differing and known pH values. This allows the sensitivity, or slope, to be determined. If acidic conditions are expected at the sample site, calibrate using the 4.0 buffer solution and the 7.0 buffer solution. If the sample site typically shows basic conditions of above pH 7, use the 7.0 buffer and the 10.0 buffer.

Always use the 7.0 buffer first and then either the 4.0 or the 10.0 to establish the slope. Because of the basic nature of Arizona's soils, most surface waters are usually above a pH of 7.0.

1. Rinse the cup and sensors two times with a small amount of the 7.0 pH buffer solution.
2. Fill the calibration cup with enough of the 7.0 pH buffer solution to completely cover the pH electrode.
3. Let the temperature and pH values stabilize before recording the current pH value.
4. Use the calibration menu to reset the pH value to 7.00. Save the new calibration value. Record the new value given by the unit in the log-book.
5. Repeat procedures 1 through 4 with a slope solution of either pH 4.00 or pH 10.00.

1.4.2.3 Dissolved Oxygen Calibration

Calibration of the dissolved oxygen (DO) probe is performed in the storage cup of the Minisonde unit. Before beginning the calibration process, check the membrane on the DO probe for wrinkles and tears. There should not be any air bubbles present under the membrane. If any of these conditions are present, the membrane should be replaced with a new one before calibration. Hydrolab recommends that the unit be allowed to sit overnight after replacing the membrane. This allows the membrane to stretch and conform itself to the probe. Although calibration can be performed using a known DO concentration, it is easier to use percent saturation DO. Saturation of oxygen in water is determined by air pressure. Most probes have builtin barometers. Use a hand held altimeter capable of reporting ambient air pressure if a probe doesn't have a built in barameter.

1. Fill the calibration cup with tap water to below the DO probe membrane (water must not cover the membrane).
2. If needed, blot the DO membrane gently with a lint-free absorbent cloth or tissue to remove any water droplets. Use a material that is non-abrasive.
3. Invert the cap and slide it over the top of the calibration cup, and let the unit sit for about 5 minutes to allow the conditions inside the cup to stabilize. Do not screw the cap back on. This will increase pressure inside the calibration cup.
4. Use the hand-held altimeter or the barometer in the unit to measure the ambient air pressure (the terms "air pressure" and "barometric pressure" are equivalent). If a barometer is not available or not functioning properly, contact a nearby airport. If the calibration site is at approximately the same elevation and is not too distant from the airport, the air pressure reading should be usable for calibration purposes.

Barometer readings from the Hydrolab or handheld barometer are usually "true" (uncorrected) values of air pressure and can be used "as is" for dissolved oxygen calibration. Weather service readings are usually not "true", i.e., they are corrected to sea level, and therefore cannot be used until they are "uncorrected". An approximate formula for this "uncorrection" (where the BP readings MUST be in mm Hg) is: True BP = [Corrected BP] – [2.5 * (Local Altitude in feet above sea level/100)]. Also note, 25.4 mm of Hg = 1 inch of Hg.

If an altimeter is not available or the altimeter on hand is not functioning properly, there is a basic rule of thumb that can be used to obtain air pressure. Standard pressure at sea level is 29.92 inches of Hg. Atmospheric pressure decreases with increasing altitude. For every increase of 1,000 feet in elevation above sea level, air pressure will decrease approximately 1.0 inch of Hg. This simple formula can be useful, but may not hold up well in cases where there is a DO exceedance that cannot be attributed to naturally occurring conditions. Be sure to qualify the DO data if this method has to be used.

5. Before calibrating the DO probe, record the pre-calibration percent saturation value after the unit has stabilized. Using the calibration menu for % saturation, enter the barometric pressure when prompted. Record the new DO percent saturation reading, which should be at or near 100%. The reading should be stable for about 20 to 30 seconds. If DO is being measured at a number of sites and at substantially different elevations, the unit should be calibrated at each site. Most stream and lake sampling will require DO calibration at each site.

1.4.3 YSI CALIBRATION PROCEDURES

Before Calibrating the YSI, connect the Sonde to the unit via cable and turn unit on. Highlight **sonde run** and press **enter**. FIGURE 1.4 shows the basic components of the YSI Sonde and Surveyor.

FIGURE 1.4. YSI Multiprobe for streams

1.4.3.1 Dissolved Oxygen

1. With the calibration cup on the sonde, open up the cap and place approximately 3 mm (1/8 inch) of water in the bottom of the calibration cup. Make certain that the DO and

temperature probes are not immersed in the water and are dry (use chem wipe to dry). Engage only 1 or 2 threads of the calibration cup to ensure the DO probe is vented to the atmosphere. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for the temperature to equilibrate.

2. Press **escape** to return main menu. Select **sonde menu** and press **enter** to connect Sonde to unit. Select **calibrate**, then **dissolved oxy**, and **DO sat**%. *Calibration of dissolved oxygen in the DO % procedure also results in calibration of the DO mg/L mode and vice versa.*
3. Next enter the barometric pressure (mmHg) located at the right bottom of the screen and press **enter**. Allow to stabilize and press enter.
4. Return to the 650 main menu by pressing **escape** 3 times and select sonde run. Allow to stabilize.

The true values for dissolved oxygen, conductivity, and pH should be recorded from the sonde run menu and not the calibration menu.

5. Record the DO% value in the equipment logbook.

1.4.3.2 Conductivity

1. With the calibration cup attached to the sonde, rinse the cup and conductivity sensor with a small amount of the standard that will be used and discard rinse. Avoid cross-contamination of standard solutions with other solutions. Make certain that there are no salt deposits around the oxygen and pH probes, particularly if employing standards of low conductivity.
2. Fill the calibration cup with the appropriate standard solution until the conductivity probe is completely immersed in the solution. Gently rotate and/or move the sonde up and down to remove any bubbles from the conductivity cell.
3. Allow at least one minute for the temperature to equilibrate before proceeding.
4. From the calibrate menu select **conductivity** and then **SpCond**. Enter the calibration value of the standard (mS/cm at 25°C) and press **enter**. The current values of all enabled sensors will appear on the screen.
5. Once the specific conductivity value becomes stable press **enter**. The screen will indicate that the calibration has been accepted. When prompted, press **enter** again to return to the calibrate menu.
6. Return to the 650 main menu by pressing **escape** 3 times and select **sonde run**. Allow to stabilize.
7. Record the conductivity value in the equipment logbook.
8. Rinse the sonde in tap or purified water and dry the sonde.

1.4.3.3 pH

1. Rinse the pH probe and calibration cup with pH 7 buffer and discard solution.
2. Fill the calibration cup just above the pH probe with pH 7 buffer.
3. From the calibrate menu, select **ISE1 pH** to access the pH calibration choices and then press **2 Point**. Enter the value of the buffer solution (7.0) and press **Enter**.

4. The current values of all enabled sensors will appear on the screen and change with time as they stabilize in the solution. Allow the pH value to stabilize and press **enter** to calibrate.
5. After the pH 7 calibration is complete, press **enter** again, as instructed on the screen, to continue.
6. Rinse the probe with pH 10 buffer and then fill the calibration cup above the probe with pH 10 buffer.
7. Enter the value of the second pH solution (10.0) and press **enter**. Allow to stabilize.
8. The current values of all enabled sensors will appear on the screen and change with time as they stabilize in the solution. Allow the pH value to stabilize and press **enter** to calibrate.
9. After the second calibration point is complete, press **enter** again, as instructed on the screen, to return to the Calibrate menu.
10. Return to the 650 main menu by pressing **escape** 3 times and select **sonde run**. Allow to stabilize.
11. Record the pH 10 value in the equipment logbook.
12. Rinse the pH probe and calibration cub with pH 7 solution and discard rinse. Fill the calibration cup above the probe with pH 7 buffer and let the value stabilize. Record pH 7 value in the equipment logbook.
13. Rinse the sonde and calibration cup in water and cap the cup with 1/8 inch of water for storage.

The majority of environmental water of all types has a pH between 7 and 10. If a site will have a low pH then use the pH 4 and 7 buffer solutions to calibrate.

1.4.4 MULTI-PARAMETER TROLL 9000

1.4.4.1 General Calibration Procedures

The Multi-Parameter Troll (MPT) can be used to measure pH, specific conductivity, and dissolved oxygen (DO). The following sections describe the procedures for calibrating each of these parameters. Complete records including the date, pre- and post- calibration values, calibration standard lot numbers and expiration dates, any maintenance performed (e.g. change DO membrane), and any problems encountered during calibration should be recorded in the field book associated with each probe.

Each field case should contain the MPT probe, pH, conductivity, and DO sensors, sensor maintenance kits, a calibration cup (Cal Cup), flow restrictor, stirrer, sensor insertion tool, sensor extraction tool, field book, and computer connection cable.

Maintenance kits for each of the sensors should contain the following:

1. DO Kit
    a. Extra Membranes
    b. DO Polishing Strips
    c. Silicon Grease
    d. 10% NH3 Cleaning Solution

e. DO Electrode Filling Solution
f. Cleaning Brush
g. Storage Bottle

2. Conductivity
   a. Silicon Grease
3. pH
   a. Silicon Grease
   b. Storage Bottle

Maintenance work on the units is normally done on a quarterly basis; equipment that is not being regularly used should be maintained every six months. A computer with Win-Situ 4.0 software installed is required for calibration; the MPT should be calibrated prior to the start of field work, recalibrated as conditions dictate (i.e. changes in barometric pressure) and the calibration checked at the completion of field work.

1.4.4.2 Conductivity

Conductivity should be calibrated first to avoid carry-over from other standards (e.g. pH buffers are highly conductive). Prior to calibration make sure that the conductivity sensor is installed and clean. To install the sensor:

1. Remove any moisture or dirt and use the sensor removal tool to remove the plug or sensor from port 4 (FIGURE 1.5). Retain the plug for future use. The sensor can be cleaned by rinsing it with tap water, then with deionized water, followed by a rinse with the solution to be used for calibration.

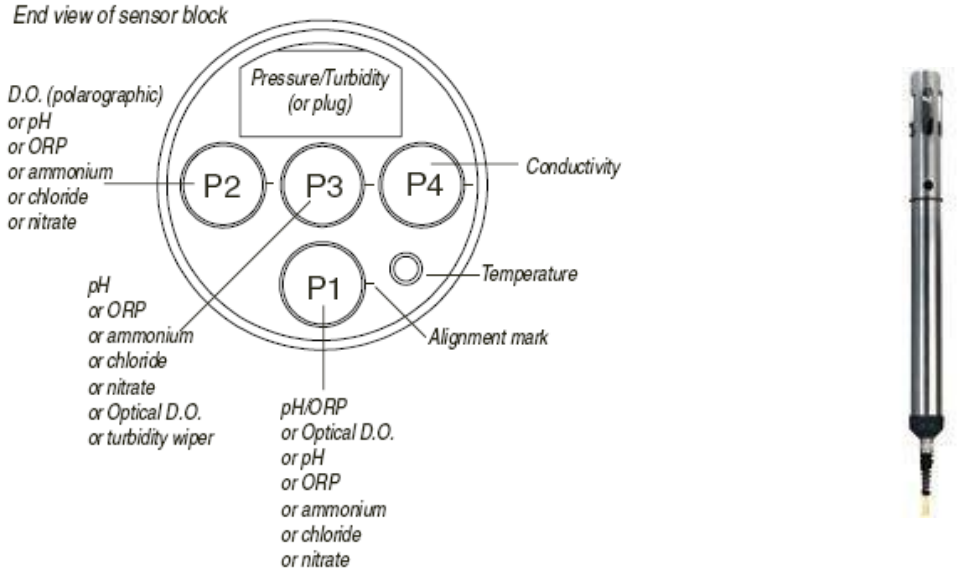


FIGURE 1.5. Sensor Port Configuration (left). Troll 9000 (right).

2. Check lubrication of the sensor o-rings.
3. Handle the sensor by the sides, not the tip and align the mark on the side of the sensor with the mark on the port.

4. Use the sensor insertion tool to press the sensor into the port until it docks with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.

ADEQ purchases with 0.1 M, 0.01 M and 0.001 M potassium chloride (KCl) solutions that have been prepared, tested and assigned an acceptable range and usually a tested lab value. These standards are typically sufficient for most conditions encountered in the field. If a site has unusually high conductivity readings, it may be necessary to have the lab prepare a standard that more closely resembles the site conditions. The ranges and values assigned to the standards are in most cases given in microSiemens per centimeter (µS/cm).

As a general rule, a mid-range solution (0.01M; 1,434 µS/cm) should be used to calibrate the MPT unless site conditions dictate use of a different solution. When calibrating with the KCl standards, insure that the solutions have not exceeded the expiration date. Standard solutions can be disposed of in the lab sink, using tap water to dilute and rinse equipment. The following steps will be followed to calibrate the conductivity probe on the MPT:

1. With the conductivity sensor installed and plugs or sensors in the other sensor ports, rinse the front end of the MPT with tap water.
2. Insure the PVC base is attached to the Cal Cup, triple rinse and fill the Cal Cup to the fill line with the selected calibration solution. If all the sensors are installed use the lower fill line as a guide (about half full), otherwise fill to the upper line.
3. Insert the front end of the MPT into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid over tightening. Ensure that the conductivity probe is completely immersed in standard. The hole in the side of the probe MUST be under the surface of the solution and NOT have any trapped bubbles in the openings.
4. Connect the MPT to a PC with the computer connection cable and establish a connection in Win-Situ 4.0.
5. Select the **MPT** in the Navigation tree. The software will automatically detect and display the installed sensors. If one or more sensors are installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then "refresh" the device before continuing.
6. Select **conductivity** in the Parameters list. The sensor serial number (SN), type, and recent calibration information is shown. Select Calibrate. The Conductivity Calibration Wizard starts.
7. Select the calibration solution the sensor is soaking in and select **Next** to continue.
8. In the next screen, select **Run** to begin the stabilization. The display will continuously update as readings are taken and compared against the stabilization criteria. Status indicators:
    a. NOT TESTED is displayed until the calibration is selected by pressing **Run**.
    b. UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.
    c. NOMINAL indicates the sensor deviation meets early stabilization criteria.

The Accept button becomes available when nominal stability is achieved, wait until STABLE appears before selecting the Accept button. Calibration proceeds automatically to the next screen. Temperature at the time of calibration is displayed for your information.

Most sensors stabilize within 1-3 minutes if the sensor is properly hydrated before calibration. To minimize stabilization times, do not handle the instrument during the time the sensor is taking readings in the calibration solution.

9. The final screen shows the new cell constant (Kcell) calculated for the selected range during the calibration process. The cell constant should range between 0.34 – 0.4.
10. Select **Finish** in order to program the sensor with the displayed cell constant. The conductivity sensor is now calibrated and ready to use in the range for which it was calibrated.

1.4.4.3 pH

Prior to calibration make sure that the pH sensor is installed and clean. To install the sensor:

1. Remove any moisture or dirt and use the sensor removal tool to remove the plug or sensor from port 1 (FIGURE 1.5). Retain the plug for future use. The sensor can be cleaned by rinsing it with tap water, then with deionized water, followed by a rinse with the solution to be used for calibration.
2. Check lubrication of the sensor o-rings.
3. Handle the sensor by the sides not the tip and align the mark on the side of the sensor with the mark on the port.
4. Use the sensor insertion tool to press the sensor into the port until it docks with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.

The following steps will be followed to calibrate the pH probe on the MPT:

1. With the pH sensor installed and plugs or sensors in the other sensor ports, rinse the front end of the MPT.
2. Insure the black PVC base is attached to the Cal Cup. Triple rinse the Cal Cup and fill to the fill line with the selected calibration solution. Begin with the lowest buffer value when performing a multi-point calibration. If all the sensors are installed use the lower fill line as a guide (about half full), otherwise fill to the upper line.
3. Insert the front end of the MPT into the open end of the Cal Cup. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid over-tightening.
4. Connect the MPT to a PC and establish a connection in Win-Situ 4.0.
5. Select the **MPT** in the Navigation tree. The software will automatically detect and display the installed sensors. If one or more sensors are installed in the wrong port, an error message will be displayed. Simply remove the sensor and install it in the correct position, then "refresh" the device before continuing.
6. Click to select **pH** in the Parameters list. The sensor serial number (SN) and recent calibration information is displayed. Select **Calibrate**.

7. Select the number of calibration points for this calibration and the pH value of the calibration solution for each point. Cal point 1 is the solution the sensor is soaking in now. Select **Next** to continue.
8. In the next screen, select **Run** to begin the stabilization. The display will continuously update as readings are taken and compared against the stabilization criteria. Status indicators:
    a. NOT TESTED is displayed until the calibration is selected by pressing **Run**.
    b. UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.
    c. NOMINAL indicates the sensor deviation meets early stabilization criteria. The Accept button becomes available when nominal stability is achieved; don't press the Accept button until a STABLE indicator is displayed.
9. If doing a one-point calibration, go to step 12.
10. For a multi-point calibration, remove the Cal Cup, discard the first solution, triple rinse and refill the Cal Cup with the second solution.
11. Select **Run** to begin the stabilization for the second calibration point. Status indicators and controls are the same as for the first calibration point (Step 8).
12. The final screen shows the sensor slope and offset calculated during the calibration process. For a three point calibration, two sets of calculated coefficients will be shown. The slope should range between -50 mV/ph and -62 mV/ph. A value outside this range may indicate a bad sensor and a replacement should be obtained.
13. Select **Finish** in order to program the sensor with the newly calculated calibration coefficients. The pH sensor is now calibrated and ready to use.

1.4.4.4 Dissolved Oxygen

The D.O. sensor performs best in clean water. In environments with high organic content, the membrane can become fouled. Rips, tears, and other damage will also affect membrane performance. For best results, replace the membrane when the slope and offset calculated during calibration change dramatically, and also after a long-term deployment. Whenever the membrane is changed, the sensor must be filled and conditioned for 24 hours prior to calibration. Because the amount of oxygen that can be dissolved in water changes with changing barometric pressure, DO should be recalibrated whenever there is a change in elevation or weather induced pressure fluctuations.

The procedure for filling and changing the membrane is as follows:

1. Remove the soft protective caps from the membrane end and the connector end of the sensor.
2. Remove the membrane module from the sensor body and fill with electrolyte as follows:
    a. Holding the membrane module open-end up, position the electrolyte dispenser against the side of the module without touching the membrane and fill slowly.

To eliminate air bubbles, tap the side of the module briskly with your fingernail or small tool.

3. Insert the sensor into the open end of the membrane module. To minimize air, some of the electrolyte should overflow from the open end as the sensor is inserted.
4. Thread the membrane module to the D.O. sensor.

Install and condition the probe as follows:

1. Remove any moisture or dirt and use the sensor removal tool to remove the plug or sensor from port 2 (FIGURE 1.5). Retain the plug for future use.
2. Check lubrication of the sensor o-rings.
3. Handle the sensor by the sides, not the tip and align the mark on the side of the sensor with the mark on the port.
4. Use the sensor insertion tool to press the sensor into the port until it docks with the connector at the bottom. When properly inserted a small gap (width of the sensor removal tool) remains between the widest part of the sensor and the instrument body, for ease of removal.
5. Put a small amount of clean water in the clean Cal Cup and attach it loosely to the instrument. Do not seal the Cal Cup; it should be at ambient pressure. The sensor membrane can be submerged or above the water level.
6. Connect the MPT to a PC and establish a connection in Win-Situ 4.0.
7. Select the **MP TROLL 9000** in the Navigation tree. All installed sensors will be displayed. Powering of the D.O. sensor begins as soon as the software recognizes the D.O. sensor and displays it in the Navigation tree. This starts the conditioning process.

It is not necessary to maintain the computer connection; conditioning continues as long as the sensor is installed. Be sure the membrane does not leak. There should no be any drops on the surface or visible air bubbles under the membrane. Condition the sensor for 24 hours before calibrating.

The following steps will be followed to calibrate the DO probe on the MPT:

1. With the D.O. sensor installed, conditioned and plugs or sensors in the other sensor ports, rinse the front end of the MPT thoroughly in clean water to remove contaminants and traces of fluids used for earlier calibrations.
2. Dry the D.O. sensor membrane by shaking the probe and/or gently wiping with a soft swab or the corner of a tissue. Be careful not to damage the membrane.
3. Triple rinse the Cal Cup with tap water and attach it to the MPT. Thread the Cal Cup onto the body until seated against the o-ring, then back off slightly to avoid over tightening.
4. Invert the Troll with Cal Cup attached and remove the black end cap.
5. Gently fill the Cal Cup with clean water until the temperature sensor is completely covered and the membrane at the tip of the D.O. sensor is in air. If any water splashes onto the membrane, gently dry it again.
6. Loosely attach the end cap to the Cal Cup. For proper venting, a small hole in the threads of the cap should be at least partly visible. A clamp or other support may be used to maintain the TROLL 9000 in this inverted position.
7. Connect the MPT to a PC and establish a connection in Win-Situ 4.0.

8. Select **MP TROLL 9000** in the Navigation tree. The software will automatically detect and display the installed sensors.
9. Select **Dissolved Oxygen** in the Parameters list. The sensor serial number (SN) and recent calibration information is displayed.
10. Select **Calibrate**. The D.O. Calibration Wizard starts.
11. Select the number of calibration points; in general a one-point calibration in air will yield satisfactory results. Refer to the MPT operator's manual for a two-point calibration in water.
12. Select the membrane type (the thickness is stamped on membrane module; if not marked, it's a **1-mil Teflon**). Be sure the correct membrane type is selected.
13. Select **air** for first calibration point.
14. Select the default stimulus at saturation. This value is calculated by the software at the current temperature and barometric pressure. Click **Next** to continue
15. Select **Run** to begin stabilization for the first calibration point. The display will continuously update as readings are taken and compared against the stabilization criteria.

Status indicators:
NOT TESTED is displayed until the calibration is selected by pressing Run.
UNSTABLE indicates the sensor response does not meet the criteria for a valid calibration point.
NOMINAL indicates the sensor deviation meets early stabilization criteria.

The Accept button becomes available when nominal stability is achieved; don't press the Accept button until a STABLE indicator is displayed. The calibration proceeds automatically to the next screen. The calculated sensor slope and offset are shown.

A properly functioning sensor with a 1-mil membrane will have a slope in a range of 30-67 nA/(mg/l). Anything outside this range suggests a problem with either the membrane or the sensor. Install a new membrane; if problems persist, a new sensor may be needed. Additionally, the default offset should read 2nA.

16. Select Finish in order to program the sensor with the new calibration coefficients.

1.4.4.5 Storage

If the instrument will be deployed in a day or so, leave all the sensors installed in the MPT. The sensors can be stored for up to two weeks in the instrument with a moist sponge in the bottom of the Cal Cup to provide a moist environment. For long-term storage, the water quality sensors should be returned to their original packaging and the lubricated o-rings should be protected from dust and dirt. The conductivity sensor should be removed, rinsed and stored dry. The pH cannot be stored dry, in order to preserve the sensor's reference solution, store the sensor in the electrode storage bottle in a strong potassium chloride (KCl) solution. Ensure the bulb is immersed to keep it hydrated. The DO sensor should be rinsed with deionized water, capped, and stored dry.

1.4.5 INSITU CALIBRATION

The pH sensor should be stored in pH storage solution or pH 4 when not in use. This should be done anytime the instrument is not deployed for more than 5 days.

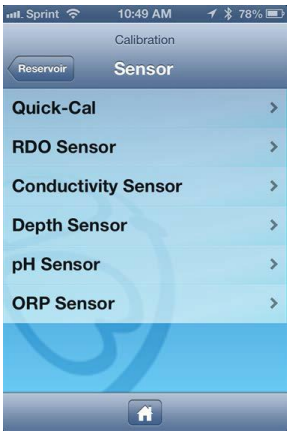
DO NOT remove RDO cap unless replacing!

1.4.5.1 Preparation for Use:

1. Take the orange pH port plug out of the sonde unit.
2. Locate the pH probe in the sensor storage bottle and remove.
3. Insert probe into unit.
4. Store sensor storage bottle in safe location.
5. Put batteries in blue tooth unit.

1.4.5.2 Calibration

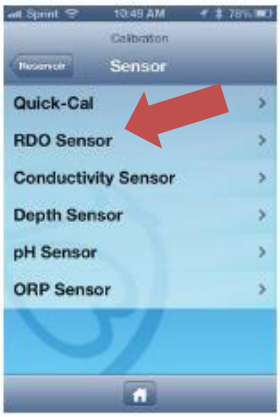
Tap the Calibration icon  in the inSitu App to access a list of sensors that are available for calibration.



1.4.5.2.1 Dissolved Oxygen

Use the vented cup for calibration

1. Tap the Calibration icon.
2. Tap RDO Sensor.



3. Select 100% Saturation.
4. Place a water-saturated sponge in the bottom of the calibration cup. Place the instrument into the calibration cup, and tap Start.

5. When the calibration is stable, tap the Accept button.
6. To view the calibration report, tap View Report.
7. Rinse the sensors thoroughly with DI water.

1.4.5.2.2 Conductivity Sensor

1. Tap the Calibration icon to access a list of sensors that are available for calibration.
2. Tap Conductivity Sensor.
3. Tap 1-Point Calibration.
4. Make sure the vented cap is installed on the calibration cup. Fill the cup to the fill line with calibration standard. Place the instrument into the calibration cup, and tap Start.
5. inSitu automatically detects the calibration standard. If not, tap the white box and type in true value of standard.

If your calibration standard references 20° C, tap the Thermometer icon and change the reference temperature.

6. Once the calibration is stable, tap the Accept button.
7. To view the calibration report, tap View Report.
8. Rinse the sensors with DI water.

1.4.5.2.3 pH Sensor

1. Tap the Calibration icon to access a list of sensors that are available for calibration.
2. Tap pH Sensor.
3. Tap 2-Point Calibration.
4. Make sure the vented cap is installed on the calibration cup. Fill the cup to the fill line with the first calibration buffer. Place the instrument into the calibration cup, and tap Start.
5. When the calibration is stable, tap the Accept button.
6. Fill the cup to the fill line with the second calibration buffer. Place the instrument into the calibration cup, and tap Start.
7. When the calibration is stable, tap the Accept button.

8. To view the calibration report, tap View Report. Document the stabilization of the pH 7 and check Live Reading screen for pH 10 and record value.

1.4.5.3 How To Store:

1. Take pH probe out of unit and insert orange pH port plug into unit.
2. Take pH probe and put on o-ring and cap. Store probe in sensor storage bottle with appropriate solution (see Section 9.4.1.3 Insitu Maintenance).
3. Take batteries out of blue tooth.

1.5 CLEANING EQUIPMENT

1.5.1 CHURN SPLITTER, DH 81 AND SAMPLE BOTTLE CLEANING

Prior to field use, the churn splitter must be cleaned as follows.

1. Wash outside and inside surfaces of the equipment (Chrun, DH81 & sample bottle) thoroughly with tap water and a non-phosphate (e.g., Liquinox) detergent using a non-metallic stiff long-handled brush and let soak for thirty minutes. Before emptying container, run about 100 milliliters of the soap solution through the spigot.
2. Rinse all surfaces thoroughly with tap water.
3. Rinse inside surfaces thoroughly with 500 milliliters of 5% hydrochloric acid (HCl). Run some of the HCl solution through the spigot; however, if the churn splitter contains a metal spring in the spigot, do not open the spigot. For field cleaning, discard acid in a bucket with enough limestone or suitable material to neutralize the acid until it can be disposed of properly at the laboratory. For laboratory cleaning, discard used acid in a waste container labeled "HCl waste" or flush down sink with a copious amount of running water.

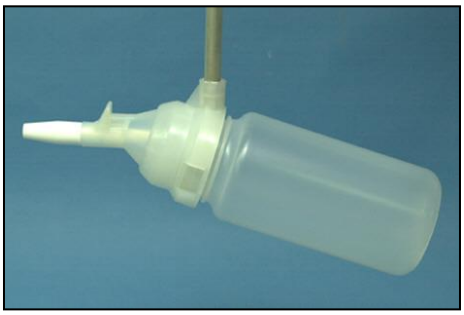


FIGURE 1.6. DH-81nozzle and bottle.

4. Rinse all surfaces thoroughly (at least twice) with de-ionized water.
5. After the second rinse, pour approximately 2 liters of de-ionized water into the churn. Swirl the water in the churn; then check the pH with test strip paper. If less than 5.5 SU, discard rinse water and rinse again with de-ionized water.
6. Set cleaned equipment on a suitable drying rack in a contaminant free environment.
7. Double wrap the churn with clean heavy-duty trash bags to protect from contaminants during storage and transportation. Place cleaned DH-81 parts in heavy duty sandwich bags to protect from contaminants.

1.6 FILTRATION AND TUBING

Silicon tubing is needed if dissolved metals are to be collected. The silicon-based tube should be cut to length in the lab before going into the field. While cutting the tubing, wear a pair of clean lab gloves and make the cut with a ceramic knife on a clean surface to prevent contamination of

the tubing. After cutting the pieces to length (one tubing per site, plus any extra needed for QA/QC samples), place them in a clean, sealable plastic bag for transport to the monitoring sites.

Do not allow tube ends to come in contact with any surfaces either in the lab or in the field.

1.7 SITE RECONNAISSANCE

Site reconnaissance a vital part of preparing for a sampling run. The reconnaissance may be as simple as looking up the information on the database to see how to get there and determining who owns the property or it may require a special visit to determine if the site is accessible.

At a minimum the following questions should be considered before heading to a site.

- Who owns the land?
- If it is a private owner, did they grant access just for one trip or for multiple trips? Do they want to be notified before you come?
- Are the directions adequate? Do you need to rewrite them?
- Will the sampling crew need a DH81 or churn splitter?
- Is the site perennial, intermittent or ephemeral?

The Monitoring Unit uses a random design for a portion of their sites. These sites typically need to be visited because ADEQ may not have an established site located nearby. The Monitoring Unit uses the Stream Reconnaissance Form to identify potential random sites (FIGURE 1.7).

STREAM RECONNAISSANCE FORM

SITE NAME:		DATE:	_ _ / _ _ / _ _ _ _
RANDOM SITE ID:	_ _ _	TEAM:	

SITE PERMISSION

LAND OWNER:	☐ Forest Service ☐ BLM ☐ State ☐ Other (Describe here): _____ ☐ Private (Fill in Private Owner Information)
PRIVATE OWNER NAME:	
PRIVATE OWNER PHONE:	
PRIVATE OWNER ADDRESS:	
WAS ACCESS GRANTED BY PRIVATE OWNER?	☐ Yes for all quarters; do not contact again ☐ Yes but wants to be notified each quarter ☐ No – Owner denied access ☐ No – Could not contact owner
COPY OF RESULTS?	☐ Yes ☐ No

SITE LOCATION

LATITUDE OF X SITE (NAD 27):	_ _ ° _ _ ' _ _ . _ "	LONGITUDE OF X SITE:	_ _ _ ° _ _ ' _ _ . _ "
WAS THE X SITE MOVED?	☐No ☐Yes If Yes, X Site Moved due to: ☐ Access Issues (describe in comments) ☐ Flow Issues (describe in comments) ☐Other (describe in comments)		
LATITUDE OF MOVED X SITE:	° ' . "	LONGITUDE OF MOVED X SITE:	° ' . "

SAMPLE

IS A DH-81 AND A CHURN SPLITTER NEEDED?	☐ Yes ☐ No
DID YOU SAMPLE THIS SITE?	☐ Yes ☐ No
IF NO, WHY?	☐ Target - Only reconnaissance was completed ☐ Non-target - Site currently dry; verified ☐ Visually ☐ Told it was dry by: _____ ☐ Non-target - Stream not perennial ☐ Non-target - Wetland ☐ Non-target - Map error ☐ Non-target - Access permission denied ☐ Non-target - Permanently Inaccessible (Unable/unsafe to reach site) ☐ Non-target - Temporarily inaccessible (Explain in comments) ☐ Other (Explain in comments)

DIRECTIONS TO SITE

SITE RECONNAISSANCE FORM

COMMENTS

SITE PHOTOS

☐ Not Applicable. Site sampled and site photo information is included with field forms.

Photo Identifier	Description

FIGURE 1.7. Stream Reconnaissance Form.

1.8 SAMPLING PREPARATION FOR STREAM ECOSYSTEM MONITORING

Chapter 7 covers how to conduct Stream Ecosystem Monitoring (SEM). SEM requires looking up the following information before going into the field (See Section 7.4).

- Flow regime
- Flow regime category
- The fields listed under the stream type identification (Watershed Area, Valley Type)
- Sinuosity and Slope
- Elevation (for riparian association)

This information will enable the samplers to determine the stream type in the field and verify that the measured bankfull width corrilates with the bankfull widths predicted by the regional curves.

CHAPTER 2 GENERAL FIELD PROCEDURES

This chapter covers general sampling information including field forms, decontamination procedures in the field and site safety.

2.1 FIELD DATA SHEETS

There are several different versions of field data sheets for the Monitoring or TMDL Unit based on the particular waterbody or study of interest. The Monitoring Unit typically uses the form listed in FIGURE 2.1. The Lake Program's field data sheets also must take into account depth and other lake specific parameters such as water clarity. TMDL's field datasheets are site specific.

ADEQ Arizona Department of Environmental Quality

AMBIENT STREAM MONITORING FIELD FORM

1.1 CHEMISTRY SITE INFORMATION

Site Code	_ _ _ _ _ _ _ _ . _ _	Date	_ _ / _ _ / _ _ _ _	Sample Time	
Site Name				Field Crew	

1.2 FIELD DATA

E. coli		CFU	TDS (meters give g/L)		mg/L
Air Temp.		°C	Sp Cond.		µS/cm
Water Temp.		°C	pH		SU
D.O.		mg/L	Turbidity		NTU
D.O. %		%			

1.3 FIELD CALIBRATIONS

% D.O.	Barometric Pressure in mm Hg =	Post-cal. Reading =	%
Turbidity	Standard =	Standard solution reading =	% Diff =

% Diff = ((Standard Value – Measured Value)/Standard Value) * 100 Typically < 0.5 NTU for lowest standard
Acceptable difference is 0-10%. Rerun if between 5-10%. Do not enter turbidity into WQDB if % difference is greater than 10%.

1.4 SAMPLE COLLECTION INFORMATION

☐ Grab ☐ Equal Width Increment (EWI) ☐ Modified EWI ☐ Equal Discharge Increment

Circle where grab sample taken	LEW----- ¾ ----- ½ ----- ¼ -----REW	Run ☐, Riffle, ☐, Pool ☐

1.5 QUALITY CONTROL SAMPLE INFORMATION

Type of QC Sample (ie blank, dup, etc)	Your Identifying Code	Lab Tracking Number

1.6 FLOAT METHOD DISCHARGE MEASUREMENT

								Average Time	
Width, ft	X	Depth, ft	X	Velocity, ft/s	X	0.85	=		cfs

Form Checked by

1.7 DETERMINING AMMONIA DETECTION LIMIT

Instructions: Ammonia's standard is dependent on pH and temperature. Use the following table to determine if a detection limit of 1 mg/L is sufficient or if a low level detection limit must be requested. Circle value on table. If a lower detection limit is needed then add "low level ammonia" on the chain of custody in the comments section.

☐ Lower detection limit not needed (standard above 1 mg/L)
☐ Requested lower detection limit (standard below 1 mg/L). Added request to chain of custody.

pH	Temperature, °C									
	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.33	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

☐ Default detection limit sufficient ☐ Request low level ammonia on COC.

Form Checked by

FIGURE 2.1. Field data sheet for ambient stream monitoring.

ADEQ – AMBIENT STREAM MONITORING FIELD FORM — REVISED DECEMBER 2013

1.8 SITE OBSERVATIONS (CHECK ALL THAT APPLY UNLESS INDICATED OTHERWISE)

General appearance in the channel	No refuse visible ☐; Small refuse visible ☐; Small volume refuse common ☐; Large volume refuse (tires, carts) rare ☐; Large volume refuse common ☐.
General appearance along the banks	No refuse visible ☐; Small refuse visible ☐; Small volume refuse common ☐; Large volume refuse (tires, carts) rare ☐; Large volume refuse common ☐.
Water Clarity	Clear ☐; Milky ☐; Light brown ☐; Dark brown ☐; Oily sheen ☐; Greenish ☐; Other_____
Water odor	None ☐; Sewage ☐; Chlorine ☐; Fishy ☐; Rotten eggs ☐; Other_____
Appearance at water's edge (check one)	No evidence of salt crusts ☐; White crusty deposits rare ☐; Numerous white crusty deposits ☐; Banks covered with white crusty deposits ☐.
Fish presence (check one)	Absent ☐; Rare ☐; Common ☐.
Crayfish presence	Absent ☐; Rare ☐; Common ☐.
Sunfish presence	Absent ☐; Rare ☐; Common ☐.
Bull frog presence	Not Observed ☐; Observed ☐
Leopard frog presence	Not Observed ☐; Number observed alive_____; Dead_____
Floating leaves or other organic matter (not algae) (check all that apply)	Absent ☐; Rare ☐; Common ☐.
Leaves or other organic matter on streambed	Absent ☐; Rare ☐; Common ☐.
% Algae cover in the wetted width of the stream 10 meters above and below sample point	%
% Macrophytes cover in the wetted width of the stream 10 m above and below sample point	%

1.9 E. COLI

Collection Time		Incubation Time		Enumeration Time	
Reagent Used?	☐ Colilert 18 (incubation time = 18 to 22 hours) ☐ Colilert (incubation time = 24 to 28 hours)				
Flag (Incubation/Holding Time Exceeded?)					

Holding time is 6 hours from collection. Incubation Period is 18 hours for Colilert technique

COLILERT RESULTS

Regular/ Duplicate/ Blank	Number Large Wells Positive	Number Small Wells Positive	Most Probable Number (from Table)

Form Checked by _____

Page 3 of 6

ADEQ – AMBIENT STREAM MONITORING FIELD FORM — REVISED DECEMBER 2013

1.10 EVENTS

THIS TABLE INCLUDES FIELD RELATED EVENT CODES YOU WILL ENTER INTO THE WQDB. CHECK THE BOX NEXT TO ALL APPLICABLE EVENTS. USE THE EVENT FLAGS (F1, F2, ETC.) IF YOU WANT TO INCLUDE A COMMENT FOR A PARTICULAR ITEM THAT YOU CIRCLED. INCLUDE FLAG COMMENTS IN SPACE PROVIDED BELOW. IT IS VERY IMPORTANT THAT RECENT OR CURRENT FLOODING BE FLAGGED.

* = FILL OUT EVERY TIME. YOU MUST FLAG AND EXPLAIN IF THESE ARE NOT CHECKED.

Check	Description	Flag
☐	*** Baseflow Conditions**	
☐	*** General – Precipitation at sample time. None ☐; Light ☐; Moderate ☐; Heavy ☐; Cloud Cover (%) =**	
☐	*** Weather – Significant rain during past 48 hours may affect results**	
☐	Flow – Low D.O. / high pH attributed to ponding or evaporation of stream	
☐	Flow – Stream dry at time of visit	
☐	Flow – Evidence of recent flooding. Fresh debris line in channel ☐, Grasses Laid Over ☐; Fresh debris line in bushes/trees ☐; Recent flood event greater than baseflow but less than bankfull ☐; Riparian vegetation scoured away ☐; •Flood Width_____ meters.	
☐	Flow – Flood event in progress at time of visit	
☐	Groundwater – DO value attributed to groundwater upwelling	
☐	Flow – Measurement from USGS gauge/records or 3rd party	
☐	Flow – Low flow conditions	
☐	Flow – No active flow, pools or ponded water only	
☐	Flow – Flood > Bankfull occurred recently or in the past season	
☐	Fire (recent) in the watershed is affecting the study reach	
☐	Spring(s) influencing samples	
☐	Weather conditions may affect samples	
☐	Algal bloom	
☐	Fish kill observed	
☐	Fish kill attributed to low DO, high pH or algal toxicity	
☐	Indication of algal toxicity	
☐	Macrophytes – Abundant macrophytes	
☐	Waterfowl – Abundant waterfowl	
☐	SOP – Deviation(s) from standard operating procedures (indicate in 'Field Notes')	
☐	Equipment problems associated with visit (data associated with the equipment not entered)	
☐	Incomplete sampling event – Missing parameter(s) or reports	
☐	Limited sampling event – Selected parameters only	
☐	QC Equipment blank associated with visit	
☐	QA/QC or duplicate sample collected at time of visit	
Flag 1		
Flag 2		
Flag 3		

Form Checked by _____

Page 4 of 6

FIGURE 2.1. Field data sheet for ambient stream monitoring.

1.11 FLOW MEASUREMENTS

Measurement from Run ☐, Riffle, ☐, Pool ☐; Comments:

Station	Distance from Initial Point	Depth, ft	Velocity, ft/s	Comments
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

Attach separate sheet or the "Discharge" Excel spreadsheet to calculate discharge.

Form Checked by

1.12 FIELD NOTES

NOTE ANY DEVIATIONS FROM STANDARD OPERATING PROCEDURES, CHANGE IN SAMPLE LOCATION, CHANGE IN FLOW CONDITIONS, FLAGGED OR QUALIFIED INFORMATION, NON-POINT SOURCE ACTIVITIES, EXCESS SEDIMENT, AND ANY OTHER USEFUL INFORMATION REGARDING DATA COLLECTED AT THIS SITE.

Form Checked by

2.1.1 FILLING OUT DATA SHEETS

The purpose of field data sheets is to document field data, how water samples were collected and other important observations. It is essential that staff write legibly and document information in such a way to enable future samplers and possibly the public to understand the observations and measurements collected in the field (FIGURE 2.2).

An important quality control check is to have the second field person (i.e. a person other than the one who filled out the form) check over the form before leaving the site.

2.1.1.1 Instructions for filling out Reach Observations on the Ambient Stream Form

Narrative observations about the general stream condition can be helpful in diagnosing potential problems. The observations consist of general appearance of the stream reach and stream bank, water appearance and odor, presence of fish, especially sunfish and crayfish as well as hydrological information about flood or drought evidence, flow regime and water source (FIGURE 2.3). Biotic interactions by exotic species such as crayfish and sunfish are an important source of impairment of the macroinvertebrate community. Hydrological information is important for identifying flood or drought impacts, and ensuring that the stream is perennial prior to macroinvertebrate sample collection.

FIGURE 2.2. Staff filling out a site sketch in the field.

REACH OBSERVATIONS (CHECK ALL THAT APPLY UNLESS INDICATED OTHERWISE)	
General appearance in the channel	No refuse visible ☐; Small refuse visible ☐; Small volume refuse common ☐; Large volume refuse (tires, carts) rare ☐; Large volume refuse common ☐.
General appearance along the banks	No refuse visible ☐; Small refuse visible ☐; Small volume refuse common ☐; Large volume refuse (tires, carts) rare ☐; Large volume refuse common ☐.
Water Clarity	Clear ☐; Milky ☐; Light brown ☐; Dark brown ☐, Oily sheen ☐; Greenish ☐; Other_____
Water odor	None ☐; Sewage ☐; Chlorine ☐; Fishy ☐; Rotten eggs ☐; Other_____
Appearance at water's edge (check one)	No evidence of salt crusts ☐; White crusty deposits rare ☐; Numerous white crusty deposits ☐; Banks covered with white crusty deposits ☐.
Fish presence (check one)	Not Observed ☐; Observed ☐
Crayfish presence	Not Observed ☐; Observed ☐
Sunfish presence	Not Observed ☐; Observed ☐
Bull frog presence	Not Observed ☐; Observed ☐
Leopard frog presence	Not Observed ☐; Number observed alive _____; Dead_____
Floating leaves or other organic matter (not algae) (check all that apply)	Absent ☐; Rare ☐; Common ☐.
Leaves or other organic matter on streambed	Absent ☐; Rare ☐; Common ☐.
% Algae cover 10 meters above and below sample point	%
% Macrophytes cover 10 meters above and below sample point	%

FIGURE 2.3. Reach Observations on the Ambient Stream Monitoring Field Form.

Procedure for Filling Out Reach Observations

The observations take place 10 meters upstream and downstream of the sample point (FIGURE 2.4). Some observations are restricted to the wetted width of the stream and some involve looking at the banks.

- % Algae refers to filamentous algae (not diatoms) and consists of green and blue-green algae that can form small tufts to large beards **attached to substrates** or are **floating** at or near the stream surface. This visual estimate is only within the wetted width of the stream.
- % Macrophytes refers to aquatic vascular plants. Do not count the plants that are found along the edge of water. Estimate the percent of the wetted width of the stream that is covered by the macrophytes 10 meters upstream and downstream of the sample point. Percent cover is visually estimated and is generally a low number unless there is nutrient enrichment.

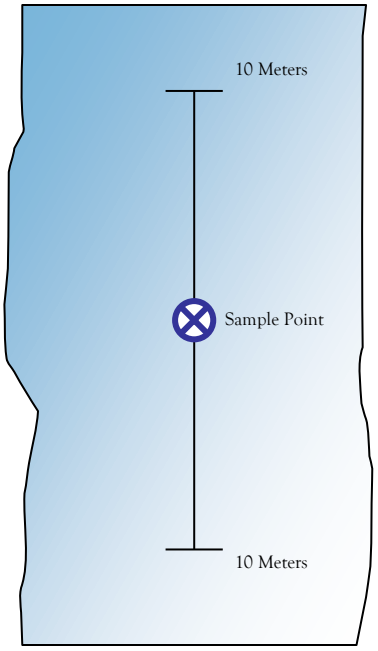


FIGURE 2.4. Plan view of a stream. Look 10 meters up and downstream of the sample point to fill out the reach observations.

2.1.2 PHOTO MONITORING

Photos are taken at each visit to a sampling site. Based on the desired objectives, the photo should provide a representative view of that site. Ideally, the photo should be taken at a fixed point of reference to enable comparison of photos over time.

Be sure the time and date on the camera are correct. Matching the time and date of the photo with your sampling event is the easiest way to keep track of where each photo was taken.

For streams, the minimum number of photos is two: looking upstream from below the sample point and looking downstream from above the sample point.

For lakes, photos should be taken to support any observations, ideally with some recognizable landmark in the background.

Taking additional photos is encouraged. Document the sampling event, any changes from the last visit, outgrowths of filamentous algae on the stream bed, channel obstructions, man-made channel alterations or disturbances, floodplain debris, trash, sediment deposition features, point bars, bank erosion, head cuts, streambed particles, riparian community, wetlands community, bank particle composition, etc. The objective is to fully document the condition of the site and photos are ideal for this purpose.

Photos should be taken to include the sample point with a person framed within the photo to show scale. If the stream channel has been altered since the last site visit, additional photos should be taken. Site alteration may include recent flood evidence, channel scour, sediment deposition, construction or man-made alterations in the floodplain or channel, or other biological or ecological changes that warrant documentation. All photos taken at a site should have the description of the photo (e.g. looking upstream, looking downstream, dam site).

2.1.2.1 Labeling Photos

Each photo should be labeled with the following information.

- Site ID
- The date the photo was taken
- Description (e.g. looking downstream, erosion along right bank, cottonwood-willow community), and
- Any applicable notes.

Photos should be placed into the respective site file (see Section 10.7 for site file organization).

2.1.2.2 Digital Photos

Representative digital photos should be downloaded to S:\common\photos\water. Create a new site folder on the "S" drive using the site ID, if a site folder does not yet exist. LCCOY002.34 and SRROO-A are examples of a correctly formatted site IDs. Do not add any extra spaces. File names should be in a yyyymmdd format followed by a one word photo description (ex. 20070930up). Be

selective with as to how many photos you add to the "s" drive. It is helpful to have multiple seasons and multiple years. Do not include 20 different pictures of the same sampling event. Extra pictures should be stored on your hard drive.

2.2 EQUIPMENT AND PERSONNEL DECONTAMINATION PROCEDURES

The purpose of this procedure is to provide a description of methods for preventing or reducing cross-contamination and a description of methods that will protect the health and safety of site personnel.

2.2.1 FIELD EQUIPMENT DECONTAMINATION

All reusable sampling equipment should be properly cleaned before going into the field. When sampling and field activities are completed, sampling equipment should be decontaminated before leaving the site. **This should be done at every site.** The purpose of the field decontamination procedures is to remove any impurities that might bias the analytical results or potentially spread invasive organisms.

1. Remove any large debris from the equipment being cleaned (such as mud on boots).
2. Rinse any personal gear (waders, boots, etc.) that has come into contact with the water being sampled with quaternary ammonia.
3. See Section 2.3.5.3.2 for boat decontamination procedures.
4. Rinse any equipment that has come into contact with the water with quaternary ammonia. Probes and sensitive equipment are not generally rinsed with quaternary ammonia but should be rinsed with clean water and wiped down.
5. Take advantage of the sun to dry/decontaminate equipment between sites.
6. Additional care should be taken for sites with known invasive or sensitive species.

2.3 SAFETY PROCEDURES

Personal safety of staff engaged in any field work activity takes is the most important part of any trip into the field. Staff should never place themselves in dangerous or risky situations. Any hazards that are known by field personnel should be communicated to other members of the field crew.

Field work should be postponed if there is indication that engagement in the field activity could cause bodily harm other than the normal risks associated with field work. All field work has some risk associated with it such as driving, hiking on uneven surfaces, wading in streams or working with chemicals while wearing appropriate personal protective gear. This is normal risk. Working during lightening storms, at night, during flash flood conditions, or during snowy weather is not considered "normal risk". If any member of the field crew is uncomfortable with a reasonable self-determined hazardous field condition, it is that person's responsibility to bring this to the attention of the project lead and that person is not required to complete the work assignment. A "reasonable self-determined hazardous field condition" is defined as other than normal risk. The project lead shall not dismiss any person's concerns that field conditions are too hazardous to complete the work assignment.

2.3.1 FIELD TRIP ROUTING AND TELEPHONE CHECK-IN PROCEDURE

Before any field trip is conducted, a Routing Form (FIGURE 2.5) must be completed. Copies shall be given to other staff members assisting on the trip and to the contact person.

Routing Form

Instructions: (1) Click File→ Make a Copy. (2) Name it in this format [yyyymmddd Lead Name]. (3) Update routing form info below. (4) Copy the web address and paste into the Check-In Spreadsheet

License#	[Insert]	Year	[Insert]	Make	[Insert]	Color	[Insert]

#	Employee on Trip	Emergency Contact	Home Phone	Work Phone
1	[Insert]	[Insert]	[Insert]	[Insert]
2				
3				
4				

Daily Check in With	[Insert]	Work Phone	[Insert]	H or M Phone	[Insert]
Trip Lead	[Insert]	Mobile	[Insert]	Date Prepared	[Insert]

1. Date: [Insert] Site: [Insert]
[Insert Itinerary]

Check-In Time: [Insert] Lodging: [Insert] Lodging Phone: [Insert]

2. Date: [Insert] Site: [Insert]
[Insert Itinerary]

Check-In Time: [Insert] Lodging: [Insert] Lodging Phone: [Insert]

FIGURE 2.5. Routing Form

2.3.2 SAFETY GUIDELINES

Safety guidelines are divided into general, streams and lake safety.

2.3.2.1 General Site Safety

The following guidelines apply to all field work by staff employed in the Surface Water Section.

- No sample or measurement is worth the risk of injury.
- Field sampling crews should consist of at least two members unless otherwise approved by the supervisor.
- Be conscious of the whereabouts of rattlesnakes, mountain lions, and other dangerous animals.
- Wear hiking shoes that fit well and use sun screen regularly.

- Open body wounds are entry sites for infection; take the necessary precautions for self protection.
- If there is storm activity in the work area, wait for safer conditions to develop or postpone the work assignment.
- Do not sample at night without approval from the supervisor. If night sampling is approved see Section 2.3.4.
- Do not trespass on private property, Indian reservations, or posted restricted public lands without prior permission and written approval from property owner or administrator.
- If strange or suspicious looking people are in the work area, either wait for them to leave or postpone the work to a later time. Do not force confrontations with strangers and back away from imposed confrontations.
- Take the necessary precautions against exposure to harmful weather conditions (e.g. heat, cold, snow, wind).
- Wear appropriate hiking shoes and apply sunscreen.
- The project lead is responsible for providing water at the work site for drinking and washing. However, it is each person's responsibility to provide enough drinking water for their own use on any work assignment. Do not rely upon others for water needs. Recommended amounts of water for summer work is two gallons per person in the field vehicle and at least one quart per person away from the vehicle.
- It is each person's responsibility to wear proper clothing for the type of work to be performed and the expected weather conditions at the work site.
- Carefully evaluate a given on-site situation to determine if the task can be performed safely. Consider potential hazards to avoid and prepare for worst-case scenarios.
- Always look for escape routes in case of flash floods.
- Always respect the on-site opinions of co-workers regarding safety issues.
- Use a personal flotation device when working around swift or deep waters.
- Consider bringing a weather radio to get the latest weather information.

FIGURE 2.6. Pay attention to and respect signs. They are there for a reason.

2.3.2.2 Stream Site Safety

- Wear protective foot wear when entering streams.
- Do not enter the stream if the water is flowing too fast.
  - Walking in streams and along stream banks are slip-and-fall conditions and it is the observer's responsibility to take appropriate precautions against sustaining personal injury.
- When fording a stream with a vehicle, the following requirements are necessary for evaluating a safe passage;
  - The depth and velocity of the water at the crossing,
  - The vehicle limitations, and adequate experience and driving skills of the operator.
  - Consider what the depth of water under worst conditions could be if a return crossing is necessary.
  - Use extreme caution when entering water deeper than the truck's axle or where the water is higher than the bottom of the truck.

- Chest straps or wader belts should be worn around chest waders to prevent possible overtopping of waders. Don't panic if waders do overtop. You can still swim in waders.

2.3.2.3 Lake Site Safety

A safe trip will depend on bringing all the necessary equipment (see Appendix A) and good communication between team members, especially when launching or trailering the boat.

A "safety meeting" should be held before going out on the lake. The trip lead should briefly describe the weather conditions expected for the day and provide the crew with information about the day's objectives and safety considerations (ex. drive slowly at the north end of the lake because it's shallow). Make sure everyone knows where the first aid kit or other safety equipment is located. A life jacket is required on-board for each person. Give the crew a chance to ask questions or bring up any other concerns

Slipping hazards can be avoided by wearing a shoe with a gripping sole (don't wear flip flops).

2.3.2.4 Fish Backpack Electroshocking Safety

Electrofishing can be dangerous. At least two people have died and over 400 people have been injured during electrofishing operations in the United States in the last 20 years. There are three serious safety concerns about electrofishing activities: 1) drowning; 2) electrocution; and 3) personal injury. The use of personal protective gear can significantly reduce chances of injury.

The following guidelines must be followed by staff collecting fish using the backpack electroshocker.

1. Before beginning sampling, all electroshocking must be checked to ensure it is good working order (no frayed or exposed wires, loose components)
2. All electrofishing gear must receive regular maintenance and inspection.
3. Staff must receive the minimal training in Section 2.3.3.
4. Gloves must be worn by all participants during all electrofishing operations. All gloves must be rubber or PVC, dry in side and free of leaks. Extra gloves should be available.
5. Boots and Waders. All personnel involved in all electrofishing operations will wear hip boots or chest high waders.
6. The use of personal floatation devices in stream shocking operations will be at the discretion of the crew leader and staff.
7. Eye protection. The wearing of polarized lens glasses is recommended to increase visibility and improve the efficiency of fish capture.
8. First Aid Kit. A full first aid kit will be available and location communicated to all staff.
9. No one should reach into the water at any time during electroshocking.
10. The lead is responsible for providing clear instructions for alerting the operator of the shocker to shut off the shocker in the event of a staff member falling into the water.

2.3.3 SAFETY TRAINING

The following training/monitoring are required for all monitoring personnel.

1. First aid (renew every two years)

2. Wilderness First Aid (renew every two years)
3. Boat safety (Lakes personnel; 1 time only)
4. CPR (renew every two years)
5. Electroshocking (applies to all staff who collect fish with the backpack shocker)

2.3.4 STORMWATER NIGHTTIME SAMPLING FIELD SAFETY GUIDELINES

- All daytime safety guidelines apply to nighttime sampling. Additional guidelines for nighttime sampling are listed.
- Participation in nighttime stormwater sampling is voluntary.
- Fording a stream at night under stormy conditions is dangerous and extreme caution should be exercised when doing so.
- Wear a personal flotation device when entering a stream.
- Use a headlamp.
- Do not hike more than 500-feet from the field vehicle.
- Take either a satellite phone or cell phone. A cell phone is sufficient if excellent cell phone coverage is available at the site. If cell phone coverage is insufficient, a satellite phone is required.
- Call or leave a message with the supervisor before leaving after normal work hours and call-in no later than 0900 hours by the next day.
- For sites considered too hazardous to sample at night, reevaluate those sites the next morning before proceeding to take samples.
- Use a weather radio to get the latest weather information.

2.3.5 BOAT SAFETY

ADEQ currently uses a pontoon boat, an aluminum boat and a raft to complete lake work.

The pontoon boat's gas tank holds approximately 20 gallons and needs to be filled with unleaded gas 87 octane or higher quality. The pontoon is started with a key ignition (FIGURE 2.7).

The aluminum boat has a gas tank on board. Re-fill it as necessary with high-performance unleaded gas. Prep the motor with the hand pump and make sure the motor is set to "start" on the throttle. Pull the cord (like a lawnmower) several times to get the motor started.

Life vests are legally required to be on-board for each passenger. The crew should have taken the 8-hour Boating Safety course provided by the Coast Guard in order to become familiar with proper boating procedures.

FIGURE 2.7. Backing the pontoon into the lake.

2.3.5.1 Pre-trip checklist

- Bring boat license aboard
- Remove cover, fold up and store under console
- Visually inspect for obvious damage on boat and trailer including breaks, cracks, loose bolts
- Bearings are greased
- Motor mountings are secure
- Rails are secured to the frame
- No oil leaks
- Check power on battery, navigation lights and horn
- Check that power steering fluid level is full
- Tires (including spare) have no cracks or wear and have adequate pressure
- Tie-downs on bow (hand crank) and stern (straps) are not worn and are secure
- Motor oil levels are adequate (dipstick is accessed by removing the hard plastic cover over the motor)
- Fuel level is adequate (considering trip duration and access to gasoline)
- Safety chains and electrical adaptor are connected
- Hitch is secured with cotter pin
- Test electrical for signals, brake lights, and taillights
- Remove tire chocks
- As you are pulling away from the parking space listen for any strange noises coming from the trailer

2.3.5.2 Launching the boat

- Disconnect stern straps and unhook bow clip on crank

Disconnect trailer lights from truck electrical power point (otherwise it will blow a fuse)

- Turn on batteries
- Load the boat with equipment
- Set up the bimini cover if necessary
- Communicate with others about where the person who is responsible for parking the truck and trailer will be picked up
- Check the boat ramp for hazards (swimmers, debris, parked vehicles, etc.)
- Slowly back boat into the water until you see the stern float
- Start boat and slowly back off the trailer
- Let the boat warm up a couple minutes before idling out of no wake zone (get away from the ramp and do not impede boat traffic at ramp)

2.3.5.3 Returning from a trip

2.3.5.3.1 Putting the boat back on the trailer

- Assist the driver of the truck in backing into the water but don't let him/her immerse the tailpipe
- Observe the water depth and raise the motor if necessary (without taking the intake out of the water)
- Slowly drive the boat back up onto the trailer rails
- Hook up bow clip, crank tight, and put in lock position
- Drive boat out of water. While still on the ramp, remove plugs from pontoons and drain out water if necessary. Replace plugs after pontoons drain.
- Pull boat up to parking lot
- Replace stern straps
- Turn off the batteries
- Reconnect electrical trailer/vehicle connections
- Remove anything from boat deck that is not secure for highway travel
- Take out key and store it with you in truck

2.3.5.3.2 Returning equipment and decontamination

Return all equipment to its previous location. Clean field equipment as needed. If any work/maintenance is needed on the boat, log it in the logbook and work with the lab coordinator to get the necessary supplies or repairs.

De-contamination prevents the spread of invasive aquatic plants and animals. After every trip, remove any aquatic plants from the anchors, boat and trailer.

Decontaminate the boat after each trip. To decontaminate, spray the boat and trailer with quaternary ammonia (recommended by Game and Fish as of February 2008) or with a 10% bleach solution or use the decontamination method prescribed by Game and Fish. Be sure to decontaminate any surfaces that were in the water including the trailer, the hull, anchors, anchor ropes and other equipment.

Before leaving the boat parked, turn off batteries, cover the boat and place tire chocks so that the boat cannot roll forward or backward.

2.3.6 BORDER SAFETY

The following procedures are to be followed when working in remote areas located within 20 miles of the Mexican Border. Increased border activity has resulted in more frequent encounters, thefts, break-ins, and resource destruction. Encounters with illegal immigrants and drug smugglers are potentially dangerous and special precautions need to be taken to ensure employee safety. Projects that are located near populated areas (within city limits) may follow modified border safety procedures but prior approval will be needed from the Section Manager.

The following requirements are necessary for any employee to work near the border.

2.3.6.1 Physical abilities:

- Able to hike over rugged terrain and caring 30lbs; and

- Have no physical limitations that would prevent prolonged exposure to inclement weather.

2.3.6.2 Training:

- First Aid and CPR;
- Wilderness First Aid;
- Familiarity with USFS Border Safety Documents; and
- Review Border Safety DVD.

2.3.6.3 Pre-trip Activities

Prior to starting fieldwork (the day before or on the way, as time permits) the project manager should contact the local Border Patrol Station, USFS District Office, and/or County Sheriff to determine if the area where fieldwork is being conducted is experiencing any activity that is out of the ordinary or is overtly dangerous at the moment and to inform them of our plans, see Appendix K for a list of local agency contacts. You should provide the local agencies with a description of the vehicle, number of people working in the field, along with the location and duration of the field activities. If the project manager receives information that the area should not be entered then the trip will need to be rescheduled.

The routine ADEQ contact evening check-in policy is not adequate for fieldwork near the border. The project manager, in consultation with their Unit Manager, will determine the appropriate call-in interval for the project. It is recommended that for work in remote areas that an initial call-in should be made as the field crew enters the area and then every 1-2 hours (maximum, but dependent on field conditions) while in the area followed by a check-out call as they leave the area. It is the responsibility of the project manager to ensure that the call-in schedule is followed. If there are multiple teams involved in the sampling effort each team must have and follow a call-in schedule. The designated ADEQ contact must be available by phone for the entire period that employees are in the field, the ADEQ should provide work, home, and cell phone numbers. There will a 30 minute maximum grace period for the field team to call in before the ADEQ contact will begin trying to contact the employees in the field, if after another 30 minutes no contact is made, the ADEQ contact will inform the local agencies of the situation and ask for assistance. For example if the call-in time is 1300 and no message is received by 1330 the ADEQ contact will begin calling all of the available numbers (ADEQ and personal) on the routing form, if by 1400 no contact is made the ADEQ contact will then call the local contacts to seek assistance.

It is imperative that both the project manager and ADEQ contact follow the call-in procedures outlined to ensure that help is sent when necessary but also that false alarms do not happen.

2.3.6.4 Develop Routing Form

See Section 2.3.1 for additional information regarding routing forms.

- Know the area and your route- ensure you have accurate maps;
- If you are sampling established sites include directions to sites and include the latitude and longitude (include datum), if conducting recon provide a description of the area you will be working in (specify area on a map);
- Include specific check-in/check-out procedures;

- Include local contacts (county sheriff, USFS, Border Patrol, and other active agencies in the area) on the routing form- each field person must have a copy along with the ADEQ contact;
- Do not alter your route/timing until you have informed the ADEQ contact of the change in plans;
- Include all phone numbers that will be taken in the field- ADEQ satellite and cell phones along with employee personal cell phone numbers;

2.3.6.5 Field Activities

Once you are in the project area continually assess your surroundings and stay alert- expect the unexpected. Look for indications of recent activity (voices, foot prints, water bottles, food, clothing, etc). While conducting fieldwork make your presence known. Talk to coworkers while working, honk the horn when arriving at a site, blow your safety whistle periodically this will alert anyone in the area that you are there and cause them to avoid you if that is their intention.

2.3.6.6 In-field safety protocols-

- Review the project Health and Safety Plan and routing form details with all coworkers before arriving at first site;
- Follow call-in protocols;
- Be sure to lock vehicle (doors and shell), take water, phones, and personal items) with you when leaving vehicle;
- Park nose out;
- Stay alert;
- Avoid confrontation;
- If you encounter someone play dumb- ask them if they have seen any water in the stream; make it clear you are not there looking for them;
- Work in pairs- at no time should employees be alone while conducting fieldwork.

2.3.6.7 Post-trip Activities

Upon completion of field activities and after leaving the area, check-out with the ADEQ contact to ensure that they know you are no longer in the area thus completing the predetermined call-in schedule. Any suspicious activity should be reported to the appropriate Border Patrol Station after leaving the area. The project manager must inform the ADEQ contact when the field crew has returned the office or hotel for the evening. The project safety procedures should be reviewed by the project manager after each sampling event and adjusted as warranted.

2.3.6.8 Additional safety precautions that may be taken:

- Deploy bilingual signs (on automated equipment, placed in stream when working, etc);
- Provide/learn common Spanish phrases (cheat sheet style);
- Determine if any local agencies will loan out a radio to ADEQ when in the area for emergency use only;
- Most illegal crossers want to avoid contact or confrontation, diffuse any situation by being non confrontational (back away from encounters, raise hands, etc);
- Stay together, no solo wonderings;

- Do not attempt to render aid to unknown persons (it may be a decoy/ploy) to get you out of the vehicle. Call for aid after leaving the area;
- If you fell uncomfortable about the situation or something just does not seem right- leave;
- Ask local agency for an escort;
- Avoid handling trash and unknown substances.

CHAPTER 3 CHEMISTRY PROCEDURES

This chapter describes how to collect chemistry data for lakes and streams. The chapter begins with field measurements and then goes over how to collect water samples in streams and lakes that will be sent to a laboratory.

3.1 FIELD MEASUREMENTS

3.1.1 DISSOLVED OXYGEN, CONDUCTIVITY, PH, TEMPERATURE, AND DEPTH

The following sections provide general instructions that cover the Insitu, YSI and Hydrolab multiprobes for lakes and streams. Additional detail regarding such topics as data logging can be found in the applicable Multimeter manual.

For streams, the stirrer on the Hydrolab should be turned on when flow velocity is less than 1 ft./sec.

3.1.1.1 Dissolved Oxygen

Dissolved oxygen concentrations fluctuate throughout the day. Concentrations are typically highest a little after noon and are lowest at night just before dawn. At the sample site, the dissolved oxygen probe must be calibrated before immersion into a lake or stream. Record all parameter readings on the field data sheet.

1. Fill the calibration cup with water to below the DO probe (do not cover the membrane with water).
2. If there is any moisture on the DO membrane, blot it gently with a lint-free absorbent cloth or tissue such as a chem wipe to remove any water droplets. Use a material that is non-abrasive.
3. Invert the cap and slide it over the top of the calibration cup, and then let the unit sit for about 5 minutes to allow the conditions inside the cup to stabilize. Do not screw the cap back on as this will increase pressure inside the calibration cup.
4. Determine ambient air pressure.
5. Before calibrating the DO, record the pre-calibration percent saturation value after the unit has stabilized.
6. Using the calibration menu for % saturation, enter the current air pressure when prompted.
7. Record the new DO percent saturation reading, which should be at or near 100%. The percent saturation reading should not drift for about 20 to 30 seconds after the calibration procedure.
8. After calibrating the DO probe, ensure that the cables are securely attached to both the sonde (or minisonde) unit and the read-out unit.
9. Attach the probe guard (this is a part of the stirrer unit on the older sonde units) before placing the unit in the stream or lake to avoid damage to the probes.
10. Place the sonde in the water body.
11. Allow a few minutes for the meter to stabilize and then record the DO readings.

FIGURE 3.1. Proper cap position.

3.1.1.2 Depth (Lakes)

For lakes the multiprobe must also be calibrated for depth.

1. Place the probe in the water at a depth of 10 cm.
2. Calibrate the depth to 0.1 m.

3.1.1.3 Specific Electrical Conductivity, pH, and Temperature

With stirrer or probe guard attached, allow meter to stabilize and take reading.

3.1.1.4 Insitu Field Instructions

3.1.1.4.1 View an Individual Reading

1. To view an individual reading, tap the Action icon.
2. Tap View Last Reading.
3. The most recent data in the last ten-second interval appears. Tap the Home icon to return to the Live Readings screen or tap the Envelope icon to email the data.

3.1.1.4.2 Create a New Site (Optional)

You do not need to create a site to get live readings.

1. From the Live Readings screen, tap the Sites button.
2. A list of existing sites appears. If desired site is listed, tap set for the site and skip to step #11.
3. Tap the New Site button. The Site Details screen appears.
4. Tap the Name field. Type the name for the new site and tap Return.
5. To add a description, tap the Description field. Type a description and tap Return. A description is optional.
6. To take a site photo, tap the Camera button, tap the camera icon to take a new photo, tap the Use button. A site photo is optional.
7. To select an existing photo, tap the Album button, tap Cameral Roll, tap an existing photo.
8. To locate your site with Maps or GPS, tap the GPS button (must have wifi) and your current location is automatically associated with the site. You can also enter GPS coordinates, or tap and hold on the map to select a location. Location Services must be turned on for an accurate location to display on the map. See Settings > Location and Security.
9. Tap the Save button.
10. Tap the Set button next to the site you created. Now you are ready to record data associated with the selected site.
11. Tap the Record button on the Live Readings screen to record data. The number on the stopwatch icon represents how many 10-second data intervals have transpired.
12. To stop recording, tap Stop. Only one record needed. Transpose data to field sheet or tablet.
13. You can email the data or download it to a computer once wifi is available.

3.1.1.4.3 View and Email Data from the Selected Site (Optional)

After you have recorded data, you can email the data as a CSV file that can be opened with common spreadsheet software. Make sure the email feature is enabled on the mobile device.

1. Tap the Action icon.
2. Tap View Log List. This shows a list for only the selected site.
3. To select all logs in the list, tap the ALL/NONE button, or to select individual logs, tap them separately.
4. Tap the Envelope icon.
5. An email form appears with the logs that were selected attached.
6. Enter an email address in the To: field.
7. Tap the Send button.

3.1.2 MULTIPROBE PLACEMENT

3.1.2.1 Stream Multiprobe Placement

Place the Multiprobe at the base of a riffle or other areas where the water is moving swiftly (FIGURE 3.2).

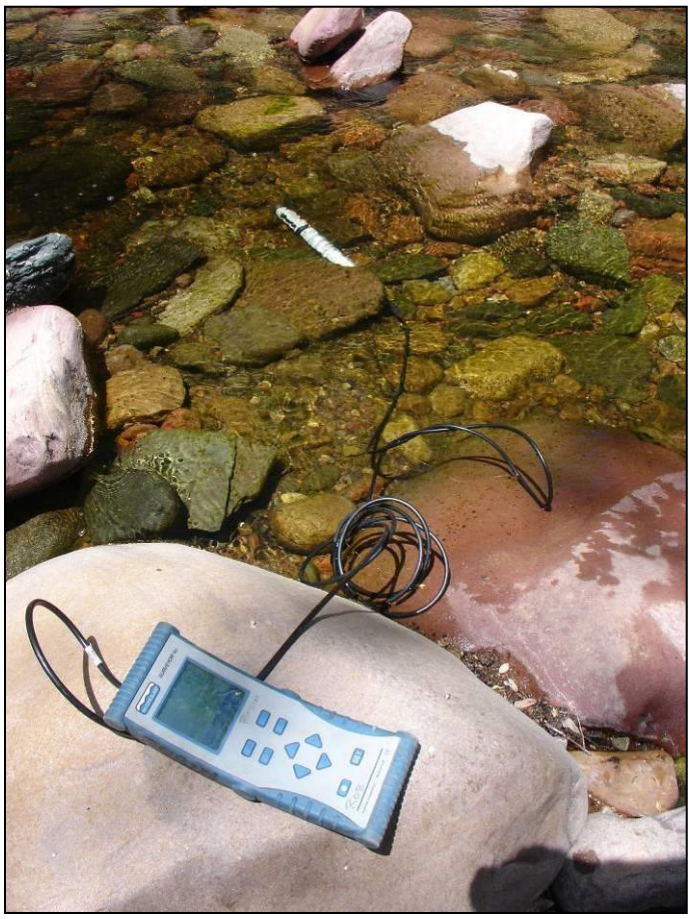


FIGURE 3.2. Field parameter collection in a stream.

3.1.2.2 Lake Multiprobe Placement / Determining Lake Stratification

See Section 3.4.

3.1.3 TURBIDITY

Precise measurements for very low turbidity samples require optically calibrated sample vials. Refer to the Hach Turbidity Manual for this procedure.

For the battery voltage check, press the Diagnostic key identified as DIAG. The number displayed is the battery voltage.

1. It is recommended that the Hach Turbidity meter be placed on a flat surface for taking measurements. Choose a Gelex Secondary Reference Standard that has a turbidity value close to that of the stream or lake (Hach Company, 1993). Thoroughly clean the outer surface of the Gelex Secondary Reference Standard vial of fingerprints, water spots, and evaporate by applying a thin coat of silicone oil and wipe with velvet cloth.
2. Insert the selected Gelex Standard into the instrument cell compartment with the white triangle on the vial aligned to the raised orientation mark on the instrument and take the measurement. The displayed value should be within 5% of the calibration value. If the difference between the measurement and the Gelex Standard calibration value is greater than 5%, re-clean and re-oil the Gelex Reference Standard vial, and take another measurement. If the problem persists, record the values on the Field Data Sheet together with a description of the problem.

FIGURE 3.4. Hach Turbidity Meter.

The turbidity value should be rerun if the percent difference is between 5 and 10 percent. Anything greater than 11 percent should not be entered into the database at all.

% Difference = ((Standard Value – Measured Value)/Standard Value) * 100

3. Rinse an empty sample vial several times with stream water. Fill the vial with stream water, replace the cap and wipe the outside surface clean and dry with a soft cotton cloth. For grab samples, the location of the sample should be representative of the entire flow. For composite samples, go through the rinsing process and take the water from the agitated churn splitter to ensure complete mixing of the suspended matter.

If there is any delay between when the vial is filled with stream or composite water and the measurement, invert the vial several times before placing it into the instrument

cell compartment.

4. Take at least three turbidity readings. This can be accomplished with two methods; by the meter default or by use of the Signal Average Key. The default setting (Signal Average off) will internally average three measurements and display the result. The signal averaging (Signal Average on) mode averages 10 measurements every 1.2 seconds which compensates for measurement fluctuations caused by the drifting of sample particles through the light path. After 22 seconds, the average of the 10 measurements is displayed.
5. Record the displayed reading and measurement type onto the Field Data Sheet.
6. For very turbid waters, the meter may display a flashing "1,000" value or E-3 error message. This indicates that the turbidity value is greater than 1,000 NTUs. There are two options with this condition: 1) perform a dilution, or record the results as >1,000 NTU. Note this on the field data sheet. Performing the dilution will give a more accurate turbidity value.
7. Add deionized water to the sample vile when sampling is complete.

3.1.3.1 Performing a Dilution for Turbidity

1. It is recommended that a dilution factor (DF) of 10 be used for the turbidity calculation. The DF is the multiplier for the meter reading. For example, if the operator were to dispense 9 mL of deionized water into a 10 mL graduated cylinder and 1 mL of sample water, for a total of 10 mL, the DF is 10 (a ratio of 9:1); therefore, the turbidity value is the meter reading times 10.
2. For samples that are extremely turbid, it may be necessary to make more than one dilution to obtain a meter reading less than 1,000. For multiple dilutions, the procedure is the same as described above; however, for the second dilution, the 9:1 diluted sample becomes the sample to be diluted. If this is the case, and a 9:1 dilution is performed a second time, the DF is 100 (DF of 10 for the first dilution and DF of 10 for the second dilution). The turbidity value is simply the meter reading times 100.

3.1.4 HACH DR/700 COLORIMETER FOR CHLORINE ANALYSIS

This procedure describes how to measure free and total chlorine with the Hach DR / 700 Colorimeter (Hach Company 1993).

3.1.4.1 Field Procedure for Measuring Free Available Chlorine

1. After powering on the instrument, a six digit number, such as 52.05.01, will appear at the bottom of the display window. This is the number of one of several filter modules that are factory installed. The filter module number required for the free chlorine analysis is 52.07.1. If a number other than the free chlorine module is displayed, press the up arrow key, in the edit box, until the correct number appears.
2. Inspect the sample vials provided with the meter for any discoloration of the glass surface or any evaporate remaining from the last analysis. The vials should have been thoroughly washed with a chlorine free detergent and rinsed with deionized water before field use.
3. Triple rinse the vials with sample water and fill a 25 mL vial with sample. Check sample acidity with pH paper. pH needs to be between 6 and 7. If pH >7, add one drop of sulfuric acid solution and measure pH again. Repeat until pH is between 6 and 7.

4. Pour 10 ml of solution into 2-10 ml vials. Place one vial into the cell holder and press ZERO (display will count down). Add the contents of one DPD Free Chlorine Powder Pillow into other vial and shake for 20 seconds. Immediately place vial into cell holder and press READ. Display will count down then show result. Record result.
5. Next, determine any result interferences. This is done by filling a 25 ml vial with sample. Next, Check sample acidity with ph paper. pH needs to be between 6 and 7. If pH > 7, add one drop of sulfuric acid solution and measure pH again. Repeat until pH is between 6 and 7.
6. Add 3 drops of Potassium Iodide Solution to 25 ml vial, mix and wait 1 minute. Add 3 drops of Sodium Arsenite and mix.
7. Pour 10 ml of solution into a 10 ml vial. Add the contents of one DPD Free Chlorine Powder Pillow into vial and shake for 20 seconds. Immediately place vial into cell holder and press READ. Display will count down then show result. Record result. Subtract this result from original result (obtained in #4) to obtain the accurate chlorine result.

3.1.4.2 Field Procedure for Measuring Total Chlorine

Follow the procedures for measuring Free Chlorine above except use the Total Chlorine Powder Pillows and wait 3 minutes before placing the vial into the cell holder.

3.1.5 AIR TEMPERATURE

A variety of thermometers are used to collect air temperature readings. When taking a reading do not place the thermometer in direct sunlight and avoid letting the probe come in contact with the ground.

Figure3.5. Thermometer.

3.2 COLLECTING WATER CHEMISTRY SAMPLES

3.2.1 GENERAL INFORMATION

3.2.1.1 Sampling Order

The order of sample collection, processing, and preservation for specific analytes should be determined before beginning field work and adhered to consistently. TABLE 3.1 describes the order of sample collection (USGS Field Manual, 2004).

Order	Parameter
1	Organic compounds. **Do not field rinse bottles.**
2	Total, dissolved, and suspended organic carbon
3	Inorganic constituents, nutrients, radiochemicals, isotopes: Collect raw samples first, followed by filtered samples. (Field rinse each bottle, as required.) a. Trace metals. b. Separate-treatment constituents (such as mercury, arsenic, selenium) and major cations. c. Major anions, alkalinity, and nutrients. Chill nutrients immediately. d. Radiochemicals and isotopes.
4	Microorganisms

TABLE 3.1. Sampling order for surface water samples.

For composite samples, Suspended Sediment Concentration should be collected from the churn splitter first.

3.2.1.2 Sample Bottle Labeling

Each water sample bottle must be labeled with a site code, a site location description, sample collection time and date, analysis, the initials of the observer collecting the water sample, and the agency name. Label the bottle with the appropriate acid sticker if preservative is added. Use a black or blue permanent marking pen, such as a Sharpie or other similar product, to label dry bottles. Handwriting must be precise and legible. Bottles are labeled in the order presented below (FIGURE 3.6). Use clear tape to affix the label.

It is important that the bottle label information matches the information on the Chain of Custody exactly. If an abbreviation is used on the bottle then use the same abbreviation on the Chain of Custody.

Sample site identification code

A sample site is given a code based on the water basin, name of the stream or lake, and the river miles or lake monitoring site. Each code is unique for a given sample site. Section 10.5.1 explains how sites are named.

Site location description (optional, except when a site code has not been assigned)

This is a brief generalized description that attempts to convey the location of the sampling point. The description will normally reference a permanent physical feature of some type. An example of this would be "Spring Creek below confluence with Dry Creek," or "Cienega Creek above Marsh Station Road Bridge." If a permanent physical feature is unavailable, the description may be as non-specific as "Trout Creek near Wikieup." Avoid using descriptions that are similar to other site descriptions.

Sample collection time and date

Mark sample bottles with the collection time and date that appears on the field data sheet. Collection times are reported in military time (e.g., 2:30 p.m. = 1430 hours).

Agency name

The placement of the agency name on the bottle informs the receiving lab of the billing entity. If samples have been collected and submitted for another agency or program that has interest in the sample site, label the bottle as "ADEQ for AGFD (or TMDL, etc.)."

Analysis

Indicate what type of analysis the lab should run (ex. Total metals, nutrients, SSC, dissolved metals, or inorganics)

Sampler's initials

The sampler's initials indicate the person responsible for collecting and submitting the water sample. Initials of other field personnel may be applied to the bottle.

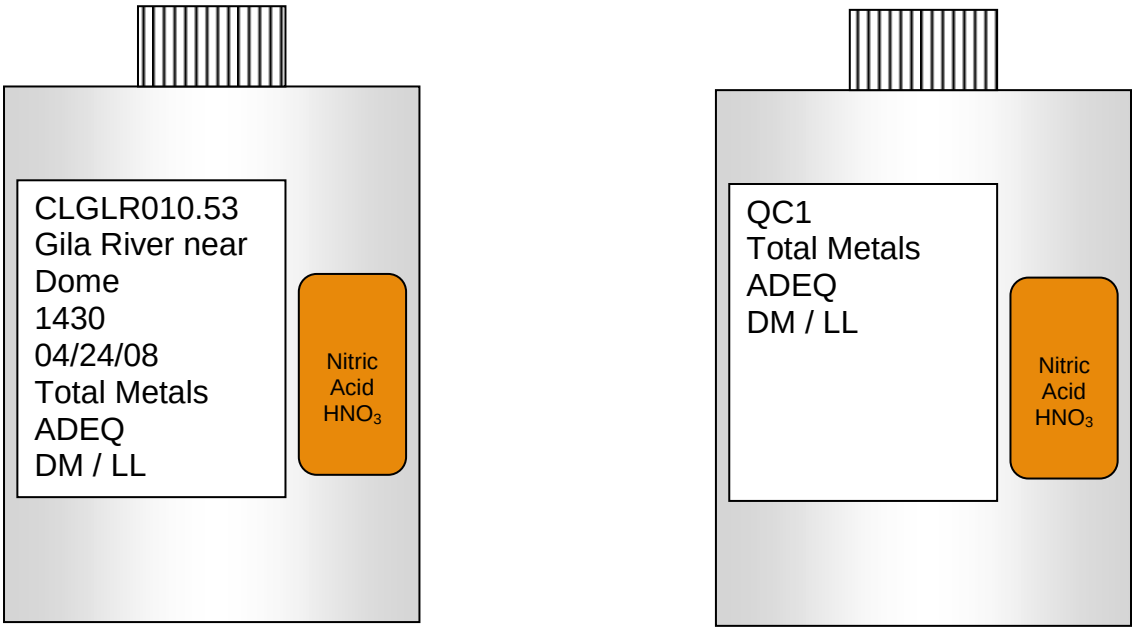
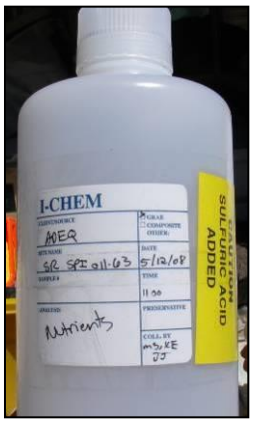


FIGURE 3.6. Properly labeled bottle (left) and a properly labeled QC bottle (right).

Miscellaneous Labeling Requirements



- Water samples that are field filtered must be labeled as "Field Filtered." When field filtering cannot be performed because of filtering equipment malfunctions, label the bottle "To Be Filtered" and make note on the laboratory submittal form.
- Water samples that are collected for suspended sediment concentration analysis are labeled prominently as "SSC."
- Dissolved and total metal samples should be acidified and labeled with a nitric acid sticker. Nutrient samples should be acidified and labeled with a sulfuric acid sticker. If problems arise with the acid preservative labels or there is a possibility of them wearing or falling off the bottles during transport, mark the bottles as either "sulfuric acid" or "nitric acid."
- Quality control samples should not be identified so as not to bias the lab. QC samples should be labeled as in FIGURE 3.6. Be sure to write on field form exactly how you identified the QC sample.

3.2.2 COLLECTION BOTTLES

The laboratory will specify the types of collection bottles they would like samples submitted in. The bottle must have been decontaminated by either the lab supplying the bottle or by ADEQ personnel. The lab currently uses 500 mL bottles for the dissolved metals, total metals and nutrients. They use 1 L bottles for SSC and inorganics.

The number of bottles required per site will be dependent on the parameters being analyzed. FIGURE 3.7 illustrates a typical bottle set used in ambient stream monitoring.

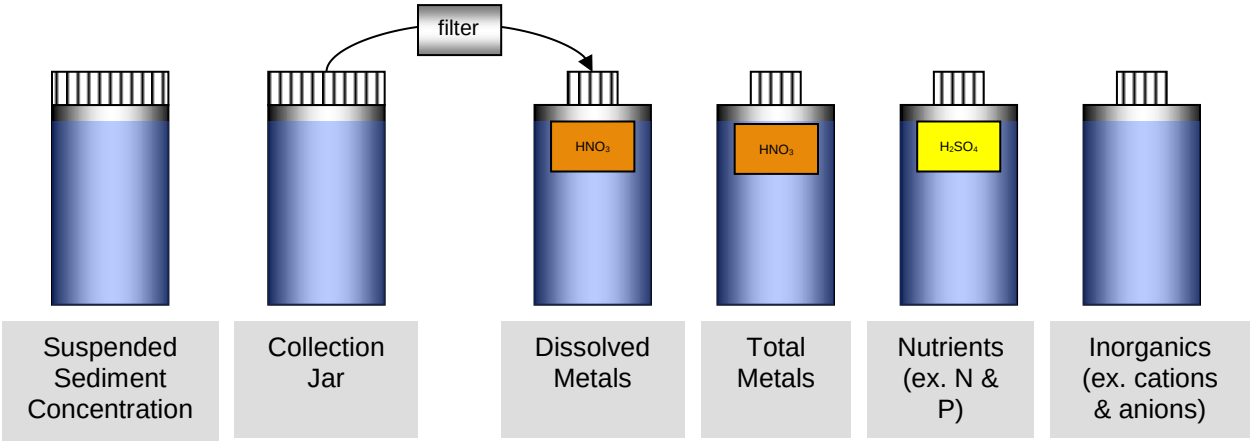


FIGURE 3.7. A typical bottle set for ambient stream monitoring.

FIGURE 3.8. A typical bottle set for ambient lake monitoring.

If the sample plan calls for the analysis of total cyanide, a sample bottle prepared with a solution of sodium hydroxide is required. When total sulfides are to be analyzed, a sample bottle that has been prepared with a solution of zinc acetate and sodium hydroxide is required. The laboratory can supply the preserved bottles upon request.

When sampling a water body that receives discharges of treated effluent, or is composed primarily of treated effluent discharges, a sample for biochemical oxygen demand (BOD) analysis may be required. A BOD sample bottle is typically black plastic or amber glass with an air-tight cap.

Bottles containing acids or bases as preservatives must always be handled with care. Nitrile gloves and eye protection should be worn for safety. Ensure that sample bottle

caps are tight before transporting. Acid spilt on skin or clothes must be rinsed and diluted immediately with clean water. When transporting acid vials or lab preserved sample bottles, keep them separated by preservative type. Some sample preservatives can be chemically incompatible and may react violently when mixed.

FIGURE 3.9. Groundwater sampling capsule

3.2.3 FILTERING DISSOLVED METALS

The analysis of dissolved metals requires filtration of the water sample prior to preserving the sample with nitric acid. Ideally, samples should be filtered as soon as possible.

An unpreserved water sample consists of two analytical components of interest: suspended metals and dissolved metals. Suspended metals are defined as the portion of a water sample that is unable to pass through a membrane filter with a 0.45 micrometer pore size. Dissolved metals are those in solution which are able to pass through the same membrane filter.

ADEQ currently uses peristaltic pumps that operate from any external 12 volt DC or 120 volt AC power source, thus allowing the sample to be filtered in either the laboratory or the field. Typically the pumps are equipped with easy-load pump heads, but some pumps may be equipped with the factory supplied standard pump head design.

The groundwater sampling capsule currently utilized by ADEQ (FIGURE 3.9) is able to filter waters with high suspended sediment concentrations. However, a smaller less expensive filter is available when filtering water with low sediment concentration. Transparent water can usually be filtered with a smaller filter. All filters should be quality certified by the supplier. Filters are designed for a single use and should be disposed of after each filtration.

FIGURE 3.10. Filtering set-up. Note the peristaltic pump, tubing, collection bottle, receiving bottle, filter and nitrile gloves.

<u>Steps to filter a dissolved metal sample</u>

1. Two clean sample bottles are required; one in which to collect the water, and

the second to contain the filtered water. The second bottle should be labeled "Dissolved Metals." or "Field Filtered".

2. Place the pump on a hard, flat surface (e.g. a table or the pickup tailgate). Position it such that the pump head of the mechanism extends over the edge of the stationary surface (FIGURE 3.10). Remove a section of the clean, pre-cut tubing from the re-sealable plastic bag. Always handle the tubing near the middle to prevent the tube ends from being contaminated.
3. Insert the tubing into the pump mechanism such that both ends are hanging loosely, but not in contact with any surface. Remove the filter from its packaging, taking care to not contaminate the nipple ends of the capsule. Securely attach the tubing to the filter.
4. Check the pump controls to ensure the flow direction of the pump is congruent with the flow direction of the capsule filter. Place the end of the tubing without the filter into either the bottle or the churn splitter.
5. Turn the pump on and allow the filter to fill with water before filling the sample bottle. Allow about twenty five to fifty milliliters of the sample to run out of the out-flow opening to flush the filter. Place the out-flow end of the tubing into the open mouth of the pre-labeled filtrate bottle.
6. Triple rinse.
7. Fill bottle and leave some space in the bottle for the addition of the preservative.
8. After placing the acid-preserved sample into the ice-chest for transport, properly dispose of the filter and tubing.

Figure 3.11. Acid droppers.

3.2.4 ACIDIFYING OR PRESERVING METAL AND NUTRIENT SAMPLES

Metal and nutrient samples should be preserved as soon as possible (within 15 minutes of collection). The best way to do this is to take acid vials with you and preserve samples on site.

Bottle	Preservative	Amount of Acid
Nutrients	Sulfuric Acid	1 vial (2 mL) 40 drops
Total Metals	Nitric Acid	1 vial (5 mL) 40 drops
Dissolved Metals	Nitric Acid	1 vial (5 mL) 40 drops

TABLE 3.2. List of preservative amounts to add to nutrients, total metals, and dissolved metals.

The analyzing lab will provide acid, usually in a dropper or vial format. Follow their preservation instructions. TABLE 3.2 indicated the correct preservative and quantity for each type of analysis. Proper gloves and eye protection should be used before adding acid or filtering. The acid vials that are currently used are illustrated in FIGURE 3.11.

Prior to adding the preservative, make sure that the bottle is either marked with the type of preservative used, or has a color-coded label that corresponds with the preservative vial being added. After adding the preservative vial to the sample bottle, replace the cap on the sample bottle tightly, and invert the sample bottle several times to mix the sample and preservative.

pH test strips can be used to identify sample bottles that, for some reason, may not have been preserved. Invert the bottle several times to make sure it is well mixed. Pour a small amount over the test strip. Do not place the strip into the bottle. The test strip should read a pH of less than 2.

To dispose of the emptied acid preservation vials place them into separate double-bagged zip-lock bags. Upon returning to ADEQ headquarters, flush the vials and caps with tap water and place them in the proper disposal area. Flush the receiving sink of any acid residues with tap water.

3.2.5 COLLECTING FIELD WATER CHEMISTRY QUALITY CONTROL SAMPLES

The Surface Water Section has a Quality Assurance Program Plan (QAPP) that addresses the 'big picture' aspects of quality assurance and control in detail. This section will cover how to collect a quality control sample, which is just one small part of the Surface Water Sections overall QAPP. Please refer to the QAPP for additional detail. TABLE 3.3 summarizes the minimum number of quality control samples should be taken for a given trip. Section 10.6.2 describes the "acceptable limits" for contamination in blank samples and differences between duplicates or splits.

There are a variety of laboratory quality control samples. This manual primarily addresses field quality assurance and quality control. Read the case narrative of the laboratory report to determine if there was any quality assurance or quality control problems from the lab.

3.2.5.1 Quality Control Sampling Frequency

Parameter	Field Splits or Duplicates	Equipment / Churn Blanks	Total
D Metals	None	5%	5%
T Metals	5%	5%	10%
Nutrients	5%	5%	10%
Inorganics	5%	5%	10%
Radiochemistry	5%	5%	10%
Bacteria	1 per trip		
Clean Metals	1 per trip		
Pesticides	5%	5%	10%
Biocriteria	10%	None	10%
Fish Tissue	5%	5%	10%
Algae	5%	None	5%

TABLE 3.3. Minimum percentages of quality control samples to be collected by parameter.

3.2.5.2 Blanks

Blank samples are a check for cross-contamination during sample collection and shipment, and in the laboratory. There are three basic types of quality control blanks: trip, field, and equipment/churn. De-ionized water should be used for metal parameters. Blanks should be

prepared by the laboratory that supplies the sample containers. The blank should be numbered, packaged, and sealed in the same manner as other samples in the set.

- Field Blank. A field blank is a water sample that travels with the sample set and is opened and exposed at the sampling point to detect contamination from air exposure. The field blank, usually deionized water, may be poured into appropriate containers to simulate actual sampling conditions. Contamination of the sample can be from air exposure during the collection process and during storage and transport. *Procedure*: In the laboratory, fill a clean sample bottle(s) with certified deionized water and transport it to the field. Blanks are typically done for total metals, inorganics and nutrients, but not for dissolved metals or suspended sediment concentration. Place the bottle(s) in the processing area (e.g., truck tail gate) in which the environmental sample(s) are being processed. Open the blank sample bottle to expose the blank sample to the atmosphere for approximately the same period of time to which an individual environmental sample(s) is exposed during sample processing. Store and transport the blank(s) in the same container as the environmental samples.

Blanks can be placed throughout the field process to determine where unintended sources of contamination are coming from. For example, you may put a blank before and after the field filtration step for dissolved metals if you suspected the filter to be the source of contamination. This process would involve filling the "before sample" with DI water and capping it. The "after sample" would involve filling the bottle with DI water and then filtering it into another clean bottle.

- Equipment/Churn Blank. A blank sample is collected form the precleaned sampling equipment in the field prior to collecting the actual field sample. An equipment blank is used to detect contamination introduced by the sampling equipment either directly or through improper cleaning. Blank water is used to fill the sampling equipment and then poured into appropriate containers. *Procedure*: While working in the sample site area (e.g., truck tail gate) in which the environmental sample(s) is being collected and processed, pour the certified deionized water directly into the precleaned churn sample splitter before native water has been introduced into the churn splitter. Run some water through the spigot and fill the sample bottle(s). If a churn splitter is not being used, pour the deionized water from its container directly into the sample bottle(s). Cap the bottle immediately and label. Store and transport the blank(s) in the same container as the environmental samples.
- Trip Blank. A trip blank is a water sample that remains with collected samples during transportation and is analyzed along with field samples to check residual contamination. A trip blank should not be opened by either the sample collector or sample handlers. *Procedure*: Store the trip blank in a container or plastic bag such that the blank bottle is not exposed to ambient conditions during transport to the sample site. At the sample site, remove the trip blank from its container and place in the same cooler as the collected samples during transport to the analyzing laboratory.

3.2.5.3 Duplicate and Split Samples

A split sample is one sample that is divided equally into two or more sample containers and then analyzed by different analysts or laboratories. Splits samples are taken from a churn splitter that has been filled with sub-samples and homogenized. Split samples may be equated to "identical twins" in that they contain the same chemical composition as each other. Laboratory analyses of split samples ideally produce identical results.

Duplicate samples are a set of similar samples collected from the same site, at about the same time, and analyzed in the same manner. Duplicate samples may be equated to "fraternal twins" in that they originate from one source but each sample may contain a slightly different chemical composition. Duplicate samples are usually taken when it is not possible to use a churn splitter to collect sub-samples and produce split samples (i.e., grab samples are collected). Also, some types of analyses preclude the use of a plastic churn splitter (e.g., volatile organic chemicals). Duplicate and split samples are typically done for total metals, inorganics and nutrients, but not for dissolved metals or suspended sediment concentration.

Collection Method

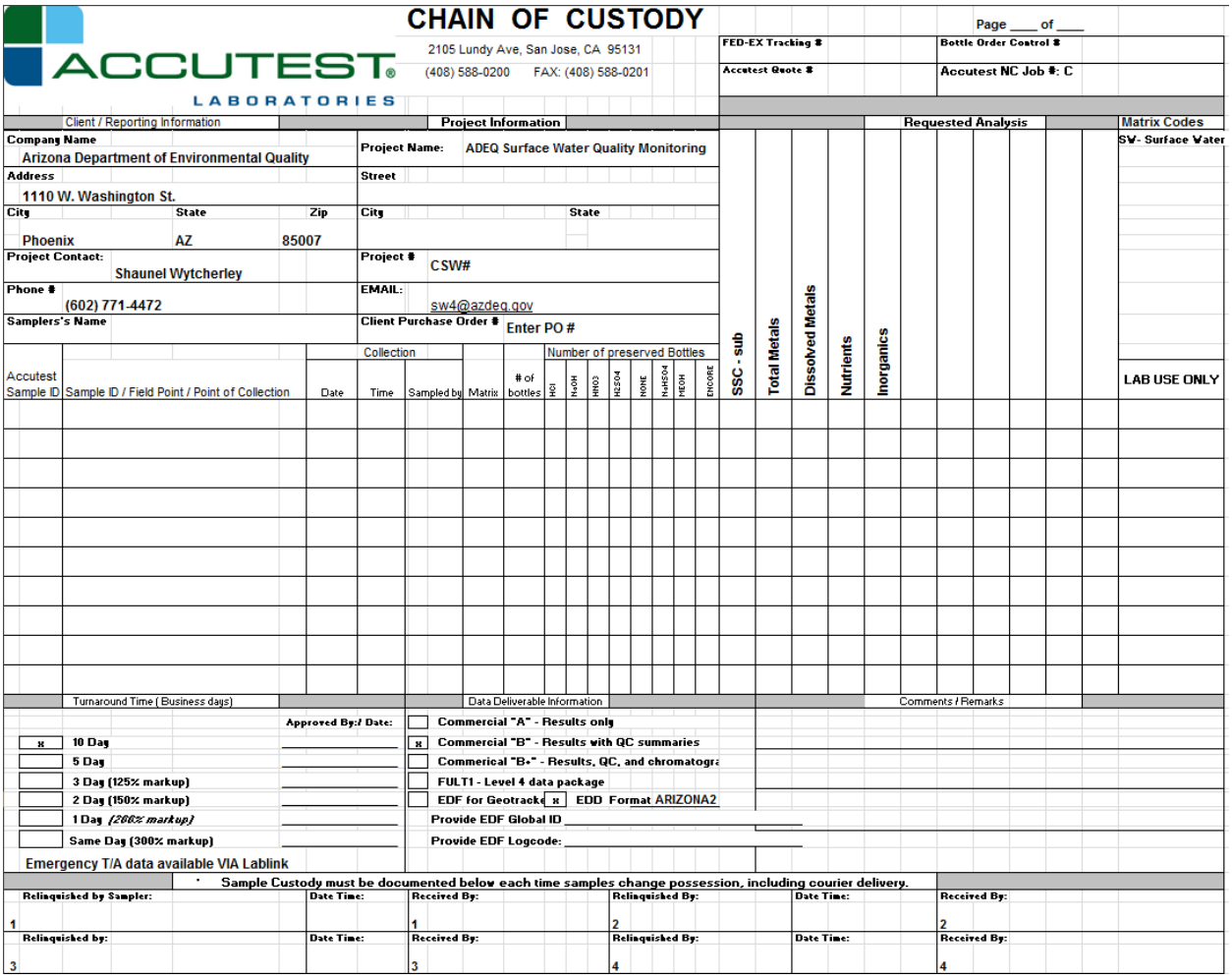
1. Splits are taken from a large sample compositor (churn splitter) that has been filled with numerous subsamples from the source. A 14-liter churn splitter should be used for split samples. Duplicates may be grab or composite samples.
2. The composited split sample is thoroughly mixed before withdrawing subsamples into two distinct chemsets of sample bottles for laboratory analysis.
3. Label appropriately, store and transport the splits in the same container as the environmental samples.

3.2.6 CHAIN OF CUSTODY AND LABORATORY SAMPLE SUBMITTAL FORMS

ADEQ has contracts with several laboratories for sample analyses. Each has their own set of forms to use when submitting samples. An example Chain of Custody is included in FIGURE 3.12

3.2.6.1 General Chain of Custody Guidelines

1. As few people as possible should handle the sample. Transfers between staff and to the lab shall be recorded on the chain of custody.
2. Prior to delivery to the lab, the container holding the samples may be sealed (e.g., evidence tape) for security especially if the container is shipped for analysis.
3. When the samples transfer possession, both parties involved in the transfer (e.g., sampler and lab) must sign, date and note the time on the chain of custody record.



CHAIN OF CUSTODY

ACCUTEST LABORATORIES
2105 Lundy Ave, San Jose, CA 95131
(408) 588-0200 FAX: (408) 588-0201

Page ___ of ___

FED-EX Tracking # | Bottle Order Control #
Accutest Quote # | Accutest NC Job #: C

Client / Reporting Information | Project Information | Requested Analysis | Matrix Codes

Company Name: Arizona Department of Environmental Quality
Address: 1110 W. Washington St.
City: Phoenix State: AZ Zip: 85007
Project Contact: Shaunel Wytcherley
Phone #: (602) 771-4472
Samplers's Name:

Project Name: ADEQ Surface Water Quality Monitoring
Street:
City: State:
Project #: CSW#
EMAIL: sw4@azdeq.gov
Client Purchase Order #: Enter PO #

Matrix Codes: SW- Surface Water

Accutest Sample ID	Sample ID / Field Point / Point of Collection	Collection: Date	Time	Sampled by	Matrix	# of bottles	Number of preserved Bottles: HCl	HNO3	H2SO4	NONE	NaHSO4	MEOH	ENCORE	SSC - sub	Total Metals	Dissolved Metals	Nutrients	Inorganics	LAB USE ONLY

Turnaround Time (Business days) | Data Deliverable Information | Comments / Remarks

Approved By:/ Date:

- [x] 10 Day
- [ ] 5 Day
- [ ] 3 Day (125% markup)
- [ ] 2 Day (150% markup)
- [ ] 1 Day (200% markup)
- [ ] Same Day (300% markup)

Emergency T/A data available VIA Lablink

- [ ] Commercial "A" - Results only
- [x] Commercial "B" - Results with QC summaries
- [ ] Commercial "B+" - Results, QC, and chromatogra
- [ ] FULT1 - Level 4 data package
- [ ] EDF for Geotrack [x] EDD Format ARIZONA2

Provide EDF Global ID:
Provide EDF Logcode:

Sample Custody must be documented below each time samples change possession, including courier delivery.

	Relinquished by Sampler:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
1			1	2		2
	Relinquished by:	Date Time:	Received By:	Relinquished By:	Date Time:	Received By:
3			3	4		4

FIGURE 3.12. Example of a Chain of Custody

3.2.7 CLEAN SAMPLING OF NATURAL WATERS FOR TRACE METALS

This Standard Operating Procedure is derived from EPA Method 1669. The original method should be consulted for additional information regarding trace metal sampling. However, if the laboratory providing the sampling equipment provides a methodology for clean sampling, this methodology should be followed. The following clean sampling techniques are a combination of EPA Method 1669 and the laboratory's clean sampling methodology.

Trace metals are analyzed for minute concentrations of metals in dissolved waters. The slightest sample contamination will affect the analytical results. The following information is an overview of the clean sampling protocol:

- Utilizes commercially acid pre-cleaned bottles (high density polyethylene is acceptable) and filtering equipment
- Acid cleaned bottles and filtering equipment must be stored and transported in double bags
- Must follow clean hands/dirty hands procedures (Section 3.2.7.1)

- Water samples must be field filtered unless they are received by the lab within 48 hours of collection. Laboratory filtering is acceptable. If field filtered, a deionized water (DIW) blank and a filter blank are required and all sample handling, filtering, etc. must be completed inside a clean box.
- A field blank or duplicate sample is required

3.2.7.1 Clean Hands/Dirty Hands Pre-Sampling Precautions

The SOP describes field sampling procedures commonly referred to as "clean hands/dirty hands" techniques. Upon arrival at the sampling site, one member of the two person sampling team is designated as "dirty hands" and a second member is designated as "clean hands." All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as clean hands. Dirty hands is responsible for preparation of the sample (except the sample container itself), operation of any machinery; e.g., pump, and for all other activities that do not involve direct contact with the sample.

Personnel may wear an unlined, long sleeved wind suit consisting of pants and jacket and constructed of nylon or other synthetic fiber to prevent mercury adsorbed onto cotton or other clothing materials from contaminating samples.

When sampling for mercury on a lake, a fiberglass boat with an electric motor and wooden or fiberglass oars is preferred. The boat should be washed and stored in an area that minimizes exposure to dust and atmospheric particles. If an internal combustion engine is required, it should be shut off at a distance far enough from the sampling point to avoid contamination, then the sampling team should manually propel the boat to the sampling point.

3.2.7.2 Manual Grab Sampling

All sampling personnel must don clean gloves before commencing sample collection activity. It is important to minimize the amount of time that the collection container, filtering equipment, and sample are exposed to ambient air. This is because the analyses can detect trace amounts of metal and mercury from the air can potentially contaminate the sample. To minimize air borne contamination, the following clean hands/dirty hands technique is used.

1. Dirty hands opens the cooler or storage container, removes the double bagged sample bottle from storage, and unzips the outer bag.
2. Clean hands opens the inside bag containing the sample collection bottle, removes the bottle, and reseals the inside bag. Dirty hands then reseals the outer bag.
3. Clean hands moves to the collection location and submerges the sample bottle underwater facing upstream and removes the cap allowing the bottle to fill completely. Recap the bottle underwater (Clean hands must ensure that the sample water does not come into contact with the air).
4. Dirty hands reopens the outer plastic bag, and clean hands opens the inside bag, places the bottle inside, and seals the inner bag.
5. Dirty hands seals the outer bag.

6. If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedure described in Section 3.2.7.5.
7. Record the bottle number or other information on the Field Data Sheets or field notes.

3.2.7.3 Grab Sampling with a Sampling Device

The following details the sampling technique with a suspended grab sampling device; e.g., DH-81 grab sampler or peristaltic pump (Lakes).

All sampling personnel must don clean gloves before commencing sample collection activity. If it is necessary to attach a bottle to the device in the field, clean hands performs this operation inside the field portable clean bag or box.

1. Dirty hands remove the sampling device from its storage container and opens the outer polyethylene bag.
2. Clean hands opens the second polyethylene bag and removes the sampling device. On those occasions where it may be possible to pre-attach a sample bottle to the sampling device in the laboratory, then the entire assembly, bottle and device, is handled as the bottle alone is in the instructions below.
3. Dirty hands open the cooler or storage container, removes the double bagged sample bottle from storage, and unzips the outer bag.
4. Clean hands open the inside bag containing the sample bottle, removes the bottle, and reseals the inside bag. Dirty hands then reseals the outer bag.
5. Clean hands change gloves.
6. Dirty hands submerges the sampling device to the desired depth.
7. When the bottle is full, dirty hands removes the sampling device from the water.
8. Dirty hands returns the sampling device to its large inner plastic bag; clean hands pulls the bottle out of the collar, unscrews the bottle from the sampling device, and caps the bottle. Clean hands and dirty hands then return the bottle to its double bagged storage. If the sampling device is to be re-used, it must be decontaminated in accordance with Section 3.2.7.6.

3.2.7.4 Sampling with a Continuous Flow Sampling Device

Before putting on wind suits and/or gloves, the sampling team removes the bags containing the pump, tubing, batteries, gloves, plastic wrap, wind suits, and, if samples are to be filtered, the filtration apparatus from the coolers or storage containers in which they are packed. This section applies primarily to lakes.

All sampling personnel must don clean gloves before commencing sample collection activity.

1. Dirty hands removes the pump from its storage bag, and opens the bag containing the new tubing.
2. Clean hands installs the tubing while dirty hands holds the pump. Clean hands immerses the inlet end of the tubing into the sample stream.
3. Both clean hands and dirty hands change gloves.
4. For lakes, place your pumping device (Geopump) on a stable place near the edge of the boat. Dirty hands stabilize the pump and place tubing between the cogs. Dirty hands

change gloves and attach a plastic-coated lead weight to the end of the tubing with a zip tie (approximately 6 inches from the tip). Clean hands lower the tubing off the side of the boat to the desired depth without touching the edge of the boat. Dirty hands turns the pump on and allows the pump to run for 5 to 10 minutes or longer to purge the pump and tubing.

5. If the sample is to be filtered, clean hands installs a new cartridge filter at the end of the tubing.
6. The sample is collected by rinsing the sample bottle (with the water from the pump) as dictated by the tier being followed and collecting the sample from the pump. The pump tubing and the filter are discarded after use.

If sampling for mercury, you will collect total mercury, dissolved mercury and methyl mercury. Fill your Dissolved bottle first, then remove the filter and continue using the same tubing to collect the Total Hg and Methyl Hg samples. Have the lab filter the samples if methyl mercury's 48 hour holding time can be met.

Filter blanks should be collected just before placing the sampling train in the water to collect a sample from depth. After the filter blank is collected place the tubing at the appropriate depth and purge the line and filter (same filter as used in blank) before collecting the dissolved mercury sample. After the dissolved sample is collected remove the filter and collect the total and methyl samples.

3.2.7.5 Field Filtering

The sampling procedures described in Sections 3.2.7.2 and 3.2.7.3 are used for samples collected using manual collection systems which require a separate filtering step. Clean sampling filtering apparatus and instructions for use are provided with the sampling bottles from the laboratory. The procedures below are used for sampling with Albion equipment.

If samples are not field filtered then the samples must be shipped to the lab and filtered within 48 hours of sample collection.

3.2.7.5.1 Processing Field Blank and Dissolved Lead and Copper Samples:

Wearing clean gloves and working inside the clean bag (each site needs a new clean bag):

1. Take the syringe filled with blank water and remove from double bags.
2. Remove the end cap from the syringe and turn the syringe outlet end up. Push plunger to expel the air and a small amount of water.
3. Install the syringe filter and turn syringe outlet down. Purge approximately 5 mL through the filter and discard the rinse water.
4. Place the syringe filter flush against the 60 mL bottle rim and apply steady, even pressure, and filter the entire contents of the syringe into the sample bottle.
5. Remove the syringe filter and place it in its original bag.
6. Remove syringe plunger and place it in its original bag.
7. Reinstall filter on syringe and fill with sample water from syringe grab bottle up to stop ring (55 mL). Make sure to shake up sample.

8. Reinstall plunger, turn syringe upright, remove filter, and purge air and small amount of water.
9. Reinstall filter and purge 5 mL of rinse water.
10. Place syringe filter flush against the 60 mL bottle rim and apply steady even pressure. It may take 2-3 min. to filter contents. Only 50-55 mL of sample water needs to be filtered from syringe grab bottle.
11. Recap sample bottle and put into original double bags and record bottle identification number.

3.2.7.5.2 Processing Field Blank for Mercury Sample (red dot equipment):

Wearing clean gloves and working inside the clean bag:

1. Take the Hg-free blank water and remove from double bags.
2. Remove the syringe filter from its double bags, remove the protective end caps. Restore the open filter in its original bag.
3. Remove the syringe plunger completely from the syringe body and place it in the original double bag.
4. Reinstall filter on syringe and fill with Hg-free blank water up to stop ring (55 mL). Recap the blank water bottle.
5. Remove filter from the syringe and turn the syringe outlet end up. Push plunger to expel the air and a small amount of water.

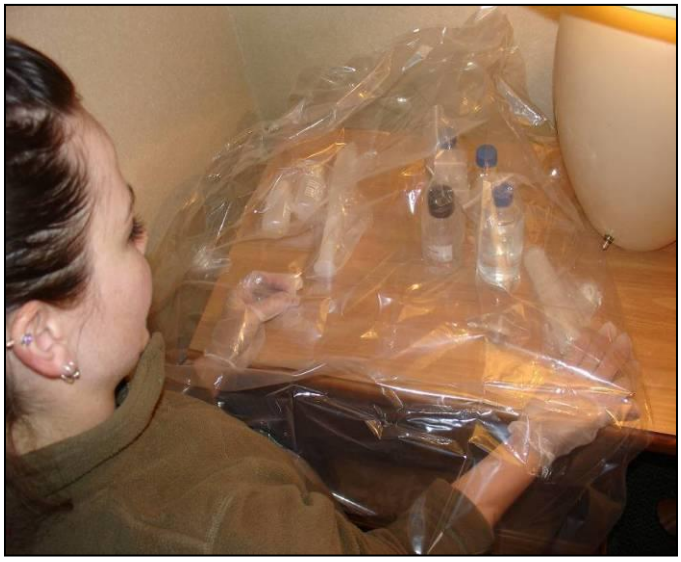


FIGURE 3.13. Field filtering of clean metals.

6. Install the syringe filter and turn syringe outlet down. Purge approximately 5 mL through the filter and discard the rinse water.
7. Place the syringe filter flush against the 250 mL syringe field blank bottle rim and apply steady, even pressure, and filter the entire contents of the syringe into the sample bottle.
8. Repeat steps 2 to 7 until 100 mL of blank water is obtained in the syringe field blank bottle.
9. Recap sample bottle and put into original double bags and record bottle identification number.

Process the mercury sample from the 250 mL syringe grab bottle into the 250 mL composite bottle (Hg) using the above method until 100 mL is obtained. Make sure to shake sample thoroughly.

Field duplicates are processed using the above methodology.

3.2.7.6 Field Decontamination of Equipment

Sampling activity can be planned such that sufficient equipment is brought to the field that field decontamination of the sampling equipment between samples in unnecessary. If it is not possible to plan sampling activity in this manner, dedicated sampling equipment should be provided for each sampling event.

If samples are collected from adjacent sites of the same source water (e.g., immediately upstream or downstream), rinsing of the sampling apparatus (i.e. tubing) with water that is to be sampled should be sufficient.

If it is necessary to cross a gradient (i.e., going from a high concentration sample to a low concentration sample), such as might occur when collecting at a second site, the following procedure may be used to clean the sampling equipment between samples.

1. Inside the clean box, use the "clean hands/dirty hands" procedure to process the dilute nitric acid solution through the apparatus. Dispose of the spent dilute acid in accordance with the project plan.
2. Process 1 L of reagent water through the apparatus to rinse the equipment and discard the spent water.
3. Collect a field blank as described in Section 3.2.7.7.
4. Rinse the apparatus with copious amounts of the ambient water sample and proceed with sample collection.

3.2.7.7 Quality Assurance/Quality Control

The sampling team shall employ a strict quality assurance/ quality control (QA/QC) program. The team must collect equipment blanks, duplicates, and field blanks as described below.

The sampling team is permitted to modify the sampling techniques described in this method to improve performance or reduce sampling costs, provided that reliable analyses of samples are obtained and that samples and blanks are not contaminated. Each time a modification is made to the procedures, the sampling team is required to demonstrate that the modification does not result in contamination of field and equipment blanks.

3.2.7.7.1 Field Blank

To demonstrate that sample contamination has not occurred during field sampling and sample processing, at least one field blank or duplicate must be generated for every 10 samples that are collected.

3.2.7.7.2 Field Duplicate

To assess the precision of the field sampling and analytical processes, at least one field split sample must be collected for every 10 samples that are collected during a given event.

Field blanks are typically done in the beginning and end of a sampling run to identify problems with sampler handling/field techniques and field duplicates in the middle of a sampling run to identify problems with the laboratory.

When the field duplicate sample analytes are >20% of the original sample analyte, add the RPD qualifier to the Results table in the WQDB. The RPD qualifier indicates that the "Relative percent difference exceeded criteria" and data should be selectively used.

The field split is collected by splitting a larger volume (a single container which is filled following clean hands/dirty hands procedures) into two aliquots in the clean box or bag. Using a churn splitter inside a clean bag is normally not practical and will be avoided.

3.3 STREAM COLLECTION TECHNIQUES

3.3.1 COLLECTING A REPRESENTATIVE STREAM SAMPLE

ADEQ employs four techniques for collecting water samples from rivers and streams: grab, equal width increment, modified equal width increment and equal discharge increment. TABLE 3.4 describes when each method should be used. The equal width increment, modified equal width increment and equal discharge increment are composite sampling techniques.

Method	When to Use
Grab Sample	Depth < 1 foot, velocity < 1.5 ft/s, homogeneous water in stream
Equal Width Increment (EWI)	Depth ≥ 1 foot, velocity ≥ 1.5 ft/s, heterogeneous water in stream
Modified EWI	Depth < 1 foot, velocity < 1.5 ft/s, heterogeneous water in stream
Equal Discharge Increment	Not commonly used. Same requirements as EWI, but provides a slightly more representative sample for SSC. Use if sand present in 250 micron sieve.

TABLE 3.4. Stream collection method matrix.

All water samples must be collected upstream of any activity that has occurred within the sample reach during field work. This refers primarily to those sampling techniques that involve physical disturbance to the stream bed (e.g. instantaneous flow measurement, pebble counts, macroinvertebrate collection, walking across the channel points in the reach, etc.).

Water samples should be collected after completion of field measurements. In those cases where the water sample cannot be practically taken at the end of the sample visit, it is important to not allow the temperature of the samples to rise significantly above the ambient temperature of the water body being sampled. If an ice chest is not readily available, place the sample bottles in a shaded location in the stream.

For composite samples, the sample for SSC analysis should be withdrawn from the churn splitter first.

A 250 micron sieve may be used to make a visual determination as to whether sand-sized particles are suspended in the water column. Using a 1-liter sample collection bottle, the field person collects a grab sample at the deepest, fastest point in the stream channel. The sampler should take care not to sample any bed material. Slowly empty the water in the sample collection bottle into the sieve and visually inspect the sieve for sand-sized particles. If sand sized particles are not in the

sieve, then the observer may collect a grab sample or use the Equal-Width-Increment (EWI) method to obtain a composite sample using a churn splitter. If sand-sized particles are in the sieve, then the sampler may collect a grab sample or use the equal-discharge-increment (EDI) method to obtain multiple sample bottles for SSC analysis. SSC protocol should be collected in wadeable, perennial streams during normal flows. The SSC field protocol has been adapted from Field Methods for Measurement of Fluvial Sediment (Edwards and Glysson, 1999). The equipment and field methods described in this protocol are designed to yield a representative sample of a water/sediment mixture moving in a stream. Tests performed by the U.S. Geological Survey demonstrate that a composite sample from a churn splitter can provide unbiased and acceptably precise (generally within 20% of the known value) SSC values as large as 1,000 mg/L when the mean diameter of sediment particles is less than about 0.25 mm. At SSC values of 10,000 mg/L or more, the bias and precision of SSC values in churn splitter sub-samples are considered unacceptable (Gray, et al., 2000).

3.3.1.1 Grab Sample Method

1. Determine a representative spot to sample that is well mixed and meets the guidelines in TABLE 3.4. Rinse the bottle with stream water three times to flush out any contaminants that might be present. Dispose of rinsate downstream of your collection point. Collect the sample by inverting the bottle open end down, and lower to half the water column depth taking care not to disturb any sediments on the stream bottom. Turn the bottle so that it is parallel to the stream bed, allowing the air to escape and the bottle to fill.

Label the bottle when it is dry before immersing it into the water.

2. Fill the individual sample bottles leaving space for the introduction of the acid preservative. Secure sample bottle caps tightly.
3. Filter the dissolved metal sample (see Section 3.2.3).
4. Add preservatives (see Section 3.2.4).
5. Place the samples in an ice-chest in an upright position.

3.3.1.2 Equal Width Increment Sample Method

Equal-Width Increment (EWI) sample collection and Equal-Discharge Increment (EDI) sample collection methods were developed and refined by the United States Geologic Survey (USGS). Both techniques utilize an isokinetic depth-integrating sampler (DH-81) that is designed to accumulate a representative water sample both continuously and isokinetically, meaning that the water approaching and entering the sampler intake does not change in velocity. EWI and EDI sampling techniques are commonly used in larger flowing systems which cannot be adequately characterized with a grab sample.

FIGURE 3.14. 14 liter churn splitter.

The purpose for collecting a EWI sample is to obtain a series of sub-samples, each representing a volume of water taken at equal vertical transit rates and at equal widths apart from each other at various intervals across the channel. This ensures obtaining a discharge weighted representative water sample from the entire flow passing through the channel.

Instantaneous discharge of the water body is determined with the Marsh McBirney flow meter and top-setting wading rod (see Chapter 5 for an explanation on how to take instantaneous discharge).

Samples are collected using a Isokinetic Depth-Integrating Sampler (US DH-81 hand-held sampler, FIGURE 3.15) which consists of four distinct parts: a three foot long metal rod with a plastic-vinyl handle on one end and machined threading on the opposite end; a US DH-81A molded Teflon adaptor which attaches to the threaded end of the wading rod; a US D-77 molded Teflon cap which has an internally molded air-vent tube; a machined Teflon US D-77 Nozzle with a 5/16 inch sample intake opening; and a 1-liter collecting bottle. ADEQ primarily uses the 1/4 inch nozzle, which is for flow velocities between 1.5 and 7.6 ft/sec.

FIGURE 3.15. DH-81 Sampler.

EWI Sampling Procedure

1. Upon arrival at the sample site, remove the churn splitter from its protective plastic bag and rinse it well two to three times with water from the stream. Fill to about 1/2 to 3/4 full and place the capped container in a shaded location in the stream. This will allow the churn splitter and ambient stream water to equilibrate prior to sampling. When ready to collect the sample, remove the cover and empty the churn splitter. Place the cover in the plastic bag to prevent contamination of the water sample when replacing the cover after the sample has been collected (or just keep the cover on).
2. Extend a measuring tape transect across the stream channel, perpendicular to the flow at a sampling location not influenced by side-channel eddies.
3. Measure the instantaneous flow discharge. This preliminary measurement is required in order to perform the EWI. Take note of the location of the fastest flow once the discharge measurement has been completed.
4. The EWI requires multiple sampling points across the transect. The number of sampling points (vertical intervals) to be sampled is based on the following variables:
   - Volume of sample needed for analysis (number of sample bottles to be filled)
   - Size of the churn splitter
   - The depth and velocity distribution in the cross section at time of sampling.

It may take several tries to get the right sample volume for a particular stream. Adjust the number of verticals to get the appropriate volume of sample for the churn splitter.

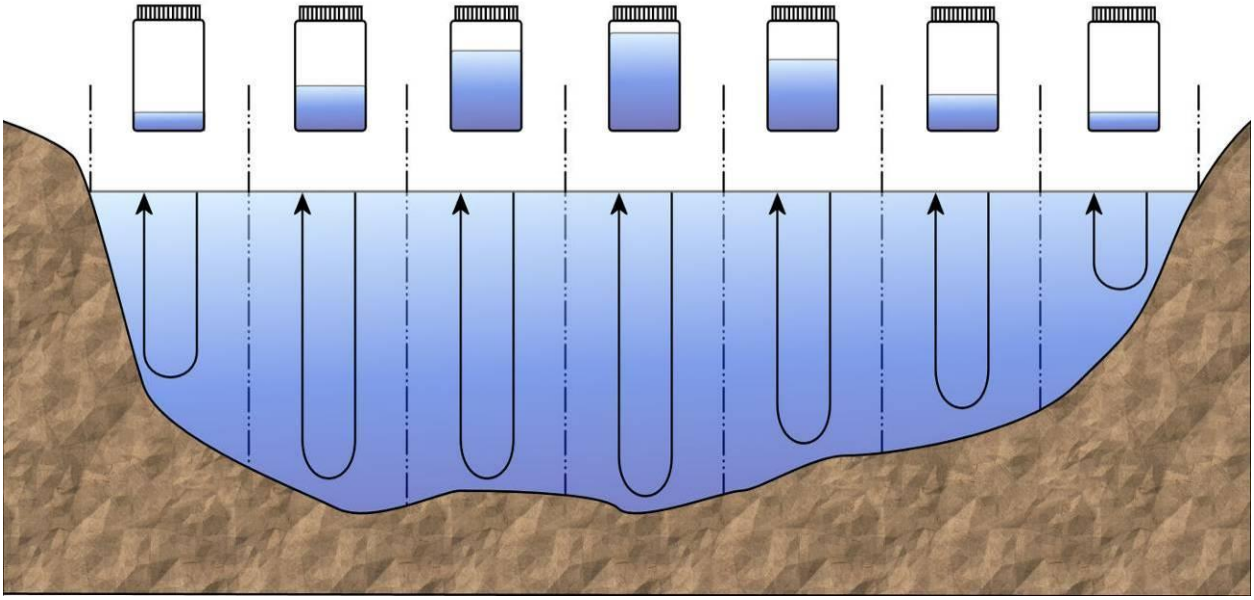


FIGURE 3.16. Depth-integrated samples collected using the equal width increment method.

5. The sampler should pick a reference point on the body (such as a belt buckle) to use as a starting reference point when initiating a vertical transect. All vertical transits across the channel should begin at the same reference point regardless of water depth.
6. Establish the vertical transit rate by determining the location of maximum velocity in the channel obtained from the discharge measurement. In most cases this will be the deepest, fastest point identified along the transect line. The sampler is positioned at the fastest point in the stream. The sampler positions the DH-81 bottle at the predetermined reference point (e.g., belt buckle) and begins lowering the DH-81 with a constant motion to the streambed and then back again to the reference point. During this period the sampler should be counting time from beginning to end of transit. If the first transit attempt did not fill the bottle, empty the bottle, repeat the process and adjust the transit rate until the DH-81 bottle is filled to just below the neck of the bottle. The sampler must repeat the transit if the DH-81 collection bottle is overfilled or underfilled. Once the correct transit rate has been determined, discard the collected water. Do not use this water as part of the final water sample.
7. Using the transit rate established in Step 6, move to either bank and prepare to collect the sub-samples at the established intervals and transit rate. The number of intervals is calculated based on the volume of water to be collected and the size of the churn splitter being used. For example, if four liters of water are needed and a six liter churn splitter is used, a minimum of five liters of sample water is needed. Once the sample water has been withdrawn from the churn splitter to fill the sample bottles, a minimum of one liter must remain in the churn splitter. To calculate the number of intervals, it is known that a full

liter will be collected at the fastest flow location and decreasing amounts will be collected on either side of that location. FIGURE 3.16 illustrates this process. Estimate the number of transit intervals by made taking into account the width of the channel, the depth of water, and the flow rate through the channel cross-section.

8. Once the number of sub-samples has been estimated, the interval width is calculated. For example, if the stream width is 20-feet, and the number of sub-samples is estimated to be 10, then the width of each sample interval would be 2 feet. The actual sampling station within each interval is located at the center of the interval. Beginning at a location of 1 foot from the bank, the intervals are then spaced 2 feet apart, resulting in sample stations at 1, 3, 5, 7, 9, 11, 13, 15, 17 and 19 feet along the 20-foot width.
9. Collect the sample in the first interval with the DH-81 at the predetermined transit rate (Step 6). It is important to remember to begin and end at an established reference point (belt buckle) and maintain a constant rate. A second observer should accompany the sampler carrying the churn splitter to receive the samples.

It is often possible to composite samples at two or more verticals near the banks without having to empty the sample collection bottle into the churn splitter to save time. However, if the collection bottle is over filled during the sample collection process, the bottle must be emptied of its contents and all verticals, which contributed to that particular sub-sample must be recollected.

10. After all the sub-samples have been deposited into the churn splitter, the individual pre-labeled sample bottles can be filled.

Bacteria samples should not be collected from the churn splitter. Plastic churn splitters cannot be autoclaved and thus may already be contaminated before the composite sample is taken.

Churn the sample at a uniform rate of about 9 inches per second. The mixing disc should touch the bottom of the churn on the down stroke but should not be allowed to break the water surface on the up stroke. A minimum of 10 strokes is required before withdrawing the first subsample. Before withdrawing the sample water, run a small quantity of water through the spigot as rinse to remove any contaminants that may have adhered to the inside of the spigot body. If the disk breaks the water surface while a subsample bottle is being filled, momentarily stop the filling process and stroke 10 times before continuing to fill the subsample bottle.

3.3.1.3 Modified Equal Width Increment Sample Collection

The Modified EWI method is often used in small wide streams where depths are less than one foot, and horizontal mixing is insufficient for capturing a representative sample. It is also used in shallow streams where tributary inflows are not well mixed with the dominant mainstream flow. The procedure is designed to produce a sample that is more representative than a grab sample, but not discharge weighted as with the EDI collection method. The sub-samples are collected by hand with the wide-mouth 1-liter collecting bottle at the determined vertical intervals.

Modified EWI Sampling Procedure

1. The procedure for the modified EWI is the same as the EWI in Section 3.3.1.2 with the exception that the no rod is used. The sampler uses their hand instead of the rod.

   For streams of shallow depth where the use of a 1-liter bottle and a churn splitter may be impractical, use a clean 250 milliliter bottle to collect the sample. Establish four sampling points along the transect that are approximately equal in distance from each other. Collect a sub-sample from each point, using a transit rate that fills the bottle completely and evenly at each point along the transect. Cap and invert the bottle several times to mix the sample.

3.3.1.4 Equal Discharge Increment Sample Collection

Equal discharge increment sampling is used when sieving indicates that sand-sized particles are entrained in the water column and the stream is 10-feet wide or wider. If sand-sized particles are entrained in the water column and the stream is less than 10-feet wide, a grab sample may be taken from a single vertical in the deepest, fastest location in the channel.

The Equal Discharge Increment (EDI) method produces a discharge-weighted sample that represents all the flow passing through the cross section by collecting a number of sub-samples, each representing equal volumes of discharge. The flow in the cross section is divided into increments of equal discharge and then equal-volume. Depth-integrated samples are collected at the centroid of each increment along the transect. The term centroid refers to the location in the channel transect where discharge is equal on both sides. EDI sample collection is used by ADEQ principally for the collection of suspended sediment concentration samples.

Equal Discharge Increment Procedure

The objective of the EDI is to collect a discharge-weighted sample that represents the entire flow passing through the cross-section by obtaining a series of samples, each representing equal volumes of stream discharge.

1. Place measuring tape across stream channel perpendicular to flow at the sampling site. Determine the stream width from the edges of water.
2. Take discharge measurements using Marsh McBirney flow meter to determine the total discharge and the flow distribution across the channel at the cross section. When recording discharge measurements on the field form, the recorder should include a cumulative discharge column and keep a running total of the cumulative discharge from the LEW.

Use the "EDI Flow Template" excel spreadsheet on a laptop or pocket PC (FIGURE 3.17) to determine the cumulative Q, centroid locations and sample station locations.

Stream Discharge Calculation

Sta.	Dist. (ft)	Width (ft)	Depth (ft	Area (ft2	Vel. (ft/se	Q (cfs)	Q (Cumulative)	Notes
1 LEW	0.0	0.75	0.00	N/A	LEW	N/A	0.00	LEW
2	1.5	1.50	0.15	0.23	0.14	0.03	0.03	
3	3.0	1.50	0.35	0.53	0.67	0.35	0.38	
4	4.5	1.50	0.50	0.75	0.91	0.68	1.06	
5	6.0	1.50	0.80	1.20	1.58	1.90	2.96	
6	7.5	1.50	1.05	1.58	1.97	3.10	6.06	
7	9.0	1.50	1.34	2.01	2.40	4.82	10.88	
8	10.5	1.50	1.35	2.03	3.85	7.80	18.68	
9	12.0	1.50	1.60	2.40	3.95	9.48	28.16	
10	13.5	1.50	1.70	2.55	3.40	8.67	36.83	
11	15.0	1.50	1.70	2.55	2.80	7.14	43.97	
12	16.5	1.50	1.70	2.55	3.00	7.65	51.62	
13	18.0	1.50	1.55	2.33	2.50	5.81	57.43	
14	19.5	1.25	1.40	1.75	2.53	4.43	61.86	
15	20.5	1.25	1.22	1.53	2.63	4.01	65.87	
16	22.0	1.50	1.30	1.95	2.88	5.62	71.49	
17	23.5	1.50	1.25	1.88	2.12	3.98	75.47	
18	25.0	1.50	1.18	1.77	1.10	1.95	77.42	
19	26.5	1.50	1.35	2.03	1.38	2.79	80.21	
20	28.0	1.50	1.52	2.28	1.07	2.44	82.65	
21	29.5	1.50	1.32	1.98	0.44	0.87	83.52	
22	31.0	1.50	1.40	2.10	0.23	0.48	84.00	
23	32.5	1.50	1.05	1.58	0.00	0.00	84.00	
24	34.0	2.15	0.40	0.86	0.00	0.00	84.00	
25 REW	36.8	1.40	0.00	N/A	REW	N/A		REW
					Total Q=	84.00	cfs	

Area and Discharge (Q) are calculated values.

5-Station EDI Calculation

Tot. Q/5=	16.8	cfs

Cumulative Q @ Centroids			Sampling Stations		
Station 1 Q	8.4	(cfs)	Sample 1	8.4	(ft)
Station 2 Q	25.2	(cfs)	Sample 2	11.5	(ft)
Station 3 Q	42.0	(cfs)	Sample 3	14.6	(ft)
Station 4 Q	58.8	(cfs)	Sample 4	18.3	(ft)
Station 5 Q	75.6	(cfs)	Sample 5	23.5	(ft)

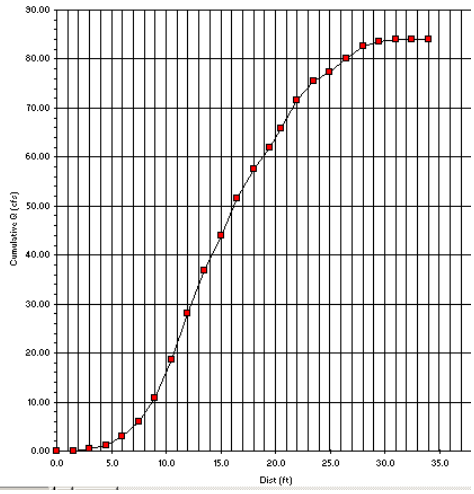


FIGURE 3.17. Flow EDI Template.

3. Calculate the EDI. The EDI is determined by dividing the total cumulative discharge by the number of verticals to be sampled. For example, if the total cumulative discharge of the stream is 84 cfs and 5 verticals are to be sampled, then the EDI method is 16.8 cfs. The number of verticals is determined by the sample volume that is needed. If 4 liters of sample are needed then 5 verticals should be used. This will leave 1 liter in the churn.
4. The location of the centroids of the equal discharge increment is determined from the cumulative discharge calculations. The first vertical is located at a point where the cumulative discharge from the LEW is half of the EDI. In the previous example, if the EDI is 16.8 cfs, then the first vertical is located at the point where the cumulative discharge = 8.4 cfs. Subsequent centroids are located by adding the EDI to the cumulative discharge at the first vertical. In our example the second vertical would be located at the point where cumulative discharge = 8.4 + 16.8 = 25.2 cfs relative to the LEW. Use the same approach to determine the centroid discharge amounts for the 3rd to 5th centroids. The spreadsheet will calculate these automatically. Adjust the spreadsheet if the number of verticals need to be adjusted.
5. Use the Cumulative Discharge Curve (FIGURE 3.17 and FIGURE 3.18) to determine the locations of the five sampling stations.

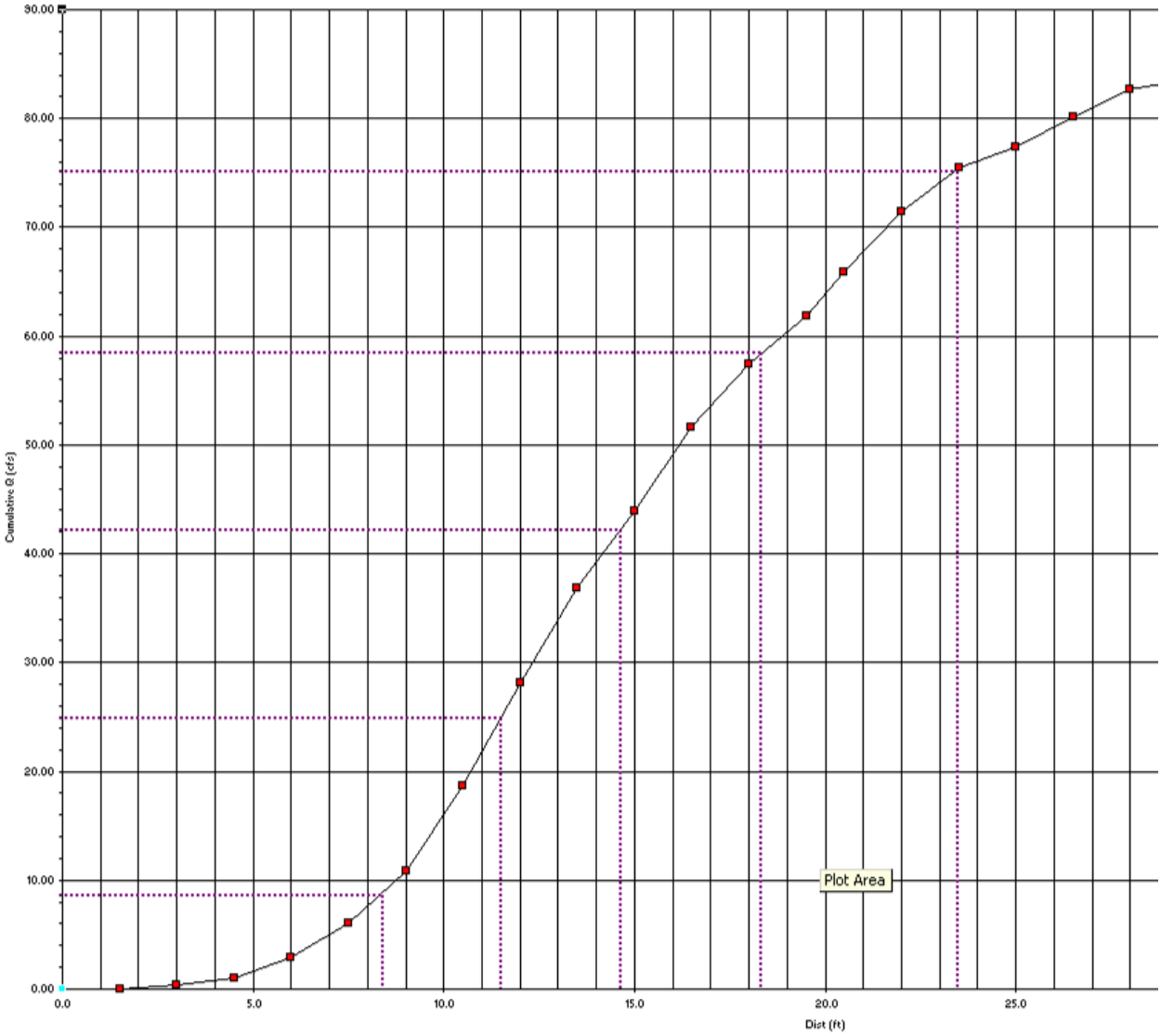


FIGURE 3.18. Close-up view of the Cumulative Discharge Curve from the "Flow EDI Template". Dotted lines represent the 5 cumulative Q centroid locations and the corresponding sample points across the transect.

6. A depth-integrated sample is collected at each sampling station using a DH-81 sampler. The transit rate used to collect a sample must be constant in one direction. However, it is not necessary to maintain equal transit rates of ascent and descent within a vertical. Also transit rates can vary at different verticals in the cross-section. A single sample bottle is filled at each vertical (FIGURE 3.19).

It is important that all sample bottles be of equal sample volume.

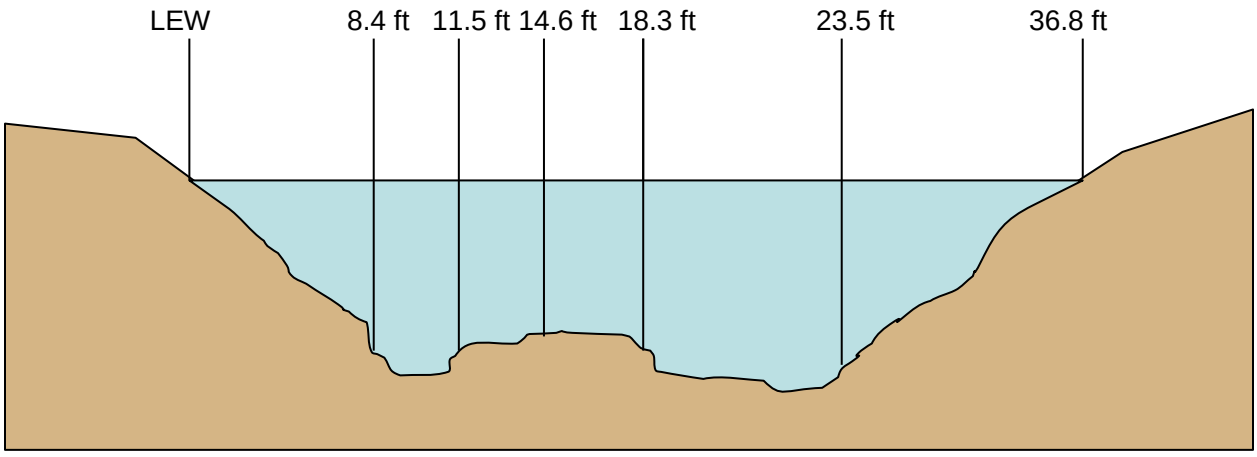


FIGURE 3.19. Cross-section showing the 5 sample locations.

3.4 LAKE SAMPLING TECHNIQUES

The number of samples collected for a particular site will depend on whether or not the lake is stratified. To determine stratification, a multimeter probe will need to be extended to the bottom of the lake at the sample site.

1. Before using the probe you will need to calibrate it for the local barometric pressure and for depth (see Section 3.1.1 for additional detail). When you get to the lake, attach the cable, face and probe.
2. Screw on the probe cover that allows water to pass through. Place the probe in the water at a depth of approximately 10 cm. Record field parameters on field data sheet (percent DO, pH, etc.).
3. Slowly lower the probe to 1m for the second reading. Continue at 1 m intervals until you reach the bottom of the lake. Allow the probe reading to stabilize before recording. Take the last reading at 0.5 m above the suspected bottom of the lake. If the site is extremely deep, consider reading the probe at every 2-5 m. Just be sure to capture at least 3 equally-distanced readings within the epilimnion and the hypolimnion and to identify the thermocline (FIGURE 3.20).

A lake is thermally stratified when there is a change of more than ONE degree Celsius per meter. This depth is called the thermocline.

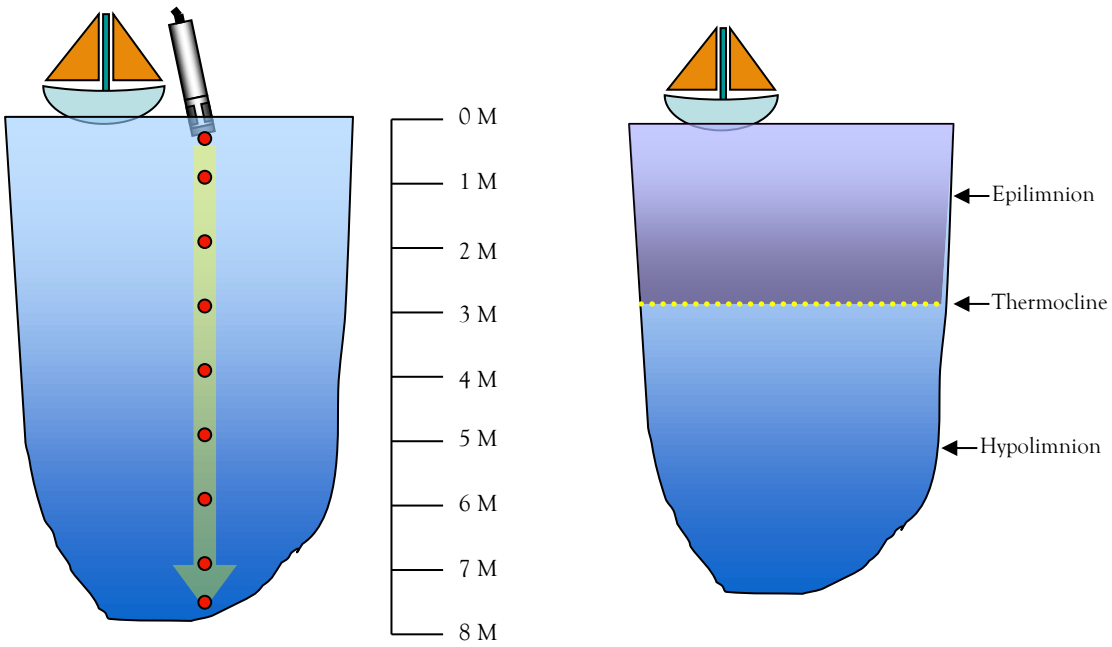


FIGURE 3.20. Red dots represent depths where multiprobe readings are taken.

Repeat any suspect measurements and make notes on the field sheet and in the instrument's logbook if the DO membrane had to be replaced.

The DO membrane will dry out if left exposed to air so, as soon as possible, cover it with the cap including about 5mL of water. When sampling is complete, return the probe to the case and be sure the cap is tight so that the water won't leak out. If there is dirt on the probe, be sure to clean it (gently wash with water) and do any necessary maintenance before returning it to the storage area.

3.4.1 COLLECTING A REPRESENTATIVE LAKES SAMPLE

A representative sample is a collection of grab samples that represent the vertical and spatial components within the main body of the lake. Samples are generally not taken in shallow, stagnant portions of the lake. Instead, lake sampling focuses on the mid-lake sample within geomorphologically distinct subunits of the lake. Examples of subunits may include the forebay, mid-lake and inlet. The morphology of each lake is unique and may require a different number of samples in order to characterize the condition of the lake. A sample is always taken near the dam site as a reference.

A small (<200 acres), round lake may not require more than two sampling locations – one at the dam and one in a more centralized location. A lake with many tributaries may exhibit different chemical concentrations in water near each inlet. While it is not necessary to sample near each inlet, the sampler should make an attempt to capture a sample in an area near main tributary inputs or near a series of similar tributary inputs (FIGURES 3.21 and 3.22).

A minimum of three sampling locations should be taken across a lake unless the lake is small (<200 acres) or has a simple (round, few tributaries, tributaries drain similar watersheds) morphology.

A representative sample relies on repeatable collection practices. Lake sampling for assessment purposes should be conducted with a thief sampler such as a beta bottle. Sample bottles should be filled from a single collection from the 6 liter beta bottle to ensure that local site variation does not contribute to variation between sample bottles. The sample should be homogenized by gently swirling the beta bottle before filling each sample bottle.

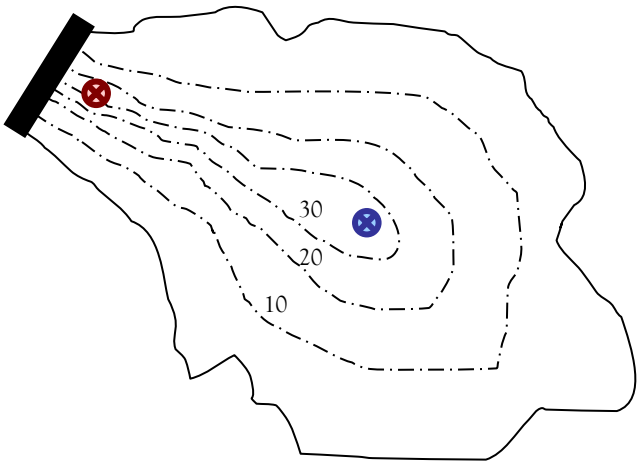


FIGURE 3.22. Simple lake with two sites. Dashed lines represent lake depth. Dam is represented by a solid black rectangle. The site is the blue "x". The dam site is the red "x"

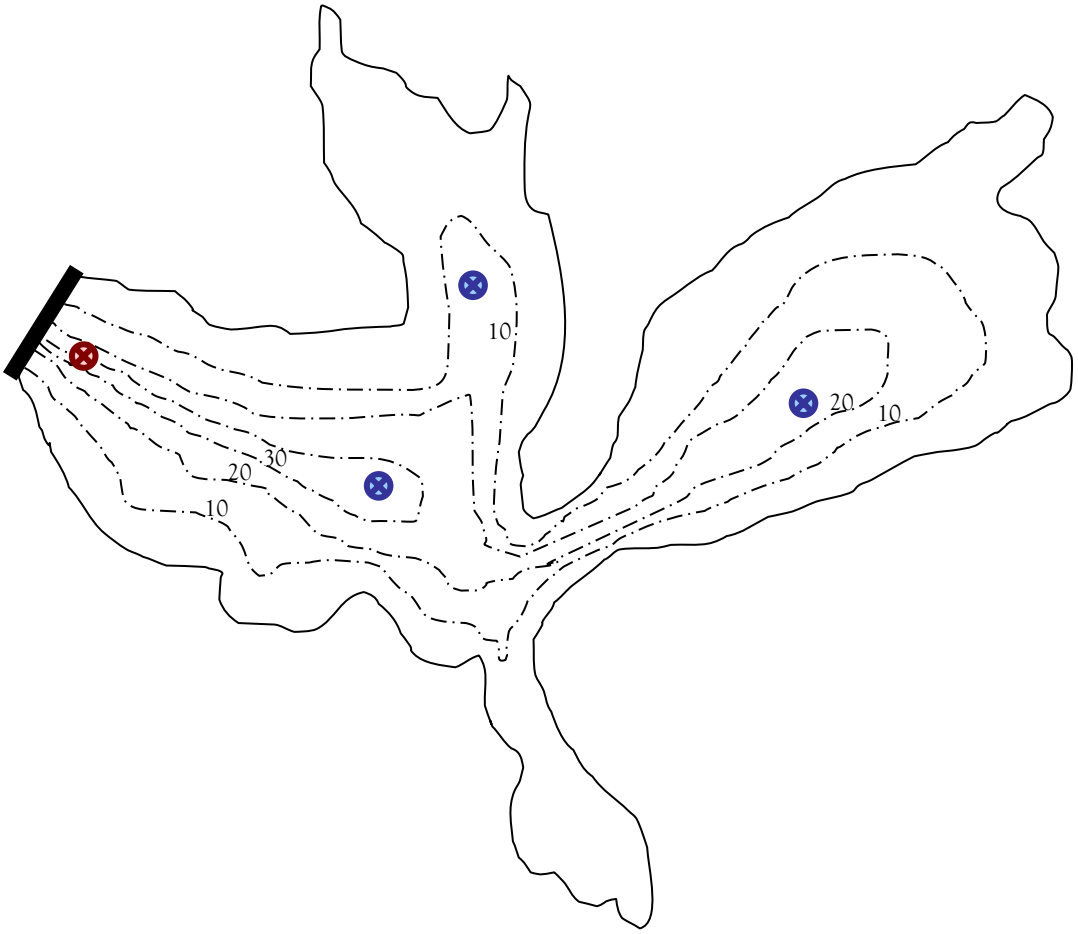


FIGURE 3.21. Complex lake with 4 sites. Dashed lines represent lake depth. Dam is represented by a solid black rectangle. The sites are represented by the "x's". The dam site is the red "x"

3.4.2 WATER SAMPLE COLLECTION

3.4.2.1 Secchi Depth

One sample is always collected in the photic zone of the lake. A secchi disc is used to determine the depth of the photic zone. The photic zone is where visible light penetrates to allow primary production.

1. Attach the secchi disc to a marked rope or to a meter tape (FIGURE 3.22). Lower the disc off the shady side of the boat and remove sunglasses or other visual obstructions. Slowly lower the secchi disc into the water until it disappears. Estimate the depth to the nearest 0.1 m. Record the depth at which it disappears. Lower the disc a little more and then slowly bring it back until it reappears. Record this depth as well. The average of these two values is the secchi depth. Record the secchi depth.
2. Multiply the secchi depth by a correction factor of 1.5. This identifies the depth of the photic zone.

FIGURE 3.22. Secchi disc and marked chain.

3.4.2.2 Beta Bottle

Prior to collecting a beta bottle sample you should have identified if the lake is stratified or not according to Section 3.4.

3.4.2.2.1 Beta Bottle Collection Point in an Unstratified Lake

Only one sampling depth is needed for unstratified lakes. The sampling depth is 1/2 the depth of the photic zone (FIGURE 3.23).

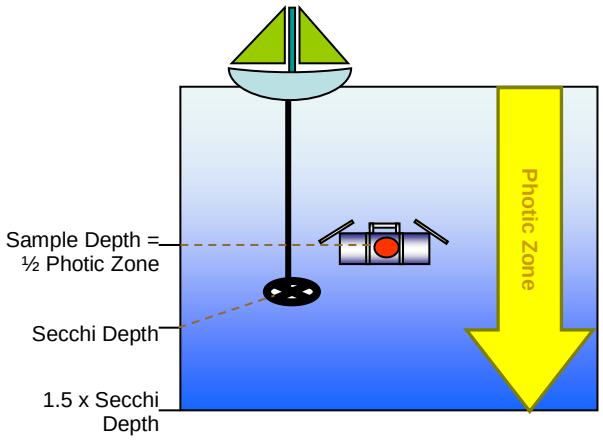


FIGURE 3.23. Sampling location for an unstratified lake.

FIGURE 3.24. Beta bottle.

The beta bottle should be rinsed in the lake water before sampling (FIGURE 3.24). Swish it back and forth slowly with the side lids open.

Record top and bottom sampling depth (generally the same).

The beta bottle rope is marked in 1 meter units. Lower the beta bottle to the desired depth. Swish the bottle horizontally back and forth and let it sit for approximately 30 seconds. Then deploy the messenger to collapse the lids. Slowly raise the beta bottle out of the water and use the pour spout to empty its contents into sample bottles. Gently swirl the beta bottle between filling up sample bottles. When pressure is low, it may help to loosen the yellow valve or to place something between the lid and the bottle to keep the lid open.

The beta bottle should not be cleaned with detergents or bleach. Use tap water and a clean brush to wash the inside and outside of the beta bottle. Keep the lids open while it dries. When dry, collapse the lids as soon as possible so that the cords do not become loose. Store the beta bottle in the plastic suitcase along with the rope and messenger.

Use the spigot to fill up the sample bottles.

3.4.2.2.2 Beta Bottle Collection Points in an Stratified Lake

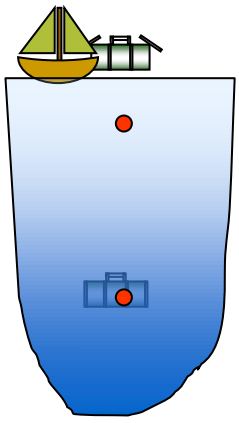


FIGURE 3.25. Stratified Lake Sample Points

At least two samples depths should be sampled for a stratified lake (FIGURE 3.25). One sample point will be collected in the epilimnion at the midpoint of the photic zone (see Section 3.4.2.2.1 for additional detail).

The other sampling point is located within the hypolimnion 2 meters below the thermocline.

3.4.2.3 Sediment Sample Collection

A sediment sample is collected for the purpose of determining recent deposition quantities of nutrients and metals. There are two main types of sediment samplers that could be used: Eckman dredge and a Wildco corer.

The Eckman dredge is best to use in shallow, loose soils. The Wildco corer should be used in rocky substrates or at deep sites.

FIGURE 3.26. Ekman dredge.

Eckman dredge

Open arms on the Eckman dredge (FIGURE 3.26). Swish it in the water to rinse, and then slowly lower it to the sediment. When you reach the sediment, let it sink in, then send the messenger down to collapse the arms. Slowly raise the dredge out of the water. Open the top to scoop out a sample. Release the unused sediment into the lake.

Wildco corers: pounder method

Wildco corers are meant to collect a core of water by pounding a heavy metal rod into the sediment. With the pounder, you can insert a plastic tube into the metal tube, and then close it off with a black sediment catcher and a white nose piece (FIGURE 3.27).

FIGURE 3.27. Wildco sediment corer.

After assembling the corer, make room for the three ropes and decide who will handle each rope. The ropes include the main handle for the corer, the rope for the lever than activates suction, and the rope to raise and drop the pounder. Slowly lower the corer until it touches the sediment. Then, raise the corer approximately 1 m from the bottom and let it free fall. Pound repeatedly (about 3 times), using the ropes to gage how well the pounding is working. When you think the corer is solidly in the soil, raise the lever rope to create suction. Now with all three ropes being pulled, bring the corer to the surface.

Bring the corer to a horizontal position in the boat. Carefully remove the nose piece and catcher and scoop out the sample.

When you have collected the desired sample volume, return the corer to the lake water for rinsing. Do not expect to remove all the mud. A thorough cleaning should be done in the lab using soapy water.

Wildco corers: Modified KB corer

The Modified KB corer relies on a plunger to provide suction. The sample is collected within a detachable hard plastic tube. This corer is heavier and longer than the pounder and may lose suction more easily. However, because of the weight, it may be easier to identify when you have stuck the corer in the mud. You can avoid losing suction by reaching as far into the water as possible to plug the bottom end.

Insert the core tube into the housing sampling apparatus and tighten the hose clamps with a nut driver. Set up the plunger so that it will drop when the messenger is deployed. Use grease if necessary to ensure a tight seal between the plunger and the metal surface.

Lower the corer keeping the line taut until you reach bottom. Then pull up the corer to approximately 2 m above the bottom. Let the line slip through the hands until it hits bottom. Then, keep the line taut so that the corer doesn't tilt. Unless you are in rocky substrate, the force of the corer should have been enough to stick into the sediment. Trip the messenger to create the suction.

Very slowly raise the corer until the top part reaches the surface of the lake. At this point it is very easy to lose suction and lose the sample. With one person holding onto and stabilizing the corer and the other holding onto the rubber plug and ready to place it on the end of the tube, slowly raise the corer out of the water until the tube is plugged. Then raise the corer completely out of the water and set it vertically on the boat (in a tub or bucket reduces the mess). Loosen the clamps using a nut driver and separate the metal piece from the plastic piece.

Collect a sample from the top of the plastic tube which reflects the most recent deposition in the lake. Using the PVC extruder, push the sediment up toward the top of the tube. Place the stage over the opening and secure it with the built in screw. When the water has been extruded so that the soil is almost to the stage, remove excess water with a siphon.

Now place a plastic column with 1cm marked on top of the stage. Continue pushing the sediment up till it reaches the 1 cm level. Push the column towards the flat part of the stage. This cleaves off the top 1 cm of soil. Use a plastic spatula to push the soil into the collection jar. Repeat the cleaving process for additional soil volume.

Release any unused soil back into the lake and rinse the corer and associated parts in the lake. The sediment sampler should be washed with soap and water between lake surveys or after a sampling run.

3.4.2.4 Zooplankton Sampling

1. Lower 80 µm net in an upright position until the mouth of the net is 0.5 meters above the lake bottom (FIGURE 3.28).
2. Pull the net to surface at a steady rate without stopping (1 ft /sec).
3. At surface, move net up and down without submersing the mouth to rinse contents into collection bucket.
4. Rinse again by spraying water against the outside of net.
5. Remove bucket from net and concentrate contents by swirling bucket to remove excess lake water.
6. Repeat steps 1-5 on opposite side of boat using 243 µm net.

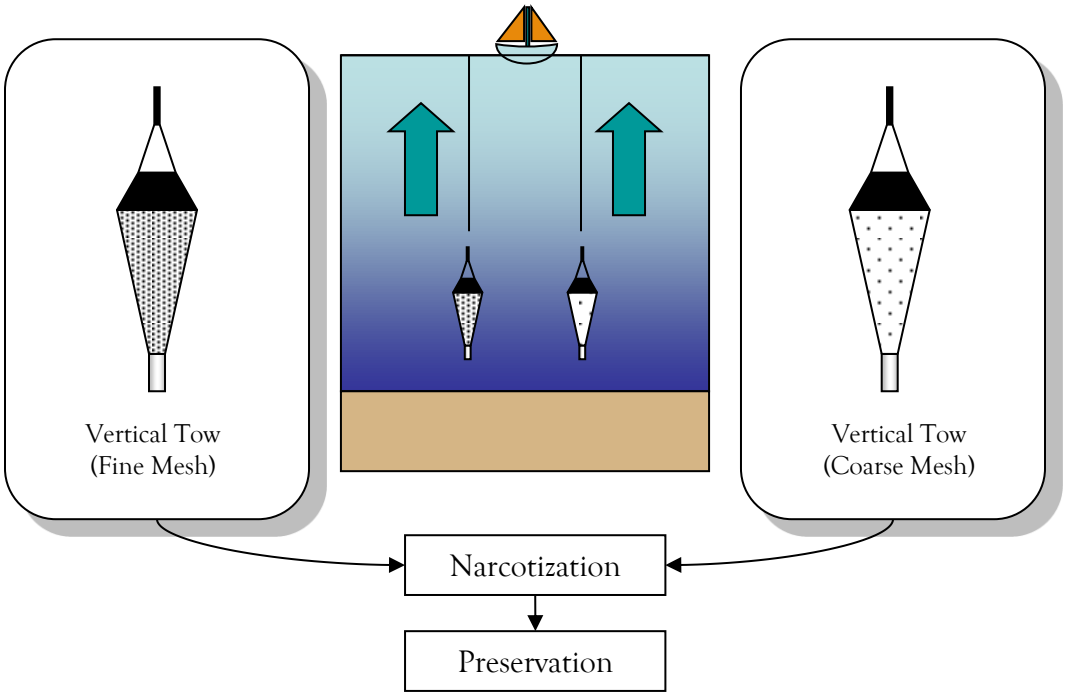


FIGURE 3.28. Coarse and Fine Zooplankton Tow s. Each are lowered 0.5 meters above the lake bottom and then raised to the surface. Samples are then narcotized and preserved.

Set collection bucket in a small container and narcotize zooplankton using water containing a CO_2 tablet (alternatively, Alka-Seltzer or club soda may be used). Wait until zooplankton movement has stopped (usually about 1 minute). Rinse contents of bucket into 125 ml jar using small volumes of DI water. Preserve sample with ethanol by filling sample jar to the 80 mL mark or a little more than half full.

3.5 FISH TISSUE

ADEQ collects fish tissue to determine risks to human health from pollutants such as mercury and pesticides. Because fish spend their entire lives in the aquatic environment, they incorporate chemicals from this environment into their body tissues. Contamination of aquatic resources has been documented for heavy metals, pesticides, and other complex organic compounds. Once these contaminants reach surface waters, they may be available for bioaccumulation, either directly or

through aquatic food webs, and may accumulate in fish and shellfish tissues. Results from fish tissue monitoring can serve as an important indicator of further contamination of sediments and surface water.

This procedure is used by the ADEQ's fish consumption advisory program to collect and process fish tissue samples to be analyzed for chemical contaminants. These procedures are based on established guidelines described in EPA's 2000 guidance for assessing chemical contaminant data for use in fish advisories.

3.5.1 SAMPLE COLLECTION

The fish consumption advisory program will employ several means of fish collection. Collections on lakes and non-wadeable streams are usually accomplished using a boat mounted electrofisher, gill nets or cast nets. Collections on wadeable streams are accomplished using backpack electrofishing techniques, cast nets or gill net "traps" (See Appendix A).

All personnel involved must be familiar with standard operational and safety procedures (Bryan, et al. AGFD, 2004; (See Secton 2.3 for additional electroshocking safety information).

Studies may use fish that are collected by other agencies or that fish that are purchased from recreational anglers. See Section 3.5.3.3 for minimum quality control measures, labeling and handling.

Use the following guidelines when selecting/collecting fish for tissue analysis:

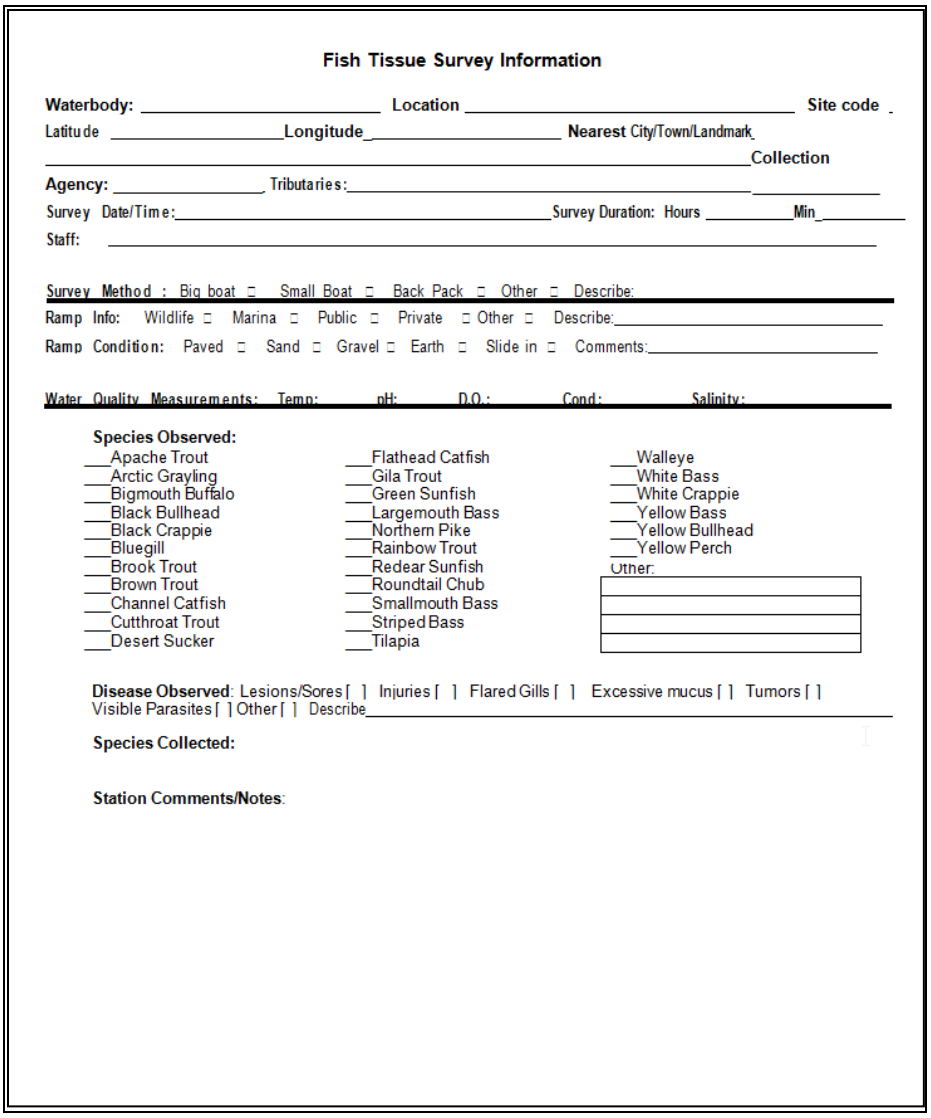
1. Species: The species selected should represent game fish most likely caught and kept by anglers.
2. Size: The size range of fish collected should be representative of:
   a. Those most likely to be caught. "Trophy" fish are much less likely to show up in an angler's creel and may skew data due to their age and size.
   b. Size or slot limits placed on the waterbody by AGFD regulation.
3. Trophic position: High order predators like largemouth bass and walleye tend to bioaccumulate pollutants to a higher concentration due to their place in the food web.
4. Pollutant accrual and storage: Pollutants can be accrued and stored differently due to species and pollutant characteristics. Generally, mercury is stored in muscle tissue and organochlorines are stored in fat. "Oily" fish like the common carp will have the highest organochlorine concentrations and muscular predators like the largemouth bass will accrue mercury at a higher rate.
5. Trophic condition: Check with AGFD prior to sampling to see if the selected waterbody has undergone any large trophic shifts. Fish in poor condition will have less body fat, which can affect pollutant concentrations in the short term and may not be representative of long term values.

The following is a list of Arizona Game Fish. Preferred species are listed in red:

Bass, Largemouth Carp Sunfish, Green

Bass, Rock	Catfish, Blue	Sunfish, Hybrid
Bass, Smallmouth	Catfish, Channel	Sunfish, Redear
Bass, Striped Bass	Catfish, Flathead	Tilapia
Bass, Yellow	Crappie, Black	Trout, Apache
Bluegill	Crappie, White	Trout, Brook
Buffalo, Bigmouth	Grayling, Arctic	Trout, Brown
Buffalo, Black	Mullet	Trout, Cutthroat
Bullhead, Black	Northern Pike	Trout, Rainbow
Bullhead, Yellow	Perch, Yellow	Walleye

At each sampling station, ADEQ personnel should fill out a Fish Tissue Survey Form (FIGURE 3.29) to provide additional information regarding the site visit. The form allows field staff to document access conditions, all species observed during sampling, water quality measurements, disease information, and any comments about the station. If fish are collected by another agency, ADEQ personnel will collect as much of the metadata as practical from sampling personnel to fill in the Fish Tissue Survey Form.



Fish Tissue Survey Information

Waterbody: _____ **Location** _____ **Site code** _

Latitude _____ **Longitude**_____ **Nearest** City/Town/Landmark_

_____ **Collection**

Agency: _____ Tributaries:_____

Survey Date/Time:_____ **Survey Duration: Hours** _____ **Min**_____

Staff: _____

Survey Method : Big boat ☐ Small Boat ☐ Back Pack ☐ Other ☐ Describe:

Ramp Info: Wildlife ☐ Marina ☐ Public ☐ Private ☐ Other ☐ Describe:_____

Ramp Condition: Paved ☐ Sand ☐ Gravel ☐ Earth ☐ Slide in ☐ Comments:_____

Water Quality Measurements: Temp: pH: D.O.: Cond: Salinity:

Species Observed:

___Apache Trout	___Flathead Catfish	___Walleye
___Arctic Grayling	___Gila Trout	___White Bass
___Bigmouth Buffalo	___Green Sunfish	___White Crappie
___Black Bullhead	___Largemouth Bass	___Yellow Bass
___Black Crappie	___Northern Pike	___Yellow Bullhead
___Bluegill	___Rainbow Trout	___Yellow Perch
___Brook Trout	___Redear Sunfish	Other:
___Brown Trout	___Roundtail Chub	
___Channel Catfish	___Smallmouth Bass	
___Cutthroat Trout	___Striped Bass	
___Desert Sucker	___Tilapia	

Disease Observed: Lesions/Sores [ ] Injuries [ ] Flared Gills [ ] Excessive mucus [ ] Tumors [ ]
Visible Parasites [ ] Other [ ] Describe_____

Species Collected:

Station Comments/Notes:

Figure 3.29. Fish Tissue Survey Form

When sampling sites are close enough samples should be transported to the sample processing laboratory prior to weighing and measurement. Samples should be placed in Ziploc bags by species and cooled to 4° C on wet ice for transport. If the distance from sample site is greater than 200 miles or the time to the lab is greater than 36 hours, samples should be weighed, measured, tagged in the field with location, date, species, length in mm and weight in grams, and sampler initials, and frozen on dry ice. (See Section 3.5.3 - 4 for procedures, FIGURES 3.30 to 3.32).

Figure 3.30. Fish measurement for total length and weight.

3.5.2 MEASUREMENT, LABELING AND TRANSPORT

Fish collected for analyses must be transported to the processing laboratory in such a manner as to prevent decomposition or contamination. Fish should be removed from live wells, holding tanks, or buckets, rinsed with ambient water to remove foreign matter, and placed on a contaminant free surface for sorting. Skins on fish selected for analysis should be examined for breaks or lacerations from sampling gear - a possible source of contamination. If a wound is severe and actively bleeding, the fish should be released or discarded. Missing scales, burns from shocking equipment or small lacerations where the area to be subsampled (3.5.3.1) is clear of injury will not be cause for rejecting the sample. It is up to the lead sampler to determine if a fish should be rejected based on abnormalities.

3.5.3.1 Weight and length measurement

A wet weight is determined for each fish to the nearest gram (Figure 3.30) and recorded on the Fish "Fish Tissue Field Datasheet" (Figure 3.33). All samples should be weighed on balances that are properly calibrated, tared and of adequate accuracy and precision to meet program data quality objectives. Balance calibration should be checked at the beginning of each weighing session.

A total length ("nose" to end of tail) is determined for each fish to the nearest millimeter using a length board (Figure 3.30) and recorded on the "Fish Tissue Field Datasheet" (Figure 3.33). When measuring, the mouth of the fish should be closed and the caudle or tail fin should be lightly compressed so that the absolute longest length is measured.

After measurement, larger fish will be dispatched by placing the fish upright (belly down) on a hard surface and administering several sharp blows with a hardwood dowel to the top of the head just behind the eyes. Smaller prey base fish will be dispatched by placing them in in a bucket filled with water so that the fish can only barely swim upright, and dropping in several Alka Seltzer tablets.

Individual fish are identified to species under the supervision of an experienced biologist familiar with Arizona fish fauna. Fish are first identified using current, regional identification manuals and other appropriate taxonomic literature (i.e.: Minkley, W. L. 1973). If questions occur, identifications are verified by other fish taxonomists or by experienced personnel from the Arizona Game and Fish Department.

3.5.3.2 Metals

Fish selected for metals analysis are placed individually in polyethylene bags. Prior to bagging the fish, a paper tag with a unique identifier, which includes date and waterbody, is affixed to the fish with a zip tie through the mouth and gills (Figure 3.31). Labels should contain the following:

- Waterbody
- Date
- Sampler initials
- Length in mm followed by weight in grams
- Fish species on the right hand side

After removing as much air as possible, the bags are sealed and tagged with the date, time, station name, species, and collector(s).

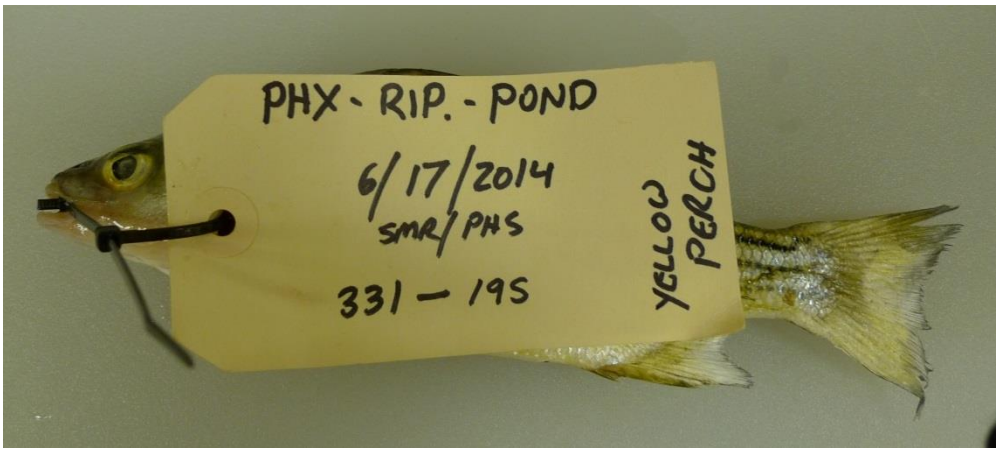


Figure 3.31. Fish labeling.

3.5.3.2 Organics

Fish selected only for organics analyses are tagged and wrapped whole in clean aluminum foil with the dull side of the foil against the skin of the animal. Large spines on any fish should be clipped to minimize puncturing of the foil (Figure 3.32). Wrapped fish are sorted by species and placed in labeled polyethylene bags as described for metals samples.

All polyethylene bags will be labeled with location, date, species, length in milimeters and weight in grams, and sampler initials (Figure 3.33).

Packaged fish are placed immediately on wet ice and chilled to 4°C for transport back to the laboratory. Samples transported on wet ice should reach the processing laboratory within 36 hours of collection to allow sufficient time for processing.

If samples cannot be transported to the processing lab within 36 hours of collection they should be frozen as whole fish, delivered to ADEQ as soon as possible, and stored at -20 °C until subsampling can be performed. If fish are frozen they should not be allowed to thaw during transport.

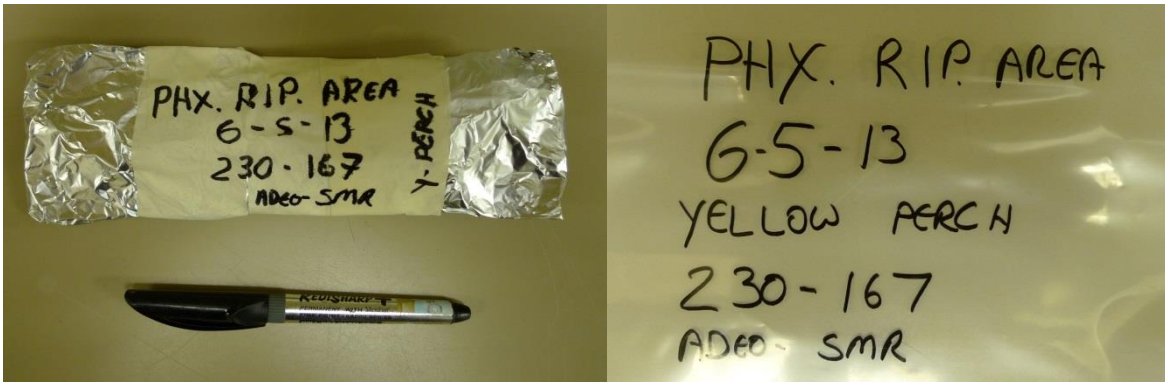


Figure 3.32. Outerbag fish labeling

3.5.3.3 Quality control and labeling of fish received from anglers

- All fish will remain whole and be weighed and measured in the field.
- Fish will be placed either aluminum foil or in ziplock bags as in 3.5.2.1 – 2.
- Individual fish will be labeled on the exterior package with:
    - Waterbody
    - Date (and time)
    - Species
    - Metric length and weight
    - Angler name (if available)
    - Receiving personnel
- Fish will be transported on ice to the ADEQ prep laboratory or frozen within 36 hours to await pickup.
- Fish will only be collected or purchased from anglers by ADEQ staff or AGFD personnel.

3.5.3 SAMPLE PROCESSING

Individual fish received for subsampling should be unwrapped and inspected carefully to ensure that they have not been compromised in any way (i.e., not properly preserved during transport). Any specimen deemed unsuitable for further processing and analysis should be discarded and identified on the sample processing record.

Fish tissue samples can be of two varieties: catchable and whole body prey base. Catchable fish (fish of a size that would be legally caught and consumed by the angling public) should be all of the same species and age class. Fish plugs are typically taken from a single fish (see below for specific protocols). Prey base fish should be all of the same species but can vary in size as long as they are of a size that could be consumed by the predatory fish in question and should be homogenized together as whole fish. Typically 3 to 10 fish are homogenized through a meat grinder for whole body prey based fish (see below for protocol).

All equipment used in processing samples for metals analysis should be made of stainless steel, glass, or plastic. Chromium and nickel contamination can occur from the use of stainless steel. Therefore, if these metals are of concern, other materials should be used during sample processing.

Equipment used in processing samples for organics analysis should be made of stainless steel, glass, or anodized aluminum.

Equipment used in processing samples for organics analysis should be of stainless steel, anodized aluminum, borosilicate glass, polytetrafluoroethylene (PTFE), ceramic, or quartz. Polypropylene and polyethylene (plastic) surfaces, implements, gloves, and containers are a potential source of contamination by organics and should not be used. If a laboratory chooses to use these materials, there should be clear documentation that they are not a source of contamination. Subsampling should be done on glass or PTFE cutting boards that are cleaned properly between fish or on cutting boards covered with heavy duty aluminum foil that is changed after each subsampling. Tissue should be removed with clean, high- quality, corrosion-resistant stainless steel, and ceramic or quartz instruments (Lowenstein and Young, 1986). Tissue homogenates may be stored in borosilicate glass, quartz, or PTFE containers with PTFE-lined lids or in heavy duty aluminum foil. Prior to preparing each composite sample, utensils and containers should be washed with detergent solution, rinsed with tap water, soaked in pesticide-grade isopropanol or acetone, and rinsed with deionized water. Work surfaces should be cleaned with pesticide-grade isopropanol or acetone, washed with distilled water, and allowed to dry completely. Knives, measurement boards, etc., should be cleaned with pesticide-grade isopropanol or acetone followed by a rinse with contaminant-free distilled water between each fish sample (Stober, 1991).

Fish tissue raw data sheet.

Waterbody _____ County _____ Subbasin _____ 8 Digit HUC _____

Latitude _____ Longitude _____ Collection Date _____

Processing Date _____ Date To Lab _____

Station Comments

Species Code	Total Length (mm)	Weight (g)	DEQ Number	Comments

Figure 3.33. Fish tissue raw data sheet.

A total length ("nose" to end of tail) is determined for each fish to the nearest millimeter using a length board (Figure 3.30) and recorded on the Fish Tissue Raw Datasheet (Figure 3.33). When measuring, the mouth of the fish should be closed and the caudle or tail fin should be lightly compressed so that the absolute longest length is measured.

Individual fish are identified to species under the supervision of an experienced biologist familiar with Arizona fish fauna. Fish are first identified using current, regional identification manuals and other appropriate taxonomic literature (i.e.: Minkley, W. L. 1973). If questions occur, identifications are verified by other fish consumption advisory program taxonomists or by experienced personnel from the Arizona Game and Fish Department.

3.5.3.1 Catchable Fish Processing

1. Prior to preparing metals samples, all surfaces in the processing laboratory are washed with a Liquinox® and rinsed with deionized (DI) water. Utensils and containers should be cleaned thoroughly with a Liquinox® solution, rinsed with tap water, soaked in 5 percent HCl , for 12 to 24 hours at room temperature, and then rinsed with DI water.

Utensils made from stainless steel may be cleaned using this recommended procedure with the acid soaking step method omitted (Stober, 1991).

2. Frozen fish samples should only be partially thawed before subsampling (ice crystals should still be visible in the fillet tissue). Subsampling is performed on HDPE cutting board rinsed with DI water between fish from different sites. Subsampling is performed using cleaned bare hands or talc free disposable gloves. Hands or gloves should be rinsed between samples to prevent cross contamination. Knives and biopsy punches are rinsed with 5 percent HCl and DI water between fish from the same station and recleaned or changed between sites.

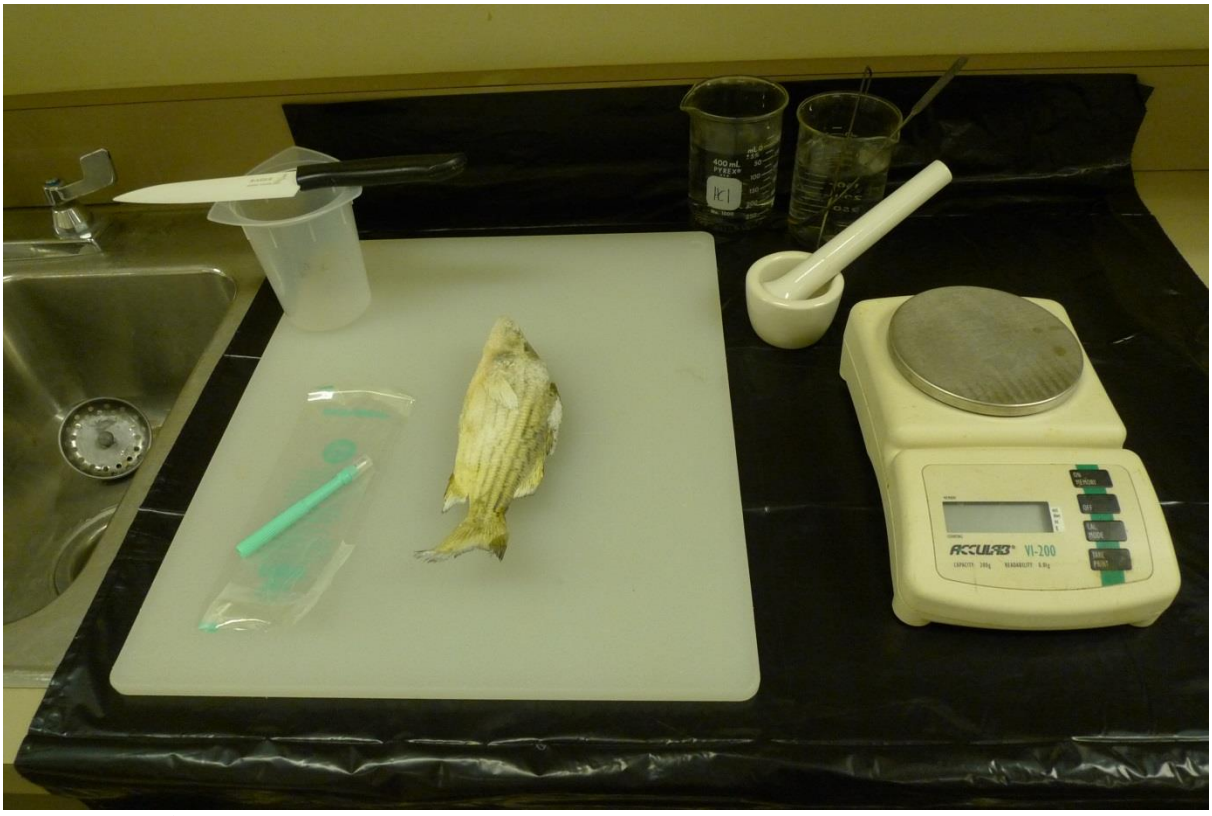


Figure 3.34. Fish preparation.

3. The fillet area should be exposed for subsampling by inserting the knife beneath the scales and skin just forward of the caudal peduncle (Figure 3.35). Cut forward, just beneath the skin until the fillet flesh is exposed between the lateral line and the dorsal fin, from insertion point to just behind the gills (Figure 3.36). Once the fillet flesh is exposed, use a 6mm biopsy punch to remove > 3.5 grams of muscle tissue (Figure 3.37). Place a tared

HDPE sample submittal bottle on a scale to assure that you have at least 3.5 grams. Use a stainless wire plunger to push plugs into the sample bottle. The number of plugs needed to make up 3.5 grams will vary due to muscle thickness and density. Care should be taken not to cut into the gut cavity as it may contaminate the fillet tissue.

Note: For a better grip, hold the fish around the caudle peduncle with a paper towel and place the "nose" against a folded paper towel on the back panel of the bench. Always cut away from your body.

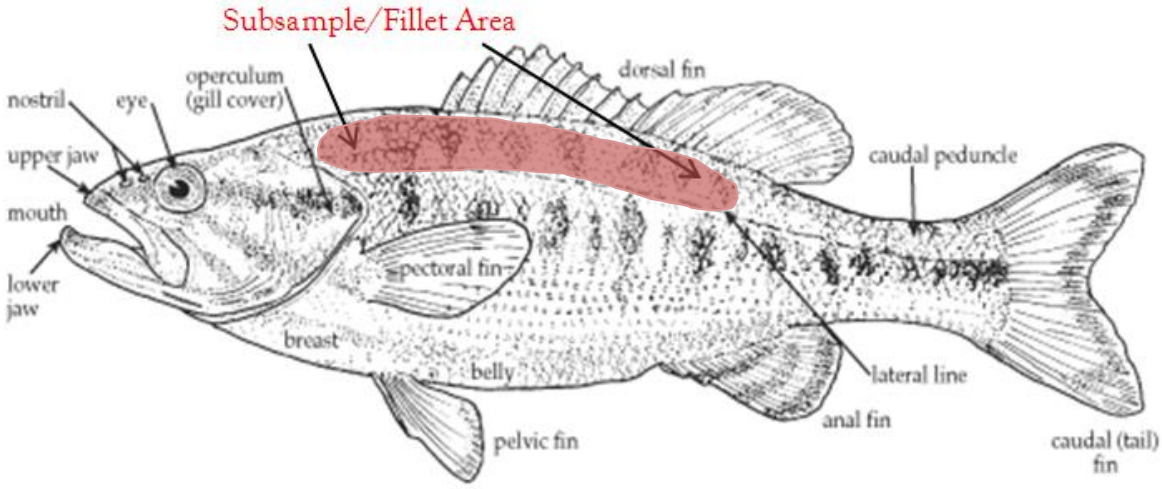


Figure 3.35. Basic fish anatomy denoting area to be subsampled.

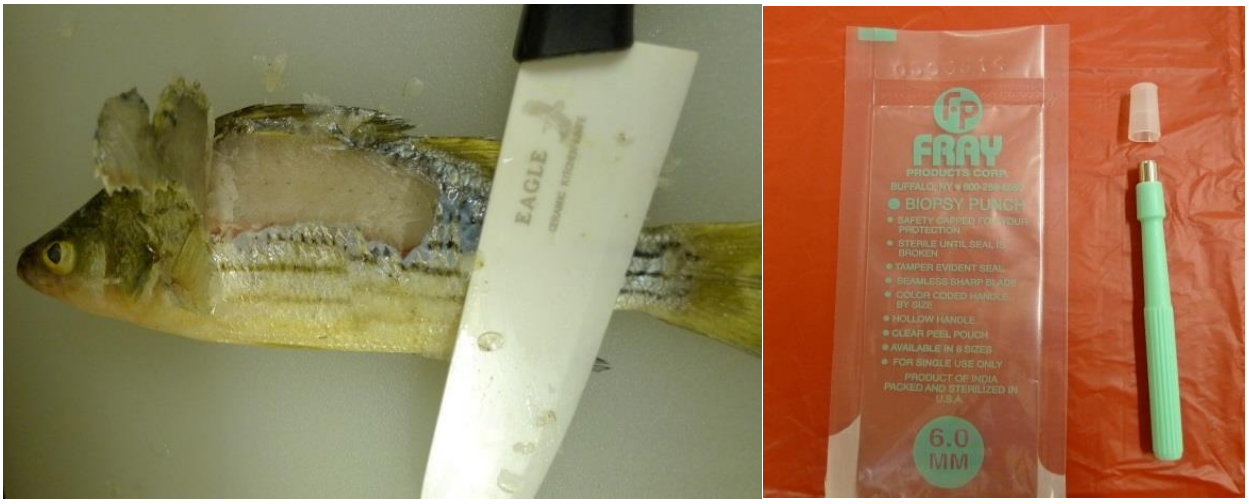


Figure 3.36. Skin removed from the subsample/filet section

Figure 3.37. Subsampling with a biopsy punch

4. Once more than 3.5 grams of muscle tissue is obtained, the plugs are placed into a precleaned mortar and pestle and ground until the tissue is homogenized, to ensure equal distribution of contaminants throughout the sample.
5. Place labeled bottle with sample back into the freezer until samples are shipped on dry ice to the laboratory for analysis.
6. Place fish carcass with identifying labels back into the freezer until laboratory results are received and QA/QC checks completed.

Composite samples, taken as a cost saving way to increase sample number when large numbers of fish are available, are prepared from at least 3 but no more than 10 individuals of the same species. Composite samples from catchable fish are prepared by subsampling equal amounts of tissue from each fish in the sample, using the muscle plug technique. Subsampled material is then homogenized by grinding in a mortar and pestle.

Individuals of different species are never mixed to form composite samples.

3.5.3.2 Whole Body Prey Base Processing

1. Whole body composite samples from prey base fish are prepared by grinding whole fish in a food grade meat grinder. Once ground, place the resultant material in a clean weigh boat and homogenize by stirring with a stainless steel laboratory spatula.

3.5.3.3 Final Sample

The final individual or composite samples should be composed of at least 3.5 g of tissue to ensure an adequate amount of material for analysis. If more sampled material is available, include it for possible lab QA/QC or calibration. Samples are submitted in small, widemouth poly bottles and

labeled (FIGURE 3.38). Composite sample bottles should be labeled with the number in the composite and range of sample *lengths* (length is the best surrogate for age/cohort). The range of lengths and weights along should be recorded for data analysis.

3.5.3.4 QA/QC Samples

Five percent of quality control samples will be blanks and five percent splits or duplicates as described in Section 3.2.5. These samples are either comprised of a 7 gram sample taken from a single filet exposure, homogenized and split into two separate sample bottles or, on smaller fish, a subsample is taken from the fillet portion on the opposite side of the fish using the same subsampling procedure as regular samples.

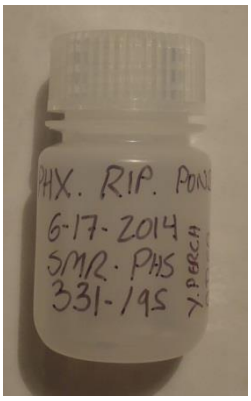


Figure 3.38. Labeled sample bottle

Blanks consist of samples of taken from frozen chicken breast meat using the same method and materials used in taking regular subsamples. Avoid sampling the fat that often is attached to the fillets.

All samples are then sent either directly to the analytical laboratory, (overnight, on dry ice), or frozen immediately and stored at -20°C for later analysis.

Section 10.6.2 describes the data review process and what acceptable values are for blanks, duplicates and/or splits.

3.5.3.4 Disposal of fish carcasses:

Fish carcasses that have been subsampled will be returned to the freezer for storage. Once sample data are received and meet QA/QC criteria, the carcasses can be disposed of in the main garbage dumpster on the east side of the parking garage with special care to assure that garbage pickup will occur within 24 hours.

CHAPTER 4 BACTERIA COLLECTION & PROCESSING

4.1 COLILERT® SYSTEM

The Colilert system utilizes prepackaged reagents which include additives to support the growth of coliform bacteria in addition to specific compounds that react with coliforms in general and *E. coli* specifically. Two options are available, Colilert-18 and Colilert-24,used for the simultaneous detection and confirmation of total coliforms and *E. coli* in fresh waters. The only difference between Colilert-18 and Colilert-24 is the incubation time, indicated by the number after Colilert (ie. 18 hours or 24 hours). When total coliforms metabolize Colilert'snutrient indicator reagent, ONPG (O-Nitrophenyl-β-d-galacotpyranoside), the reaction produces an easily recognized yellow color. When *E. coli* metabolizes Colilert- nutrient-indicator, MUG (4-Methumbelliferyl-β-d-glucoronide) the sample fluoresces. Colilert-can simultaneously detect these bacteria at 1 cfu/100 ml within 18 to 24 hours for Colilert 18 to 22 to 28 hours for Colilert 24. The test is effective and free of interference in waters with population densities of other heterotrophic bacteria up to 10,000 cfu/100 ml. Non-coliform bacteria that also have these enzymes are suppressed, for the incubation period, by other reagents in the media.

EPA refers to Colilert® as MMO-MUG while Standard Methods for the Examination of Water and Wastewater refers to Colilert® as a chromogenic substrate.

Catalog #WP020-18 and WP200-18 contain 20 and 200 Snap Packs respectively, each containing sufficient Colilert-18 reagent for a 100 ml water sample. The reagents should be stored at 4-25°C away from light.

Samples are collected wearing gloves and using a sealed, sterile 100ml bottle submerged in the stream while facing upstream. The bottle should be opened and recapped under water during sampling so that surface contaminants are not sampled. Samples must be chilled and processed within six hours of sample collection.

4.1.1 QUANTI-TRAY/2000 ENUMERATION PROCEDURE

Gloves must be worn during all bacteria sampling, handling, and processing.

1. Turn on sealer. It will take approximately 15 minutes to warm to operating temperature.
2. Verify that the incubator is operating at 35 +/- 0.5°C.


FIGURE 4.1. Colilert Sealer (left) and incubator (right).

3. Check level of water in bottle against 100ml line, if too much water is present, decant to the 100ml line.
4. Pour the contents of one reagent packet into each sample bottle. When opening the reagent packets, avoid inhaling the media.
5. Cap vessel and shake gently until dissolved and allow the foam at the top the bottle to settle. Chilled samples will take longer to dissolve the reagent. A hot water bath can be used to warm chilled samples prior to adding reagent.
6. Use a permanent marker to label the foil side of the Quanti-Tray with the following:
    - Site
    - Date
    - In: (incubation time)
    - Out (time when you read the sample – will be blank for now)
    - L: (# of large wells positive for *E. Coli* – will be blank for now)
    - S: (# of small wells positive for *E. Coli* – will be blank for now)
7. Use one hand to hold a Quanti-Tray upright with the well side facing the palm. Gently pull foil tab to separate the foil from the tray. Avoid touching the inside of the foil or tray.
8. Squeeze the upper part of the Quanti-Tray so that the Quanti-Tray bends towards the palm.
9. Pour the reagent/sample mixture directly into the Quanti-Tray avoiding contact with the foil tab. Tap the small wells to release any air bubbles.

Empty wells do not affect the test interpretation as long as the entire sample volume is in the tray. An empty or partially filled well is interpreted the same way as a full well.

10. Place the sample-filled Quanti-Tray onto the Quanti-Tray/2000 rubber insert of the Quanti-Tray Sealer with the well side (plastic) of the Quanti-Tray facing down.
11. Once all samples have been processed note the "time in the incubator" on the back of the Quanti-Tray and place the samples in the incubator.
12. Remove samples from the incubator after 18-22 for Colilert 18 and 24-28 hours for Colilert 24.
13. Wells that are yellow under plain light are positive for total coliforms.

Wells that are yellow and then fluoresce under a black light are positive for *E. coli*. Wells that are just flouresent or yellow are negative for *E. coli*.

Sample results are obtained by counting and recording the number of large and small yellow, fluorescing wells. Once the number of large and small wells is obtained the "most probable number" (MPN) is recorded from the MPN table (TABLE 4.3).

14. Results must be noted on the field sheets, field notebook, or some other type of record.

Dilutions can be done if the results are expected to be greater than 2419 cfu/100ml. High cfu counts may be experienced during storm run-off events, high recreational periods, and downstream of known fecal pollution sources. When performing dilutions two sample bottles are collected for each site (FIGURE 4.2).

- The first bottle is processed following the standard processing procedures outlined above;
- Using the second sample bottle, pipette 10ml of the sample into an empty IDEXX bottle. Then repeat using a 1ml and 0.1ml pipette into separate IDEXX bottles. Add deionized water to each bottle filling them to the 100ml line;
- Prepare samples following the procedures outlined above.
- Multiply the dilution ratio by the result for each sample (TABLE 4.2)
- Enter the result from the dilution bottle with the greatest amount of sample that is not too numerous to count and add the dilution flag (See Section 10.4.4). In the example given in TABLE 4.2, the value of 25,040 CFU/100 mL would be entered into the database.

Dilution	MPN Value	Multiplier	Result
100%	Too numerous to count	1	Too numerous to count
10%	Too numerous to count	10	Too numerous to count
1%	250.4	100	25,040 CFU/100 mL
0.1%	47	1000	47,000 CFU/100mL

TABLE 4.1. Example of dilution results using Colilert.

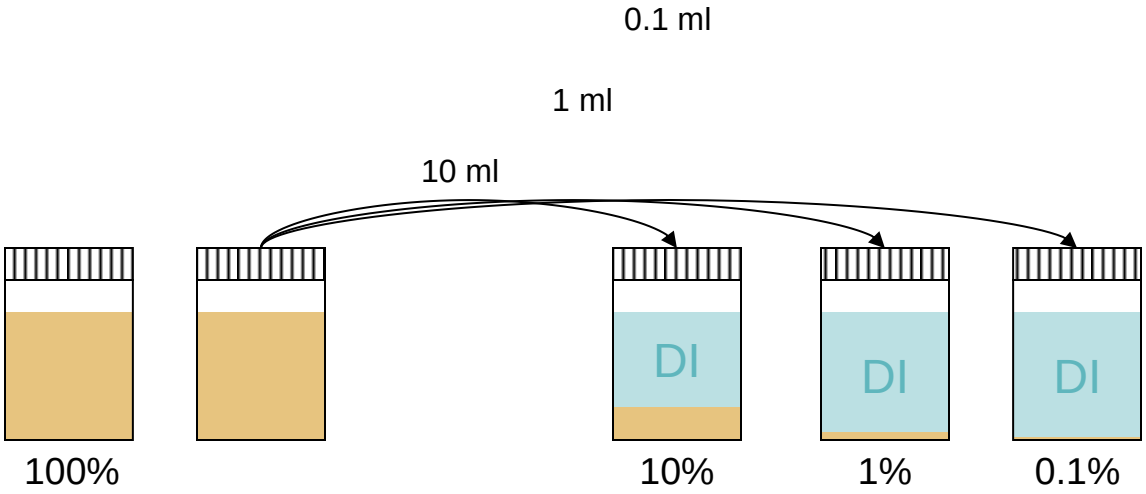


FIGURE 4.2. Bacteria dilutions of 100%, 10%, 1% and 0.1% for sites with bacteria that are expected to be greater than 2419.6 CFU/100 mL The brown liquid is the sample, while the blue is deionized water.

Values <1 on the MPN table should be entered into the WQDB with the lab notation of "LT" and the detection limit of 1 CFU/100 mL.

Duplicate Values should also be stored in the WQDB using the "D" for the Evaluation Purpose. To avoid the unique constraint problem in the database simply enter "DUP" into the "Lab ID" value to make it different than the "regular" sample. Otherwise the database will not let you save.

If multiple dilutions were made, the lowest dilution result should be entered into the Water Quality Database with the appropriate lab qualifier. Other dilution results may be added to sample comment field.

All waste generated by using the Colilert- method is considered a biohazard. The waste material (gloves, bottles, trays, etc) must be placed in red biohazard bags for proper disposal.

Appearance	Result
Colorless or slight tinge	Negative for total coliforms and *E. coli*
Yellow equal to or greater than the comparator	Positive for total coliforms
Yellow and fluorescence equal to or greater than the comparator	Positive for *E. coli*

TABLE 4.2. Result Interpretation table for Presence/Absence Procedure

Note: 1. Look for fluorescence with a 6 watt, 365 nm, UV light within 5 inches (13 cm) of the sample. Face light away from your eyes and towards the sample.
2. Samples are negative if at any time after 18 hours (Colilert-18) or 24 hours (Colilert-24) there is no yellow and/or fluorescence.

3. Yellow or yellow/fluorescence observed before 18 or 24 hours is a valid positive. However, after 22 or 28 hours from inoculation, heterotrophs may overwhelm Colilert inhibition system. Therefore, yellow or yellow/fluorescence first observed after 22 hours from inoculation is not a valid positive.

4.1.2 PROCEDURAL NOTES

- A slight tinge may be observed when Colilert- mediais added to the sample.
- Colilert-can be run in any multiple tube format. Standard Methods for the Examination of Water and Wastewater MPN tables should be used to find Most Probable Number.
- Some water samples containing humic material may have an innate color. If a water sample has some background color, compare inoculated Colilert-sample to a control blank of the same water sample.
- Do not dilute sample in buffered water. Colilert-media is already buffered.
- Colilert-is a primary water test. Colilert-performance characteristics do not apply to samples altered by any pre-enrichment or concentration.
- In samples with excessive chlorine, a blue flash may be seen when adding Colilert-. If this is seen, consider sample invalid and discontinue testing.
- Aseptic technique should be always followed when using Colilert-. Dispose of waste in accordance with good laboratory practices.

4.1.3 QUALITY CONTROL PROCEDURES

4.1.3.1 Blank Collection and Acceptance Criteria

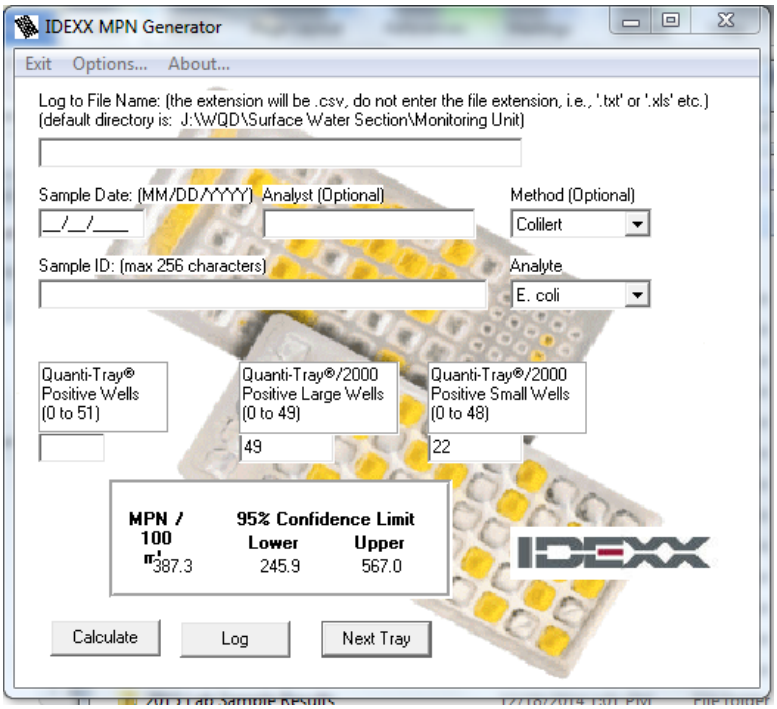
1. Fill bottle to line with DI (sterile) water. Process sample as listed in the Quanti-Tray/2000 Enumeration Procedure (section 4.1.2).
2. After the incubation period, none of the wells should be yellow or fluoresce. If this occurs then the sample lot associated with the failed QC should be disregarded and not recorded in the database. Section 10.6.2.3 has additional information on blank contamination.

All deleted data must be noted in the WQDB by using the "REJECTED DATA DUE TO QA/QC PROBLEMS" event. All data within the run to the point of the next blank QC sample should also be deleted and flagged also. In the event comments field indicate what data was rejected and why. For example, "E. Coli duplicate value out of range".

4.1.3.2 Duplicate Collection and Acceptance Criteria

1. Collect a duplicate sample in the same manner as the original sample. Collect both samples as close in time as possible.
2. Process duplicate sample in same manner as the original.
3. To determine if a duplicate sample is in range of the original, the IDEXX MPN Generator is used (shown below)
   - Enter Method (Colilert or Colilert-18)
   - Enter E. Coli as Analyte
   - Enter number of large wells and small wells

- Click calculate



4. The Generator will give the MPN and the 95% confidence range. The duplicate sample's 95% confidence range must fall with-in the range or have overlapping ranges for the duplicate sample to be accepted.

All deleted data must be noted in the WQDB by using the "REJECTED DATA DUE TO QA/QC PROBLEMS" event. All data within the run to the point of the next duplicate QC sample should also be deleted and flagged also. In the event comments field indicate what data was rejected and why. For example, "E. Coli duplicate value out of range".

Blank samples should have a value of <1 MPN (ie. No wells fluorescing or yellow). If a well is positive for coliforms or E-Coli, add an event to the WQDB and delete the "regular sample."

4.2 LAKE SAMPLING LOCATIONS FOR BACTERIA

Bacteria concentrations can be monitored at any location on the lake. Typically, there are negligible quantities of bacteria at deep-water sampling sites. In order to determine the threat of *E. coli* to public health, the samplers should consider taking several samples at beaches or docks. There is a 6 hour maximum holding time between the time of sampling and the time the bacteria are placed in the incubator.

IDEXX Quanti-Tray®/2000 MPN Table *(per 100ml)*

# Large Wells Positive	# Small Wells Positive																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
0	<1	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.1	15.1	16.1	17.1	18.1	19.1	20.2	21.2	22.2	23.3	24.3
1	1.0	2.0	3.0	4.0	5.0	6.0	7.1	8.1	9.1	10.1	11.1	12.1	13.2	14.2	15.2	16.2	17.3	18.3	19.3	20.4	21.4	22.4	23.5	24.5	25.6
2	2.0	3.0	4.1	5.1	6.1	7.1	8.1	9.2	10.2	11.2	12.2	13.3	14.3	15.4	16.4	17.4	18.5	19.5	20.6	21.6	22.7	23.7	24.8	25.8	26.9
3	3.1	4.1	5.1	6.1	7.2	8.2	9.2	10.3	11.3	12.4	13.4	14.5	15.5	16.5	17.6	18.6	19.7	20.8	21.8	22.9	23.9	25.0	26.1	27.1	28.2
4	4.1	5.2	6.2	7.2	8.3	9.3	10.4	11.4	12.5	13.5	14.6	15.6	16.7	17.8	18.8	19.9	21.0	22.0	23.1	24.2	25.3	26.3	27.4	28.5	29.6
5	5.2	6.3	7.3	8.4	9.4	10.5	11.5	12.6	13.7	14.7	15.8	16.9	17.9	19.0	20.1	21.2	22.2	23.3	24.4	25.5	26.6	27.7	28.8	29.9	31.0
6	6.3	7.4	8.4	9.5	10.6	11.6	12.7	13.8	14.9	16.0	17.0	18.1	19.2	20.3	21.4	22.5	23.6	24.7	25.8	26.9	28.0	29.1	30.2	31.3	32.4
7	7.5	8.5	9.6	10.7	11.8	12.8	13.9	15.0	16.1	17.2	18.3	19.4	20.5	21.6	22.7	23.8	24.9	26.0	27.1	28.3	29.4	30.5	31.6	32.8	33.9
8	8.6	9.7	10.8	11.9	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.8	22.9	24.1	25.2	26.3	27.4	28.6	29.7	30.8	32.0	33.1	34.3	35.4
9	9.8	10.9	12.0	13.1	14.2	15.3	16.4	17.6	18.7	19.8	20.9	22.0	23.2	24.3	25.4	26.6	27.7	28.9	30.0	31.2	32.3	33.5	34.6	35.8	37.0
10	11.0	12.1	13.2	14.4	15.5	16.6	17.7	18.9	20.0	21.1	22.3	23.4	24.6	25.7	26.9	28.0	29.2	30.3	31.5	32.7	33.8	35.0	36.2	37.4	38.6
11	12.2	13.4	14.5	15.6	16.8	17.9	19.1	20.2	21.4	22.5	23.7	24.8	26.0	27.2	28.3	29.5	30.7	31.9	33.0	34.2	35.4	36.6	37.8	39.0	40.2
12	13.5	14.6	15.8	16.9	18.1	19.3	20.4	21.6	22.8	23.9	25.1	26.3	27.5	28.6	29.8	31.0	32.2	33.4	34.6	35.8	37.0	38.2	39.5	40.7	41.9
13	14.8	16.0	17.1	18.3	19.5	20.6	21.8	23.0	24.2	25.4	26.6	27.8	29.0	30.2	31.4	32.6	33.8	35.0	36.2	37.5	38.7	39.9	41.2	42.4	43.6
14	16.1	17.3	18.5	19.7	20.9	22.1	23.3	24.5	25.7	26.9	28.1	29.3	30.5	31.7	33.0	34.2	35.4	36.7	37.9	39.1	40.4	41.6	42.9	44.2	45.4
15	17.5	18.7	19.9	21.1	22.3	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33.3	34.6	35.8	37.1	38.4	39.6	40.9	42.2	43.4	44.7	46.0	47.3
16	18.9	20.1	21.3	22.6	23.8	25.0	26.2	27.5	28.7	30.0	31.2	32.5	33.7	35.0	36.3	37.5	38.8	40.1	41.4	42.7	44.0	45.3	46.6	47.9	49.2
17	20.3	21.6	22.8	24.1	25.3	26.6	27.8	29.1	30.3	31.6	32.9	34.1	35.4	36.7	38.0	39.3	40.6	41.9	43.2	44.5	45.9	47.2	48.5	49.8	51.2
18	21.8	23.1	24.3	25.6	26.9	28.1	29.4	30.7	32.0	33.3	34.6	35.9	37.2	38.5	39.8	41.1	42.4	43.8	45.1	46.5	47.8	49.2	50.5	51.9	53.2
19	23.3	24.6	25.9	27.2	28.5	29.8	31.1	32.4	33.7	35.0	36.3	37.6	39.0	40.3	41.6	43.0	44.3	45.7	47.1	48.4	49.8	51.2	52.6	54.0	55.4
20	24.9	26.2	27.5	28.8	30.1	31.5	32.8	34.1	35.4	36.8	38.1	39.5	40.8	42.2	43.6	44.9	46.3	47.7	49.1	50.5	51.9	53.3	54.7	56.1	57.6
21	26.5	27.9	29.2	30.5	31.8	33.2	34.5	35.9	37.3	38.6	40.0	41.4	42.8	44.1	45.5	46.9	48.4	49.8	51.2	52.6	54.1	55.5	56.9	58.4	59.9
22	28.2	29.5	30.9	32.3	33.6	35.0	36.4	37.7	39.1	40.5	41.9	43.3	44.8	46.2	47.6	49.0	50.5	51.9	53.4	54.8	56.3	57.8	59.3	60.8	62.3
23	29.9	31.3	32.7	34.1	35.5	36.8	38.3	39.7	41.1	42.5	43.9	45.4	46.8	48.3	49.7	51.2	52.7	54.2	55.6	57.1	58.6	60.2	61.7	63.2	64.7
24	31.7	33.1	34.5	35.9	37.3	38.8	40.2	41.7	43.1	44.6	46.0	47.5	49.0	50.5	52.0	53.5	55.0	56.5	58.0	59.5	61.1	62.6	64.2	65.8	67.3
25	33.6	35.0	36.4	37.9	39.3	40.8	42.2	43.7	45.2	46.7	48.2	49.7	51.2	52.7	54.3	55.8	57.3	58.9	60.5	62.0	63.6	65.2	66.8	68.4	70.0
26	35.5	36.9	38.4	39.9	41.4	42.8	44.3	45.9	47.4	48.9	50.4	52.0	53.5	55.1	56.7	58.2	59.8	61.4	63.0	64.7	66.3	67.9	69.6	71.2	72.9
27	37.4	38.9	40.4	42.0	43.5	45.0	46.5	48.1	49.6	51.2	52.8	54.4	56.0	57.6	59.2	60.8	62.4	64.1	65.7	67.4	69.1	70.8	72.5	74.2	75.9
28	39.5	41.0	42.6	44.1	45.7	47.3	48.8	50.4	52.0	53.6	55.2	56.9	58.5	60.2	61.8	63.5	65.2	66.9	68.6	70.3	72.0	73.7	75.5	77.3	79.0
29	41.7	43.2	44.8	46.4	48.0	49.6	51.2	52.8	54.5	56.1	57.8	59.5	61.2	62.9	64.6	66.3	68.0	69.8	71.5	73.3	75.1	76.9	78.7	80.5	82.4
30	43.9	45.5	47.1	48.7	50.4	52.0	53.7	55.4	57.1	58.8	60.5	62.2	64.0	65.7	67.5	69.3	71.0	72.9	74.7	76.5	78.3	80.2	82.1	84.0	85.9
31	46.2	47.9	49.5	51.2	52.9	54.6	56.3	58.1	59.8	61.6	63.3	65.1	66.9	68.7	70.5	72.4	74.2	76.1	78.0	79.9	81.8	83.7	85.7	87.6	89.6
32	48.7	50.4	52.1	53.8	55.6	57.3	59.1	60.9	62.7	64.5	66.3	68.2	70.0	71.9	73.8	75.7	77.6	79.5	81.5	83.5	85.4	87.5	89.5	91.5	93.6
33	51.2	53.0	54.8	56.5	58.3	60.2	62.0	63.8	65.7	67.6	69.5	71.4	73.3	75.2	77.2	79.2	81.2	83.2	85.2	87.3	89.3	91.4	93.6	95.7	97.8
34	53.9	55.7	57.6	59.4	61.3	63.1	65.0	67.0	68.9	70.8	72.8	74.8	76.8	78.8	80.8	82.9	85.0	87.1	89.2	91.4	93.5	95.7	97.9	100.2	102.4
35	56.8	58.6	60.5	62.4	64.4	66.3	68.3	70.3	72.3	74.3	76.3	78.4	80.5	82.6	84.7	86.9	89.1	91.3	93.5	95.7	98.0	100.3	102.6	105.0	107.3
36	59.8	61.7	63.7	65.7	67.7	69.7	71.7	73.8	75.9	78.0	80.1	82.3	84.5	86.7	88.9	91.2	93.5	95.8	98.1	100.5	102.9	105.3	107.7	110.2	112.7
37	62.9	65.0	67.0	69.1	71.2	73.3	75.4	77.6	79.8	82.0	84.2	86.5	88.8	91.1	93.4	95.8	98.2	100.6	103.1	105.6	108.1	110.7	113.3	115.9	118.6
38	66.3	68.4	70.6	72.7	74.9	77.1	79.4	81.6	83.9	86.2	88.6	91.0	93.4	95.8	98.3	100.8	103.4	105.9	108.6	111.2	113.9	116.6	119.4	122.2	125.0
39	70.0	72.2	74.4	76.7	78.9	81.3	83.6	86.0	88.4	90.9	93.4	95.9	98.4	101.0	103.6	106.3	109.0	111.8	114.6	117.4	120.3	123.2	126.1	129.2	132.2
40	73.8	76.2	78.5	80.9	83.3	85.7	88.2	90.8	93.3	95.9	98.5	101.2	103.9	106.7	109.5	112.4	115.3	118.2	121.2	124.3	127.4	130.5	133.7	137.0	140.3
41	78.0	80.5	83.0	85.5	88.0	90.6	93.3	95.9	98.7	101.4	104.3	107.1	110.0	113.0	116.0	119.1	122.2	125.4	128.7	132.0	135.4	138.8	142.3	145.9	149.5
42	82.6	85.2	87.8	90.5	93.2	96.0	98.8	101.7	104.6	107.6	110.6	113.7	116.9	120.1	123.4	126.7	130.1	133.6	137.2	140.8	144.5	148.3	152.2	156.1	160.2
43	87.6	90.4	93.2	96.0	99.0	101.9	105.0	108.1	111.2	114.5	117.8	121.1	124.6	128.1	131.7	135.4	139.1	143.0	147.0	151.0	155.2	159.4	163.8	168.2	172.8
44	93.1	96.1	99.1	102.2	105.4	108.6	111.9	115.3	118.7	122.3	125.9	129.6	133.4	137.4	141.4	145.5	149.7	154.1	158.5	163.1	167.9	172.7	177.7	182.9	188.2
45	99.3	102.5	105.8	109.2	112.6	116.2	119.8	123.6	127.4	131.4	135.4	139.6	143.9	148.3	152.9	157.6	162.4	167.4	172.6	178.0	183.5	189.2	195.1	201.2	207.5
46	106.3	109.8	113.4	117.2	121.0	125.0	129.1	133.3	137.6	142.1	146.7	151.5	156.5	161.6	167.0	172.5	178.2	184.2	190.4	196.8	203.5	210.5	217.8	225.4	233.3
47	114.3	118.3	122.4	126.6	130.9	135.4	140.1	145.0	150.0	155.3	160.7	166.4	172.3	178.5	185.0	191.8	198.9	206.4	214.2	222.4	231.0	240.0	249.5	259.5	270.0
48	123.9	128.4	133.1	137.9	143.0	148.3	153.9	159.7	165.8	172.2	178.9	186.0	193.5	201.4	209.8	218.7	228.2	238.2	248.9	260.3	272.3	285.1	298.7	313.0	328.2
49	135.5	140.8	146.4	152.3	158.5	165.0	172.0	179.3	187.2	195.6	204.6	214.3	224.7	235.9	248.1	261.3	275.5	290.9	307.6	325.5	344.8	365.4	387.3	410.6	435.2

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TABLE 4.3 IDEXX Quanti-Tray/2000 MPN TABLE

IDEXX Quanti-Tray®/2000 MPN Table (per 100ml)

# Large Wells Positive	# Small Wells Positive																							
	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
0	25.3	26.4	27.4	28.4	29.5	30.5	31.5	32.6	33.6	34.7	35.7	36.8	37.8	38.9	40.0	41.0	42.1	43.1	44.2	45.3	46.3	47.4	48.5	49.5
1	26.6	27.7	28.7	29.8	30.8	31.9	32.9	34.0	35.0	36.1	37.2	38.2	39.3	40.4	41.4	42.5	43.6	44.7	45.7	46.8	47.9	49.0	50.1	51.2
2	27.9	29.0	30.0	31.1	32.2	33.2	34.3	35.4	36.5	37.5	38.6	39.7	40.8	41.9	43.0	44.0	45.1	46.2	47.3	48.4	49.5	50.6	51.7	52.8
3	29.3	30.4	31.4	32.5	33.6	34.7	35.8	36.8	37.9	39.0	40.1	41.2	42.3	43.4	44.5	45.6	46.7	47.8	48.9	50.0	51.2	52.3	53.4	54.5
4	30.7	31.8	32.8	33.9	35.0	36.1	37.2	38.3	39.4	40.5	41.6	42.8	43.9	45.0	46.1	47.2	48.3	49.5	50.6	51.7	52.9	54.0	55.1	56.3
5	32.1	33.2	34.3	35.4	36.5	37.6	38.7	39.9	41.0	42.1	43.2	44.4	45.5	46.6	47.7	48.9	50.0	51.2	52.3	53.5	54.6	55.8	56.9	58.1
6	33.5	34.7	35.8	36.9	38.0	39.2	40.3	41.4	42.6	43.7	44.8	46.0	47.1	48.3	49.4	50.6	51.7	52.9	54.1	55.2	56.4	57.6	58.7	59.9
7	35.0	36.2	37.3	38.4	39.6	40.7	41.9	43.0	44.2	45.3	46.5	47.7	48.8	50.0	51.2	52.3	53.5	54.7	55.9	57.1	58.3	59.4	60.6	61.8
8	36.6	37.7	38.9	40.0	41.2	42.3	43.5	44.7	45.9	47.0	48.2	49.4	50.6	51.8	53.0	54.1	55.3	56.5	57.7	59.0	60.2	61.4	62.6	63.8
9	38.1	39.3	40.5	41.6	42.8	44.0	45.2	46.4	47.6	48.8	50.0	51.2	52.4	53.6	54.8	56.0	57.2	58.4	59.7	60.9	62.1	63.4	64.6	65.8
10	39.7	40.9	42.1	43.3	44.5	45.7	46.9	48.1	49.3	50.6	51.8	53.0	54.2	55.5	56.7	57.9	59.2	60.4	61.7	62.9	64.2	65.4	66.7	67.9
11	41.4	42.6	43.8	45.0	46.3	47.5	48.7	49.9	51.2	52.4	53.7	54.9	56.1	57.4	58.6	59.9	61.2	62.4	63.7	65.0	66.3	67.5	68.8	70.1
12	43.1	44.3	45.6	46.8	48.1	49.3	50.6	51.8	53.1	54.3	55.6	56.8	58.1	59.4	60.7	62.0	63.2	64.5	65.8	67.1	68.4	69.7	71.0	72.4
13	44.9	46.1	47.4	48.6	49.9	51.2	52.5	53.7	55.0	56.3	57.6	58.9	60.2	61.5	62.8	64.1	65.4	66.7	68.0	69.3	70.7	72.0	73.3	74.7
14	46.7	48.0	49.3	50.5	51.8	53.1	54.4	55.7	57.0	58.3	59.6	60.9	62.3	63.6	64.9	66.3	67.6	68.9	70.3	71.6	73.0	74.4	75.7	77.1
15	48.6	49.9	51.2	52.5	53.8	55.1	56.4	57.8	59.1	60.4	61.8	63.1	64.5	65.8	67.2	68.5	69.9	71.3	72.6	74.0	75.4	76.8	78.2	79.6
16	50.5	51.8	53.2	54.5	55.8	57.2	58.5	59.9	61.2	62.6	64.0	65.3	66.7	68.1	69.5	70.9	72.3	73.7	75.1	76.5	77.9	79.3	80.8	82.2
17	52.5	53.9	55.2	56.6	58.0	59.3	60.7	62.1	63.5	64.9	66.3	67.7	69.1	70.5	71.9	73.3	74.8	76.2	77.6	79.1	80.5	82.0	83.5	84.9
18	54.6	56.0	57.4	58.8	60.2	61.6	63.0	64.4	65.8	67.2	68.6	70.1	71.5	73.0	74.4	75.9	77.3	78.8	80.3	81.8	83.3	84.8	86.3	87.8
19	56.8	58.2	59.6	61.0	62.4	63.9	65.3	66.8	68.2	69.7	71.1	72.6	74.1	75.5	77.0	78.5	80.0	81.5	83.1	84.6	86.1	87.6	89.2	90.7
20	59.0	60.4	61.9	63.3	64.8	66.3	67.7	69.2	70.7	72.2	73.7	75.2	76.7	78.2	79.8	81.3	82.8	84.4	85.9	87.5	89.1	90.7	92.2	93.8
21	61.3	62.8	64.3	65.8	67.3	68.8	70.3	71.8	73.3	74.9	76.4	77.9	79.5	81.1	82.6	84.2	85.8	87.4	89.0	90.6	92.2	93.8	95.4	97.1
22	63.8	65.3	66.8	68.3	69.8	71.4	72.9	74.5	76.1	77.6	79.2	80.8	82.4	84.0	85.6	87.2	88.9	90.5	92.1	93.8	95.5	97.1	98.8	100.5
23	66.3	67.8	69.4	71.0	72.5	74.1	75.7	77.3	78.9	80.5	82.2	83.8	85.4	87.1	88.7	90.4	92.1	93.8	95.5	97.2	98.9	100.6	102.4	104.1
24	68.9	70.5	72.1	73.7	75.3	77.0	78.6	80.3	81.9	83.6	85.2	86.9	88.6	90.3	92.0	93.8	95.5	97.2	99.0	100.7	102.5	104.3	106.1	107.9
25	71.7	73.3	75.0	76.6	78.3	80.0	81.7	83.3	85.1	86.8	88.5	90.2	92.0	93.7	95.5	97.3	99.1	100.9	102.7	104.5	106.3	108.2	110.0	111.9
26	74.6	76.3	78.0	79.7	81.4	83.1	84.8	86.6	88.4	90.1	91.9	93.7	95.5	97.3	99.2	101.0	102.9	104.7	106.6	108.5	110.4	112.3	114.2	116.2
27	77.6	79.4	81.1	82.9	84.6	86.4	88.2	90.0	91.9	93.7	95.5	97.4	99.3	101.2	103.1	105.0	106.9	108.8	110.8	112.7	114.7	116.7	118.7	120.7
28	80.8	82.6	84.4	86.3	88.1	89.9	91.8	93.7	95.6	97.5	99.4	101.3	103.3	105.2	107.2	109.2	111.2	113.2	115.2	117.3	119.3	121.4	123.5	125.6
29	84.2	86.1	87.9	89.8	91.7	93.7	95.6	97.5	99.5	101.5	103.5	105.5	107.5	109.5	111.6	113.7	115.7	117.8	120.0	122.1	124.2	126.4	128.6	130.8
30	87.8	89.7	91.7	93.6	95.6	97.6	99.6	101.6	103.7	105.7	107.8	109.9	112.0	114.2	116.3	118.5	120.6	122.8	125.1	127.3	129.5	131.8	134.1	136.4
31	91.6	93.6	95.6	97.7	99.7	101.8	103.9	106.0	108.2	110.3	112.5	114.7	116.9	119.1	121.4	123.6	125.9	128.2	130.5	132.9	135.3	137.7	140.1	142.5
32	95.7	97.8	99.9	102.0	104.2	106.3	108.5	110.7	113.0	115.2	117.5	119.8	122.1	124.5	126.8	129.2	131.6	134.0	136.5	139.0	141.5	144.0	146.6	149.1
33	100.0	102.2	104.4	106.6	108.9	111.2	113.5	115.8	118.2	120.5	122.9	125.4	127.8	130.3	132.8	135.3	137.8	140.4	143.0	145.6	148.3	150.9	153.7	156.4
34	104.7	107.0	109.3	111.7	114.0	116.4	118.9	121.3	123.8	126.3	128.8	131.4	134.0	136.6	139.2	141.9	144.6	147.4	150.1	152.9	155.7	158.6	161.5	164.4
35	109.7	112.2	114.6	117.1	119.6	122.2	124.7	127.3	129.9	132.6	135.3	138.0	140.8	143.6	146.4	149.2	152.1	155.0	158.0	161.0	164.0	167.1	170.2	173.3
36	115.2	117.8	120.4	123.0	125.7	128.4	131.1	133.9	136.7	139.5	142.4	145.3	148.3	151.3	154.3	157.3	160.5	163.6	166.8	170.0	173.3	176.6	179.9	183.3
37	121.3	124.0	126.8	129.6	132.4	135.3	138.2	141.2	144.2	147.3	150.3	153.5	156.7	159.9	163.1	166.5	169.8	173.2	176.7	180.2	183.7	187.3	191.0	194.7
38	127.9	130.8	133.8	136.8	139.9	143.0	146.2	149.4	152.6	155.9	159.2	162.6	166.1	169.6	173.2	176.8	180.4	184.2	188.0	191.8	195.7	199.7	203.7	207.7
39	135.3	138.5	141.7	145.0	148.3	151.7	155.1	158.6	162.1	165.7	169.4	173.1	176.9	180.7	184.7	188.7	192.7	196.8	201.0	205.3	209.6	214.0	218.5	223.0
40	143.7	147.1	150.6	154.2	157.8	161.5	165.3	169.1	173.0	177.0	181.1	185.2	189.4	193.7	198.1	202.5	207.1	211.7	216.4	221.1	226.0	231.0	236.0	241.1
41	153.2	157.0	160.9	164.8	168.9	173.0	177.2	181.5	185.8	190.3	194.8	199.5	204.2	209.1	214.0	219.1	224.2	229.4	234.8	240.2	245.8	251.5	257.2	263.1
42	164.3	168.6	172.9	177.3	181.9	186.5	191.3	196.1	201.1	206.2	211.4	216.7	222.2	227.7	233.4	239.2	245.2	251.3	257.5	263.8	270.3	276.9	283.6	290.5
43	177.5	182.3	187.3	192.4	197.6	202.9	208.4	214.0	219.8	225.8	231.8	238.1	244.5	251.0	257.7	264.6	271.7	278.9	286.3	293.8	301.5	309.4	317.4	325.7
44	193.6	199.3	205.1	211.0	217.2	223.5	230.0	236.7	243.6	250.8	258.1	265.6	273.3	281.2	289.4	297.8	306.3	315.1	324.1	333.3	342.8	352.4	362.3	372.4
45	214.1	220.9	227.9	235.2	242.7	250.4	258.4	266.7	275.3	284.1	293.3	302.6	312.3	322.3	332.5	343.0	353.8	364.9	376.2	387.9	399.8	412.0	424.5	437.4
46	241.5	250.0	258.9	268.2	277.8	287.8	298.1	308.8	319.9	331.4	343.3	355.5	368.1	381.1	394.5	408.3	422.5	437.1	452.0	467.4	483.3	499.6	516.3	533.5
47	280.9	292.4	304.4	316.9	330.0	343.6	357.8	372.5	387.7	403.4	419.8	436.6	454.1	472.1	490.7	509.9	529.8	550.4	571.7	593.8	616.7	640.5	665.3	691.0
48	344.1	360.9	378.4	396.8	416.0	436.0	456.9	478.6	501.2	524.7	549.3	574.8	601.5	629.4	658.6	689.3	721.5	755.6	791.5	829.7	870.4	913.9	960.6	1011.2
49	461.1	488.4	517.2	547.5	579.4	613.1	648.8	686.7	727.0	770.1	816.4	866.4	920.8	980.4	1046.2	1119.9	1203.3	1299.7	1413.6	1553.1	1732.9	1986.3	2419.6	>2419.6

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TABLE 4.3 IDEXX Quanti-Tray/2000 MPN TABLE

CHAPTER 5 MEASURING FLOW

Stream discharge is the volume of water passing through a cross-sectional area per unit of time. As such, discharge is expressed in terms of volume per unit of time; examples might include cubic feet per second, gallons per minute, millions of gallons per day, cubic meters per second, etc. Different types of discharge measurement methods may require the use or application of different units of measurement. Flows measured by gauging a cross-section are typically reported in cubic feet per second; flows measured volumetrically are recorded in units of gallons per minute or gallons per second. All such measurements, however, are converted to cubic feet per second (CFS) for consistency.

5.1 INSTANTANEOUS DISCHARGE WITH FLOW METER

Instantaneous discharge with a flow meter is calculated as the velocity (V) in feet per second multiplied by cross-sectional area (A) in square feet. For metered measurements, cross-sectional area is determined by stringing a graduated tape (1/10 ft. increments) across the channel to measure distance at cross-section stations where depth and velocity are measured. Depth of water is measured with a top setting rod having 1/10 foot increments. Area is depth multiplied by width in small increments (Harrelson et al., 1994). A Marsh-McBirney Flow Meter is used to measure velocity and depth at a pre-determined position in the channel (Marsh McBirney Inc., 1999) (FIGURE 5.1). Select a location in the stream channel that will provide a representative measurement of the entire flow.

FIGURE 5.1. Flo-Mate meter. Sensor on right.

Do not select a location with a split channel, on a meander, or one with an obstruction immediately upstream from the measurement location.

Ponded water (flow = 0 ft/sec) is not typically sampled.

Add the event "STREAM DRY AT TIME OF SITE VISIT" to the Water Quality Database (WQDB) if the stream is dry. This data is important even if there are not test results associated with the visit. See Section 10.4.3 for details on how to enter event information to the WQDB.

5.1.1 FIELD PROCEDURE

1. Extend the tape across the channel from bank-to-bank and perpendicular to the flow. Each end of the tape should be tied to a tent peg or other firmly secured structure. After the tape has been tied to the tent pegs, the tape should be taut with as little sag as possible.

If the channel is wide and the wind is blowing, tie strips of flagging on the tape to keep it from whipping.

2. Attach the meter sensor to the top-setting wading rod, place the sensor in the flow, turn the meter on, and check the reporting units. The meter should be set for reading flow in feet per second. Press down on the **ON/C** and **OFF** keys simultaneously to cycle between feet per second and meters per second.

The meter can be set to average flows over a set period of time. To set the fixed point average, press the ↑ and ↓ keys simultaneously until the display shows the letters Fixed Point Averaging (FPA). Press ↑ or ↓ keys until the FPA increment is set to 10 seconds. Wait until the display automatically switches back to velocity.

FIGURE 5.2. Top set wading rod.

3. The observer taking the measurements should move to one edge of the channel, for example the right edge of water (REW), as determined by facing downstream. Position one eye directly above the tape at the exact location where the water and the bank interface, and call out the measurement to the Recorder, for example the reading is 0.8 feet. This number should be recorded under "Distance from Initial Point" together with the abbreviation REW (right edge of water).
4. The observer should move toward the LEW, and read the measurement off the tape at the water-bank interface and calculate the width of channel. Divide the width by 20 and round to the nearest whole number. USGS recommends that no more than 5% of the stream discharge be represented in each sub-sectional area of the cross-section; in practice, this usually equates to 20 to 25 measurements across the width of the stream. For example, if the channel is 58 feet wide, 58 / 20 = 2.5; round up to 3.0. Take flow measurements every 3 feet.

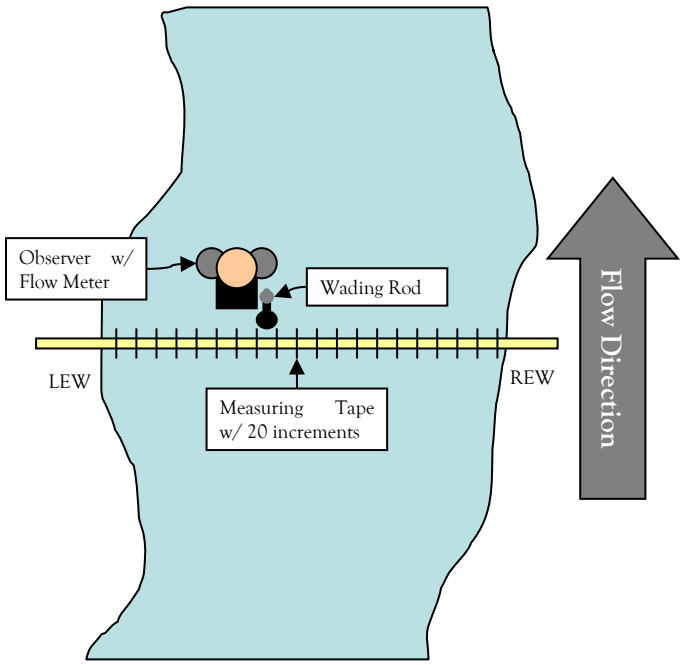


FIGURE 5.3. Plan view of observer and measuring tape with respect the stream.

For narrow channels the minimum spacing is 0.3 feet.

5a. *For depths ≤ 2.5 feet*. The observer positions the wading rod vertically with the sensor pointed upstream into the flow. Determine the depth of water from the rod depth gauge to the nearest 10th of a foot. If the water level is at the half way mark between 0.4 feet and 0.5 feet on the depth gauge (hexagonal rod); in this case the reading is 0.45 feet. If the water level is between 0.4 and 0.45 or between 0.45 and 0.5, round off to the nearest 1/10 foot increment. The depth measurement is recorded under "Depth". Depress the unlocking lever and move the round rod up to depth you just recorded. This is 0.6 of the depth. Record the velocity for that station after the meter stabilizes.

FIGURE 5.4. Discharge measurement.

5b. *For depths > 2.5 feet*. Use the two-point method for measuring flow. The one-point method measures flow at 0.6D (Depth), while the two-point method requires an average of flow measurements taken at 0.2D and 0.8D (Corbett, 1962). If the depth is 2 feet, the single-point method requires a measurement at 1.2 feet (2 ft. x 0.6). If the depth is 3.5 feet, the two-point method requires readings at 0.7 feet. (3.5 ft. x 0.2) and 2.8 feet (3.5 ft. x 0.8). Record the average of the two velocities for that station after the meter stabilizes.

6. Repeat steps 3-5 until the left edge of water is reached. Record the LEW distance under "Distance from Initial Point" with the abbreviation LEW next to it.

7. Use the excel sheet to calculate discharge (See Chapter 9 - Post-Trip Procedures).

5.1.2 METER ERROR MESSAGES

The displaying of errors alerts the user of possible problems with either the meter or the process. Errors can be displayed as messages or numerical codes. There are three error messages and five numerical codes.

With the exception of **Err 2**, error codes freeze the display. Turn the unit OFF, and then back ON to clear the display. If the error message persists, return the meter to the manufacturer for maintenance.

Low Bat - Indicates low battery voltage. Replace the batteries with two D cells. This operation will require a screwdriver or coin to open the battery compartment.

Noise - Indicates electrical noise is present in the flow. The noise flag usually comes on for a few seconds right after the sensor is placed in the water. This is normal. If the noise level is too high to get accurate readings, the screen will blank out.

Con Lost - Indicates sensor electrodes are out of the water or have become coated with oil or grease. After a few minutes, the unit will turn itself off. If the electrodes are coated, clean the sensor with a mild soap and a soft cloth.

Numbered Error Messages

- **Error #1** - Problem with sensor drive circuit. Check sensor disconnect.
- **Error #2** - Memory full error. Memory must be cleared before another reading can be stored.
- **Error #3** - Incorrect zero adjust start sequence. Reinitiate zero start sequence.
- **Error #4** - Zero offset is greater than the zero adjust range. Repeat the zero adjust procedure. If error is still displayed, unit needs servicing.
- **Error #5** - Electroconductivity lost or noises detected during zero adjust. Usually caused by the sensor being out of the water.

5.1.3 KEY SUMMARY

The function keys can be operated as single key functions or two-key functions.

<u>One Key Function</u>

- ON/C - Turns Unit ON. Clears the display and restarts the meter.
- OFF - Turns Unit OFF.
- ↑ Increments FPA (fixed point averaging), TC (Time Constant), and Memory Location.
- ↓ Decrements FPA, TC, and Memory Location.
- RCL - Alternates between Recall and Real-Time Operating Modes.
- STO - Stores Values in Memory.

<u>Two Key Function</u>

- ON/C + OFF - Change Units, Turns Beeper ON/OFF.
- ↑+ ↓ - Alternates between FPA (fixed point averaging) and rC (Time Constant) Filtering.
- ON/C + STO – Memory may be cleared from either the real-time or recall mode by pressing ON/C and STO simultaneously.
- RCL + STO - Initiates zero adjust sequence. Zero stability is ± 0.05 ft/sec.

5.2 FLOAT METHOD

The float method is a simple means of estimating discharge in low or high flow streams where the Marsh McBirney flow meter will not operate or is not safe to operate.

5.2.1 FLOAT METHOD PROCEDURE

1. Measure and mark two points along the length of the channel, at least two to three channel widths apart, at the channel cross-section. Record this value on the field form.
2. Measure three depths across at the channel cross-section. Average the 3 depths and record the value on the field form.
3. Two observers are best. One tosses the float into the channel above the marker and calls out when it crosses the upstream point. The float should be something that will partially submerge in the water such as an apple or stick. Toss each float a different distance from the bank to obtain an average of velocities.
4. The downstream observer starts the timer, sighting across the stream from the lower point. When the float passes, stop the watch and record the time. Repeat the procedure 5 to 10 times. Determine the mean surface velocity. A coefficient of 0.85 is commonly used to convert the velocity of a surface float to mean velocity in the vertical (USGS Field Manual, 2004).
5. Using the previously measured cross-sectional area (A), multiply velocity (V) times area to find discharge (Q= VA). Record it on a data sheet with date, time, etc. If the cross-sectional area cannot be obtained because of unsafe wading conditions, record the velocity. If it is possible to return to the site under favorable conditions, measure the cross-sectional area and compute the estimated Q (Harrelson et al, 1994).

5.3 U.S.G.S. STAFF GAGE

At sites located near or next to a U.S.G.S. gauging station, a discharge measurement can be made by recording the time of day and the staff gauge height. On the U.S.G.S. web page http://waterdata.usgs.gov/nwis/, find the appropriate gauging station and determine the discharge from the table provided and record on the field data sheet for that site.

5.4 VOLUMETRIC MEASUREMENT

The volumetric measurement of discharge is only applicable to small discharges, but it is the most accurate method of measuring such flows. In this method the hydrographer observes the time required to fill a container of known capacity, or the time required to partly fill a calibrated container to a known volume.

Volumetric measurements are usually made where the flow is concentrated in a narrow stream, or can be so concentrated, so that all the flow may be diverted into a container (Examples or possible locations include: V-notch weir, artificial control where all the flow is confined to a notch or to a narrow width of catenary-shaped weir crest, and a cross section of natural channel where a temporary earth dam can be built over a pipe of small diameter, through which the entire flow is diverted).

Volumetric measurements have also been made when no other type of measurement is feasible, as for example on small streams composed of a series of pools behind broad-crested weirs. At low flows the depth of water on the weir crest is too shallow to be measured by current meter, and the velocity in the pools is too slow for such measurement. Discharge is measured by taking timed samples of flow sufficient to fill a container of known volume held along the downstream face of a control.

CHAPTER 6 AUTOMATED FIELD EQUIPMENT

The TMDL Unit utilizes a wide variety of automated equipment to collect water quality, stream stage, and meteorological data. A list of materials potentially required to install equipment is listed in Appendix A. Each installation is unique and should be well thought out to ensure all necessary items are available. Specific installation requirements for each instrument are discussed below in the appropriate section.

6.1 RAIN GAGE

Precipitation data is often needed to calibrate hydrologic models. If no precipitation data is available for a particular watershed a rain gage can be deployed to collect data for use in any future modeling needs. The TMDL Unit uses Texas Electronics 8" Rain Gages. The rain gage consists of a tipping bucket mechanism and a HOBO Event Data Logger. The buckets tip in response to every 1/100 inch of precipitation, which is recorded as an event on the HOBO Event Data Logger. Prior to deployment the logger should be connected to a computer and "named" for the site where it will be deployed. This will place the site name in the header of the data when it is downloaded. The logger is connected to the tipping buckets relay output via two wires and has a red light that blinks every two seconds while it's logging and blinks rapidly four times as it stores an event.

It is important that the serial numbers associated with the gage and the location of the deployment is recorded on the TMDL equipment inventory list and any changes are noted promptly.

6.1.1 PLACEMENT

The rain gage should be mounted in a relatively level spot, which is representative of the surrounding native area (do not place on paved surfaces). The lip of the funnel should be horizontal and at least 30 cm above the ground. Consideration should be given to average snow depth if the gage is placed in an area that receives sufficient snowfall to bury the gage. The gage should be placed away from objects that could obstruct wind or rain. The distance should be 2-4 times the height of the obstruction. Potential mounting options include a fence post for taller installation needs or attached to a typical garden paver. The bucket should be secured to an anchored object via a lock and cable.

6.1.2 PRE-TRIP ACTIVITIES

Before leaving to retrieve data sign out a "Rain Gage Bag". The bag contains all the necessary tools for maintaining and downloading data for the rain gages. The project manager should insure that the bag contains the following:

1. HOBO Shuttle;
2. Enough batteries to replace each HOBO Event Data Logger serviced and two additional for the shuttle;
3. Cleaning supplies (paper towels and filled water bottle);
4. Tools (screwdrivers, wrench, and level);
5. Communication cables (shuttle and PC); and
6. Equipment manuals.

The HOBO Shuttle's clock should be checked before leaving for the field. Launching the shuttle while it is connected to a host computer will synchronize the shuttle's clock to the computer's clock. This will ensure that the event loggers are relaunched with an accurate time and date settings. To launch the shuttle, connect to the host computer with the cable provided (serial port cable). Open the Boxcar Pro software and select launch from the logger menu. Boxcar Pro will automatically synchronize the shuttle clock and the battery status. Replace the shuttle batteries if necessary. The shuttle must be relaunched after changing its batteries.

It is recommended that a laptop, with Boxcar software loaded, be brought in the field as a backup to the HOBO Shuttle. If problems are encountered while downloading the data the laptop may be needed.

6.1.3 MAINTENANCE AND CALIBRATION

The funnel, screen, tipping buckets, and tipping mechanism must be kept clean. Routine maintenance should be scheduled to remove any accumulation of dirt, dust, and foreign material. A general 1-3 month maintenance schedule should be followed and include:

1. Clean funnel, screen, and tipping buckets;
2. Inspect tipping buckets for proper operation (i.e. test tips);
3. Check to make sure HOBO Event Logger is logging the events as they occur (during a test tip the LED should blink quickly four times as it logs the event
4. Insure gage is level; and
5. Replace HOBO Event Logger battery (CR2032) annually.

The rain gages should be calibrated annually. Calibration can be accomplished using a graduated cylinder. The event logger should be downloaded before calibrating and relaunched after calibration if the gage is being calibrated during deployment. If deployed, a laptop computer should be brought to download and display the test data. Clean and wet the gage thoroughly allowing water to flow through the gage before beginning the test, this reduces the chance of water adhering to portions of the gage and causing errors in the calibration. Allow 824 mL of water to flow through the funnel at the rate of 1mL per second. The number of tips can be counted manually and verified by displaying the logger data. Best results are obtained by running multiple tests and by using multiple volumes of water. 824mL of water should yield 100 +/- 3 tips; therefore, 8.24 mL of water should cause the bucket to tip once.

Should the gage need adjustment, change the heights of the two calibration post adjustment screws. Rotate each screw by a small amount and recheck the calibration for the new screw positions using 8.24 mL of water. The calibration posts should be adjusted upward (counter clockwise) whenever the amount of water needed to cause the bucket to tip is more than 8.24 mL. Whenever less water is needed the posts should be adjusted downward (clockwise). Do not dry the tipping buckets during the calibration process. Carefully tighten the locking nuts on the calibration screws after completing the adjustments.

6.1.4 DOWNLOADING DATA

Data can be downloaded from the event logger in the field by using the HOBO Shuttle or laptop computer. Connect the event logger to the shuttle by plugging the foot long cable stored inside the shuttle cover into the event logger. Press the black button located on top of the shuttle to start offloading the logger. The series of LED lights on the shuttle will progress through the offload process starting with a blinking orange LED while offloading. Once the offloading of data is complete the shuttle will check the battery status of the logger. If the battery level is below 30% the red "Change Battery" LED will blink. Disconnect the shuttle, replace the batteries, reconnect, and press the black button. Once the battery test passes the orange "Testing" LED will blink, press the button to proceed. Press the button again to relaunch the event logger. When the green LED indicating successful download is blinking, press the button one more time. If the red "Com failure" LED blinks, check the connections and press the button once to clear the failure and to attempt offloading again. If the failure continues, replace the batteries in the event logger and attempt once again. Remove the event logger from the rain gage if the communication failure cannot be fixed in the field and return to the manufacturer for repair. The event logger can also be offloaded using a laptop computer by connecting the serial cable, opening Boxcar Pro and selecting "readout" from the logger menu. Once the logger has been relaunched the old data is erased. When placing the event logger back into the rain gage it is imperative that the wire connecting the logger to the tipping bucket mechanism does not obstruct the movement of the tipping buckets (FIGURE 6.1).

FIGURE 6.1. View of rain gage with funnel and screen removed. Note that the tipping buckets are free of any cables or wires that may hinder them from moving freely.

It is recommended that a laptop, with Boxcar software loaded, be brought in the field as a backup to the HOBO Shuttle. If problems are encountered while downloading the data the laptop may be needed.

6.1.5 POST-TRIP ACTIVITIES

Upon return to the office replace consumables in the HOBO bag (batteries, towels, etc) and offload data from the HOBO Shuttle. Data is offloaded from the shuttle by connecting it to a computer, opening BoxCar Pro, and selecting HOBO Shuttle Readout from the logger menu. The program will offload the data from the event logger. Be sure to store each logger's data to the user-defined location (do not use the default location), check the shuttle's battery and synchronize its clock. Data will not be erased from the shuttle until it has been "offloaded" and then used to offload another event logger. Once consumables have been replaced and the shuttle has been offloaded place the bag back in the cabinet for future use.

6.1.6 FILE STORAGE

Electronic files should be stored on the project manager's d-drive within the project's file structure. Copies of data files must also be maintained on the project manager's m-drive or on a CD. Raw data files should also be maintained to preserve data integrity. As new data is collected it should be added to a running list of compiled data.

All field activities related to installation, data downloads, maintenance, calibration, etc. must be documented in the project field notebook. Observations noted should include, but are not limited to date and time, cleanliness of equipment upon arrival, actions taken (cleaned funnel, checked level, etc.), destination of downloaded files, problems encountered, check serial numbers, etc.

6.2 TEMPERATURE GAGES

ADEQ uses HOBO Pro Temperature Gages. The gages are deployed in conjunction with rain gages at sites where snow is possible and in watersheds where no temperature data is available. The gages contain a HOBO Event Logger encased within a series of air baffles. Prior to deployment the event logger should be connected to a computer and "named" for the site where it will be deployed. This will place the site name in the header of the data when it is downloaded. The temperature is logged every 15 minutes.

It is important that the serial numbers associated with the gage and the location of the deployment is recorded on the TMDL equipment inventory list and any changes are noted promptly.

6.2.1 PLACEMENT

The gage should be placed away from objects that could obstruct wind or rain. The distance should be 2-4 times the height of the obstruction. The gage should be placed approximately three feet above the ground to avoid saturating the gage.

6.2.2 DOWNLOADING DATA

Data can be downloaded from the event logger in the field by using the HOBO Shuttle or laptop computer. Connect the logger to the shuttle by plugging the foot long cable stored inside the shuttle cover into the logger. Press the black button located on top of the shuttle to start offloading the logger. The series of LED lights on the shuttle will progress through the offload process starting with a blinking orange LED while offloading. Once the offloading of data is complete the shuttle will check the battery status of the logger. If the battery level is below 30% the red "Change Battery" LED will blink. Disconnect the shuttle; replace the batteries, reconnect, and press the black button. Once the battery test passes the orange "Testing" LED will blink, press the button to proceed. Press the button again to relaunch the event logger. When the green LED indicating successful download is blinking, press the button one more time. If the red "Com failure" LED blinks, check the connections and press the button once to clear the failure and to attempt offloading again. If the failure continues, replace the batteries in the event logger and attempt once again. Remove the logger from the rain gage if the communication failure cannot be fixed in the field and return to manufacturer for repair. The logger can also be offloaded using a

laptop computer by connecting the serial cable, opening Boxcar Pro and selecting "readout" from the logger menu. Once the logger has been relaunched the old data is erased.

6.2.3 POST-TRIP ACTIVITIES

Data is offloaded from the shuttle by connecting it to a computer by opening BoxCar Pro, and selecting HOBO Shuttle Readout from the logger menu. The program will offload the data from the logger. Be sure to store each logger's data to the user-defined location (do not use the default location), check the shuttle's battery and synchronize its clock. Data will not be erased from the shuttle until it has been read out and then used to offload another event logger.

6.2.4 FILE STORAGE

Electronic files should be stored on the project manager's d-drive within the project's file structure. Copies of data files must also be maintained on the project manager's m-drive or on a CD. Raw data files should also be maintained to preserve data integrity. As new data is collected it should be added to a running list of compiled data.

All field activities related to installation, data downloads, maintenance, calibration, etc. must be documented in the project field notebook. Observations noted should include but are not limited to, date and time, cleanliness of equipment upon arrival, actions taken, destination of downloaded files, problems encountered, check serial numbers, etc.

6.3 PORTABLE (AUTOMATIC) SAMPLERS

6.3.1 GENERAL OVERVIEW

The TMDL Unit utilizes portable (often referred to as automatic samplers) to supplement grab sampling efforts. Portable samplers are deployed and programmed to start sampling as water levels rise. The use of portable samplers allows for the sampling of storm events over a larger portion of the hydrograph at more locations than could be accomplished by traditional grab sampling methods. The samplers typically are configured to hold 24 one liter bottles and can be programmed to collect samples over varying time frames (i.e. one bottle every hour or two bottles every two hours). The autosamplers are powered by a 12-volt rechargeable battery which will hold enough charge to complete a sampling program for up to five weeks. In order to continuously charge to the battery during deployment 5-W solar panels are available for use with the ISCO samplers.

Currently the TMDL Unit uses portable samplers manufactured by American Sigma (models 800 and 900 Max; FIGURE 6.2) and Teledyne ISCO (model 6712). Both brands are constructed and operate similarly. They consist of a base that holds the bottles, controller section, and a lid. The controller section houses the electronics, pump, distributor arm, and battery. Standard configurations are battery powered but 5W solar panels can be installed to continually charge the battery.

FIGURE 6.2. Sigma 900 Max autosampler (left) and ISCO 6712 autosampler (right)

6.3.2 QUALITY CONTROL

Prior to deploying a sampler to a new location the intake, pump, and distributor tubing must be replaced and the unit completely cleaned. Additionally, if polyethylene bottles are used they are project and site specific and cannot be used at sites other than where they were originally deployed. Typically two sets of bottles are ordered for each site, one to replace the other after samples are collected. Bottles are acid washed when new and after each sampling event. The bottles are capped, bagged and placed inside a container during storage and transport. The bottle sets should be labeled to indicate the site and set (e.g. "A" or "B") once they have been deployed so that they can be identified independently. The sample volume should be calibrated before each deployment to ensure bottles will be filled properly. Volume calibration can be performed using the volume calibration/test-run kit developed by the TMDL Unit.

Bottle and equipment blanks should be collected and analyzed for the same parameters that are being sampled through the autosampler prior to deployment. Equipment blanks are collected after the tubing has been replaced and prior to field deployment. Typically one liter bottle of DI water is pumped through the intake, pump and distributor tubing into one of the new bottles (after acid cleaning), then poured into a regular sample bottle supplied by the analytical laboratory. Bottle blanks should be collected for each set of bottles after the initial acid wash (as part of the equipment blank) and periodically throughout the project as the bottles are cleaned prior to redeployment.

Ideally several grab samples will be collected simultaneously with autosampler sample collection to determine that the autosamplers are not biasing the results.

6.3.3 PLACEMENT/DEPLOYMENT

Portable samplers can be deployed for long or short terms depending on the requirements of the project. Regardless of the length of deployment, installation should follow the same general guidelines listed below:

- Place and secure sampler above potential high water line, see FIGURE 6.3
- Run intake tubing and float switch wiring from autosampler to stream and secure (long-term deployments should include anchored PVC pipe which the tubing and wire is routed through), see FIGURE 6.4

- The intake strainer should be placed approximately 4" above the stream channel to avoid sampling bedload material;
- Secure float switch in stream and attach wiring to autosampler.

The TMDL Unit utilizes simple float switches to activate the automatic samplers in response to changes in water level, see FIGURE 6.5 for an example. When deploying autosamplers care must be taken to minimize vandalism, lose of equipment, and required maintenance while allowing for sample retrieval under adverse weather conditions.

See Appendix A for a list of equipment needed for installation of autosamplers and Appendix H for detailed instructions for float switch construction.

FIGURE 6.3. Example autosampler installation scenarios- under bridge (left) and secured to bridge support (right)

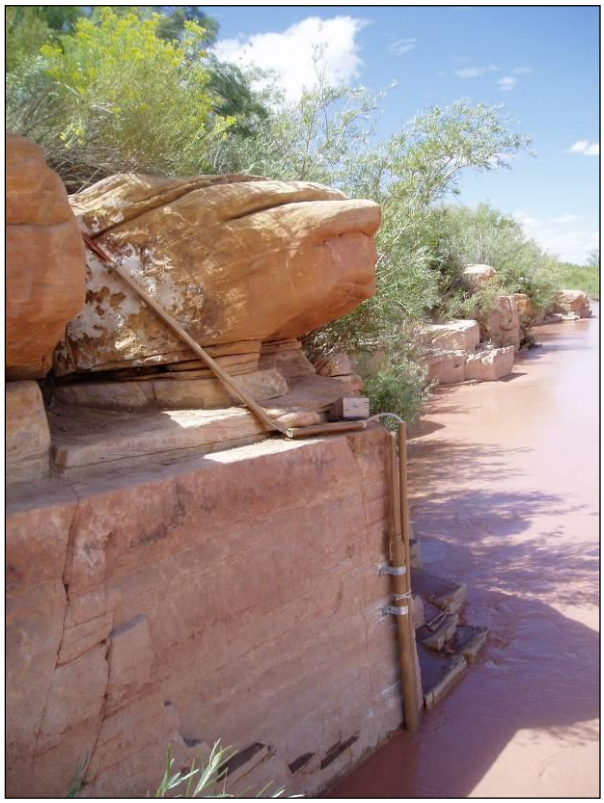


FIGURE 6.5. Float switch (black) connected to PVC cap

FIGURE 6.4. Examples of intake tubing (with strainer attached) and float switch installations, note anchoring to fix objects.

In order to determine the discharge at time of sampling the sampler should be deployed at or near a USGS gaging station or with a level logger. If deployed with a level logger a stage to discharge relationship will have to be developed by measuring the instantaneous discharge at several stages of flow. This task is normally accomplished through discharge measurements taken when collecting grab samples.

6.3.4 PROGRAMMING OPTIONS

Autosamplers have a wide range of programming options. Although the different manufacturers have slightly different "buttonology", each operate in a similar fashion, see FIGURE 6.6. They can be programmed, using the keypad, to collect individual or multiple samples at programmable time intervals.

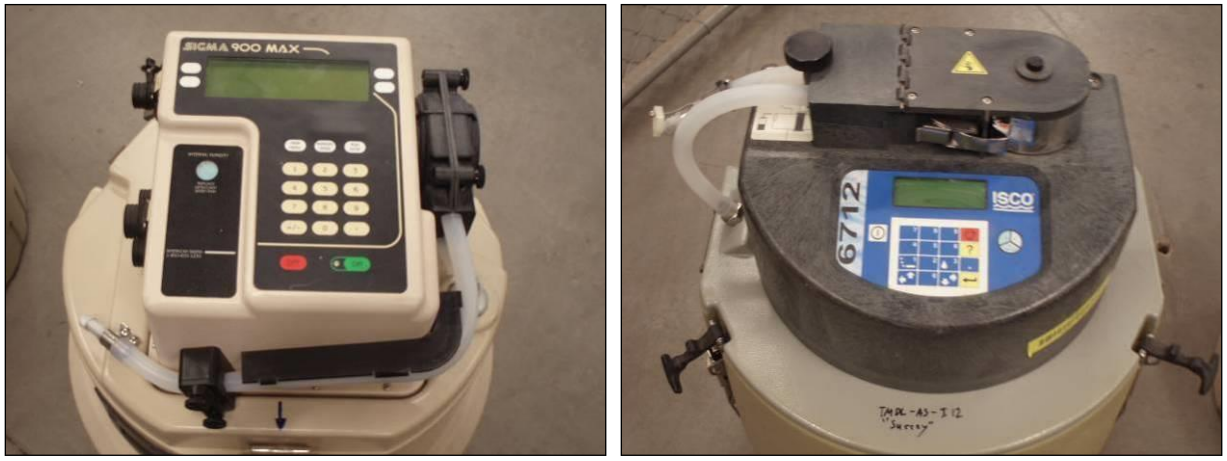


FIGURE 6.6. Overview of autosampler keyboards- Sigma 900 Max (left) and ISCO 6712 (right)

Appendix J contains an example of a Sigma and ISCO program. It is important to keep in mind that the number of bottles collected per sample and the sampling interval are dependent on the data needs of the project. Additionally, the required analytical sample volume and holding times need to be considered.

6.3.5 EQUIPMENT KEYS

Equipment that is deployed in the field for any extended period of time must be secured to prevent theft. A large number of keys and locks have been used within the unit. To enable access to equipment for sample and data collection it is the project manager's responsibility to record the key number and the corresponding location that the key fits. This is best recorded in the cover of the field notebook and in a spreadsheet.

6.4 WATER LEVEL LOGGERS

Water level loggers typically consist of a pressure transducer used to record water level and temperature in a stream or lake over a period of time. Water level loggers are designed for long-term deployment. They can be deployed and left unattended for months at a time, collecting water level data at user-defined intervals and storing it digitally into logger memory. By operating in a

continuous 24/7 monitoring mode, water level loggers eliminate many of the hassles of manual data collection approaches and facilitate monitoring of multiple locations at the same time.

The logger data, in conjunction with several manually obtained stream discharge measurements (obtained at different stages), and a survey channel cross section provide the information required to construct a stage-discharge relationship. Once this relationship is established, stream discharge can be estimated on the basis of the stage data alone.

6.4.1 GENERAL CARE

Loggers should be installed where the stream channel is most stable (e.g. bedrock lined channel). In most cases the logger should be placed inside a slotted PVC pipe or similar material that serves as a stilling well that will dampen water level fluctuations and protect the logger. The pipe may be secured to a permanent structure, buried in the riverbank, secured with rocks, or fastened to the bank with rebar or similar material, see FIGURE 6.4. Once installed a reference point should be established upon which future water depth measurements can be made. For example, the bottom of the stream channel if bedrock lined or the PVC cap at the end of the well screen could be used as the reference point. It is important that the reference point be stable throughout the span of the project.

Loggers should be cleaned and downloaded every six weeks. Depending on the model, batteries should be replaced/checked every six months. Most loggers come pre-calibrated from the factory, where possible real-time measurements should be taken and compared to the data recorded by the logger. The calibration on the loggers, regardless of manufacturer, should be checked upon installation and every six months during deployment. The calibration can be checked by filling a known length (e.g. three feet) 1" PVC pipe with water, placing the pressure transducer in the pipe and reading the level recorded by the logger. A "dry" (pressure transducer not submerged in water) reading should equal zero. If the measurements are off by more than two-tenths of a foot, the logger should be sent back to the factory for calibration.

Once a level logger is installed, a stream channel cross-section must be completed following the procedures discussed in Sections 8.2 and 8.3 of the Standard Operating Procedures for Water Quality Sampling. The cross-section transect should include the position of the level logger and reference point. If large deposition or scour events occur a new cross-section will need to be completed.

The following sections describe the procedures for logger set-up, deployment, and data retrieval of three common water level loggers used by the ADEQ TMDL Unit. The necessary materials needed to perform routine maintenance are included in Appendix A.

6.4.2 LEVEL LOGGER FIELD OBSERVATIONS

During each site visit several observations must be made and include:

- Current water level as measured from the reference point (if dry, record as "dry");
- Compare actual water depth to real-time instrument reading;
- Changes in stream channel (material, geometry, etc) since last visit;

- Logger time relative to laptop, GPS, or other accurate reference time;
- File path where data was saved; and
- Serial number of logger.

6.4.3 HOBO® U-20 WATER LEVEL LOGGERS

The HOBO® U-20 Water Level Logger is a completely self-contained unit meaning there are no vent tubes or desiccants to maintain, see FIGURE 6.7. This non-vented logger is compact, and requires minimal maintenance. However, the logger depends on either a second logger, or weather station to correct for changing barometric pressures. The procedures for setup, deployment, data retrieval, and barometric pressure compensation are discussed below. The HOBOware™ Software Kit loaded onto a computer and an optic USB Base Station are required for logger setup and retrieval.

The following steps should be taken for the deployment of the HOBO® U-20 Water Level Logger:

1. Install the HOBOware™ Software onto computer.
2. Plug the USB-Optic Base Station cable into a USB port on the computer. If the base station has never been connected to the computer before, it may take a few seconds for the new hardware to be detected by the computer. It may also be necessary to reboot the computer.
3. Unscrew the black plastic end cap from the logger by turning it counter-clockwise.
4. Align flat areas of the logger and base station, then insert the logger. Gently twist the logger to be sure that it is fully seated in the base station. If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected by the computer.
5. Click the Launch icon on the toolbar. This displays the logger's launch window.

FIGURE 6.7. HOBO U-20 Level Logger

6. Review the default launch settings and make any necessary changes. Enter a new name in the description field and select or deselect channels to log. You must select absolute pressure and temperature. Determine the appropriate logging interval and program the logger. Loggers are usually set to record data at 15 minute intervals. You may start logging immediately or choose the date/time you wish logging to start.
7. Click **Launch** to begin logging. HOBOware displays the progress of the launch and warns you not to unplug the logger while it is being configured.
8. Once this is complete you can unplug the logger. Make sure to screw the black plastic end cap back onto the logger before deployment.

The logger is now ready to be installed in the stream channel or lake. At the end of the logging period, the following steps should be followed in downloading the HOBO® U-20 Water Level Logger:

1. Connect the logger to the computer (see logger deployment steps 2-3).

2. Click the Readout icon on the toolbar, or choose readout from the logger menu. A message will ask whether you want to stop the logger; click OK.
3. Wait while the data is read out from the logger.
4. HOBOware prompts you to save the data. Specify the location and name of the file and click Save.
5. A Plot Setup dialog box will appear. When you have made your selections, click the plot button.
6. From the displayed plot you can export the data to Excel; under the file menu select Export Points as Excel Text. This will prompt another save screen; input the file name and location and click save.

6.4.3.1 Barometric Pressure Compensation

Storms and changes in elevation have a significant impact on barometric pressure. Stormy weather can produce up to 25 millibars of pressure differential during a single day. Since one millibar equals one centimeter of water this equates to almost 10" of error in water level readings. The HOBO® U-20 Water Level Logger does not automatically correct for changing barometric pressures; instead a second water level logger, a HOBO Weather Station, or import ASCII formatted barometric data must be used to correct for barometric compensation. When a second logger is used it should be placed in a secure location near the logger, and should be set up to record at the same times as the HOBO Water Level Logger. The HOBOware™ Software uses a barometric compensation assistant to convert water pressure data to water level or sensor depth values, and compensate for barometric pressure.

To use the barometric compensation assistant:

1. Open the HOBOware™ Software;
2. Open the data file to be corrected;
3. When the Plot Set Up dialog box opens, select the Barometric Compensation Assistant under data assistants, and click the Process key;
4. To use the barometric data file from another HOBO logger, click the Use Barometric Data file button and browse to the .hobo file that contains a pressure series from an overlapping time period;
5. Name the new file, and click Create New Series. The new series will be displayed. The new series file can then be exported to Excel (see step 6 above).

6.4.4 GLOBAL WATER WL15 AND WL16 WATER LEVEL LOGGERS

The Global Water WL15 Water Level Loggers consists of a pressure transducer connected to a data recorder by a sensor cable, see FIGURE 6.8. WL16 models also record temperature but their basic operation is similar to the WL15.

The following steps should be followed in setting up the Global Water Level Loggers for deployment:

1. Install the Global Logger Software (verify version if using a WL16) onto a laptop computer;
2. Verify the logger is reading accurately by placing the transducer in a three foot long PVC pipe filled with water. Launch the Global Water Software and check the real-time reading of the logger. At the main screen "check" the "Sample Continuously" box to view real-time values. If the reading is within 0.05' of 3.0' the logger is properly calibrated;
3. Make sure the computer is reading the correct date and time;
4. Double click the "**Global Logger**" icon. Once the main Global Logger window will appears, select the clear memory button.

Figure 6.8. Global Water Level Logger

Make sure that data has been saved before pressing this button.

5. Click the "**Synchronize Time**" button; this will synchronize the logger time with that of the computer;
6. Click on the "**Setup**" button; here you can specify the logger/site name and the sample interval. In general loggers should be set to record data at 15 minute intervals;
7. The logger comes pre-calibrated from the factory; however site specific calibrations can be made. Refer to the Water Level Logger Users Guide (Global Water Instruments Inc, 2002) for the calibration procedure; and
8. Click **OK**, the logger is now ready for deployment.

The following steps should be followed in downloading the Global Water WL15 Water Level Logger:

1. Double click the "**Global Logger**" icon. Once the Global Logger main window will opens, click the "**Get History Data**" button;
2. A historical data viewer window will open. Save the current reading by clicking the "**Save to File**" button, select the location to save data and a file name, and click **save**. The file will save as a comma separated file that can be opened in Excel.

Data should be downloaded every six weeks. In addition, the Global Water WL15 Water Level runs on a 12V lithium battery which should be changed every six months. The battery is accessed by unscrewing the black cap on the end of the data logger. The screen on the end of the sensor should be periodically checked for clogging. The screen can be cleaned with soap and water and/or scrubbed gently with a toothbrush.

The Global Water WL15 Water Level's cable contains a vent tube that automatically corrects for barometric pressure compensation. This vent tube must not be kinked or obstructed, or erroneous

data will result. Additionally, the data logger is water resistant, not waterproof. It should not be submerged and should be protected from condensation and rainfall.

6.4.5 IN-SITU LEVEL TROLL 500 WATER LEVEL LOGGERS

The Level Troll 500 Water Level Logger is a completely sealed unit that contains pressure and temperature sensors with an optional vented or non-vented pressure sensor, see FIGURE 6.9.

The following steps should be followed in setting up the Level Troll 500 Water Level Logger for deployment:

1. Remove the protective caps from the Level Troll and vented/communication cable.
2. Slide back the sleeve on the cable connector.
3. Orient the "flats" (grooves) so they will mate up, and insert the Level Troll connector firmly into the vented/communication cable connector. Slide the sleeve on the cable toward the Level Troll body until the pin on the body pops into the round hole in the slot on the cable connector.
4. Grasp the knurled (textured) section of the cable connector in one hand and the Level Troll body in the other. Push and twist firmly so that the pin on the body connector slides along the slot on the cable connector and locks securely into the other hole.
5. Connect vented/communication cable to the PC serial port via the TROLL COM cable and make sure that Win-Situ software is loaded onto the computer.
6. Start Win-Situ by double-clicking the shortcut created on the desktop. When the Win-Situ application window opens, select File menu >Settings and check your PC's COM port (usually COM 1 for direct serial port connection). Click the "**OK**" button.

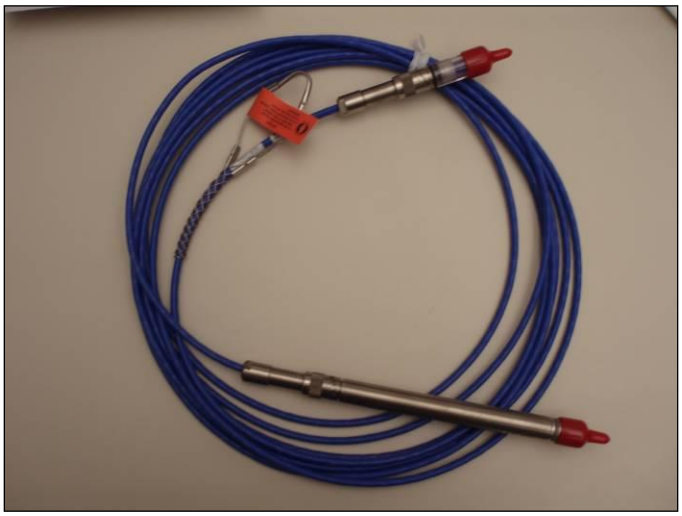


FIGURE 6.9. In-situ Water Level Logger with vented cable attached

7. Click the "**Connect**" button to connect to the Level Troll. The software will connect to the Level TROLL and display current level/depth, pressure, and temperature readings (pressure and temperature for a BaroTROLL).
8. Set the clock. Both the device clock and the system (PC) clock are shown on the dashboard when the device is connected. The clocks update every two seconds. If the device clock is more than two seconds off from the system clock, the device clock is displayed in red. To synchronize the clocks, click the **Sync** button.
9. To prepare the device to log data, first select the Logging tab. Click the "**New**" button. The Logging Setup Wizard will prompt you through the configuration of a data log—including

the site, log name, parameters to measure, sample schedule, start time, stop time, output (pressure, depth, or water level with a reference), and other options.

To start logging:
A "Pending" (scheduled) log will start at its programmed time. You can start a "Ready" (manual) log at any time while connected by selecting the log and pressing "**Start**" to start logging;
To stop logging:
Select the log and press the "**Stop**" button or suspend (temporarily stop) it with the "**Pause**" button.

10. After entering the logging program, you're ready to Exit the software (File menu > Exit). Disconnect the Troll Com cable by grasping the knurled (textured) section of the cable connector in one hand and the Troll Com cable in the other. Twist in opposite directions to unlock the Troll Com cable from the vented cable.
11. Install the instrument in its field location.

The following steps should be followed in downloading the Level Troll 500 Water Level Logger:
1. Connect logger to computer as described above;
2. Start Win-Situ software; and
3. Select the log and press the "Download" button.

Similarly to the Global Water WL15, the Level Troll cable contains a vent tube that automatically corrects for barometric pressure changes. This vent tube must not be kinked or obstructed, or erroneous data will result. Additionally, the data logger is water resistant, not waterproof. It should not be submerged and should be protected from condensation and rainfall.

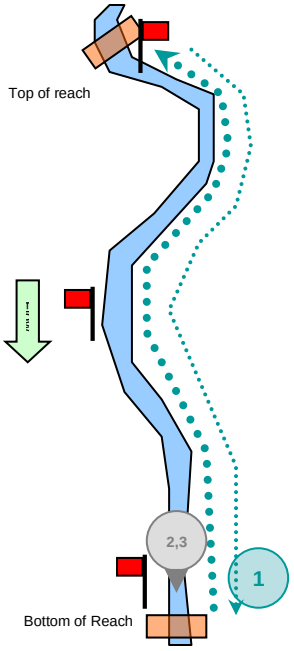
CHAPTER 7 STREAM ECOSYSTEM MONITORING

This chapter covers how to collect macroinvertebrates, diatoms and habitat data using the Stream Ecosystem Monitoring (SEM) form. SEM data is typically collected during the spring.

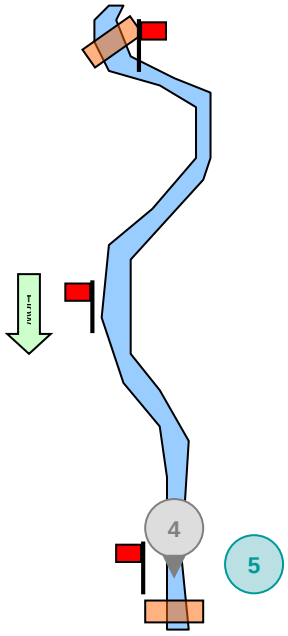
7.1 SAMPLING ORDER

The following section provides a general outline to efficiently collect chemistry, algae, macroinvertebrate and habitat data at a particular site with a two person team. Person one is identified in blue. Person two is identified in grey. Each task is listed in the circle corresponding to each person's color.

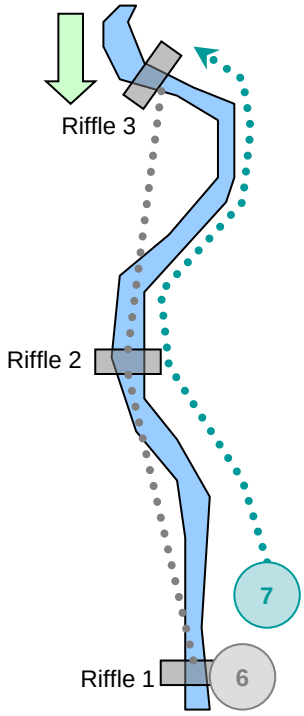
The information contained in this section is meant to summarize the order of data collection in the field from the chapters that follow. The original procedures from this manual should be consulted to verify that the summary information will meet your needs.



1. Lay out reach. The reach length should equal 40 times the wetted width. The minimum reach is 300 feet. This person needs the tape measure, flagging and a knowledge of their pace. Record number of paces of riffles, pools, runs on the SEM form. Note the 3 good riffles. Begin site sketch.
2. Take field chemistry measurements w/ multimeter.
3. Collect (3) 1 liter bottles, (2) 500 mL bottles, , SSC bottle, 1 Colilert bottle, 1 turbidity, (and any other QC or additional parameters). Use DH-81 and churn splitter if avg depth > 1 foot, avg velocity > 1 ft/s, or grab sample not appropriate.



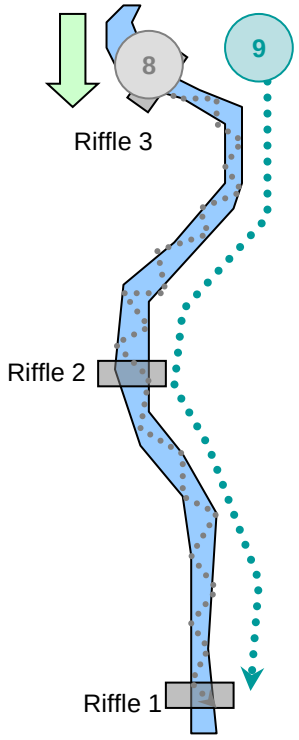
4. Take discharge measurements. Measure wetted width. Divide by 20. Minimum width separation 0.3 ft (for small streams). For depths > 2.5 ft use 2 point method (0.2 and 0.8 depths rather than 0.6 depth).
5. Record discharge. Take photos (up, down, banks). Work ahead on the field forms.



6. Collect bugs in 3 good riffle habitats. Do 1 minute kicks over a 1 square meter area and place bugs in bucket at each riffle. For cold water streams, do transect pebble counts and embeddedness at same riffles (33 pebbles per transect). Take densiometer readings.

7. Record and fill out remainder of sheets including site sketch.

8. Do the reach wide pebble count. Goal is 100 reach wide particles evenly spaced. Do % algae and macrophyte cover along with the reachwide pebble count.
   Record and fill out remainder of sheets including site sketch.
9. Collect Rosgen channel data, riparian tree data and fill out proper functioning condition, habitat score and Pfankuch stability evaluation.



7.2 COLLECTING MACROINVERTEBRATES

Macroinvertebrate sampling is conducted to assess the biological integrity of perennial, wadeable streams. ADEQ has developed bioassessment tools in the form of Indexes of Biological Integrity (IBI) along with habitat evaluations for this purpose. There are two IBIs, the Warm water IBI and Cold water IBI. The procedure for calculating the IBIs is found in the Biocriteria Implementation Procedures (ADEQ, 2013).

7.2.1 SITE SELECTION

The stream reach length for Stream Ecosystem Monitoring should be one of the following:

1. 40 times the wetted width of the stream.
   - A. A minimum reach length of 300 feet.
   - B. A maximum reach length of 3,000 feet.

The stream reach should be selected to represent typical habitat conditions found in the larger stream segment. The stream reach length should begin at the top of a riffle or run and end at the bottom of a riffle or run.

7.2.2 REFERENCE SITE SELECTION

If the reach is to be used as a reference or background reach, the following general criteria must be met:

- No known discharges upstream
- No major impoundments upstream
- No human caused channel alterations at the site; e.g. diversions, dredge and fill projects
- No known mines upstream in the watershed
- At least 0.5 miles downstream of road crossings
- The site should be perennial. The indicators for perennial condition are likely to be the presence of fish, univoltine insects (i.e. one generation per year), and healthy unstressed riparian plants
- The site should be free of local land use impacts
- There should be no recorded violations of pH or dissolved oxygen water quality standards
- The Habitat Assessment Index score should be greater than 14
- Crayfish should not be present or present in low abundance
- No recent fire in the watershed
- No recent major floods (>10 yr return interval) within the past year

7.2.3 WHEN TO SAMPLE MACROINVERTEBRATES

The narrative biocriteria standard (A.A.C. R18-11-108.01) applys to wadeable, perennial streams with either an aquatic and wildlife cold or warm designated use. The following sampling conditions and time frames must be met in order to collect macroinvertebrates for ADEQ bioassessment purposes. A stream reach must be:

- **Wadeable**. Wadeable means no deeper than can be safely waded across when collecting samples.
- **Perennial**. Perennial refers to stream segments which flow continuously throughout the year (excluding effluent dependent waterbodies).
- **Contain fast-flowing riffle or run habitat**. Riffle habitat refers to the portions of streams where moderate velocities and substrate roughness produce moderately turbulent conditions which break the surface tension of the water and may produce whitewater. Run habitat refers to segments of streams where there is moderate velocity water, but non-turbulent conditions which do not break the surface tension of the water and do not produce whitewater (Bain and Stevenson, eds.1999).
- **Sampled during the spring index period** (April-May for warm water streams (<5,000 ft.) and May-June for cold water streams (>5,000 ft)). The spring index period is described as a period of time following winter runoff in which baseflow conditions will be found in most streams. Baseflow conditions generally are achieved post winter runoff in the desert streams in April-May and in mountain streams in May-June. A period of 4 weeks post-bankfull flood condition is generally required prior to macroinvertebrate sampling, even during the spring index sampling period. Hydrologic conditions are checked in the office

prior to a site visit and field conditions are documented on the SEM form macroinvertebrate conditions table in the field prior to sampling to confirm that sampling is occurring during the correct sample collection conditions.

Macroinvertebrate samples are not collected when the following conditions occur:

- A bankfull or greater magnitude flow event has occurred within 4 weeks of site visit or when extreme high flow events have occurred, resulting in deep scouring of the streambed and benthic community such that the macroinvertebrate community will not recover within the spring index period.
- A 10 year or greater flood event has occurred within 6 months of the sampling event.
- Extended drought conditions have reduced flow from previously perennial condition to pools only or stagnant wetland habitat.
- Stream substrates that are dominated (consisting of >50% of that substrate type) by bedrock, or travertine are considered non-target conditions.

FIGURE 7.1 D-frame net with 500 micron mesh net.

Macroinvertebrate samples should be collected before pebble counts and before any disturbance to the stream channel by investigators. The collection begins at the downstream end of the assessment reach and proceeds upstream.

A macroinvertebrate sample consists of a three-minute timed composite sample from kick samples collected with a D-frame dip net (FIGURE 7.1) from three riffle habitats within the study reach. The target sampling area is approximately one square meter per each one minute sample. Select three or more riffles which represent the variety of substrate sizes, velocities, depths, and habitats found within the reach. Collect one-minute timed samples from each of three habitats or divide the time as needed among the variety of habitats. If three good-sized riffles are not available to be sampled, spread the three minute sample time over whatever riffle/run areas are available.

7.2.4 HOW TO SAMPLE MACROINVERTEBRATES

Once the sampling sites within the reach have been selected, the first sample should be at the lowermost riffle.

1. Fill a bucket half full with stream water.
2. Place the D-frame (FIGURE 7.2) net on the stream bed in the path of flowing water, and agitate a one square meter area of substrate vigorously for one minute by kicking or hand

turning rocks to collect dislodged material. Sample as much variation of the flow and substrate as possible including large and small substrates.

3. Deposit the contents of the net into the bucket. At this point there is no need to pick the net clean.
4. Repeat the sampling procedure for the second and third riffles. After the last riffle, rinse as many invertebrates into the bucket as possible. Use forceps to remove organisms attached to the D-frame net. Before leaving the site, the D-frame dip net, bucket, and sieve should be rinsed and scrubbed to dislodge small invertebrates, egg masses, and organic material, so that it is not transferred to the next site. Spray the net and bucket with Quat 128 decontaminating solution before leaving the site.
5. Swirl the contents of the bucket and pour the non-sediment portion into a 500 µm mesh sieve.
6. Add water again to the bucket, swirl and pour the contents into the sieve. Repeat this procedure several times until all insects and organic debris are emptied and only sediment remains.

FIGURE 7.2. Macroinvertebrate sampling.

7. Transfer the remaining sediment into a dissecting tray and search the sediment for any remaining organisms, especially cased Trichoptera, snails, and freshwater clams and then discard the remaining sediment.
8. Gently, squeeze the sample to remove excess water from algae laden samples. Using a plastic spoon or hands, gently dispense the sample from the sieve into a wide mouth, one-liter sample jar. Fill the jar half to three-quarters full. If additional sample remains in the sieve, use an extra jar to contain it. Rinse any leftover material in the sieve into a corner and spoon out as much as possible. Check the sieve for any remaining animals If the sample will not fit into two jars, then field split the sample.

A field split consists of dividing the collected material in half. Half of the material is returned to the stream. Half is placed in the collection jar(s). Be sure to mark the field split check box in the "Biological Sampling" part of the form. To perform a one-half field split, evenly spread the entire sample in a white dissecting tray and divide the sample with your hands into two equal portions. Place one half of the sample into the two sample jars and discard the other half into the stream. Note on the field form that the sample was "field split 1/2 or 50%" retained. A quarter split can be performed if a half-split still provides too much sample material to fit in two jars.

The total time spent kicking should total 3 minutes for a 3 square meter area. More than three riffles can be used, but it is important to be consistent with sampling time and sampling area. Use a stop watch to keep track of time.

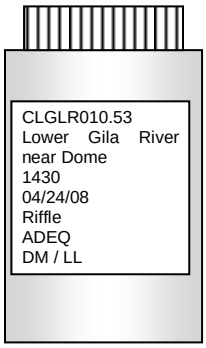
9. Place label(s) (see Section 7.2.6) in the jar(s); add enough 99% isopropyl alcohol (or ethanol) to fill the jar.
10. Seal and label the jar(s).

7.2.5 DUPLICATE SAMPLES

Duplicate macroinvertebrate samples should be collected for ten percent of the total number of samples. To collect a duplicate sample repeat the procedure described in Section 7.2.4 near the riffle location you kicked for the regular sample. Do not kick the same area twice. You can collect the second macroinvertebrate sample in a separate bucket concurrently with the first sample in one pass through the study reach. Do not split a combined sample for the duplicate.

7.2.6 MACROINVERTEBRATE SAMPLE LABELING

Each macroinvertebrate sample should have two identification labels. One should be taped on the outside of the bottle while the other one should be penciled on "write-in-the-rain" paper: inside the jar, visible from the outside. If more than one jar is used for a sample, put jar numbers on all labels (e.g., 1 of 2, 2 of 2). Each tag should have the following information at a minimum.



- Stream name
- Site code number
- Habitat sampled (riffle)
- Date and Time
- ADEQ and collectors' initials

Quality control samples should be identified with a unique identifier such as (Prescott Run #2). Leave the date and time blank. Be sure to cross reference the unique identifier on the field form so that the data can be compared when the results come in.

7.2.7 STORAGE

After samples have been preserved with 99% isopropyl alcohol, samples should be placed in an ice chest with ice to cool the sample. This prevents overheating and degradation of the sample, and prevents fumes from developing inside truck camper shells. Samples should be stored in a cool environment and within flammable storage areas in the ADEQ laboratory prior to shipping to the receiving laboratory (FIGURE 7.3).

FIGURE 7.3. Flammable storage.

7.2.8 CHAIN OF CUSTODY

To complete the Chain of Custody, samples shall be locked in field trucks when sampling personnel are away from the truck. Sample jars shall be placed in the large, flammable cabinet in the equipment storage area of the ADEQ laboratory for storage, prior to shipping. The use of tamper-evident tape on shipping boxes to prevent tampering with samples during shipping is required. A Chain of Custody form will accompany the samples during shipment.

7.3 CHLOROPHYLL & PERIPHYTON

The chlorophyll-and periphyton protocols in this section are adopted from EPA's 2013 National River and Stream Assessment methods (USEPA, 2013).

7.3.1 SAMPLE COLLECTION

7.3.1.1 Water Column Chlorophyll-a

1. Rinse the 2 L amber Nalgene bottle 3 times. Discard the water downstream.
2. Fill the 2 L amber Nalgene bottle with stream water. Cap the bottle tightly.

This sample will be filtered later and the bottle will be reused at future sites, therefore it is not necessary to label this bottle. Place the sample bottle in a cooler with ice to store until processing, or if the cooler is not available, keep cool in stream water.

7.3.1.2 Periphyton Chlorophyll-a and Identification

1. Starting at the bottom of the reach, collect a single sample from the assigned sampling station (Left, Center or Right) at each of 11 transects using the procedure below. The goal is to collect 11 equally spaced samples ending at the top of the reach.
    - A. Select the dominate substrate in the left, center or right part of the stream.
        - 1) Removable substrate (rock/wood).
            - i. Collect a sample of substrate (rock or wood) that is small enough (< 15 cm diameter) and can be easily removed from the water. Place the substrate in a plastic funnel which drains into a 500-mL plastic bottle with 45 mL volume graduations marked on it.
            - ii. Use the 2" diameter circular delimiter to define a 12-cm2 area on the upper surface of the substrate. Dislodge attached periphyton from the substrate within the delimiter into the funnel by brushing with a stiff-bristled toothbrush for 30 seconds. Take care to ensure that the upper surface of the substrate is the surface that is being scrubbed, and that the entire surface within the delimiter is scrubbed.
            - iii. Fill a wash bottle with river water. Using water from this bottle, wash the dislodged periphyton from the funnel into the 500-mL bottle to bring the composite bottle volume up to approximately 45 mL for that transect or up to the next graduation mark on the bottle.
        - 2) Substrate that cannot be removed (large boulders/trees)

i. For substrate that cannot be removed, use the delimiter to mark the area. Use the toothbrush to scrub the surface within the delimiter and carefully use the squirt bottle and syringe to collect the rinsate.

3) If no coarse sediment (cobbles or larger) is present:

i. Use the area delimiter to confine a 12-cm^2 area of soft sediments.

ii. Vacuum the top 1 cm of sediments from within the delimited area into a de-tipped 60-mL syringe with a short length of tubing attached.

iii. Empty the syringe into the same 500-mL plastic bottle as above. If the volume of the vacuumed sediment is not enough to raise the composite volume to the next graduation on the bottle (~45 mL), add additional stream water to the bottle to raise the level to the next graduation.

B. Keep samples as cool and dark as possible. Use a portable cooler with ice if possible when moving between transects. (The samples need to be kept cool and dark because a chlorophyll sample will be filtered from the composite.)

2. Repeat Step 1 for 10 more transects alternating between the left center and right stations of the transect as you move up stream.

3. After samples have been collected from all 11 stations, thoroughly mix the 500-mL bottle regardless of substrate type. Record the total volume of the composite sample in the periphyton section of the SEM Form.

4. If all 11 samples are not collected, record the number of transects collected and reason for any missed collection on the field forms.

7.3.2 PROCESSING

7.3.2.1 Water Column Chlorophyll-a

1. Use clean forceps to place a Whatman GF/F 0.7 µm glass fiber filter in the graduated filter holder apparatus with the gridded/stippled side of the filter facing down.

2. Retrieve the 2 liter chlorophyll sample bottle from the cooler and shake the bottle to homogenize the sample. While filtering sample, keep the bottle in the cooler on ice.

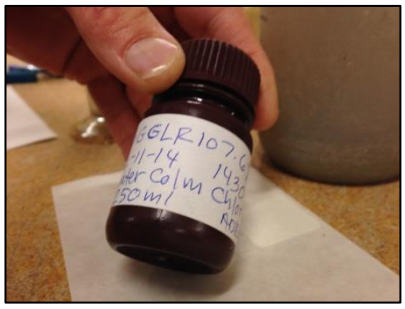
3. Measure 250 mL of water with a graduated cylinder and pour into the filter holder, and use the vacuum pump to draw the sample through the filter (do not exceed 7 inches of Hg). If 250 mL of site water will not pass through the filter, change the filter, rinse the apparatus with DI water, and repeat the procedures using 100-mL of site water.

If the water is green or turbid, use a smaller volume to start with.

4. Observe the filter for visible color. If there is visible color, proceed; if not, repeat steps 3 & 4 until color is visible on the filter or until a maximum of 2,000 mL have been filtered. Record the actual sample volume filtered on the field sheet and sample label.
5. Rinse the upper portion of the filtration apparatus and graduated cylinder thoroughly with DI water to include any remaining cells adhering to the sides and pump through the filter.

Monitor the level of water in the lower chamber to ensure that it does not contact the filter or flow into the pump. Remove the bottom portion of the apparatus and pour off the water from the bottom as often as needed.

6. Remove filter funnel from base without disturbing filter.
7. Remove the filter from the holder with clean forceps. Avoid touching the colored portion of the filter. Fold the filter in half, with the colored side folded in on itself.
8 Place the folded filter into 30 mL screw-top amber bottle. Tighten the cap. Failure to tighten the lid completely could allow water to infiltrate into the sample and may compromise its integrity.
9. Record the sample information and volume filtered on a chlorophyll label and attach it to the bottle as indicated below. Ensure that all written information is complete and legible. Cover with a strip of clear tape.



CLGLR010.53
1430
04/24/14
Water Column Chlor-a
ADEQ
PHS
Vol Filtered = 250 mL

10. Place in a self-sealing plastic bag. Place this bag on wet ice.

7.3.2.2 Periphyton ID

1. Thoroughly mix the bottle containing the composite sample.
2. Immediately after mixing, withdraw 250 mL of the mixed sample into the graduated cylinder and place the contents into a 250 mL sample bottle.
3. Use a syringe or bulb pipette to add 2ml of lugol solution to preserve the sample. Continue to add by dropperful until a weak tea color is obtained. Cap the tube tightly and seal with plastic electrical tape. Tighten the cap.
4. Shake gently to distribute preservative.

7.3.2.3 Periphyton Chlorophyll-a

Prepare the periphyton chlorophyll-a sample by filtering a 25-mL aliquot of the composite index sample through a 47 mm 0.7 micron GF/F glass fiber filter. Chlorophyll-a can degrade rapidly

when exposed to bright light. If possible, prepare the samples in subdued light (or shade), filtering as quickly as possible after collection to minimize degradation.

If you are reusing a filtration chamber from a previous site, you should rinse it with DI water each day before use at the base site and then seal in a plastic bag until needed at the stream. Keep the glass fiber filters in a sealed plastic bag until needed.

1. Using clean forceps, place a Whatman GF/F 0.7 µm glass fiber filter on the filter holder, gridded/stippled side down. If needed, use a small amount of deionized water from a wash bottle to help settle the filter properly. Attach the filter funnel to the filter holder and filter chamber, and then attach the vacuum pump to the filter flask.
2. Rinse the sides of the filter funnel and the filter with a small volume of deionized water.
3. Rinse a 25-mL or 50-mL graduated cylinder three times with small volumes of deionized water and discard.
4. Mix the composite sample bottle thoroughly.
5. Measure 25 mL (±1 mL) of sample into the graduated cylinder.

For a composite sample containing fine sediment, allow grit to settle for 10 - 20 seconds before pouring the sample into the graduated cylinder.

6. Pour the 25-mL aliquot into the filter funnel and pull the sample through the filter using the vacuum pump. Vacuum pressure from the pump should not exceed 7 inches of Hg to avoid rupture of fragile algal cells.

If 25 mL of sample will not pass through the filter, discard the filter and rinse the chamber thoroughly with deionized water. Collect a new sample using 10 mL of sample, measured to ±1 mL. Be sure to record the actual volume sampled on the sample label and the Field Form.

7. Monitor the level of water in the lower chamber to ensure that it does not contact the filter or flow into the pump. Remove the bottom portion of the apparatus and pour off the water from the bottom as often as needed.
8. Remove the filter chamber from the filter holder being careful not to disturb the filter. Remove the filter from the holder with clean forceps. Avoid touching the colored portion of the filter. Fold the filter in half, with the colored sample (filtrate) side folded in on itself. Place the folded filter in a 30 mL amber bottle and tighten the cap.
9. Prepare a sample label with the Site ID, time, date, analysis, agency, your initials, and volume filtered as in the following example. Cover the label with a strip of clear tape.

CLGLR010.53
1430
04/24/14
Periphyton Chl a
ADEQ
PHS

Vol Filtered = 25 mL

11. Place the 30mL amber sample bottle into a self-sealing plastic bag.
12. Record the volume filtered on the field form. Double check that the volume recorded on the collection form matches the total volume recorded on the sample label.
13. Place the amber bottle containing the filter on wet ice.

7.4 HABITAT ASSESSMENTS

The habitat assessment provides ecological information needed to interpret macroinvertebrate bioassessments and bottom deposits. Habitat and chemistry data provide an ecological context in which to place the macroinvertebrate data. Causes and sources of biological impairment can be identified using chemical, physical, biological and land use information produced in the habitat assessment.

Filling out habitat forms requires a little bit of homework. Elevation, watershed area, predicted cross-sectional area, valley type, slope, stream order, estimated floodprone width and sinuosity (SEM Form Section 2.1 and 2.5) should be determined before going into the field so that the Rosgen "Stream Type" can be accurately determined.

The following sections follow the Stream Ecosystem Monitoring form except for the first several pages of the form, which match the Ambient stream monitoring form used during 'chemistry only' surveys, which occur during the summer, fall and winter quarters. Additional information for these sections can be found in the previous chapters.

7.4.1 STREAM TYPE IDENTIFICATION

Determining the Rosgen stream type requires several measurements to be collected including slope, valley type, watershed area, predicted cross-sectional area, sinuosity and stream order. Slope and sinuosity are used directly in determining the stream type (FIGURE 7.10). The other fields are used to make sure that the stream type you came up with is correct.

The watershed area can be determined by using a GIS watershed delineation program or using the value in the water quality database. See Appendix C to calculate watershed area using GIS. Use FIGURE 7.5 to determine the cross-section area based on the size of the watershed. Indicate which regional curve is used (FIGURE 7.4). Slope should be obtained directly using field measurements rather than using topos map, which can be inaccurate (Se Section 7.4.3.7).

2.1 STREAM TYPE IDENTIFICATION (OFFICE MEASUREMENTS)			
Elevation (ft)		Sinuosity	
Watershed Area (mi^2):		Stream Order	
Predicted Cross-section Area (ft^2)		Which Regional Curve Used?	☐ M Gila, Salt (lower), Santa Cruz, Verde, San Pedro ☐ U Gila, LCR, Salt (upper)
Floodprone width (ft)		Map printed showing flood prone width and depositional features (must have scale)	☐ Check if done

FIGURE 7.4. SEM Form. Stream Type Identification.

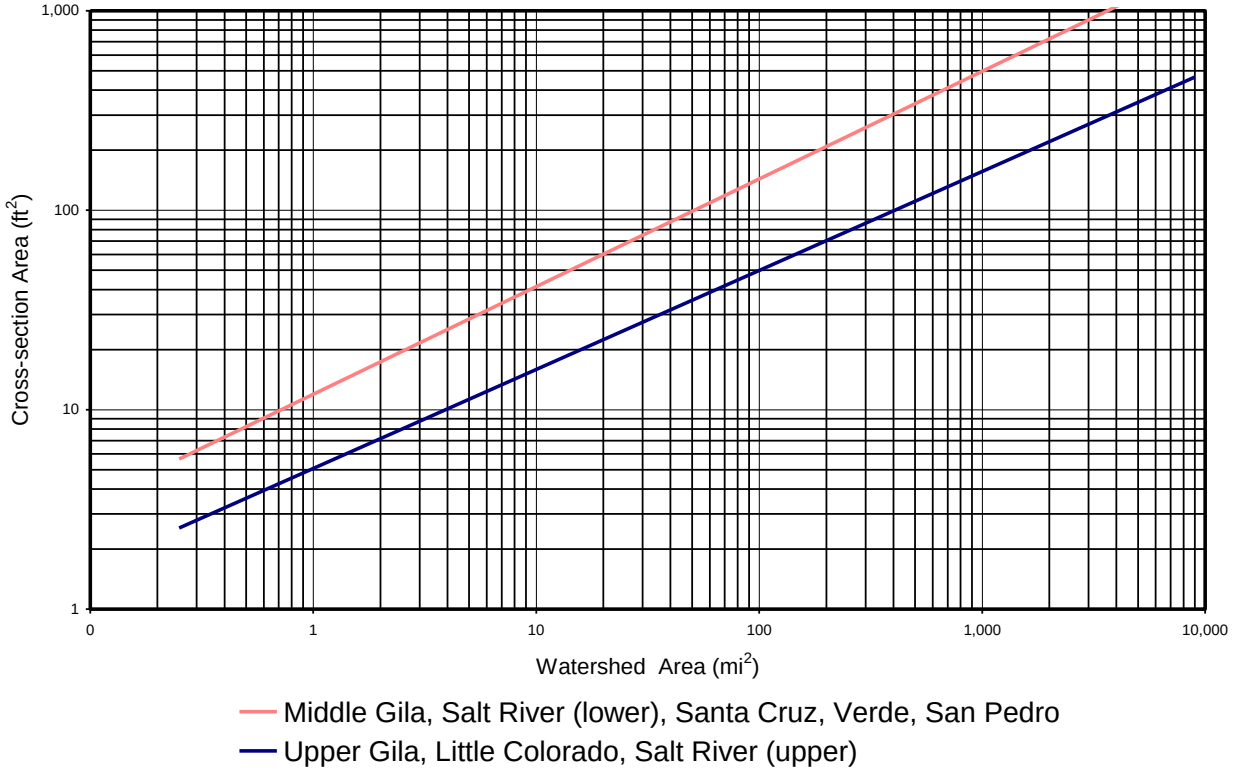


FIGURE 7.5. Cross-sectional area based on watershed size (Moody et al., 2003).

7.4.2 REACH LENGTH AND COMPLEXITY

7.4.2.1 Reach Length

Determine reach length by:

1. Take at least three representative wetted width measurements.
2. Average the stream width measurements.
3. Multiply the average stream width by 40 to get the total reach length (FIGURE 7.6).

2.2 REACH LENGTH								
REACH LENGTH = AVERAGE WETTED WIDTH * 40. MINIMUM REACH = 300 FT. MAXIMUM = 3,000 FT.								
Width 1		Width 2		Width 3		Average		* 40 =
						Reach Length		ft
Top of Reach	Latitude	.			Longitude	-	.	
Bottom of Reach	Latitude	.			Longitude	-	.	

FIGURE 7.6. SEM Form. Reach length.

4. Record the latitude and longitude in NAD 83 and in decimal degrees.

7.4.2.2 Reach Complexity & Flow Regime

7.4.2.2.1 Reach Complexity

Pace off the reach and note the length of the pools, riffle and run habitats. (FIGURE 7.7). Walk along the streambank closely following the contour of the channel.

To determine how many feet are in your specific pace, lay out at least 100 feet of tape and count the number of paces it takes you to walk 100 feet. 100 divided by the number of paces equals the number of feet in your pace.

2.3 REACH COMPLEXITY		
Habitat	Number of ☐ Paces, ☐ feet, ☐ meters	Total
Pool		
Riffle		
Run		
	Riffle / Pool Ratio =	
	My Pace =	to a foot

FIGURE 7.7. Reach complexity.

7.4.3 MEASUREMENTS FOR DETERMINING STREAM TYPE

Rosgen (1994) developed a stream type classification system which provides a basic understanding of channel processes. The stream type must be identified prior to collecting other measurements for the stream stability assessment, such as depositional pattern, Pfankuch channel stability rating and stream type evolutionary scenario (FIGURE 7.8).

If bank-pins and cross-sections have already been done for you site then take the measurements at the same location. Check the site file for this information.

2.6 STREAM TYPE MEASUREMENTS (FIELD MEASUREMENTS)				
Measurement	Comment/Cal	X Section 1	X Section 2	Bankfull Indicators Used
Bankfull Width				☐ Top of point bars
Bankfull Max. Depth	At thalweg			☐ Change in particle size
Correction Factor	Determined by X-section type			☐ Slope break
Bankfull Mean Depth	= (BF Max Depth) * (Correction Factor)			☐ Vegetation line
Cross-sectional Area	= (BF Mean Depth) * (BF Width)			☐ Undercut banks
2 times BF Max Depth	= (2*BF Max Depth)			☐ Presence of a floodplain at the elevation of incipient flooding
Floodprone Width	Measure width at 2 * BF Max Depth (Note if estimated)			☐ Is flood debris above bankfull elevation? (if so, document cross-sectional area.)
Entrenchment Ratio	= (Floodprone width) / (BF Width)			Valley Type
Width / Depth Ratio	= (BF Width) / (BF Mean Depth)			☐ I ☐ II ☐ III ☐ IV ☐ VI ☐ VIII
STREAM TYPE =				

FIGURE 7.8. SEM Form. Measurements for Determining Stream Type

The following information is needed to determine Stream Type:

- Entrenchment ratio (floodprone width/bankfull width) (determined in the field). For larger streams it is better to estimate floodprone width in the office using GIS.
- Bankfull width/bankfull mean depth ratio (determined in the field)
- Sinuosity. Use FIGURE 7.9 to estimate sinuosity (determined at the office) or calculate using a simple ratio of stream distance between two points which are 2 meander lengths apart, to straight line distance between those two points, as measured in GIS or on a topo map.

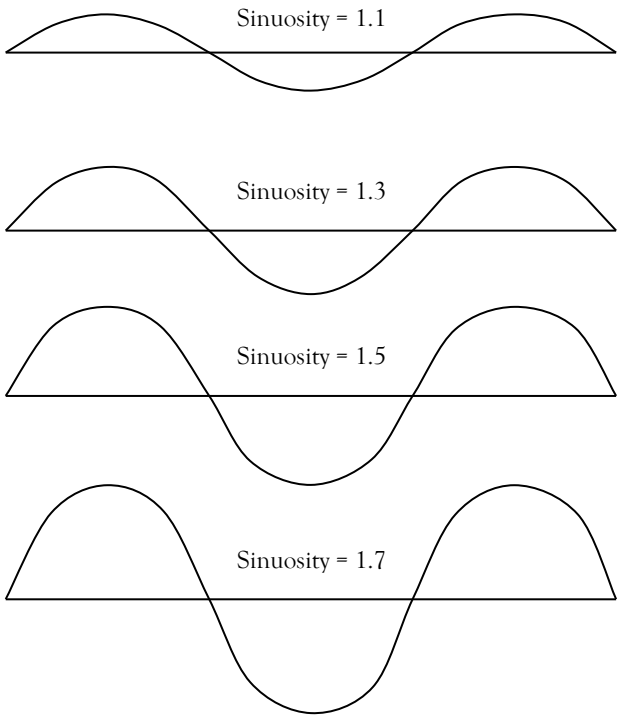


FIGURE 7.9. Classes of sinuosity of a stream channel.

- Reach slope. Percent slope = [Change in Elevation (ft)/ Distance of Reach (ft)] *100 (determined at the office)
- Channel bed material, median particle diameter (D50) (determined in the field)

The following sections will explain how to calculate each of these metrics and explain how to determine stream type. Fill in the values in the "Stream Type Measurements" on the SEM form. After completing this section you will be able to use FIGURE 7.10 to determine the stream type and FIGURE 7.5 to determine how close the stream reach is with respect to the regional curve.

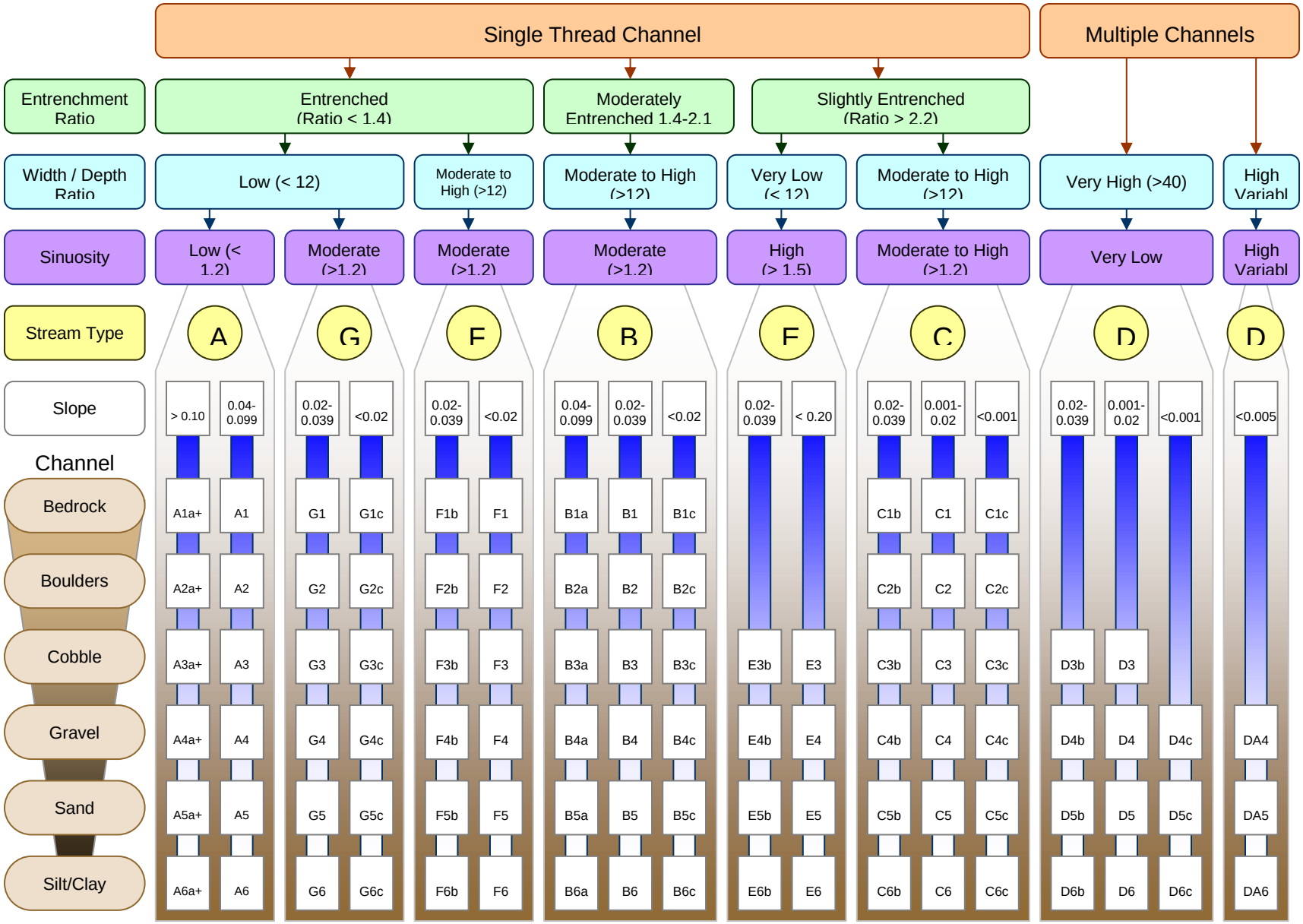


FIGURE 7.10. A Key for Rosgen Stream Type Classification (Rosgen, 1996).

7.4.3.1 Determining Bankfull Width

Rosgen's classification system for identifying different channel types is based on a common frame of reference among all streams; the bankfull elevation.

The bankfull stage is the elevation at which incipient flooding occurs; that is the point at which stream flow overtops the natural channel banks and spreads across the floodplain.

Evidence from a large number of rivers suggests that these flows are frequent, moderate sized flows with a typical return interval of 1-2 years and that they represent the channel forming or maintenance flows. Similar return intervals were empirically identified for Arizona streams, where the range of return intervals for over 30 gauged stations was determined to be 1.1 – 1.8 years (Moody and Odem, 1999).

The bankfull discharge is also equivalent to the "effective discharge"; the flow which transports the greatest volume of sediment over time. Though very high flows can move significant amounts of material, they occur infrequently and therefore transport only a small fraction of the total sediment volume over time. However, frequent moderate flood events typically carry the greatest amount of sediment; thus the bankfull flow is the most common channel shaping flow. The bankfull elevation must be consistently identified in the field in order to correctly identify the stream type. The stream type depends on measurements of bankfull width/depth ratio and entrenchment ratio which are dependant upon measurements of the bankfull stage.

Field Procedure for Identifying Bankfull without a Laser Level

1. Walk a stream reach of a minimum of two meander lengths or 40 times the wetted width and look for bankfull indicators, such as:
   - topographic breaks in slope
   - tops of point bars
   - changes in vegetation
   - changes in size of bank or bar materials
   - evidence of an inundation feature such as small benches
   - the presence of a floodplain
   - exposed root hairs below an intact soil layer indicating exposure to erosive flow
   - bank undercuts.

Vegetation is usually not a good bankfull indicator and must be used with caution. At high elevations, an ash tree or willow tree line may at times be useful; however, a grass or seep willow line at any elevation is not.

FIGURE 7.11. Left: Bankfull identified by tape measurer at slope break. Right: Multiple bankfull indicators (change in particle size, top of point bar, slope break).

2. Place stake flags, pieces of flagging, or other marking devices on the identified points along the reach where bankfull indicators are present. If bankfull stage has been properly identified, the stake flags should delineate a line identifying bankfull depth.
3. Stretch the tape measure across the stream channel using at a riffle where the bankfull indicators are good. Make sure the tape is level. Avoid taking bankfull widths on meanders.
4. Repeat steps 2 and 3 at a second riffle.

7.4.3.2 Bankfull Maximum Depth

1. Measure the distance from the bottom of the stream (in the thalweg) to the top of the tape using a stadia rod (FIGURE 7.12).

Alternately, the sampler may also use a clinometer to sight to the pole assuming that the clinometer is level with bankfull.

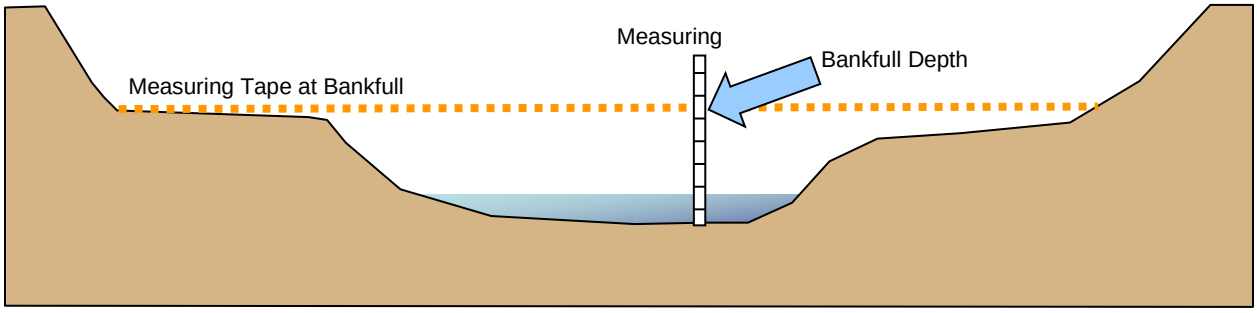


FIGURE 7.12. Measuring bankfull depth.

7.4.3.3 Correction Factors

Correction factors can vary from about 0.4 to 0.8 depending on the shape of the stream's cross-section. TABLE 7.1 provides common cross-sections and their corresponding correction factors.

0.6 is the average coefficient for all streams.

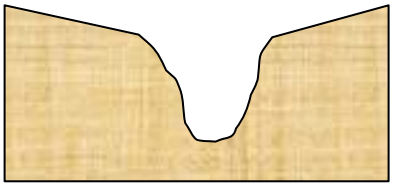
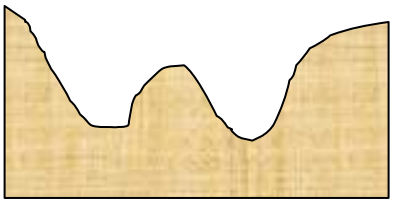
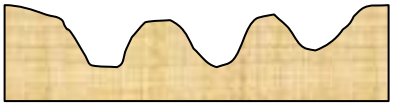
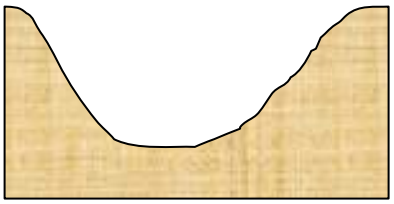
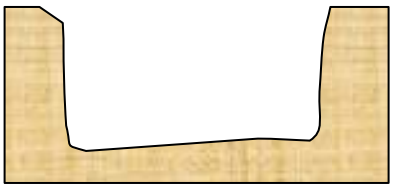
Type	Cross-section	Correction Factor
Triangular		0.5
Skewed		0.5
Bimodal		0.5
Multi-modal		0.35
Basin shaped		0.67
Nearly rectangular		0.75

TABLE 7.1. Correction factors based on cross-section type (Lawson, unpublished data, 2008).

7.4.3.4 Field Bankfull Mean Depth

Mean depth is calculated by multiplying the bankfull maximum depth by the appropriate coefficient in TABLE 7.1.

7.4.3.5 Cross-Sectional Area

Multiply "mean depth" times average "bankfull width" to obtain the cross-sectional area.

7.4.3.6 Floodprone width

The flood prone width is located at an elevation that is 2 times the maximum bankfull depth (FIGURE 7.13). You may need to estimate the distance for larger systems.

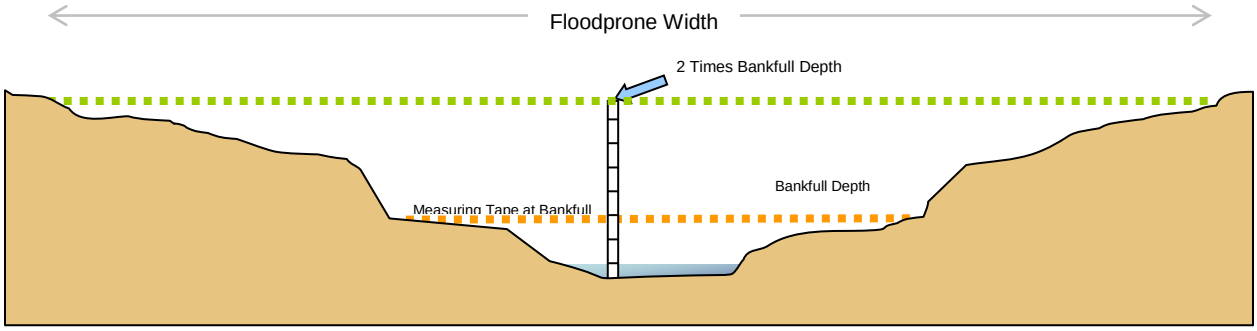


FIGURE 7.13. Floodprone is represented by the green dotted line and the width of the channel at 2 times bankfull depth.

7.4.3.7 Determine Slope

1. Determine the reach length (average wetted width *40) and mark off the top and bottom of the reach using flagging.
2. Position the tripod on the bank with an unobstructed view of as much of the reach as possible.
3. Make sure the tripod legs are set firmly in the ground and level the base plate.
4. Attach the transit level (FIGURE 7.13.A) to the tripod, adjusting the leveling screws as necessary until the bubble is centered.
5. Adjust the focus and brightness to the user's preference.
6. Staff person #1 holds the stadia rod at the water's surface at one end of the reach. Keep the stadia rod as vertical as possible with the numbers facing the transit level.

FIGURE 7.13.A. Transit level

7. Staff person # 2 then sites through the transit level and records the measurement to the nearest centimeter on scrap paper.
8. Collect a measurement at the other end of the reach and repeat steps 5 and 6.
9. Calculate the % Slope: **((Elevation at the top of the reach - Elevation at the bottom of the reach)/Length of the reach)*100**, and add the value to the data sheet.

Back sighting might be necessary if you are unable to sight the entire reach. In this case collect a measurement at the furthest point upstream that can be read using the transit level. Have the staff person remain at that spot holding the stadia rod, while the other staff person moves the transit level and tripod to a new location. Then collect the back sighting measurement and subtract the value from the last recorded value. Continue with steps 5 and 6.

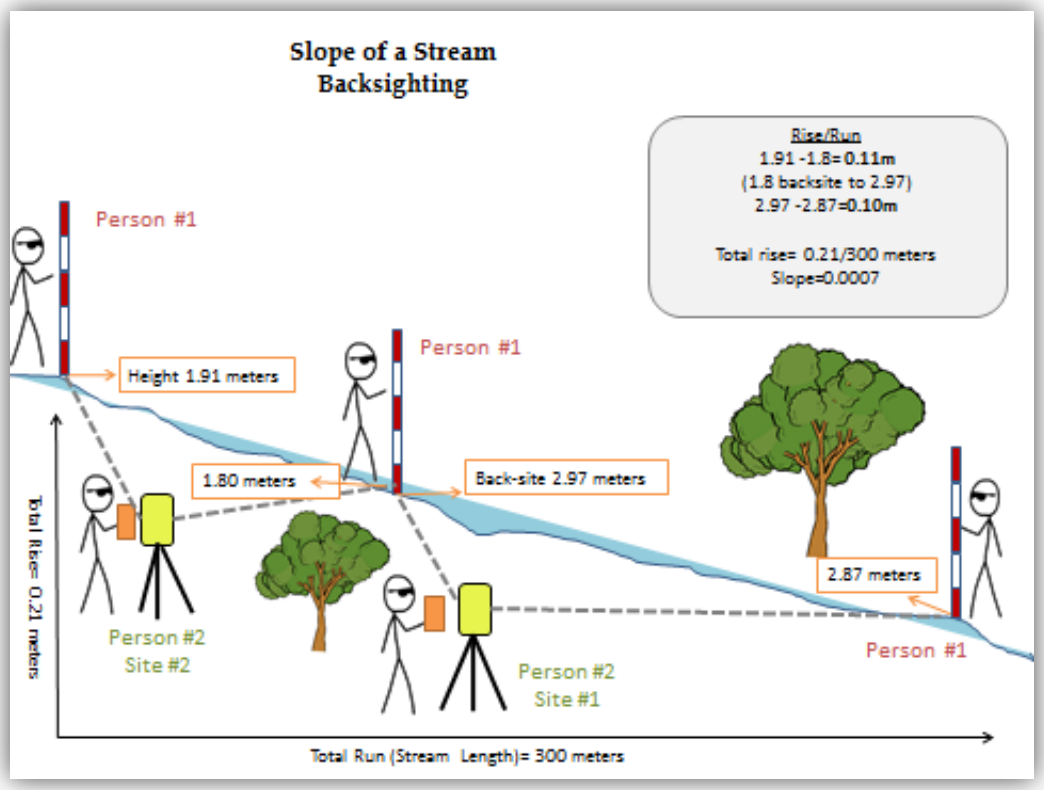


FIGURE 7.13.B. Backsighting example.

7.4.3.8 Determining Stream Type

1. Compare the field calculated cross-section value against the appropriate regional curve value. The field value should be similar or close to the predicted value. If the field value is very dissimilar from the predicted value then reexamine the measurements and bankfull identification. Typical explanations are an incorrect bankfull depth, a water diversion, or an impoundment in the watershed. If the issue cannot be resolved, use the field observed bankfull indicators to obtain cross-sectional area.
2. Use the Rosgen classification chart (FIGURE 7.10) to identify the stream type.
   a. **Entrenchment Ratio** is calculated by dividing floodprone width by bankfull width.
   b. **Bankfull width/depth ratio** is calculated by dividing bankfull width by bankfull mean depth.
   c. **Sinuosity** can be calculated from a topographical map or aerial photo for the study reach. Sinuosity can also be estimated by using FIGURE 7.9.
   d. Calculate **slope** in the field using a transit level according to Section 7.4.3.7.

      ((Elevation at the top of the reach - Elevation at the bottom of the reach)/Length of the reach)*100

e. The median particle size (D50) can be determined from the reach pebble count cumulative percent data or from a graph of the cumulative percent by particle size class.

3. Determine **stream type** by using Rosgen's classification chart (FIGURE 7.10) and the five classification variables.

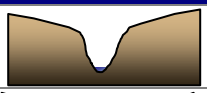
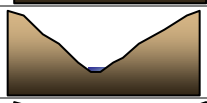
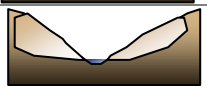
The classification system scheme sorts fluvial streams into broad stream types A through G, representing the following categories:

A – Headwater
B – Intermediate
C – Meandering alluvial
E – Meandering alluvial with high sinuosity and low w/d ratio
D – Braided
F – Entrenched
G – Gully

These broad categories are further refined by the addition of slope ranges and median particle size to produce 41 categories of stream types which are described and photographed in detail in Rosgen (1996).

7.4.3.9 Determining Valley Type

Rosgen delineated eleven valley types and associated them with stream types (TABLE 7.2). Valley Types V, VII, X, and XI are unlikely to be found in Arizona and are not listed. For a discussion of valley types, see Rosgen (1996), Chapter 4.

Valley Type	Environment	Geomorphic Characteristics	Profile	Stream Type	
				Dominant	Other
I	Rugged mountains	Narrow valleys		A,G	
II	Less rugged mountains	Narrow valleys		B	G
III	Broad valleys in mountains	Incised upland rivers with alluvial fans at confluence		A,B,G,D	
IV	Gorges, canyons & confined alluvial valleys	Confined alluvial valleys		F	C
VI	Fault line valleys			B	C,F

Valley Type	Environment	Geomorphic Characteristics	Profile	Stream Type	
				Dominant	Other
VIII	Developed floodplains	Alluvial terraces and floodplains		C,E	D,F,G
IX	Dune plains			C,D	

TABLE 7.2. Valley types and their associated stream types (Rosgen, 1996).

7.4.4 REACH OBSERVATIONS

7.4.4.1 Reach Habitat Quality

Knowing the habitats present and their abundance assists with conducting the habitat assessment at the end of the survey. Note whether cobble, undercut banks, etc. are absent, rare, common, or abundant in the wetted width of the stream channel throughout the reach (FIGURE 7.15).

Absent = None present.
Rare = Some present, but not very much.
Common = Moderate amount present
Abundant = Dominant throughout reach.

2.4 REACH HABITAT QUALITY				
Reach length equals 2 meander lengths or 20-30 times bankfull width of the stream. Use a minimum 300-feet reach to identify habitat types for large streams or rivers.				
Undercut banks	Absent ☐;	Rare ☐;	Common ☐;	Abundant ☐
Leaf packs	Absent ☐;	Rare ☐;	Common ☐;	Abundant ☐
Root masses	Absent ☐;	Rare ☐;	Common ☐;	Abundant ☐
Submerged logs / snares	Absent ☐;	Rare ☐;	Common ☐;	Abundant ☐

FIGURE 7.15. SEM Form. Habitat Quality.

7.4.5 DEPOSITIONAL FEATURES

Channel changes due to floods, direct disturbances, change in riparian vegetation or flow regime are reflected in depositional features in streams. Excess sediment deposits are an indicator of imbalance in the channel or its watershed. For the depositional features parameter, mark all categories that apply to the stream channel within the study reach. Keep in mind that Rosgen A and B type streams are usually without depositional features.

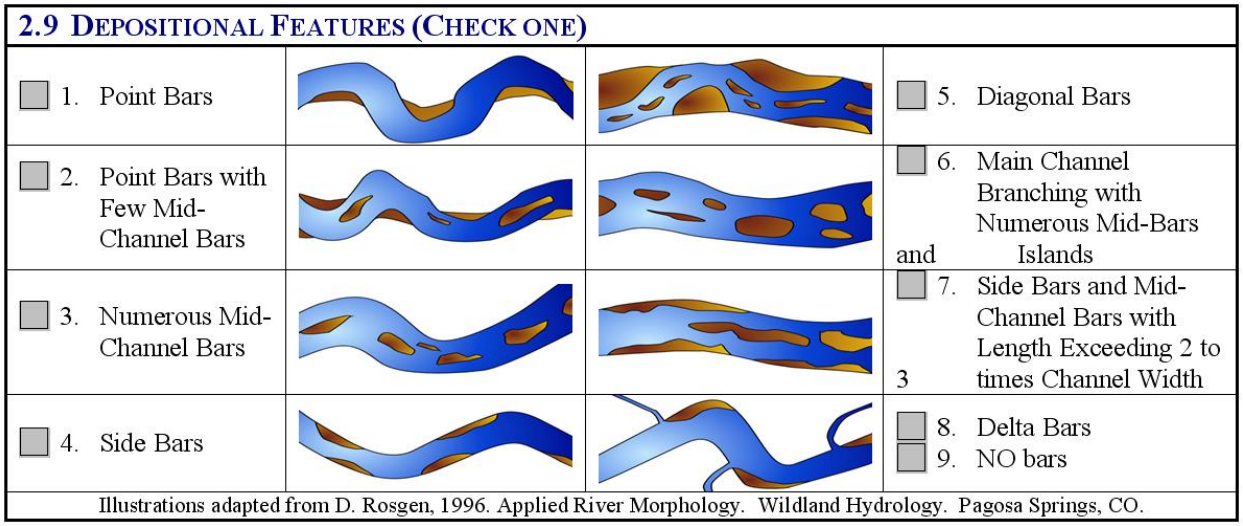


FIGURE 7.16. SEM Form. Depositional Features.

A bar is defined as a submerged or exposed accumulation of sand, gravel, or other alluvial material formed within an active channel, along the banks, or at the terminus of a stream where a decrease in velocity induces deposition.

- A point bar is found on the inside of meander bends.
- Diagonal bars form diagonally to a stream channel, and may extend completely across the channel.
- Mid-channel bars form in the mid-channel zone and do not extend completely across the channel.
- Islands are exposed bars or land segments within the stream channel that are relatively stable and normally surrounded by water.
- A side bar (or lateral bar) is located at the side of a stream channel, usually associated with the inside of slight curves.
- Delta bars are formed immediately downstream of the confluence of a tributary and the main stream (Armantrout, 1998).

7.4.7 PEBBLE COUNTS

Pebble counts measure the range of particle sizes in a wadeable perennial stream. Excess sediment can have adverse affects on the habitation, growth and propagation of aquatic life. ADEQ has adopted a narrative standard (R18–11-108.02) for bottom deposits which is determined by measuring stream bottom particles or "pebbles" in a systematic way to obtain a value for percent fine sediment in the streambed. Implementation procedures for bottom deposits have also been developed (ADEQ, 2013a).

The elevation or the applicable designated use of the stream must be known in order to choose the right pebble count procedure. TABLE 7.3 has the bottom deposit standard for warm and coldwater streams. The standard is exceeded when a cold water stream has more than 30% fines and a warmwater stream has more than 50% fines..

Designated Use	Elevation	Exceedance of the Bottom Deposit Criterion (% of fine sediment <2mm)	Pebble Count Procedure to Use
A&Wc	>5000 ft	> 30 %	Riffle & Reach (Section 7.4.7.1 and 7.4.7.2)
A&Ww	<5000 ft	> 50 %	Reach (Section (7.4.7.2)

TABLE 7.3. Pebble count standards and appropriate procedures.

The riffle pebble count is collected to identify the percent fines within the riffle habitat in cold water streams where macroinvertebrate collections occur. In other words, it is a procedure for characterizing particle size distributions of riffle habitats of a study reach. The reachwide pebble count is used to identify the percent fines in all habitats of a warmwater stream, but also to identify the Rosgen Stream Type in both cold and warmwater streams. The percent fines data is used to evaluate whether a bimodal particle size distribution exists and to determine the amount of fine sediment in the substrate, affecting colonization space for aquatic life. The data is also used to determine whether changes in the substrate are occurring over time.

7.4.7.1 Riffle Pebble Count

The riffle pebble count is conducted in three riffles and is a modified version of the Wolman pebble count (Leopold, et al. 1964). The purpose of the riffle pebble count is to calculate percent fines sediment in riffles and evaluate whether a bimodal particle size distribution exists. The ADEQ riffle pebble count consists of measuring particles at equal increments across multiple transects within the wetted width of riffle habitats where the macroinvertebrates were collected. The count objective is 100 particles.

Riffle pebble counts are only required for coldwater streams (stream > 5,000 feet in elevation.

Riffle Pebble Count Procedure

1. Establish the study reach (see Section 7.1). Pebble count measurements will be collected along three transects/riffles where the macroinvertebrates were collected. Begin work at the most downstream transect and move in an upstream direction to the midstream and upstream transects.
2. Divide the stream width by thirty-three to obtain the increment needed to collect thirty-three particles across the transect in a single pass. Do not collect particles closer than 0.3 tenths of a foot apart.

Sand will feel gritty while silt and clay will feel smooth or slick.

If thirty-three particles cannot be collected in one pass along the transect, make a second or third pass as close as possible to the transect, and work in an upstream direction without working the same area.

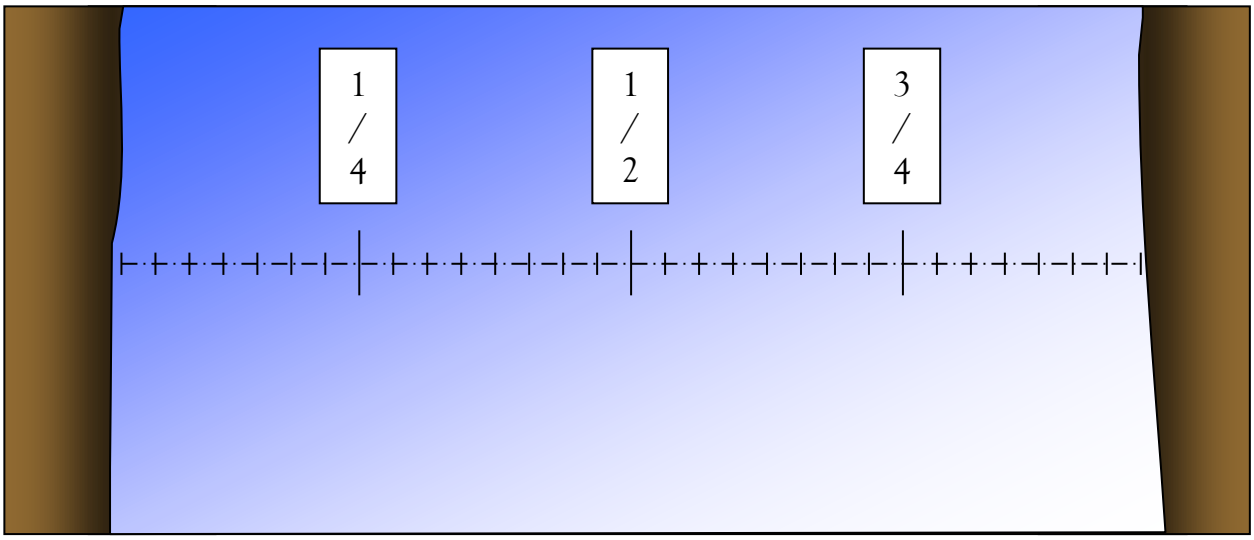


FIGURE 7.18. Visual representation of stream divided into 1/4, 1/2, and 3/4 segments.

A measuring tape may be used to divide the stream into 33 equal increments. It is quicker and just as representative to visually divide the stream into quarter segments. Pick 8 pebbles from each quarter. The 8 pebbles should be equally spaced and should be at least 4 inches apart (FIGURE 7.18).

3. Use the tip of your boot or a pointer to take a particle reading. Extend the forefinger, and without looking down, pick up the first pebble touched, and measure the intermediate axis in millimeters (FIGURE 7.19). The intermediate axis is neither the longer nor shorter of the three perpendicular sides. Determine the Size Range from the Field Data Sheet and record the tally (FIGURE 7.20). For embedded or very heavy rocks, measure them in place by measuring the smaller of the two exposed axes.

There is a tendency to look down and select a pebble, but this should be avoided or the results will be biased toward larger particle sizes.

4. Discard the measured pebble downstream, move to the next station, and repeat step 3.
5. Continue working across the transect from wetted edge to wetted edge of the streambed (FIGURE 7.21). After completing the first thirty-three measurements at this transect, move upstream to the next transect, and repeat the process.
6. Once the count has been completed, and before leaving the stream, sum the tallies to ensure that the goal of 100 particles have been counted.
7. Estimate the embeddedness of all the particles in the transect and record the percentage on the field form. In other words, gravel, cobble, and boulder particles are

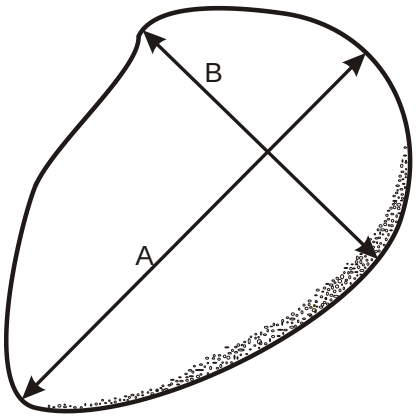


FIGURE 7.19. Axes of pebble. A = Longest Axis (length). B = Intermediate Axis (width). Thickness = Shortest Axis

surrounded by what percentage of fine sediment? This value will be used in the Habitat Assessment (Section 7.4.18).

Bedrock is always counted as 0% embedded; Silt/clay and sand are counted as 100% embedded.

Instructions: Tally 100-pebbles in riffle habitat only. Measure particles at equal increments across 3 transects within the wetted width throughout the reach. A reachwide and transect/riffle pebble count is required for coldwater streams.

2.9 COLDWATER - TRANSECT PEBBLE COUNT			
Size Class	**Size (mm)**	**Tally**	**Count**
Silt/Clay	<0.062		
Sand	0.063 – 2.0		
Very Fine Gravel	3 – 4		
Fine Gravel	5 – 8		
Medium Gravel	9 – 16		
Coarse Gravel	17 – 32		
Very Course Gravel	33 – 64		
Small Cobble	65 – 90		
Medium Cobble	91 – 128		
Large Cobble	129 – 180		
Very Large Cobble	181 – 256		
Small Boulder	257 – 512		
Medium Boulder	513 – 1024		
Large Boulder	1025 – 2048		
Very Large Boulder	2049 – 4096		
Bedrock	>4097		
Attach separate sheet or the "Pebble Count" Excel spreadsheet to summarize and calculate pebble count metrics.			

2.10 EMBEDDEDNESS	
Use a Visual Estimate Only for riffle embeddedness. The visual estimate is used to fill out the Habitat	
Gravel, cobble and boulders are surrounded by how much fine sediment in the riffles? (Check One)	
☐ 0 – 25 %	
☐ 26 – 50 %	
☐ 51-75 %	
☐ 76-100 %	
Riffle D100	

FIGURE 7.20. SEM Form. Transect/Riffle pebble count form.

7.4.7.2 Reachwide Pebble Count

A distilled version of the Zigzag Pebble Count Method (Bevenger and King, 1995) is presented below. This count is a direct measure of the median particle size for the entire reach.

FIGURE 7.21. Pebble count.

Reachwide Pebble Count Procedure

1. Pace off the study reach (see Section 7.1). Stay as close to the streambank as possible. Laying out the reach should be done in conjunction with the "Reach Complexity" section. Flagging should be used to ensure that 100 pebbles are sampled evenly throughout the reach. Dividing the in half, quarters or tenths

will enable the samplers to assess if they are on track with their pebble counts.

2. Randomly choose a starting spot by looking at the second hand of your watch (TABLE 7.4)

Seconds	Sampling Location
1 & 6	LEW
2 & 7	1/4
3 & 8	1/2
4 & 9	3/4
5 & 0	REW

TABLE 7.4. Use the last digit on your watch to randomly choose the beginning point for the 5 point method.

3. Take the total number of paces (ie. reach length) obtained from step 1 and divide it by 100. This will give you the number of paces that need to be walked for each of the 100 pebbles that will be sampled. For example, if your reach is 350 paces long then you will need to count a pebble every 3.5 paces. This works best if the recorder paces along side the sampler so that the sampler has a point of reference as they are zigzagging across the stream.
4. Begin sampling the reach as diagramed in FIGURE 7.22. Use the tip of your boot or a pointer to take a particle reading. Extend the forefinger, and without looking down, pick up the first pebble touched, and measure the intermediate axis in millimeters (FIGURE 7.19). The intermediate axis is neither the longer nor shorter of the three perpendicular sides. Determine the Size Range from the Field Data Sheet and record the tally. For embedded or very heavy rocks, measure them in place by measuring the smaller of the two exposed axes. Discard the measured pebble downstream.

   Make a visual estimate of what percent of the particle is embedded. Embeddedness is the percent of a particle surrounded by sand, silt and other small particles. **Bedrock is always counted as 0% embedded; Silt/clay and sand are counted as 100% embedded.**
5. At the same spot where you measured the pebble, also note the type of macrophyte or algae species present for each of the 100 pebble count locations. Identify the plant type, using the list provided on the field form (FIGURE 7.28) and the field plant ID guide (Jones, 2011).
6. Record the tally on the reachwide pebble count field form, in consecutive order (FIGURE 7.25). Make sure to write values from left to right on each row because the number of runs, for calculating diversity, is dependent on the number of consecutive sightings of the same plant species. Mark your observations using the assigned code letters for each species (A = algae and M = Macrophyte).
7. After marking plant cover observations for the 100 stations along the reach length, calculate the percent plant cover. Count the number of macrophyte and algae observations / 100 to calculate plant cover % as follows:

$$C\% = (Np/Nt) \times 100$$

Where: C% = cover percent

Np = number of plants "points"
Nt = total number of points (=100)

This will give you a measurement of the percent cover of the stream bed by plants.

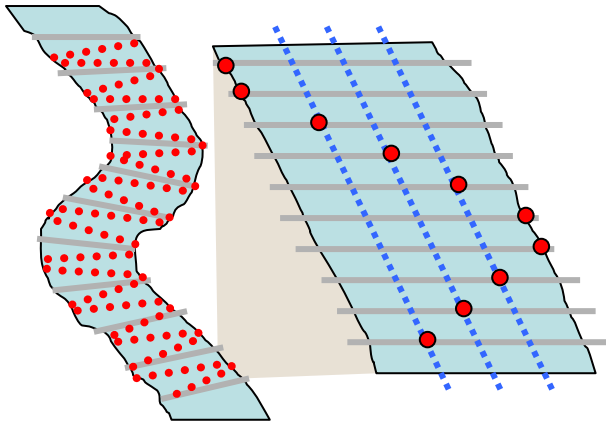


FIGURE 7.22. The reach wide pebble count. The stream is divided into 5 vertical segments and 20 lateral segments for a total pebble count of 100.

There is a tendency to look down and select a pebble, but this should be avoided or the results will be biased toward larger particle sizes.

8. Continue working up or down the reach until you reach the stream edge. Be sure to sample the edge twice as you zig zag through the stream (see FIGURE 7.22). This will ensure an equal representation of all sampling stations.
9. The pebble count tallies must be graphed to determine the D15, D50 (median particle size), and D84 classes (See Section 9.2, Post-trip procedures).

Parts of the reach may not be wadeable due to deep pools or fast flowing water. Do not collect a pebble count if more than 25% of the reach will have estimated values. Wade in as close to the specified location and either measure the size of the particle between your feet, take a visual estimate if you can see the particle, or jab the substrate with a pointer to estimate size class. If you cannot enter the pool, use your pointer to jab a particle at approximately 1m from the stream edge and estimate the size class. Record the number of estimated particles on the field form. Be sure to comment on the number of estimated particles in the EDAS database.

7.4.7.2.1 How to Calculate Number of Runs and Diversity

Aquatic plant diversity is a measure of both species richness and evenness of the species distribution in the study area. High abundance with low diversity is an indicator of nutrient stress. Using the algae/macrophyte observations recorded for the percent plant cover estimate (above), calculate the plant diversity using the Sequential Comparison Index (Cairns, et al., 1968).

1. Count the number of runs of each plant type present, including algae, macrophytes and fungal growths. Data will be organized by the number of "runs" or consecutive instances of

encountering the same plant in subsequent samples and counted as in this example, where X, Y, Z, C, A and O are different plant species and the numbers indicate number of runs:

XX O X OOOO YY Z A C AAA
1 2 3 4 5 6 7 8 9

2. Calculate the diversity using the following formula, where the number of runs is divided by the number of samples (total number of plant points observed).

DI = (number of runs) / (number of samples)

3. This formula will yield a number between zero and one. This number will then be compared to the following table:

Rating	Score
Poor	0 – 0.3
Fair	0.3 – 0.6
Good	0.6 – 1.0

Instructions: Tally 100-pebbles in throughout the reach using the 5 point or 9 point method. Don't include bedrock in the 100 count tally. Sand/Silt = High Embeddedness. Bedrock = 0. A reachwide and transect/riffle pebble count is required for coldwater streams.

2.14 REACHWIDE - (WARM AND COLDWATER STREAMS)

Size Class	Size (mm)	Reach	Riffle	Count
Silt/Clay	<0.062			
Sand	0.063 – 2.0			
Very Fine Gravel	3 – 4			
Fine Gravel	5 – 8			
Medium Gravel	9 – 16			
Coarse Gravel	17 – 32			
Very Course Gravel	33 – 64			
Small Cobble	65 – 90			
Medium Cobble	91 – 128			
Large Cobble	129 – 180			
Very Large Cobble	181 – 256			
Small Boulder	257 – 512			
Medium Boulder	513 – 1024			
Large Boulder	1025 – 2048			
Very Large Boulder	2049 – 4096			
Bedrock	>4097			
Estimated Tally	Enter D100 (Largest particle)	Reach D100	Riffle D100	

2.15 EMBEDDEDNESS

Category	Low	Med	High
Range	0 – 33	34 – 66	67 100
Tally	Mid-pt = 17	Mid-pt = 52	Mid-pt = 83
Reach			
Riffle			
A = Tally Sum by Class			
B = Class Mid-pt * A	17 * A	52 * A	83 * A
C = Sum of A across classes			
D = Sum of B across classes			
Mean Embeddedness = D/C			

Attach separate sheet or the "Pebble Count" Excel spreadsheet to summarize and calculate pebble count metrics.

2.16 PLANT ID (USE CODES IN 2.13)

1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32
33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56
57	58	59	60	61	62	63	64
65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88
89	90	91	92	93	94	95	96
97	98	99	100				

Algae Points		% Algae	
Plant Points		% Plant	
(a) # of runs		(b) Total Points	
(a/b) diversity			
Algae Richness / Macrophyte Richness		☐ Skewed sample	

FIGURE 7.23. SEM Form. Reachwide Pebble Count Forms.

7.4.8 RIFFLE GEOMETRY

Pace or measure off the length and width of the 3 riffles where bugs were collected (FIGURE 7.24). The width is from the wetted edge of one bank to the other. The length is measured from the beginning to the end of a riffle.

Pase or measure the riparian width at the same location where the riffle width was taken. Measure from the edge of the stream to the upland zone, which is the zone where riparian plants no longer make up 50% of the species. Note if the riparian width was estimated for larger river systems.

Calculate the length/width ratio by dividing the riffle length by the riffle width.

2.11 RIFFLE GEOMETRY (USE RIFFLES WHERE BUGS COLLECTED)

Riffle #	Length	Width	Riparian Width (left bank)	Riparian Width (right bank)	Length / Width Ratio
1					
2					
3					
		Average length / Width Ratio			
		☐ Paces, ☐ feet, or ☐ meters			

FIGURE 7.24. Riffle geometry.

7.4.9 CANOPY DENSITY

Percent canopy density is measured with a concave Spherical Densiometer, manufactured by Forest Densiometers, Bartlesville, Oklahoma. Densiometers should be modified by placing narrow strips of black tape at a right angle forming a "V" as shown in FIGURE 7.25. This will provide 17 intersect recording points. The modification improves the measurement of canopy closure (Platts et al, 1987). To facilitate the reading of the mirror surface in the field, place black dots at the intersections of all lines with a Sharpie.

FIGURE 7.25. Modified Spherical Densiometer.

The Spherical Densiometer optically identifies a series of points in the canopy above the sampling location. The observer records the number of shaded points.

Canopy Density Procedure

1. Canopy density readings are taken at the same transects as the transect pebble counts and riffle bug sample locations (i.e. 3 transects). For streams less than or equal to 16 feet wide (wetted width) the four measurements are taken (FIGURE 7.26);
   - at right edge of water facing the right bank,
   - at mid-channel facing upstream,
   - at mid-channel facing downstream, and
   - at left edge of water facing the left bank.

   For streams greater than 16 feet wide also take measurements at ¼ and ¾ the wetted width looking upstream and downstream.
2. At edge of water while standing in the stream, and facing the stream bank, hold the instrument level, away from the body, with the "V" pointing toward the observer. Position the densitometer twelve inches above the water surface, and twelve inches from the edge of water.

The observers head reflection should be touching the top of the uppermost grid line.

3. Count all intersecting points on the densitometer where vegetation is present and record that number on the field data sheet.
4. Repeat at the middle upstream, middle downstream and other edge of water.
5. On the SEM form, sum the tallies for each column. Each column represents a cross-section. Sum the cross-section tallies and divide by 3 to obtain the mean number of points.

Do not intermingle the 4 point and 8 point method in one study reach.

2.12 CANOPY DENSITY			
Position	**Upper Reach**	**Mid-Reach**	**Lower Reach**
REW			
¼ Upstream (if > 16')			
¼ Downstream (if > 16')			
Middle – Looking Upstream			
Middle – Looking Downstream			
¾ Upstream (if > 16')			
¾ Downstream (if > 16')			
LEW			
Sum			
Number of Points =	Sum of three columns _____ / 3 = _____		
Stream width ≤ 16 ft	Percent Canopy Density = Number of Points x 1.47 =		%
Stream width > 16 ft	Percent Canopy Density = Number of Points x 0.735 =		%

FIGURE 7.26. SEM Form. Canopy Density..

7.4.9.1 Determining Stream Order

Stream order can range from a "1" for a headwater stream to around a "10" for a very large river. The Amazon River is the highest order river on Earth with a Strahler stream order of "12."

When two first-order streams come together, they form a second-order stream. When two second-order streams come together, they form a third-order stream. Streams of lower order joining a higher order stream do not change the order of the higher stream. Thus, if a first-order stream joins a second-order stream, it remains a second-order stream. It is not until a second-order stream combines with another second-order stream that it becomes a third-order stream (FIGURE 7.27). A GIS shapefile has been created to make determining stream order easier.

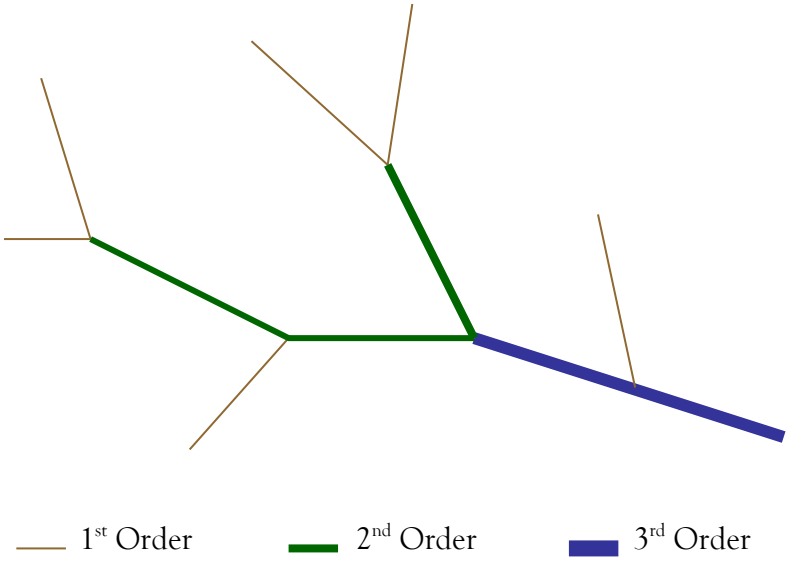


FIGURE 7.27. Determining Strahler stream order.

7.4.10 RIPARIAN SPECIES

Riparian zones are vital to the protection of aquatic habitat. Riparian plants have been shown to reduce the amount of pollutants that can enter the stream. Riparian trees, shrubs and herbs are hydrophytic plants that are found between (and sometimes in) the stream and the upland area. The upland area is generally defined as the area that has 50% or fewer of its species as facultative or obligate species (ACOE, 1988). Use the "ADEQ Guide to Algae and Plants" or associated field guides to identify algae and plant in the riparian zone (Jones, 2011) to identify common plants and algae.

Some riparian species identification guides include:

- Shrubs and Trees of the southwest uplands (Elmore and Janish, 1976)
- Desert Plants: Riparian forest and scrubland community types of Arizona and New Mexico (Szaro, 1989)
- Trees of Arizona (Little, 1968; Brockman, 1968)
- Salicaceae: willow family key (Argus, 1995)
- Willow quick ID guide (ADEQa)
- Riparian tree quick ID guide (ADEQb)

2.13 PLANT DIVERSITY (TALLY ACROSS REACH)			
Check which algae and macrophytes are present in the wetted width. Record the tally in the space below using the codes provided next to each organism. A = Algae M = Macrophyte.			
☐ A	(aCl) - *Cladophora* (hair like feel, long beards)	☐ M	(mW) - Watercress (*Rorippa*)
☐ A	(aSg) - *Spirogyra* (slimy to touch, bright green)	☐ M	(mMF) - Monkey flower (*Mimulus*, yellow flower)
☐ A	(aN) - *Nostoc* (looks like jelly beans or round black to blue colored nodules)	☐ M	(mPW) - Pondweed (*Potomogeton*, submerged water grass)
☐ A	(aBG) - Blue-greens (blue-green to black in color, e.g. *Oscillatoria*, *Anabena*)	☐ M	(mCb) Columbine (yellow flower)
☐ A	(aV) - *Vaucheria* (dark green felt-like mats)	☐ M	(mB) - Buttercup (*Ranunculus*)
☐ A	(aSt) - Stonewort's (feels gritty, looks like a vascular plant, found in upwelling zones)	☐ M	(mMf) - Eurasian water milfoil (*Myriophyllum*) INVASIVE
☐ A	(aH) - *Hydrodictyon* (bright green, net forming algae)	☐ M	(mHy) - Hydrilla INVASIVE
☐ A	(aP) - *Praesiola* (cold water algae, looks like sea lettuce)	☐ M	(mR) - Rush
☐ M	(mL) - *Lemna* / Duckweed	☐ M	(mMs) - Moss
☐ M	(mSp) - Speedwell	☐ M	(mSe) - Sedge
☐		☐	
☐		☐	

FIGURE 7.28. SEM Form. Riparian Species and Regeneration Potential of Riparian Trees.

7.4.11 BIOLOGICAL OBSERVATIONS

This section seems very similar to the "Site Observations" at the beginning of the field form. The main difference is that the Biological Observations are taken throughout the reach instead of 10 meters up and downstream of the sample point.

There are three algae categories. Each question considers a different algae strata within the wetted width of the channel. Do not include floating algae and algal slime in the 'filamentous algae covering streambed throughout the reach' (FIGURE 7.29).

Use the calculated values from Section 7.4.7.2 for the percent filamentous algae covering streambed and macrophyte cover.

2.8 BIOLOGICAL OBSERVATIONS	
Filamentous Algae Covering Streambed throughout the reach (circle range; get from Section 2.16)	1) <1% 2) 1-25% 3) 26-50% 4) 51-100%
Macrophytes covering streambed throughout the reach (circle range; get from Section 2.16)	1) <1% 2) 1-25% 3) 26-50% 4) 51-100%
Floating algae (detached clumps/mats) floating downstream (circle range)	1) <1% 2) 1-25% 3) 26-50% 4) 51-100%
Algal slime on rocks, wood, etc. (not filamentous)	Absent ☐; rare-thin coating ☐; common thick coating ☐

FIGURE 7.29. Biological Observations.

7.4.12 INDICATORS OF EXCESS NUTRIENTS

The following stream nutrient assessment protocol provides an evaluation of multiple field observed ecological indicators of nutrient stress, to support the narrative nutrient standard in the ADEQ Surface Water Standards (AAC 18-11-108). This assessment should be conducted during the growing season in the spring. This assessment protocol utilizes biological endpoint indicators, supported by chemical and physical observations to make a weight of evidence assessment of nutrient enrichment.

7.4.12.1 Physical – Depositional Area Conditions (Optional Section)

Nine measurements will be taken in three depositional areas: deep or shallow pools, backwaters, eddies, or slack edge water areas, including macrophyte beds (don't use plunge pools). Depositional area conditions are evaluated to look for indicators of excess organic matter buildup, decay and anoxia and associated indicators of presence of a thick organic sludge layer overlying bed sediments, a sulfur smell released from sediment, and presence of red bloodworms, an anoxia indicator.

This protocol is conducted at stream nutrient criteria research sites.

Do not do this method on channel types that don't have well defined depositional areas (such as an A type channel).

1. Draw the site sketch first and map out the different kinds of depositional areas that are present (deep or shallow pools, backwaters, eddies, slackwater edge areas and macrophyte beds). Then select 3 of those locations at which to mark observations. Select locations which are representative of the quantity of each type present in the reach.
2. Within each depositional area, select three points where observations of decay and anoxia will be made: one at the deepest part of the pool and two other locations that are representative of the deposits in that habitat.
3. Place the ski-pole down in the center of that habitat, then pick up a handful of sediment. Examine it for thick black sludge-like organic matter, smell it for sulfur content then look for bloodworms. Record the scores as follows: absent (0), present but rare (1), and present/abundant (2) for each indicator in the table on the field form.
4. An evaluation of overall pool conditions (good, fair, poor) is made using the following guidelines. Sum up the total score of the 27 indicator boxes in Figure 7.3.0 and calculate the percentage of a total of 54 points. Use the following scoring categories.

Number of indicators	Condition
≤25% of a possible score of 54	Good condition
26-49%	Fair condition
≥50%	Poor condition

2.21 DEPOSITIONAL AREA CONDITIONS (RECORD AS P/A FOR PRESENT/ABSENT)				
Depositional Area #1	Dead, black organic matter overlying bottom sediment	Anoxic/black sediment & sulfur smell	Bloodworms	Comments(record depositional type=pool, edge, backwater, eddy, macrophyte bed)
A				
B				
C				
Depositional Area #2				
A				
B				
C				
Depositional Area #3				
A				
B				
C				

FIGURE 7.30. SEM Form. Depositional area conditions.

7.4.12.3 Other indicators of excess nutrients

There can be many riparian, reach, and landscape level indicators which could be indicators of nutrient inputs or sources. The following should be noted to document natural and anthropogenic sources or contributors to nutrient enrichment in a stream reach.

2.22 OTHER INDICATORS OF EXCESS NUTRIENTS (RECORD AS P/A FOR PRESENT/ABSENT)					
NOTED BECAUSE THERE CAN BE NATURAL SOURCES OF NUTRIENTS VERSUS ANTHROPOGENIC SOURCES.					
Present?	**Parameter**	**Comments**	**Present?**	**Parameter**	**Comments**
General			Natural Nutrient Sources		
☐	General odor – Does it smell like rotten eggs, feces (cattle or human) ammonia?		☐	Landscape patterns – Is there an alluvium to bedrock transition, or open basin to canyon transition?	
☐	Health of fish- Are fish lethargic, swimming erratically, odd-colored or blotchy?		☐	Natural springs or seeps - Are there areas of perched water, *Fissidens* moss, "butterscotch pudding bacteria, wet canyon walls, red monkey flowers, change in temperature/pH/ conductivity?	
☐	Point/nonpoint discharges in reach– agricultural, industrial, sewage treatment, septic or other facilities?		☐	Tributaries - Are there any tributaries (wet or dry) or are there any "perched channels" entering onto the floodplain?	
☐			☐	Downwelling – Is the water moving into the sediments and "drying up"? Is organic matter "heaped up" at the bottom of the wetted reach as if by wave action?	

FIGURE 7.31. SEM Form. Other indicators of excess nutrients.

7.4.13 REGENERATION POTENTIAL OF RIPARIAN TREES

Observations of regeneration capacity aid in evaluating the health of the riparian community. A stressed community will exhibit reduced age class diversity, changes in percent cover, loss of species diversity and increased abundance of exotic species. To complete the regeneration potential table, record the presence of the five most common trees in four age classes; mature trees, young trees, saplings, and seedlings. The observations for all size classes are taken at 5 feet above the ground. For example, to determine if a tree fits into the mature tree category look at trees throughout the study reach at 5 feet high and see if they are greater than 16 inches in diameter. The community is considered in best condition if tree species are abundant in three age classes (FIGURE 7.32). Identify unknown species in the empty boxes if common (>25%). Be sure to distinguish age classes for unknown species.

2.17 RIPARIAN & INVASIVE SPECIES

USE THE ADEQ GUIDE TO ALGAE AND PLANTS TO IDENTIFY RIPARIAN AND INVASIVE SPECIES.

Macrophytes	Grasses & Shrubs	Trees	Invasive
☐ Buttercup	☐ Bamboo	☐ Spikerush	☐ Alder, Arizona	☐ Walnut, Arizona	☐ Russian knapweed
☐ Checkered Mallow, NM	☐ Bulrush, Hardstemed	☐ Vine Mequite	☐ Alder, Thinleaf	☐ Willow, Arroyo	☐ Russian olive
☐ Columbine	☐ Cattail	☐ Arrowweed	☐ Ash, Velvet	☐ Willow, Bebb	☐ Water hyacinth
☐ Monkey Flower	☐ Deer Grass	☐ Desert Broom	☐ Boxelder	☐ Willow, Bonpland's	☐ Salt ceder
☐ Primrose, Floating	☐ Desert Saltgrass	☐ Willow, Arizona	☐ Cottonwood, Fremont	☐ Willow, Coyote	☐ Parrot's feather
☐ Gooseberry	☐ Horsetail	☐ Willow, Seep	☐ Cottonwood, Narrowleaf	☐ Willow, Pacific	☐
☐ Spearmint	☐ Muhly, Alkaki	☐	☐ Maple, Big Toothed	☐ Willow, Goodding	☐
☐ Speedwell	☐ Reed, Giant	☐	☐ Maple, Rocky Mountain	☐ Willow, Scouler	☐
☐ Watercress	☐ Sacaton	☐	☐ Sycamore, Arizona	☐	☐
☐ Buttercup	☐ Sedge	☐	☐ Tree tobacco	☐	☐

2.18 REGENERATION POTENTIAL OF RIPARIAN TREES

Species in order of dominance	Mature Trees >16" @ 5 ft height	Young Trees <16" >1¼" @ 5 ft. height	Saplings < 1 ¼"	Seedlings New growth
1				
2				
3				
4				
5				

Age Classes of Riparian Tree Species
(Classify according to species present, not just the dominant tree type of that plant association)

☐	Species abundant in 3 age classes	☐	Abundant in 2 age classes	☐	One age class present	☐	No regeneration evident, few mature trees present, no saplings or seedlings, or if present, they are heavily grazed

FIGURE 7.32. Riparian species and regeneration potential.

7.4.14 ESTIMATING RIPARIAN VEGETATION COVER

Estimating percent cover of different canopy layers of the riparian community is a semi-quantitative measure of riparian condition. Record the estimated percent cover of the over story of riparian trees, the understory of shrubs, ground cover and barren ground within the floodplain. Consider each vegetative layer separately with a score of 0-100 percent for each (FIGURES 7.33 and 7.34).

FIGURE 7.33. Figure used for estimating percent areal cover.

2.19 RIPARIAN VEGETATION COVER

Record the percent cover of each vegetation type within the floodplain. Consider each vegetative layer separately with a score of 0 – 100% for each (See above figure). The object is to identify what vegetation type is holding the banks and floodplain together.

Riparian Vegetation Cover	Estimated Percent Cover
Canopy of riparian trees > 15 feet high	
Understory of woody shrubs, saplings, herbs, grasses and forbs – 1.5 to 15 feet high	
Ground cover of woody shrubs, seedlings, herbs, and forbs - < 1.5 feet high	
Barren or bare dirt	

FIGURE 7.34. SEM Form. Riparian Vegetation Cover

7.4.15 NON-POINT SOURCE OBSERVATIONS

Sources of potential impairment must be identified as part of the bioassessment process. Sources adjacent to the study reach as well as sources within the watershed are identified from visual observations in the field and from topographic maps or aerial photos.

2.20 NON-POINT SOURCE CODES			
Add a Circle for direct sources and an asterisk for sources in the watershed in the Source Category column. Bold indicates common categories.			
Code	**Source Category**	**Code**	**Source Category**
0100-Wastewater	0100-Industrial Point Source		5990-Sand/gravel Mining
Industrial	0200-Municipal Point Source	6000-Land Disposal/	6200-Wastewater
	0500-Collection System Failure	Storage/Treatment	6300-Landfills
	0900-Sewage Lagoons		6350-Inappropriate Disposal/wildcat
1000 - Agriculture	1100-Non-Irrigated Crop		6400-Indust. Land Mangment
	1200-Irrigated Crop		**6500-Wastewater Treatment septic sys.**
	1300-Specialty Crop - Citrus /nuts /fruits		6600-Hazardous Waste
Grazing	**1350-Grazing Related Sources**		**6700-Septic Disposal**
	1400-Pasture Grazing		6800-Waste Storage/AST leaks
	1500-Range Grazing		6900-Waste Storage/UST leaks
1600 - CAFO	Animal Feeding Operations	7000-Hydromodification	7100-Channelization
1700-Aquaculture	Fish Hatchery		7190-Channel Erosion/incision
2000 - Silviculture/	2100-Harvesting/Residue Management		7200-Dredging
Forestry	2200-Forest Mngm-pumped drainage		7300-Dam Construction
	fertilization/pesticide app		7350-Upstream Impoundment
	2300-Road Construction/maintenance		**7400-Flow Regulation/Modification**
	2990-Reforestation		**7550-Other Habitat Modification**
3000-Construction	**3100-Highways/roads/bridges**		**7555-Erosion materials from tribs**
	3200-Land (Re-)Deveopment		7600-Removal of Riparian Veg
4000-Urban Runoff	4190-Municipal		**7700-Streambank Modification/Destab.**
/Stormwater	4191-Commercial		7800-Drainage/filling of wetlands
	4192-Residential-Non commercial auto pet waste etc.		**7850-Groundwater Withdrawal**
	4400-Illicit connections/illegal hookup	7900-Marinas/Boating	7990-Pumpouts
	4450-Dry weather flows		7991-Sanitary on-vessel discharges
	4500-Hwy/road/bridge runoff		7992-other on-vessel discharges
	4590-Post-development erosion/sed.		7994-Boat Construction
	4600-Non-urban runoff/erosion/sediment		7995-Boat Maintenance
	4650-Salt Storage Sites		7997-Fueling
5000-Resource	5100-Surface Mining		7996-Shoreline Erosion
Extraction	5200-Subsurface Mining	8000 - Other NPS	8050-Erosion from Derelict Land
	5290-Open Pit Mining	Pollution	8100-Atmospheric Deposition
	5300-Placer Mining		8400-Spills
	5400-Dredge Mining		**8600-Natural Sources (such as fire)**
	5500-Petroleum Activities		8910-Groundwater Loadings
	5600-Mill Tailings		8950-Wildlife
	5700-Mine Tailings	8500-Hist. pollutants	8590-Contaminated Sediments
	5800-Abandoned Mine (Drainage)		8591-Clean Sediments
NPS Codes and Observations			8592-Other Historical Pollutants
		8700-Turf Management/	**8700- Rec and Tourism (non-boating)**
		Recreation/non-boating	8710-Golf Courses
			8790-Yard Maintenance
			8791-Other Turf Management

FIGURE 7.35. SEM Form. Non-point Source Codes.

7.4.16 PFANKUCH CHANNEL STABILITY EVALUATION

The Pfankuch Channel Stability Evaluation (Pfankuch, 1975) is a channel stability assessment tool, recommended by Wildland Hydrology's Dave Rosgen in making evaluations of channel

stability (Rosgen, 1996). The original scoring form was developed by Dale Pfankuch in 1975 (USFS, 1975). The original form assessed stream condition based on 15 parameters. ADEQ modified the form to better fit arid southwest streams, deleting, modifying and adding parameters. The evaluation is segregated into three categories: upper banks, lower banks, and channel bottom. Each category has three to four ratings. The sum of the category ratings is transformed into an adjective rating of stream stability (e.g., Excellent, Good, Fair, and Poor), using Rosgen stream type.

Pfankuch's original evaluation was designed for use in western U.S.A. mountain stream channels, but did not provide for the varieties of stream type. Rosgen (1996) incorporated the evaluation into his river classification system, but dropped the "excellent" rating. After extensive use of Rosgen's modified version, ADEQ determined that some portions of the evaluation did not adequately evaluate arid land stream channels. Therefore, ADEQ staff made the appropriate modifications to the rating categories that evaluate Arizona streams. Under the "Lower Banks" category, two changes were made; "Bank Rock Content" was deleted and replaced by "Surface Protection," and "Deposition" was deleted. Pfankuch's entire category of six ratings for channel "Bottom" was removed and replaced by three ratings that more accurately describe arid land stream channel bottoms. Therefore, a correction factor of 1.226 is applied to convert the ADEQ scores upward for use with the original Pfankuch scoring criteria for each stream type shown in the table following the Pfankuch form.

2.23 MODIFIED PFANKUCH CHANNEL STABILITY EVALUATION (LEVEL III)

The Pfankuch evaluation is segregated into three categories; upper banks, lower banks, and channel bottom. Each category has four ratings to be scored. The low score is the ideal condition. You may choose a score between the ones given if there is uncertainty about which rating category is most fitting for the condition. The Pfankuch Worksheet should be filled out last and as a group.

Description	Rating
A. "Upper Banks", or first terrace, is the floodplain area and is above bankfull. This landform comes into play only during floods. This category is designed to aid in rating the relative resistance to detachment and transport of particles (large and small, organic and inorganic) by floods.	
1. "Landform Slope" is the angle of slope of the floodplain. This can be estimated or measured with an Abney level (or similar device). Always choose the worst condition for the rating. If you have one floodplain at 30% and the other at >60%, rate the steeper slope because that is the area where erosion will be occurring at flood. Score A and B type channels as a 2 or excellent.	
a. Excellent: Side slopes to the channel are generally less than 30% on both banks	2
b. Good: Side slopes up to 40% on one or occasionally both banks	4
c. Fair: Side slopes to 60% common on one or both banks	6
d. Poor: Steep slopes, over 60%, provide larger volumes of soil for downstream sedimentation from lateral bank cutting.	8
2. "Mass Wasting" involves existing or potential detachment of relatively large pieces of earth. Mass movement of banks by slumping or sliding introduces large volumes of soil and debris into the channel. This condition is common at meanders or on incised channels where high banks exist at great angles, especially over 60%.	
a. Excellent: There is no evidence of mass wasting that has or could reach the stream channel in recent times.	3
b. Good: There is evidence of infrequent and / or very small slumps. Those that exist may occasionally be "raw" but predominantly the areas are revegetated and relatively stable.	6
c. Fair: Frequency and / or magnitude of the mass wasting situation increases to the point where normal high water (bankfull or a little less) aggravates the problem of channel changes and subsequent undercutting or unstable areas with increased sedimentation.	9
d. Poor: Mass wasting is not difficult to detect.	12
3. "Debris Jam" includes those floatable objects that have been deposited on stream banks, in the floodplain, by man or by natural processes. It usually consists of tree trunks, limbs, twigs, and leaves. It forms obstructions, flow deflectors, and sediment traps. This inventory item assesses the potential for increasing these impediments to the natural direction and force of flow where they now lay. The Pfankuch evaluation considers debris jams to be a negative influence on the stream channel except when it is protecting the floodplain banks (see 'Organic Debris Form' for percentages).	
a. Excellent: Some small debris may be present on the floodplain banks, but is essentially absent (< 10%).	2
b. Good: Some debris present but it is small enough to be floated away in time. Only small jams could be formed with this material alone (10 – 30%).	4
c. Fair: There is a noticeable accumulation of all sizes and the stream is large enough to float it away (31 – 50%).	6
d. Poor: Moderate to heavy accumulations are present due to fires, insect damage to trees, disease mortality, windthrow, and logging slash. High flows will float some debris away and the remainder will cause channel changes (> 50%).	8
4. "Vegetative Bank Protection" concerns the vegetative component in the floodplain. Factors to consider for this rating are the density of plant stems, varieties of vegetation, plant vigor, and recruitment.	
a. Excellent: Trees, shrubs, grass and forbs combined cover is more than 90% of the ground. Openings in the ground covers are small and evenly dispersed. A variety of age classes and species are represented. Growth is vigorous and reproduction of species in both the under- and over-story is proceeding at a rate to insure continued ground cover conditions. A deep dense root mat is inferred.	3
b. Good: Plants cover 70 to 90 percent of the ground. Shrub species may be more prevalent than trees. Openings in the tree canopy are large. While the growth vigor is generally good for all species, recruitment of new individuals may be sparse or lacking entirely. A deep root mat is not continuous and more serious erosive incursions are possible in the openings.	6
c. Fair: Plant cover ranges from 50 to 70 percent. Lack of vigor is evident in some individuals and / or species. Seedling reproduction is nil. Most of the floodplain does not have a deep root mat.	9
d. Poor: Less than 50 percent of the ground is covered. Trees are essentially absent. Shrubs largely exist in scattered clumps. Growth and reproduction vigor is generally poor. Root mats discontinuous and shallow.	12
UPPER BANK TOTAL	
B. "Lower Banks" is the area between bankfull and base flow. Aquatic, semi-aquatic, and terrestrial plants may grow here.	
1. "Channel Capacity" is the inventory of the channel width, depth, gradient and roughness determined by the volume of water carried downstream. This is essentially a measure of channel stability and departure from the ideal condition. See → Section 2.4 for the width depth ratio.	
a. Excellent: The ideal condition. The stream is balance with its watershed, neither aggrading nor degrading. Width / depth ratios are in the range of the desired stream type for that ecosystem.	1
b. Good: Not the ideal condition. Possibly a small amount of aggrading or entrenchment occurring, but nothing serious.	2
c. Fair: Channel is widening and becoming shallower (stream is aggrading). Or, channel is degrading and is noticeably incised.	3
d. Poor: Channel may be so aggraded that its capacity is generally inadequate to handle bankfull flows and overbank floods common. Or, the channel is deeply entrenched and bank erosion is occurring.	4
2. "Surface Protection" refers to the composition of bank materials which prevent erosion due to freeze/thaw activity and the near bank stress of bankfull or high flows. Look at root density and cobble armoring for this evaluation (See → Section 2.5).	
a. Excellent: Greater than 75% of bank surface area is protected by dense root mats or cobble armoring.	2
b. Good: Between 50-75% of bank surface area is protected by dense root mats or cobble armoring.	4
c. Fair: Between 25-50% of bank surface area is protected by dense root mats or cobble armoring.	6
d. Poor: Less than 25% of bank surface area is protected by dense root mats or cobble armoring.	8
3. "Obstructions to Flow" is an inventory of objects within the stream channel, like rocks, embedded logs, bridge pilings, etc., that change the flow and sometimes the velocity. Obstructions may produce adverse stability effects when they increase the velocity and deflect the flow into unstable and unprotected banks and across unstable bottom materials. They also may produce favorable impacts when velocity is decreased by turbulence and pools are formed (See → Section 2.5).	
a. Excellent: Logs, rocks, and other obstructions to flow are firmly embedded and produce a pattern of flow which does not erode the banks and bottom or cause sediment buildup. Pool/riffle relationship stable.	2
b. Good: Obstructions to flow and sediment traps are present, causing cross currents which create some minor bank and bottom erosion. Some of the obstructions are newer, not firmly embedded and move to new locations during high flows. Some sediment is trapped in pools decreasing their capacity.	4
c. Fair: Moderately frequent and quite often unstable obstructions, cause noticeable seasonal erosion of the channel. Considerable sediment accumulations behind obstructions.	6
d. Poor: Obstructions and traps are common, are often unstable to movement and cause a continual shift of sediments at all seasons. Since traps are filled as soon as formed, the channel migrates and widens.	8

Description	Rating
4. "Cutting" or downcutting of the channel is preempted first by scouring, uprooting, and loss of vegetation. In channels devoid naturally of vegetation, the first stages would be an increase in the steepness of the channel banks. If plant roots bind the surface horizon of the adjacent upper bank into a cohesive mass, undercutting will follow. Eventually the weight of the overhang will slump into the channel. Unconsolidated banks with or without vegetation will be nibbled away and never develop an overhang. See → Section 2.5.	LB RB
Notice that you must evaluate both the left bank and the right bank of the rated reach.	2 2
a. Excellent: Very little or no cutting is evident. Overall <5% of bank length is erosional.	
b. Good: Some intermittent cutting along channel outcurves and at prominent constrictions. Banks moderately stable with 5-30% of bank length erosional.	3 3
c. Fair: Significant bank cutting occurs frequently in the reach. Banks moderately unstable with 30-60% of bank length eroding.	6 6
d. Poor: Nearly continuous bank cutting. Banks unstable; 60-100% of bank length is eroding.	8 8
LOWER BANK TOTAL	
C. Channel "Bottom" condition is the evaluation of sediment deposition within the bankfull channel.	
1. Bottom Deposits" is the evaluation of how well the channel is moving its sediment downstream. Ideally, there should be a defined thalweg, riffles, and pools. However, you have to be the judge whether or not this is the naturally occurring condition for that ecosystem. Some low gradient desert streams may be the exception. Calculate the percentage of silt & sand particles (< 2mm) from →Section 2.13.	
a. Excellent: A stream channel that is in balance with its watershed. Less than 20% of the stream bed is affected by sediment deposition.	6
b. Good: Some deposition occurring in the pools. For the whole reach, 20-50% of the bottom is experiencing some deposition.	12
c. Fair: Deposition is quite noticeable. 50-80% of the channel is affected. Sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools and riffles, and stream braiding may be occurring.	18
d. Poor: Very noticeable deposition occurring over more than 80% of the reach. Pools and riffles mostly or entirely absent.	24
2. "Bar Development and Deposition" plays a vital role in alluvial C, D, and F stream types. Not applicable to A, B, E, G type streams and geologically constrained streams (score as 4). The appearance of sand and gravel bars where they did not previously exist may be one of the first signs of upstream erosion.	
a. Excellent: Little or no enlargement of point bars; sand bars are stable and completely vegetated.	4
b. Good: Some new increase in bar formation, mostly from gravel, sand or fine sediment; sand bars stable but not completely vegetated.	8
c. Fair: Moderate deposition on new gravel, sand or fine sediment on old and new bars; sand bars unstable with sparse vegetation.	12
d. Poor: Heavy deposits of fine material; increased bar development; sand bars unstable with no vegetation; transverse bars may be present.	16
3. "Reachwide Embeddedness" is an inventory of the degree of sedimentation in riffles and pools. (see →Section 2.13)	
a. Excellent: Gravel and cobble particles are 0 - 25% surrounded by fine sediment.	2
b. Good: Gravel and cobble particles are 25 - 50% surrounded by fine sediment.	4
c. Fair: Gravel and cobble particles are 50 - 75% surrounded by fine sediment.	6
d. Poor: Gravel and cobble particles are more than 75% surrounded by fine sediment, or there is an absence of riffles and pools.	8
CHANNEL BOTTOM TOTAL	
Sum of "Upper Banks", "Lower Banks", and "Channel Bottom"	
Final Pfankuch Score (Sum of all categories X 1.226)	
Rosgen Stream Type	
Pfankuch Rating category (Good, Fair, Poor)	

Sediment Supply Condition (use Bottom Deposits & Bar Deposition parameters to evaluate)	Stream Bed Stability	Width Depth Ratio
☐ Extreme – Substrate is nearly all runs, few if any riffles and/or mid, side-channel or delta bars are present throughout the reach	☐ Aggrading – Excess bottom deposits and/or bar features are present indicating increased sedimentation, channel is likely wide and shallow	☐ Very High - Substrate is nearly all runs with no defined thalweg, and/or mid, side-channel or delta bars are present throughout the reach; probably wide and shallow
☐ Very High – Loss of pool & riffle habitat due to sedimentation and/or excess bar features are present	☐ Degrading – Lack of fine sand & gravel compared to bar feature materials; vertical raw banks are usually present	☐ High – Some loss of riffle or pool habitat, some excess bar features
☐ High – Stream bottom is moderately affected by sedimentation and/or excess bar features are present	☐ Stable – No excess bar features or excess sediment in pools	☐ Normal – riffle & pool habitat is maintained for that channel type
☐ Low – Stream bottom is not affected by sedimentation and there are no excess bar features		

CONVERSION OF STABILITY RATING TO REACH CONDITION BY STREAM TYPE (ROSGEN, 1996)

Stream Type	A1	A2	A3	A4	A5	A6	B1	B2	B3	B4	B5	B6
GOOD	38-43	38-43	54-90	60-95	60-95	50-80	38-45	38-45	40-60	40-64	48-68	40-60
FAIR	44-47	44-47	91-129	96-132	96-132	81-110	46-58	46-58	61-78	65-84	69-88	61-78
POOR	48+	48+	130+	133+	133+	111+	59+	59+	79+	85+	89+	79+
Stream Type	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**D3**	**D4**	**D5**	**D6**		
GOOD	38-35	38-35	60-85	70-90	70-90	60-85	85-107	85-107	85-107	67-98		
FAIR	51-61	51-61	86-105	91-110	91-110	86-105	108-132	108-132	108-132	99-125		
POOR	62+	62+	106+	111+	111+	106+	133+	133+	133+	126+		
Stream Type	**DA3**	**DA4**	**DA5**	**DA6**	**E3**	**E4**	**E5**	**E6**				
GOOD	40-63	40-63	40-63	40-63	40-63	50-75	50-75	40-63				
FAIR	64-86	64-86	64-86	64-86	64-86	76-96	76-96	64-86				
POOR	87+	87+	87+	87+	87+	97+	97+	87+				
Stream Type	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**G1**	**G2**	**G3**	**G4**	**G5**	**G6**
GOOD	60-85	60-85	85-110	85-110	90-115	80-95	40-60	40-60	85-107	85-107	90-112	85-107
FAIR	86-105	86-105	111-125	111-125	116-130	96-110	61-78	61-78	108-120	108-120	113-125	108-120
POOR	106+	106+	126+	126+	131+	111+	79+	79+	121+	121+	126+	121+

FIGURE 7.36. SEM Form. Pfankuch Assessment.

7.4.17 PROPER FUNCTIONING CONDITION (PFC) ASSESSMENT

Proper Functioning Condition (PFC) is a qualitative method for assessing the condition of riparian-wetland areas (Prichard et al, 1993). The term PFC is used to describe both the assessment process, and a defined, on-the-ground condition of a riparian-wetland area.

The PFC assessment refers to a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of riparian-wetland areas. A checklist is used for the PFC assessment which synthesizes information that is essential for determining the overall health of a riparian-wetland system. The on-the-ground condition termed PFC refers to how well the physical processes are functioning. PFC is a state of resiliency that will allow a riparian-wetland area to hold together during high-flow events with a high degree of reliability. This resiliency allows an area to produce desired values, such as fish habitat, bird habitat, or forage, over a period of time. Riparian-wetland areas that are not functioning properly cannot sustain these values.

PFC is a qualitative assessment based on quantitative science. The PFC assessment is intended to be performed by an interdisciplinary team with local, on-the-ground experience in the kind of quantitative sampling techniques that support the PFC checklist. These quantitative techniques are encouraged in conjunction with the PFC assessment for individual calibration, where answers are uncertain, or where experience is limited. PFC is also an appropriate starting point for determining and prioritizing the type and location of a quantitative inventory or monitoring.

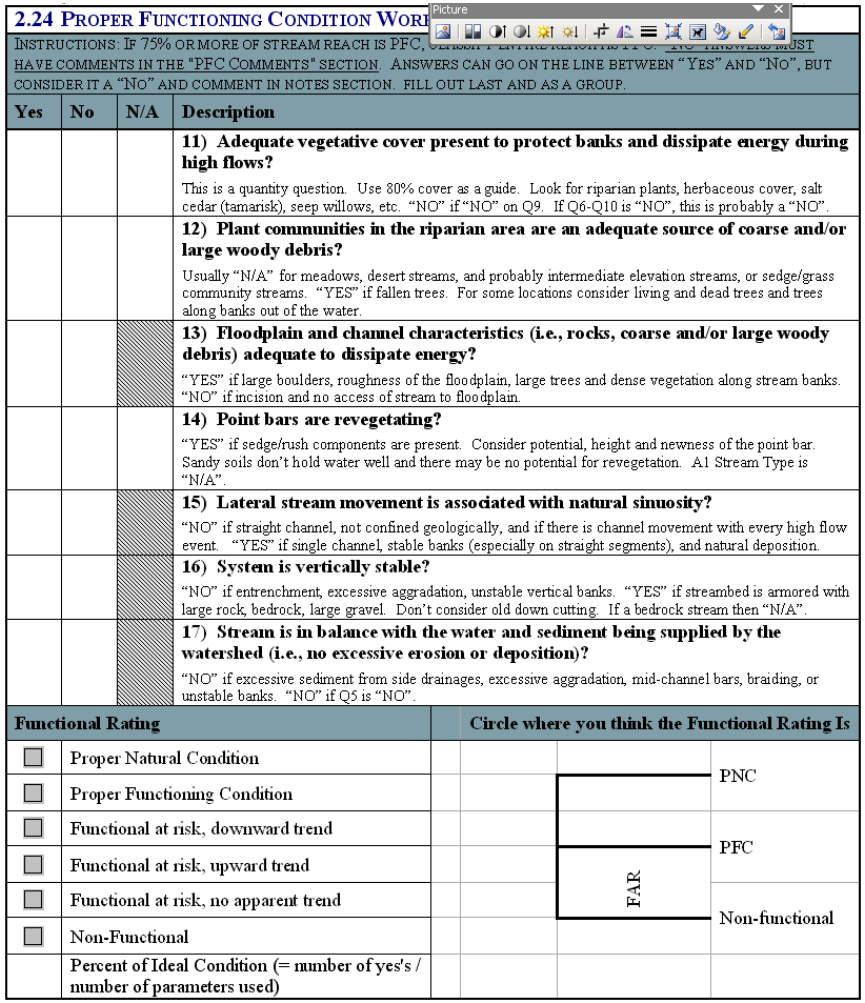
The PFC form consists of a set of guidelines for filling out the checklist. The guidelines are from Bureau of Land Management training courses and training materials. The guidelines should accompany the checklist into the field and be referred to as the checklist is being filled out by the assessment team.

Several of the field data sheet habitat measurements should be used to assist the PFC evaluations, such as depositional features, pebble count, regeneration potential, and Rosgen stream type. If a "No" answer is given for any of the PFC items, a remark must be given that describes the condition. The number of yes and no answers on the checklist are used to summarize the overall condition into one of six categories: Proper functioning condition, Functional at risk/upward trend, Functional at risk/downward trend, Functional at risk/no apparent trend, Non-functional, and Unknown. There is no numeric scoring involved. Best professional judgment is used to determine the appropriate assessment category.

2.24 PROPER FUNCTIONING CONDITION WORKSHEET

INSTRUCTIONS: IF 75% OR MORE OF STREAM REACH IS PFC, CLASSIFY ENTIRE REACH AS PFC. "NO" ANSWERS MUST HAVE COMMENTS IN THE "PFC COMMENTS" SECTION. ANSWERS CAN GO ON THE LINE BETWEEN "YES" AND "NO", BUT CONSIDER IT A "NO" AND COMMENT IN NOTES SECTION. FILL OUT LAST AND AS A GROUP.

Yes	No	N/A	Description
			1) Floodplain is inundated in "relatively frequent" events (1-3 years)? Instantaneous peak flows don't count. Inundation means to bankfull depth. Bankfull can be identified from top of the point bars, changes in vegetation, topographic break in slope, change in size of bank materials, evidence of an inundation feature such as small benches, exposed root hairs below an intact soil layer indicating exposure to erosive flow, and bank undercuts. "NO" if channelization or entrenchment. "N/A" if a "V"-canyon without floodplain development.
			2) Active/stable beaver dams present? Usually "N/A", but may be applicable at high altitude sites; also, consider the present environment (could they be present).
			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)? Based on the stream type expected and the regional curves. All three features must indicate stability for a "YES". Use bankfull width, not wetted width. "NO" if straightness, excessive sediment, or entrenched channel.
			4) Riparian zone is widening or has achieved its potential extent? Widening can mean encroaching on the channel as well as moving toward the terraces. The age of the vegetation is an indicator. "NO" if upland species encroaching on the floodplain or Kentucky bluegrass present. "YES" if recruitment of wetland/riparian species on new landforms. "N/A" if an A1 stream type.
			5) The upland watershed is not contributing to riparian degradation? Need to look at upland ground cover and erosion signs (e.g. plants on pedestals, debris dams around plants, rills, gullies). "NO" if side channel and mid-channel bars, gullies, fan shaped deposits from tributaries, braided channels, overloading of point bars, or cementing of streambed.
			6) Diverse (3) age structure of vegetation (Recruitment for maintenance/recovery)? "YES" if 3 age classes (mature, young, saplings) present for a single species, or young and sapling classes if recruitment & replacement is occurring, or dense matting of herbaceous riparian/wetland plants. "NO" if individual plants. "N/A" if A1 Stream Type. Refer to → Section 2.19 'Regeneration Potential of Riparian Trees'.
			7) Diverse composition of vegetation (For maintenance/recovery)? Maintenance means recruitment. Is it occurring? "YES" if several different species present (e.g. willows, rushes, sedges). However, it depends on the elevation and the potential natural community that might be present if all human stresses are removed. In some environments, 2 species could be a "YES". Usually "NO" if 1 species present, the exceptions are sometimes high meadow streams. Refer to → Section 2.19, 'Regeneration Potential of Riparian Trees'.
			8) Species present indicate maintenance of riparian soil moisture characteristics? Don't consider quantity. "YES" if sedges, rushes, willows, seep willows, alders, cottonwoods, etc. See 'Riparian Species' → Section 2.18.
			9) Stream bank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high stream flow events? A high stream flow event is one that occurs once in 25-30 years. Q9 is similar to Q8, but you are now looking for quantity. "NO" if upland species are present. "YES" if willows, alder, aspen, birch, cottonwood, sedge, rush, bulrush, and wetland grasses.
			10) Riparian plants exhibit high vigor? Are the plants healthy and dense? "NO" if yellow leaves, stunted plants, many dead stems and branches, a thin crown, infested with insects, diseased, or grazed down by browsers.



2.24 PROPER FUNCTIONING CONDITION WORI

INSTRUCTIONS: IF 75% OR MORE OF STREAM REACH IS PFC, [illegible] HAVE COMMENTS IN THE "PFC COMMENTS" SECTION. ANSWERS CAN GO ON THE LINE BETWEEN "YES" AND "NO", BUT CONSIDER IT A "NO" AND COMMENT IN NOTES SECTION. FILL OUT LAST AND AS A GROUP.

Yes	No	N/A	Description
			11) Adequate vegetative cover present to protect banks and dissipate energy during high flows? This is a quantity question. Use 80% cover as a guide. Look for riparian plants, herbaceous cover, salt cedar (tamarisk), seep willows, etc. "NO" if "NO" on Q9. If Q6-Q10 is "NO", this is probably a "NO".
			12) Plant communities in the riparian area are an adequate source of coarse and/or large woody debris? Usually "N/A" for meadows, desert streams, and probably intermediate elevation streams, or sedge/grass community streams. "YES" if fallen trees. For some locations consider living and dead trees and trees along banks out of the water.
			13) Floodplain and channel characteristics (i.e., rocks, coarse and/or large woody debris) adequate to dissipate energy? "YES" if large boulders, roughness of the floodplain, large trees and dense vegetation along stream banks. "NO" if incision and no access of stream to floodplain.
			14) Point bars are revegetating? "YES" if sedge/rush components are present. Consider potential, height and newness of the point bar. Sandy soils don't hold water well and there may be no potential for revegetation. A1 Stream Type is "N/A".
			15) Lateral stream movement is associated with natural sinuosity? "NO" if straight channel, not confined geologically, and if there is channel movement with every high flow event. "YES" if single channel, stable banks (especially on straight segments), and natural deposition.
			16) System is vertically stable? "NO" if entrenchment, excessive aggradation, unstable vertical banks. "YES" if streambed is armored with large rock, bedrock, large gravel. Don't consider old down cutting. If a bedrock stream then "N/A".
			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)? "NO" if excessive sediment from side drainages, excessive aggradation, mid-channel bars, braiding, or unstable banks. "NO" if Q5 is "NO".

Functional Rating		Circle where you think the Functional Rating Is	
☐	Proper Natural Condition		PNC
☐	Proper Functioning Condition		
☐	Functional at risk, downward trend		PFC
☐	Functional at risk, upward trend	FAR	
☐	Functional at risk, no apparent trend		Non-functional
☐	Non-Functional		
	Percent of Ideal Condition (= number of yes's / number of parameters used)		

FIGURE 7.37. SEM Form. Proper Functioning Condition.

7.4.18 HABITAT ASSESSMENT

The habitat assessment focuses on stream substrates and bank stability, which are important for biotic communities such as periphyton, macroinvertebrates and fish. It is used in association with the macroinvertebrate index of biological integrity to identify habitat problems as potential stressors. The habitat condition parameters were extracted from USEPA's visual based habitat assessment protocols described in the Rapid Bioassessment Protocols (Barbour et al., 1999) and USEPA's Environmental Monitoring and Assessment Protocols (Lazorchak et al (eds.), 1998).

7.4.18.1 Riffle Habitat Quality

Habitat quality within riffles is evaluated through a survey of the variety of natural structures within the stream reach, such as cobble, large rocks, woody debris, and undercut banks available for colonization by macroinvertebrates. A wide variety and abundance of submerged structures provides benthic macroinvertebrates with a large number of habitat niches, thus increasing community diversity. As the habitat structure becomes less complex, the variety and abundance of cover decreases. Habitat loss leads to a decrease in community diversity, and the potential for community recovery lessens.

Complete the Reach Habitat Quality portion of the SEM Form prior to conducting the habitat scoring. It is best to complete this form as one of the last tasks before leaving the study area. Walk the entire reach, identifying the relative abundance of each micro- and macro-habitat. For warm water streams, give an optimal score if there are 2-3 habitats in the common to abundant categories; suboptimal if there are 2+ habitats with 1 abundant; marginal if sand is common or abundant with 1 additional habitat; poor if the habitat is dominated by abundant sand with possible algae or macrophytes present. For cold water streams, give an optimal score if there are 3+ habitats in the common to abundant categories; suboptimal if there are 2+ habitats with 1 abundant; marginal if there are 2+ habitats that are rare or common; poor if the habitat is dominated by abundant sand with possible algae or macrophytes present.

7.4.18.2 Extent of Riffle Habitat

In addition to habitat quality, the quantity of the riffle habitat is an important factor for the support of healthy biological stream communities. Good riffle habitat covers the width of the streambed, extends twice the width in riffle length, and is populated with an abundance of cobble. When present, these factors provide abundant habitat for maintenance of the macroinvertebrate community and support of the aquatic food web. Where cobble substrate is lacking, riffles may also be lacking. In streams with excess sediment, the interstitial spaces around the rocks fill with sand which converts the riffle to a sandy run. The lack of habitat in sandy runs prevent macroinvertebrate communities from developing.

Complete the Riffle Geometry portion of the field form prior to conducting the habitat scoring. Mark the widths and lengths of three riffles in the study reach. Calculate the length to width ratios for each and then calculate the average ratio. Use these data to score the Extent of Riffle Habitat.

7.4.18.3 Embeddedness in Riffles

Embeddedness refers to the extent to which rocks (gravel, cobble, and boulders) and woody debris are covered or sunken into the silt, sand, or mud in stream riffles. As rocks become more embedded, the surface area available as habitat for macroinvertebrates decreases. Embeddedness is the result of an infusion of fine sediments from upland and stream bank erosion into stream substrates. Embeddedness is one of the primary measures of excess bottom deposits.

Note average the riffle embeddedness while doing the reachwide pebble count.

7.4.18.4 Sediment Deposition

This parameter measures the amount of sediment that has accumulated on the stream bottom and in pools throughout the reach, and for large-scale movement of sediment into a stream. Sediment deposition may cause the formation of side or mid-channel bars, enlargement of point bars, or may result in the filling of riffles and pools. Usually sediment deposition is evident in areas that are obstructed by natural or manmade debris and in areas where stream flow decreases, such as at bends. Large amounts of fine sediment deposition throughout the reach creates a homogenous, unstable, sandy substrate that is unsuitable for macroinvertebrate colonization.

Field staff should be familiar with Rosgen stream types (Rosgen, 1996) and be able to identify the stream type of the study reach. The stream type is required to evaluate whether excess sediment is present for that stream type and to determine whether the channel features conform to the model for a stream type.

7.4.18.5 Bank Stability

The bank stability parameter evaluates the active bankfull channel and is an indicator of the source and amount of sediment contributing to sediment deposition in the stream. Stable, well vegetated banks with little erosion will maintain a stable geomorphic profile and adequate cobble habitat. Unstable banks are characterized by steep walls, banks devoid of vegetation, exposed tree roots, and exposed soil. Unstable banks will erode during moderate flows, contributing large amounts of sediment to the stream bed.

Bank stability is evaluated by visual estimation or measurement of the percent of bank erosion for each bank. Both bank scores are summed for the total bank stability score. A visual estimate of bank erosion for each bank is determined from markings on the site sketch. To measure bank erosion, the length of eroding banks can be paced off or measured with a tape measure, as a percentage of the total bank length.

7.4.18.6 Habitat Assessment Index Scoring

Scores for the five habitat parameters are summed for either a warm water or cold water habitat index score. The five in-stream and bank habitat parameters are scored on a scale of 1 to 4, with higher scores indicating better condition. The habitat scores are summed for a total habitat score ranging from 5-20, with habitat improving with increasing scores. The Habitat Assessment Index

score is then categorized as being good, impaired or very impaired; using the 25th percentile of ADEQ reference habitat assessment scores as the criterion. The 25th percentile of reference method was selected because it is a conservative scoring criterion and allows for the natural variance among reference site scores. The scoring criteria are the same for both the cold and warm water Habitat Assessment Indexes.

3.3 HABITAT ASSESSMENT

Habitat Parameter	Optimal	Sub-optimal	Marginal	Poor
Habitat Quality (use reach habitat quality table, →Section 2.4)	Large variety of habitats available for colonization which may include cobble, undercut banks, snags, submerged logs, leaf packs, root masses, macrophyte beds or other organic material.	Moderate variety of habitats which may include cobble, leaf packs, root masses, macrophyte beds or other organic material.	Habitat has minimal variety, substrate dominated by one particle size, may have some cobble, macrophyte beds, or algae beds.	Homogeneous substrate dominated by sand, shallow with uniform velocity, no shade on riffles, may have extensive filamentous algae beds.
Score	**4**	**3**	**2**	**1**
Extent of Riffle Habitat (use riffle geometry table, →Section 2.3)	Well developed riffle that is as wide as stream and its length extends 2x the wetted width of the stream.	Riffle is as wide as stream, but is less than 2x stream width; abundance of cobble; boulders and gravel are common.	Reduced riffle area does not extend across entire cross-section and is less than 2x width; gravel or large boulders and bedrock prevalent; cobble present.	Riffles virtually non-existent; sand, gravel, large boulders or bedrock prevalent; cobble lacking.
Score	**4**	**3**	**2**	**1**
Embeddedness of Riffles (use visual based embeddedness, in → Section 2.10)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment (bedrock is 0% embedded).	Gravel, cobble, and boulder particles are 26-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 51-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment (sand is 100% embedded).
Score	**4**	**3**	**2**	**1**
Reach Sediment Deposition (use reach pebble count →Section 2.14)	Point bars in C type channel maintained, no mid-channel or side bars. No bimodal particle size distribution. No excess sediment in riffles and pools of A, B, or C type channels.	Point bars with few mid-channel bars or side bars in C type channels. No bimodal particle size distribution. Some filling in of pools in A, B, and C type channels.	Numerous mid-channel or diagonal bars in C type channels. Some loss of pool and riffle habitat in A, B, and C type channels. Bimodal distribution may be present with excess fines in the substrate.	Branched or braided C channel with numerous mid-channel bars and islands, some exceeding 2-3x channel width in length. Heavy deposits of fine material evident with bimodal particle distribution. Pools and riffles filled in, with run habitat dominating.
Score	**4**	**3**	**2**	**1**
Bank Stability within the active bankfull channel (score each bank)	Banks stable; no evidence of erosion or bank failure; <5% of bank length affected.	Banks moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank length in reach has areas of erosion.	Banks moderately unstable; 30-60% of bank length in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; 60-100% of bank length has erosional scars.
Score Left Bank	**2**	**1.5**	**1**	**0.5**
Score Right Bank	**2**	**1.5**	**1**	**0.5**

Sum of Habitat Scores		Rating Category		
		0 – 7	8 – 14	15 - 20
		☐ Very Impaired	☐ Impaired	☐ Good Condition

FIGURE 7.38. SEM Form. Habitat Assessment.

7.4.19 SITE SKETCH

A sketch of the stream reach provides a visual representation of the general habitat available to the macroinvertebrate community. The site sketch demonstrates the relative proportions of macro-habitats, such as riffles, runs, and pools. It should also display micro-habitats such as woody debris, leaf packs, macrophyte and algae beds, undercut banks, and riparian vegetation. The sketch can also present potential sources of impairment such as areas of bank erosion, and excess sediment in the form of side and mid-channel bars from cut banks or degraded tributaries. The map should be scaled to include the entire study reach, displaying floodplains, terraces, features such as trees, rocks or flood debris, the stream name, date, direction of stream flow, a north arrow, benchmarks, point bars, abandoned channels, and sample locations for water, bugs and pool deposits.

Using an aerial photo of the stream reach can speed up your drawing and make your sketch more accurate.

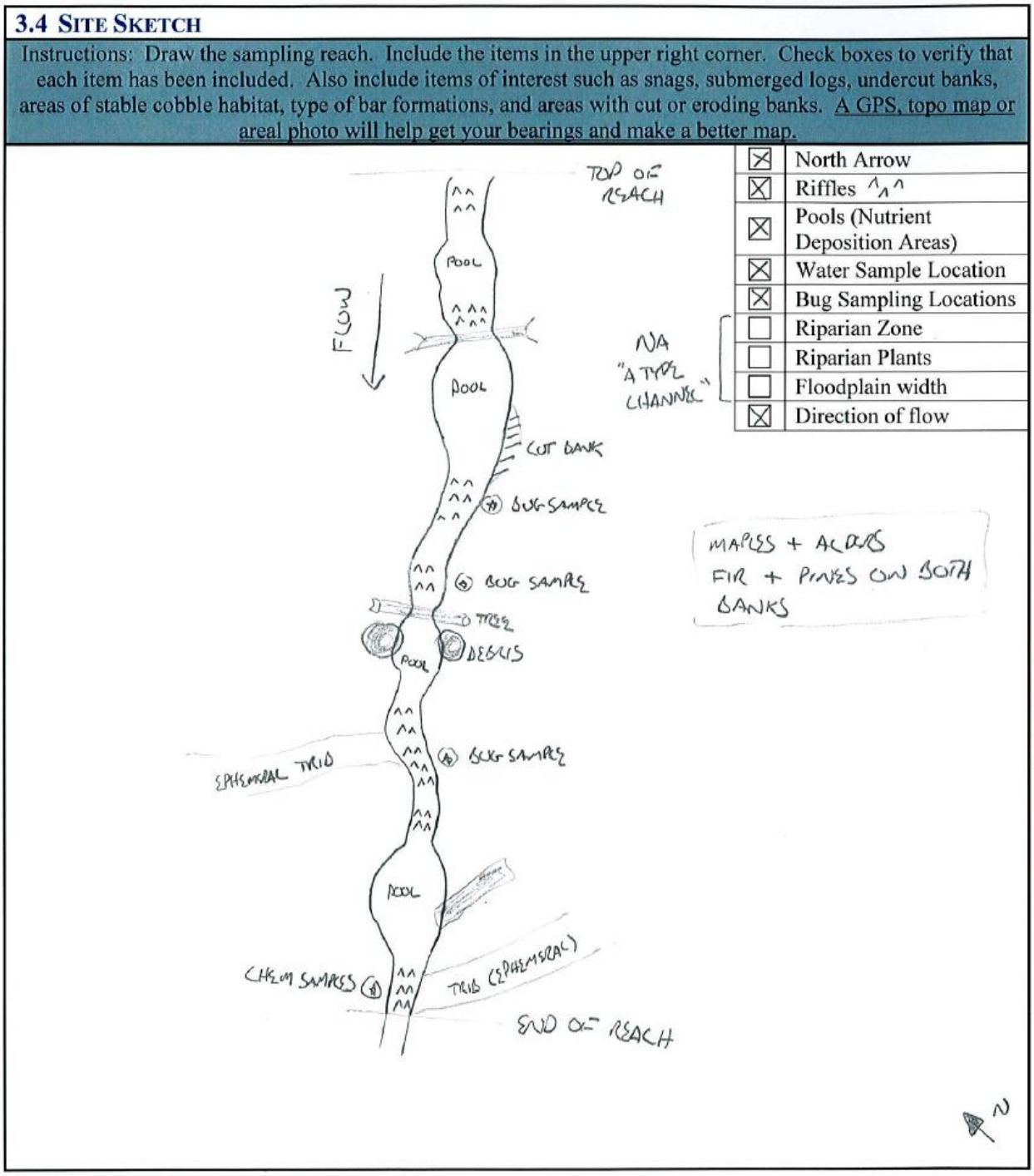


FIGURE 7.39. Site Sketch.

CHAPTER 8 GEOMORPHOLOGY PROCEDURES

A geomorphic assessment of stream channels provides a process-based framework for understanding past and present watershed dynamics. A fluvial geomorphic assessment generally includes data collection, field investigations, and channel stability assessments (USDA, 1998). Much of ADEQ's field methodology is based on or derived from the work of Dr. Dave Rosgen, a consulting hydrologist and author with extensive work and expertise in fluvial geomorphology, with references detailed in Rosgen's text Applied River Morphology (1996). This chapter details those methods.

8.1 STREAM CHANNEL CONDITION

Stream channel condition or state is determined from field inspection and measurement of stream channel characteristics which include: amount, types, and age classes of riparian vegetation, sediment deposition patterns, frequency and amount of debris occurrence, meander patterns, stream size, flow regime, and altered states due to direct disturbance. The depositional pattern is particularly important as a screening level evaluation of excess sediment conditions. Depositional patterns, defined as bar features in alluvial channels, are evaluated and scored for purposes of the Rosgen channel stability index.

8.2 CROSS-SECTION SURVEYS

Cross section surveys are conducted primarily for purposes of identifying Rosgen stream channel type, to represent riffle and pool habitats present in a reach, and to document bank erosion. A riffle cross-section survey is required for identifying stream channel type. Other cross-section surveys may be needed to conduct a Stream Stability Assessment. The riffle cross-section should be located where bankfull and floodprone indicators are present. An illustrated guide to field surveying techniques is provided in Harrelson et al (1994). The following is an abbreviated version of the Harrelson procedure.

Equipment Required: Topcon Rotating Laser Level, stadia or telescoping rod, two pieces of rebar, flagging, camera, GPS unit, fiberglass measuring tape, calculator, laptop computer with spreadsheet or RiverMorph software installed, and cross-section field data sheets.

8.2.1 CROSS-SECTION SURVEYING PROCEDURE USING THE TOPCON ROTATING LASER LEVEL

1. Position the Topcon Rotating Laser Level (FIGURE 8.1) on a promontory near the cross-section to be measured and, if possible, at an elevation above the floodprone depth. The Topcon unit should have an unobstructed view of the cross-section.
2. The first and last measurement should be made at a monumented benchmark, such as found at a USGS gauging station. Use the Cross-Section Survey Form (FIGURE 8.2) to record data. If a monumented benchmark is not available, as will often be the case, you must create a site benchmark having a relative elevation of 100 feet. "Monumented" refers to a benchmark of known and precise elevation and xy coordinates. We establish site benchmarks with relative elevation and unknown xy coordinates. To construct a site benchmark, either pound a piece of rebar into the ground or mark a boulder or a rock

outcropping. The rebar should extend out of the earth approximately two inches. These benchmarks need to be exactly noted on the field sketch with measurements from notable stationary and permanent objects so that they can be found at the next visit. Several photographs of the monumented benchmark and the surrounding area, as well as a GPS reading are useful for re-locating the benchmark.

3. Anchor the measuring tape to the rebar on the left bank, with zero as the starting point at the rebar pin. Using the left bank as zero allows for conventional survey graphing of the cross-section. Run the tape across and perpendicular to the stream channel. Find a place on the opposite (right) bank that is near the same elevation as the first rebar and perpendicular to the direction of flow in the channel. Place a second piece of rebar here. Pull the tape as taut as possible and anchor the tape to the second in-ground rebar. Ensure that the tape is not deflected by vegetation along the cross-section. To prevent the tape from whipping in the wind, tie several pieces of flagging to the tape.

FIGURE 8.1. Rotating laser level.

4. If a USGS or other benchmark is available, shoot its elevation. Use the elevation of the benchmark above mean sea level as the reference elevation for the graphic. If no benchmark is available, start the cross-section at the constructed site benchmark.
5. Shoot the elevation of the constructed site benchmark on the left bank which is the starting point. The stadia rod should be placed on top of the rebar for this measurement. Also collect a measurement at the base of the left bank pin. The station number at this point is zero.
6. Moving downslope and along the cross-section, record the elevations of all relevant features in a field book or form. Relevant features might include changes in slope, edges of water, thalweg, bankfull, floodprone elevation, change in vegetation, etc. The person recording the elevations on the field data sheet must provide a description notation for each measurement in the comments column for each station (e.g., bankfull, LEW, REW, thalweg, top of terrace, bottom of bank). This information is very important when constructing the cross-section graphic
7. At each elevation measurement, record the cross-sectional distance from station 0+00 to the nearest tenth of a foot. Use a bubble level to ensure that the stadia rod is perpendicular to the earth before taking the elevation reading.
8. Shoot the rebar on the right bank at the top and base of the right bank rebar pin.
9. To check the accuracy of the survey, go back to the starting point, either the benchmark or the site benchmark, and shoot that elevation again. The difference between the original elevation and the new calculated elevation is the error. Very small errors may result from rounding and are acceptable. Typically a closure of 0.02 feet is acceptable. Large errors may result from mistakes in calculation, so check the arithmetic first. Other errors may be due to inaccurately reading the rod, or note taking. If the error is too large, the line must be resurveyed to locate and correct the error. To estimate the allowable error, use the following equation.

$$0.007\sqrt{\frac{TotalDISTANCE}{100}}$$

10. Plot the cross-section in the field in a spreadsheet program or RiverMorph software if possible. The plotting of the cross-section in the field is a QC measure. Review the plot to determine if the survey is complete and that the bankfull elevation is reasonable. Resurvey near slope breaks if needed to verify the bankfull elevation or to eliminate possible errors before leaving the site. An example of a completed cross-section diagram is presented in FIGURE 8.3.

Page_____ of ___
Observers:

☐ LONGITUDINAL PROFILE ☐ CROSS-SECTION # _____

Site ID:	Site Name:	Date:

BKF = Bankfull Indicator; **BNKPN** = Top of Bank Pin; **BRIF** = Bottom of riffle; **CL** = Centerline of Channel; **FP** = Floodplain; **HT** = High Terrace; **LB** = Left Bank; **LEP** = Left End Pin; **LEW** = Left Edge Water; **LT** = Low Terrace; **MT** = Middle Terrace; **P** = Pool; **PB** = Point Bar; **RB** = Right Bank; **REP** = Right End Pin; **REW** = Right Edge Water; **TP** = Turning Point; **TRIF** = Top of Riffle; **TW** = Thalweg; **WS** = Water Surface

Station	BS (+)	HI	FS (-)	ELEV.	COMMENTS

FIGURE 8.2. ADEQ Longitudinal Profile and Cross-section survey field form. Only fill in the white areas. Grey areas can be filled in back in the office.

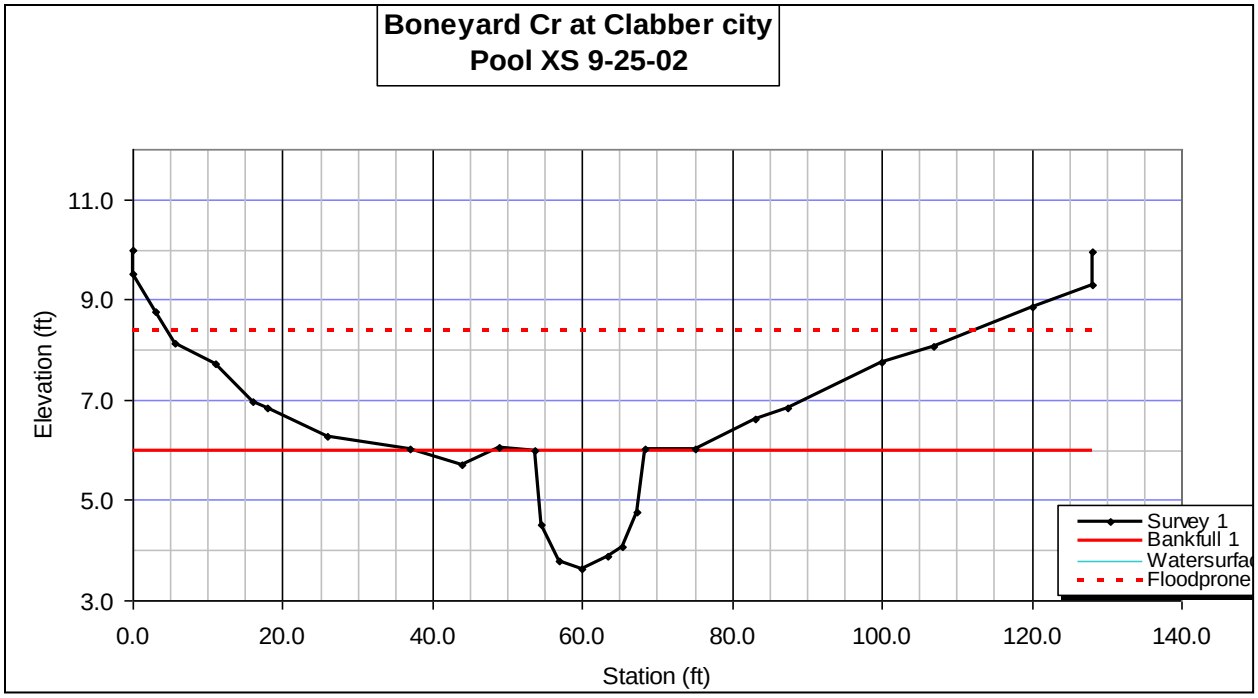


FIGURE 8.3. Example of Cross-section survey. Point of observation is looking downstream while station 0, 0 corresponds to the left bank.

8.3 LONGITUDINAL PROFILE PROCEDURE

The procedure described here is an extract of that described in Stream Channel Reference Sites: An Illustrated Guide to Field Technique (Harrelson, et al, 1994). For a detailed description of the procedure, see that publication.

The placement of the laser level and tripod should be planned in advance such that as many points along the channel can be taken without using a turning point. When a turning point is required there is the possibility of introducing error to the measured profile. The profile is best measured with two observers; one to operate the rod and one to record the measurements on the field form (FIGURE 8.4). If a total station is used, the recorder also operates the total station.

The ideal location for measuring a profile is one that has unobstructed views from the laser level to the extendable rod; a condition that may only exist on meadow streams and channels that have been denuded of vegetation. Since unobstructed views along stream channels are rare, a survey of the selected reach should be conducted to ascertain the best placement of the laser level, usually at a high point (e.g., high bank or hill), and one that the extendable rod can reach for interception of the laser beam. Where high points are unavailable or dense vegetation exists, some clearing of tree limbs and brush may be required, but kept to a minimum.

The length of the profile reach is usually determined by the need for the measurements. At a minimum, the profile should not be less than twenty times the bankfull width or two channel meander wavelengths. A long profile reach will better represent the slope of the profile and minimize local disturbances in the channel.

If a benchmark of known elevation is available, then the benchmark is the elevation reference point (backsight; BS) from which all feature elevations (foresight; FS) are determined. The "…height of instrument (HI) is the elevation of the line of sight projected by the instrument. It can be found by adding the backsight rod elevation to the known (or assumed) elevation of the benchmark or the point on which the backsight was taken" (Harrelson et al, 1994). Where benchmarks are available, the elevation of the first feature is the elevation of the reference point. Typically, this is given an elevation of 100 feet. If the laser beam is 4.5 feet above the reference elevation, the height of instrument is 104.5 feet. All foresight rod readings are subtracted from the height of instrument to obtain feature elevations.

As the observers move downstream and move out of range of the laser level or encounter vegetation obstructions, a turning point must be made to continue the survey. A turning point (TP) "…is a reliable point upon which a foresight is taken to establish elevation. A backsight is then made to establish a new HI (Height of Instrument) and to continue a line of levels. The turning point retains the same elevation while the instrument is moved. Set the rod on a turning point (the last measured elevation) and record the foresight. Move the instrument as the rod stays in place. Make a backsight and record it" (Harrelson et al, 1994). It is critical when employing a turning point to continue a survey that the rod stays in-place at the last measured elevation while the laser level is repositioned.

The survey begins at the top of the reach where the end of fiberglass tape is anchored and the tape laid along the path of the thalweg. Measured elevation points, recorded as rod height, are determined by channel morphology. The distance from the end of the tape to the measured features is recorded as stations. When the reel end of the tape has been reached, the tape is again repositioned along the thalweg for the next downstream leg of the survey. This procedure is repeated until the entire reach has been surveyed. Water surface, banks, channel and/or water edges, and terraces are typically measured at the same stations as the bed features. It is important this process not be rushed and that enough time be allocated to complete the entire profile. Care should be taken to locate, as accurately as possible, the location of a new feature and the maximum depth of a pool. The latter measurement is especially important if pool facet slopes are to be calculated off the profile.

An alternative method of measuring a profile is a "leapfrogging" method where the length of each feature is measured separately. This method is best employed with three observers and two extendable rods. The first observer measures the elevation of point one (e.g., top of pool) and holds one end of the tape. The second observer moves to the second feature point (e.g., maximum pool depth) with the other end of the tape. The elevation of the second point is measured as well as the distance between the two features. The third observer records the feature callout, length, and rod height measurements. The first observer then moves to the third point (e.g., top of run) bringing the end of the tape to the next feature, where the elevation and feature length is measured. The "leapfrogging" continues to the end of the reach. Water surface, low banks, bankfull, and terraces are typically measured at the same stations as the features or wherever good indicators exist along the profile.

From the field profile survey form (FIGURE 8.3), elevations of geomorphic features are calculated. Plots of the profile are made with either RiverMorph or Excel software from which geomorphic analyses are made.

8.4 CHANNEL VERTICAL STABILITY ASSESSMENT USING THE BANK HEIGHT RATIO

A channel that is entrenched or vertically contained cannot access its floodplain and will experience bank erosion at bankfull or greater flows. The bank height ratio (BHR) is a measure of the degree of incision of the study channel. Bank height ratio is defined as the ratio of the low bank height divided by the maximum bankfull depth at that cross-section (Rosgen, 2001a). Low bank height is any substantial bank above bankfull maximum depth. The ratio can be calculated from a single riffle or pool cross-section survey. Ideally, a longitudinal profile delineating numerous low bank and maximum bankfull heights provides an accurate bank condition assessment. Use the maximum value of all available BHR data in the study reach for the final scoring criterion as shown in TABLE 8.1. The scoring criterion for BHR is used to evaluate the range of conditions from vertically stable to unstable, as per Rosgen (2001).

Bank height ratio	Stability rating	Sediment supply category	Sediment supply score
1.0 – 1.1	Stable	Low	2
1.11 – 1.3	Moderately unstable	Moderate	5
>1.3	Unstable	High	10

TABLE 8.1. Bank height ratio scoring criteria.

8.4.1 BANK HEIGHT RATIO PROCEDURE

1. Conduct cross-section surveys at both riffle and pool cross-sections, identifying the low bank height and bankfull elevations. Then divide the low bank height reading by the bankfull maximum depth at the cross-section to obtain the bank height ratio for each respective location.
2. Conduct a longitudinal profile, incorporating measurements of low bank heights and bankfull elevations. Plot the profile data. Then calculate bank height ratio wherever low bank height data points were collected, using the bankfull elevation line plotted on the graph.
3. Use Rosgen's scoring criteria in TABLE 8.1 to determine the stability rating, sediment supply category and sediment supply score. The sediment supply score is then used in the final 6-parameter stability assessment score.

8.5 CHANNEL LATERAL STABILITY USING THE BANK ERODIBILITY HAZARD INDEX AND NEAR BANK STRESS RATIOS

Bank erosion is congruent with natural river processes; however, lateral migration rates of stream channels can be accelerated when variables controlling bank erosion processes are altered. The

Bank Erosion Hazard Index (BEHI) provides an estimate of bank stability or stream bank erosion potential through measurement of eight parameters. Rosgen's BEHI index (Rosgen, 1996) addresses the ability of stream-banks to resist erosion through measurement of the following variables:

1. Stream bank height to bankfull height ratio
2. Riparian vegetation rooting depth to stream bank height ratio
3. Rooting density
4. Stream bank angle or slope
5. Bank surface protection by debris and vegetation
6. Composition of bank materials
7. Stratification of bank materials and presence of soil lenses
8. Shear stress in the near bank region.

The first seven variables are scored according to Rosgen's BEHI method at riffle and pool cross-sections. As a final step, near bank stress (NBS) is calculated. A reach BEHI assessment is then performed. Additional BEHI /NBS surveys are performed if different bank types are encountered. The number of linear feet in each BEHI category is multiplied by the predicted erosion rate for that bank type and summed for an estimate of soil loss for the whole study reach. A predicted bank erosion rate is obtained by locating the BEHI and NBS categories on a graph of empirical bank erosion data. Graphs developed by Rosgen integrate the potential for bank erosion with the sheer stress directed at the bank by stream flow (Near Bank Stress) to predict an average annual erosion rate. The dominant BEHI and NBS categories determine which sediment supply category applies, as shown in the scoring criteria in TABLE 8.2 (Rosgen, 2001c).

Dominant categories		Stability rating	Sediment supply category	Sediment supply score
BEHI	NBS			
Low	Low	Stable	Low	5
Low	Moderate			
Low	High	Moderately Unstable	Moderate	10
Low	Extreme			
Moderate	Low			
Moderate	Moderate			
Moderate	High	Unstable	High	20
Moderate	Extreme			
High	Moderate			
High	High			
High	Extreme			
Extreme	Extreme			

TABLE 8.2. Bank Erosion Hazard Index and Near Bank Stress scoring criteria.

Required equipment: Laser level, two surveying rods, receiver, bubble levels, and Bank angle indicator/compass.

Bank Erosion Hazard Index (BEHI) Procedure

This procedure provides a description for each parameter in the BEHI as well as for the Near Bank Stress (NBS). The BEHI model uses several physical attributes of a bank to determine Bank Erosion Potential (BEP). Bankfull stage is used as a common point for this characterization. Bankfull stage is used as a common reference point because it is the primary channel-shaping or channel flow in the Rosgen system and can be identified in the field. The study bank, for purposes of the BEHI evaluation, is defined as a three foot (one meter) wide section of bank that is intersected by bankfull stage. Bank Erosion Potential is determined using the following field protocols.

1. **Total bank height divided by bankfull height (ft/ft).** Total bank height is the vertical measurement from base of bank to top of bank. All bank height measurements begin where the slope of the bank meets the bed. Measure the height of the continuous bank intersected by bankfull stage. If a second bank is set back in a terrace away from the bankfull bank, it is not included in measuring height. Bank height is most accurately measured using a laser level and surveying rod and receiver, as part of a cross-section survey. Bank height can alternatively be measured with two rods and bubble levels as part of a bank profile, though this method is less accurate. To calculate this metric, total bank height is divided by the bankfull stage at that bank profile location. Both values plus the metric value must be recorded on the BEHI form.
2. **Root depth divided by bank height (ft/ft).** Root depth is defined as the depth of root mass providing stability to the bank. Long individual roots are not considered in root depth because these are not thought to add significant strength to the bank. On sloping or vegetated banks, overall root depth is generally assumed to be equivalent to the bank height, but is verified by surficial digging and exposing the roots of the dominant vegetation. Root depth is most accurately measured from the top of bank to the bottom root depth using a laser level and surveying rod and receiver, as part of a cross-section survey. Rooting depth can alternatively be measured with two rods and bubble levels as part of a bank profile. To calculate this metric, rooting depth is divided by the total bank height at that cross-section. The root depth plus the metric value should be recorded on the BEHI form.
3. **Root Density (%).** The root density is defined as the ratio of the root mass surface area to the total bank surface area. Root density on sloping, well-vegetated banks (native grasses, sedges and riparian trees) is typically near 100%. The root density value will be similar to the surface protection value when banks are well protected by vegetation. In cut banks with high erosion potential, there may be some root density above the bankfull elevation, but none below it. In such cases, make a weighted estimate of the whole bank root density by considering both the density in the upper soil layer and also the rooting depth. Scrape away the loose soil to expose roots, in order to properly evaluate root density. Make a visual estimate of root density, using rooting depth to assist the evaluation in cut banks.
4. **Bank Slope (ft/ft).** Bank slope or angle is measured in degrees from the horizontal of the streambed. Bank slope is defined as rise over run from the toe of the bank to the top of the continuous bank intersected by bankfull stage. A vertical bank is 90 degrees. Bank slope can be measured with a clinometer, a compass, or a bank angle indicator. It can also be calculated from a cross-section graph, using the formula of Δ rise/Δ run. If there are

two distinctly different bank angles on a bank, use the steepest slope to evaluate this parameter.

5. **Surface Protection (%).** Surface protection is defined as the percentage of the bank surface protected by vegetation, root wads, large boulders or other resistant materials which protects the bank from eroding due to freeze and thaw action. Materials such as car bodies or uprooted tree trunks, which may contribute to bank erosion by redirecting high velocity toward the bank are not included as surface protection. Surface protection on sloping, well-vegetated banks is generally considered to be near 100%. In alluvial streams, surface protection will be similar to root density values.
6. **Bank Materials**. The BEHI score is adjusted for composition of bank materials. Where banks are composed of bedrock and boulders, no adjustment is made. Where banks are dominated by cobble, subtract 10 points from the BEHI score. Where cobble banks consist of a mixture of sand and gravel, no adjustment in BEHI score is made. For gravel dominated banks, add 5 points to the BEHI score. For banks dominated by sand, add 10 points. For silt/clay dominated banks no adjustment to BEHI score is made.
7. **Bank Stratification**. The BEHI score is adjusted for soil stratification layers which contribute to bank erosion potential. In a cut bank, unstable layers of sand and gravel, especially at or below the bankfull level, contribute to bank erosion potential. Add 5-10 points depending on the number of layers and position of the unstable layers in relation to the bankfull stage. Typically, five points are added when there is one unstable layer, and ten points for two or more unstable layers.
8. **Calculation of BEHI score**. Rosgen (1996) developed a 1-10 scoring system for each of the seven metrics, with a sum total BEHI score of 5 - 50 (TABLE 8.3). This scoring system is included in the specialized BEHI field form (Rosgen, 2001a). The total BEHI scores give the following rating categories.

BEHI Total Score	BEHI Category
5 – 9.5	Very Low
10 – 19.5	Low
20 – 29.5	Moderate
30 – 39.5	High
40 – 45	Very High
46 - 50	Extreme

TABLE 8.3. Bank Erosion Hazard Index rating categories

Bank Erodibility Hazard Index - Rating Guide

Stream | Reach | Date | Crew

Bank (LB or RB) | Bank Description

Bank Erosion Potential		Bank Height (ft): / Bankfull Height (ft):	Bank Height/ Bankfull Ht	Root Depth/ Bank Height	Root Density %	Bank Angle (Degrees)	Surface Protection%
VERY LOW	Value		1.0-1.1	1.0-0.9	100-80	0-20	100-80
	Index		1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9	1.0-1.9
	Choice		V: I:	V: I:	V: I:	V: I:	V: I:
LOW	Value		1.11-1.19	0.89-0.5	79-55	21-60	79-55
	Index		2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9	2.0-3.9
	Choice		V: I:	V: I:	V: I:	V: I:	V: I:
MODERATE	Value		1.2-1.5	0.49-0.3	54-30	61-80	54-30
	Index		4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9	4.0-5.9
	Choice		V: I:	V: I:	V: I:	V: I:	V: I:
HIGH	Value		1.6-2.0	0.29-0.15	29-15	81-90	29-15
	Index		6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9	6.0-7.9
	Choice		V: I:	V: I:	V: I:	V: I:	V: I:
VERY HIGH	Value		2.1-2.8	0.14-0.05	14-5.0	91-119	14-10
	Index		8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0	8.0-9.0
	Choice		V: I:	V: I:	V: I:	V: I:	V: I:
EXTREME	Value		>2.8	<0.05	<5	>119	<10
	Index		10	10	10	10	10
	Choice		V: I:	V: I:	V: I:	V: I:	V: I:
V = value, I = index					**SUB-TOTAL** (Sum one index from each column)		

Bank Material Description:

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
Gravel (Add 5-10 points depending percentage of bank material that is composed of sand)
Sand (Add 10 points)
Silt Clay (+ 0: no adjustment)

BANK MATERIAL ADJUSTMENT

Stratification Comments:

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

STRATIFICATION ADJUSTMENT

VERY LOW	LOW	MODERATE	HIGH	VERY HIGH	EXTREME
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

Bank location description (circle one)
Straight Reach Outside of Bend

GRAND TOTAL
BEHI RATING

FIGURE 8.4. Bank erodibility hazard index.

8.5.1 NEAR BANK STRESS PROCEDURE

The erosive force against a bank is actually the shear stress contributed by the stream flow. Shear Stress in a stream is defined as the specific weight of water multiplied by the hydraulic radius and water surface slope. Slope should refer to the water surface at bankfull stage. Hydraulic radius is

defined as the cross-sectional area divided by the wetted perimeter. Bank erosion potential increases directly with increases in the ratio of near bank stress to channel shear stress.

There are several methods for estimating or calculating near bank stress for any given bank in the study reach. Rosgen (2003) identified seven methods, associated with Level I through Level IV field assessment procedures. The Near Bank Stress procedure from the Rosgen suite of methods is given below. Near bank stress is characterized by a ratio of the shear stress in the 1/3 of the channel nearest the eroding bank to the entire cross-sectional shear stress. The following measurements are required to calculate the shear stress ratios:

1. Mean depth at a cross-section
2. Average water surface slope for reach
3. Water surface slope in near bank region for that habitat type (e.g. pool), and
4. Nar bank maximum depth.

This ratio of near bank to mean channel shear stress is then categorized similarly as the BEHI scores, as very low to extreme, as shown in TABLE 8.4.

NBS Ratio	NBS Category
<0.8	Very Low
0.8 – 1.05	Low
1.06 – 1.14	Moderate
1.15 – 1.19	High
1.2 – 1.6	Very High
>1.6	Extreme

TABLE 8.4. Near Bank Stress rating categories.

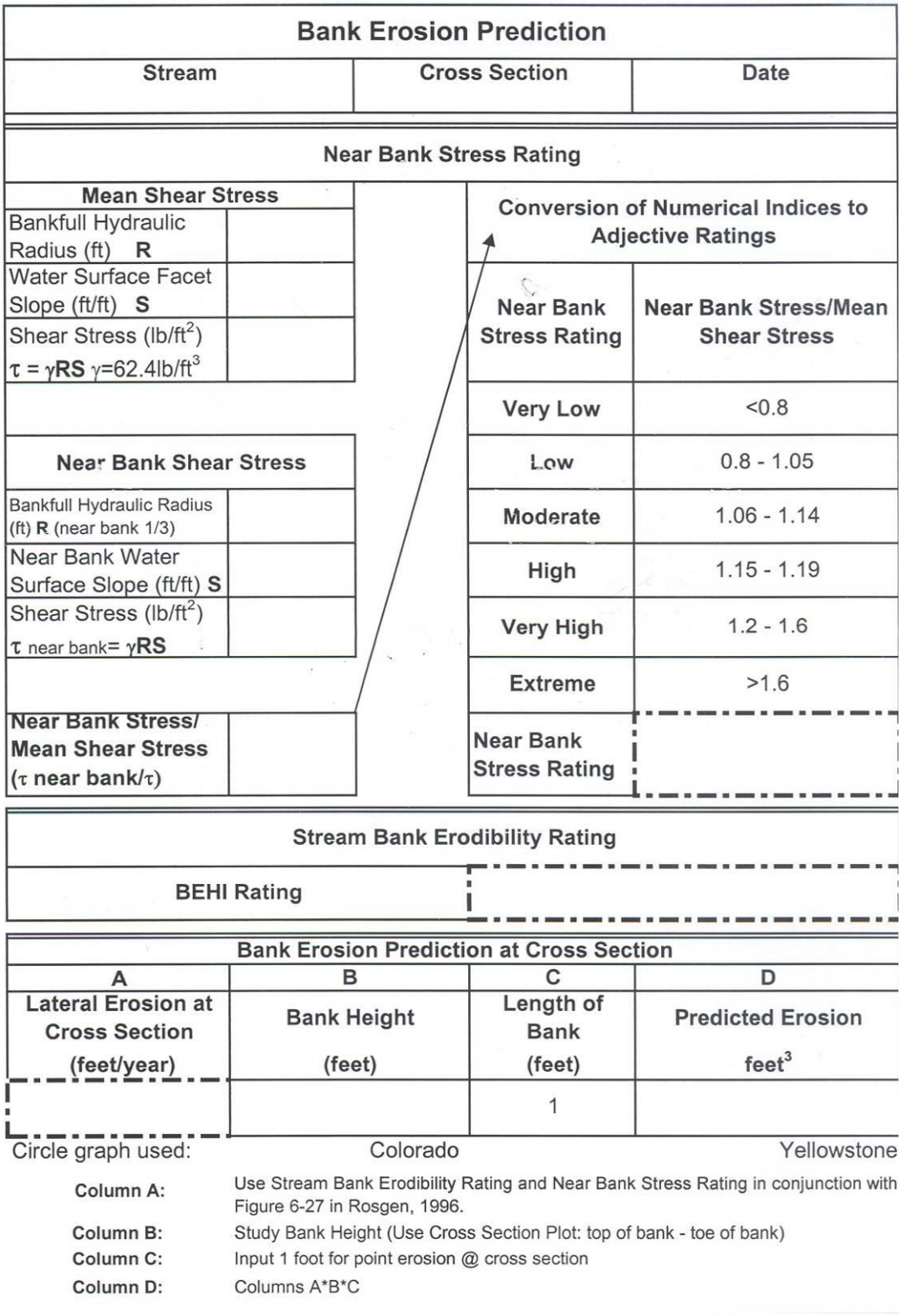
1. **Field Measurements.** A cross-section survey is needed to calculate cross-sectional area, wetted perimeter and hydraulic radius at bankfull elevation. A longitudinal profile is also needed to calculate the water surface slope of the reach and the water surface slope in the near bank region. Average water surface slope is measured along the thalweg of the whole study reach, beginning and ending at the top of riffle feature. The water surface slope in the near bank region is measured at the top and bottom of the bed feature in which the cross-section lies (e.g. Riffle, run or pool habitat feature). Elevation measurements are collected at the thalweg on the stream bottom and at the water surface at the upstream end of the feature, such as top of pool and also at the downstream end of the feature, below the cross-section. If the stream is dry, take thalweg measurements one bankfull width upstream and downstream of the cross-section location.
2. **Calculations.** After plotting the cross-section profile, extract the necessary variables to calculate mean shear stress and near bank stress. Cross-sectional area and mean depth are first calculated. Bankfull mean depth is the ratio of bankfull cross-sectional area to bankfull width. Then, hydraulic radius of both the channel and the near bank region is calculated by dividing cross-sectional area by wetted perimeter (width plus 2 times mean depth). Values for the near bank shear stress and average reach shear stress are calculated by multiplying water surface slope, hydraulic radius, and the weight of water (Rosgen, 2001c). The ratio of near bank shear stress to average shear stress is calculated and the

NBS category determined from the ratio indicated in TABLE 8.4. Alternately, measurements can be entered into "RiverMorph" software, which performs the shear stress calculations (RiverMorph LLC, 2002).

3. **Predicted bank erosion.** Rosgen (1996) produced two different graphs to integrate the BEHI and NBS scores and categories into a predicted bank erosion rate (FIGURE 8.6). The predicted bank erosion rate (ft/year) is plotted against both the NBS category and BEHI regression line in these graphs. This predicted lateral erosion rate is then multiplied by the bank height and length in the reach for a bank soil loss estimate (ft3/year) as shown in the form in FIGURE 8.6. This predicted soil loss estimate is then determined for each bank type in the reach and summed for a total soil loss estimate for the entire reach (FIGURE 8.8). Moody et al. (2003) determined that the Colorado USFS 1989 graph (FIGURE 8.7) worked best in Arizona for predicting bank erosion rates, which were verified in a BEHI validation study of over 40 sites in the Verde and San Pedro River basins.

4. **Measured bank erosion**

   Actual bank erosion rates are measured with the use of multiple bank pins placed along eroding banks. Pin lengths protruding from the bank are remeasured after major storm and flow events. One or more bank pins (4' x 3/8" smooth rebar) are installed horizontally into bank material at bankfull elevation or above and below bankfull at each cross-section. Each cross-section represents a different common bank type occurring in the reach. In addition, bank pins are placed at upstream and downstream locations from the cross-section location in order to obtain an average bank loss from a minimum of three bank pins in that bank type. The length of the bank pin exposed after each flood event indicates the amount of bank material lost at that cross-section. The average bank loss is then multiplied by the length of that bank type for the total erosion rate (ft3/yr).



Bank Erosion Prediction

Stream	Cross Section	Date

Near Bank Stress Rating

Mean Shear Stress	
Bankfull Hydraulic Radius (ft) **R**	
Water Surface Facet Slope (ft/ft) **S**	
Shear Stress (lb/ft^2) $\tau = \gamma RS$ γ=62.4lb/ft^3	

Near Bank Shear Stress	
Bankfull Hydraulic Radius (ft) **R** (near bank 1/3)	
Near Bank Water Surface Slope (ft/ft) **S**	
Shear Stress (lb/ft^2) τ near bank= γRS	

Near Bank Stress/ Mean Shear Stress (τ near bank/τ)	

Conversion of Numerical Indices to Adjective Ratings

Near Bank Stress Rating	Near Bank Stress/Mean Shear Stress
Very Low	<0.8
Low	0.8 - 1.05
Moderate	1.06 - 1.14
High	1.15 - 1.19
Very High	1.2 - 1.6
Extreme	>1.6
Near Bank Stress Rating	

Stream Bank Erodibility Rating

BEHI Rating	

Bank Erosion Prediction at Cross Section

A	B	C	D
Lateral Erosion at Cross Section (feet/year)	Bank Height (feet)	Length of Bank (feet)	Predicted Erosion feet^3
		1	

Circle graph used: Colorado Yellowstone

Column A: Use Stream Bank Erodibility Rating and Near Bank Stress Rating in conjunction with Figure 6-27 in Rosgen, 1996.

Column B: Study Bank Height (Use Cross Section Plot: top of bank - toe of bank)

Column C: Input 1 foot for point erosion @ cross section

Column D: Columns A*B*C

FIGURE 8.6. Near Bank Stress (NBS) rating and Bank erosion prediction form by Rosgen (2001a).

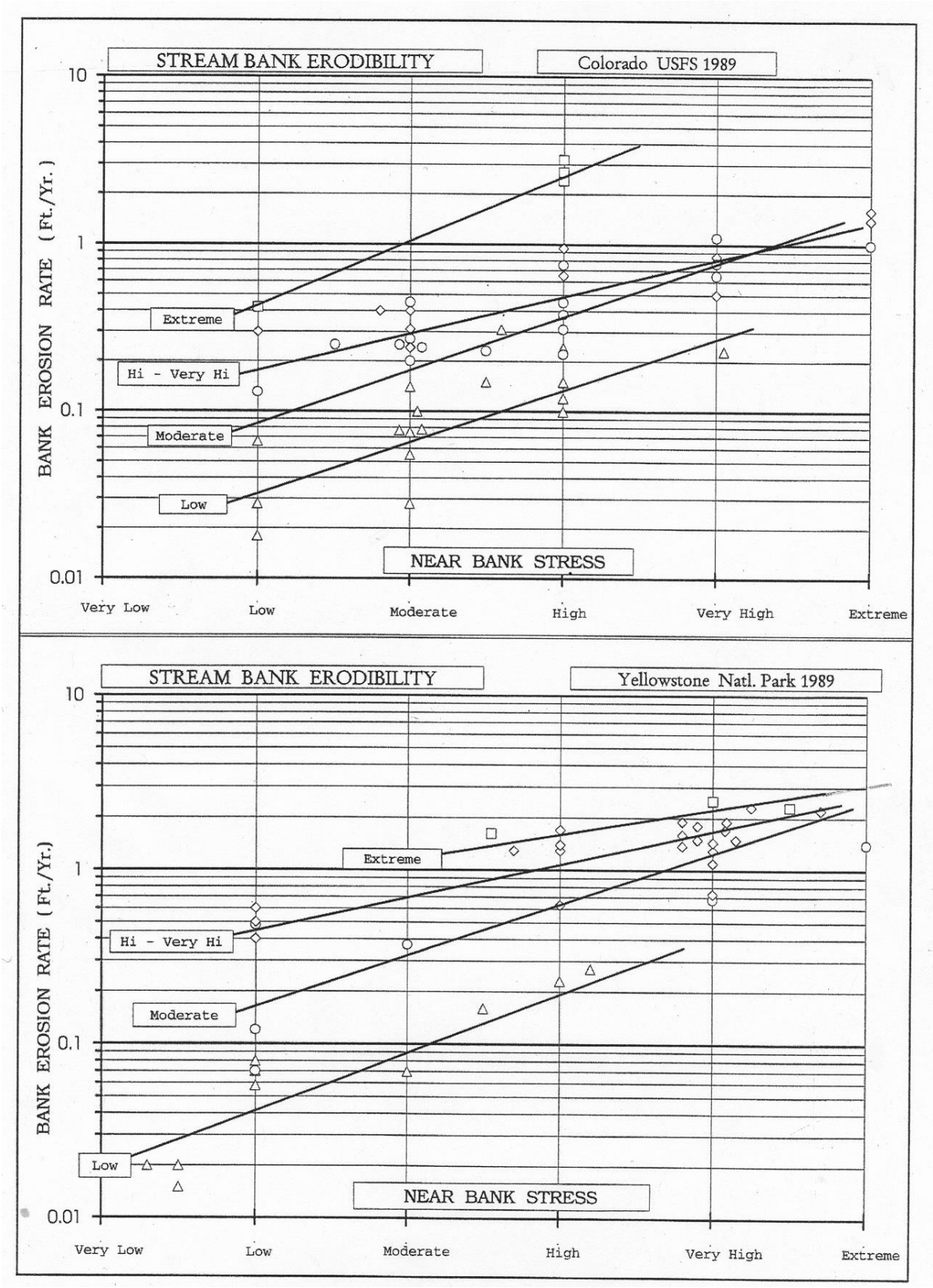


FIGURE 8.7. Bank erosion rate prediction graphs by Rosgen (1996).

Total Bank Erosion Calculation

Stream:			Total Bank Length:		Stream Type:	
Observers:			Date:		Graph Used:	
	BEHI (adjective)	**Near Bank Stress (adjective)**	**Erosion Rate (ft/yr)**	**Length of Bank (ft)**	**Bank Height (ft)**	**Erosion Sub-Total (ft^3/yr)**
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
I. Sum erosion sub-totals for each BEHI/NBS combination					**Total Erosion (ft^3/yr)**	
II. Divide total erosion ($feet^3$) by 27 $feet^3/yard^3$					**Total Erosion (yd^3/yr)**	
III. Multiply Total Erosion ($yard^3$) by 1.3 (conversion of yd^3 to tons for average material type)					**Total Erosion (tons/year)**	

FIGURE 8.8. Bank erosion calculation.

8.6 CHANNEL PATTERN

A well developed and appropriate meander pattern is important for maintenance of stream channel stability. Channel pattern measurements include: meander length, belt width, radius of curvature, meander width ratio, arc length, arc angle, ratio of radius of curvature to bankfull width, ratio of meander length to bankfull width, and sinuosity. These data are determined from measurements of stream channel characteristics obtained from ortho-photo quad maps or aerial photos. Measurements can alternately be collected in the field, but only in locations where the lack of vegetation allows.

Channel pattern parameters are important for comparison of study sites to reference sites and for restoration design; however, they are not scored and used in Rosgen's channel stability index. When the reference reach data for the same valley and stream type differ in watershed size, values for channel pattern parameters can be converted to dimensionless ratios by dividing by bankfull width. A large departure from meander reference values indicates instability as the stream channel evolves to a more stable form (e.g. lateral instability results from inadequate meander width or small radius of curvature ratios). Down-valley meander migration and excessive near-bank stress due to ratios of radius of curvature/bankfull width values of less than 2.0 indicate channel adjustment due to instability.

8.6.1 CHANNEL PATTERN PROCEDURES

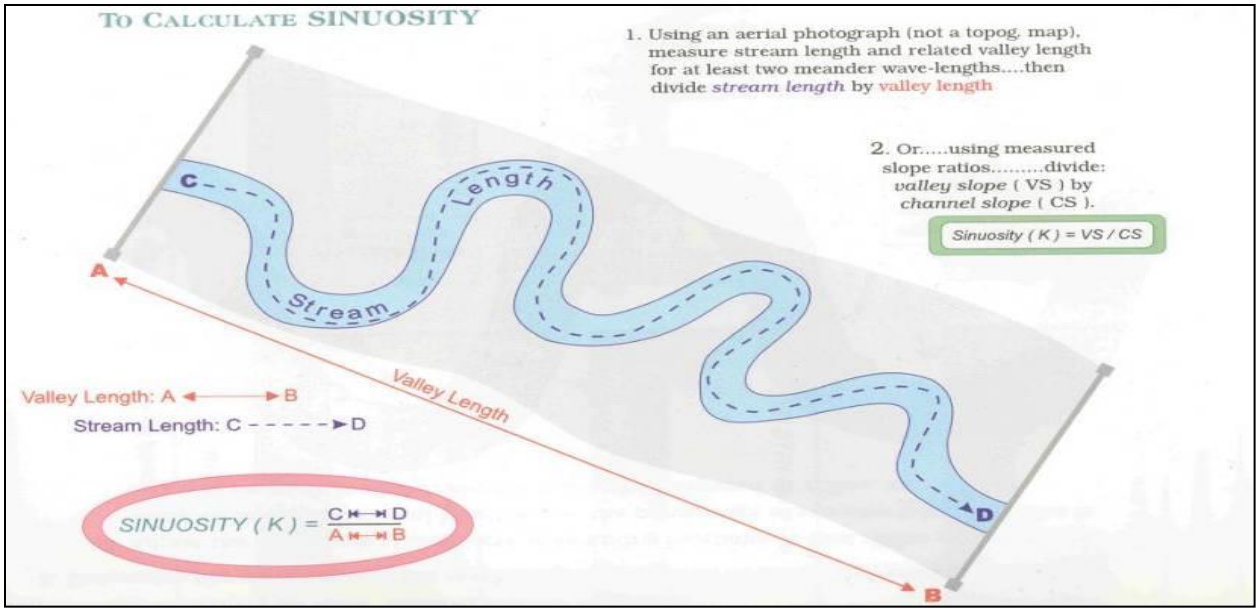


FIGURE 8.9. Measurements needed to calculate river sinuosity (after Rosgen and Silvey, 1998).

1. A narrative description of meander pattern is selected from Rosgen's (1996) Level III form "Meander Patterns". Identification of meander pattern is best performed by inspection of recent aerial photographs or ortho-photo quads. Topographic maps can also be used but they typically provide only an historic perspective.

2. Sinuosity is defined as the ratio of meandering channel length to straight-line valley length and indicates how the stream has adjusted its slope to that of its valley. Sinuosity is best measured from recent aerial photographs or ortho-photo quads. Use a stream length that is at least two meander wavelengths for the measurement (FIGURE 8.9). The greatest sinuosity is found in a highly meandering "E" type alluvial channel, whereas the least sinuosity is common in "A" type high relief, entrenched streams.

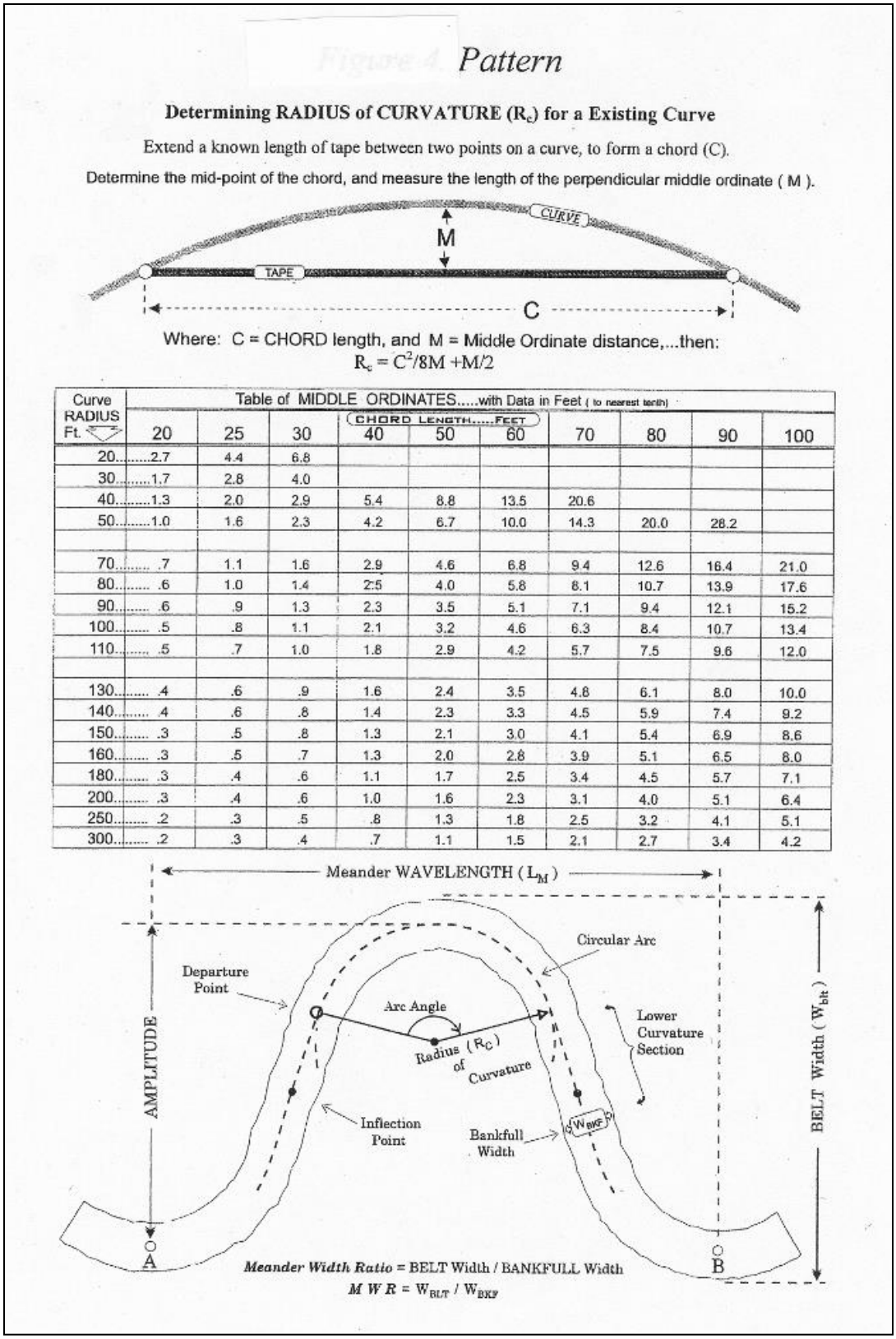


FIGURE 8.10. Measurements needed to calculate river meander geometry (Rosgen, 2001).

3. Meander wavelength (Lm) is the linear downstream distance of one river meander as shown in FIGURE 8.10. Collect several field measurements or a minimum of three measurements from recent aerial photographs or ortho-photo quads. Calculate minimum, maximum and average values for ratio of meander wavelength / bankfull width. Distance values ranging from 10-14 bankfull widths are common for an individual meander wavelength.
4. Meander belt width (Wblt) is the width of a meander from outside bend to outside bend. Collect several measurements or a minimum of three measurements from recent aerial photographs or ortho-photo quads. Meander width ratios can then be calculated by dividing the belt width / bankfull width. Obtain minimum, maximum and average values.
5. The radius of curvature is used to evaluate channel resistance to erosion and meander migration rates. Collect several field measurements or a minimum of three measurements from recent aerial photographs or ortho-photo quads. Radius of curvature is defined by the following formula:

$$R_c = \frac{L_m K^{-1.5}}{13(K-1)^{0.5}}$$

where: R_c = radius of curvature in feet
Lm = meander length in feet
K = sinuosity

Another technique for field measurement is establishing the Chord length/mid-ordinate ratio as shown in FIGURE 8.10. Chord length is the measured distance between two points along the river meander. To determine the mid-ordinate, locate the mid-point of the chord, then measure the length of the perpendicular middle ordinate. The formula for calculating radius of curvature from these measurements is as follows:

$$R^c = \frac{C2}{8M} + \frac{M}{2}$$

where: R_c = radius of curvature in feet
C = Chord length in feet
M = Mid-ordinate distance in feet

8.7 CHANNEL DIMENSION RELATIONS USING WIDTH/DEPTH RATIOS

The ratio of the riffle cross-section width/depth of a study reach to the width/depth ratio of a reference reach provides a measure of vertical stability. A reference reach is one that is either unimpaired or least impaired. A least impaired reach is one that is as close to being unimpaired as can be found in the area of the study reach. The bankfull width/mean bankfull depth ratio is obtained from riffle cross-section data. Increases in width/depth ratio are often associated with channel aggradation due to accelerated stream bank erosion, excess sediment deposition and channel widening, which commonly occur in "C" type alluvial channels. Decreases in width/depth ratio can indicate channel incision, as for example when a "B" type channel degrades into a "G" type channel. The width/depth ratio is one of the six variables used and scored for

purposes of the Rosgen channel stability index and the TABLE 8.5 presents scoring criteria for evaluating stability using this variable (Rosgen, 2001).

Width/depth ratio / Reference w/d ratio	Stability rating	Sediment supply category	Sediment supply score
< 1.4	Stable	Low	2
1.4 – 1.7	Moderately unstable	Moderate	5
> 1.7	Unstable	High	10

TABLE 8.5. Scoring criteria for evaluating channel stability.

8.7.1 FIELD AND ANALYTICAL PROCEDURES

1. Conduct a cross-section survey at the study reach as indicated in Harrelson et al. (1994), identifying bankfull features.
2. Using a spreadsheet program, calculate bankfull cross-sectional area, and divide it by bankfull width to determine bankfull mean depth.
3. Calculate width/depth ratio by dividing bankfull width by bankfull mean depth.
4. For the reference reach width/depth ratio, use either a local reference site on a similar stream type, the Rosgen guidance provided in FIGURE 8.11, or use regional mean ratios by channel type (Moody et al., 2003).
5. Calculate the ratio of the study reach width/depth ratio to the reference reach width/depth ratio and apply stability ratings given in the table above for purposes of the Rosgen stability index.

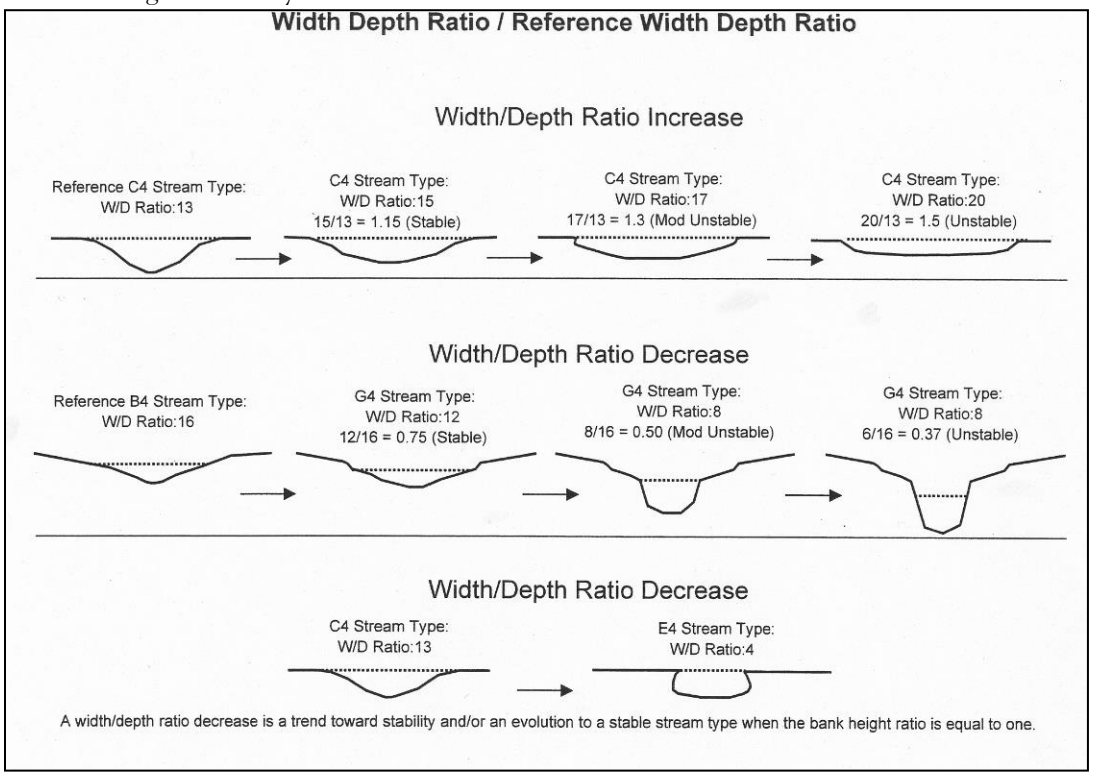


FIGURE 8.11. Examples of increases and decreases in width/depth ratios to reference condition that indicate impairment of stream stability (Rosgen, 2001).

8.8 STREAM CHANNEL SCOUR AND DEPOSITION POTENTIAL

Adequate sediment transport is an essential component for maintenance of a stable channel. If either the channel depth or slope is less than needed to move the largest particle size of a bar sample, then aggradation or excessive deposition and a high width/depth ratio will occur. If the depth or slope exceeds that required to move the largest particle size, then degradation or excess scour may lead to channel incision. Sediment competence is determined by measuring the ability of a riffle cross-section to transport the largest particle in motion at bankfull stage. Though sediment competence is not one of the 6 variables in Rosgen's Stability Index, it is an important measure of vertical stability for alluvial stream channels, and can be used separately to evaluate channel stability. Implicit in this procedure is the assumption that bankfull discharge is responsible for transporting the greatest volume of sediment over time; that the bankfull discharge is the "effective discharge".

8.8.1 SEDIMENT COMPETENCE PROCEDURE

Field methods require collection of a pebble count from the riffle cross-section, sieve analysis of a bar sample collected from a bankfull bar feature or sub-pavement sample, and a longitudinal profile. The bar sample must be collected from the lower third of a bankfull bar at an elevation halfway between bankfull stage and the channel thalweg as indicated in FIGURE 8.12 (Rosgen, 2001a). The sub-pavement sample should be collected at the head of a riffle on either side or the thalweg. Critical dimensionless shear stress is calculated from the median particle sizes from both the riffle pebble count and the bar sample, using the following formula as described by Rosgen (2001).

$$\tau_{ci} = 0.0834\left(\frac{d_i}{d_{50}}\right)^{-0.872}$$

where: τci = critical dimensionless shear stress
d_i = median diameter of riffle bed material in mm.
d_{50} = median diameter of bar sample in mm.

The Shield's formula is used to calculate the bankfull mean depth needed to entrain the largest particle size in the bar sample, utilizing the largest particle size from the bar sample sieve test and the water surface slope of the study reach. The following formula is used to calculate the required bankfull mean depth (Rosgen, 2001). Scores in the following table indicate when a channel is in stable, aggrading or degrading condition.

$$D_r = (\tau_{ci} * 1.65 * d_i) S_e$$

where: D_r = bankfull mean depth in feet
τ_{ci} = critical dimensionless shear stress
d_i = median diameter of riffle bed material
S_e = existing water surface slope of study reach

Slope evaluation	Depth evaluation	Stability category

Slope evaluation	Depth evaluation	Stability category
Se/Sr = 1	De/Dr = 1	Stable
Se/Sr < 1	De/Dr < 1	Aggrading
Se/Sr > 1	De/Dr > 1	Degrading

TABLE 8.6. Determining the stability category based on a slope and depth evaluation.

Where: Se = existing water surface slope of study reach
Sr = bankfull water surface slope required
De = existing bankfull mean depth (from riffle cross-section)
Dr = bankfull mean depth required

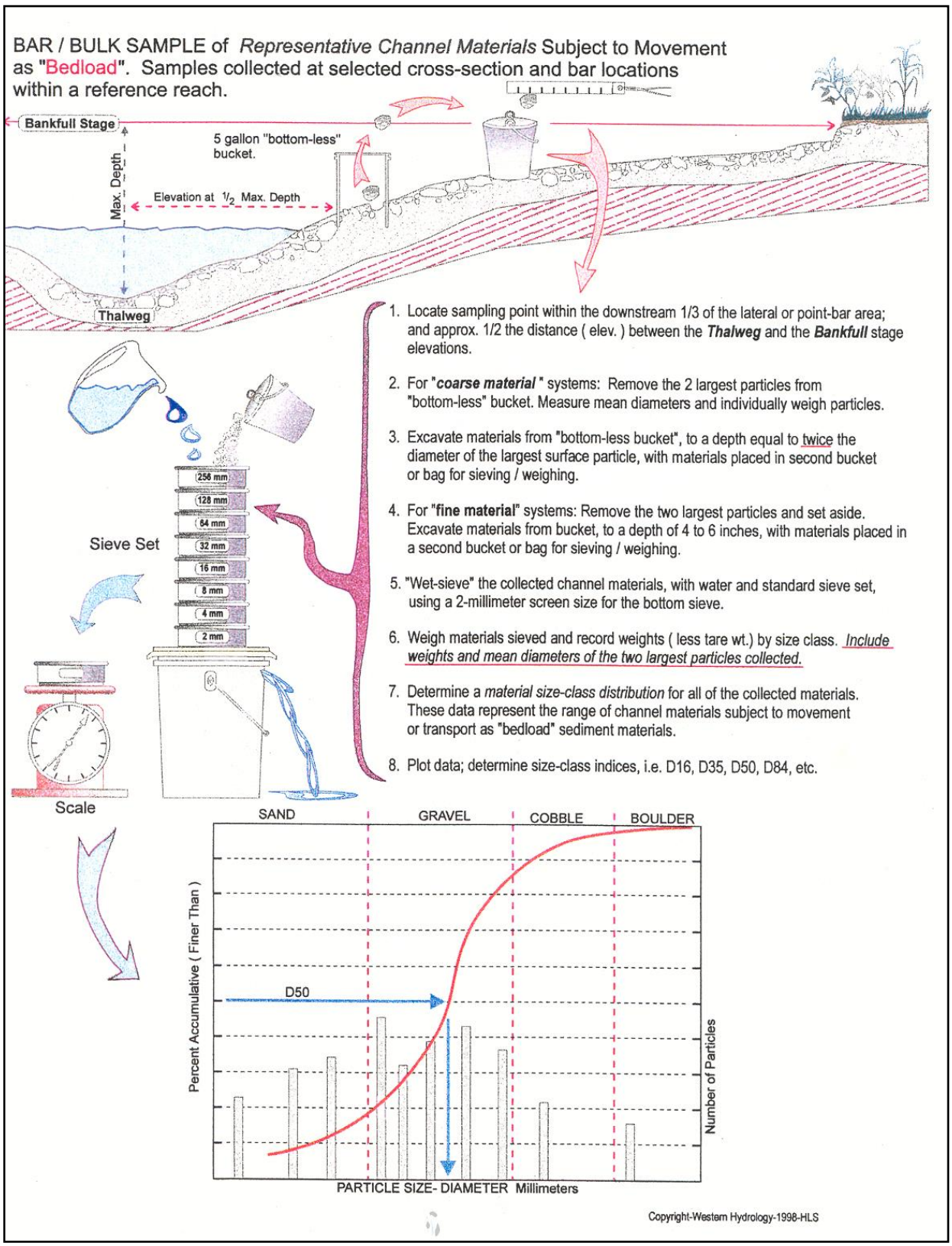


FIGURE 8.12. Bar sample procedure (Rosgen, 2001a).

Entrainment Calculation Form

Stream:	Reach:
Date:	Observers:

Critical Dimensionless Shear Stress:

$$\tau_{ci} = 0.0834(d_i/d_{50})^{-0.872}$$

Value	Variable	Definition
	d_i (mm)	D50 Bed Material (D50 from riffle pebble count)
	d_{50} (mm)	Bar Sample D50 or Sub-pavement D50
	τ_{ci}	**Critical Dimensionless Shear Stress**

Bankfull Mean Depth Required for Entrainment of Largest Particle in Bar Sample:

$$d_r = (\tau_{ci}*1.65*D_i)/S_e$$ 1.65 = submerged specific weight of sediment

Value	Variable	Definition
	τ_{ci}	Critical Dimensionless Shear Stress
	D_i (feet)	Largest particle from bar sample
	S_e (ft/ft)	Existing Bankfull Water Surface Slope
	d_r (ft)	**Bankfull Mean Depth Required**
	d_e (ft)	**Existing Bankfull Mean Depth (from riffle cross section)**
Circle:	Stable (d_e/d_r =1)	Aggrading (d_e/d_r <1) Degrading (d_e/d_r >1)

Bankfull Water Surface Slope Required for Entrainment of Largest Particle in Bar Sample:

$$S_r = (\tau_{ci}*1.65*D_i)/d_e$$ 1.65 = submerged specific weight of sediment

Value	Variable	Definition
	τ_{ci}	Critical Dimensionless Shear Stress
	D_i (feet)	Largest particle from bar sample
	d_e (ft)	Existing Bankfull Mean Depth (from riffle cross section)
	S_r (ft/ft)	Bankfull Water Surface Slope Required
Circle:	Stable (S_e/S_r =1)	Aggrading (S_e/S_r <1) Degrading (S_e/S_r >1)

Sediment Transport Validation

	Largest Particle in Bar Sample D_i (mm)
	Bankfull Shear Stress $\tau_c=\gamma RS$ (lb/ft^2)
	Moveable particle size (mm) at bankfull shear stress (predicted by the Shields Diagram: Blue field book:p238, Red field book: p190)
	Predicted shear stress required to initiate movement of D_i (mm) (see Shields Diagram: Blue field book:p238, Red field book: p190)

FIGURE 8.13. Sediment transport calculation form provided by Rosgen (2001c).

8.9 STREAM TYPE EVOLUTIONARY SCENARIOS

Natural channels are dynamic by nature, responding to changes in flows and sediment loads by vertical and lateral adjustments and changes in bed material. Channel type evolution occurs as a result of vertical or lateral instability created as a stream system exceeds a geomorphic threshold. The formation of gullies, an unstable channel type, followed by a succession of channel types toward a more stable form is the best known of the channel evolution sequences (TABLE 8.7). Various stream type evolutionary scenarios, which commonly occur in alluvial channels, have been described (Rosgen, 1996) and are used in the Rosgen Stability Index.

8.9.1 FIELD PROTOCOLS

Field protocols consist of performing a riffle cross-section survey and identifying other channel types that may occur within the two meander study reach. The existing stream type(s) occurring in the study reach are determined from the riffle cross-section data (entrenchment ratio, width/depth ratio), sinuosity, slope and median particle size of the bed material using Rosgen's stream classification system (Rosgen, 1994). The field observer must select not only the existing stream type, but also the location in one of the sequences of evolution. The field observer should also determine the potential stable stream type in addition to the existing stream type. This requires additional information about the valley type. For instance, which stream types are naturally associated with that valley type; what other "background" or "reference" stream channel types are common in the local area? The table below indicates channel type sequences indicative of low, moderate and high sediment supply or channel stability categories, and the associated Rosgen Stability Index score (Rosgen, 2001).

Evolutionary sequence	Stability rating	Sediment supply category	Sediment supply score
(C → E), (Fb → B), (G → B), (F →Bc)	Stable	Low	5
(F → C), (B → G)	Moderately Unstable	Moderate	10
(E or C → G), (E or C → D) (G → F), (D → G)	Unstable	High	15

TABLE 8.7. Evolutionary sequences that estimate sediment supply by stream type.

8.9.2 ROSGEN STABILITY ASSESSMENT

Variables that describe vertical and lateral stability, excess sediment conditions, a change in stream type, and overall channel, bank and floodplain condition are included in the Rosgen Stability Index for a holistic geomorphic stability assessment. The bank height ratio measures vertical stability and the dominant BEHI/NBS category; width/depth ratio measures lateral stability. The depositional pattern is an indicator of excess sediment conditions, while the Pfankuch stability rating is an assessment of the overall channel, bank and floodplain conditions. Lastly, the evolutionary stage documents instability associated with channel type changes. These six variables are transformed into qualitative rating and then quantitative ratings of sediment supply, using guidance from Rosgen (2001). The sediment supply ratings are given in the following tables.

Sediment Supply Summary

Sediment Supply	Dominant BEHI/NBS	(Width/depth ratio) / (Reference width/ depth ratio)	Bank Height Ratio	Pfankuch Channel Stability Rating	Evolutionary Stage	Depositional Pattern
Low	L/L, L/M	< 1.4	1.0 – 1.1	Good	(C → E), (Fb → B), (G → B), (F → Bc)	1,4
Moderate	M/M, M/L, L/H, L/Ex	1.4 – 1.7	1.11 – 1.3	Fair	(F → C), (B → G)	3
High	M/H, H/M, H/H, M/Ex, H/Ex, Ex/Ex	> 1.7	> 1.3	Poor	(E or C → G), (E or C → D) (G → F), (D → G)	2,5,6,7,8

Variables	Stability Categories		
	Low	Moderate	High
Dominant BEHI/NBS	5	10	20
(Width/depth ratio) / (Reference width/ depth ratio)	2	5	10
Bank Height Ratio	2	5	10
Pfankuch Channel Stability Rating	5	10	15
Evolutionary Stage	5	10	15
Depositional Pattern	2	5	10
Total Stability Index Score	21	45	80

Conversion of stability index score to overall channel stability rating

Channel Stability Rating	Stability Index Score
Low (not attaining)	21 – 33
Moderate (inconclusive)	34 – 45
High (attaining)	46 - 80

TABLE 8.8 Rosgen Stability Assessment Variables (Rosgen, 2001).

8.10 LINEAR HABITAT COMPLEXITY INDEX

The Linear Habitat Complexity Index (LHCI) identifies the degree of morphological complexity within a stream channel. The Index is based on run, riffle, and pool lengths. For the Index, glides are considered to be runs. It was inferred that reaches of stream channel with extensive runs were less physically heterogeneous (i.e. lacking complexity and habitat diversity for aquatic organisms) than complex channels having short runs frequently intermixed with pools and riffles. A heterogeneous channel is considered to be indicative of stability.

8.10.1 LINEAR HABITAT COMPLEXITY INDEX CALCULATION PROCEDURE

The Index is calculated from feature identification and feature lengths on a longitudinal profile. A run reference norm is determined from a reference reach using the LHCI calculation. When applied to a study reach, the index identifies runs exceeding the reference run norm. The Index is structured such that as LHCI values increase, habitat complexity trends toward homogeneity; thus, increasing index values indicate lower physical integrity than the reference reach.

The reference reach mean run length and standard deviation are calculated from the profile data. For the index, a reference run length norm is determined to be the mean run length plus one standard deviation.

The Index is a moving average of ten contiguous features. After the Index is calculated for the first ten features, the first feature is dropped and the eleventh feature added for the next reach calculation. This process continues to the end of the profile.

Linear Habitat Complexity Index = 1 – ((total length of ten features – the sum of the portions of runs exceeding reference run norm) / total length of ten features).

Plots of the results of the LHCI are composed for the reference and study reaches. Significant departures of the study reach from the reference reach are determined. Significant departures indicate that the study reach has less habitat complexity than the reference reach.

8.11 POOL FACET SLOPE ANALYSIS

The intent of this metric analysis is to quantitatively measure the degree of sedimentation in stream channels, especially in "C" and "E" type channels. Pools fill with sediment under conditions of sediment deposition. When deposition is severe, the number of pools become fewer and the pools that are present loose depth as they fill with sediment. In the longitudinal profile, pools follow riffles and runs. The pool facet slope is the angle of declination from the end of the upstream feature (riffle or run) to the lowest point in the pool. This angle will trend towards the horizontal as the pool fills with sediment; therefore, the pool facet slope is an indicator of sediment conditions in a stream channel that is expected to contain pools.

When measuring the facet slope, care must be taken to measure, as accurately as possible, both ends of the facet. A procedure for measuring a more accurate longitudinal profile is described in the longitudinal profile procedure documentation. Examples of this analysis are detailed in Lawson and Huth (2003).

8.11.1 Pool Facet Slope Analysis Procedure

The facet angles are measured from longitudinal profiles where feature types and feature depths are known. This calculation is the rise over run and expressed as the mathematical ratio or a degree angle of declination (arctan □ = rise/run). A profile of sufficient length for the analysis is determined by localized conditions. The length of the profile could be as much as 2,000 feet or several meanders. The profile length should give enough facet angles for statistical analysis when a study reach is compared to a reference reach. It is suggested that both the study and reference reaches contain a minimum of twenty-five pools. It is unknown, at this time, how different the angles of the two reaches must be to be significantly different. The calculations of mean, minimum, maximum, and standard deviation of reach pools are recommended for comparisons.

CHAPTER 9 POST-TRIP PROCEDURES

9.1 CALCULATING DISCHARGE

After all flow measurements have been recorded on the field data sheet, discharge can be calculated using an excel spreadsheet (FIGURE 9.1). The "Calculating Discharge" template can be found at J:\WQD\Surface Water Section\Monitoring Unit\Streams

The completed form should be printed and included with the field data sheets in the site file.

	A	B	C	D	E	F	G	H
1								
2	Site Name:	SRBEV001.40						
3	Date:	4/22/2008						
4	Time:	1245						
5	Party:	JDJ/JOW						
6	Weather:							
7	Air Temp:	21.6						
8	Water Temp:	12.37						
9								
10	Shaded columns contain formulas; do not enter values in these columns.							
11	Distance From			Observation	Velocity	Mean		
12	Initial Point	Width	Depth	Depth	at point:	Velocity:	Area	Discharge
13				Valid Entries:	Field	Averages of 2		
14				(0.2, 0.6, 0.8)	Readings	Point Velocities		
15	0.32808	0.16404	0		0			
16	0.65616	0.4101	0.4		0.09		0.16404	0.0147636
17	1.14828	0.49212	0.55		0.88		0.270666	0.23818608
18	1.6404	0.49212	0.6		1.33		0.295272	0.39271176
19	2.13252	0.49212	0.65		2		0.319878	0.639756
20	2.62464	0.49212	0.65		0.83		0.319878	0.26549874
21	3.11676	0.4101	0.5		0.98		0.20505	0.200949
22	3.44484	0.4101	0.55		2.28		0.225555	0.5142654
23	3.93696	0.65616	0.5		2.43		0.32808	0.7972344
24	4.75716	0.73818	0.85		2.34		0.627453	1.46824002
25	5.41332	0.65616	0.8		2.09		0.524928	1.09709952
26	6.06948	0.57414	0.7		1.98		0.401898	0.79575804
27	6.5616	0.49212	0.75		1.94		0.36909	0.7160346
28	7.05372	0.49212	0.8		2.16		0.393696	0.85038336
29	7.54584	0.57414	0.9		1.95		0.516726	1.0076157
30	8.202	0.73818	0.7		2.04		0.516726	1.05412104
31	9.0222	0.73818	0.55		1.54		0.405999	0.62523846
32	9.67836	0.65616	0.5		1.4		0.32808	0.459312
33	10.33452	0.8202	0.35		0.55		0.28707	0.1578885
34	11.31876	0.8202	0.1		0.2		0.08202	0.016404
35	11.97492	0.32808	0		0		0	0
61	Total Width	Sum of Widths	Average Depth		Average Velocity			
62	11.64684	11.64684	0.54		1.38	Total Area:	6.58	
63						Total Discharge:		11
64	Width:							
65	Method:							
66	# of Sections:							
67	Type of Meter:	Flow mate				No. of Sections:		20
68	Meter #:	2000						
69	Remarks:							
70								
71		Note: FSN Procedures include bank depths and velocities of 0 in the average velocity and average depth.						
72								

FIGURE 9.1. Discharge results from Excel template.

9.2 PEBBLE COUNTS

The median particle size (d50) can be calculated using the pebble count spreadsheet on the "J" drive. The 15th, 85th and 100th percentiles are also automatically calculated. Print out a copy of the completed data sheet and place it into the site file.

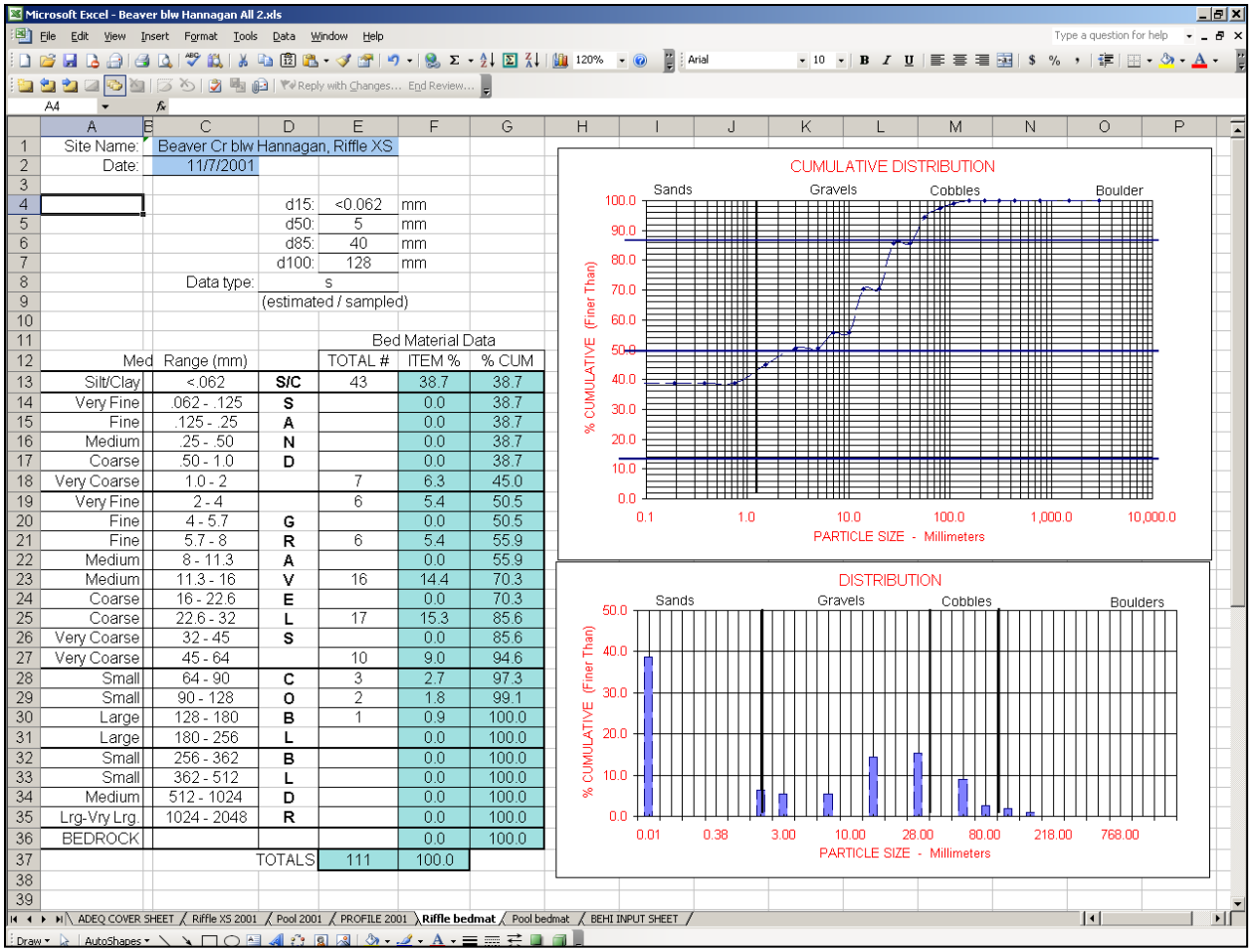


FIGURE 9.2. Pebble count excel sheet.

9.3 POST-TRIP CALIBRATIONS

Calibrate pH, dissolved oxygen and conductivity when you return to the office. Values should agree with the precalibration results within the following limits.

Parameter	Acceptable Range
pH	Post-trip reading should be within 0.3 standard units of the pre-trip readings for each buffer solution used. Hydrolab instrument specifications specify an instrument tolerance of +/- 0.2 SU, and additional 0.1 SU is permitted for minor environmental differences (temperature, etc.).
Conductivity	EC readings shall be within 10% of pre-trip post-calibration values.
Dissolved Oxygen	Dissolved oxygen saturation values will be evaluated site by site according to calibration performance in the field. Readings will be evaluated after site calibration by stabilization time (should be within 2 minutes) and adherence to a full 100% calibration for YSI. Hydrolab measurements should be within 10%.

TABLE 9.1 Post-trip calibrations.

If the field meter post trip checks are out of the ranges identified below, the following steps must be done:

What to do if the calibration value is outside the "Acceptable Range".

1. If the post-trip check results in readings that deviated outside of the acceptable range, the data will not be acceptable for assessment or compliance purposes and should be excluded or discarded from the dataset. Be sure to make a note in the field notes that such data was rejected.
3. Determine when, if possible, any problems occurred in the field. If this can be determined, the readings taken before the problem occurred may be acceptable. Any values obtained after the problem occurred should be discarded.
4. If the problem resulted in large differences between meter readings and stated solution values, try to isolate the problem and correct it as outlined in the Pre-Trip Equipment Calibration Procedures. If the problem cannot be corrected satisfactorily, tag the meter for repair.

9.4 ROUTINE MAINTENANCE

Maintenance of active multiprobes should be conducted every quarter. Equipment that is not being regularly used should be maintained every six months. This section covers both YSI and Hydrolab multiprobes. The maintenance is the same for both units unless otherwise noted.

Record what maintenance was performed, the date, who performed the maintenance and any problems encountered in the equipment log book.

9.4.1 MULTIPROBE CALIBRATION

9.4.1.1 Hydrolab Maintenance

9.4.1.1.1 Specific Electrical Conductivity

1. Prepare the unit by attaching the cable and transmitter. On older sonde units and on some older minisondes, the EC probe consists of a set of nickel electrodes covered by a hard plastic conductivity cell block. When working with this type of probe, first remove the conductivity cell block with a screwdriver and then remove the rubber o-rings from the electrodes.
2. Newer units will probably be equipped with a four electrode graphite conductivity sensor (FIGURE 9.3). This type of sensor should never be cleaned with abrasive material of any type. When cleaning the electrodes, use cotton and a solvent such as methanol or isopropyl alcohol to remove any residue that may present. The sensor can also be cleaned using warm soapy water. Rinse with

FIGURE 9.3. New graphite conductivity sensor (left). Old nickle conductivity electrodes (rig ht). Both are combined with the DO probe.

deionized water when finished.

3. For older units, polish all exposed surfaces of the nickel electrodes including the ends with the emery strips (#400 wet/dry sandpaper) found in the maintenance kit. Do not to touch the other probes with the sandpaper (especially the pH and redox); protect them with wet cotton. Rinse with deionized water and then replace the o-rings and the conductivity cell block.

9.4.1.1.2 pH

1. Clean the glass probe with a cotton ball or Q-tip saturated with methanol or isopropyl alcohol. Rinse the probe thoroughly with deionized water.
2. If the response time of the pH probe does not produce 95% of the calibration reading within 90 seconds, then shock the probe with a weak HCl solution or pH 4.0 buffer.
3. Wrap the probe with cotton saturated with 0.1M HCl and leave for 5 minutes. Remove the cotton and rinse with deionized water. Soak the probe in pH 7.0 buffer for 10 minutes before calibrating.
4. The reference electrolyte is replaced in the older sonde units by inverting the entire unit and gently pulling off the white cylindrical sleeve. Empty the remaining electrolyte and rinse the sleeve with a small amount of fresh pH reference electrolyte. After rinsing, refill the sleeve to the top with standard pH electrolyte and push sleeve back about half-way onto its mount. At this point, turn the sonde unit so the probes are pointing upwards, allowing any air bubbles in the electrolyte to move up towards the porous Teflon junction. Push the sleeve down the rest of the way, purging any air within the chamber and flushing the porous junction on the tip of the sleeve with fresh reference solution. In most cases the fresh reference solution can be seen coming through the pores in the junction. In the newer minisonde units, the porous Teflon junction is located at the top of the probe next to the pH electrode. A screw driver is used to remove it so that the old reference solution can be dispensed and replaced with new solution. Use a syringe to replace the solution in the probe. When the porous junction is replaced, the fresh solution is flushed thru the junction.
5. The porous junction of the electrolyte sleeve can become clogged with impurities over time. A new junction may be required if air bubbles are obstructing the flow of electrolyte to pass through the junction during the process described in step #4.

9.4.1.1.3 Dissolved Oxygen

1. To change the DO membrane, remove the DO sensor guard (older sonde units) and o-ring securing the membrane. The membrane should be replaced each time the unit is serviced. The membrane should be replaced if air bubbles are under the membrane, the membrane is damaged, or if the membrane is wrinkled.
2. To replace the DO electrolyte solution, tip the probe until the old solution is dispensed. Slowly refill with the squeeze bottle of KCL electrolyte provided in the kit. Empty the probe a second time. Refill the probe again being careful not to induce any bubbles into the cylinder. Gently tap the cylinder to remove any bubbles and let the unit sit for 5-10 minutes to allow gases to escape. Add a few more drops of solution to form a meniscus if needed.

3. To replace the standard membrane, secure the membrane on one side of the top of the sleeve with the thumb, and with a smooth firm motion, stretch the other end of the membrane over the sensor surface and hold it in place with the index finger. Secure the membrane with the o-ring and trim the excess membrane below the o-ring. There should be no wrinkles in the membrane or bubbles in the electrolyte under the membrane. Avoid overstretching the membrane. Do not touch any of the internal parts of the DO sensor.
4. Test the unit for bubbles by gently tapping the sonde cylinder and by inverting the probe a few times.
5. The DO sensor should be allowed to sit overnight to allow the membrane to relax before calibrating.

9.4.1.1.4 Temperature

The temperature portion of the probe requires no maintenance. Temperature should be verified to a NIST traceable thermometer at least once a year.

9.4.1.2 YSI Maintenance

9.4.1.2.1 Conductivity

The openings that allow fluid access to the conductivity electrodes must be cleaned regularly. The small cleaning brush included in the 6570 Maintenance Kit is ideal for this purpose. Dip the brush in clean water and insert it into each hole 15-20 times. In the event that deposits have formed on the electrodes, it may be necessary to use a mild detergent with the brush. After cleaning, check the response and accuracy of the conductivity cell with a calibration standard.

If this procedure is unsuccessful, or if probe performance is impaired, it may be necessary to return the probe to an authorized dealer.

9.4.1.2.2 pH

Cleaning is required whenever deposits or contaminants appear on the glass and/or platinum surfaces of these probes or when the response of the probe becomes slow.

Remove the probe from the sonde. Initially, simply use clean water and a soft clean cloth, lens cleaning tissue, or cotton swab to remove all foreign material from the glass bulb and platinum button. Then use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor.

When using a cotton swab, be careful NOT to wedge the swab tip between the guard and the glass sensor. If necessary, remove cotton from the swab tip, so that the cotton can reach all parts of the sensor tip without stress. You can also use a pipe cleaner for this operation if more convenient.

If good pH and/or ORP response is not restored by the above procedure, perform the following additional procedure:

1. Soak the probe for 10-15 minutes in clean water containing a few drops of commercial dishwashing liquid.

2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the cleaning solution.
3. Rinse the probe in clean water, wipe with a cotton swab saturated with clean water, and then rerinse with clean water.

If good pH and/or ORP response is still not restored by the above procedure, perform the following additional procedure:

1. Soak the probe for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). This reagent can be purchased from most distributors. Be sure to follow the safety instructions included with the acid.
2. Rinse the probe in clean water, wipe with a cotton swab saturated with clean water, and then rerinse with clean water. To be certain that all traces of the acid are removed from the probe crevices, soak the probe in clean water for about an hour with occasional stirring.

If biological contamination of the reference junction is suspected or if good response is not restored by the above procedures, perform the following additional cleaning step:

1. Soak the probe for approximately 1 hour in a 1 to 1 dilution of commercially-available chlorine bleach.
2. Rinse the probe with clean water and then soak for at least 1 hour in clean water with occasional stirring to remove residual bleach from the junction. (If possible, soak the probe for period of time longer than 1 hour in order to be certain that all traces of chlorine bleach are removed.) Then rerinse the probe with clean water and retest.

Dry the sonde port and probe connector with compressed air and apply a very thin coat of O-ring lubricant to all O-rings before re-installation.

9.4.1.2.3 Dissolved Oxygen

The KCl solution and the Teflon membrane at the tip of the probe should be changed prior to each sonde deployment and at least once every 30 days during the use of the sonde in sampling studies. In addition, the KCl solution and membrane should be changed if (a) bubbles are visible under the membrane; (b) significant deposits of dried electrolyte are visible on the membrane or the O-ring; and (c) if the probe shows unstable readings or other probe-related symptoms.

After removing the used membrane from the tip of the probe, examine the electrodes at the tip of the probe. If either or both of the silver electrodes are black in color, the probe should be resurfaced using fine sanding disks.

To resurface the probe using the fine sanding disk, follow the instructions below. First dry the probe tip completely with lens cleaning tissue. Next, hold the probe in a vertical position, place one of the sanding disks under your thumb, and stroke the probe face in a direction parallel to the gold electrode (located between the two silver electrodes). The motion is similar to that used in striking a match. Usually 10-15 strokes of the sanding disk are sufficient to remove black deposits on the silver electrodes. However, in extreme cases, more sanding may be required to regenerate the original silver surface.

After completing the sanding procedure, repeatedly rinse the probe face with clean water and wipe with lens cleaning tissue to remove any grit left by the sanding disk. After cleaning, thoroughly rinse the entire tip of the probe with distilled or deionized water and install a new membrane.

Be sure to: (1) Use only the fine sanding disks in the resurfacing operation and (2) Sand in a direction parallel to the gold electrode. Not adhering to either of these instructions can seriously damage the electrodes.

If this procedure is unsuccessful, as indicated by improper probe performance, it may be necessary to return the probe to an authorized service center.

9.4.1.2.4 Temperature

The temperature portion of the probe requires no maintenance. Temperature should be verified to a NIST traceable thermometer at least once a year.

9.4.1.3 Insitu Maintenance

RDO Fast Sensor Cap Replacement:
The RDO Fast Sensor Cap has a 1 year typical life (15 mo. of total useage) after the sensor takes its first reading, or 36 monthsfrom the date of manufacture. Follow the instructions included in the RDO Sensor Cap Replacement Kit.

pH/ORP Sensor Replacement:
To replace the pH/ORP sensor or to refill the reference junction, follow the instructions in the pH/ORP Sensor Instruction Sheet that is included with the replacement sensor.

9.4.1.3.1 Cleaning the pH/ORP Sensor

Begin with the gentlest cleaning method and continue to the other methods only if necessary. Do not directly touch or wipe the glass bulb.

To clean the pH sensor, gently rinse with cold water. If further cleaning is required consider the nature of the debris.

Remove Crystalline deposits

- Clean sensor with warm water and mild soap.
- Soak sensor in 5% HCl solution for 10 to 30 minutes
- If deposits persist, alternate soaking in 5% HCl and 5%NaOH solutions.

Remove Oily or Greasy Residue

- Clean sensor with warm water and mild soap.
- Methanol or isopropyl alcohol may be used for short soaking periods up to 1 hour.
- Do not soak the sensor in strong solvents such as chlorinated solvents, ethers, or ketones, including acetone.

Remove Protein Like Material or Slimy Film

- Clean sensor with warm water and mild soap.
- Soak the sensor in 0.1M HCl solution for 10 minutes and then rinse with deionized water

When performing any of these methods rinse the sensor with water and soak overnight in pH 4 buffer.

9.4.1.3.2 Cleaning the RDO Sensor

Cleaning the Sensor Cap

1. Leave the cap on the sensor.
2. Rinse the sensor with clean water from a squirt bottle or spray bottle.
3. Gently wipe with a soft cloth or brush if biofouling present.
4. If extensive fouling or mineral build-up is present, soak the RDO cap end (while the cap is still installed on the sensor) in commercially available household vinegar for 15 minutes, then soak in deionized water for 15 minutes.
5. After cleaning the sensor cap, perform a 2 point calibration

Cleaning the optical window

1. Perform this task only once per year when you replace the sensor cap.
2. Pull to remove the sensor cap.
3. Gently wipe the optical window with the supplied lens wipe.

Do not wet the interior lense area with water or any solution

9.4.1.3.3 Cleaning the Conductivity Sensor

1. Before you begin, ensure that the RDO Cap and the pH/ORP sensor are in place. Rinse the conductivity sensor under running water to remove loose material.
2. Follow cleaning procedure 1. If debris is still present, progress to the next cleaning procedure. If the debris is removed, skip to the last step.

Cleaning Procedure 1

Avoid damaging the plastic material of the conductivity cell. Gently scrub the conductivity cell with a soft swab and mild soap such as a dilute solution of dish detergent. The probe is shipped with polyurethane foam swabs for this purpose. You can also achieve good results using a gentle back-and-forth motion with a thin cotton pipe cleaner. If debris is still present, continue to Cleaning Procedure 2. If the sensor is clean, skip to the last step.

Cleaning Procedure 2

Avoid damaging the plastic material of the conductivity cell. Gently scrub the conductivity cell with a foam swab and an aggressive soap such as Alconox cleaner. If debris is still present, continue to Cleaning Procedure 3. If the sensor is clean, skip to the last step.

Cleaning Procedure 3

Soak the sensor with dilute acetic acid (10:1 solution) or commercially available household vinegar to pre-soften calcium deposits. Follow this with Cleaning Procedure 1 or Cleaning Procedure 2, depending on the degree of residual contamination. The probe can soak for any length of time in household vinegar. If debris is still present, continue to Cleaning Procedure 4. If the sensor is clean, skip to the last step.

Cleaning Procedure 4

Topically apply dilute phosphoric acid (< 27 %) or the consumer product LIME-A-WAY with a soft swab to remove iron or calcium deposits that remain after using Process 3. Do not allow the cleaner to be in contact with the sensor for more than 10 minutes. Rinse well with clean water and continue to the last step. Check the sensor calibration before redeployment. Recalibrate the sensor when necessary.

9.4.2 TURBIDITY

The Hach 2100 Turbidity meter should be calibrated with the primary standard every quarter. The primary reference standard is different from the secondary gel standards that travel with the unit.

FIGURE 9.4. Turbidity primary reference standards.

Turbidity Maintenance

- Check batteries (takes 4 AA)
- Clean unit including sample cells
- Replace velvet cloth if dirty
- Replace secondary standards or sample vials if scratched
- Add label with calibration results and date

Be sure to check the expiration date of the primary standards and keep them refrigerated. Warm to room temperature and mix the standards well before calibrating.

Quarterly Calibration Procedure

1. Insert the 0.1 NTU primary reference standard in the cell compartment (the one in the refriderator). Shake/mix well. Be sure to align the arrow on the cell with the arrow on the cell compartment. Close the lid and press I/O button to turn the machine on.
2. Press the CAL button and then the arrow key → to get a numerical value.
3. Then press READ. The instrument will count back from 60 seconds and then ask for the next Gelex Primary Standard.
4. Insert the 20 NTU primary reference standard in the cell compartment and press the READ button. The instrument will count back from 60 seconds and then ask for the next Gelex Primary Standard.

5. Insert the 100 NTU primary reference standard in the cell compartment and press the READ button. The instrument will count back from 60 seconds and then ask for the next Gelex Primary Standard.
6. Insert the 800 NTU primary reference standard in the cell compartment and press the READ button. The instrument will count back from 60 seconds.
7. Remove the cell from the compartment and press CAL to accept the calibration. The instrument will return to the measurement mode automatically.
8. If the calibration is not accepted start back at step one and try it again.
9. Next, insert the 0-10 gel standard (the one that is used in the field) and press READ. Do this three times to obtain an average that will become the calibration value. Write this value down on a label that will be placed on the instrument.

Press the 'RANGE' button if you see a blinking 9.99 value.

10. Insert the 0-100 gel standard and press READ. Do this three times to obtain an average that will become the calibration value. Write this value down on a label that will be placed on the instrument.
11. Insert the 0-1000 gel standard and press READ. Do this three times to obtain an average that will become the calibration value. Write this value down on a label that will be placed on the instrument.

9.4.3 FLOW METER

Maintenance for the flow meter basically consists of checking the batteries and calibrating using the bucket test.

Flow Meter Maintenance

- Check Batteries (takes 2 D)
- Add label with calibration date and noting that batteries were good

Flow Meter Quarterly Calibration

1. Fill a 5 gallon bucket of water half full of water. Clean sensor if needed with soap and water.
2. Attach the probe to a wading rod and insert the probe into the bucket so that it doesn't touch the sites of the bucket. Let the probe sit for at least a minute so that the water is not moving.
3. Turn on the unit and press RCL and STO at the same time. The number "3" should be displayed. Quickly press ↓ until "0" is displayed. Quickly press RCL and STO again.

If you are not quick enough you may need to power down the unit and start over.

9.4.4 SEM MONITORING

Maintenance for SEM monitoring should include verifying that all the needed equipment is present and in good repair before the spring sampling event.

9.5 MACROINVERTEBRATE SHIPPING

9.5.1 SAMPLE PREPARATION FOR SHIPPING TO TAXONOMY LABORATORY

THIS PROTOCOL OUTLINES THE PROCEDURES FOR PREPARING MACROINVERTEBRATE SAMPLES FOR BATCH SHIPPING TO THE OUT OF STATE TAXONOMY LABORATORY. THE PROCEDURE COVERS PACKING, MARKING, LABELING AND SHIPPING AS PER THE HAZARDOUS MATERIALS SHIPPING GUIDE FOR FEDEX GROUND SHIPMENT. A DEQ EMPLOYEE WHO IS CERTIFIED TO SHIP HAZARDOUS MATERIALS MUST OVERSEE THE PACKAGING AND SHIPPING PREPARATIONS. CERTIFICATION IS OBTAINED VIA AN ONLINE TRAINING COURSE SPONSORED BY FEDEX GROUND SHIP SAFE SHIP SMART COURSE, COSTING $150 (WWW.SHIPSAFESHIPSMART.COM). THE CERTIFICATION IS VALID FOR ONE YEAR, BUT IS AUTOMATICALLY RENEWED ANNUALLY UNLESS TERMINATED BY FEDEX. QUESTIONS CAN BE DIRECTED TO THE FEDEX HOTLINE AT 1-800-463-3339; THE ADEQ ACCOUNT # AND SHIPPER # ARE NEEDED AND CAN BE OBTAINED FROM THE ADEQ MAILROOM STAFF. THE PROCEDURE FOR PACKAGING AND PREPARING MACROINVERTEBRATE SAMPLES FOR SHIPPING IS AS FOLLOWS:

1. THE MACROINVERTEBRATE SAMPLES SHOULD BE PRESERVED WITH 99% ISOPROPANOL, COMPLETELY FILLED, AND CONTAINED IN 1L NALGENE BOTTLES. THE LIDS SHOULD BE TIGHTLY CLOSED AND WRAPPED SECURELY IN BLACK ELECTRICAL TAPE OR PARAFILM FOR TRANSPORT.
2. SAMPLES SHOULD BE PACKAGED IN ICE CHESTS, PREFERABLY WITHOUT SPIGOTS OR WITH SPIGOTS TAPED. ICE CHEST SHOULD BE IN GOOD CONDITION WITHOUT CRACKS OR LEAKS. SECURE AND TAPE THE DRAIN PLUG WITH REINFORCED FIBER TAPE INSIDE AND OUTSIDE.
3. LINE THE ICE CHEST WITH A LARGE HEAVY DUTY PLASTIC BAG.
4. PLACE CUSHIONING/ABSORBENT MATERIAL IN THE BOTTOM OF THE COOLER (IE, LAYERED ABSORBENT CLOTHS OR PET ABSORBENT PADS) AND PLACE THE SAMPLE CONTAINERS IN THE COOLER WITH SUFFICIENT SPACE TO ALLOW FOR ADDITIONAL CUSHIONING MATERIALS BETWEEN THE CONTAINERS.
5. PLACE PAPER CUSHIONS AROUND THE EDGES OF THE PACKAGE AND PACKING PEANUTS BETWEEN THE SAMPLE BOTTLES, AS WELL AS ADDITIONAL PACKING MATERIALS ON TOP, TO ABSORB SHOCK IN TRANSPORT.
6. SECURELY FASTEN THE TOP OF THE LARGE PLASTIC BAG WITH A ZIPTIE OR TAPE.
7. PLACE A COPY OF THE CHAIN OF CUSTODY FORM/INVENTORY FORM IN A GALLON ZIPLOC BAG AND TAPE TO THE INSIDE LID OF THE COOLER.
8. WEIGH THE BOX USING ONE OF THE LAB SCALES. THE TOTAL PER BOX/COOLER WEIGHT MUST BE <30KG/66LBS.
9. CLOSE THE COOLER AND SECURELY TAPE WITH REINFORCED FIBER STRAPPING TAPE AROUND EACH END OF THE COOLER, WRAPPING AROUND THE COOLER TWICE.
10. ATTACH THE "LIMITED QUANTITY" (LTD. QTY) LABEL TO THE COOLER/BOX AND MARK IT WITH "THIS SIDE UP" SYMBOL ON TWO OPPOSITE SIDES OF THE PACKAGE.
11. A NORMAL FEDEX GROUND SHIPPING LABEL IS USED ALONG WITH A LIMITED QUANTITY LABEL (FIGURE 9.5). NO HAZARDOUS MATERIAL LABELLING IS REQUIRED FOR ISOPROPANOL

PRESERVED BUG SAMPLES IF THEY MEET FEDEX "LIMITED QUANTITY" REGULATIONS. A PACKAGE IS CONSIDERED "LIMITED QUANTITY" IF EACH SAMPLE BOTTLE CONTAINS <1LITER OF ISOPROPANOL AND THE OVERALL WEIGHT OF THE COOLER/BOX IS <30KG/66LBS.

12. Deliver sample coolers to mailroom staff for Fedex pickup.

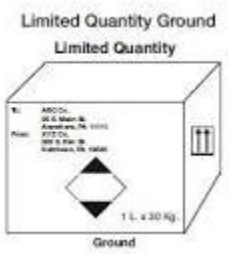


Figure 9.5. Labeling of shipping container for macroinvertebrate samples

All macroinvertebrate samples from a spring sample event are shipped as one batch to the taxonomy laboratory in July of each year or as soon as practical after sampling.

CHAPTER 10 DATA MANAGEMENT

This chapter is meant to provide clear data entry methods that encourage uniformity and accuracy in surface water quality data management. It is to be used by anyone who enters data into the surface water side of the WQDB. For the purposes of this manual, WQDB will reference the surface water portion of the database.

10.1 WHERE IS WATER QUALITY DATA STORED?

Most surface water quality data is stored in an Oracle based database called the Water Quality Database (WQDB). Macroinvertebrate, algae, fish, and habitat data is stored in a Microsoft Access database called the Ecological Data Application System (EDAS). This chapter will focus primarily on WQDB navigation and data entry.

10.2 WQDB BASICS

The WQDB is a relational database that makes the task of storing hundreds of thousands of water quality records easier. All databases are made up of multiple tables that are related to one another. The WQDB has four main tables that are interconnected (FIGURES 10.1 and 10.2).

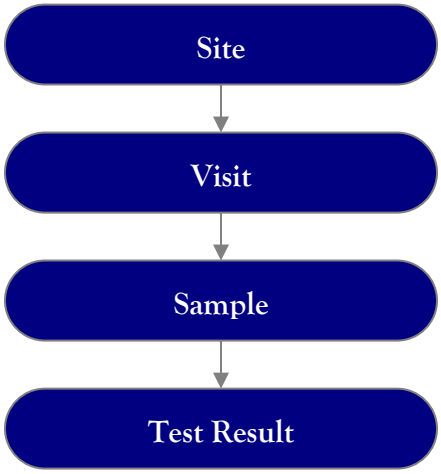


FIGURE 10.1. WQDB table hierarchy. One site is related to many visits. One visit is related to many samples etc.

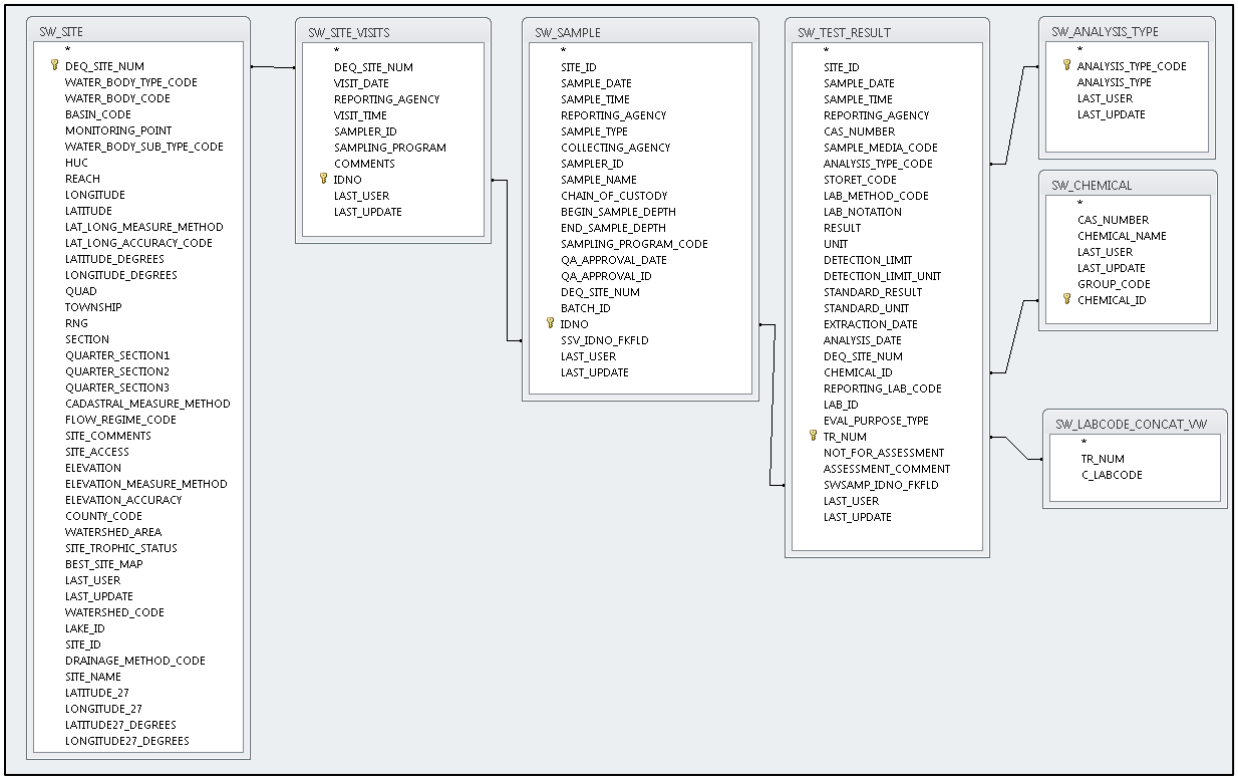


FIGURE 10.2. A slightly more complicated view of the main tables in the WQDB and their associated fields.

The water quality database currently has over 1 million records from internal and external sources. A record is a defined as a discrete parameter at a particular location at a particular time. For example, an alkalinity concentration of 123 mg/L at Roosevelt Lake 15 feet below the surface on March 23, 2008 would be one record. ADEQ is the primary source of most of the data in the WQDB (FIGURE 10.3). Fifty-seven percent of the data in the WQDB is from ADEQ, 23 percent of the data is from USGS and 20 percent if from other sources such as the Salt River Project and Arizona Game and Fish (to name just a few).

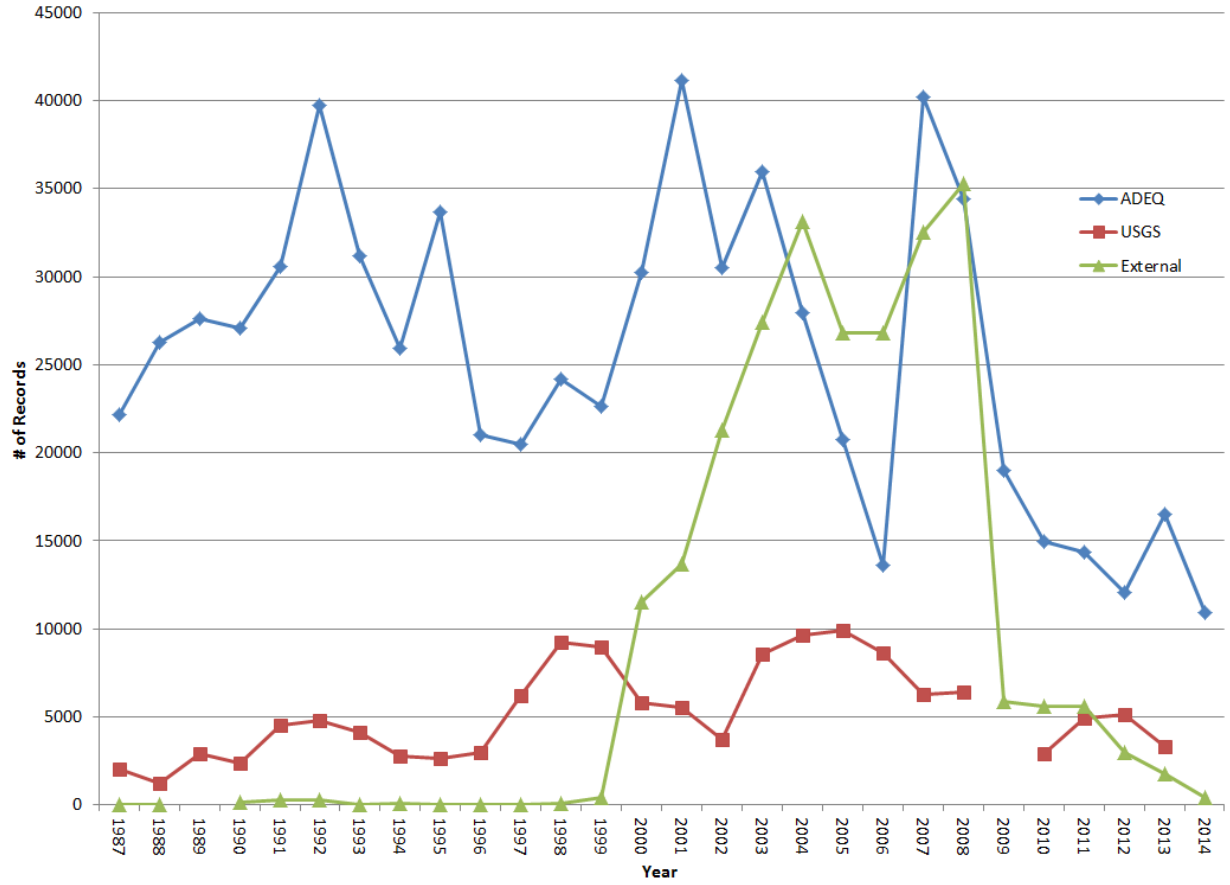


FIGURE 10.3. Number of WQDB records by year and by reporting agency.

10.3 NAVIGATING THE WQDB

This section will focus on how to move from screen to screen in the WQDB. There are a variety of forms and reports that are prepackaged in the database. There are also a number of ways to query the database.

10.3.1 LOGGING INTO THE DATABASE

Opening the database is as simple as double clicking on the water faucet that should be on the users' desktop.

There are two databases for Surface Water. The "production database" and the "test database". The "test database" is used to test modifications to the database in a safe environment and should be accessed using a <u>different</u> icon. The information technology staff will typically email you the URL for this application when beta testers need to test enhancements or changes to the database.

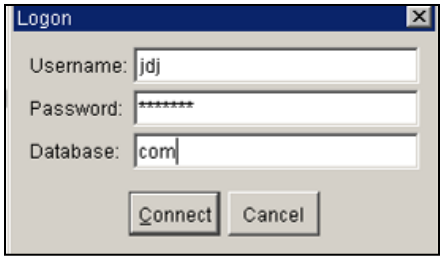


FIGURE 10.4. Logon screen.

Your username will be your LAN ID. See your supervisor for your password. The database is "com" (FIGURE 10.4).

A Water Quality Division Database Access Request Form must be filled out (and approved) prior to accessing certain parts of the database. This form will indicate what rights you have (supervisor, read-only, add/delete, etc.). This form can be found on the intranet under "Forms".

10.3.2 NAVIGATING THROUGH THE WQDB

FIGURE 10.5 is the main menu for the database and includes all the various screens to view the data for the water quality division. Click "Surface Water" to enter the surface water quality database.

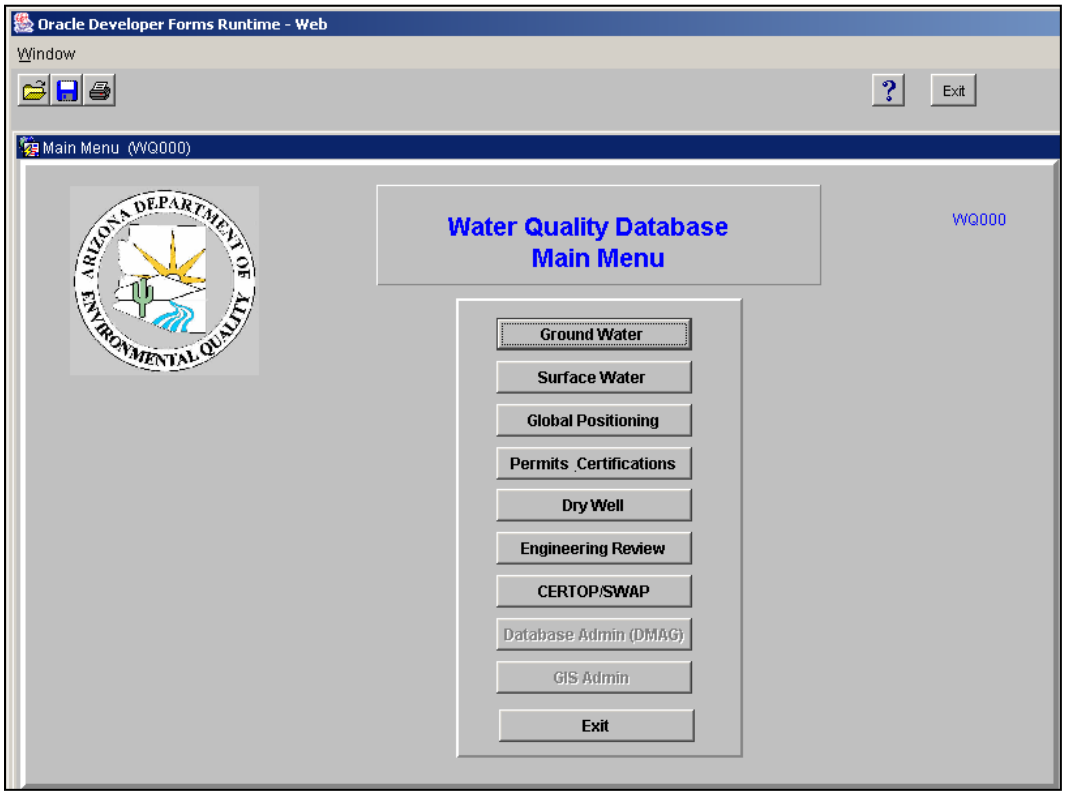


FIGURE 10.5. The WQDB Main Menu.

The surface water main menu has six choices (FIGURE 10.6). The enter/update menu will be described in Section 10.6. The Inquiry, Report and Database Lookup Tables, and Supervisor menus are described below. FIGURE 10.7 provides a flow chart which identifies the relationship between all the screens, forms and reports that can be accessed in the WQDB.

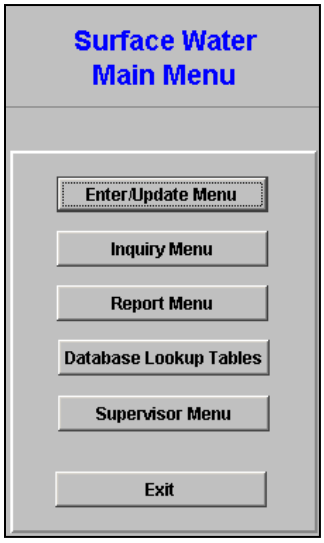


FIGURE 10.6. The main menu for the Surface Water Database.

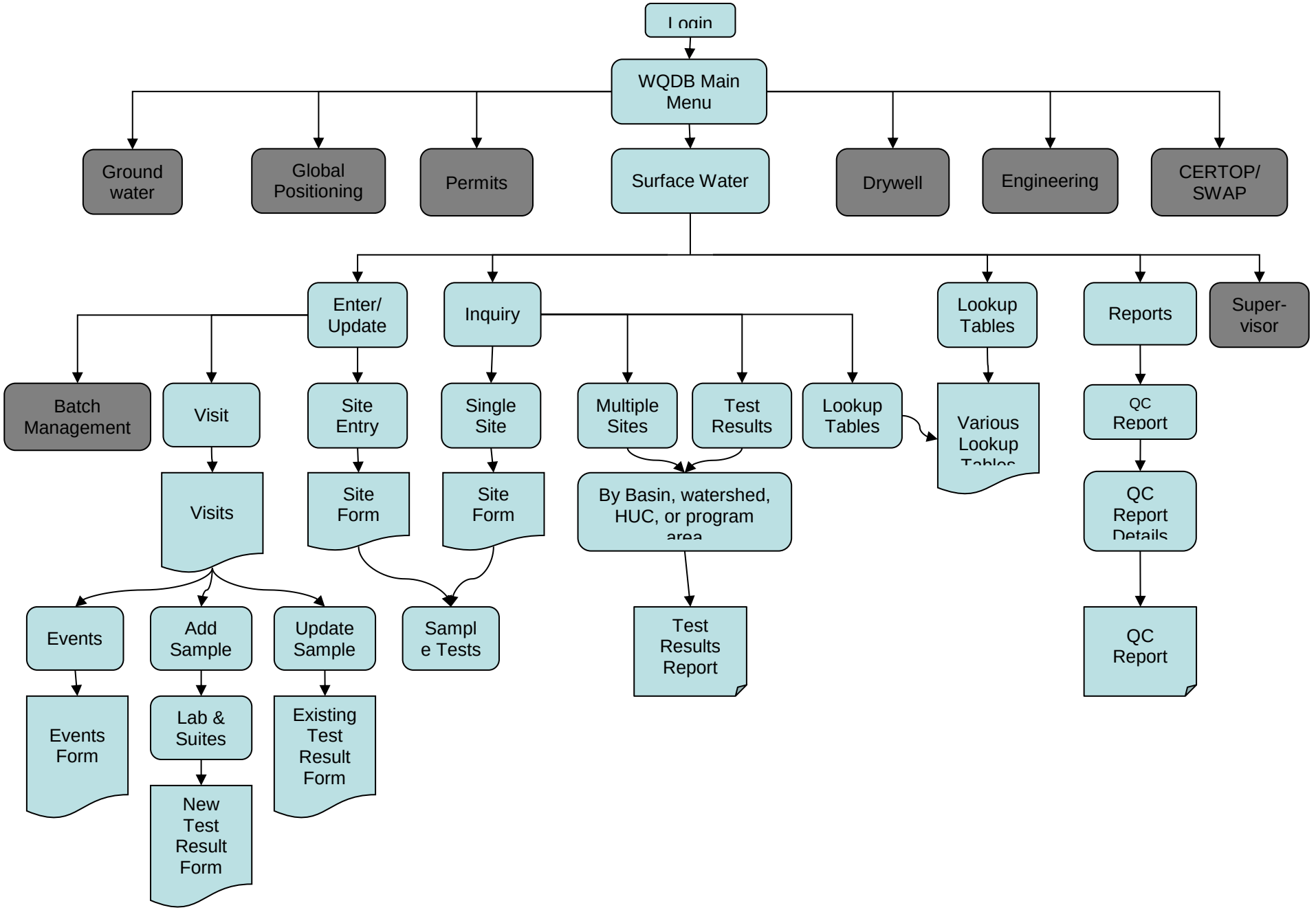


FIGURE 10.7. Flow chart of the forms and reports within the WQDB.

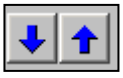
10.3.2.1 Inquiry Menu

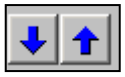
The inquiry menu provides a variety of canned reports and forms to complete simple queries of the database. Other tools such asMicrosoft Access, Microsoft Query, or the Water Quality Data warehouse should be used to run more complicated queries. The four query choices within the WQDB are listed in FIGURE 10.8.

FIGURE 10.8. Surface Water Inquiry Menu

10.3.2.1.1 Single Site Detailed

This query will open up a blank site form (FIGURE 10.9). You may query any field on this form.

1. Use the wildcard "%" to return multiple records. For example, entering "LCLCR%" in the "Site ID" field will give all the sites with LCLCR which is the Little Colorado River. Entering %STONE% in the "Site Name" field will give all the site names with STONE before or after the percent sign (like Tombstone or Stoneman Lake).
2. Press the flashlight button. 
3. Use the blue up and down arrows to scroll through the records. 
4. Press the "Sample/Test" button to see the test results at this particular site. 

5. Use the blue up and down arrows to scroll through the different dates. 

You can also query directly from the Sample/Test Results screen.

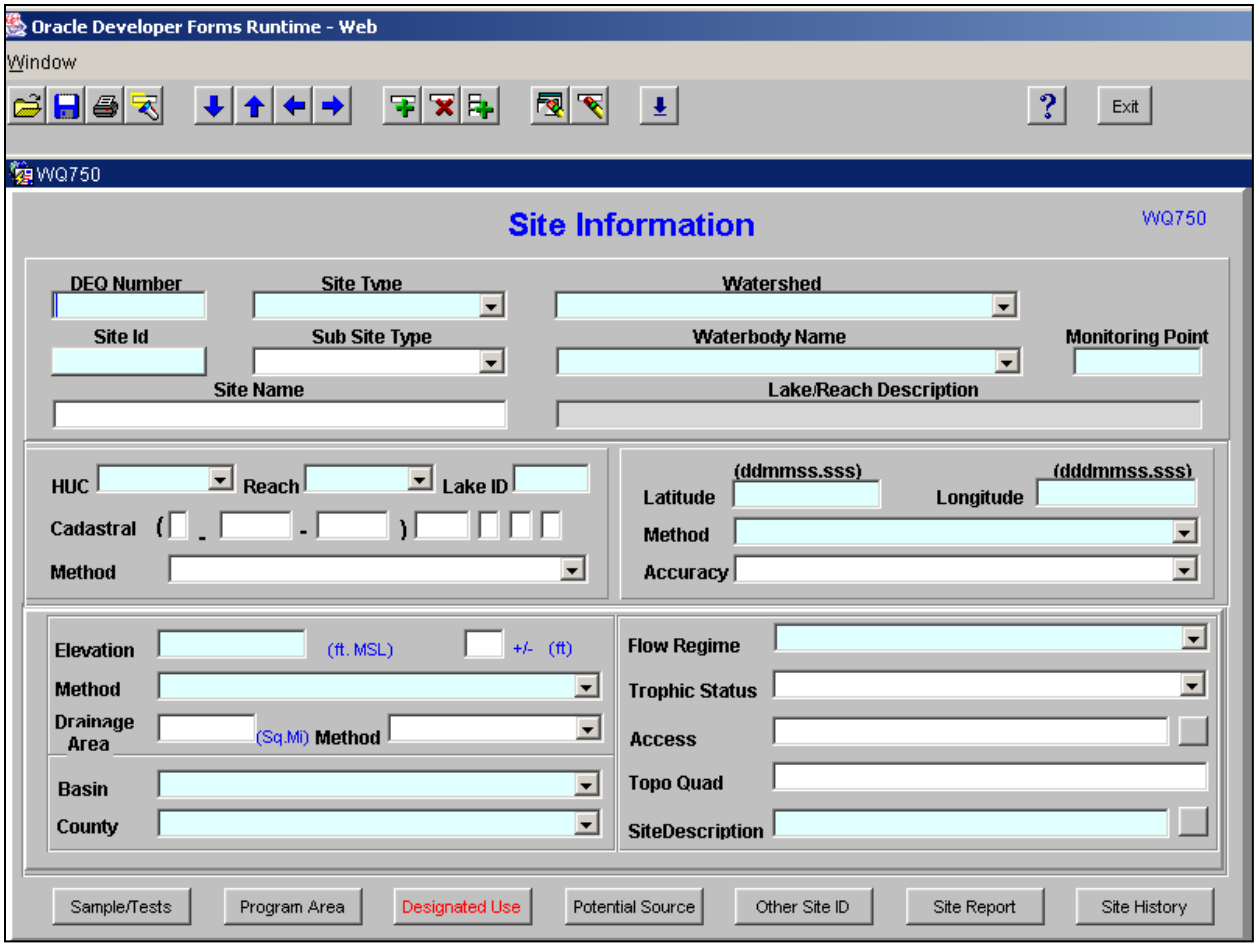
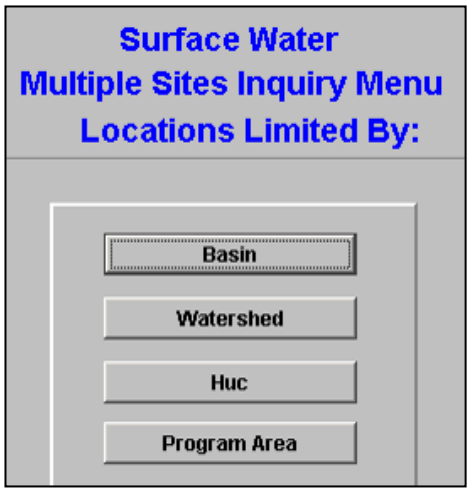


FIGURE 10.9. Single site detailed.

10.3.2.1.2 Multiple Site Menu

You can query multiple sites by using the multiple site menu. The basin, watershed, and HUC reports all work in roughly the same manner.



1. Enter the applicable HUC/watershed.
2. Enter the waterbody type (stream, lake, etc).
3. Its strongly recommended that you also enter a specific stream or lake to limit the number of records that will be returned.

The pull down arrow may need to be pressed twice to get a filtered list of streams or lakes.

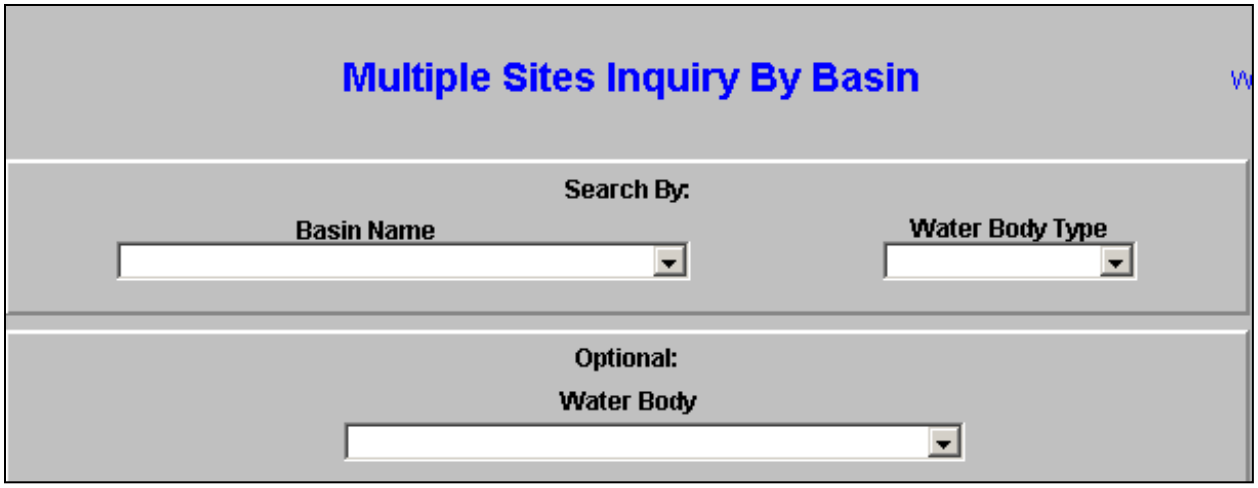


FIGURE 10.10. Multiple sites by basin query.

4. Enter the format you would like to see your data in. The output options are as follows

   A. Screen. This will take you to a listing of all the sites fitting the criteria you entered. You may "drill down" to the test results by clicking "deq number".
   B. Preview. This is a "PDF" adobe acrobat list of all the sites in the query.
   C. Flat File. This will generate a text file listing of all the sites in the query.

   To execute, click the "Perform Query" button.

10.3.2.1.3 Test Results

The test results query works in much the same manner as the multiple site query with the exception that all results for a particular site will be returned. You can drill down by parameter (FIGURE 10.11) to filter your results.

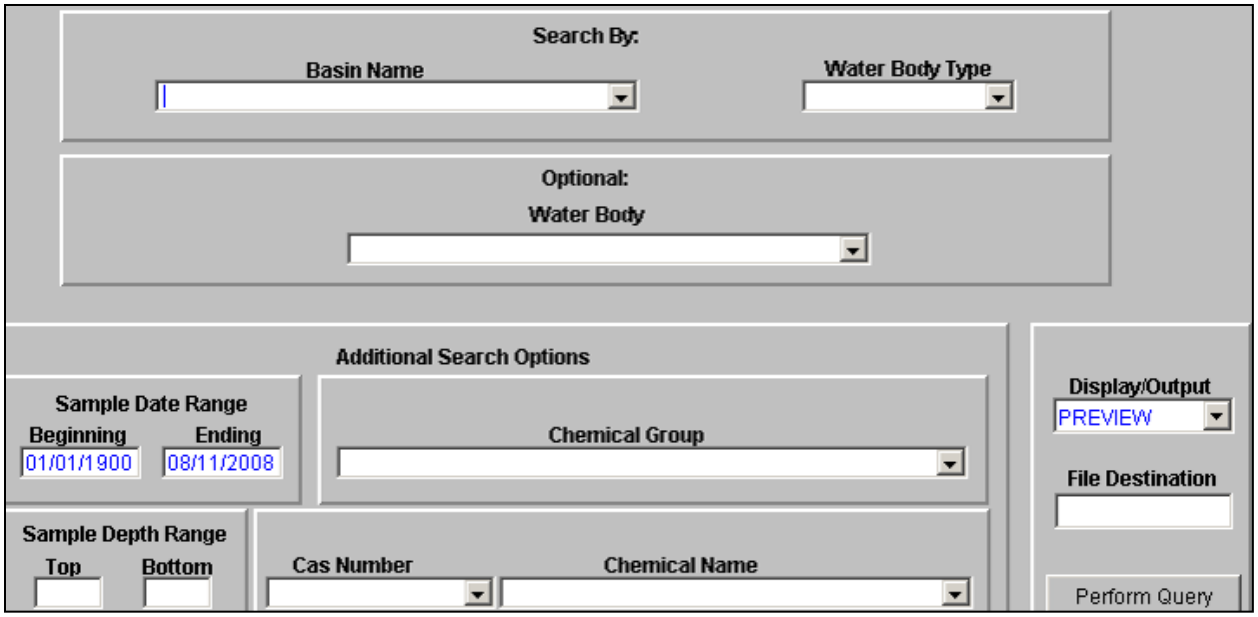


FIGURE 10.11. Test result query.

10.3.2.2 Report Menu

The report menu currently only has one report for quality control calculations. This is primarily for streams work and deals with calculating things like cation and anion ratios to determine if there were any quality assurance problems at the lab. See Section 10.5 for additional detail on quality assurance and control.

10.3.2.3 Lookup Table Menu

The lookup tables provide all the background information in the database. For example, there is a lookup table for county names that enables the sampler to fill in one of the Arizona counties on the Site screen. The information from the pull down list comes from the lookup tables. Supervisors and administrators are typically the only ones with rights to change the lookup tables.

One of the most important lookup tables for a sampler is the Chemical Suite List. This template is lab specific and fills all the information in automatically except for the sample result. If the lab methods or parameters change then this table will need to be updated.

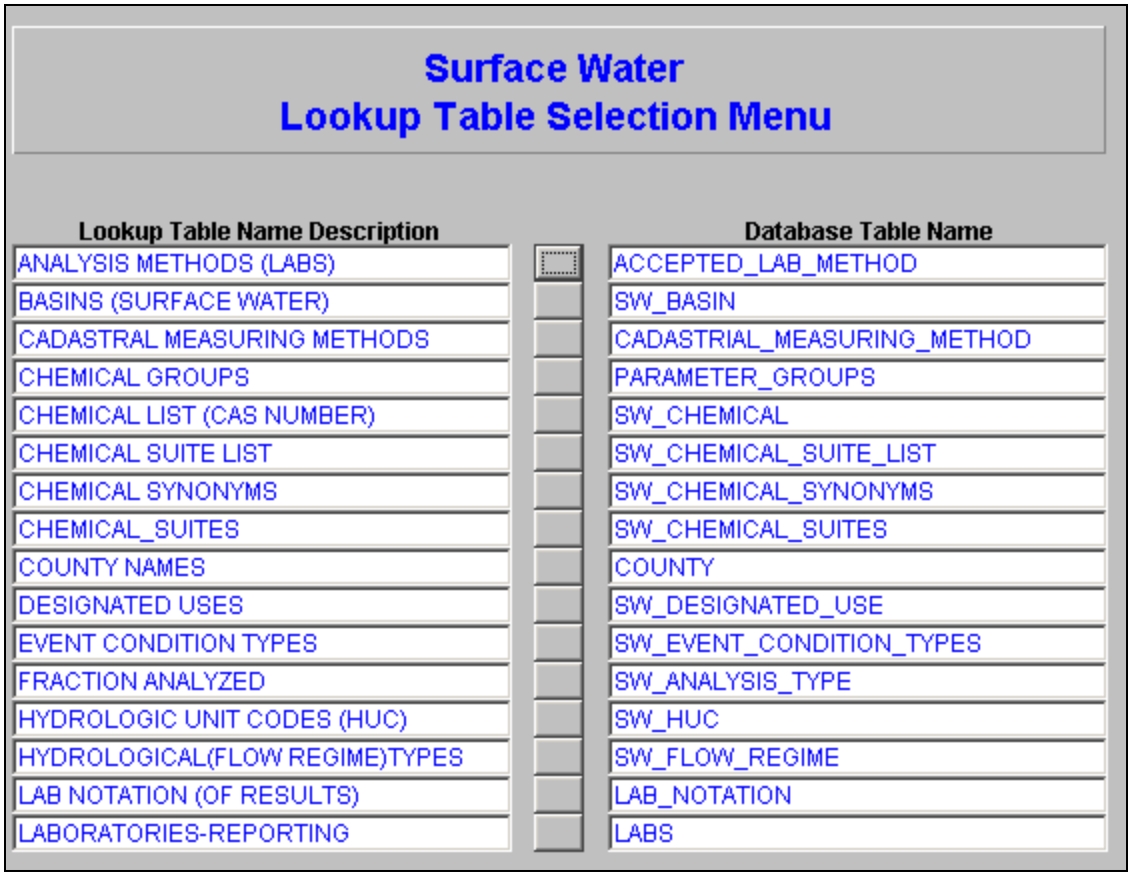


FIGURE 10.12. Surface water lookup tables.

10.3.2.4 Supervisor Menu

The supervisors menu allows the supervisor to edit the lookup tables.

10.4 ENTERING DATA

10.4.1 ELECTRONIC UPLOADS

Electronically uploading data from the lab greatly speeds up the data entry process. It also reduces transcription errors by lab and data entry staff. A batch upload file must conform to an ASCII fixed-width format with the following information. See Surface Water Data Submission Guidance for additional information.
http://www.azdeq.gov/environ/water/assessment/download/sw/swds.pdf

Field Name	Character Position
ADEQ Number	01-06
Lab Name	07-11
Reporting Agency	12-16
Collecting Agency	17-21
Sample ID	22-81
Field Sample Type	82

Field Name	Character Position
Lab Sample Type	83
Lab ID	84-98
Sample Date	99-108
Sample time	109-112
Sample Depth	113-119
Method	120-139
STORET	140-144
Lab Reporting Limit	145-152
Lab Reporting Limit Unit	153-160
Sample Result	161-172
Lab Notation	173-175
Sample Result Unit	176-183
Dilution	184-193
Lab Qualifier 1	194-196
Lab Qualifier 2	197-199
Lab Qualifier 3	200-202
Sampler Name	203-232
Site ID	233-244
Comment	245-444

TABLE 10.1. Fixed width format required for electronic uploads into the Surface Water database.

10.4.1.1 Electronic Upload Process

ADEQ has developed a process to upload data from the lab (FIGURE 10.13). The lab emails the batch upload manager an EDD (Electronic Data Deliverable) with all the lab results. The batch upload managerl is the person at ADEQ who is designated to receive all electronic submittals and upload the data into the database for the surface water section. The sampler will receive an email that their data has been loaded successfully.

Error messages will be displayed in the lower left hand side of the screen or as a text box. Additional information about the type of error can be obtained by pressing SHIFT + F1.

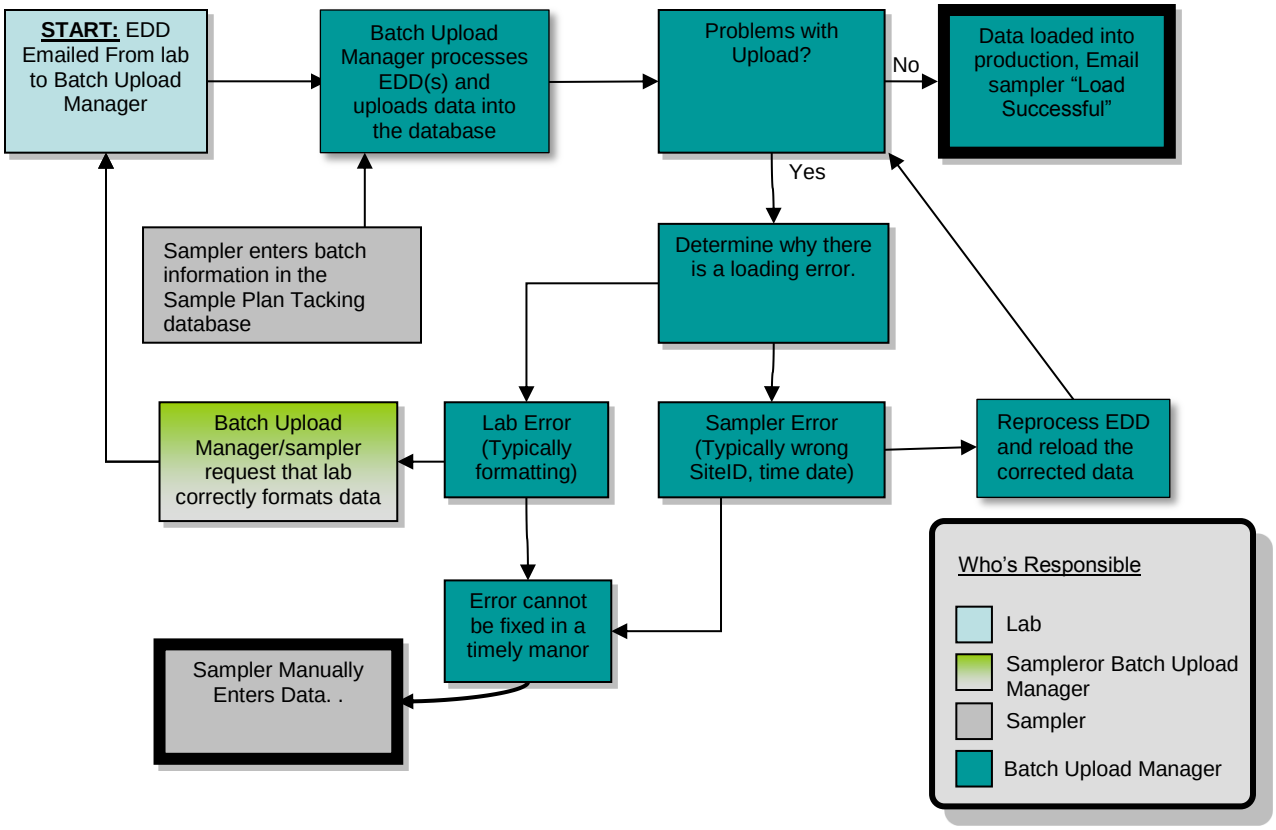


FIGURE 10.13. Flow chart of the electronic upload process.

The batch upload manager will work with the samplers if there is a problem. Once the problem is identified, ADEQ request that the data be reloaded with the correct information. If there is no timely fix the sampler may decide to load the data manually (see Section 10.3.2).

The sampler must email the batch upload manager if they choose to load the data manually.

10.4.1.2 What Parameters are Electronically Uploaded?

Lab and field parameters can be electronically uploaded. Samplers can either enter field parameters manually (see Section 10.4.2) or email EDD's to the batch upload manager for electronic uploads. Samplers also need to add sampling event information or comments, add missing lab data qualifiers, and validate the data. Rerun results will also need to be manually entered.

10.4.1.3 How to Avoid Electronically Uploading Data

The batch upload manager cannot load the data into the WQDB without a valid SiteID. Use the temporary code "999" followed by a descriptive name for the site if you do not wish to have your data electronically uploaded. For example, use 999QC1 for a blank.

10.4.2 MANUAL DATA ENTRY

There are a couple of different ways to manually enter data into the database. This section covers the fastest and most commonly used route for entering data.

10.4.2.1 Navigating to the Site Visit Screen

The visit screen allows you to see all the samples taken at a site for a particular date. To enter the visit screen, click surface water, enter/update menu and then visit (FIGURE 10.14).

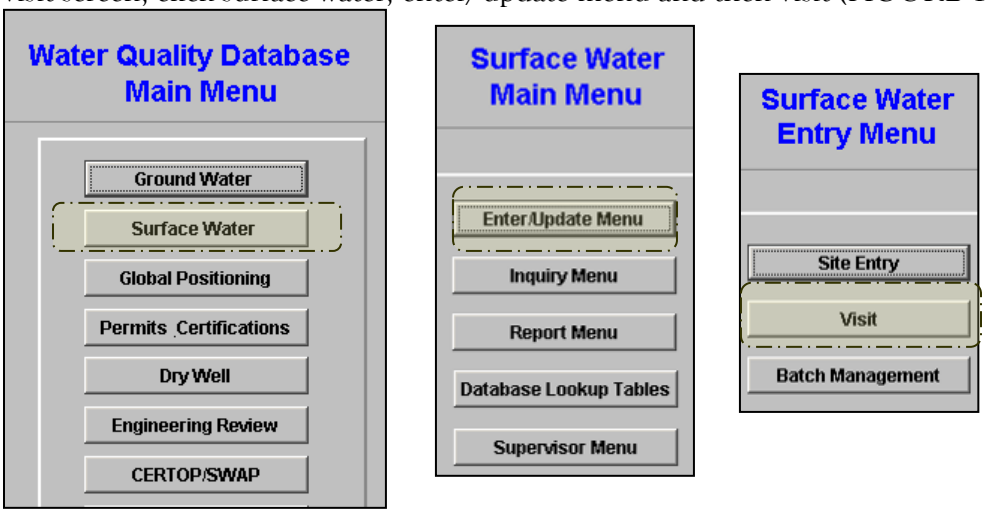


FIGURE 10.14. Pathway to the visit screen.

To open up an existing site on the visit screen either enter the SiteID or the DEQ number and then hit the searchlight button  . The screen will show all samples collected at that particular site and sort them by date (newest at the top) (FIGURE 10.15).

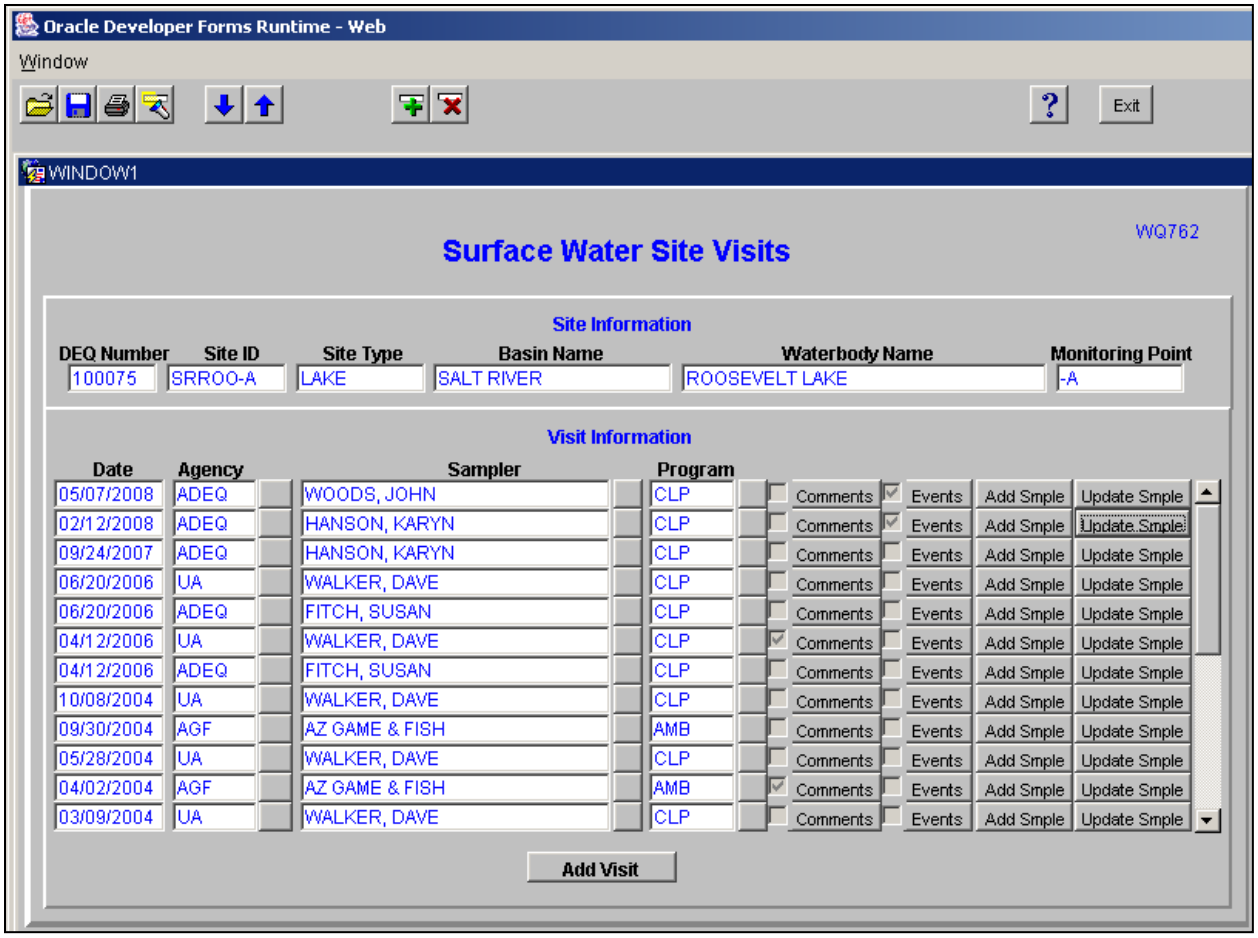


FIGURE 10.15. Visits screen.

10.4.2.2 Adding a New Visit

This section applies to data that will not be electronically uploaded. Use this procedure for a site that has no data listed for the date you sampled. For visits that already have existing data for a particular date (or will soon) see Section 10.4.2.3.

1. Click on the top most date and then click the add record button  .
2. Add the date, agency, sampler and program information.
3. Click the "Add Sample" button.
4. See Section 10.4.3 to enter data using a template or Section 10.4.4 to enter it manually.

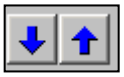
10.4.2.3 Adding a Sample to an Existing Visit

Use the "Add Sample" button to add a new time or depth for that particular date (typically lakes only). See Section 10.4.3 to enter data using a template.

10.4.2.4 Updating an Existing Sample

Use the "Update Sample" button to add parameters to a particular time/depth for a particular date. The "Update Sample" button is used when adding field parameters to data that has been electronically uploaded.

You can add a new sample with the same date and time. For example, your field data should be entered as a different sample using the same date and time as your chemistry sample but selecting the different sample type (i.e., FIELD CONDITIONS).

Use the up and down arrows  to find the record you need to update. You can either enter all the data manually (not recommended) or use a template by clicking on the "Add Sample Suite" button on the "Sample &Test Results" Screen (FIGURE 10.16). See Section 10.4.3 for the procedure to add a sample suite.

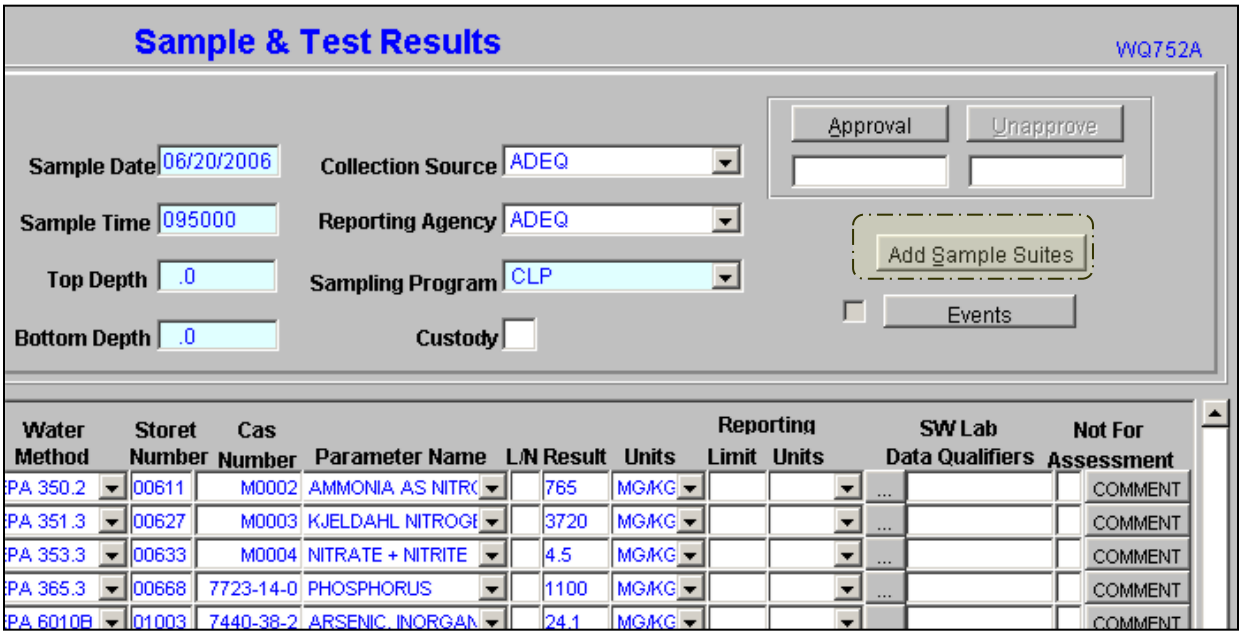


FIGURE 10.16. Test Results Screen shot.

10.4.3 ENTERING DATA USING A TEMPLATE

You should use a template to enter data whenever possible. A template is a list of parameters that has all the lab methods, units, etc. The ambient streams program has a template that lists all the metals, nutrients, inorganic and field parameters. This saves time and reduces errors when entering data.

The chemical suite selection screen may be reached by the visit screen or by the test results screen. The procedure for both is the same.

1. Select the analyzing lab (FIGURE 10.17).
2. Enter the Lab Number (optional). The lab number is number that the lab gives to a sample and is usually on the chain of custody.
3. Enter the Lab Sample Type (Regular, Duplicate, Split)
4. Select the appropriate premade sample suite. You can go to the lookup tables under the "inquiry" menu to see what parameters each suite currently has.

5. Click the Enter Sample/Test Results button (FIGURE 10.17).

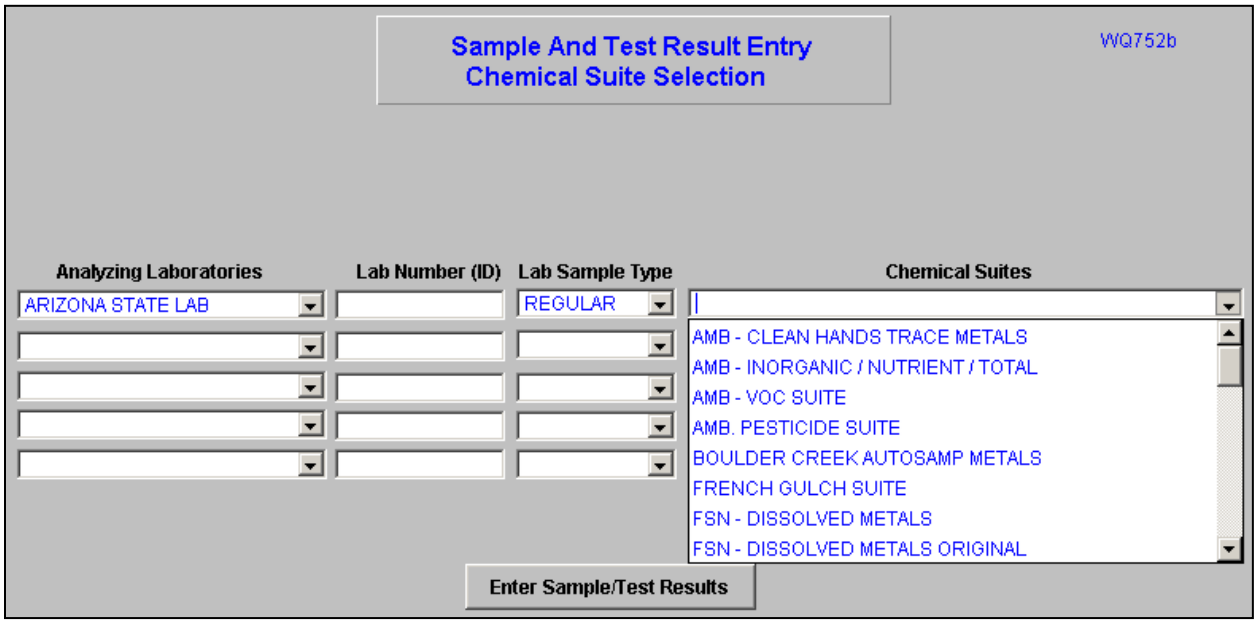
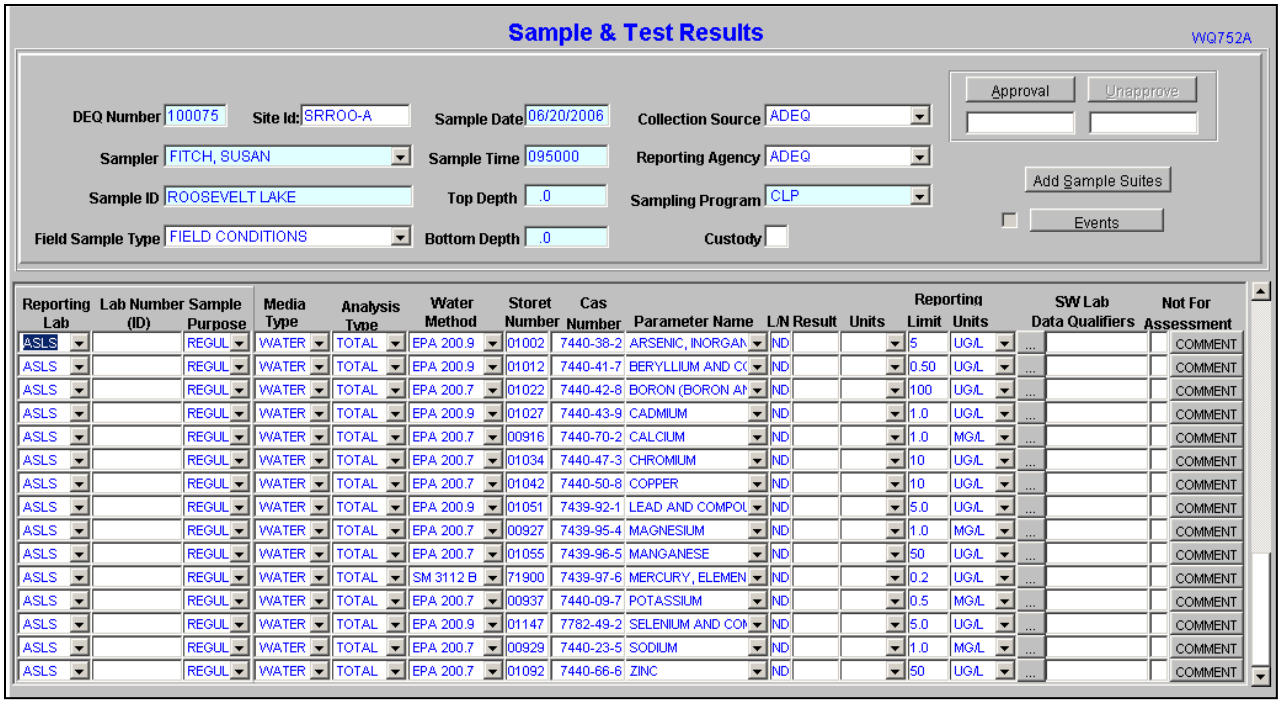


FIGURE 10.17. Chemical suite selection.

6. Enter the following if not already filled out (FIGURE 10.18):
   - Sample ID - Same as the Lab Sample ID
   - Field Sample Type (composite, grab, insitu etc.)
   - Sample Time (this is in military time, required)
   - Depth (if it is a lake)
   - Custody (was there a chain of custody? Almost always a "Y" for yes)

The collection agency and reporting agency fields should be filled out already. The Collection agency is the group that collects the sample (usually ADEQ). The reporting agency is the agency that paid for the data (again, usually ADEQ).



Reporting Lab	Lab Number (ID)	Sample Purpose	Media Type	Analysis Type	Water Method	Storet Number	Cas Number	Parameter Name	L/N	Result	Units	Reporting Limit	Units	SW Lab Data Qualifiers	Not For Assessment
ASLS		REGUL	WATER	TOTAL	EPA 200.9	01002	7440-38-2	ARSENIC, INORGAN	ND			5	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.9	01012	7440-41-7	BERYLLIUM AND C(	ND			0.50	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	01022	7440-42-8	BORON (BORON AI	ND			100	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.9	01027	7440-43-9	CADMIUM	ND			1.0	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	00916	7440-70-2	CALCIUM	ND			1.0	MG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	01034	7440-47-3	CHROMIUM	ND			10	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	01042	7440-50-8	COPPER	ND			10	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.9	01051	7439-92-1	LEAD AND COMPOU	ND			5.0	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	00927	7439-95-4	MAGNESIUM	ND			1.0	MG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	01055	7439-96-5	MANGANESE	ND			50	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	SM 3112 B	71900	7439-97-6	MERCURY, ELEMEN	ND			0.2	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	00937	7440-09-7	POTASSIUM	ND			0.5	MG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.9	01147	7782-49-2	SELENIUM AND CO	ND			5.0	UG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	00929	7440-23-5	SODIUM	ND			1.0	MG/L		COMMENT
ASLS		REGUL	WATER	TOTAL	EPA 200.7	01092	7440-66-6	ZINC	ND			50	UG/L		COMMENT

FIGURE 10.18. Test results screen shot after a template has been loaded. Note all the "ND" results.

7. By default, all the results will be listed as "ND" or non-detect in the Test Results Screen. Go through and enter each result for all the parameters in the template. Add any applicable lab data qualifiers and comments. Verify that the analytical method, reporting limits, and etc. are correct and match what has been reported by the lab.

8. Save your work by clicking  .

9. Add any applicable "Events" by clicking on the event button. Events are basically qualifiers for that particular date and site or for an entire visit. All events listed in TABLE 10.2 that apply to a site must be noted in the database. Nobody wants to spend countless hours pouring over your field notes to figure out why a pH reading wasn't taken. Multiple events can and should be entered for each site. They are vitally important when other people are trying to make sense of your data. Although observations could simply be written into the comment field, a set of critical "event descriptions codes" were established so that data could be queried by these codes.

What's the difference between a sample and a visit? A sample is specific to a particular date, location and time. A visit is only specific to a date and place. This is important for lakes which may have multiple samples per visit. You can flag the entire visit rather than each sample.

VISIT OR EVENT DESCRIPTION
ABUNDENT MACROPHYTES
ABUNDENT WATERFOWL
ALGAL BLOOM
ALGAL BLOOM IN THE LACUSTRIN PORTION OF THE LAKE

VISIT OR EVENT DESCRIPTION
APPROXIMATE SAMPLE TIME OR SAMPLE TIME UNKNOWN
BASEFLOW CONDITIONS
DATA CHECK COMPLETED
DEVIATION FROM STANDARD OPERATING PROCEDURES
DIEL DO SWING IS MORE THAN 5 MG/L IN LAKE PHOTIC ZONE
DISSOLVED OXYGEN VALUE ATTRIBUTED TO GROUNDWATER UPWELLING
EQUIPMENT PROBLEMS ASSOCIATED WITH VISIT (DATA ASSOCIATED WITH THE EQUIPMENT NOT ENTERED)
EVIDENCE OF RECENT FLOODING
EXCEEDANCE(S) AT TIME OF SAMPLING
FIELD BLANK CONTAMINATION ABOVE MRL - DATA NOT ACCEPTED
FISH KILL ATTRIBUTED TO LOW DO, HIGH PH OR ALGAL TOXICITY
FISH KILL OBSERVED
FLOOD EVENT IN PROGRESS AT TIME OF SITE VISIT
FLOW MEASUREMENT FROM USGS GAUGE/RECORDS OR 3RD PARTY
GENERAL – ADDITIONAL COMMENT
GENERAL/ADDITIONAL
GROUNDWATER ~ DISSOLVED OXYGEN VALUE ATTRIBUTED TO GROUNDWATER UPWELLING
HOLDING TIME EXCEEDED
INCOMPLETE SAMPLING EVENT
INCOMPLETE SAMPLING EVENT - MISSING PARAMETER(S) OR REPORTS
INDEPENDENT HYDROLOGIC EVENT (ALTHOUGH WITHIN 7 DAYS OF OTHER VISITS)
INDICATION OF TOXIC ALGAE
LIMITED SAMPLING EVENT - SELECTED PARAMETERS ONLY
LOW D.O./HIGH PH ATTRIBUTED TO PONDING OR EVAPORATION OF STREAM
LOW FLOW CONDITIONS
LOW LAKE LEVELS
MACROPHYTES – ABUNDANT MACROPHYTES
NEARBY SPRINGS INFLUENCING SAMPLES
NO ACTIVE FLOW; POOLS OR PONDED WATER ONLY
NOT RECOMMENDED FOR ASSESSMENT
QA/QC OR DUPLICATE SAMPLE COLLECTED AT TIME OF VISIT
QC EQUIPMENT BLANK ASSOCIATED WITH VISIT
QC RATIO OUTSIDE ACCEPTABLE RANGE - CATION / ANION BALANCE
QC RATIO OUTSIDE ACCEPTABLE RANGE - F/L EC
QC RATIO OUTSIDE ACCEPTABLE RANGE - F/L PH
QC RATIO OUTSIDE ACCEPTABLE RANGE - TDS / CALC. SUM
QC RATIO OUTSIDE ACCEPTABLE RANGE - TDS / EC
REGULATED FLOW
REJECTED DATA DUE TO QA/QC PROBLEMS
REJECTED DATA DUE TO QA/QC PROBLEMS
SIGNIFICANT RAIN DURING PAST 48 HOURS MAY AFFECT RESULTS
SPLIT/DUPLICATE ANALYSIS ALL WITHIN CONTROL LIMITS
SPLIT/DUPLICATE ANALYSIS OUTSIDE CONTROL LIMITS
STREAM DRY AT TIME OF SITE VISIT
SUBMERGED AQUATIC VEGETATION COVERING >50% LAKE BOTTOM
VISIT MEMBER OF INDEPENDENT EVENT GROUPING - AFTER EVENT
VISIT MEMBER OF INDEPENDENT EVENT GROUPING - DURING EVENT

VISIT OR EVENT DESCRIPTION
WATERFOWL – ABUNDANT WATERFOWL
WEATHER CONDITIONS MAY AFFECT SAMPLES

TABLE 10.2. "Event codes" in the WQDB.

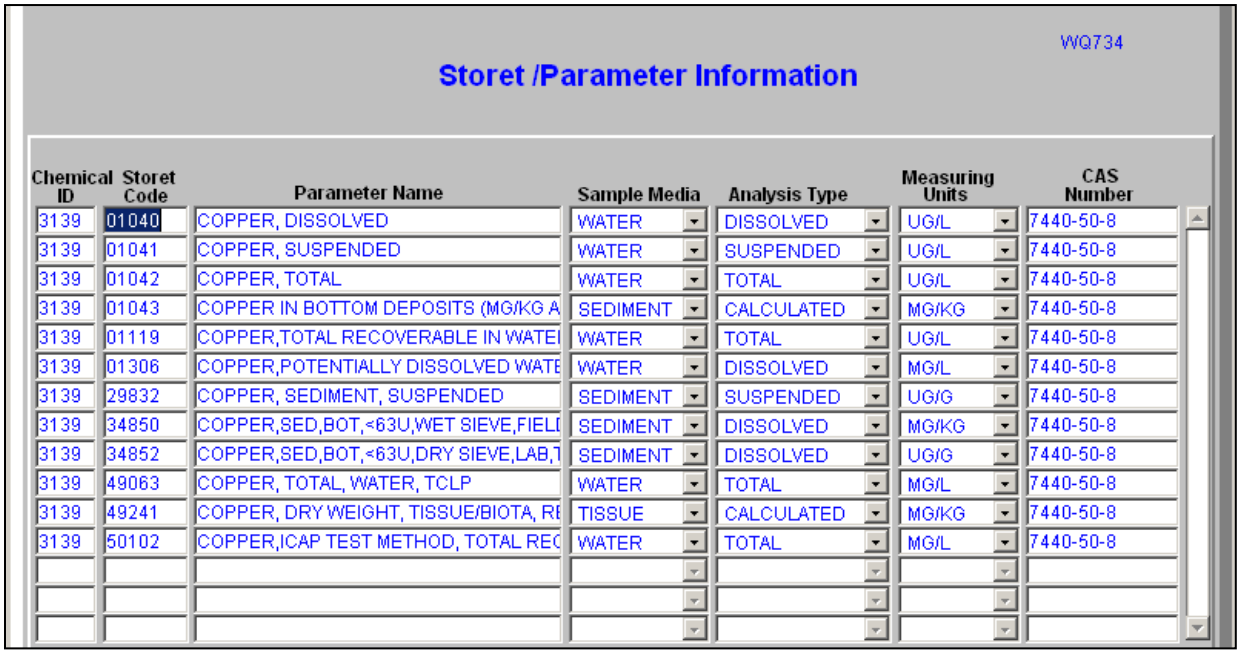
10. Save your work by clicking  .

10.4.4 ENTERING DATA BY HAND

Occasionally you may need to add a few parameters by hand into the database. Individual parameters can be added by hand to the WQDB using the following method.

1. Navigate to the Test Results Screen and locate the site, date and time you want to update.
2. Click on the top most parameter (the field under "reporting lab will work fine) and then click the add record button  .
3. Input the STORET number. STORET codes can be looked up by parameter name using the SW STORET lookup table in the WQDB. (A list is provided in Appendix D) Additional STORET codes are available in the EPA STORET lookup table. Contact your supervisor if you need to create a new STORET code.

   A STORET code is selected based on the parameter name, unit of measurement, media, and analysis type. They must all be correct. For example, if you were looking for possible STORET codes for dissolved copper, you would query the STORET / Parameter Information table. Use the search button (flashlight). to enter the parameter, surrounded by "%" signs: %**copper**%**.** This would bring up the alternatives shown below.



WQ734

Storet /Parameter Information

Chemical ID	Storet Code	Parameter Name	Sample Media	Analysis Type	Measuring Units	CAS Number
3139	01040	COPPER, DISSOLVED	WATER	DISSOLVED	UG/L	7440-50-8
3139	01041	COPPER, SUSPENDED	WATER	SUSPENDED	UG/L	7440-50-8
3139	01042	COPPER, TOTAL	WATER	TOTAL	UG/L	7440-50-8
3139	01043	COPPER IN BOTTOM DEPOSITS (MG/KG A	SEDIMENT	CALCULATED	MG/KG	7440-50-8
3139	01119	COPPER,TOTAL RECOVERABLE IN WATEI	WATER	TOTAL	UG/L	7440-50-8
3139	01306	COPPER,POTENTIALLY DISSOLVED WATE	WATER	DISSOLVED	MG/L	7440-50-8
3139	29832	COPPER, SEDIMENT, SUSPENDED	SEDIMENT	SUSPENDED	UG/G	7440-50-8
3139	34850	COPPER,SED,BOT,<63U,WET SIEVE,FIELI	SEDIMENT	DISSOLVED	MG/KG	7440-50-8
3139	34852	COPPER,SED,BOT,<63U,DRY SIEVE,LAB,T	SEDIMENT	DISSOLVED	UG/G	7440-50-8
3139	49063	COPPER, TOTAL, WATER, TCLP	WATER	TOTAL	MG/L	7440-50-8
3139	49241	COPPER, DRY WEIGHT, TISSUE/BIOTA, RE	TISSUE	CALCULATED	MG/KG	7440-50-8
3139	50102	COPPER,ICAP TEST METHOD, TOTAL REC	WATER	TOTAL	MG/L	7440-50-8

FIGURE 10.19. STORET query.

To narrow the field of alternatives you could have entered, the sample media (water) and analysis type (dissolved) or measuring units (µg/l).

4. Enter the reporting lab.

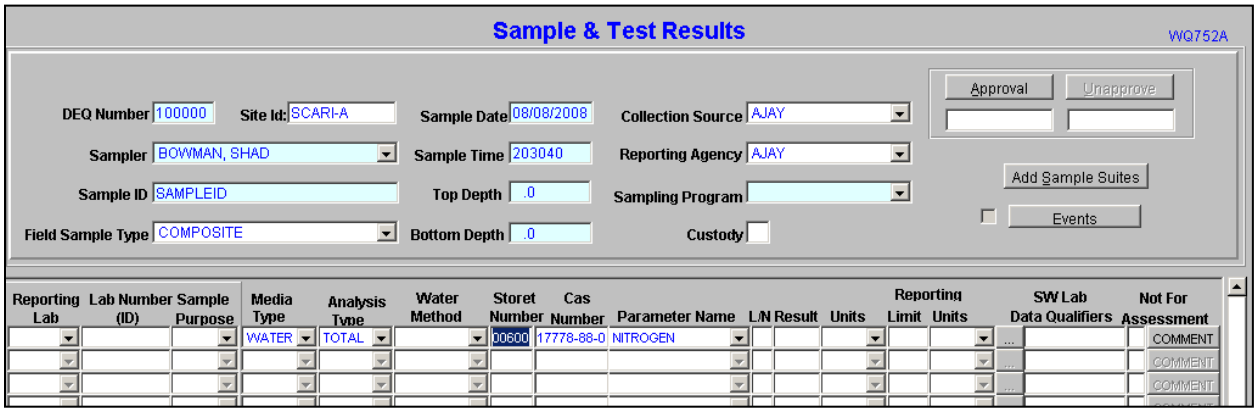


FIGURE 10.20. Entering the STORET number automatically updates several other fields.

5. Enter the lab number ID
6. Enter the sample purpose (regular, duplicate, split).
7. Enter the water method.

Only approved analytical methods should be sited. The methods in the drop down list in the WQDB may not be approved for ambient surface water quality data. The methods list in WQDB is currently shared by all programs. It includes many methods approved for analysis for other programs (e.g., hazardous wastes and soil contamination).

8. Enter the lab notation if needed. ND or not detected is the most common lab notation. When the lab notation is present the results should be blank and vice versa.

If bacteria counts are reported as "too numerous to count," then enter GT for the lab notation. A rough estimate of the upper detection limit should also be entered. This may be an educated guess. The upper limit for Colilert analysis is 2419.6 CFU per 100 mL (unless dilutions are preformed). Also enter the A1 data qualifier indicating that the bacteria is too numerous to count.

Bacterial results are not recorded as "0" as this number will interfere with automated geometric mean calculations (Chapter 4 has additional information regarding bacteria).

Code	Lab Notation
AB	Compound is absent
GT	Greater than quantification level
LT	Less than (Unknown if below quantification level)

Code	Lab Notation
LT-	Less than (No presence of compound detected)
N	Presumptive evidence of the presence of the compound
ND	Not detected
PR	Compound is present

TABLE 10.3. Lab notation descriptions.

9. Enter the results and units. Results are entered using the units provided by the laboratory and that agree with the STORET code chosen. Be sure that the units and results match. Incorrect units are one of the most common errors.
You will seldom report a result of "0." Instead you will report that it was measured below the lower reporting or detection limit – even with field equipment. The Sampling and Analysis Plan should contain the default detection limits for the laboratory analysis as well as the lowest reliable range for all field equipment.

   This issue is more complex when dealing with hardness dependent standards. Several areas in the state, primarily in higher elevations, have hardness that varies well below 100 mg/L. Such low hardness values result in very low criteria to be met. In these areas, special arrangements may be necessary to detect dissolved metals below the applicable criteria.
10. Enter the reporting limit and reporting limit units. The reporting limit for the WQDB is typically the Method Reporting Level (MRL). Lab results can be reported between the Method Detection Limit and the MRL. These results will be flagged with one of the "Estimate" qualifiers in TABLE 10.4.

Samples that are analyzed at a detection limit above any applicable water quality criterion do not tell us if the standard was exceeded. Such analysis should be avoided. For example, the chronic selenium criterion is 2.0 µg/L; therefore, a lab result reported as <5 µg/L will not provide any information about if the standard was exceeded.

11. Enter applicable lab data qualifiers. Lab qualifiers provide a wealth of information concerning the lab analysis that also needs to be documented with the data. Choose one or more Laboratory Data Qualifiers from the drop down list provided. TABLE 10.4 lists the most current lab qualifiers.

Qualifer	Short Description	Description	Decision	For 303d List?
A	ANALYTE - VALUE IS THE MEAN OF TWO OR MORE DETERMINATIONS	VALUE REPORTED IS THE MEAN OF TWO OR MORE DETERMINATIONS		
A1	BACTERIA - TOO NUMEROUS TO COUNT	MICROBIOLOGY: TOO NUMEROUS TO COUNT.		
A2	BACTERIA - INCUBATION PERIOD EXCEEDED	MICROBIOLOGY: SAMPLE INCUBATION PERIOD EXCEEDED METHOD REQUIREMENT.		
A3	BACTERIA - INCUBATION PERIOD SHORTER THAN REQUIRED.	MICROBIOLOGY: SAMPLE INCUBATION PERIOD WAS SHORTER THAN METHOD REQUIREMENT.		
A4	BACTERIA - DETECTED IN METHOD BLANK.	MICROBIOLOGY: TARGET ORGANISM DETECTED IN ASSOCIATED METHOD BLANK.	Reject	No
A5	BACTERIA - INCUBATOR/WATER BATH TEMP OUTSIDE REQUIREMENTS	MICROBIOLOGY: INCUBATOR/WATER BATH TEMPERATURE WAS OUTSIDE METHOD REQUIREMENTS.		
A6	BACTERIA - NOT DETECTED IN POSITIVE CONTROL	MICROBIOLOGY: TARGET ORGANISM NOT DETECTED IN ASSOCIATED POSITIVE CONTROL.	Reject	No
A7	BACTERIA - SAMPLE HAD INADEQUATE HEADSPACE	MICRO SAMPLE RECEIVED WITHOUT ADEQUATE HEADSPACE.		
A8	BACTERIA - PLATE COUNT WAS OUTSIDE THE METHOD'S REPORTING RANGE.	MICROBIOLOGY: PLATE COUNT WAS OUTSIDE THE METHOD'S REPORTING RANGE. REPORTED VALUE IS ESTIMATED.		
AB	ANALYTE - CONCENTRATION BETWEEN MDL AND PQL. USE DATA WITH CAUTION	ANALYTE CONCENTRATION DETECTED BETWEEN METHOD DETECTION LIMIT AND PRACTICAL QUANTITATION LIMIT. USE DATA WITH CAUTION.		
ASI	Lab ID assigned internally by DEQ. Data is still credible. See visit comments for details.	AA.		
B	BACTERIA - COLONY COUNTS OUTSIDE IDEAL RANGE (20-60 CFU)	COLONY COUNTS OUTSIDE ACCEPTABLE RANGE (20-60 CFU)		
B1	BLANK - ANALYTE IN METHOD BLANK DETECTED AT OR ABOVE METHOD REPORTING LIMIT	METHOD BLANK: TARGET ANALYTE DETECTED IN METHOD BLANK AT OR ABOVE THE METHOD REPORTING LIMIT.	Reject	No
B2	BLANK - NON-TARGET ANALYTE DETECTED IN METHOD BLANK AND SAMPLE PRODUCING INTERFERENCE	METHOD BLANK: NON-TARGET ANALYTE DETECTED IN METHOD BLANK AND SAMPLE, PRODUCING INTERFERENCE.	Reject	No
B3	BLANK - ANALYTE IN CALIBRATION BLANK AT OR ABOVE THE METHOD REPORTING LIMIT.	METHOD BLANK: TARGET ANALYTE DETECTED IN CALIBRATION BLANK AT OR ABOVE THE METHOD REPORTING LIMIT.	Reject	No
B4	BLANK - ANALYTE IN BLANK AT OR ABOVE METHOD ACCEPTANCE CRITERIA.	METHOD BLANK: TARGET ANALYTE DETECTED IN BLANK AT OR ABOVE METHOD ACCEPTANCE CRITERIA.	Reject	No
B5	BLANK - ANALYTE IN METHOD BLANK AT OR ABOVE THE METHOD REPORTING LIMIT, BUT BELOW STANDARD.	METHOD BLANK: TARGET ANALYTE DETECTED IN METHOD BLANK AT OR ABOVE THE METHOD REPORTING LIMIT, BUT BELOW TRIGGER LEVEL OR MCL.	Reject	No
B6	BLANK - ANALYTE IN CALIBRATION BLANK AT OR ABOVE THE METHOD REPORTING LIMIT, BUT BELOW STANDARD	METHOD BLANK: TARGET ANALYTE DETECTED IN CALIBRATION BLANK AT OR ABOVE THE METHOD REPORTING LIMIT, BUT BELOW TRIGGER LEVEL OR MCL.	Reject	No

Qualifer	Short Description	Description	Decision	For 303d List?
B7	BLANK - ANALYTE IN METHOD BLANK AT OR ABOVE MRL, BUT CONC. IN SAMPLE IS 10X ABOVE CONC IN BLANK	MEHTOD BLANK: TARGET ANALYTE DETECTED IN METHOD BLANK AT OR ABOVE METHOD REPORTING LIMIT.CONCENTRATION FOUND IN THE SMP WAS 10 TIMES ABOVE THE CONCENTRATION FOUND IN THE MTHD BLK.	Reject	No
B8	BLANK - ANALYTE FOUND IN BOTH THE TRAVEL BLANK AND SAMPLE	TRIP BLANK: ANALYTE FOUND IN BOTH THE TRAVEL BLANK AND SAMPLE.	Reject	No
C	ANALYTE - VALUE IS CALCULATED	VALUE CALCULATED		
C1	CONFIRMATION - ANALYSIS NOT PERFORMED AS REQUIRED.	CONFIRMATION: CONFIRMATORY ANALYSIS NOT PERFORMED AS REQUIRED BY THE METHOD.		
C3	CONFIRMATION - QUALITATIVE CONFIRMATION PERFORMED.	CONFIRMATION: QUALITATIVE CONFIRMATION PERFORMED.		
C4	CONFIRMATION - PAST HOLDING TIME.	CONFIRMATION: CONFIRMATORY ANALYSIS WAS PAST HOLDING TIME.		
C5	CONFIRMATION - NOT CONFIRMED, PAST HOLDING TIME.	CONFIRMATION. CONFIRMATORY ANALYSIS WAS PAST HOLDING TIME. ORIGINAL RESULT NOT CONFIRMED.		
CH1	FIELD - EPA METHOD 1669 FIELD PROTOCOLS EMPLOYED W/ CLEAN LAB ANALYSIS	EPA METHOD 1669 "CLEAN HANDS" FIELD PROTOCOLS EMPLOYED W/ CLEAN LAB ANALYSIS		
CH2	FIELD - STANDARD FIELD COLLECTION PROTOCOLS EMPLOYED W/ CLEAN LAB ANALYSIS	STANDARD FIELD COLLECTION/FILTRATION PROTOCOLS (NON "CLEAN HANDS") EMPLOYED W/ CLEAN LAB ANALYSIS		
CH3	FIELD - MODIFIED EPA METHOD 1669 FIELD PROTOCOLS EMPLOYED W/ CLEAN LAB ANALYSIS	MODIFIED EPA METHOD 1669 "CLEAN HANDS" PROTOCOLS EMPLOYED W/ CLEAN LAB ANALYSIS		
CH4	FIELD - EPA METHOD 1669 FIELD PROTOCOLS EMPLOYED W/ STANDARD LAB ANALYSIS	EPA METHOD 1669 FIELD PROTOCOLS EMPLOYED W/ STANDARD LAB ANALYSIS		
D	DILUTION - DILUTION FACTOR USED.	DILUTION FACTOR USED		
D1	DILUTION - REQUIRED DUE TO MATRIX INTERFERENCE.	DILUTION: SAMPLE REQUIRED DILUTION DUE TO MATRIX.		
D2	DILUTION - REQUIRED DUE TO HIGH CONCENTRATION OF ANALYTE.	DILUTION: SAMPLE REQUIRED DILUTION DUE TO HIGH CONCENTRATION OF TARGET ANALYTE. SEE CASE NARRATIVE.		
D4	DILUTION - MINIMUM REPORTING LEVEL ADJUSTED DUE TO SAMPLE AMOUNT.	DILUTION: MINIMUM REPORTING LEVEL (MRL) ADJUSTED TO REFLECT SAMPLE AMOUNT RECEIVED AND ANALYZED.		
D5	DILUTION - MINIMUM REPORTING LIMIT ADUSTED DUE TO SAMPLE DILUTION; ANALYTE NONDETECT IN SAMPLE.	DILUTION - MINIMUM REPORTING LIMIT ADUSTED DUE TO SAMPLE DILUTION; ANALYTE NONDETECT IN SAMPLE.		
D7	DILUTION - MINIMUM REPORTING LIMIT ADJUSTED TO REFLECT SAMPLE DILUTION.	DILUTION: MINIMUM REPORTING LIMIT ADJUSTED TO REFLECT SAMPLE DILUTION.		
DLR	ANALYTE - DETECTION LIMIT REPORTED	ANALYTE DETECTION LIMIT REPORTED IN LIEU OF METHOD REPORTING LIMIT		
E	ESTIMATE - ESTIMATED VALUE.	REPORTED VALUE ESTIMATED DUE TO MATRIX INTERFERENCE		
E1	ESTIMATE - ANALYTE EXCEEDED CALIBRATION RANGE. INSUFFICIENT SAMPLE TO REANALYZE.	ESTIMATED CONCENTRATION: CONCENTRATION ESTIMATED. ANALYTE EXCEEDED CALIBRATION RANGE. REANALYSIS NOT POSSIBLE DUE TO INSUFFICIENT SAMPLE.		No

Qualifer	Short Description	Description	Decision	For 303d List?
E2	ESTIMATE - ANALYTE EXCEEDED CALIBRATION RANGE. NOT REANALYSED DUE TO MATRIX PROBLEMS.	ESTIMATED CONCENTRATION: CONCENTRATION ESTIMATED. ANALYTE EXCEEDED CALIBRATION RANGE. REANALYSIS NOT PERFORMED DUE TO SAMPLE MATRIX.		No
E3	ESTIMATE - ANALYTE EXCEEDED CALIBRATION RANGE. NOT REANALYSED DUE TO HOLDING TIMES.	ESTIMATED CONCENTRATION: CONCENTRATION ESTIMATED. ANALYTE EXCEEDED CALIBRATION RANGE. REANALYSIS NOT PERFORMED DUE TO HOLDING TIME REQUIREMENTS.		No
E4	ESTIMATE - ANALYTE BELOW LAB REPORTING LEVEL BUT ABOVE MDL	ESTIMATED - ANALYTE WAS DETECTED BELOW LABORATORY MINIMUM REPORTING		No
E5	ESTIMATE - ANALYTE DETECTED BELOW LAB REPORTING LEVEL. NOT CONFIRMED BY ALT ANALYSIS.	ESTIMATED CONCENTRATION: CONCENTRATION ESTIMATED. ANALYTE WAS DETECTED BELOW LABORATORY MINIMUM REPORTING LEVEL (MRL), BUT NOT CONFIRMED BY ALTERNATE ANALYSIS.		No
E6	ESTIMATE - INTERNAL STANDARD RECOVERIES DID NOT MEET METHOD ACCEPTANCE CRITERIA.	ESTIMATED CONCENTRATION: CONCENTRATION ESTIMATED. INTERNAL STANDARD RECOVERIES DID NOT MEET METHOD ACCEPTANCE CRITERIA.	Reject	No
E7	ESTIMATE - INTERNAL STANDARD RECOVERIES DID NOT MEET LAB ACCEPTANCE CRITERIA.	ESTIMATED CONCENTRAITON: CONCENTRATION ESTIMATED. INTERNAL STANDARD RECOVERIES DID NOT MEET LABORATORY ACCEPTANCE CRITERIA.	Reject	No
E8	ESTIMATE - ANALYTE WAS NOT DETECTED; REPORTED TO MDL PER PROJECT SPECIFICATION.	ANALYTE REPORTED TO MDL PER PROJECT SPECIFICATION. TARGET ANALYTE WAS NOT DETECTED IN THE SAMPLE.		No
F	CONTAMINATION - ANALYTE FOUND IN SAMPLE BLANK AS WELL AS SAMPLE	ANALYTE FOUND IN SAMPLE BLANK AS WELL AS SAMPLE		No
FB1	CONTAMINATION - FIELD BLANK TAKEN FOR ANALYTE, NO CONTAMINATION	FIELD BLANK TAKEN FOR ANALYTE: NON-DETECT REPORTED, NO CONTAMINATION.		
FB2	CONTAMINATION - FIELD BLANK TAKEN FOR ANALYTE, MINOR CONTAMINATION	FIELD BLANK TAKEN FOR ANALYTE: MINOR CONTAMINATION REPORTED AT LEVELS BETWEEN MRL AND MDL. ASSOCIATED DATA CONSIDERED USABLE FOR LIMITED PURPOSES.		No
FH1	FIELD - RECOMMENDED HOLDING TIME PRIOR TO FILTRATION/PROCESSING EXCEEDED	AUTOSAMPLER DATA COLLECTION QUALIFIER. RECOMMENDED 15 MINUTE HOLDING TIME PRIOR TO FILTRATION/PROCESSING EXCEEDED.		
G	ANALYTE - VALUE IS THE MAXIMUM OF TWO OR MORE DETERMINATIONS	VALUE REPORTED IS THE MAXIMUM OF TWO OR MORE DETERMINATIONS		
H	HOLDING TIME EXCEEDED	VALUES ARE ESTIMATED BY FIELD KIT METHOD		No
H1	HOLDING TIME - ANALYSIS PERFORMED PAST HOLDING TIME	HOLD TIME: SAMPLE ANALYSIS PERFORMED PAST HOLDING TIME.		No, except E.coli
H2	HOLDING TIME - REANALYSIS FOR DILUTION WAS PAST HOLDING TIME	HOLD TIME: INITIAL ANALYSIS WITHIN HOLDING TIME. REANALYSIS FOR THE REQUIRED DILUTION WAS PAST HOLDING TIME.		No
H3	HOLDING TIME - SAMPLE RECEIVED AND/ OR ANALYSIS REQUESTED PAST HOLDING TIME.	HOLD TIME: SAMPLE WAS RECEIVED AND/ OR ANALYSIS REQUESTED PAST HOLDING TIME.		No

Qualifer	Short Description	Description	Decision	For 303d List?
H4	HOLDING TIME - EXCEEDED SAMPLE EXTRACTION HOLDING TIME, BUT ANAL HOLDING TIME OK	HOLD TIME: SAMPLE WAS EXTRACTED PAST REQUIRED EXTRACTION HOLDING TIME, BUT ANALYZED WITHIN ANALYSIS HOLDING TIME.		
H5	HOLDING TIME - FIELD TEST: 15 MINUTES HT. SAMPLE RECEIVED & ANALYZED PAST HOLDING TIME.	HOLDING TIME: THIS TEST IS SPECIFIED TO BE PERFORMED IN THE FIELD WITHIN 15 MINUTES OF SAMPLING; SAMPLE WAS RECEIVED AND ANALYZED PAST THE REGULATORY HOLDING TIME.		No
H6	HOLDING TIME - FILTRATION NOT DONE WITHIN 15 MINUTES OF SAMPLING.	HOLD TIME: THE FILTRATION WAS NOT DONE WITHIN THE REQUIRED 15 MINUTES OF SAMPLING, THE SAMPLE WAS FILTERED IN THE LABORATORY.		
J	ESTIMATE	VALUES ARE ESTIMATED, DATA IS VALID FOR LIMITED PURPOSES.		No
K	ESTIMATE - COMPOUND IS PRESENT, BUT BELOW LISTED VALUE (TYPICALLY, THE LAB DETECTION LIMIT).	COMPOUND IS PRESENT, BUT BELOW LISTED VALUE(TYPICALLY, THE LAB DETECTION LIMIT).		No
K1	BOD - DILUTIONS DID NOT MEET THE OXYGEN DEPLETION CRITERIA (2 MG/L)	BOD: THE SAMLE DILUTIONS SET-UP FOR THE BOD ANALYSIS DID NOT MEET THE OXYGEN DEPLETION CRITERIA OF AT LEAST 2 MG/L. THE REPORTED RESULT IS AN ESTIMATED VALUE.		
K10	BOD - SEED CONTROL SAMPLES DO NOT DEPLETE AT LEAST 2.0 MG/L.	BOD: SEED CONTROL SAMPLES DO NOT DEPLETE AT LEAST 2.0 MG/L, WITH A RETENTION OF AT LEAST 1.0 MG/L DO CRITERIA IN ALL SAMPLES.		
K11	BOD - MINIMUM DO IS LESS THAN 1.0 MG/L IN ALL DILUTIONS.	BOD: MINIMUM DO IS LESS THAN 1.0 MG/L IN ALL DILUTIONS.		
K2	BOD - DILUTIONS DID NOT MEET THE RESIDUAL D.O. CRITERIA (1 MG/L)	BOD: THE SAMPLE DILUTIONS SET UP FOR THE BOD ANALYSIS FAILED TO MEET THE CRITERIA OF A RESIDUAL DISSOLVED LXYGEN OF AT LEAST 1 MG/L. THE REPORTED RESULT IS AN ESTIMATED VALUE.		
K4	BOD - SEED DEPLETION OUTSIDE METHOD ACCEPTANCE LIMITS.	BOD: THE SEED DEPLETION WAS OUTSIDE THE METHOD AND LABORATORY ACCEPTANCE LIMITS. THE REPORTED RESULT IS AN ESTIMATED VALUE. DELETED IN REVISION 4.0 9/5/12.		
K5	BOD - DILUTION WATER D.O. DEPLETION WAS > 0.2 MG/L.	BOD: THE DILUTION WATER D.O. DEPLETION WAS > 0.2 MG/L.		
K6	BOD - GLUCOSE / GLUTAMIC ACID BOD BELOW METHOD ACCEPTANCE CRITERIA.	BOD: GLUCOSE/GLUTAMIC ACID BOD WAS BELOW METHOD ACCEPTANCE CRITERIA.		
K7	BOD - DISCREPANCY BETWEEN THE BOD AND COD. RESULTS VERIFIED BY REANALYSIS OF COD.	BOD: A DISCREPANCY BETWEEN THE BOD AND COD RESULTS HAS BEEN VERIFIED BY REANALYSIS OF THE SAMPLE FOR COD.		
K8	BOD - GLUCOSE / GLUTAMIC ACID BOD ABOVE METHOD ACCEPTANCE LEVELS.	BOD: GLUCOSE / GLUTAMIC ACID BOD WAS ABOVE METHOD ACCEPTANCE LEVELS.		
K9	BOD - TEST REPLICATES MORE THAN 30% DIFFERENCE.	BOD: TEST REPLICATES SHOW MORE THAN 30% DIFFERENCE BETWEEN HIGH AND LOW VALUES.		
L	ANALYTE - VALUE REPORTED IS ABOVE INSTRUMENT DETECTION LIMIT	RESULT BETWEEN CONTRACT QUANTITATION AND INSTRUMENT DETECTION LIMIT		
L1	SPIKE - BLANK SPIKE RECOVERY ABOVE LAB ACCEPTANCE LIMITS.	LABORATORY FORTIFIED BLANK/BLANK SPIKE: THE ASSOCIATED BLANK SPIKE RECOVERY WAS ABOVE LABORATORY ACCEPTANCE LIMITS.	Reject	No

Qualifer	Short Description	Description	Decision	For 303d List?
L2	SPIKE - BLANK SPIKE RECOVERY BELOW LAB ACCEPTANCE LIMITS.	LABORATORY FORTIFIED BLANK/BLANK SPIKE: THE ASSOCIATED BLANK SPIKE RECOVERY WAS BELOW LABORATORY ACCEPTANCE LIMITS.	Reject	
L3	SPIKE - BLANK SPIKE RECOVERY ABOVE METHOD ACCEPTANCE LIMITS.	THE ASSOCIATED BLANK SPIKE RECOVERY WAS ABOVE METHOD ACCEPTANCE LIMITS.	Reject	No
L4	SPIKE - BLANK SPIKE RECOVERY BELOW METHOD ACCEPTANCE LIMITS.	LABORATORY FORTIFIED BLANK/BLANK SPIKE: THE ASSOCIATED BLANK SPIKE RECOVERY WAS BELOW METHOD ACCEPTANCE LIMITS.	Reject	
L5	SPIKE - BLANK SPIKE RECOVERY ABOVE METHOD ACCEPTANCE LIMITS. NO ANALYTE DETECTED IN SAMPLE.	LABORATORY FORTIFIED BLANK/BLANK SPIKE: THE ASSOCIATED BLANK SPIKE RECOVERY WAS ABOVE LABORATORY/METHOD ACCEPTANCE LIMITS. THIS ANALYTE WAS NOT DETECTED IN THE SAMPLE.		No
M	DUPLICATES - DUPLICATE ANALYSIS OUTSIDE CONTROL LIMITS	DUPLICATE ANALYSIS OUTSIDE OF CONTROL LIMITS	Reject	No
M1	SPIKE - MATRIX SPIKE - RECOVERY WAS HIGH. ACCEPTABLE METHOD CONTROL SAMPLE RECOVERY.	MATRIX SPIKE: MATRIX SPIKE RECOVERY WAS HIGH, THE METHOD CONTROL SAMPLE RECOVERY WAS ACCEPTABLE.		
M2	SPIKE - MATRIX SPIKE - RECOVERY WAS LOW. ACCEPTABLE METHOD CONTROL SAMPLE RECOVERY.	MATRIX SPIKE: MATRIX SPIKE RECOVERY WAS LOW, THE METHOD CONTROL SAMPLE RECOVERY WAS ACCEPTABLE.		
M3	SPIKE - MATRIX SPIKE - ACCURACY REDUCED AS CONC IS DISPROPORTIONATE TO SPIKE CONC.	MATRIX SPIKE: THE ACCURACY OF THE SPIKE RECOVERY VALUE IS REDUCED SINCE THE ANALYTE CONCENTRATION IN THE SAMPLE IS DISPROPORTIONATE TO SPIKE LEVEL. THE METHOD CONTROL SMPLE RECOV		
M4	SPIKE - MATRIX SPIKE - CONC DILUTED BELOW REPORT LIMIT. METHOD CONTROL SAMPLE RECOVERY OK	MATRIX SPIKE: THE ANALYSIS OF THE SPIKED SAMPLE REQUIRED A DILUTION SUCH THAT THE SPIKE CONCENTRATION WAS DILUTED BELOW THE REPORTING LIMIT. THE METHOD CONTROL SAMPLE RECOVERY WA		
M5	SPIKE - MATRIX SPIKE - ANALYTE CONC. DETERMINED BY THE METHOD OF STANDARD ADDITION (MSA).	MATRIX SPIKE: ANALYTE CONCENTRATION WAS DETERMINED BY THE METHOD OF STANDARD ADDITION (MSA).		
M6	SPIKE - MATRIX SPIKE - RECOVERY WAS HIGH (ADEQ POLICY 0154).	MATRIX SPIKE: MATRIX SPIKE RECOVERY WAS HIGH. DATA REPORTED PER ADEQ POLICY 0154.000. MATRIX INTERFERENCE WAS CONFIRMED.		No
M7	SPIKE - MATRIX SPIKE - RECOVERY WAS LOW (ADEQ POLICY 0154.000).	MATRIX SPIKE: MATRIX SPIKE RECOVERY WAS LOW. DATA REPORTED PER ADEQ POLICY 0154.000. MATRIX INTERFERENCE WAS CONFIRMED.		No
MDL	ANALYTE - MDL REPORTED AS THE DETECTION LIMIT	ANALYTE - MDL REPORTED AS THE DETECTION LIMIT		
MPV	BACTERIA - MOST PROBABLE VALUE.	MOST PROBABLE VALUE.		
MX	ANALYTE - VALUE NOT DETERMINABLE DUE TO MATRIX INTERFERENCE.	VALUE NOT DETERMINABLE DUE TO MATRIX INTERFERENCE. TITRATION OR CHEMICAL ANALYSIS CAN NOT BE PERFORMED.		No
MX1	SERIAL DILUTION DETERMINED MATRIX INTERFERENCE WAS PRESENT	SERIAL DILUTION DETERMINED MATRIX INTERFERENCE WAS PRESENT FOR METAL ANALYTES		
N1	ANALYTE - SEE LAB CASE NARRATIVE.	SEE CASE NARRATIVE.		

Qualifer	Short Description	Description	Decision	For 303d List?
N2	ANALYTE - SEE LAB CORRECTIVE ACTION REPORT	SEE CORRECTIVE ACTION REPORT.		
N3	METHOD - ALL METHOD REQUIREMENTS MET.	THE ANALYSIS MEETS ALL METHOD REQUIREMENTS. SEE CASE NARRATIVE. DELETED IN REVISION 4.0 9/5/12.		
N4	THE MINIMUM REPORTING LIMIT VERIFICATION CHECK DID NOT MEET THE LABORATORY ACCEPTANCE LIMIT.	THE MINIMUM REPORTING LIMIT VERIFICATION CHECK DID NOT MEET THE LABORATORY ACCEPTANCE LIMIT.	Reject	No
N5	GENERAL - MINIMUM REPORTING LIMIT VERIFICATION CHECK DID NOT MEET THE METHOD ACCEPTANCE LIMIT.	GENERAL: THE MINIMUM REPORTING LIMIT (MRL) VERIFICATION CHECK DID NOT MEET THE METHOD ACCEPTANCE LIMIT.	Reject	No
N6	GENERAL - DATA SUSPECT DUE TO QUALITY CONTROL FAILURE, REPORTED PER DATA USER'S REQUEST.	GENERAL: DATA SUSPECT DUE TO QUALITY CONTROL FAILURE, REPORTED PER DATA USER'S REQUEST.	Reject	No
N7	GENERAL - ADDITIONAL ANALYSIS WAS NOT PERFORMED BASED ON THE "TOTAL" RESULT.	GENERAL: ADDITIONAL ANALYSIS WAS NOT PERFORMED BASED ON THE "TOTAL" RESULT WHICH WAS BELOW THE REQUESTED ANALYTE'S MCL/ACTION LEVEL/TRIGGER LEVEL.		
Q1	QC - SAMPLE INTEGRITY WAS NOT MAINTAINED.	SAMPLE QUALITY: SAMPLE INTEGRITY WAS NOT MAINTAINED. SEE CASE NARRATIVE.	Reject	No
Q10	QC - SAMPLE IN INAPPROPRIATE SAMPLE CONTAINER.	SAMPLE QUALITY: SAMPLE RECEIVED IN INAPPROPRIATE SAMPLE CONTAINER.	Reject	No
Q11	QC - SAMPLE IS HETEROGENEOUS. SAMPLE HOMOGENEITY COULD NOT BE ACHIEVED.	SAMPLE QUALITY: SAMPLE IS METEROGENEOUS. SAMPLE HOMOGENEITY COULD NOT BE READILY ACHIEVED USING ROUTINE LABORATORY PRACTICES.		No
Q2	QC - SAMPLE RECEIVED WITH HEAD SPACE.	SAMPLE QUALITY: SAMPLE RECEIVED WITH HEAD SPACE.		
Q3	QC - SAMPLE RECEIVED WITH IMPROPER CHEMICAL PRESERVATION.	SAMPLE QUALITY: SAMPLE RECEIVED WITH IMPROPER CHEMICAL PRESERVATION.	Reject	No
Q4	QC - SAMPLE RECEIVED AND ANALYZED WITHOUT CHEMICAL PRESERVATION.	SAMPLE QUALITY: SAMPLE RECEIVED AND ANALYZED WITHOUT CHEMICAL PRESERVATION	Reject	No
Q5	QC - SAMPLE RECEIVED WITHOUT CHEM PRESERVATION,. PRESERVED BY THE LAB.	SAMPLE QUALITY: SAMPLE RECEIVED WITHOUT CHEMICAL PRESERVATION, BUT PRESERVED BY THE LABORATORY.	Reject	No
Q6	QC - SAMPLE RECEIVED ABOVE RECOMMENDED TEMPERATURE.	SAMPLE QUALITY: SAMPLE WAS RECEIVED ABOVE RECOMMENDED TEMPERATURE.		
Q7	QC - SAMPLE INADEQUATELY DECHLORINATED.	SAMPLE QUALITY: SAMPLE INADEQUATELY DECHLORINATED.	Reject	No
Q8	QC - INSUFFICIENT SAMPLE TO MEET METHOD QC REQUIREMENTS, BUT BATCH QC REQUIREMENTS MET.	SAMPLE QUALITY: INSUFFICIENT SAMPLE RECEIVED TO MEET METHOD QC REQUIREMENTS. BATCH QC REQUIREMENTS SATISFY ADEQ POLICY 0154.000.		
Q9	QC - INSUFFICIENT SAMPLE TO MEET METHOD QC REQUIREMENTS.	SAMPLE QUALITY: INSUFFICIENT SAMPLE RECEIVED TO MEET METHOD QC REQUIREMENTS.		
R1	DUPLICATES - RPD EXCEEDED THE METHOD CONTROL LIMIT.	DUPLICATES: RPD EXCEEDED THE METHOD CONTROL LIMIT. SEE CASE NARRATIVE.	Reject	No

Qualifer	Short Description	Description	Decision	For 303d List?
R11	DUPLICATES - THE RPD CALCULATION FOR MS/MSD NOT USEFUL DUE TO THE VARYING SAMPLE WEIGHTS.	DUPLICATES: THE RPD CALCULATION FOR MS/MSD DOES NOT PROVIDE USEFUL INFORMATION DUE TO THE VARYING SAMPLE WEIGHTS WHEN ENCORE SAMPLERS / METHANOL FIELD PRESERVED SAMPLES ARE USED.		
R12	DUPLICATES - RPD/RSD EXCEEDED THE METHOD ACCEPTANCE LIMIT. RESULT LESS THAN 5 TIMES THE PQL.	DUPLICATES: RPD/RSD EXCEEDED THE METHOD ACCEPTANCE LIMIT. RESULT LESS THAN 5 TIMES THE PQL.	Reject	No
R13	DUPLICATES - MS/MSD RPD EXCEEDED METHOD ACCEPTANCE LIMIT.	DUPLICATES: MS/MSD RPD EXCEEDED METHOD ACCEPTANCE LIMIT. MATRIX SPIKE RECOVERY WAS OUTSIDE ACCEPTANCE CRITERIA. BATCH PRECISION AND ACCURACY WERE DEMONSTRATED.	Reject	No
R2	DUPLICATES - RPD EXCEEDED THE LAB CONTROL LIMIT	DUPLICATES: RPD EXCEEDED THE LABORATORY CONTROL LIMIT	Reject	No
R4	DUPLICATES - RPD > METHOD CONTROL LIMIT, BUT RECOVERY MET ACCEPTANCE CRITERIA.	DUPLICATES: RPD EXCEEDED THE METHOD CONTROL LIMIT. RECOVERY MET ACCEPTANCE CRITERIA.	Reject	No
R5	DUPLICATES - RPD > LAB CONTROL LIMIT, BUT RECOVERY MET ACCEPTANCE CRITERIA.	DUPLICATES: RPD EXCEEDED THE LABORATORY CONTROL LIMIT. RECOVERY MET ACCEPTANCE CRITERIA.	Reject	No
R6	DUPLICATES - LFB/LFBD RPD > METHOD CONTROL LIMIT, BUT RECOVERY MET ACCEPTANCE CRITERIA.	DUPLICATES: LFB/LFBD RPD EXCEEDED THE METHOD CONTROL LIMIT. RECOVERY MET ACCEPTANCE CRITERIA.	Reject	No
R7	DUPLICATES - LFB/LFBD RPD > LAB CONTROL LIMIT, BUT RECOVERY MET ACCEPTANCE CRITERIA.	DUPLICATES: LFB/LFBD RPD EXCEEDED THE LABORATORY CONTROL LIMIT. RECOVERY MET ACCEPTANCE CRITERIA.	Reject	No
R8	DUPLICATES - SAMPLE RPD EXCEEDED THE METHOD ACCEPTANCE LIMIT.	DUPLICATES: SAMPLE RPD EXCEEDED THE METHOD ACCEPTANCE LIMIT.	Reject	No
R9	DUPLICATES - SAMPLE RPD EXCEEDED THE LABORATORY ACCEPTANCE LIMIT.	DUPLICATES: SAMPLE RPD EXCEEDED THE LABORATORY ACCEPTANCE LIMIT.	Reject	No
RPD	RELATIVE PERCENT DIFFERENCE	RELATIVE PERCENT DIFFERENCE EXCEEDED CRITERIA		
S	SPIKE - BLANK SPIKE SAMPLE RECOVERY OUTSIDE CONTROL LIMITS	SPIKED SAMPLE RECOVERY OUTSIDE CONTROL LIMITS	Reject	No
S1	SUR RECOV - ABOVE LAB ACCEPT LIMITS. METHOD ACCEPTANCE LIMITS OK.	SURROGATE: SURROGATE RECOVERY WAS ABOVE LABORATORY ACCEPTANCE LIMITS, BUT WITHIN METHOD ACCEPTANCE LIMITS.		No
S10	SUR RECOV - WAS ABOVE LAB & METHOD ACCEPTANCE LIMITS.	SURROGATE: SURROGATE RECOVERY WAS ABOVE LABORATORY AND METHOD ACCEPTANCE LIMITS. SEE CASE MARRATIVE (NI).		No
S11	SUR RECOV - WAS HIGH (ADEQ POLICY 0154.000).	SURROGATE: SURROGATE RECOVERY WAS HIGH. DATA REPORTED PER ADEQ POLICY 0154.000.		No
S12	SUR RECOV - WAS LOW (ADEQ POLICY 0154.000).	SURROGATE: SURROGATE RECOVERY WAS LOW. DATA REPORTED PER ADEQ POLICY 0154.000.		No
S3	SUR RECOV - ABOVE LAB ACCEPT LIMITS. METHOD ACCEPTANCE LIMITS OK. TARGET ANALYTE NOT DETECT	SURROGATE: SURROGATE RECOVERY WAS ABOVE LABORATORY ACCEPTANCE LIMITS, BUT WITHIN METHOD ACCEPTANCE LIMITS. NO TARGET ANALYTES WERE DETECTED IN THE SAMPLE.		No

Qualifer	Short Description	Description	Decision	For 303d List?
S4	SUR RECOV - ABOVE LAB AND METHOD ACCEPTANCE LIMITS. TARGET ANALYTES NOT DETECTED	SURROGATE: SURROGATE RECOVERY WAS ABOVE LABORATORY AND METHOD ACCEPTANCE LIMITS. NO TARGET ANALYTES WERE DETECTED IN THE SAMPLE.		No
S5	SUR RECOV - BELOW LAB ACCEPTANCE LIMITS, BUT WITHIN METHOD ACCEPTANCE LIMITS.	SURROGATE: SURROGATE RECOVERY WAS BELOW LABORATORY ACCEPTANCE LIMITS, BUT WITHIN METHOD ACCEPTANCE LIMITS.		No
S6	SUR RECOV - BELOW LAB & METHOD ACCEPT LIMITS. REANALYSIS LOW RECOV DUE MATRIX EFFECT	SURROGATE: SURROGATE RECOVERY WAS BELOW LABORATORY AND METHOD ACCEPTANCE LIMITS. REEXTRACTION AND/OR REANALYSIS CONFIRMS LOW RECOVERY CAUSED BY MATRIX EFFECT.		
S7	SUR RECOV - BELOW LAB & METHOD ACCEPTANCE LIMITS. UNABLE TO CONFIRM MATRIX EFFECT.	SURROGATE: SURROGATE RECOVERY WAS BELOW LABORATORY AND METHOD ACCEPTANCE LIMITS. UNABLE TO CONFIRM MATRIX EFFECT.		
S8	SUR RECOV - CALC NOT USEFUL DUE SAMPLE DILUTION. METHOD CONTROL SAMP RECOV ACCEPTABLE.	SURROGATE: THE ANALYSIS OF THE SAMPLE REQUIRED A DILUTION SUCH THAT THE SURROGATE RECOVERY CALCULATION DOES NOT PROVIDE ANY USEFUL INFORMATION. THE METHOD CONTROL SAMPLE RECOVE		
SOP	FIELD - DEVIATIONS FROM STANDARD FIELD OPERATING PROCEDURES, ANALYTE-SPECIFIC	DEVIATIONS FROM STANDARD FIELD OPERATING PROCEDURES, ANALYTE-SPECIFIC		
T	ESTIMATE - VALUE IS LESS THAN DETECTION CRITERIA	VALUE REPORTED IS LESS THAN DETECTION CRITERIA		
T1	METHOD - APPROVED BY EPA, BUT NOT YET LICENCED BY ADHS.	METHOD/ANALYTE DISCREPANCIES: METHOD APPROVED BY EPA, BUT NOT YET LICENSED BY ADHS.		
T2	METHOD - APPROVED METHOD, BUT ANALYTE NOT INCLUDED IN THE METHOD COUMPOUND LIST.	METHOD/ANALYTE DISCREPANCIES: CITED ADHS LICENSED METHOD DOES NOT CONTAIN THIS ANALYTE AS PART OF METHOD COUMPOUND LIST.		
T3	METHOD - NOT PROMULGATED EITHER BY EPA OR ADHS.	METHOD/ANALYTE DISCREPANCIES: METHOD NOT PROMULGATED EITHER BY EPA OR ADHS.		
T4	ESTIMATE - TENTATIVELY IDENTIFIED COMPOUND. CONCENTRATION ESTIMATED.	METHOD/ANALYTE DISCREPANCIES: TENTATIVELY IDENTIFIED COMPOUND. CONCENTRATION IS ESTIMATED AND BASED ON THE CLOSEST INTERNAL STANDARD.		
T5	METHOD - LABORATORY NOT LICENSED FOR THIS PARAMETER.	METHOD/ANALYTE DISCREPANCIES: LABORATORY NOT LICENSED FOR THIS PARAMETER.		
T6	METHOD - THE REPORTED RESULT CANNOT BE USED FOR COMPLIANCE PURPOSES.	METHOD/ANALYTE DISCREPANCIES: THE REPORTED RESULT CANNOT BE USED FOR COMPLIANCE PURPOSES.		
T7	METHOD - INCUBATOR/OVEN TEMPERATURES NOT MONITORED DURING ALL DAYS OF USE.	METHOD/ANALYTE DISCREPANCIES: INCUBATOR/OVEN TEMPERATURES WERE NOT MONITORED AS REQUIRED DURING ALL DAYS OF USE.		
T8	METHOD - METHOD USED NOT LISTED IN 40 CFR 136; ALTERNATE METHOD CHOSEN PER PERMIT.	METHOD/ANALYTE DISCREPANCIES: METHOD USED NOT LISTED IN 40 CFR 136; ALTERNATE METHOD CHOSEN AS ACCEPTABLE PER PERMIT.		

Qualifer	Short Description	Description	Decision	For 303d List?
T9	METHOD - LESS THAN THE PRESCRIBED SAMPLE AMOUNT WAS AVAILABLE FOR THE LEACHATE EXTRACTION.	METHOD/ANALYTE DISCREPANCIES: LESS THAN THE PRESCRIBED SAMPLE AMOUNT WAS AVAILABLE TO PERFORM THE LEACHATE EXTRACTION. THE VOLUME OF EXTRACTION FLUID WAS ADJUSTED PROPORTIONATELY BASED ON THE METHOD PRESCRIBED RATIO OF EXTRACTION FLUID TO SAMPLE WEIGHT.		
TR	ESTIMATE - LAB REPORTED A TRACE VALUE	LABORATORY REPORTED A TRACE VALUE FOR THE COMPOUND		
UJ	ESTIMATE - QUANT LIMIT ADJUSTED DUE TO BLANK CONTAMINATION / ANAL DEFICIENCIES.	SAMPLE QUANTITATION LIMIT WAS ADJUSTED. VALUE IS ESTIMATED. DUE TO BLANK CONTAMINATION AND/OR ANALYTICAL DEFICIENCIES, ADJUSTMENT OF THE SAMPLE QUANTITATION LIMIT WAS NECESSARY.		
V	CONTAMINATION - ANALYTE DETECTED IN BOTH ENVIRONMENTAL SAMPLE & ASSOCIATED BLANKS.	ANALYTE WAS DETECTED IN BOTH THE ENVIRONMENTAL SAMPLE AND THE ASSOCIATED BLANKS & BIOLOGICAL ORGANISM ESTIMATED AS DOMINANT		
V1	CALIBRATION - RECOV ABOVE METHOD ACCEPT LIMITS. TARGET ANALYTE NOT DETECTED.	CALIBRATION VERIFICATION: CCV RECOVERY WAS ABOVE METHOD ACCEPTANCE LIMITS. THIS TARGET ANALYTE WAS NOT DETECTED IN THE SAMPLE.		
V2	CALIBRATION - RECOV ABOVE METHOD ACCEPT LIMITS. ANALYTE DET. INSUFFICIENT SAMPLE 2 CONFIRM	CALIBRATION VERIFICATION: CCV RECOVERY WAS ABOVE METHOD ACCEPTANCE LIMITS. THIS TARGET ANALYRTE WAS DETECTED IN THE SAMPLE. THE SAMPLE COULD NOT BE REANALYZED DUE TO INSUFICIENT		
V3	CALIBRATION - RECOV ABOVE METHOD ACCEPT LIMITS. ANALYTE DET. SAMPLE NOT REANALYZED.	CALIBRATION VERIFICATION: CCV RECOVERY WAS ABOVE METHOD ACCEPTANCE LIMITS. THIS TARGET ANALYTE WAS DETECTED IN THE SAMPLE, BUT THE SAMPLE WAS NOT REANALYZED. SEE CASE NARRATIVE.		
V5	CALIBRATION - RECOV AFTER GROUP OF SAMPLES ABOVE ACCEPT LIMITS. TARGET ANALYTE NOT DET.	CALIBRATION VERIFICATION: CCV RECOVERY AFTER A GROUP OF SAMPLES WAS ABOVE ACCEPTANCE LIMITS. THIS TARGET ANALYTE WAS NOT DETECTED IN THE SAMPLE. ACCEPTABLE PER PEA METHOD 8000B.		
V6	CALIBRATION - DATA FROM ONE-POINT CALIBRATION CRITERIA	CALIBRATION VERIFICATION: DATA REPORTED FROM ONE-POINT CALIBRATION CRITERIA.		
V7	CALIBRATION - RECOV ABOVE METHOD CONTROL LIMIT. AVE %DIFFERENCE (% DRIFT) MET METHOD CRIT.	CALIBRATION VERIFICATION: CV RECOVERY WAS ABOVE THE METHOD CONTROL LIMIT FOR THIS ANALYTE, HOWEVER, AVERAG % DIFFERENCE OR % DRIFT FOR ALL THE ANALYTES MET METHOD CRITERIA. DELETED IN REVISION 4.0 9/5/12.		
W	ESTIMATE - VALUE IS LOWER THAN VALUE UNDER "T"	VALUE IS LESS THAN LOWEST VALUE UNDER "T"		
X	ANALYTE - SEE EVENT DESCRIPTION OR PARAMETER FLAGS	OTHER (SEE COMMENTS FROM SAMPLE)		
Y	QC - RATIOS OUTSIDE ACCEPTABLE RANGE	QC RATIONS OUTSIDE ACCEPTABLE RANGE		

Qualifer	Short Description	Description	Decision	For 303d List?
ZQL	ANALYTE - DATA QUALIFIED: SEE COMMENTS FOR FURTHER DISCUSSION.	DATA QUALIFIED, BUT STILL CONSIDERED USABLE FOR ASSESSMENTS AND TMDL PURPOSES. SEE ANALYTE COMMENT OR GENERAL COMMENTS FOR SAMPLER COMMENT ON USE.		

Table 10.4 ADEQ Laboratory data qualifiers

Data that cannot be used for assessments is flagged using the "Assessment Comment" button. This is reserved primarily for data that is not scientifically defensible or does not meet credible data requirements. Currently only the Assessment Program can add the flag and a comment about why the data is flagged.

11. Repeat the process if additional parameters need to be entered.

12. Save your work by clicking  .

10.5 CREATING NEW SITES

Avoid establishing unnecessary sites by looking for existing sites in AZMAPPER, ArcMap or querying the database. A new site should be established when it is hydrologically distinct from existing sites.

In general, a new site can be created if it is more than 200 meters or 656 feet apart from an existing site on a stream. This rule is only meant to reduce redundant sites in the database. Hydrological differences that should be considered include confluences from tributaries, springs, point source discharges or land use that might discharge pollutants during runoff events.

10.5.1 PROCEDURE TO CREATE A NEW SITE

To create a site you will need to navigate to the Site Information screen (Surface Water – Enter/Update Menu – Site Entry) and fill in the site information except for the Site ID and DEQ number (FIGURE 10.9). Everything in blue is required. Everything in white is optional.

10.5.2 HOW SITES ARE NAMED

The Site Identification Number (a.k.a. SITEID) is also used to identify a site. It has a distinct advantage over the DEQ number by using a naming convention that describes a particular site. Lake and stream sites are each identified a little differently.

10.5.2.1 Stream Code Abbreviations

Each surface water code abbreviation is unique within the watershed and within the surface water type. For instance, "RED" can only be used for one stream in the Bill Williams Watershed. However, RED could also be used for a lake in the Bill Williams, and RED could be used for another stream in the Santa Cruz Watershed.

If the site is on a stream or canal, the monitoring point is the "river mile" distance calculated from the streams mouth point (confluence with another stream or lake) up to the monitoring site, measured in miles. The river miles are shown as a 5-digit number with a decimal point to 100ths (e.g., 001.32).

A stream site code contains a numeric river mile, along with the watershed and stream code. For example: VREVR012.21, is the East Verde River at 12.21 miles upstream from its confluence with the Verde River.

The three letter stream code is primarily derived from the first three letters of the name, except as stated below or to avoid duplications (e.g., Aluminum Creek might be ALU)

- The third letter is dedicated for the following stream names endings
  - C is dedicated to names ending in "Canyon." It is not used for names ending in Creek (e.g., Chevelon Canyon = CHC) (C is also used for canals, see canal abbreviations below)
  - W is dedicated to names ending in "Wash" (Indian Bend Wash = IBW);
  - R is dedicated to names ending in "River" or "Run" (e.g., San Pedro River = SPR)
  - G is dedicated to names ending in "Gulch" (e.g., Alum Gulch = ALG);
- Use only the first letter of a common name (East, San, Little) (e.g., East Clear Creek = ECL)
- Ignore the word "Fork" (e.g., East Fork Black River = EBR)
- Use first letters of each word if three or more words (e.g., Copper Camp Wash = CCW)
- Use the number in the name (e.g., 3-Mile Creek = 3MI)

Unnamed Streams – These are assigned codes on an as-needed basis (when sampling sites).

- The first code is always a "U" for unnamed stream.
- The next two letters are taken from the first two code letter used for the stream or lake it is draining to.
- If unnamed tributary to an unnamed tributary, use "UU" and then a letter for the stream or lake it is draining into.

For example: If Bitter Creek's code is BTR, then the first unnamed tributary would be UBT. The next unnamed tributary would be UB1, then UB2, etc. If samples are collected on an unnamed tributary to an unnamed tributary to Bitter Creek, the code would be UUB.

Duplicate Codes – If the abbreviation is already used for a stream within the watershed, do the following in order, until a unique code is derived:

- Use the next consonant until all consonants in the name have been used,
- Use the next vowel until all vowels in the name have been used,
- Use a number

For example, multiple unnamed tributaries to Pinto Creek became: UP1, UP2, UP3, UP4….

10.5.2.2 Lake Code Abbreviations

Lake monitoring points are created by adding a dash and up to a 5 letter code abbreviation. The most common lake sites are routinely given the following abbreviations:

- A = Dam site
- B = Mid lake
- MAR = Marina or -BR = Boat Ramp

Lake sites can also be given descriptive abbreviations. For example, a site on Roosevelt Lake near Pitney Picnic Grounds might be "- PIT."

The three letter lake code is primarily derived from the first three letters of the name, except as stated below or to avoid duplications (e.g., Alamo Lake = ALA).

- Ignore the word "Lake" if it is the first name of the lake (e.g., Lake Havasu = HAV)
- Use the first letter of the second name if multiple words (e.g., Soldier's Annex Lake = SAL)

If the abbreviation is already used for a lake within the watershed, do the following to derive a unique code:

- Use the next letter in the name or
- Use a number (last resort).

10.5.2.3 Canal ID and Code Abbreviations

Canals are special cases requiring unique protocols to identify monitoring points. River mile monitoring points cannot properly be applied to canals because the conventions associated with rivers are not consistent with canals. Consequently, a convention has been adopted for canal IDs that uses a special descriptor with a mix of both text and integers for the monitoring point to distinguish canals from both streams and lakes.

Watershed codes are applied to canal monitoring points as with any other site in the database. Codes are assigned to canals or their laterals. Canals codes are a composite of:

- The first code is a letter – generally the first letter of the name,
- The second code is a number from 1-9, and
- The letter C for canal.

Example: Atwater Canal = A1C

The monitoring point for any canal follows the following protocol:

Determine the cadastral section number the monitoring point falls within from a USGS quadrangle or other map source. The section number comprises the second and third characters of the monitoring point (single digit section numbers shall be prefaced with a "0").

Determine the quarter (Q), the quarter-quarter (QQ), and the quarter-quarter-quarter (QQQ) section designation for the part of the section the monitoring point falls within. AZMapper has a

tool to assist with this operation. Generally, each successively smaller quarter is designated as follows:

"A" – Northeast quarter
"B" – Northwest quarter
"C" – Southwest quarter
"D" – Southeast quarter

These three characters (for the quarter, quarter-quarter, quarter-quarter-quarter respectively) comprise the fourth, fifth, and sixth characters of the monitoring point.

If the site is the first or only site within a unique QQQ for the canal water body ID and watershed, preface the monitoring point designation with an "X". If the site is the second within the same QQQ, preface the monitoring point with a "Q". Either of these letters will occupy the first character of the monitoring point.

For example, a fictitious monitoring point associated with the example code above might be developed in the following fashion. If the monitoring point is the first in the extreme northwest QQQ of section 22 for the Middle Gila watershed, its code would be MG-A1C-X22BBB (dashes added for illustration purposes only). A site on the Middle Gila's portion of the Arizona Canal falling just to the southwest of the center of Section 9 and the second one within the QQQ would be MG-AZC-Q09CAA

While it is theoretically possible that codes could be duplicated with this protocol, the likelihood is not high that this would occur. As of 2010, only approximately 60 canal sites are recorded state-wide in the WQDB. Following the protocol will yield unique and identifiable site ID codes with inherent locational information content that differ in format from both stream codes and lake codes.

10.6 DATA MANAGEMENT QUALITY CONTROL

10.6.1 OVERVIEW AND TIMEFRAMES

Quality assurance is achieved by a myriad of activites, described in the Surface Water Quality Assurance Program Plan (ADEQ, 2014). A large portion of the QA Plan deals with the quality control checks conducted on the field and laboratory data prior to entry into the WQDB, assessment and listing. All data entered into the WQDB must undergo a quality control check which includes all the review items contained in the "WQDB Data Entry & Lab Data Package Review Checklist" performed within 30 days of receipt so that the lab can rerun samples if there is a problem. The quality control review includes everything from looking for odd values to seeing if there are any problems with blanks or duplicates. A second staff member double checks the data entry and quality control actions, then the original staff member can approve the data by clicking the "Approve" button on the test results screen. Clicking the approval button will lock the

records from further editing. The following section outlines details of the QC process utilizing the "Checklist".

10.6.2 DATA REVIEW PROCESS

The data review process utilizes the Checklist shown in Figure 10.21. This checklist is used by all ADEQ programs that collect water quality samples (fish, TMDL, ambient, lakes, etc).

Some sections of the form may be not applicable. For example, TMDL may not collect the anions/cations necessary to look at the QC ratios. Simply put "NA" over the checkbox for sections of the form that do not apply.

WQDB Data Entry & Lab Data Package Review Checklist **Date Approved in WQDB __/__/20__**

Site ID:	DEQ Number:
Site Name and Description:	Date/Time Sampled:

Instructions: Each section of the checklist corresponds to the applicable section in the Standard Operating Procedures for Surface Water Sampling. Check that section of the SOP for additional information.

PRELIMINARY DATA CHECK

❑ **10.6.2.1. WQS EXCEEDANCES?** Check lab report and field data sheets
List exceedance(s)_____

❑ Check hardness dependent dissolved metals (Cu, Pb, Cd, and Zn) for standards exceedances, using metals calculator.

❑ **10.6.2.2. SPLIT/DUP RPD WITHIN LIMITS?**

❑ Check split / duplicate field samples associated with the run. Acceptable relative percent difference (RPD) is <20% for results greater than 2x the MRL (Acceptable criteria for E. Coli is if confidence intervals overlap using IDEXX program).
List analyte(s) with unacceptable RPD & flag with RPD qualifier _____

❑ QC samples affect the entire run; Flag all samples in that sample event with the RPD flag, in the Event Table.

❑ Rerun analytes which are out of limits (For Accutest, email Elvin Kumar)

❑ The QC sample for this run was at site_____

❑ **10.6.2.3. ARE EQUIPMENT BLANKS CLEAN?**

❑ No Blank on this run

❑ Blank clean

❑ Data Rejected (for entire run). Parameter detected above MRL (Excluding 'detectable parameters' like TDS & Conductivity). For E. Coli all wells must be clean.
List parameters _____.
Add 'REJECTED DATA DUE TO QA/QC ISSUES' event. List parameters and reason data removed.

❑ **10.6.2.4. DATASET COMPLETE?** All test results received and uploaded correctly.
Check that all test results requested from the Lab were received and verify that all data values, method reporting limits, and qualifiers were uploaded correctly to WQDB.

DATA ENTRY - FIELD

❑ **10.6.2.5. Add FIELD PARAMETERS, FIELD DUPLICATES, AND FIELD QUALIFIERS**

❑ **10.6.2.6. Add EVENT CODES** (relevant/comment event codes listed below; see Table 10.2 of the SOP for a full list)

❑ BASEFLOW CONDITIONS

❑ SIGNIFICANT RAIN DURING PAST 48 HOURS MAY AFFECT RESULTS (This will exempt any SSC standard violation).

❑ REJECTED DATA DUE TO QA/QC PROBLEMS (Indicate which parameters were rejected/removed from database & why)

❑ EQUIPMENT PROBLEMS ASSOCIATED WITH VISIT for Hydrolab and other equipment problems.
List parameter(s) affected _____

❑ DEVIATION(S) FROM SOPs _____

❑ EXCEEDANCE(S) AT TIME OF SAMPLING (pH, DO, E.Coli)

❑ EXEMPTIONS FROM "EXCEEDANCE" DUE TO NATURAL SOURCES (Low DO from upwelling or spring source)

❑ Other Events _____

DATA ENTRY – LAB QC DATA PACKAGE REVIEW

❑ **10.6.2.7. LAB QUALIFIERS UPDATED?**

❑ Verify that MRL's / Data Qualifiers match

❑ Dilutions conducted by the Lab (D)?

❑ Method blank results are <MRL and none are flagged "Outside QC limits" _____

❑ Matrix spike results: Flag if %Recoverable is outside QC limits (M1 – M7) _____

☐ ADEQ Sample requested for matrix spike/matrix spike duplicate (MS/MSD)? _____

☐ Spiked blank results: Flag if %Recoverable is outside QC limits for your sample (L5) _____

☐ Serial Dilution results: Flag if %Difference is outside QC limits for your sample (MX1) _____

☐ **Reject Data / Delete results associated with QC problems, when (See Table 10.4 of the SOP for full list):**

☐ A4 – Bacteria in method blank contaminated

☐ B1-B7 – Lab Method blank contaminated

☐ E6-E7 – Estimate, Internal Lab standard recoveries did not meet acceptance criteria

☐ L1- L4 – Blank spike recovery abv method acceptance limits

☐ M – Duplicates outside control limits

☐ N4-N6 – Minimum reporting limit verification check not meeting criteria

☐ Q1-Q10– Sample integrity not maintained

☐ R1-R13 – Internal lab duplicates exceeded control limits

☐ S – Spike blank sample recovery outside control limits.

☐ **10.6.2.8. CALCULATE F/L RATIOS & ION CHECKS:**

Field/Lab Specific Conductivity ratio between 0.9 and 1.1.	☐ Yes ☐ No _____
Field/Lab pH ratio between 0.9 and 1.1.	☐ Yes ☐ No _____
TDS/Specific Conductivity ratio between 0.55 and 0.75.	☐ Yes ☐ No _____
TDS/Calculated Sum ratio between 1.0 and 1.2	☐ Yes ☐ No _____
Cation/Anion balance percent difference in the acceptable range.	☐ Yes ☐ No _____

☐ **10.6.2.9. RERUN REQUESTED?** For Accutest, call or email Elvin Kumar at 408-588-0200 (elvink@accutest.com) to rerun samples if needed.
List Reruns requested _____

☐ Reruns within QC limits?

☐ **10.6.2.10. Data approved in WQDB (both routine & duplicate)?**

☐ **10.6.2.10. Record WQDB data approval date in Sample Tracking DB**

☐ **ACCEPT ALL TEST RESULTS AS ACCURATE?**

LIST FLAGGED TEST RESULTS: _____

LIST DELETED TEST RESULTS: _____ ☐ **ADDED EVENT FOR "REJECTED DATA"**

Data Entry completed	**Date:**_____ **Initials:**_____
Staff QC Check completed **□ Reviewer initials added to event section**	**Date:**_____ **Initials:**_____
QA/QC completed within 30 days of data upload to WQDB?	☐ **Yes** ☐ **No** **If no, why?**_____
Have exceedance letters been sent out?	☐ **Yes** ☐ **No** ☐ **NA**
Has notice of exceedence been filed in both the site file and exceedence file?	☐ **Yes** ☐ **No** ☐ **NA**

FIGURE 10.21. WQDB entry checklist for quality control purposes. Found on the network drive in the 'Surface Water' folder then in the 'Sampling Forms' folder.

10.6.2.1 Determine and Report Surface Water Quality Standard Exceedances

Water quality data should be reviewed and compared to surface water quality standards as soon as possible after receipt of analytical results from the laboratory to determine whether there are any exceedances of surface water quality standards.

Surface water quality standards are located in Title 18, Chapter 11, Article 1 of the Arizona Administrative Code (A.A.C.). Standards are available on the internet at http://www.azsos.gov/public_services/Table_of_Contents.htm.

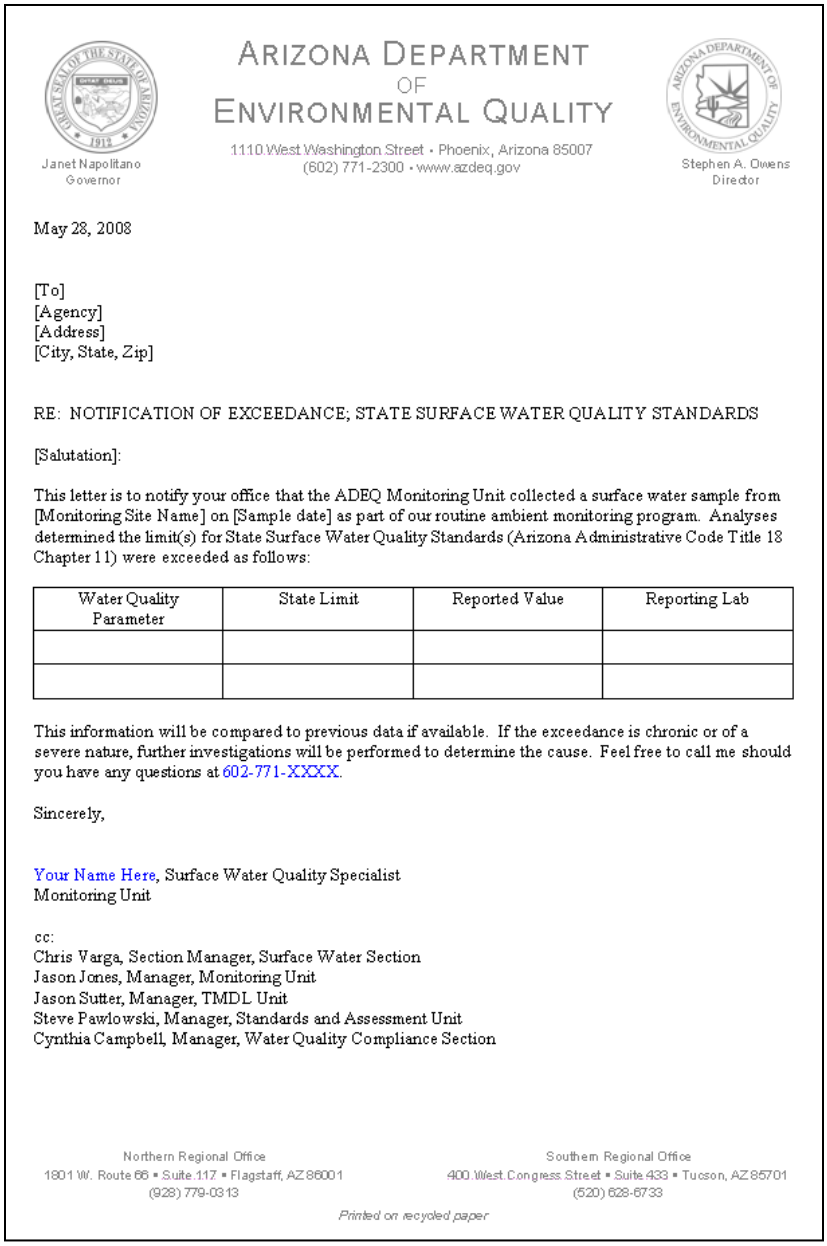
Procedure to determine if there has been a Surface Water Quality Exceedance

1. Determine applicable designated uses for the stream reach where the sample was collected from Appendix B of the Surface Water Quality Standards rules or the WQDB. This information may have already been determined and placed in the Sampling and Analysis Plan. Many surface waters are specifically listed in A.A.C. Appendix B by major river basin. Look to see if the surface water that you sampled is listed in Appendix B. If the surface water you sampled is not listed in Appendix B, consult the tributary rule at A.A.C. R18-11-105 to determine designated uses. Designated uses for a particular site can also be found through the Deisgnated Use or Site Report button on the Site Information screen of the WQDB. If the designate uses are missing for your site, contact the database manager to update this information in the database so the data can be used for assessment.
2. Compare water quality data from laboratory report to the applicable water quality standards. Highlight any water quality standards that are exceeded. Remember to compare water quality data to both acute and chronic aquatic life criteria.
3. Note if any of the water quality standards exceedances were based on suspicious values or qualified data. Could any exceedance be related to natural background conditions?
4. If an exceedance is of a surface water quality standard intended to protect human health (i.e., the domestic water source (DWS), fish consumption (FC), full body contact recreation (FBC) or the partial body contact recreation (PBC) designated uses) a Notice of Exceedance letter (FIGURE 10.22) should be prepared and sent to the Director of the County Health Department of the county where the sampling site is located and the property owner.

Do not send notices to the County Health Director when the exceedance is for a water quality standard to protect aquatic life.

Call the property owner and county health department if there is an exceedance of a standard that is an immediate human health concern such as high E. coli values in a highly recreated waterbody. Calls should be placed as soon as you receive/read the results. Use best professional judgement to determine if a site is highly recreated enough and if the value warrents immediate contact with the land owner and county health department to protect human health.

5. File a copy of the Notice of Exceedance in the site file and reading file. Add the event "Exceedance at Time of Sampling" to the sample page in the WQDB. This should be done even if the exceedance is for an aquatic use.



ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

1110 West Washington Street • Phoenix, Arizona 85007
(602) 771-2300 • www.azdeq.gov

Janet Napolitano
Governor

Stephen A. Owens
Director

May 28, 2008

[To]
[Agency]
[Address]
[City, State, Zip]

RE: NOTIFICATION OF EXCEEDANCE; STATE SURFACE WATER QUALITY STANDARDS

[Salutation]:

This letter is to notify your office that the ADEQ Monitoring Unit collected a surface water sample from [Monitoring Site Name] on [Sample date] as part of our routine ambient monitoring program. Analyses determined the limit(s) for State Surface Water Quality Standards (Arizona Administrative Code Title 18 Chapter 11) were exceeded as follows:

Water Quality Parameter	State Limit	Reported Value	Reporting Lab

This information will be compared to previous data if available. If the exceedance is chronic or of a severe nature, further investigations will be performed to determine the cause. Feel free to call me should you have any questions at 602-771-XXXX.

Sincerely,

Your Name Here, Surface Water Quality Specialist
Monitoring Unit

cc:
Chris Varga, Section Manager, Surface Water Section
Jason Jones, Manager, Monitoring Unit
Jason Sutter, Manager, TMDL Unit
Steve Pawlowski, Manager, Standards and Assessment Unit
Cynthia Campbell, Manager, Water Quality Compliance Section

Northern Regional Office
1801 W. Route 66 • Suite 117 • Flagstaff, AZ 86001
(928) 779-0313

Southern Regional Office
400 West Congress Street • Suite 433 • Tucson, AZ 85701
(520) 628-6733

Printed on recycled paper

FIGURE 10.22. Notice of Exceedance.

Procedure for Determining Exceedances of Hardness Dependent Standards

When reviewing laboratory data special attention must be given when comparing the results to the surface water quality standards that are hardness dependent. Several hardness dependent dissolved metal standards (copper, zinc, cadmium, and lead) may fall below standard method reporting limits (MRL) at low hardness values. As an example, the dissolved copper (chronic aquatic and wildlife, warmwater) standard equals 9.94 ug/L at a hardness of 113 mg/L; the typical MRL for copper (EPA 200.7) is 10 ug/L. Additional examples are shown in TABLE 10.5 Therefore a non-detect result (ND) at a hardness of 113 mg/L may or may not be an exceedance. When laboratory MRL values are above the applicable standard it may be appropriate to request estimated values to be reported by the laboratory. These values, when entered into the database, would be assigned

the appropriate lab data qualifier (E1 to E8). If data consistently is qualified a trace level analytical method may need to be sought.

Dissolved Metal	MRL (method)	Hardness Value	Applicable Standard
Copper	0.010 (200.7)	113	0.00994
Zinc	0.05 (200.7)	36	0.0493
Cadmium	0.0010 (200.9)	228	0.00099
Lead	0.005 (200.9)	188	0.00497
Nickel	0.10 (200.7)	216	0.09977
Silver	0.001 (200.9)	50	0.00098

TABLE 10.5. Dissolved Metal Standard and MRL comparison. All units are mg/L. Standard based on A&W chronic, except silver which is A&W acute.

10.6.2.2 Compare Results from Split and Duplicate Samples

Precision for split and duplicate samples is determined by calculating a Relative Percent Difference (RPD), or coefficient of variation, of the duplicate samples. The smaller the RPD, the more precise the measurement is. The relative percent difference is calculated using the following equation:

Do not use RPD for E. Coli duplicates. See Section 4.1.3.2 for instructions on determining if duplicate results are acceptable.

$$RPD = \frac{(X_1 - X_2)}{(X_1 + X_2)/2} \times 100$$

Where X1 is the larger of the two values and X2 is the smaller of the two values.

In general, acceptable relative percent difference between split or duplicate samples is 20 % or less if the value of the results of the duplicate samples are greater than 2 times the method reporting limit (MRL). Values at or near the detection limit may have a RPD greater than 20% and still be acceptable.

Exceptions:

- Trace metals,
- Analytes whose averages are less than two times the MRL, and
- Splits/duplicates where one result is reported as a non-detect and the other value is above the detection limit.

The trace metal values are reported in µg/L and are generally small. Therefore, a slight variation in numbers may cause a one-hundred percent difference which would be non-indicative of a real problem. A five-hundred percent difference may be more indicative of a true problem. Use professional judgment.

Analytes close to the detection limit are also more likely to show a large percentage difference when the absolute magnitude of the difference is small. In these cases, the 20% rule of thumb should be disregarded.

Where one duplicate or split is reported as a non-detect, and the other a value above the detection limit, ADEQ has adopted the ADHS protocol of acceptance of the duplicate or split results if the reported value in such a case is less than two times the detection limit.

In select cases, where splits or duplicates have widely-differing results, have the test rerun.

Rejecting Data Based on Duplicates or Splits

In general data is acceptable if +/- 20% difference from the original value. This works for most cations, anions, and nutrients.

As discussed above, a much larger variation is acceptable when working with trace metals, analytes whose averages are less than two times the detection level, and splits or duplicates where one is reported as a non-detect.

Unacceptable data should be removed from the database. All data for the parameter that was unacceptable should be removed for the entire sampling run or batch. Add the 'REJECTED DATA DUE TO QA/QC PROBLEMS' event to the sample. In the comments section detail what parameters were removed and why.

10.6.2.3 Determine if Blanks were "Clean."

Detection of contaminants in blanks (equipment, trip, etc.) should be carefully noted with the data. The sample may not be valid if a pollutant is detected in the blank.

Rejecting Data Based on Contaminated Blanks

When blanks demonstrate that contamination occurred, the Project Lead must consider on a case-by-case basis if the contamination is significant enough to reject the data or whether the data should just be flagged. Rejected data is removed from the database. When deciding whether or not the data need to be rejected the Project Lead should consider the following:

1. Try to ascertain where the contamination is coming from. Is it the tubing/equipment, is it the lab, is it the DI water? Rule out contamination of the DI water by looking at values from other samplers. Is there a trend for a particular contaminant that could be traced back to that particular batch of DI water?
2. In general, blank contamination above the method reporting limit should be rejected (including E. Coli). Parameters that are typically above the MRL such as conductivity and TDS may be detected, but should still be relatively low. Do not reject these parameters unless they are significantly above the detection limit
3. If lab error rather than field error is suspected then have the lab rerun the sample.

Unacceptable data should be removed from the database. All data for the parameter that was unacceptable should be removed for the entire sampling run or batch. Add the 'REJECTED DATA DUE TO QA/QC PROBLEMS' event to the sample. In the comments section detail what parameters were removed and why.

It is rare that a field blank qualifier will be used since the test results are generally removed from the database. If data is reported to the method detection limit then the "FB2 - FIELD BLANK TAKEN FOR ANALYTE: MINOR CONTAMINATION REPORTED AT LEVELS BETWEEN MRL AND MDL. ASSOCIATED DATA CONSIDERED USABLE FOR LIMITED PURPOSES" qualifier could be used.

Do NOT use the FB1 and F qualifiers. FB1 is for "CONTAMINATION - FIELD BLANK TAKEN FOR ANALYTE: NON-DETECT REPORTED, NO CONTAMINATION.". The F qualifier is for "CONTAMINATION - ANALYTE FOUND IN SAMPLE BLANK AS WELL AS SAMPLE". Since we delete bad data from the WQDB the F qualifier should never be used.

10.6.2.4 Errors & Completeness

Compare the data entered to the hard copy files to be sure that the entries are accurate and complete. Contact the lab to verify data if necessary. Check to make sure that all parameters and all sites requested by the lab are present in the laboratory data submittal.

Data review includes checking that:

- Sample times and dates are formatted correctly and lab and field data match (date, time, sites).
- Lab data are complete and no tests are missing.
- Correct decimal placement.
- No missing data.
- No erroneous values.
- All pertinent field comments were entered, using appropriate event codes and comments.
- All pertinent lab comments were entered, using appropriate lab data qualifiers.
- Appropriate "lab notations" were used and lab reporting limits and units were provided.
- Compared to prior records, no unusual or dubious data.
- Field measurements that are not representative of surface water conditions.
- Field measurements on equipment that was not functioning properly.

Dubious or questionable data values are more easily identified when the data reviewer has familiarity with past analytical results from the sample site. All results are scrutinized and any dubious or questionable values that are found are tracked back to the lab or field sheets for possible transcription errors or misreported values. Conversations with laboratory personnel may be necessary to resolve the problem.

Review field measurements collected with equipment that was not functioning properly or didn't field calibrate. Adding a comment that the equipment was not functioning properly is probably

not enough if the standards were not met. You should reject this data and delete it from the database. Add the 'REJECTED DATA DUE TO QA/QC PROBLEMS' event to the sample. In the comments section detail what parameters were removed and why.

When the pH or dissolved oxygen probes will not calibrate in the field, be sure to apply the "E3" data qualifier (Concentration estimated. Analyte exceeded calibration range) when entering the results into the WQDB.

In select cases, where unusual values are present have the test rerun. Keep a written record of any values or comments that need further verification on the QC checklist. You will need to follow up on these items before the review is complete. Keeping and rejecting data requires best professional judgment. Recognize that such decisions will affect other programs and agencies that depend on our quality data.

Criteria for rejecting data are provided in Section 10.6.2 and in the Data Qualifier list in Table 10.4. Results that do not pass quality control checks in the Quality Control Checklist are either rejected and removed from WQDB or qualified with an appropriate data qualifier code, for limited use.

10.6.2.5 Add Field Parameter, Field Duplicates and Field Qualifiers

1. Go through the steps in Section 10.4 to electronically or manually enter field parameters, duplicate results and any qualifiers that weren't automatically updated by the lab (For ambient streams, use the AMB-FIELD MEASUREMENTS template for regular samples, Use AMB–TAX Stream FY2010 Suite for duplicates).
2. Enter any applicable field qualifiers such as H5 – pH past hold time; E3-Analyte exceeded calibration range; A1-5 Bacteria protocol issues.
3. Typical field qualifiers include
   - A1-5 – Bacteria protocol issues (Reject A5)
   - E3 – Analyte exceeded calibration range (DO)
   - FB2 – Field blank issues
   - FH1 – Field filtering hold time of 15min exceeded
   - H5 – pH past hold time
   - M – Duplicates outside control limits (Reject)

10.6.2.6 Add Event Codes

1. Add applicable events from Table 10.2. These codes are basically qualifiers that apply to the entire sample (weather, flooding, groundwater upwelling, etc).

10.6.2.7 Review of Lab QC Data Package / Lab Internal QC

10.6.2.7.1 Verify/Add Lab Qualifiers

1. Verify that the MRL's and the Data Qualifiers match between the WQDB and lab report. Add any missing lab qualifiers. Dilutions (D) are not typically added by Accutest and should be checked manually.

2 Look at Table 10.4 and the QC Checklist to see if qualified data needs to be rejected. Rejected means that the data will be deleted from the database. Add the 'REJECTED DATA DUE TO QA/QC PROBLEMS' event to the sample. In the comments section detail what parameters were removed and why.

10.6.2.7.2 Method Blank

A method blank is a sample of reagent water prepared and treated exactly like the field sample and is used to determine lab sources of contamination. In the Lab QC Summary section of the Lab Report, check Lab Method Blank for results outside of QC limits. Look for an asterisk next to the values in the shaded field, which indicates that analyte was detected in the Lab QC blank sample (FIGURE 10.25). These results should be non-detect. If the analyte is detected in the sample then, "Reject" the reported sample results and do not enter in the WQDB.

BLANK RESULTS SUMMARY
Part 2 - Method Blanks

Login Number: C35848
Account: ALNCA - Accutest Northern California, Inc.
Project: ADEQAZP: ADEQ-Surface Water Quality Monitoring

QC Batch ID: MP24257
Matrix Type: AQUEOUS

Methods: EPA 200.8
Units: ug/l

Prep Date: 09/24/14

Metal	RL	IDL	MDL	MB raw	final
Aluminum	100	25	24		
Antimony	4.0	.048	.17	-0.79	<4.0
Arsenic	4.0	.12	.55	-0.32	<4.0
Barium	2.0	.026	.19		
Beryllium	2.0	.04	.22	-0.35	<2.0
Boron	10	.73	.61		
Cadmium	2.0	.058	.2	-0.38	<2.0
Calcium	500	24	13		

FIGURE 10.25. Method blank lab report.

Lab data packages should not have qualifiers for this QC check, as this parameter is a verification of Lab accuracy. This QC Check should be automatically rerun when value is outside acceptance levels/QC limits, until routine QC limits are met. Contact the lab for a rerun if value is outside normal QC limits.

10.6.2.7.3 Matrix Spikes

A matrix spike is a separate aliquot of the sample spiked with known concentrations of the analytes being tested for and is used to determine if there are matrix interferences and the procedure is working within control limits. The lab reports out the percent recovery and also the matrix spike/matrix spike duplicate percent difference. The latter is the metric that is flagged if >20%. In the Lab QC Summary section of the Lab Report, check the Matrix Spike and Matrix Duplicate Spike for results outside of QC limits. Look for an asterisk next to the values in the shaded field, which indicates that the percent difference was >20% (FIGURE 10.26). Typically these results will not be exceeding the 20% QC limit. If the data is flagged as outside QC limits, contact the Lab and ask for a rerun of Lab QC samples. If the rerun still results in QC limits exceeded, then flag the test result analytes with an M1-M7 qualifier in the WQDB.

MATRIX SPIKE AND DUPLICATE RESULTS SUMMARY

Login Number: C34192
Account: ADEQAZP - Arizona Dept. of Environmental Quality
Project: ADEQ-Surface Water Quality Monitoring

QC Batch ID: MP7911 Methods: EPA 200.7
Matrix Type: AQUEOUS Units: ug/l

Prep Date: 06/02/14

Metal	C34186-1 Original	MSD	Spikelot MPIR5	% Rec	MSD RPD	QC Limit
Aluminum						
Antimony						
Arsenic						
Barium						
Beryllium						
Boron	68.3	582	500	102.7	0.0	20
Cadmium						
Calcium	55700	69300	12500	108.8	0.1	20
Chromium	1.2	512	500	102.2	2.5	20
Cobalt						
Copper	0.0	502	500	100.4	2.2	20

FIGURE 10.26. Matrix spike duplicate lab report

10.6.2.7.4 Blank Spikes

A blank spike is an interference-free matrix spiked with known concentrations of the analytes of interest, used to evaluate the accuracy of analyses. In the QC Summaries section of the lab report, the lab reports out the percent recovery which should be ±15% of 100%. These blanks are for internal Lab QC and ususally are within limits (FIGURE 10.27). Out of range spike blanks are not

typical. Labs should address these issues internally before reporting the data. If the percent recovery is outside of QC limits then reject the reported sample results unless there is no analyte detected in the sample. This would be flagged with a L5 qualifer.

SPIKE BLANK AND LAB CONTROL SAMPLE SUMMARY

Login Number: C34192
Account: ADEQAZP - Arizona Dept. of Environmental Quality
Project: ADEQ-Surface Water Quality Monitoring

QC Batch ID: MP7911
Matrix Type: AQUEOUS

Methods: EPA 200.7
Units: ug/l

Prep Date: 06/02/14

Metal	BSP Result	Spikelot MPIR5	% Rec	QC Limits
Aluminum				
Antimony				
Arsenic				
Barium				
Beryllium				
Boron	532	500	106.4	85-115
Cadmium				
Calcium	13100	12500	104.8	85-115
Chromium	534	500	106.8	85-115

FIGURE 10.27. Spike blank and lab control sample summary

10.6.2.7.5 Serial Dilutions

Serial dilutions are used to determine matrix interference in metals samples. An aliquot of sample is diluted sufficiently that matrix interference effects are negated, prior to spiking. Once the matrix effects are diluted out, the spike recovery should meet the 10% criteria. In the QC Summary section, the lab provides the percent recovery which should meet the <10% criteria (FIGURE 10.28).

These serial dilutions are for internal Lab QC and this test is usually the metric most often out of limits. If the serial dilutions are out of limits due to matrix interference, flag the test results with a MX1 qualifier, but only when it applies to a submitted sample. The example in FIGURE 10.28, would not be flagged since TC55140-1 is not our sample.

SERIAL DILUTION RESULTS SUMMARY

Login Number: C35848
Account: ALNCA - Accutest Northern California, Inc.
Project: ADEQQASP: ADEQ-Surface Water Quality Monitoring

QC Batch ID: MP24257 Methods: EPA 200.8
Matrix Type: AQUEOUS Units: ug/l

Prep Date: 09/24/14

Metal	TC55140-1 Original	SDL 2:10	%DIF	QC Limits
Aluminum	anr			
Antimony	11.8	9.75	17.1*(a)	0-10
Arsenic	4.10	3.14	23.4 (b)	0-10
Barium	anr			
Beryllium	0.00	0.00	NC	0-10
Boron				
Cadmium	0.00	0.00	NC	0-10
Calcium				
Chromium	anr			
Cobalt				
Copper	anr			
Iron				
Lead	2.14	1.03	52.1 (b)	0-10
Magnesium				
Manganese	23.0	28.7	24.9*(a)	0-10

FIGURE 10.28. Serial dilution lab report

10.6.2.8 QC Ratios

The WQDB has a built in quality control report to determine various ratios and balances. There are two options for the report, dissolved and total. ADEQ typically uses the total concentrations of cations and anions.

As of December 2014, the WQDB QC Ratio report is not functioning. Use the 'LiveWQDB.mxb' Standard Methods QA Report instead.

Do not censor or restrict the data use on the basis of the ratio alone. To reject the data, you need corroborating evidence of a problem from another source (e.g., post-trip calibrations out of bounds, field notes indicating equipment problems, lab qualifiers, etc.). Exceeding holding times is not sufficient supporting evidence.

What to do when a ratio or balance is outside the "acceptable" value

- Check values in the database against the lab report for errors.
- Check to be sure that all the parameters needed to run the QC check are present.
- Check historic ratios at this site to determine if the ratio is normal for this site. Long-term sites have a compilation sheet showing historic QC values in the site file. Refer to the sheet for a determination of historic trend data.
- Check to see if the sample was collected under unusual conditions (i.e. flood, drought, incoming pollutants, high algae content, etc). This can potentially throw ion balances out of the acceptable range.
- Have the lab provide you with their ion balances as well as other internal checks that labs perform to assure the quality of their data. If the lab has a problem with the ion balances, they will often state this on the cover sheet or in the remarks area provided on the lab reports. Typically, if the lab has problems, they will have already tried to resolve them and have found that they cannot be resolved.
- For the TDS/Conductivity ratio check bicarbonate and sulfate values to see if they are exceedingly high or low compared to past data at the site.
- Calculate the values by hand and see if the WQDB report is reporting the right value
- Call lab to check on reported lab values or have tests rerun.
- If all the checks still point to the data being outside the acceptable range then qualify the data using the Event code in TABLE 10.2.

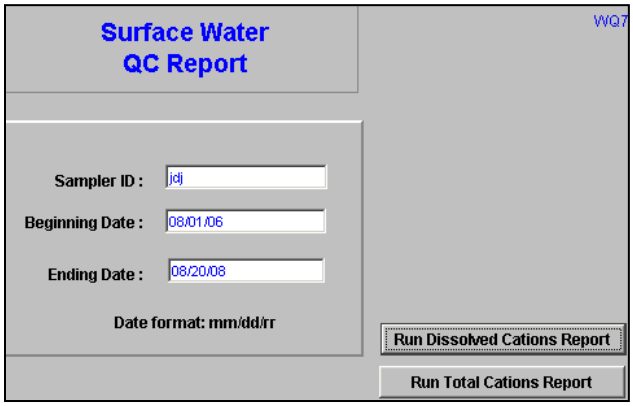


FIGURE 10.23. QC Report screen.

The report provides the following information.

SWR006a

Quality Control Run for the New Lab Types 1

Total Cations Report

For Sampler_ID: jdj
From: 08/01/06 **Thru:** 08/20/08

Number of Records Returned: 13

Site Id	Sample Date	Sample Type	EC Ratio (0.9-1.1)	PH Ratio (0.9-1.1)	TDS/EC Ratio (0.55-0.75)	TDS/Sum Ratio (1.0-1.2)	Cation	Anion	Percent Difference	Absolute Difference	C/A Balance Met ?
LCSIL041.04	24 APR 2007		.95	1.04	.59	1.30	1.569	1.230	12.10	.34	NO :(
LCECL018.17	20 JUN 2007		.99	.97	.41	.82	3.521	3.885	- 4.92	- .36	NO :(
LCCHC081.26	25 APR 2007		.90	.96	.46	.98	1.925	1.875	1.31	.05	YES!
LCCHC081.26	19 JUN 2007		.99	.94	.52	1.07	2.760	2.954	- 3.39	- .19	YES!
LCSLR003.72	21 JUN 2007	REGULAR	.95	1.00	.55	1.33	1.745	1.810	- 1.85	- .07	YES!
LCSIL024.83	23 APR 2007		.92	1.01	.65	1.09	4.368	4.075	3.47	.29	NO :(
LCLCR211.73	24 APR 2007	REGULAR								.00	YES!
LCCHC060.61	25 APR 2007		.94	1.03	.44	.73	1.690	2.257	- 14.36	- .57	NO :(
LCLCR211.73	24 APR 2007		.95	1.04	.56	1.44	37.491	12.483	50.04	25.01	NO :(
LCBRB006.74	18 JUN 2007	REGULAR	.96	1.00	.55	1.26	.872	.918	- 2.61	- .05	YES!
LCCHC081.26	19 JUN 2007	REGULAR								.00	YES!
LCECL018.17	20 JUN 2007	REGULAR								.00	YES!
LCSLR003.72	21 JUN 2007									.00	YES!

FIGURE 10.24. QC Report.

10.6.2.8.1 Lab and Field Specific Conductivity Ratio

The ratio between the field and lab specific conductivity = field conductivity ÷ lab conductivity.

- Unacceptable Below 0.90
- Acceptable Between 0.90 and 1.10
- Unacceptable Above 1.10

10.6.2.8.2 Lab and Field pH Ratio

The ratio between the field pH and lab pH = field pH ÷ lab pH

- Unacceptable Below 0.90
- Qualified Between 0.90 to 0.95
- Acceptable Between 0.95 to 1.05
- Qualified Between 1.05 to 1.10
- Unacceptable Above 1.10

For example, if the field pH is 7.6 and the Lab pH is 7.1, then the ration is 7.6 ÷ 7.1 = 1.07. This ratio is within the qualified range. The pH values should be investigated more closely, as a difference of 0.5 standard units represents a sizable shift in the acidic-basic character of the water. Further investigation is advised.

Effluent dominated waters, industrial sewage, and other highly polluted samples will have more problems with the pH ratio than ambient water samples. The pH of a sample may change very rapidly if the sample contains large amounts of algae, microbes or air bubbles. Over-zealous churning of the churn splitter can also cause a change in pH by aerating a sample that may have been anaerobic when field measurements were taken. Floods or drought have little negative impact on this QA/QC ratio.

10.6.2.8.3 TDS and Specific Conductivity Ratio

The TDS and Specific Conductivity Ratio = lab TDS ÷ lab conductivity. This ratio should range from 0.55 to 0.75 (Hem, 1998). The reason this ratio is not equal to 1.0 is that some constituents that are reflected in the lab EC are not detected in the lab TDS.

For example, if TDS is 388 and lab EC is 439, the ratio is 388 ÷ 439 = 0.88. Since the acceptable range is between 0.55 to 0.75, this value is not acceptable without additional investigation.

Some ambient waters in the state will consistently have values that fall outside this ratio. This is acceptable if the trend is established and obvious as observed in historic sample results.

10.6.2.8.4 TDS and Calculated Sum of Constituent Ratios

The TDS and calculated sum of constituent ratios = lab TDS ÷ the sum of the major constituents (lab values for Ca, Mg, Na, K, SO_4, F, NO_3+NO_2 and Cl in mg/L plus total alkalinity as $CaCO_3$ at 0.6 times its reported value). An acceptable ratio is 1.0 to 1.2.

For example:
The sum of Ca+Mg+Na+K+F+(NO_2+NO_3) +SO_4+Cl = 108.5 mg/L,
Hardness as $CaCO_3$ = 350 mg/L
Sum of major constituents = 108.5 + (0.6 * 350) = 318.5
TDS = 388
Therefore the ratio is 388 ÷ 318.5 = 1.2

This value falls at the limit of the range and is acceptable.

10.6.2.8.5 Cation and Anion Balance

The sum of five major cations should be roughly equivalent to the sum of six major anions in a sample, when measured in milliequivalents per liter (meq/L).

Cations: calcium, magnesium, sodium, potassium, and ammonia.
Anions: fluoride, carbonate, bicarbonate, sulfate, chloride, and nitrate-nitrite.

The cation/anion values are converted from mg/L (milligrams per liter) to meq/L by using the following conversion factors obtained from Standard Methods for the Examination of Water and Wastewater - 20th Edition.

Standard Methods outlines the following acceptance criteria for ion balance calculations:

Anion Sum (meq/l)	Acceptable Difference
0 - 3.0 meq	+/- 0.2 meq/l
3.0 - 10.0	+/- 2%
10.0 – 800	+/- 5%

TABLE 10.6. Acceptable differences for cation/anion ratios.

Simply look at the last column of the WQDB report to determine if the cation/anion balance is met. The cation, anion, percent difference, and absolute difference columns are there to document the "YES!" or "NO:(".

10.6.2.9 Rerun Requested

It is the lead samplers responsibility to decide if a sample need to be rerun or not. Instances where a sample might need to be rerun include:

- High RPD between regular and duplicate samples
- Contamination in blank
- Out of range QC ratios (does not automatically warrant a rerun; use best professional judgement)
- Data that is unusually high or low for a particular site.

10.6.2.10 Data Approval

Clicking the approval button is a statement by the reviewer that the data is ready to be sent on to WQX, used for assessments, listing decisions, or TMDL development (FIGURE 10.29). Clicking the approve button also means the following:

- The data has been checked for exceedances.
- The data has been reviewed for errors, omissions and dubious or unusual data
- Results from duplicates and splits were compared.
- Results from blanks were assessed.
- The QC Ratio Report was run
- All the appropriate EVENTS and QUALIFIERS have been added.

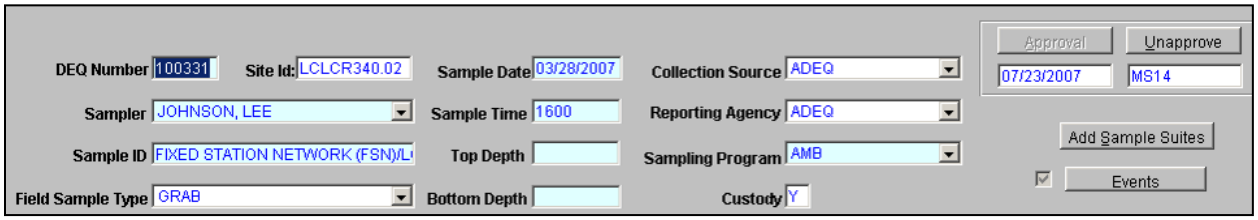


FIGURE 10.29. The approval button (upper right) locks the records in the test results screen.

The records are locked once the data is approved. A supervisor must "unapprove" the data for changes to the records to be made.

10.7 SITE FILES

Monitoring site information and data from the Surface Water Monitoring and the TMDL Units are contained in individual files for each sampling site. Sites are grouped by watershed. Individual site files are housed on the 5th Floor at the central Phoenix office. Lateral file cabinets are dedicated to housing the site files.

10.7.1 SITE FILE CONTENTS

Each site file should contain the following information starting with the inside cover of the file.

Site Information sheet

The Site Information sheet can be copied from the Water Quality Database. It will have information regarding the site, such as the name of the site, DEQ Database number, site location, and, if applicable, a signed written permission form from the property owner to enter the property and collect samples. Ownership of the land should not be assumed to be public land and should be investigate during the reconnaissance stage of site selection.

Road Log and Map

A detail road log should be written during the reconnaissance stage of site selection. In addition, any special comments such as locked gates, 4x4 roads, or other access issues need to be attached to the log.

Correspondence/Exceedances

- Any miscellaneous correspondence with the property owner
- All correspondence on Surface Water Quality Standards exceedances that apply to the site
- Any contractual or sampling agreements pertaining to the site
- All internal and external correspondence regarding the site

Photographs

Archive-quality slides, prints or digital images of site taken at each site visit. For sites with a lot of photos, consider taking a few representative photos and storing the rest on a CD.

Biological Data

All field and taxonomy laboratory data sheets pertaining to macroinvertebrate or other biological collections.

Stream Channel Physical Assessments

Habitat Assessment Field Data Sheet for Cold and Warm Water Streams, Stream Ecosystem Monitoring Data Sheets and any other data sheets describing the physical condition of the stream channel. Use EDAS to print out the habitat data for each site.

Field Notes

- Field data sheets and field measurements from each site visit
- A flow calculation sheet
- Any historic copies of field notes from each site visit
- Sketches or diagrams representing the site

Water Quality Chemical Data

- Located on inside back cover of site file
- All analytical laboratory data from each site visit
- Water Quality Standards Exceedance and QA/QC check off sheet
- Cation/Anion report

10.7.2 FILING SYSTEM

There are three separate filing systems for streams, lakes, and TMDL.

Stream site files are filed in the lateral file cabinets by hydrologic basin. There are ten major basins:

1. Colorado-Grand canyon (CG)
2. Colorado-Lower Gila (CL)
3. Little Colorado River Basin (LC)
4. Verde River Basin (VR)
5. Salt River Basin (SR)
6. Upper Gila River Basin (UG)
7. Middle Gila River Basin (MG)
8. San Pedro River Basin (SP)
9. Santa Cruz River Basin (SC)
10. Bill Williams River Basin (BW)

Site files are sorted within each file cabinet drawer in alphabetical order by a 2 character basin code (e.g. UG for Upper Gila River) and a 3-character stream identification code (e.g. ETK). Sort streams with the same name numerically by the river mile.

Lake site files are organized by basin and then by lake.

10.7.3 SITE FILE SECURITY

Site files contain unique and irreplaceable information, thus are kept in locked lateral file cabinets to provide security against loss. The lateral file cabinets are located on the west wall on the 5th Floor. Access to the SWS site file cabinets is limited to SWS personnel and all others by special arrangement. SWS staff is responsible for site files that are removed to their work areas. They must be returned and properly filed in alphanumeric order after usage.

It is recommended that site files be returned to the file cabinet after one week. If files need to be used for a longer period of time, an "OUT CARD" should be placed in the file with the user's name and cubicle number.

10.7.4 SIGNING OUT FILES

Non-SWS staff may check out site files to their work areas for an 8-hour work day, but the files must not be removed from the 5th floor and must be returned by 5:00 p.m. Files may be signed out from the Surface Water Section secretary or TMDL or Monitoring unit manager. An "OUT CARD" must be filled out with the date, name, telephone extension and cubicle number where the file will be kept during the work day.

10.7.5 PUBLIC REVIEW OF SITE FILES

The data and information in SWS site files are public records and they may be viewed by members of the public upon request during regular business hours. Members of the public who wish to review a site file must make arrangements with the ADEQ Records Center.

10.7.6 RECORDS RETENTION AND ARCHIVING FILES

Monitoring site files (chemistry and biocriteria) do not have a "destruction date" in accordance with our retention schedule (FIGURE 10.30). This means that facility data should be kept with the file throughout time. Old data can be shipped to the State Archives. See the section secretary for the appropriate forms and instructions for archiving files.

Division *WQD* **Office** Surface Water Section

Records Series	*Ret Total*	*Ret Remarks*
1. Macroinvertebrates and Fish Tissue Sample Data Records	Permanent	Permanent
2. 305 305(b) Assessment and 303(d) Listing Report (including supporting documentation)	05	After completed
3. 208 Consistency Reviews	05	After Completed
4. 208 Areawide Water Quality Management Plans	-	Keep until superseded
5. Complaint Investigation Files	05	After Resolved
6. Monitoring Site Files (including biocriteria files)	15	from date generated
7. Triennial review (separate from rulemaking)	10	date of report
8. Surface Water Monitoring Program Files (sample plans, annual data reports, guidance)	05	after fiscal year that monitoring program ends
9. AZPDES individual & general permits (except construction) approvals (RS Replaced WS)	05	After permit expires or is superseded
11. Construction General Permit (NOI, NOT & SWPPP) (WL RS Replaced)	02	From NOT or from new permit

FIGURE 10.30. Records retention schedule.

APPENDIX A CHECKLISTS

AMBIENT STREAMS

Equipment List

LAB/OFFICE

Meters

- ☐ Hydrolab/YSI (need barometer?)
- ☐ Dissolved Oxygen Titration Kit
- ☐ Chlorine Meter
- ☐ Thermometer

Sample Equipment

- ☐ Sample Bottles : per site
  - ~1 wide mouth
  - ~3 one liter small mouth
  - ~2 500ml small mouth
- ☐ Bottles for a Duplicate or Blank (blanks need DI water)
- ☐ Tubing
- ☐ Filters
- ☐ Gloves
- ☐ Nitric Acid and Stickers
- ☐ Sulfuric Acid and Stickers
- ☐ Tape

Bacteria

- ☐ Incubator
- ☐ Sealer
- ☐ Bottles
- ☐ Trays
- ☐ Reagents
- ☐ Black Light

Office Supplies

- ☐ Clipboard (Pens and Pencils)
- ☐ Field Forms
- ☐ Camera (Extra AA Bateries)
- ☐ Truck Keys/ Bluebook/Gas Card
- ☐ Maps
- ☐ Lab Forms and Tracking Number
- ☐ GPS (Extra AA Batteries)
- ☐ Sample Plan and SOPs

CAGE

Meters

- ☐ Turbidity
- ☐ Flow Meter

Sample Equipment

- ☐ Wading Rod
- ☐ Measuring Tape
- ☐ DH-81 Rod and Nozzle
- ☐ Chain Pins
- ☐ Float Bottle
- ☐ Flagging
- ☐ Ice Chests
- ☐ Churn Splitter
- ☐ Backpack, Bucket, or Duffel Bag
- ☐ Waders, Hip Boots, or Irrigation Boots

First Aid/ Safety

- ☐ First Aid Kit
- ☐ Shovel
- ☐ Drinking Water
- ☐ Bug Repellant
- ☐ Cell or Satellite Phone

SEM Supplies

- ☐ 250 mL Bottle (for Periphyton ID)
- ☐ 500 mL Graduated Composite Bottle,
- ☐ 2" delimeter, angled toothbrush, 1L Wash bottle, 60mL syringe w/ tube, 1" stickon sample labels Lugols, DI Wash bottle.
- ☐ Whatman GF/F 0.7um glass fiber filter
- ☐ Filtration apparatus (Millipore) & Pump
- ☐ Large Funnel
- ☐ 30 mL amber bottle ~ 2 per site
- ☐ 250/50 mL Gradulated cylinder
- ☐ Forceps (reuse)
- ☐ Bug Net
- ☐ Bucket and Sieve
- ☐ 2nd Bucket for Bug Duplicate
- ☐ Wide Mouth Bug Jars
- ☐ Alcohol
- ☐ Bug Bag (pebble count ruler, densito-meter, watch, spoon, tape, and labels)

Lakes

Office

- ☐ Determine depth of lake, if possible, so you can decide which length of rope to bring
- ☐ Current or historical problems at the lake?
- ☐ Lake map
- ☐ List of site ID names and GPS locations
- ☐ Plan # of samples to take at each site and order bottles
- ☐ Reserve truck
- ☐ Make reservations

Paperwork and Logistics

- ☐ Clipboard
- ☐ Site files/maps
- ☐ Field forms
- ☐ Truck logbook
- ☐ Truck keys and Gas card
- ☐ Pontoon keys
- ☐ Routing form/float plan
- ☐ Chain of custody and lab forms
- ☐ Tracking, PCA, and Index #s
- ☐ Permission Forms
- ☐ AZ Atlas
- ☐ Forest Service maps
- ☐ Labels
- ☐ Table for DO/elevation
- ☐ Tape for labels
- ☐ Extra pencils, pens and sharpies
- ☐ SOPs

Personal Gear

- ☐ Hip or chest waders
- ☐ Seal skin gloves
- ☐ Hand sanitizer

Safety

- ☐ First Aid kit
- ☐ Life jackets
- ☐ Sunscreen
- ☐ Bug repellant
- ☐ Drinking water
- ☐ Rain gear
- ☐ Squincher drink
- ☐ Satellite phone
- ☐ VHF radio
- ☐ Flashlight
- ☐ Tool box
- ☐ Fire extinguisher

Filtered metals

- ☐ Tubing
- ☐ Capsule filters
- ☐ Geopump
- ☐ Battery if using geopump

Meters

- ☐ YSI
- ☐ YSI cable
- ☐ Barometer if using the Hydrolab

Sampling Equipment

- ☐ Secchi disk with sufficient rope
- ☐ Depth finder
- ☐ Beta bottle with sufficient rope
- ☐ Sediment corer or Eckman dredge with sufficient rope
- ☐ Sediment scoops
- ☐ Sediment glass container
- ☐ Sediment noses pieces
- ☐ Sediment catchers
- ☐ GPS
- ☐ Camera
- ☐ Ice chests with ice
- ☐ Bacteria incubator
- ☐ Bacteria sealer
- ☐ Bacteria bottles
- ☐ Bacteria additive
- ☐ Bacteria trays
- ☐ Black light
- ☐ Whirlpacks
- ☐ Plastic bags for sample bottles
- ☐ Garbage bags

- ☐ Sampling bottles
- ☐ Duplicate sampling bottles
- ☐ Acid stickers
- ☐ Acid
- ☐ Measuring tape
- ☐ Extra batteries

Boat Equipment

- ☐ Anchor
- ☐ Extra rope
- ☐ Adapter
- ☐ Boat lock
- ☐ Bleach for de-contamination
- ☐ Oars
- ☐ Motor flush
- ☐ Inflatable Raft

Pump
Seat
trawling motor
Battery and battery cover
Battery charger

- ☐ Aluminum boat

2" ball hitch
2 stroke Outboard motor oil

- ☐ Pontoon

Keys
Get gas
Hitch with 2" drop if taking a Ford 250, 2" ball

TMDL - GENERAL

Office and Paperwork

- ☐ Field data sheets
- ☐ Cell/satellite phone
- ☐ Field notebook
- ☐ Laptop (with necessary cables)
- ☐ Keys (equipment and access)
- ☐ SAP (site maps, safety plan)
- ☐ Digital Camera
- ☐ Clipboard (pens, Sharpies)
- ☐ GPS
- ☐ Equipment manuals
- ☐ Weather radio
- ☐ Copies of routing form
- ☐ Tracking # _____
- ☐ P.O #_____
- ☐ Index #_____

Personal Gear

- ☐ Hip or chest waders
- ☐ Irrigation boots
- ☐ Seal skin gloves
- ☐ Rain Gear
- ☐ PFD

Safety

- ☐ First Aid kit

- ☐ Sunscreen
- ☐ Bug repellant
- ☐ Drinking water
- ☐ Squincher drink
- ☐ Tool box
- ☐ Hand sanitizer

Filtered metals

- ☐ Tubing
- ☐ Capsule filters
- ☐ Nitric acid vials

Sample Bottles

- ☐ 1-liter bottles
- ☐ SSC bottles
- ☐ Specialty bottles
- ☐ Clean metals
- ☐ Autosampler bottles

Equipment from Cage

- ☐ Shovel
- ☐ 5-gal bucket
- ☐ Flow Meter (SN_____)
- ☐ Wading rod
- ☐ Hydrolab (SN_____)
- ☐ Turbidity Meter (SN_____)
- ☐ DH-81 rod, nozzle, and cap
- ☐ Geopump
- ☐ Ice chest(s)
- ☐ Tape measure
- ☐ Steel Arrows
- ☐ Rope
- ☐ Backpack(s)

Water Laboratory Supplies

- ☐ DI Carboy
- ☐ Field Box
  - ☐ Gloves
  - ☐ Buffer solutions
  - ☐ Batteries
  - ☐ Ziploc Bags
  - ☐ Garbage bags
  - ☐ Cubitaners
- ☐ Sulfuric acid vials

☐ Autosampler batteries

Bacteria

☐ Bacteria incubator
☐ Bacteria sealer
☐ Bacteria bottles
☐ Bacteria additive
☐ Bacteria trays
☐ Black light
☐ Inverter

☐ Ice

TMDL - AUTOSAMPLER

Pre-trip - Make sure equipment to install is functioning properly before leaving ADEQ

- Tools
- Drill with appropriate drill bits
- Generator with extension cord and gas
- Tool kit
- Anchor bolts
- Clamps (2" fence post for 2" well casing/float switch, 1" PVC U or C-clamps for securing 1" PVC tubing)
- Saws
- Sledgehammer
- Wire crimpers
- Wire nuts
- Electrical tape
- Wire cable, ferrules, and swag
- Extra wire

Autosampler specific

- Autosampler
- New pump and distributor arm tubing installed for each deployment
- Bottles (Bottle racks and bags if using disposable bottle packs)
- Intake tubing
- Charged Battery(ies)
- Bottle retaining ring
- Intake strainer
- ½ cables if needed for float switches
- Padlock
- Cable to lock autosampler to tree, etc.
- Cable(s) to secure autosampler
- Ceramic knife

- Autosampler program
- 1” PVC pipe (glue, caps, elbows)
- Float switch
- Level/Stage Logger specific
- Level logger
- Laptop to program logger
- 2” PVC well screen (caps, elbows)
- 1” PVC pipe (glue, caps, elbows)
- Equipment Enclosure (outdoor electrical box, etc.)
- Camera
- GPS, unless existing site

SURVEYING EQUIPMENT

- Laser level
- Extendable Rod
- Laser receiving unit
- Tripod
- Rolls of flagging
- Stake flags
- Field data sheets
- GPS-Garmin
- GPS-GeoExplorer
- Auto Levels
- Rods & rod levels
- Measuring tape reel , 1/10 ft
- Cross-section and caps
- Short & long-handled sledgehammers
- Machetes
- Tightening strap and chaining pin
- Bank pins
- Toe pins and caps
- Scour chains, duckbills, and driver
- Boltcutters DH-76 or DH-74 SSC sampler w/ glass jars
- 3" Helly Smith bedload sampler w/ 500micron mesh bag
- Bedload jars or bags
- 6" Helly Smith bedload sampler w/ 500micron mesh bag
- A" and "B" reels for use on cableways
- Shovels, monuments, galvanized steel pipe and concrete
- Bucket setup for bar samples
- Set of sieves and scale
- Lathe stakes
- BEHI equipment (16' rod, meter stick w/ line level, angle measure or calculator)
- Metal tags

- Walkie talkies
- Clipboards w/ reference documents
- Digital camera or 35mm Camera

FISH

Field Sampling Equipment and Supplies:

_____Collecting Permit
_____Copy of this SOP
_____GPS Unit
_____Fish weigh scale
_____Paper tags and zip ties
_____Plastic bags
_____Coolers with dry ice or regular ice
_____Field data sheet
_____Fish sample labels
_____Nitrile gloves
_____Heavy duty aluminum foil
_____Fish collection gear (nets, electro-shocker, etc.)
_____Fish measuring board
_____Clear and masking tape
_____Waterproof pen
_____Scale

Laboratory processing supplies

_____Copy of this SOP
_____Cooler(s) containing fish to be processed
_____Cooler containing ice only (for processed samples)
_____Nitrile gloves
_____Ceramic knife
_____PTFE cutting board
_____6mm biopsy punch
_____Porcelain mortar and pestle
_____10 percent nitric acid rinse made from ultra-pure certified trace-metal grade
_____Laboratory-grade deionized water
_____Teflon wash bottles (fill with the 10% nitric acid solution before beginning procedure)
_____400 ml beakers
_____50ml PTFE sample bottles
_____Sample Analysis Lab Request forms for State Laboratory or Chain of Custody forms and seals for EPA Laboratory

APPENDIX B MACROINVERTEBRATE LAB REQUIREMENTS

The procedures followed at the consultant taxonomic laboratory are not part of the field procedures for collecting and preserving macroinvertebrate samples. However, this section is included to explain practices and requirements for documentation and future reference.

SAMPLE RECEIPT

Upon receipt of the samples, the laboratory will check and adjust the preservation in each sample, catalog the samples, check the attached inventory for accuracy, and sign the chain of custody papers. The consultant will then notify ADEQ of the receipt of samples, any damaged samples, or discrepancies between the inventory and actual sample labels.

SAMPLE PROCESSING

Samples must be sorted to separate the invertebrates from the sample matrix. The entire sample should be floated in water in a white plastic tray. Large debris is rinsed and removed from the sample until all organic matter and invertebrates are floated off the mineral residue. The mineral residue is then searched for stone-cased caddisflies and mollusks.

SUB-SAMPLING

Arizona samples typically contain thousands of invertebrates and must be sub-sampled into equal squares for results to meet a minimum count of 500 organisms. A Caton Tray is be used to randomly obtain fractions of the total sample from which all the invertebrates are removed and counted. Additional fractions are selected until the 500 target level is reached after which the number of squares subsampled are recorded. Terrestrial insects and non-benthic insects (e.g. corixidae, other swimmers, mosquitoes, or surface tension dwellers) should not be included in the count. Additional fractions are examined if one fraction is dominated by a single species. After the target number of specimens has been achieved, the entire unsorted sample is scanned for large or rare taxa, which may aid in identification of smaller instars or may expand the taxa list for that sample. The remaining unsorted sample is re-preserved with 70% ethanol in individual containers and archived at the laboratory for one year from the date of sample receipt, after which time the laboratory will contact ADEQ prior to disposal.

SORTING

The sorting of invertebrates from the sample matrix shall be performed by trained technicians, using dissecting scopes with a minimum magnification of 6X. After identifications have been made, the sorted specimens, including the separated Chironomidae, should be archived for one year or incorporated into the reference or voucher specimen set. The laboratory shall keep logs for each sample sorted, the fraction sorted, sample matrix problems, etc. in addition to bench sheets of the taxa identified in each sample.

SORTING EFFICACY

The laboratory shall check the sample residues to insure a sorting efficacy of 95% or better. A statement of sorting efficacy for the ADEQ batch of samples should be presented in the laboratory report.

TAXONOMIC IDENTIFICATION

Invertebrate identifications shall be performed by a trained and experienced taxonomist. The taxonomy contractor is responsible for obtaining the most accurate, consistently achievable identifications for ADEQ samples. Specialists are used as needed to obtain identifications to the general taxonomic levels listed in TABLE 1. The specific identifications are presented on the ADEQ Macroinvertebrate Master Taxa List (TABLE 2).

Invertebrate Group	Level of taxonomy required
Aquatic insects	Genus or species, where consistently identifiable
Chironomidae	Genus level
Semi-aquatic insects	Family
Arachnida (Mites)	Class
Cladocera, Copepoda, Ostracoda	Class
Amphipoda, Decapoda, Isopoda	Class
Nematoda, Nematomorpha	Phylum
Turbellaria	Class
Annelida	Class
Mollusca	Family or Genus

TABLE 1. ADEQ Taxonomic levels of identification for macroinvertebrates

REFERENCE COLLECTION AND STORAGE

A set of reference or voucher specimens shall be prepared from the batch of samples each year for incorporation into ADEQ's reference specimen collection. The reference specimen collection is maintained for several reasons: 1) the voucher collection supports all research conducted by the Department, 2) for performing interlaboratory taxonomy QC checks on voucher specimens, and 3) for training and in-house taxonomic identifications. Several specimens shall be preserved for each new taxon and the best or largest larval instars of other taxa shall be preserved to represent the taxa found that year and to update the historic reference collection at ADEQ. The Contractor shall make recommendations for archiving any important specimens, if verification of identification by national specialists is required.

REPORTING

Laboratory reports containing taxonomic identifications and counts for all samples for that year shall be submitted to ADEQ in electronic format. The electronic data shall be submitted in ACCESS database format or Excel spreadsheets formatted for database uploading. The Contractor shall perform quality control checks on the electronic data prior to submittal to ADEQ. The data set should contain at a minimum the Station Identification (ID), waterbody name and location, habitat, collection date, laboratory tracking number, complete taxa ID from phylum to lowest level ID, raw number of individuals, and the portion of sample analyzed including field splits where applicable, and adjusted final counts, which are corrected for sub-sample size and field splits. Other attribute data should also be provided for any new taxa which are not currently in ADEQ's EDAS database, such as tolerance value, functional feeding group, and habit.

QUALITY CONTROL TASKS

ADEQ may conduct Laboratory audits as needed. ADEQ may also periodically request the laboratory to examine quality control reconstituted samples or voucher specimens from another lab and produce a short letter regarding the accuracy of identifications.

QUALITY CONTROL FIELD AND LABORATORY PROCEDURES

Quality control procedures for macroinvertebrate sample collection consist of controls in equipment type, sampling methodology, selection of appropriate sampling habitats and timeframes, replicate sampling, detailed sorting and subsampling lab methods, use of taxonomy specialists for macroinvertebrate identifications, and re-identification of samples in the lab. A detailed list of these biological field and laboratory quality control procedures and performance characteristics is provided in TABLE 3.

In addition to these QC procedures, a decontamination protocol for macroinvertebrate field collection equipment has now been added to this document to prevent transport of biological agents among streams. The D-frame dip net, bucket, and sieve should be rinsed and scrubbed with a brush to dislodge small invertebrates, egg masses, and organic material, prior to leaving any given site and all sampling equipment should be sprayed with an acetic acid (vinegar) or bleach solution to decontaminate equipment.

Procedure	Performance Characteristic	Description
Sampling device	Precision - repeatability in a habitat	The D-frame dip net is a good choice for use in Arizona streams, as it can be used in riffle habitats with virtually all substrate sizes. The precision of sampling with this net is repeatable because a timed sampling effort is used which applies across different stream substrate types.
	Bias - exclusion of certain taxa (mesh size)	The D-frame sampler is outfitted with a 500Φ mesh size net opening, which retains organisms of a consistent size for identification.
	Interferences - matrix/physical limitations	Excess filamentous algae can foul a sample, but it is considered part of the organic matter of a sample and is packaged with the biological sample.

Procedure	Performance Characteristic	Description
Sampling method	Precision - variable metrics or measures among replicate samples at a site	Measurement error is quantified by replicate sampling at 10% of our sampling sites each year. Samples are processed and analyzed separately and their metrics and IBI score compared to obtain a measure of the method precision. This is an estimate of the precision of the entire method which includes variability due to small-scale spatial variability within a site, operator consistency and bias, and laboratory consistency.
	Bias - exclusion of certain taxa or habitats	Riffle only, 500Φ mesh size
	Performance range - limitations in certain habitats or substrates	Riffle only, sample edge vegetation for sandy substrates riffles
	Interferences - high river flows, training of personnel	Sampling not performed during high flows for safety reasons. The method has only been tested on a limited basis for large river sampling.
Field Sample Processing	Bias - efficiency of locating small organisms in sample transfer	The sieve is carefully rinsed after straining a sample. The sieve is washed prior to leaving a sample site.
	Performance range - sample preservation and holding time	Sample preserved with isopropanol and capful of formalin for better preservation in Arizona heat. Formalin also allows longer holding time.
	Interferences - Weather conditions	Sample taking maybe performed during light rains and slightly elevated flows, but not during bankfull or greater flows.
	Accuracy - of sample transfer process and labeling	There is a standard format for sample labels which includes stream name, site id, date, habitat sampled, collector info, whether sample was field split and # of jars in sample.

TABLE 3. Biological field quality control procedures and performance characteristics.

BIOASSESSMENTS AS APPLIED TO PROJECTS BY OTHER ENTITIES (NPDES PERMITS)

The application of bioassessments to projects by other entities than ADEQ must adhere to the following requirements:

- A bioassessment should occur concurrently with ambient water monitoring
- A bioassessment survey plan should be completed and submitted to ADEQ by December 31st of each year. The plan should contain sample dates, locations of background and study sites, sampling personnel and qualifications, name and location of contract laboratory, biological and habitat sampling protocols and method of analysis
- ADEQ sampling and analysis protocols should be followed as closely as possible while using the most updated Quality Assurance Program Plan
- Laboratory protocols should follow ADEQ recommendations in TABLE 4
- The bioassessment report should be submitted to ADEQ for review. The report should contain: an executive summary, introduction, study area description table, including maps and photos, methods, results and discussion, literature cited, and appendices with complete taxa lists and copies of completed field forms for each site. The results and discussion section should cover a physical characterization of the sites, a habitat

assessment, water quality, fish and wildlife, macroinvertebrates, and long term trends at the study sites.

- Macroinvertebrate analyses should contain: a list of taxa and abundances, the calculated warm or cold water IBI score, the benthic habitat score, and graphs indicating a comparison of reference and study site IBI scores for the current year, changes in the reference and study IBI scores over a permit period and changes in the reference and study site habitat scores or habitat values over the permit period.
- The first bioassessment shall be subject to a quality assurance review to be conducted by ADEQ. The voucher specimens from the laboratory should be submitted to ADEQ for a quality control review of the taxonomic identifications by the ADEQ contract taxonomist. Major revisions should be incorporated into the final bioassessment report.

Procedure	Performance Characteristic	Description
Laboratory sample processing	Precision - split samples	Duplicate samples are collected at the rate of 10% of the total # of samples during each year's index period. This is a test of the labs ability to create consistent IDs.
	Bias - sorting certain taxonomic groups or organism size	Large specimens are removed first from the sample. All organisms, regardless of size are sorted for ID from each 1/32 section of the sample.
	Interferences - distractions, equipment	Field and lab equipment, such as sieves and nets, are thoroughly washed between sites and samples.
	Accuracy - sorting method, lab equipment	Caton Tray used for consistent method of sorting samples, especially where thousands of insects per sample are found.
Taxonomic enumeration	Precision - split samples	The similarity of duplicate samples is verified using the Arizona warm water and cold water IBI's, rather than the individual taxonomic identifications.
	Bias - counts and identifications for certain taxonomic groups	Our taxonomist offers 500 counts of insects per sample, which exceeds the number of specimens counted by many other states. Where a particular taxa is dominant in the sample, that taxon is not included in the 500 count. Our laboratory has used a number of nationally recognized specialists to provide confirmed identifications of specimens for our reference/voucher collection.
	Interferences - appropriateness of taxonomic keys	List of taxonomic keys used by our laboratory is included in our SOP's.
	Sensitivity - level of taxonomy related to type of stressor	Our standard taxonomic effort (identifications to genus in most cases, with midges at family level) is generally used for all samples. Identification of Chironomidae to genus can be done on an as-needed basis for samples/sites found to be impaired.
	Accuracy - identification and counts	Use of nationally recognized specialists to create the Arizona reference collection, by which all other samples are identified.

TABLE 4. Biological laboratory quality control procedures and performance characteristics.

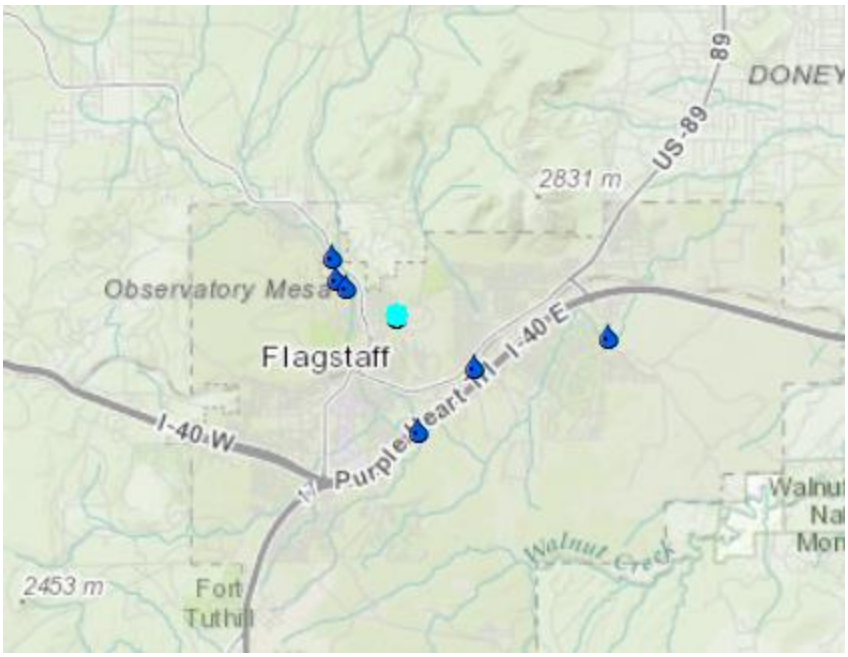
APPENDIX C WATERSHED DELINEATIONS

This tool allows the user to calculate watershed delinations based on a point feature class.

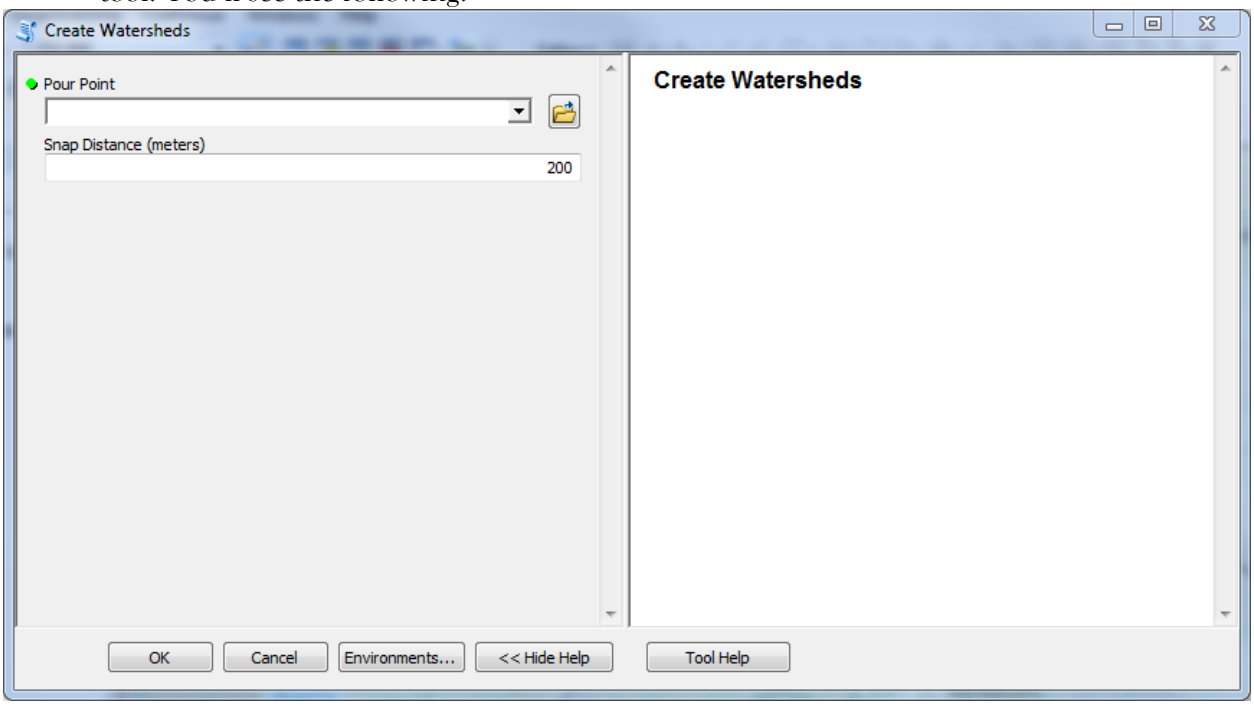
1. To load the tool, open arcToolBox, right click "ArcToolbox" at the top of the Toolbox pane, select Add Toolbox, navigate to r:\common\ADEQ Tools and select the ADEQ Tools.tbx toolbox.

2. Once you've selected the toolbox, you can save it permanently by right clicking the top of the ArcToolbox again and selecting Save Settings\To Default.

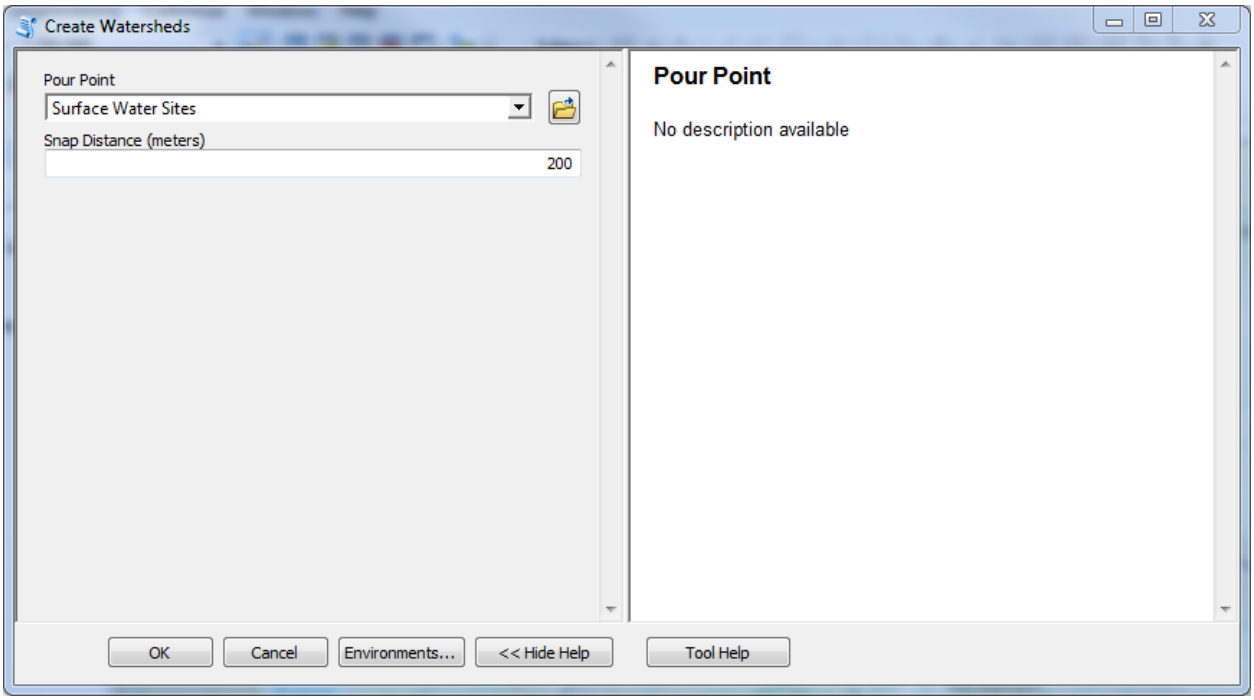
3. To use the tool, open a point layer consisting of points you want to use as a pour point(s). This layer can be any existing point layer such as the Surface Water Sites layer or a point file that you create yourself. Select one or more points from the layer with the select tool (see below). If you select more than one point, all points need to be in the same watershed (The tool will know if you've select points from different watersheds and will not run).



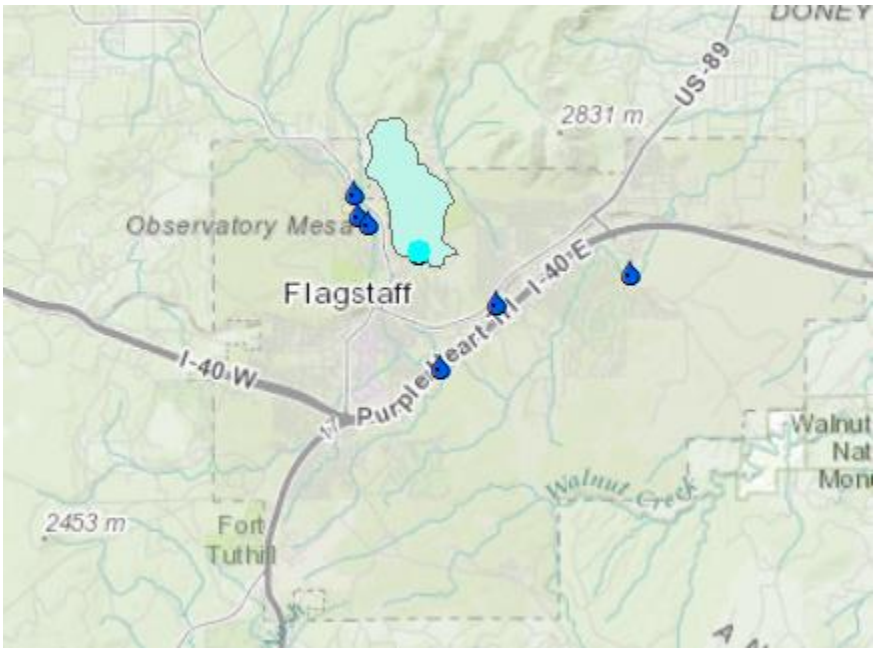
4. From the ADEQ Tools toolbox, double-click on the "Create Watersheds" script to run the tool. You'll see the following:



5. Select the name of the layer you want to use for the pour points and a Snap Distance (the default is 200 meters). The Snap Distance is the distance you want the program to search to determine the best location for the pour point. You can vary this distance if you're not happy with the watershed that is created.



6. In this case I'm using the Surface Water Sites layer to use as pour points. Click OK to run the script.



7. A polygon representing the watershed will be added to the map. It will be named something like NewWSPoly_Layer… (1,2,3, etc.). This polygon layer only exists in the ArcGIS memory, because you may not be happy with the result and may want to modify the model parameters (snap distance) to produce a better watershed. Once you are happy with the result, save the polygon layer to a Feature Class of your choice by right clicking on

the layer name and selecting Data/Export Data. If you quit ArcMap before saving the polygon layer, you will lose it.

USGS has an online tool for creating watersheds, which is a good back up option if the Arc Map tool isn't available or deals with watersheds outside of Arizona http://water.usgs.gov/osw/streamstats/ssonline.html

APPENDIX D STORET CODES

This appendix contains common STORET codes, arranged alphabetically by parameter name. It is not a complete listing. If you have access, it is preferable to use the "SW STORET" look-up table in the Water Quality Database.

To choose a STORET code, the parameter name, unit, media, and analysis type must all be correct.

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
50624	(1S*,2R*,5R*,7S*)-2,4-DIMETHYL-7-ETHYL-6M8-DI, TOTAL WATER	UG/L	Water	Total
77562	1,1,1,2-TETRACHLOROETHANE, TOTAL WATER	UG/L	Water	Total
34506	1,1,1-TRICHLOROETHANE TOTAL WATER	UG/L	Water	Total
34516	1,1,2,2-TETRACHLOROETHANE, TOTAL WATER	UG/L	Water	Total
77652	1,1,2-TRICHLORO-1,2,2-TRIFLUOROET, TOTAL WATER	UG/L	Water	Total
34511	1,1,2-TRICHLOROETHANE, TOTAL WATER	UG/L	Water	Total
34496	1,1-DICHLOROETHANE, TOTAL WATER	UG/L	Water	Total
34501	1,1-DICHLOROETHYLENE, TOTAL WATER	UG/L	Water	Total
77168	1,1-DICHLOROPROPENE, TOTAL WATER	UG/L	Water	Total
99941	1,2,2-TRICHLORO-1,2-DIFLUOROETHANE	UG/L	Water	Total
77613	1,2,3-TRICHLOROBENZENE, TOTAL WATER	UG/L	Water	Total
77443	1,2,3-TRICHLOROPROPANE, TOTAL WATER	UG/L	Water	Total
77221	1,2,3-TRIMETHYLBENZENE, TOTAL WATER	UG/L	Water	Total
77734	1,2,4,5-TETRACHLOROBENZENE, TOTAL WATER	UG/L	Water	Total
34551	1,2,4-TRICHLOROBENZENE, TOTAL WATER	UG/L	Water	Total
77222	1,2,4-TRIMETHYLBENZENE, TOTAL WATER	UG/L	Water	Total
34556	1,2,5,6-DIBENZANTHRACENE. TOTAL WATER	UG/L	Water	Total
77651	1,2-DIBROMOETHANE, TOTAL WATER	UG/L	Water	Total
34536	1,2-DICHLOROBENZENE, TOTAL WATER	UG/L	Water	Total
34531	1,2-DICHLOROETHANE, TOTAL WATER	UG/L	Water	Total
32103	1,2-DICHLOROETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
34541	1,2-DICHLOROPROPANE, TOTAL WATER UG/L	UG/L	Water	Total
82626	1,2-DIPHENYLHYDRAZINE, WATER, TOTAL RECOVERABLE, UG/L	UG/L	Water	Total
77226	1,3,5-TRIMETHYLBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
34566	1,3-DICHLOROBENZENE, TOTAL WATER UG/L	UG/L	Water	Total
77173	1,3-DICHLOROPROPANE , TOTAL WATER, UG/L	UG/L	Water	Total
77163	1,3-DICHLOROPROPENE-1, TOTAL WATER, UG/L	UG/L	Water	Total
34571	1,4-DICHLOROBENZENE, TOTAL WATER UG/L	UG/L	Water	Total
50283	112-TRICHLORO-122-TRIFLUOROETHANE, WATER, UNFILTERED, N2ATM PG/KG	PG/KG	Water	Total
77275	1-METHYL-2-CHLOROBENZENE (O-CHLOR), TOTAL WATER, UG/L	UG/L	Water	Total
77220	1-METHYL-2-ETHYLBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
77277	1-METHYL-4-CHLOROBENZENE (P-CHLOR),TOTAL WATER, UG/L	UG/L	Water	Total
77356	1-METHYL-4-ISOPROPYLBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
77170	2,2-DICHLOROPROPANE, TOTAL WATER, UG/L	UG/L	Water	Total
39741	2,4,5-T, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39742	2,4,5-T, FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39743	2,4,5-T, SUSPENDED, WATER, UG/L	UG/L	Water	Suspended
39740	2,4,5-T, TOTAL WATER, UG/L	UG/L	Water	Total
34621	2,4,6-TRICHLOROPHENOL, TOTAL WATER, UG/L	UG/L	Water	Total
39731	2,4-D, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
39732	2,4-D, FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39733	2,4-D, SUSPENDED, WATER, UG/L	UG/L	Water	Suspended
39730	2,4-D, TOTAL WATER, UG/L	UG/L	Water	Total
38746	2,4-DB, WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
34601	2,4-DICHLOROPHENOL, TOTAL WATER, UG/L	UG/L	Water	Total
34606	2,4-DIMETHYLPHENOL, TOTAL WATER, UG/L	UG/L	Water	Total
34616	2,4-DINITROPHENOL, TOTAL WATER, UG/L	UG/L	Water	Total
34611	2,4-DINITROTOLUENE, TOTAL WATER, UG/L	UG/L	Water	Total
82183	2,4-DP (DICHLORPROP), TOTAL WATER	UG/L	Water	Total
34626	2,6-DINITROTOLUENE, TOTAL WATER	UG/L	Water	Total
73547	2-BUTENE, 1,4-DICHLORO-, TOTAL WATER	UG/L	Water	Total
34581	2-CHLORONAPHTHALENE, TOTAL WATER	UG/L	Water	Total
34586	2-CHLOROPHENOL, TOTAL WATER	UG/L	Water	Total
77103	2-HEXANONE TOTAL WATER	UG/L	Water	Total
34591	2-NITROPHENOL TOTAL WATER	UG/L	Water	Total
73570	2-PROPENOIC ACID, 2-METHYL-, ETHYL ESTER, TOTAL WATER	UG/L	Water	Total
34631	3,3'-DICHLOROBENZIDINE, TOTAL WATER	UG/L	Water	Total
34636	4-BROMOPHENYL PHENYL ETHER, TOTAL WATER	UG/L	Water	Total
34641	4-CHLOROPHENYL PHENYL ETHER, TOTAL WATER	UG/L	Water	Total
78133	4-METHYL-2-PENTANONE, WATER	UG/L	Water	Total
34646	4-NITROPHENOL, TOTAL WATER	UG/L	Water	Total
34253	A-BHC-ALPHA, DISSOLVED	UG/L	Water	Dissolved
61726	ABSORBANCE, UV, ORGANIC CONSTITUENTS, 280 NM, PATHLENGT	UNITS/CM	Water	Total
34205	ACENAPHTHENE, TOTAL WATER	UG/L	Water	Total
49429	ACENAPHTHENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
34200	ACENAPHTHYLENE, TOTAL WATER	UG/L	Water	Total
34203	ACENAPHTHYLENE, DRY WEIGHT, BOTTOM DEPOSITS	UG/KG	Sed/soil	Calculated
49428	ACENAPHTHYLENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
49260	ACETOCHLOR, RECOVERABLE, WATER, FILTERED UG/L	UG/L	Water	Standard
81552	ACETONE, TOTAL WATER, UG/L	UG/L	Water	Total
81553	ACETOPHENE, TOTAL WATER	UG/L	Water	Total
90410	ACID NEAUTRALIZING CAPACITY(LAB MEASUREMENT OF ALKALINITY) CACO3, MG?L	MG/L	Water	Calculated
00435	ACIDITY, TOTAL (mg/L AS CACO3)	MG/L	Water	Total
49315	ACIFLUORFEN, RECOVERABLE, FILTERED, WATER, GF,0.7U, UG/L	UG/L	Water	Standard
49430	ACRIDINE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
34210	ACROLEIN, TOTAL WATER, UG/L	UG/L	Water	Total
34215	ACRYLONITRILE, TOTAL WATER, UG/L	UG/L	Water	Total
46342	ALACHLOR (LASSO), WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
49313	ALDICARB SULFONE, RECOVERABLE, FILTERED, GF,0.7U, UG/L	UG/L	Water	Standard
49314	ALDICARB SULFOXIDE,RECOVERABLE, FILTERED, GF,0.7U, UG/L	UG/L	Water	Standard
49312	ALDICARB, RECOVERABLE, FILTERED, WATER, GF,0.7U, UG/L	UG/L	Water	Standard
39333	ALDRIN, BOTTOM DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39331	ALDRIN, FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39332	ALDRIN, SUSPENDED, WATER, UG/L	UG/L	Water	Suspended
39330	ALDRIN, TOTAL WATER, UG/L	UG/L	Water	Total
49319	ALDRIN, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
49353	ALDRIN, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	Tissue	Calculated
60050	ALGAE, TOTAL (CELLS/ML)	#/ML	Water	Total
00425	ALKALINITY, BICARBONATE (MG/L AS CACO3)	MG/L	Water	Total
00430	ALKALINITY, CARBONATE (MG/L AS CACO3)	MG/L	Water	Total

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
00419	ALKALINITY, CARBONATE, INCREMENTAL TITRATION, FIELD MG/L	MG/L	Water	Total
39036	ALKALINITY, FILTERED, WATER, AS CACO3 MG/L	MG/L	Water	Total
00417	ALKALINITY, FIXED ENDPOINT TITRATION, USGS LAB MG/L	MG/L	Water	Total
00420	ALKALINITY, HYDROXIDE (MG/L AS CACO3)	MG/L	Water	Other
00415	ALKALINITY, PHENOLPHTHALEIN (MG/L)	MG/L	Water	Total
00410	ALKALINITY, TOTAL (MG/L AS CACO3)	MG/L	Water	Total
29801	ALKALINITY, WATER, DISSOLVED, FIXED ENDPOINT, LAB, AS CACO3, MG/L	MG/L	Water	Dissolved
29802	ALKALINITY, WATER, DISSOLVED, GRAN TITRATION, FIELD, AS CACO3, MG/L	MG/L	Water	Dissolved
39086	ALKALINITY, WATER, DISSOVED, INCREMENTAL TITRATION, FIELD, AS CACO3, MG/L	MG/L	Water	Other
78109	ALLYLCHLORIDE, TOTAL, WATER UG/L	UG/L	Water	Total
39337	ALPHA BENZENE HEXACHLORIDE, TOTAL WATER, UG/L	UG/L	Water	Total
80045	ALPHA GROSS PARTICLE ACTIVITY IN WATER, TOTAL PC/L	PC/L	Water	Total
75986	ALPHA GROSS, 1 SIGMA PRC EST AS NAT U, DISSOLVED, WATER, UG/L	UG/L	Water	Dissolved
75965	ALPHA GROSS, 1 SIGMA PRC EST AS NAT U, SUSPENDED SEDIMENT UG/G	UG/G	Sed/soil	Suspended
75987	ALPHA GROSS, 1 SIGMA PRC EST AS TH230, DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
75955	ALPHA GROSS, 1 SIGMA PRC EST AS TH230, SUSPENDED SEDIMENT, PCI/G	PCI/G	Sed/soil	Suspended Total
76004	ALPHA GROSS, 1 SIGMA PRC EST AS TH230, SUSPENDED WATER PCI/L	PCI/L	Water	Suspended
01515	ALPHA, DISSOLVED GROSS, AS URANIUM-NATURAL, PCI/L	PCI/L	Water	Dissolved
04126	ALPHA, DISSOLVED, WATER (AS TH-230),PCI/L	PCI/L	Water	Standard
04125	ALPHA, DRY WEIGHT, SEDIMENT (AS TH-230), PCI/G	PCI/G	Sed/soil	Total
80030	ALPHA, GROSS, DISSOLVED, AS URANIUM-NATURAL, UG/L	UG/L	Water	Other
01507	ALPHA, GROSS, SEDIMENT (PCI/G OF DRY SOLIDS)	PCI/G	Sed/soil	Calculated
01516	ALPHA, GROSS, SUSPENDED, AS URANIUM NATURAL, PCI/L	PCI/L	Water	Suspended
80040	ALPHA, GROSS, SUSPENDED AS URANIUM NATURAL, UG/L	UG/L	Water	Suspended
01501	ALPHA, TOTAL	PCI/L	Water	Total
01502	ALPHA, TOTAL, COUNTING ERROR	PC/L	Water	Total
49275	ALPHA-BHC, D6, DRY WT, SIEVE	PERCENT	Sed/soil	Other
49261	ALPHA-BHC, D6, WET WT, TISSUE, WHOLE ORG	PERCENT	Tissue	Calculated
49338	ALPHA-BHC, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	Sed/soil	Calculated
49366	ALPHA-BHC, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	Tissue	Standard
01106	ALUMINUM, DISSOLVED (UG/L AS AL)	UG/L	Water	Dissolved
49237	ALUMINUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	Tissue	Calculated
34792	ALUMINUM, SEDIMENT, BOTTOM MATERIAL, <63U, DRY SIEVE, LAB, TOTAL ALUMINUM, PERCENT	PERCENT	Sed/soil	Dissolved
30221	ALUMINUM, SEDIMENT, SUSPENDED, PERCENT	PERCENT	Sed/soil	Suspended
01105	ALUMINUM, TOTAL (UG/L AS AL)	UG/L	Water	Total
49307	AMIBEN, RECOVERABLE, FILTERED, WATER, GF, 0.7U, UG/L	UG/L	Water	Standard
99430	ANC, CARBONATE, IT, FIELD (MG/L AS HCO3)	MG/L	Water	Total
04227	ANIONS, SU, TOTAL, WATER (MEQ/L)	OTHERS	Water	Total
49435	ANTHRACENE, 2-METHYL-, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
49434	ANTHRACENE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34220	ANTHRACENE, TOTAL WATER, UG/L	UG/L	Water	Total
49437	ANTHRAQUINONE, 9, 10-, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
01268	ATIMONY (SB), WATER, TOTAL RECV, UG/L	UG/L	Water	Standard
01098	ANTIMONY, BOTTOM DEPOSITS (MG/KG AS SB DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01095	ANTIMONY, DISSOLVED (UG/L AS SB)	UG/L	Water	Dissolved
49246	ANTIMONY, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	Tissue	Calculated
29816	ANTIMONY, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01097	ANTIMONY, TOTAL (UG/L AS SB)	UG/L	Water	Total
49056	ANTIMONY, TOTAL, WATER, TCLP	MG/L	Water	Total

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34795	ANTIMONY, SED, BOT, <63U, TOTAL, WET SIEVE, FIELD	MG/KG	Sed/soil	Suspended
82632	AREA, CROSS-SECTIONAL, OF STREAM, SQUARE FEET	OTHERS	Water	Calculated
01003	ARSENIC, BOTTOM DEPOSITS (MG/KG AS AS DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01000	ARSENIC, DISSOLVED (UG/L AS AS)	UG/L	Water	Dissolved
49247	ARSENIC, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	Tissue	Calculated
50094	ARSENIC, ICAP TEST METHOD, TOTAL RECV	MG/L	Water	Total
01309	ARSENIC, POTENTIALLY, DISSOLVED, WATER	MG/L	Water	Dissolved
34802	ARSENIC, SEDIMENT, BOTTOM DEPOSITS, DRY SIEVE, <63U, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
34800	ARSENIC, SEDIMENT, BOTTOM DEPOSITS, WET SIEVE, <63U, FIELD, TOTAL	MG/KG	Sed/soil	Dissolved
29818	ARSENIC, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01001	ARSENIC, SUSPENDED (UG/L AS AS)	UG/L	Water	Suspended
49613	ARSENIC, TCLP, ICP, TOTAL, WATER	MG/L	Water	Total
01002	ARSENIC, TOTAL (UG/L AS AS)	UG/L	Water	Total
00978	ARSENIC, TOTAL, RECV IN WATER AS ARSENIC, UG/L	UG/L	Water	Total
39630	ATRAZINE (AATREX), TOTAL WATER, UG/L	UG/L	Water	Total
39631	ATRAZINE, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39632	ATRAZINE, DISSOLVED IN WATER PPB (UG/L)	UG/L	Water	Dissolved
49443	AZOBENZENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Standard
31855	BACTERIA, SULFATE-REDUCING (MPN)	CFU/G	Water	Total
01008	BARIUM, BOTTOM DEPOSITS (MG/KG AS BA DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01005	BARIUM, DISSOLVED (UG/L AS BA)	UG/L	Water	Dissolved
49238	BARIUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	Tissue	Calculated
01311	BARIUM, POTENTIALLY, DISSOLVED, WATER	MG/L	Water	Dissolved
34807	BARIUM, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL, UG/G (MG/KG)	MG/KG	Sed/soil	Dissolved
34805	BARIUM, SEDMITE, BOTTOM DEPOSITS, <63U, WET SIEVE, FIELD, TOTAL	MG/KG	Sed/soil	Suspended
29820	BARIUM, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01006	BARIUM, SUSPENDED (UG/L AS BA)	UG/L	Water	Suspended
49612	BARIUM, TCLP, ICP, TOTAL, WATER	MG/L	Water	Total
01007	BARIUM, TOTAL (UG/L AS BA)	UG/L	Water	Total
00025	BAROMETRIC PRESSURE (MM OF HG)	MMHG	A	Standard
80164	BED MATERIAL SIEVE DIAMETER, %, FINER THAN .062MM	PERCENT	Sed/soil	Dissolved
80165	BED MATERIAL SIEVE DIAMETER, %, FINER THAN .125MM	PERCENT	Sed/soil	Dissolved
80166	BED MATERIAL SIEVE DIAMETER, %, FINER THAN .250MM	PERCENT	Sed/soil	Dissolved
80167	BED MATERIAL SIEVE DIAMETER, %, FINER THAN .500MM	PERCENT	Sed/soil	Dissolved
80168	BED MATERIAL SIEVE DIAMETER, %, FINER THAN 1.00MM	PERCENT	Sed/soil	Dissolved
80172	BED MATERIAL SIEVE DIAMETER, %, FINER THAN 16.0MM	PERCENT	Sed/soil	Dissolved
80169	BED MATERIAL SIEVE DIAMETER, %, FINER THAN 2.00MM	PERCENT	Sed/soil	Dissolved
80173	BED MATERIAL SIEVE DIAMETER, %, FINER THAN 32.0MM	PERCENT	Sed/soil	Dissolved
80170	BED MATERIAL SIEVE DIAMETER, %, FINER THAN 4.00MM	PERCENT	Sed/soil	Dissolved
80171	BED MATERIAL SIEVE DIAMETER, %, FINER THAN 8.00MM	PERCENT	Sed/soil	Dissolved
82673	BENFLURALIN, 0.7 UM FILT, TOTAL RECV, WATER, UG/L	UG/L	Water	Standard
38711	BENTAZON, WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
49436	BENZ(A)ANTHRACENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
81554	BENZALDEHYDE, WHOLE WATER SAMPLE, UG/L	UG/L	Water	Total
49438	BENZENE, 1,2,4-TRICHLORO-, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
49441	BENZENE, M-DICHLORO-, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Standard
49444	BENZENE, NITRO-, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Standard
49439	BENZENE, O-DICHLORO-, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
49442	BENZENE, P-DICHLORO-, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Standard
34030	BENZENE, WATER, GC-MS, HEXADECONE EXTR., UG/L	UG/L	Water	Total
49280	BENZENE,NITRO-,D5, DRY WEIGHT, SIEVE, PERCENT	PERCENT	Sed/soil	Calculated
49446	BENZENE,PENTACHLORONITRO-, DRY WEIGHT, SIEVE, UG/KG	UG/KG	Sed/soil	Standard

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39120	BENZIDINE, TOTAL WATER, UG/L	UG/L	Water	Total
34526	BENZO(A)ANTHRACENE1,2-BENZANTHRACENE, TOTAL WATER, UG/L	UG/L	Water	Total
49458	BENZO(B)FLUORANTHENE, DRY WEIGHT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34230	BENZO(B)FLUORANTHENE, TOTAL WATER, UG/L	UG/L	Water	Total
49468	BENZO(C)CINNOLINE, SEDIMENT, BED MATERIAL, WET SIEVE	PERCENT	Sed/soil	Calculated
49408	BENZO(G,H,I)PERYLENE, DRY WEIGHT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34521	BENZO(GHI)PERYLENE1,12-BENZOPERYLENE, TOTAL WATER, UG/L	UG/L	Water	Total
49397	BENZO(K)FLUORANTHENE, DRY WEIGHT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34242	BENZO(K)FLUORANTHENE, TOTAL, WATER, UG/L	UG/L	Water	Total
34247	BENZO-A-PYRENE, TOTAL WATER, UG/L	UG/L	Water	Total
01013	BERYLLIUM, BOTTOM DEPOSITS, DRY WEIGHT, MG/KG	MG/KG	Sed/soil	Calculated
01010	BERYLLIUM, DISSOLVED (UG/L AS BE)	UG/L	Water	Dissolved
49248	BERYLLIUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	Tissue	Calculated
50097	BERYLLIUM, ICAP TEST METHOD, TOTAL RECV	MG/L	Water	Total
01312	BERYLLIUM, POTENTIALLY, DISSOLVED, WATER	MG/L	Water	Dissolved
34812	BERYLLIUM, SEDIMENT, BOTTOM DEPOSITS, DRY SIEVE,<63U,LAB,TOTAL,UG/G	MG/KG	Sed/soil	Dissolved
34810	BERYLLIUM SEDIMENT, BOTTOM DEPOSITS, WET SIEVE, ,63Y, FIELD, TOTAL	MG/KG	Sed/soil	Suspended
29822	BERYLLIUM, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01012	BERYLLIUM, TOTAL (UG/L AS BE)	UG/L	Water	Total
00998	BERYLLIUM, TOTAL RECOVERABLE IN WATER, UG/L	UG/L	Water	Total
49058	BERYLLIUM TOTAL, WATER, TCLP	MG/L	Water	Total
39338	BETA BENZENE HEXACHLORIDE, TOTAL WATER, UG/L	UG/L	Water	Total
75988	BETA GROSS, DISSOLVED, 1 SIGMA PRC EST AS SR90/Y90 PCI/L	PCI/L	Water	Dissolved
75966	BETA GROSS, SUSPENDED, 1 SIGMA PRC EST AS SR90/Y90, PCI/G	PCI/G	Sed/soil	
76005	BETA GROSS, SUSPENDED, 1 SIGMA PRC EST AS SR90/Y90, PCI/L	PCI/L	Water	Suspended
75989	BETA GROSS,1 SIGMA PRC EST AS CS-137, DISSOLVED, WATER, PCI/L	PCI/L	Water	Dissolved
03515	BETA, DISSOLVED GROSS, AS CS-137, PCI/L	PCI/L	Water	Dissolved
80050	BETA, DISSOLVED GROSS, AS SR-Y-90, PCI/L	PCI/L	Water	Dissolved
04102	BETA, DRY WEIGHT, SEDIMENT, (AS SR,Y-90) PCI/G	PCI/G	Sed/soil	Calculated
03516	BETA, SUSPENDED GROSS, AS CS-137, PCI/L	PCI/L	Water	Suspended
80060	BETA, SUSPENDED GROSS, AS SR-Y-90, PCI/L	PCI/L	Water	Standard
03501	BETA, TOTAL	PC/L	Water	Total
03519	BETA, TOTAL GROSS AS CS-137	PCI/L	Water	Total
03502	BETA, TOTAL, COUNTING ERROR	PC/L	Water	Total
49339	BETA-BHC, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	Sed/soil	Calculated
49365	BETA-BHC, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	Tissue	Calculated
34253	BHC-ALPHA, (A-) DISSOLVED, UG/L	UG/L	Water	Dissolved
00440	BICARBONATE ION (MG/L AS HCO3)	MG/L	Water	Total
29804	BICARBONATE, FIXED ENDPOINT, DISSOLVED WATER, FIELD, AS HCO3, MG/L	MG/L	Water	Dissolved
29805	BICARBONATE, FIXED ENDPOINT, DISSOLVED WATER, LAB, AS HCO3, MG/L	MG/L	Water	Dissolved
00453	BICARBONATE, INCREMENTAL TITRATION, DISSOLVED WATER, (HC03), FIELD, MG/L	MG/L	Water	Dissolved
00450	BICARBONATE, INCREMENTAL TITRATION, TOTAL WATER, (HCO3), FIELD MG/L	MG/L	Water	Total
99440	BICARBONATE, MG/L AS HCO3	MG/L	Water	Total
00572	BIOMASS, PERIPHYTON (GRAMS PER SQUARE METER)	G/SQ M	Water	Standard
00573	BIOMASS, PERIPHYTON, DRY WEIGHT TOTAL (G/M2)	G/SQ M	Water	Total
70950	BIOMASS-CHLOROPHYLL RATIO, PERIPHYTON (UNITS)	NO UNITS	Other	Standard
49279	BIPHENYL, 2-FLUORO, DRY WEIGHT, SIEVE, PERCENT	PERCENT	Sed/soil	Calculated
49277	BIPHENYL, 3, 5-DICHLORO-, DRY WEIGHT, SIEVE	PERCENT	Sed/soil	Calculated

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49264	BIPHENYL, 3, 5-DICHLORO-, WET WEIGHT, TISSUE, WHOLE ORGANISM, RECOVERABLE	PERCENT	Sed/soil	Standard
49391	BIQUINOLINE,2,2'-, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34278	BIS (2-CHLOROETHOXY) METHANE, TOTAL WATER, UG/L	UG/L	Water	Total
34273	BIS (2-CHLOROETHYL) ETHER, TOTAL WATER, UG/L	UG/L	Water	Total
34283	BIS (2-CHLOROISOPROPYL) ETHER, TOTAL WATER, UG/L	UG/L	Water	Total
39100	BIS(2-ETHYLHEXYL) PHTHALATE, TOTAL WATER, UG/L	UG/L	Water	Total
01015	BISMUTH, DISSOLVED (UG/L AS BISMUTH)	UG/L	Water	Dissolved
34817	BISMUTH, SEDIMENT, BOTTOM DEPOSITS, DRY SIEVE, <63U, LAB, TOTAL	UG/G	Sed/soil	Dissolved
34816	BISMUTH, SEDIMENT, BOTTOM DEPOSITS, WET SIEVE, LAB	MG/KG	Sed/soil	Total
00310	BOD, 5 DAY, 20 DEG C MG/L	MG/L	Water	Total
01020	BORON, DISSOLVED (UG/L AS B)	UG/L	Water	Dissolved
49239	BORON, DRY WEIGHT, TISSUE/BIOTA, RECOVERABLE	MG/KG	Tissue	Calculated
50095	BORON, ICAP TEST METHOD, TOTAL RECOVERABLE	MG/L	Water	Total
01021	BORON, SUSPENDED (UG/L AS B)	UG/L	Water	Suspended
01022	BORON, TOTAL (UG/L AS B)	UG/L	Water	Total
04029	BROMACIL, DISSOLVED, WATER, TOTAL RECOVERABLE UG/L	UG/L	Water	Dissolved
82298	BROMIDE, DISSOLVED (UG/L)	UG/L	Water	Dissolved
45629	BROMIDE, IN ORGANIC COMPOUNDS, WATER, TOTAL	MG/L	Water	Total
03716	BROMIDE, LIQUID FRACTION, ELUTRIATE, MG/L	MG/L	Other	Dissolved
71870	BROMIDE, WATER (MG/L AS BR)	MG/L	Water	Total
81555	BROMOBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
32101	BROMODICHLOROMETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
50002	BROMOETHENE, TOTAL RECOVERABLE, WATER, UG/L	UG/L	Water	Standard
32104	BROMOFORM, TOTAL WATER, UG/L	UG/L	Water	Total
34636	BROMOPHENYL PHENYL ETHER (4-), TOTAL WATER, UG/L	UG/L	Water	Total
49454	BROMOPHENYL, 4-PHENYL ETHER, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
49311	BROMOXYNIL, TOTAL RECOVERABLE, FILTERED, WATER, GF, 0.7U,UG/L	UG/L	Water	Standard
50005	BUTANE,2-METHOXY-2-METHYL-, TOTAL RECOVERABLE, WATER UG/L	UG/L	Water	Standard
73547	BUTENE, 1,4-DICHLORO- (2-), TOTAL WATER, UG/L	UG/L	Water	Total
04028	BUTYLATE, DISSOLVED, WATER, TOTAL RECOVERABLE UG/L	UG/L	Water	Dissolved
01025	CADMIUM, DISSOLVED (UG/L AS CD)	UG/L	Water	Dissolved
49249	CADMIUM, DRY WEIGHT, TISSUE/BIOTA, RECOVERABLE	MG/KG	Tissue	Calculated
01313	CADMIUM, POTENTIALLY, DISSOLVED, WATER	MG/L	Water	Dissolved
50099	CADMIUM, ICAP TEST METHOD, TOTAL RECOVERABLE	MG/L	Water	Total
34827	CADMIUM, SEDIMENT, BOTTOM DEP., <63U, DRY SIEVE, LAB, TOTAL UG/G	MG/KG	Sed/soil	Dissolved
34825	CADMIUM, SEDIMENT, BOTTOM DEP., >63U, WET SIEVE, FIELD, TOTAL	MG/KG	Sed/soil	Dissolved
29826	CADMIUM, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01026	CADMIUM, SUSPENDED (UG/L AS CD)	UG/L	Water	Suspended
01027	CADMIUM, TOTAL (UG/L AS CD)	UG/L	Water	Total
01113	CADMIUM, TOTAL RECOVERABLE IN WATER, UG/L	UG/L	Water	Total
01028	CADMIUM, TOTAL, BOTTOM DEPOSITS, DRY WEIGHT, MG/KG	MG/KG	Sed/soil	Calculated
49059	CADMIUM, TOTAL, WATER, TCLP	MG/L	Water	Total
00910	CALCIUM (MG/L AS CACO3)	MG/L	Water	Total
00915	CALCIUM, DISSOLVED (MG/L AS CA)	MG/L	Water	Dissolved
82036	CALCIUM, DISSOLVED (UG/L AS CA)	UG/L	Water	Dissolved
34832	CALCIUM, SEDIMENT, BOTTOM DEPOSITS,<63U, DRY SIEVE, LAB, TOTAL PERCENT	PERCENT	Sed/soil	Dissolved
34830	CALCIUM, SEDIMENT, BOTTOM DEPOSITS, <63 WET SIEVE, FIELD, TOTAL	PERCENT	Sed/soil	Dissolved
81357	CALCIUM, SUSPENDED MG/L	MG/L	Water	Suspended
00916	CALCIUM, TOTAL (MG/L AS CA)	MG/L	Water	Total

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82032	CALCIUM, TOTAL (UG/L AS CA)	UG/L	Water	Total
77177	CAPROLACTAM, TOTAL WATER	UG/L	Water	Total
82680	CARBARYL, 0.7 UM FILTER, TOTAL RECOVERABLE	UG/L	Water	Standard
49310	CARBARYL, RECOVERABLE, FILTERED, WATER, GF,0.7U	UG/L	Water	Dissolved
49449	CARBAZOLE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Standard
82674	CARBOFURAN, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER UG/L	UG/L	Water	Standard
49309	CARBOFURAN, RECOVERABLE, FILTERED, WATER, GF,0.7U,UG/L	UG/L	Water	Dissolved
00405	CARBON DIOXIDE (MG/L AS CO2)	MG/L	Water	Total
77041	CARBON DISULFIDE, TOTAL WATER, UG/L	UG/L	Water	Total
32102	CARBON TETRACHLORIDE, TOTAL WATER, UG/L	UG/L	Water	Total
00681	CARBON, DISSOLVED ORGANIC (MG/L AS C)	MG/L	Water	Dissolved
49269	CARBON, INORGANIC, DRY WEIGHT, SEDIMENT, RECOVERABLE, SIEVE	PERCENT	Sed/soil	Other
49270	CARBON, INORGANIC, DRY WEIGHT, SEDIMENT, RECOVERABLE, SIEVE	PERCENT	Sed/soil	Unknown
00686	CARBON, INORGANIC, IN BED MATERIAL (GM/KG AS C)	MG/KG	Sed/soil	Unknown
49266	CARBON, ORGANIC, DRY WEIGHT, SEDIMENT, RECOVERABLE, SIEVE	PERCENT	Sed/soil	Calculated
49271	CARBON, ORGANIC, DRY WEIGHT, SEDIMENT, RECOVERABLE, SIEVE	PERCENT	Sed/soil	Total
00687	CARBON, ORGANIC, IN BED MATERIAL (GM/KG AS C)	MG/KG	Sed/soil	Other
50465	CARBON, ORGANIC, SEDIMENT, SUSPENDED,RECOVERABLE, AS C, PERCENT	PERCENT	Sed/soil	Total
00693	CARBON, ORGANIC & INORGANIC, BOTTOM MATERIAL	MG/KG	Sed/soil	Calculated
49264	CARBON, ORGANIC & INORGANIC, DRY WEIGHT, RECOVERABLE, SIEVE	PERCENT	Sed/soil	Standard
49272	CARBON, ORGANIC & INORGANIC, DRY WEIGHT, RECOVERABLE, SIEVE	PERCENT	Sed/soil	Calculated
30244	CARBON, SEDIMENT, SUSPENDED, PERCENT	PERCENT	Sed/soil	Suspended
00688	CARBON, SUSPENDED INORGANIC (MG/L AS C)	MG/L	Water	Suspended
00689	CARBON, SUSPENDED ORGANIC (MG/L AS C)	MG/L	Water	Suspended
00694	CARBON, SUSPENDED TOTAL (MG/L AS C)	MG/L	Water	Suspended
00690	CARBON, TOTAL (MG/L AS C)	MG/L	Water	Other
00685	CARBON, TOTAL INORGANIC (MG/L AS C)	MG/L	Water	Standard
00680	CARBON, TOTAL ORGANIC (MG/L AS C)	MG/L	Water	Total
82081	CARBON-13 / CARBON-12 STABLE ISOTOPE RATIO PER MIL	NO UNITS	Water	Total
49934	CARBON-14, COUNTING ERROR, DISSOLVED, WATER	PERCENT	Water	Dissolved
49933	CARBON-14, DISSOLVED, WATER	PERCENT	Water	Dissolved
99445	CARBONATE MG/L AS CO3	MG/L	Water	Total
00445	CARBONATE ION (MG/L AS CO3)	MG/L	Water	Total
00447	CARBONATE, INCREMENTAL TITRATION, (CO3) FIELD, MG/L	MG/L	Water	Total
00452	CARBONATE, INCREMENTAL TITRATION, DISSOLVED, WATER, FIELD, AS CO3, MG/L	MG/L	Water	Dissolved
04225	CATION AND ANION SUMMATION, QC CHECK, % DIFFER	PERCENT	WATER	OTHER
04226	CATIONS, SUM, TOTAL, WATER	MEQ/L	WATER	OTHER
34835	CERIUM, SEDIMENT, BOTTOM DEP, <63U, WET SIEVE, FIELD	MG/KG	SED/SOIL	Total
34837	CERIUM, SEDIMENT, BOTTOM DEPOSITS, <63U, WET SIEVE, LAB, TOTAL UG/G	UG/G	Sed/soil	Total
34840	CERIUM, SEDIMENT, SUSPENDED >63U, WET SIEVE, TOTAL	MG/KG	SED/SOIL	Total
76007	CESIUM 137, DRY WEIGHT, SOIL PCI/G	PCI/G	Sed/soil	Calculated
04103	CESIUM-137,2 SIGMA PRECISION, DRY WEIGHT, SOIL PCI/G	PCI/G	Sed/soil	Calculated
39352	CHLORDANE (TECH MIX & METABS), DISSOLVED, UG/L	UG/L	Water	Dissolved
39353	CHLORDANE (TECH MIX & METABS), SUSPENDED, UG/L	UG/L	Water	Suspended
39350	CHLORDANE (TECH MIX & METABS), TOTAL WATER, UG/L	UG/L	Water	Total
39351	CHLORDANE (TECH MIX&METABS), SEDIMENTS, DRY WT	UG/KG	Sed/soil	Calculated
49320	CHLORDANE, CIS-, DRY WT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated

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49380	CHLORDANE, CIS-, WET WT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
49321	CHLORDANE, TRANS- DRY WT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49379	CHLORDANE, TRANS-, WET WT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
39062	CHLORDANE-CIS ISOMER, TOTAL WATER, UG/L	UG/L	Water	Total
39065	CHLORDANE-TRNS ISOMER, TOTAL WATER, UG/L	UG/L	Water	Total
00940	CHLORIDE, TOTAL, WATER, MG/L	MG/L	Water	Total
50064	CHLORINE, FREE AVAILABLE (MG/L)	MG/L	Water	Other
50060	CHLORINE, TOTAL RESIDUAL (MG/L)	MG/L	Water	Total
34301	CHLOROBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
39460	CHLOROBENZILATE, IN WHOLE WATER	UG/L	WATER	TOTAL
77297	CHLOROBROMOMETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
73085	CHLOROBROMOMETHANE, TOTAL, WATER, UG/L	UG/L	Water	Total
34311	CHLOROETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
32106	CHLOROFORM, TOTAL WATER, UG/L	UG/L	Water	Total
49322	CHLORONEB, DRY WT, SEDIMENT SIEVE	PERCENT	SED/SOIL	OTHER
49455	CHLOROPHENYL, 4-PHENYL ETHER, SEDIMENT, SIEVE	UG/KG	SED/SOIL	Total
34581	CHLORONAPHTHALENE (2-), TOTAL WATER, UG/L	UG/L	Water	Total
34586	CHLOROPHENOL (2-), TOTAL WATER, UG/L	UG/L	Water	Total
34641	CHLOROPHENYL PHENYL ETHER (4-), TOTAL WATER, UG/L	UG/L	Water	Total
49455	CHLOROPHENYL, 4-PHENYL ETHER, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
32230	CHLOROPHYLL-A (MG/L)	MG/L	Water	Total
32228	CHLOROPHYLL-A, PERIPHYTON, SPECTRO, MG/M2	OTHERS	Water	Standard
32231	CHLOROPHYLL B (MG/L)	MG/L	Water	Total
32226	CHLOROPHYLL B, PERIPHYTON, SPECTRO, MG/M2	OTHERS	Water	Standard
32216	CHLOROPHYLL, TOTAL UG/L TRICHROMATIC UNCORRECTED	UG/L	Water	Total
32232	CHLOROPHYLL C	MG/L	WATER	TOTAL
32227	CHLOROPHYLL C, PERIPHYTON SPECTRO, MG/M2	MG/M2	WATER	STANDARD
32216	CHLOROPHYLL, TOTAL, UG/L TRICHROMATIC UNCORRECT	UG/L	WATER	Total
32211	CHLOROPHYLL-A, UG/L, SPECTRO, ACID. METHOD	UG/L	WATER	Total
46460	CHLOROPHYLL-A, SPECTRO,CORRECT FOR PHEOPHYTIN	UG/L	Water	Total
70955	CHLOROPHYLL-A, PERIDHYTON, UG/L, CHROMO-SPECTRO	UG/L	Water	Standard
99855	CHLOROPHYLL-A, PERIHYTON, CHROMO-SPECTRO, MG/M2	MG/M2	WATER	STANDARD
70957	CHLOROPHYLL-A, PERIPHYTON, UG/L, CHROMO-FLUORO	UG/L	Water	Other
99857	CHLOROPHYLL-A,PERIPHYTON,CHROMO-FLUORO			
70953	CHLOROPHYLL-A, PHYTOPLANKTON, CHROMO-FLUORO	UG/L	Water	Total
70958	CHLOROPHYLL-B, PERIPHYTON, UG/L, CHROMO-FLUORO	UG/L	Water	Total
70956	CHLOROPHYLL-B, PERIPHYTON, UG/L, CHROMO-SPECTRO	UG/L	Water	Total
99858	CHLOROPHYLL-B,PERIPHYTON,CHROMO-FLUORO	UG/L	Water	Total
99856	CHLOROPHYLL-B,PERIPHYTON,CHROMO-SPECTRO	UG/L	Water	Total
70954	CHLOROPHYLL-B, PHYTOPLANKTON, CHROMO-FLUORO	UG/L	Water	Total
32215	CHLOROPHYLL-C, SPECTROPHOTOMETRIC 430MU METH	UG/L	Water	Total
32214	CHLOROPHYLL-C, UG/L, TRICHROMATIC UNCORRECTED	UG/L	Water	Total
49306	CHLOROTHALONIL, RECOVERABLE, FILTERED, WATER, GF,0.7U,UG/L	UG/L	Water	Standard
99943	CHLOROTRIFLUOROETHYLENE UG/L	UG/L	Water	Standard
38932	CHLOROPYRIFOS, TOTAL RECOVERABLE	UG/L	Water	Total
38933	CHLORPYRIFOS, DISSOLVED	UG/L	Water	Dissolved
01118	CHROMIUM, TOTAL RECOVERABLE IN WATER	UG/L	WATER	TOTAL
01030	CHROMIUM, DISSOLVED (UG/L AS CR)	UG/L	Water	Dissolved
01032	CHROMIUM, HEXAVALENT (UG/L AS CR)	UG/L	Water	Standard
01220	CHROMIUM, HEXAVALENT, DISSOLVED IN (UG/L AS CR)	UG/L	WATER	Dissolved
34842	CHROMIUM, SEDIMENT, BOTTOM DEPOSITS, UG/G (MG/KG)	UG/G	Sed/soil	Dissolved
29829	CHROMIUM, SEDIMENT, SUSPENDED UG/G (MG/KG)	UG/G	Sed/soil	Suspended
01031	CHROMIUM, SUSPENDED (UG/L AS CR)	UG/L	Water	Suspended

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49240	CHROMIUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
01034	CHROMIUM, TOTAL (UG/L AS CR)	UG/L	Water	Total
49061	CHROMIUM, TOTAL, WATER, TCLP	MG/L	WATER	Total
01314	CHROMIUM, TRIVALENT, POTENTIALLY, DISS, WATER MG/L	MG/L	WATER	Dissolved
50101	CHROMIUM, ICAP TEST METHOD, TOTAL RECOVERABLE	MG/L	WATER	Total
34842	CHROMIUM, SEDIMENT, BOTTOM DEPOSITS	UG/G	SED/SOIL	Total
01029	CHROMIUM, TOTAL, BOTTOM DEPOSITS, DRY WEIGHT	MG/KG	Sed/soil	Calculated
49450	CHRYSENE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34320	CHRYSENE, TOTAL WATER, UG/L	UG/L	Water	Total
77093	CIS-1,2-DICHLOROETHYLENE, TOTAL WATER, UG/L	UG/L	Water	Total
34704	CIS-1,3-DICHLOROPROPENE, TOTAL, WATER, UG/L	UG/L	Water	Total
50798	CIS-1,4-DICHLORO-2-BUTENE	UG/L	WATER	Total
49305	CLOPYRALID, RECOVERABLE, FILTERED, WATER, GF,0.7U,UG/L	UG/L	Water	Standard
01038	COBALT, BOTTOM DEPOSITS (MG/KG AS CO DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01035	COBALT, DISSOLVED (UG/L AS CO)	UG/L	Water	Dissolved
34847	COBALT, SEDIMENT, BOTTOM DEPOSITS,	UG/G	Sed/soil	Dissolved
01036	COBALT, SUSPENDED (UG/L AS CO)	UG/L	Water	Suspended
35031	COBALT, SUSPENDED, SEDIMENT UG/G	UG/G	Sed/soil	Suspended
01037	COBALT, TOTAL (UG/L AS CO)	UG/L	Water	Total
34845	COBALT, SEDIMENT, BOTTOM DEPOSIT	MG/KG	SED/SOIL	Total
34847	COBALT, SEDIMENT, BOTTOM DEPOSIT	UG/G	SED/SOIL	Total
49062	COBALT, TOTAL, WATER, TCLP	MG/L	WATER	Total
49250	COBALT, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
00335	COD, .025N K2CR2O7, MG/L	MG/L	Water	Total
00340	COD, .25N K2CR2O7, MG/L	MG/L	Water	Total
00339	COD, BOTTOM DEPOSITS, DRY WEIGHT MG/KG	MG/KG	Sed/soil	Calculated
31501	COLIFORM, TOTAL, MEMBRANE FILTER, IMMED. M-ENDO MED, 35C	#/100 ML	Water	Total
31505	COLIFORM, TOTAL, MPN, CONFIRMED TEST, 35C (TUBE 31506)	OTHERS	Water	Total
00080	COLOR (PLATINUM-COBALT UNITS)	OTHERS	Water	Total
01043	COPPER, BOTTOM DEPOSITS (MG/KG AS CU DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01040	COPPER, DISSOLVED (UG/L AS CU)	UG/L	Water	Dissolved
34852	COPPER, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL UG/G	UG/G	Sed/soil	Dissolved
29832	COPPER, SEDIMENT, SUSPENDED,UG/G	UG/G	Sed/soil	Suspended
01041	COPPER, SUSPENDED (UG/L AS CU)	UG/L	Water	Suspended
01042	COPPER, TOTAL (UG/L AS CU)	UG/L	Water	Total
49063	COPPER, TOTAL, WATER, TCLP	MG/L	WATER	Total
50102	COPPER,ICAP TEST METHOD, TOTAL RECOVERABLE	MG/L	WATER	Total
01306	COPPER,POTENTIALLY DISSOLVED WATER	MG/L	WATER	Dissolved
49241	COPPER, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
34850	COPPER,SED,BOT,<63U,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Total
01119	COPPER,TOTAL RECOVERABLE IN WATER AS CU UG/L	UG/L	WATER	Total
49299	CRESOL,O-, RECOVERABLE, FILTERED, WATER, GF,0.7U	UG/L	Water	Standard
82632	CROSS-SECTIONAL AREA OF STREAM, SQUARE FEET	OTHERS	Water	Calculated
04041	CYANAZINE, DISSOLVED, WATER, TOTAL RECOVERABLE	UG/L	Water	Dissolved
00721	CYANIDE, BOTTOM DEPOSITS (MG/KG AS CN DRY WEIGHT)	MG/KG	Sed/soil	Calculated
00723	CYANIDE, DISSOLVED, STD METHOD, UG/L	UG/L	Water	Dissolved
00720	CYANIDE, TOTAL (MG/L AS CN) MG/L	MG/L	Water	Total
01291	CYANIDE, FILTERABLE, IN WATER UG/L	UG/L	WATER	TOTAL
49411	CYCLOPENTA(DEF)PHENANTHRENE, 4H-, DRY WT, SIEVE	UG/KG	Sed/soil	Calculated
39731	D (2,4-), BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39732	D (2,4-), FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39733	D (2,4-), SUSPENDED, WATER, UG/L	UG/L	Water	Suspended

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39730	D (2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
49304	DACTHAL, RECOVERABLE, FILTERED, WATER, GF,0.7U UG/L	UG/L	Water	Dissolved
38746	DB (2,4-), WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
82682	DCPA, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER,UG/L	UG/L	Water	Standard
39316	DDD (O,P'-) BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39311	DDD (P,P'-), BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39310	DDD (P,P'-), TOTAL WATER, UG/L	UG/L	Water	Total
39363	DDD, BOTTOM DEPOSITS, (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39361	DDD, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39362	DDD, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39360	DDD, TOTAL WATER, UG/L	UG/L	Water	Total
39328	DDE (O,P'-), BOTTOM DEPOS , DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39321	DDE (P,P'-), BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
34653	DDE (P,P'-), DISSOLVED, UG/L	UG/L	Water	Dissolved
49325	DDD,O,P '-, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49374	DDD,O,P'-, WET WEIGHT,TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	TOTAL
49326	DDD,P,P'-, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49375	DDD,P,P'-, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	TOTAL
39320	DDE (P,P'-), TOTAL WATER, UG/L	UG/L	Water	Total
39368	DDE, BOTTOM DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39366	DDE, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39367	DDE, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39365	DDE, TOTAL WATER, UG/L	UG/L	Water	Total
49327	DDE,O,P'-, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49373	DDE,O,P'-, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
49328	DDE,P,P'-, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49372	DDE,P,P', WET WT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
39306	DDT (O,P'-), BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39301	DDT (P,P'-), BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39300	DDT (P,P'-), TOTAL WATER, UG/L	UG/L	Water	Total
39373	DDT, BOTTOM DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39371	DDT, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39372	DDT, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39370	DDT, TOTAL WATER, UG/L	UG/L	Water	Total
49329	DDT,O,P'-, DRY WT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49377	DDT,O,P', WET WT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
49330	DDT,P,P'-, DRY WT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49376	DDT,P,P', WET WEIGHT,TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
04040	DEETHYL ATRAZINE,DISSOLVED,WATER,TOTAL REC UG/L	UG/L	Water	Dissolved
34259	DELTA BENZENE HEXACHLORIDE TOTAL WATER, UG/L	UG/L	Water	Total
00064	DEPTH OF STREAM, MEAN (FT)	FT	Water	Standard
00205	DEPTH, MAXIMUM OF LAKE OR RESERVOIR (METERS)	M	WATER	Calculated
82082	DEUTERIUM/PROTIUM (H-2/H-1) STABLE ISOTOPE RATIO	NO UNITS	Water	Total
39571	DIAZINON IN BOT. DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39572	DIAZINON, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39573	DIAZINON, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39570	DIAZINON, TOTAL WATER, UG/L	UG/L	Water	Total
49461	DIBENZ(A,H)ANTHRACENE, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
34556	DIBENZANTHRACENE(1,2,5,6-), TOTAL WATER UG/L	UG/L	Water	Total
49452	DIBENZOTHIOPHENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
32105	DIBROMOCHLOROMETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
82625	DIBROMOCHLOROPROPANE, WATER,TOTAL RECOV	UG/L	Water	Total
77651	DIBROMOETHANE (1,2-), TOTAL WATER, UG/L	UG/L	Water	Total
30217	DIBROMOMETHANE, WATER, TOTAL, RECOVERABLE UG/L	UG/L	Water	Standard
49381	DIBUTYLPHTHALATE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated

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38442	DICAMBA (BANVEL), WATER,DISSOLVED, UG/L	UG/L	Water	Dissolved
49303	DICHLOBENIL, RECOVERABLE, FILTERED, WATER, GF,0.7U	UG/L	Water	Standard
34536	DICHLOROBENZENE (1,2-), TOTAL WATER UG/L	UG/L	Water	Total
34566	DICHLOROBENZENE (1,3-), TOTAL WATER UG/L	UG/L	Water	Total
34571	DICHLOROBENZENE (1,4-), TOTAL WATER UG/L	UG/L	Water	Total
34631	DICHLOROBENZIDINE (3,3'-), TOTAL WATER, UG/L	UG/L	Water	Total
50282	DICHLORODIFLUOROMENTHANE, WATER, UNFILTERED, N2 ATM PG/KG	PG/KG	Water	Total
34668	DICHLORODIFUOROMETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
34496	DICHLOROETHANE (1,1-), TOTAL WATER, UG/L	UG/L	Water	Total
34531	DICHLOROETHANE (1,2-), TOTAL WATER UG/L	UG/L	Water	Total
32103	DICHLOROETHANE (1,2-), TOTAL WATER, UG/L	UG/L	Water	Total
34501	DICHLOROETHYLENE (1,1-), TOTAL WATER, UG/L	UG/L	Water	Total
34601	DICHLOROPHENOL (2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
34541	DICHLOROPROPANE (1,2-), TOTAL WATER UG/L	UG/L	Water	Total
77173	DICHLOROPROPANE (1,3-), TOTAL WATER, UG/L	UG/L	Water	Total
77170	DICHLOROPROPANE (2,2-), TOTAL WATER, UG/L	UG/L	Water	Total
77168	DICHLOROPROPENE (1,1-), TOTAL WATER, UG/L	UG/L	Water	Total
77163	DICHLOROPROPENE-1(1,3-), TOTAL WATER, UG/L	UG/L	Water	Total
49302	DICHLORPROP, RECOVERABLE, FILTERED, WATER, GF,0.7U	UG/L	Water	Standard
39383	DIELDRIN, BOTTOM DEPOSITS (UG/KILOGRAM DRY SOL.)	UG/KG	Sed/soil	Calculated
39381	DIELDRIN, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39382	DIELDRIN, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39380	DIELDRIN, TOTAL WATER, UG/L	UG/L	Water	Total
49331	DIELDRIN,DRY WEIGHT,SEDIMENT,SIEVE	PERCENT	SED/SOIL	Calculated
49371	DIELDRIN,WET WEIGHT,TISSUE,WHOLE ORG,RECV	UG/KG	WATER	Total
81576	DIETHYL ETHER TOTAL WATER, UG/L	UG/L	Water	Total
34336	DIETHYL PHTHALATE, TOTAL WATER, UG/L	UG/L	Water	Total
82660	DIETHYLANILINE, 2, 6-,0.7UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
49383	DIETHYLPHTHALATE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
81577	DIISOPROPYL ETHER, TOTAL WATER, UG/L	UG/L	Water	Total
34341	DIMETHYL PHTHALATE, TOTAL WATER, UG/L	UG/L	Water	Total
50624	DIMETHYL-7-ETHYL-6M8-DI ((1S*,2R*,5R*,7S*)-2,4-), TOTAL	UG/L	Water	Total
34606	DIMETHYLPHENOL (2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
49384	DIMETHYLPHTHALATE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
39110	DI-N-BUTYL PHTHALATE, TOTAL WATER, UG/L	UG/L	Water	Total
34616	DINITROPHENOL (2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
34611	DINITROTOLUENE (2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
34626	DINITROTOLUENE (2,6-), TOTAL WATER, UG/L	UG/L	Water	Total
34596	DI-N-OCTYL PHTHALATE,TOTAL WATER, UG/L	UG/L	Water	Total
49301	DINOSEB, RECV, FILTERED, WATER, GF, 0.7U, UG/L	UG/L	Water	Standard
49382	DIOCTYLPHTHALATE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
82626	DIPHENYLHYDRAZINE (1,2-), WATER, TOTAL RECOVERABLE	UG/L	Water	Total
82677	DISULFOTON, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
49300	DIURON, RECV,FILTERED, WATER, GF, 0.7U,UG/L	UG/L	Water	Standard
34657	DNOC (4,6-DINITRO-ORTHO-CRESOL), TOTAL WATER, UG/L	UG/L	Water	Total
82183	DP (2,4-) (DICHLORPROP), TOTAL WATER, UG/L	UG/L	Water	Total
31648	E. COLI MTEC-MF N0/100ML	CFU/100	WATER	Total
31633	E.COLI,THERMOTOL, MF, M-TEC, IN SITU UREASE #/100ML	#/100 ML	WATER	Total
50922	ECOLI, NA+MUG ,4 HOURS ,35C ,COL MPN/100ML	CFU/100	WATER	Total
78151	EDTA	MG/L	Water	Total
00062	ELEVATION, RESERVIOR SURFACE WATER IN FEET	FT	WATER	Calculated
49332	ENDOSULFAN I, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
34351	ENDOSULFAN SULFATE, TOTAL WATER, UG/L	UG/L	Water	Total
34361	ENDOSULFAN, ALPHA, TOTAL WATER, UG/L	UG/L	Water	Total

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34356	ENDOSULFAN, BETA, TOTAL WATER, UG/L	UG/L	Water	Total
39389	ENDOSULFAN, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
82354	ENDOSULFAN, DISSOLVED,WATER, UG/L	UG/L	Water	Dissolved
39388	ENDOSULFAN, TOTAL WATER, UG/L	UG/L	Water	Total
34366	ENDRIN ALDEHYDE, TOTAL WATER, UG/L	UG/L	Water	Total
39393	ENDRIN, BOTTOM DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39391	ENDRIN, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39392	ENDRIN, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39390	ENDRIN, TOTAL WATER, UG/L	UG/L	Water	Total
49335	ENDRIN, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49370	ENDRIN, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
82668	EPTC, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER,UG/L	UG/L	Water	Standard
99906	E. COLI (ESCHERICHIA COLI) (COLILERT) (IN WATER)	CFU/100	WATER	
99909	E. COLI (ESCHERICHIA COLI) (COLILERT) (IN SEDIMENT)	CFU/100	SED/SOIL	Total
99918	E. COLI (ESCHERICHIA COLI) (COLILERT) (IN WASTE)	CFU/G	WASTE	Total
82663	ETHALFLURALIN, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
39399	ETHION, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39398	ETHION, TOTAL WATER, UG/L	UG/L	Water	Total
82672	ETHOPROP, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
34371	ETHYLBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
77023	ETHYLENE GLYCOL, WHOLE WATER, UG/L	UG/L	WATER	Total
34855	EUROPIUM, SEDIMENT, BOTTOM DEPOSITS, <63 U, WET SIEVE, FIELD, TOTAL	MG/KG	SED/SOIL	Dissolved
34857	EUROPIUM, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
31613	FECAL COLIFORM, MEM FILTER, M-FC AGAR, 44.5C, 24HR	CFU/100	Water	Total
31616	FECAL COLIFORM, MEMBRANE FILTER, M-FC BROTH, 44.5 C	#/100 ML	Water	Total
31625	FECAL COLIFORM, MILLIPORE FILTER, M-FC, 0.7 UM	#/100 ML	Water	Standard
48201	FECAL COLIFORM, MPN & MEMBRANE FILTER, 44.5C	#/ML	Water	Total
31673	FECAL STREPTOCOCCI, MEM FILTER, KF AGAR, 35C, 48HR	CFU/100	Water	Total
31679	FECAL STREPTOCOCCI, MILLIPORE FILTER, M-ENTEROCOCCUS AGAR,35C,48H	#/100 ML	Water	Standard
31677	FECAL STREPTOCOCCI, MPN, AD-EVA, 35C (TUBE 31678)	OTHERS	WATER	Total
49297	FENURON, RECOVERABLE, FILTERED, WATER, GF,0.7U, UG/L	UG/L	Water	Standard
62170	FIPRONIL DISULFINYL	UG/L	WATER	Total
62167	FIPRONIL SULFIDE, WATER, FILTERED, RECOVERABLE	UG/L	Water	Dissolved
62168	FIPRONIL SULFONE, WATER, FILTERED, RECOVERABLE	UG/L	Water	Dissolved
62166	FIPRONIL, WATER, FILTERED, RECOVERABLE	UG/L	Water	Dissolved
03605	FLOW METER CALIBRATION, WATER CODE	NO UNITS	Water	Total
74069	FLOW, ESTIMATED STREAM, CFS	CFS	Water	Total
85663	FLOW, RATE,FT/SEC	FT/SEC	Water	Total
00059	FLOW, RATE, INSTANTANEOUS, GALONS/MIN	GPM	WATER	Calculated
81395	FLOW, STORMWATER MGD	OTHERS	WATER	Calculated
01351	FLOW, STREAM, 1DRY, 2LOW, 3NORM, 4FLOOD, 5ABOVE NORM, CODE	NO UNITS	Water	Other
84163	FLOW, STREAM, CLASSIFICATION,CODE	NO UNITS	Water	Other
00061	FLOW, STREAM, INSTANTANEOUS, CFS	CFS	Water	Standard
00060	FLOW, STREAM, MEAN DAILY,CFS	CFS	Water	Total
38811	FLUOMETURON, WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
34376	FLUORANTHENE, TOTAL WATER, UG/L	UG/L	Water	Total
49466	FLUORANTHENE, SEDIMENT, BED MATERIAL, WET SIEVE	UG/KG	Sed/soil	Calculated
34381	FLUORENE, TOTAL WATER, UG/L	UG/L	Water	Total
49399	FLUORENE,9H-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
00950	FLUORIDE, DISSOLVED (MG/L AS F)	MG/L	Water	Dissolved
00951	FLUORIDE, TOTAL (MG/L AS F)	MG/L	Water	Total
00953	FLUORINE, TOTAL, UG/L	UG/L	Water	Total

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
04095	FONOFOS, DISSOLVED, WATER, TOTAL RECOVERABLE, UG/L	UG/L	Water	Dissolved
71880	FORMALDEHYDE, MG/L	MG/L	WATER	Total
01120	GALLIUM, DISSOLVED (UG/L AS GA)	UG/L	WATER	Total
34860	GALLIUM, SEDIMENT, BOT, <63U ,WET SIEVE, FIELD	UG/G	SED/SOIL	Total
34862	GALLIUM, SEDIMENT, BOT DEP,<63U, DRY SIEVE, LAB, TOT	UG/G	Sed/soil	Dissolved
39341	GAMMA-BHC (LINDANE), DISSOLVED, UG/L	UG/L	Water	Dissolved
39343	GAMMA-BHC (LINDANE), SEDIMENTS, DRY WEIGHT,UG/KG	UG/KG	Sed/soil	Calculated
39342	GAMMA-BHC (LINDANE), SUSPENDED, C482UG/L	UG/L	Water	Suspended
39340	GAMMA-BHC (LINDANE), TOTAL WATER, UG/L	UG/L	Water	Total
01125	GERMANIUM, DISSOLVED (UG/L AS GE)	UG/L	WATER	Dissolved
34872	GOLD, SEDIMENT, BOT DEP, <63U, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
22413	HARDNESS, DISSOLVED, WATER MG/L	MG/L	WATER	Dissolved
78151	HARDNESS AS EDTA	MG/L	Water	Total
46570	HARDNESS, CA MG CALCULATED (MG/L AS CACO3)	MG/L	Water	Calculated
95902	HARDNESS, NONCARBONATE (MG/L AS CACO3)	MG/L	Water	Standard
00902	HARDNESS, NON-CARBONATE (MG/L AS CACO3)	MG/L	Water	Other
00903	HARDNESS, NON-CARBONATE, FIXED ENDPOINT TITRATION, LAB MG/L	MG/L	Water	Total
00904	HARDNESS, NONCARBONATE, WATER, DISSOLVED, AS CACO3, FIELD, MG/L	MG/L	Water	Dissolved
00905	HARDNESS, NONCARBONATE, WATER, DISSOLVED, AS CACO3, LAB, MG/L	MG/L	Water	Dissolved
00900	HARDNESS, TOTAL (MG/L AS CACO3)	MG/L	Water	Standard
82394	HARDNESS, TOTAL CALCULATED (CA,MG,FE) AS CACO3	MG/L	Water	Calculated
39423	HEPTACHLOR EPOXIDE, BOT DEPOSITS (UG/KG DRY SOL.)	UG/KG	Sed/soil	Calculated
39421	HEPTACHLOR EPOXIDE, FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39422	HEPTACHLOR EPOXIDE, SUSPENDED WATER, UG/L	UG/L	Water	Suspended
39420	HEPTACHLOR EPOXIDE, TOTAL WATER, UG/L	UG/L	Water	Total
49342	HEPTACHLOR EPOXIDE, DRY WT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49368	HEPTACHLOR EPOXIDE, WET WT, TISS, WHOLE ORG, RECV	UG/KG	TISSUE	Total
39413	HEPTACHLOR, BOT DEPOSIT, (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39411	HEPTACHLOR, FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39412	HEPTACHLOR, SUSPENDED, WATER, UG/L	UG/L	Water	Suspended
39410	HEPTACHLOR, TOTAL WATER, UG/L	UG/L	Water	Total
49341	HEPTACHLOR, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49369	HEPTACHLOR, WET WT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
49343	HEXACHLOROBENZENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
39700	HEXACHLOROBENZENE, TOTAL WATER, UG/L	UG/L	Water	Total
39702	HEXACHLOROBUTADIENE, TOTAL WATER, UG/L	UG/L	Water	Total
34386	HEXACHLOROCYCLOPENTADIENE, TOTAL WATER, UG/L	UG/L	Water	Total
34396	HEXACHLOROETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
77103	HEXANONE (2-), TOTAL WATER,UG/L	UG/L	Water	Total
34877	HOLMIUM, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
45501	HYDROCARBON IN WATER, FREON EXT, CHROMAT, IR MG/L	MG/L	Water	Total
71830	HYDROXIDE ION (MG/L AS OH)	MG/L	Water	Total
71834	HYDROXIDE, WATER, DISSOLVED, INCREMENTAL TITRATION, FIELD, AS OH, MG/L	MG/L	Water	Dissolved
71832	HYDROXIDE, INCREMENTAL TITRATION,(OH) FIELD,MG/L	MG/L	Water	Standard
49308	HYDROXYCARBOFURAN,3-, RECOVERABLE, FILTERED, WATER, GF, 0.7U UG/L	UG/L	Water	Standard
34403	INDENO (1,2,3-CD) PYRENE, TOTAL WATER, UG/L	UG/L	Water	Total
71865	IODIDE (MG/L AS I)	MG/L	Water	Total
77424	IODOMETHANE, TOTAL WATER,UG/L	UG/L	Water	Total
71885	IRON (UG/L AS FE)	UG/L	Water	Standard
01170	IRON, BOTTOM DEPOSITS (MG/KG AS FE DRY WEIGHT)	MG/KG	Sed/soil	Calculated

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01046	IRON, DISSOLVED (UG/L AS FE)	UG/L	Water	Dissolved
49242	IRON, DRY WEIGHT, TISSUE / TIOTA, RECOV	MG/KG	TISSUE	Total
50103	IRON, ICAP TEST METHOD, TOTL RECOVERABLE	MG/L	WATER	Total
99926	IRON, PORE WATER, TOTAL	MG/L	PORE	Total
01317	IRON, POTENTIALLY, DISSOLVED, WATER	MG/L	WATER	Dissolved
34882	IRON, SEDIMENT, BOT DEP,<63U, DRY SIEVE, LAB, TOTAL, PERCENT	PERCENT	Sed/soil	Total
34880	IRON, SEDIMENT, BOT DEP, <63U, WET SIEVE, FIELD, TOTAL	PERCENT	SED/SOIL	Dissolved
30269	IRON, SEDIMENT, SUSPENDED, PERCENT	PERCENT	Sed/soil	Suspended
01044	IRON, SUSPENDED (UG/L AS FE)	UG/L	Water	Suspended
01045	IRON, TOTAL (UG/L AS FE)	UG/L	Water	Total
49041	IRON, TOTAL, SEDIMENT, TCLP	MG/L	SED/SOLI	Total
49064	IRON, TOTAL, WATER, TCLP	MG/L	WATER	Total
50000	ISODURENE, TOTAL RECOVERABLE, WATER, UG/L	UG/L	Water	Standard
34408	ISOPHORONE TOTAL WATER, UG/L	UG/L	Water	Total
49400	ISOPHORONE, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
77223	ISOPROPYLBENZENE TOTAL WATER,UG/L	UG/L	Water	Total
49394	ISOQUINOLINE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
34887	LANTHANUM, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL,UG/G	UG/G	Sed/soil	Dissolved
17503	LEAD 210, DISSOLVED	PCI/L	Water	Dissolved
75946	LEAD 210, SUSPENDED, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
17501	LEAD 210, TOTAL	PCI/L	WATER	Total
75995	LEAD 210,1 SIGMA PRC EST,DISSOLVED,WATER, PCI/L	PCI/L	Water	Dissolved
75949	LEAD 210,1 SIGMA PRC EST,SUSPENDED,SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
01052	LEAD, BOTTOM DEPOSITS (MG/KG AS PB DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01049	LEAD, DISSOLVED (UG/L AS PB)	UG/L	Water	Dissolved
49251	LEAD, DRY WEIGHT, TISSUE/BIOTA, RECOV	MG/KG	TISSUE	Total
34892	LEAD, SEDIMENT, BOT DEP,<63U, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Total
29836	LEAD, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01050	LEAD, SUSPENDED (UG/L AS PB)	UG/L	Water	Suspended
70021	LEAD, TCLP, WATER, TOTAL	MG/L	WATER	Total
01051	LEAD, TOTAL (UG/L AS PB)	UG/L	Water	Total
34890	LEAD, SED, BOT, <63U, WET SIEVE, FIELD, TOTAL	MG/KG	SED/SOIL	Total
01114	LEAD,TOTAL RECOVERABLE IN WATER AS PB UG/L	UG/L	WATER	Total
49345	LINDANE, DRY WEIGHT, SEDIMENT, SIEVE	PERCENT	SED/SOIL	Calculated
49363	LINDANE, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
38478	LINURON, WATER,DISSOLVED, UG/L	UG/L	Water	Dissolved
82666	LINURON, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER	UG/L	Water	Standard
49289	LIPIDS, WET WEIGHT, TISSUE, WHOLE ORGANISM, RECOV	PERCENT	TISSUE	Total
01130	LITHIUM, DISSOLVED (UG/L AS LI)	UG/L	Water	Dissolved
34897	LITHIUM, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
35050	LITHIUM, SUSPENDED, SEDIMENT UG/G	UG/G	Sed/soil	Suspended
01132	LITHIUM, TOTAL (UG/L AS LI)	UG/L	Water	Total
00925	MAGNESIUM, DISSOLVED (MG/L AS MG)	MG/L	Water	Dissolved
34902	MAGNESIUM, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL, PERCENT	PERCENT	Sed/soil	Dissolved
00927	MAGNESIUM, TOTAL (MG/L AS MG)	MG/L	Water	Total
34895	LITHIUM,SED,BOT,<63U,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Total
82033	MAGNESIUM - TOTAL UG/L(AS MG)	UG/L	WATER	Total
49131	MAGNESIUM, TOTAL, WATER, TCLP MG/L	MG/L	WATER	Total
50105	MAGNESIUM, ICAP TEST METHOD, TOTAL RECOV MG/L	MG/L	WATER	Total
34900	MAGNESIUM,SED,BOT,<63U,WET SIEVE,FIELD,TOTAL	PERCENT	SED/SOIL	Dissolved
49243	MANGANESE, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
99927	MANGANESE, PORE WATER, TOTAL	UG/L	WATER	Total

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01319	MANGANESE, POTENTIALLY, DISSOLVED, WATER	MG/L	WATER	Dissolved
99929	MANGANESE, SED, LEACHED	MG/KG	SED/SOIL	Total
71883	MANGANESE, TOTAL ELEMENTAL	UG/L	WATER	Total
49044	MANGANESE, TOTAL, SEDIMENT, TCLP	UG/L	SED/SOIL	Total
49065	MANGANESE, TOTAL, WATER, TCLP	MG/L	WATER	Total
50106	MANGANESE, ICAP TEST METHOD, TOTAL RECOV, MG/L	MG/L	WATER	Total
34905	MANGANESE, SED, BOT, <63U, WET SIEVE, FIELD	MG/KG	SED/SOIL	Total
01123	MANGANESE, TOTAL RECOVERABLE IN WATER AS MN UG/L	UG/L	WATER	Total
39531	MALATHION IN BOT. DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39532	MALATHION, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39533	MALATHION, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39530	MALATHION, TOTAL WATER, UG/L	UG/L	Water	Total
01053	MANGANESE, BOTTOM DEPOSITS (MG/KG AS MN) DRY WT	MG/KG	Sed/soil	Calculated
01056	MANGANESE, DISSOLVED (UG/L AS MN)	UG/L	Water	Dissolved
34907	MANGANESE, SEDIMENT, BOTTOM DEPOSITS, <63U, DRY SIEVE, LAB, TOTAL,UG/G	UG/G	Sed/soil	Dissolved
29839	MANGANESE, SEDIMENT, SUSPENDED UG/G	UG/G	Sed/soil	Suspended
01054	MANGANESE, SUSPENDED (UG/L AS MN)	UG/L	Water	Suspended
01055	MANGANESE, TOTAL (UG/L AS MN)	UG/L	Water	Total
38482	MCPA, WATER,DISSOLVED, UG/L	UG/L	Water	Dissolved
38487	MCPB, WATER,DISSOLVED, UG/L	UG/L	Water	Dissolved
49422	M-CRESOL, 4-CHLORO-, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
71890	MERCURY, DISSOLVED (UG/L AS HG)	UG/L	Water	Dissolved
29841	MERCURY, SEDIMENT, SUSPENDED UG/G	UG/G	Sed/soil	Suspended
71895	MERCURY, SUSPENDED (UG/L AS HG)	UG/L	Water	Suspended
71900	MERCURY, TOTAL (UG/L AS HG)	UG/L	Water	Total
71921	MERCURY, TOTAL, BOT DEPOSITS (MG/KG AS HG) DRY WT	MG/KG	Sed/soil	Calculated
49258	MERCURY, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
01321	MERCURY, POTENTIALLY, DISSOLVED, WATER MG/L	MG/L	WATER	Dissolved
49133	MERCURY, TOTAL, WATER, TCLP MG/L	MG/L	WATER	Total
34912	MERCURY, SED,BOT,<63U,DRY SIEVE,LAB,TOTAL	UG/G	SED/SOIL	Total
34910	MERCURY, SED,BOT,<63U,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Total
71901	MERCURY, TOTAL RECOVERABLE IN WATER AS HG	UG/L	WATER	Total
99920	MERCURY- DIS, FILTERED WATER, ULTRATRACE METHOD	NG/L	WATER	Dissolved
99924	MERCURY- MONOMETHYL TL , SEDIMENT, ULTRATRACE METHOD,DRY NG/G	NG/G	SED/SOIL	Total
99921	MERCURY- MONOMETHYL TL WATER, ULTRATRACE METHOD NG/L	NG/L	WATER	Total
99925	MERCURY- MONOMETHYL TL, SEDIMENT, ULTRATRACE METHOD, WET NG/G	NG/G	WS	Total
99922	MERCURY- TL, SEDIMENT, ULTRATRACE METHOD, DRY	NG/G	SED/SOIL	Total
99923	MERCURY- TL, SEDIMENT, ULTRATRACE METHOD, WET	NG/G	WS	Total
50092	MERCURY- TL, UNFILTERED WATER, ULTRATRACE METHOD	NG/L	WATER	Total
81593	METHACRYLONITRILE, TOTAL WATER, UG/L	UG/L	Water	Total
49401	METHANE, BIS(2-CHLOROETHOXY), DRY WEIGHT,SEV	UG/KG	Sed/soil	Calculated
38501	METHIOCARB, WATER,DISSOLVED, UG/L	UG/L	Water	Dissolved
49296	METHOMYL, RECOV, FILTERED, WATER, GF, 0.7U, UG/L	UG/L	Water	Standard
39481	METHOXYCHLOR, BOTTOM DEPOSITS (UG/KG DRY SOL.)	UG/KG	Sed/soil	Calculated
82350	METHOXYCHLOR, DISSOLVED IN WATER, UG/L	UG/L	Water	Dissolved
39480	METHOXYCHLOR, TOTAL WATER, UG/L	UG/L	Water	Total
49991	METHYL ACRYLATE, TOTAL RECOVERABLE, WATER, UG/L	UG/L	Water	Standard
82686	METHYL AZINPHOS, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
34413	METHYL BROMIDE, TOTAL WATER, UG/L	UG/L	Water	Total
34418	METHYL CHLORIDE, TOTAL WATER, UG/L	UG/L	Water	Total
81595	METHYL ETHYL KETONE, TOTAL WATER, UG/L	UG/L	Water	Total
81597	METHYL METHACRYLATE, TOTAL WATER, UG/L	UG/L	Water	Total

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39601	METHYL PARATHION IN BOT DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
82667	METHYL PARATHION, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
39602	METHYL PARATHION, FILTERED FRAC. WATER SAMP, UG/L	UG/L	Water	Dissolved
39603	METHYL PARATHION, SUSPENDED, WATER SAMP, UG/L	UG/L	Water	Suspended
39600	METHYL PARATHION, TOTAL WATER, UG/L	UG/L	Water	Total
46491	METHYL TERTIARY BUTYL ETHER (MTBE), TOTAL, WATER	UG/L	Water	Total
39791	METHYL TRITHION, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39790	METHYL TRITHION, TOTAL WATER, UG/L	UG/L	Water	Total
77275	METHYL-2-CHLOROBENZENE (1-) (O-CHLOR) , TOTAL WATER	UG/L	Water	Total
77220	METHYL-2-ETHYLBENZENE (1-), TOTAL WATER, UG/L	UG/L	Water	Total
78133	METHYL-2-PENTANONE (4-), WATER UG/L	UG/L	Water	Total
77277	METHYL-4-CHLOROBENZENE (1-) (P-CHLOR),TOTAL WATER	UG/L	Water	Total
77356	METHYL-4-ISOPROPYLBENZENE (1-), TOTAL WATER, UG/L	UG/L	Water	Total
49398	METHYL-9H-FLUORENE, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49389	METHYLBENZO(A)PYRENE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34423	METHYLENE CHLORIDE, TOTAL WATER, UG/L	UG/L	Water	Total
49390	METHYLINDENO(1,2,3-CD)PYRENE, DRY WEIGHT,SIEVE	UG/KG	Sed/soil	Calculated
49410	METHYLPHENANTHRENE, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49388	METHYLPYRENE, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
39415	METOLACHLOR, WATER, DISSOLVED UG/L	UG/L	Water	Dissolved
82630	METRIBUZIN (SENCOR), WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
39758	MIREX, BOTTOM MATERIAL, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39756	MIREX, DISSOLVED, UG/L	UG/L	Water	Dissolved
39755	MIREX, TOTAL, UG/L	UG/L	Water	Total
00495	MOISTURE CONTENT (PERCENT OF TOTAL DRY WEIGHT)	PERCENT	SED/SOIL	Calculated
82671	MOLINATE, 0.7 UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
01060	MOLYBDENUM, DISSOLVED (UG/L AS MO)	UG/L	Water	Dissolved
49252	MOLYBDENUM, DRY WEITHT, TISSUE/BIOTA, RECOV	MG/KG	TISSUE	TOTAL
E4915	MOLYBDENUM, SEDIMENT, BOT DEP, <63, WET SIEVE, FIELD	MG/KG	SED/SOIL	Dissolved
34917	MOLYBDENUM, SEDIMENT, BOTTOM DEPOSITS, <63, DRY SIEVE, LAB, TOTAL,UG/G	UG/G	Sed/soil	Dissolved
29843	MOLYBDENUM, SEDIMENT, SUSPENDEDUG/G	UG/G	Sed/soil	Suspended
01062	MOLYBDENUM, TOTAL (UG/L AS MO)	UG/L	Water	Total
34696	NAPHTHALENE, TOTAL WATER, UG/L	UG/L	Water	Total
49403	NAPHTHALENE, 1,2-DIMETHYL-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49404	NAPHTHALENE, 1,6-DIMETHYL-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49405	NAPHTHALENE, 2,3,6-TRIMETHYL-, DRY WEIGHT,SEV	UG/KG	Sed/soil	Calculated
49406	NAPHTHALENE, 2,6-DIMETHYL-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49407	NAPHTHALENE, 2-CHLORO-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49402	NAPHTHALENE, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49948	NAPHTHALENE,2-ETHYL-,BEDMAT,WETSIEV,	UG/KG	Sed/soil	Dissolved
82684	NAPROPAMIDE, 0.7 UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
39250	NAPTHALENES, POLYCHLORINATED, UG/L	UG/L	Water	Total
82360	NAPTHALENES, POLYCHLORINATED, DISS, WATER UG/L	UG/L	Water	Dissolved
34292	N-BUTYL BENZYL PHTHALATE, TOTAL WATER, UG/L	UG/L	Water	Total
77342	N-BUTYLBENZENE, TOTAL WATER,UG/L	UG/L	Water	Total
49294	NEBURON, RECOVERABLE, FILTERED, WATER, GF,0.7U	UG/L	Water	Standard
34922	NEODYMIUM, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Total
99892	NH3 + ORGANIC N	MG/L	Water	Other
99894	NH3 + ORGANIC N DISSOLVED	MG/L	Water	Dissolved
01065	NICKEL, DISSOLVED (UG/L AS NI)	UG/L	Water	Dissolved
34927	NICKEL, SEDIMENT, BOTTOM DEPOSITS,<63, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
29845	NICKEL, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
01066	NICKEL, SUSPENDED (UG/L AS NI)	UG/L	Water	Suspended
01067	NICKEL, TOTAL (UG/L AS NI)	UG/L	Water	Total
01068	NICKEL, TOTAL, BOTTOM DEPOSITS (MG/KG, DRY WEIGHT)	MG/KG	Sed/soil	Calculated
49253	NICKEL, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
49066	NICKEL, TOTAL, WATER, TCLP	MG/L	WATER	Total
34927	NICKEL, SED, BOT, <63,DRY SIEVE, LAB, TOTAL	UGL	Sed/soil	Dissolved
34925	NICKEL, SED, BOT, <63,WET SIEVE, FIELD, TOTAL	MG/KG	Sed/soil	Dissolved
34930	NIOBIUM, SED, BOT, <63,WET SIEVE, FIELD, TOTAL	MG/KG	Sed/soil	Dissolved
34932	NIOBIUM, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
00618	NITRATE NITROGEN, DISSOLVED (MG/L AS N)	MG/L	Water	Dissolved
71851	NITRATE NITROGEN, DISSOLVED (MG/L AS NO3)	MG/L	Water	Dissolved
00620	NITRATE NITROGEN, TOTAL (MG/L AS N)	MG/L	Water	Total
71850	NITRATE NITROGEN, TOTAL (MG/L AS NO3)	MG/L	Water	Total
00613	NITRITE NITROGEN, DISSOLVED (MG/L AS N)	MG/L	Water	Dissolved
71856	NITRITE NITROGEN, DISSOLVED (MG/L AS NO2)	MG/L	Water	Dissolved
00615	NITRITE NITROGEN, TOTAL (MG/L AS N)	MG/L	Water	Total
00633	NITRITE PLUS NITRATE, BOTOM DEPOSITS (MG/KG-N DRY WEIGHT)	MG/KG	Sed/soil	Calculated
00631	NITRITE PLUS NITRATE, DISSOLVED 1 DET. (MG/L AS N)	MG/L	Water	Dissolved
00630	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)	MG/L	Water	Total
34447	NITROBENZENETOTAL WATER, UG/L	UG/L	Water	Total
00627	NITROGEN, KJELDAHL TOTAL, BOT DEP, DRY WT MG/KG	MG/KG	Sed/soil	Calculated
49570	NITROGEN, PARTICULATE, FIELD FILTER, SUSP MG/L	MG/L	Water	Suspended
00636	NITROGEN, AMMONIA & ORGANIC, DISS, 1 DET (MG/L AS N)	MG/L	Water	Dissolved
00635	NITROGEN, AMMONIA & ORGANIC, TOTAL 1 DET (MG/L AS N)	MG/L	Water	Standard
00611	NITROGEN, AMMONIA, BOTTOM DEPOSITS (MG/KG-N)	MG/KG	Sed/soil	Calculated
00608	NITROGEN, AMMONIA, DISSOLVED (MG/L AS N)	MG/L	Water	Dissolved
71846	NITROGEN, AMMONIA, DISSOLVED (MG/L AS NH4)	MG/L	Water	Dissolved
00610	NITROGEN, AMMONIA, TOTAL (MG/L AS N)	MG/L	Water	Total
71845	NITROGEN, AMMONIA, TOTAL (MG/L AS NH4)	MG/L	Water	Total
00602	NITROGEN, DISSOLVED (MG/L AS N)	MG/L	Water	Dissolved
00623	NITROGEN, KJELDAHL, DISSOLVED (MG/L AS N)	MG/L	Water	Dissolved
00624	NITROGEN, KJELDAHL, SUSPENDED (MG/L AS N)	MG/L	Water	Suspended
00625	NITROGEN, KJELDAHL, TOTAL, (MG/L AS N)	MG/L	Water	Total
00626	NITROGEN, ORG. KJELDAHL, BOT DEP (MG/KG-N DRY WT)	MG/KG	Sed/soil	Calculated
00607	NITROGEN, ORGANIC, DISSOLVED (MG/L AS N)	MG/L	Water	Dissolved
00605	NITROGEN, ORGANIC, TOTAL (MG/L AS N)	MG/L	Water	Total
00600	NITROGEN, TOTAL (MG/L AS N)	MG/L	Water	Total
71887	NITROGEN, TOTAL, AS NO3 - MG/L	MG/L	Water	Standard
62845	NITROGEN, TOTAL, SEDIMENT, SUSPENDED, WT PERCENT	PERCENT	Sed/soil	Suspended
34591	NITROPHENOL (2-), TOTAL WATER, UG/L	UG/L	Water	Total
34646	NITROPHENOL (4-), TOTAL WATER, UG/L	UG/L	Water	Total
34438	N-NITROSODIMETHYLAMINE, TOTAL WATER, UG/L	UG/L	Water	Total
34428	N-NITROSODI-N-PROPYLAMINE TOTAL WATER, UG/L	UG/L	Water	Total
34433	N-NITROSODIPHENYLAMINE, TOTAL WATER, UG/L	UG/L	Water	Total
49433	N-NITROSO-DIPHENYLAMINE, DRY WEIGHT,SED,SEV	UG/KG	Sed/soil	Calculated
49431	N-NITROSO-DIPROPYLAMINE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
49293	NORFLURAZON, RECOVERABLE, FILTERED, WATER, GF 0.7U, UG/L	UG/L	Water	Standard
77224	N-PROPYLBENZENE,TOTAL WATER,UG/L	UG/L	Water	Total
39316	O,P' DDD, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39328	O,P' DDE, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39306	O,P' DDT, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
00556	OIL & GREASE (FREON EXTR.-GRAV METHOD) TOTAL, RECV	MG/L	Water	Total

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00557	OIL & GREASE, SED, DRY WT, FREON EXTR-GRAV METH	MG/KG	SED/SOIL	Total
50786	ORTHOPHOSPHATE AS P, WATER (SEE ALSO PHOSPHORUS)	MG/L	WATER	Total
49292	ORYZALIN, RECOVERABLE, FILTERED, WATER, GF, 0.7U	UG/L	Water	Standard
38866	OXAMYLWATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
00090	OXIDATION REDUCTION POTENTIAL (MILLIVOLTS)	MVOLTS	Water	Total
99911	OXIDATION REDUCTION POTENTIAL (SEDIMENT) MV	MVOLTS	SED/SOIL	Total
46480	OXIDATION REDUCTION POTENTIAL, FIELD MV	MVOLTS	WATER	Total
78871	OXYCHLORDANE IN SEDIMENT, DRY WEIGHT, UG/KG	UG/KG	Sed/soil	Calculated
00300	OXYGEN, DISSOLVED, MG/L	MG/L	Water	Dissolved
00301	OXYGEN, DISSOLVED, PERCENT OF SATURATION,PERCENT	PERCENT	Water	Standard
82085	OXYGEN-18/OXYGEN-16 STABLE ISOTOPE RATIO PER MIL	NO UNITS	Water	Total
77135	O-XYLENE, TOTAL WATER,UG/L	UG/L	Water	Total
39311	P,P' DDD, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39310	P,P' DDD, TOTAL WATER, UG/L	UG/L	Water	Total
39321	P,P' DDE, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
34653	P,P' DDE, DISSOLVED, UG/L	UG/L	Water	Dissolved
39320	P,P' DDE, TOTAL WATER, UG/L	UG/L	Water	Total
39301	P,P' DDT, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39300	P,P' DDT, TOTAL WATER, UG/L	UG/L	Water	Total
34452	PARACHLOROMETA CRESOL, TOTAL WATER, UG/L	UG/L	Water	Total
39541	PARATHION IN BOT. DEPOSITS (UG/KILOGRAM DRY SOLIDS)	UG/KG	Sed/soil	Calculated
39542	PARATHION, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39543	PARATHION, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39540	PARATHION, TOTAL WATER, UG/L	UG/L	Water	Total
34671	PCB - 1016 TOTAL WATER, UG/L	UG/L	Water	Total
81648	PCB - 1016/1242, TOTAL WATER UG/L	UG/L	Water	Total
39488	PCB - 1221, TOTAL WATER UG/L	UG/L	Water	Total
39492	PCB - 1232, PCB SERIES TOTAL WATER UG/L	UG/L	Water	Total
39496	PCB - 1242, PCB SERIES TOTAL WATER UG/L	UG/L	Water	Total
39500	PCB - 1248, PCB SERIES TOTAL WATER UG/L	UG/L	Water	Total
39504	PCB - 1254, PCB SERIES TOTAL WATER UG/L	UG/L	Water	Total
39508	PCB - 1260, PCB SERIES TOTAL WATER UG/L	UG/L	Water	Total
39519	PCBS, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39517	PCBS, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
49354	PCB, WET WEIGHT, TISSUE, WHOLE ORG, RECV	UG/KG	TISSUE	Total
49459	PCB, DRY WEIGHT, BED MATERIAL, SIEVE	PERCENT	SED/SOIL	Percent
39519	PCBS IN BOTTOM DEPOSITS (UG/KG DRY SOLIDS)	UG/KG	SED/SOIL	Total
39517	PCBS IN FILT. FRAC. OF WATER SAMPLE	UG/L	WATER	Dissolved
39518	PCBS, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39516	PCBS, TOTAL WATER, UG/L	UG/L	Water	Total
39251	PCNS, BOTTOM DEPOS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39032	PCP (PENTACHLOROPHENOL) TOTAL WATER,UG/L	UG/L	Water	Total
49451	P-CRESOL, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
82669	PEBULATE, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER	UG/L	Water	Standard
82683	PENDIMETHALIN, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
49460	PENTACHLOROANISOLE, DRY WT, BED MATERIAL, SIEVE	UG/KG	Sed/soil	Calculated
61209	PERCHLORATE (CLO4)	UG/L	WATER	TOTAL
61210	PERCHLORATE (CLO4)	MG/KG	SED/SOIL	TOTAL
82687	PERMETHRIN, CIS, 0.7 UM FILTER, TOTAL RECOV, WATER	UG/L	Water	Standard
82348	PERTHANE, DISSOLVED IN WATER UG/L	UG/L	Water	Dissolved
81886	PERTHANE, SEDIMENT, DRY WEIGHT, UG/KG	UG/KG	Sed/soil	Calculated
39034	PERTHANE, TOTAL WATER, UG/L	UG/L	Water	Total
00400	PH (STANDARD UNITS)	SU	Water	Standard
00406	PH, FIELD	SU	Water	Total
00403	PH, LAB	SU	Water	Total

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49409	PHENANTHRENE, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
34461	PHENANTHRENETOTAL WATER, UG/L	UG/L	Water	Total
34694	PHENOL(C6H5OH)- SINGLE COMPOUND, TOTAL WATER	UG/L	Water	Total
49424	PHENOL, C8-ALKYL-, DRY WEIGHT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
49413	PHENOL, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
32730	PHENOLICS, TOTAL, RECOVERABLE, UG/L	UG/L	Water	Total
32218	PHEOPHYTIN-A UG/L SPECTROPHOTOMETRIC ACID. METH.	UG/L	Water	Total
82664	PHORATE, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER	UG/L	Water	Standard
00660	PHOSPHATE, ORTHO (MG/L AS PO4)	MG/L	Water	Other
00650	PHOSPHATE, TOTAL (MG/L AS PO4)	MG/L	Water	Total
00653	PHOSPHATE, TOTAL SOLUBLE (MG/L)	MG/L	Water	Dissolved
70505	PHOSPHATE, TOTAL, COLORIMETRIC METHOD (MG/L AS P)	MG/L	Water	Total
30292	PHOSPHOROUS, SEDIMENT, SUSPENDED, PERCENT	PERCENT	Sed/soil	Suspended
00666	PHOSPHORUS, DISSOLVED (MG/L AS P)	MG/L	Water	Dissolved
00671	PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE (MG/L AS P)	MG/L	Water	Standard
34937	PHOSPHORUS, SEDIMENT, BOTTOM DEPOSITS,<63, DRY SIEVE, LAB, TOTAL, PERCENT	PERCENT	Sed/soil	Dissolved
00665	PHOSPHORUS, TOTAL (MG/L AS P)	MG/L	Water	Total
71886	PHOSPHORUS, TOTAL, AS PO4 - MG/L	MG/L	Water	Standard
00668	PHOSPHORUS, TOTAL, BOT DEPOSIT (MG/KG-P DRY WT)	MG/KG	Sed/soil	Calculated
70507	PHOSPHORUS,IN TOTAL ORTHOPHOSPHATE (MG/L AS P)	MG/L	Water	Other
49426	PHTHALATE, BIS(2-ETHYLHEXYL)-, DRY WEIGHT,SEV	UG/KG	Sed/soil	Calculated
49427	PHTHALATE, BUTYL BENZYL, DRY WT, SEDIMENT, SIEVE	UG/KG	Sed/soil	Calculated
49291	PICLORAM, RECOVERABLE, FILTERED, WATER, GF, 0.7U	UG/L	Water	Standard
82068	POTASSIUM 40, DISSOLVED, K-40,PCI/LITER	PCI/L	Water	Dissolved
81204	POTASSIUM, (TONS PER DAY AS K)	TONS/DAY	Water	Standard
00935	POTASSIUM, DISSOLVED (MG/L AS K)	MG/L	Water	Dissolved
34942	POTASSIUM, SEDIMENT, BOTTOM DEPOSITS,<63, DRY SIEVE, LAB, TOTAL, PERCENT	PERCENT	Sed/soil	Dissolved
00937	POTASSIUM, TOTAL MG/L AS K)	MG/L	Water	Total
34940	POTASSIUM, SED, BOT, <63,WET SIEVE, FIELD, TOTAL	PERCENT	SED/SOIL	Calculated
82038	POTASSIUM, DISSOLVED UG/L(AS K)	UG/L	WATER	Dissolved
82034	POTASSIUM, TOTAL UG/L(AS K)	UG/L	WATER	Total
49999	PREHNITENE, TOTAL RECOVERABLE, WATER, UG/L	UG/L	Water	Standard
04037	PROMETON, DISSOLVED, WATER, TOTAL RECOVERABLE	UG/L	Water	Dissolved
82676	PRONAMIDE, 0.7 UM FILTER, TOTAL RECOVERABLE, WATER	UG/L	Water	Standard
04024	PROPACHLOR, DISSOLVED, WATER, TOTAL RECOVERABLE	UG/L	Water	Dissolved
78032	PROPANE, 2-METHOXY-2-METHYL-, WATER, TOTAL, UG/L	UG/L	Water	Total
50004	PROPANE,2-ETHOXY-2-METHYL-, TOTAL RECOV, WATER	UG/L	Water	Standard
82679	PROPANIL, 0.7 UM FILTER, TOTAL RECOV, WATER,UG/L	UG/L	Water	Standard
82685	PROPARGITE, 0.7 UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
73570	PROPENOIC ACID, 2-METHYL-ETHYL ESTER (2-), TOTAL WATER, UG/L	UG/L	Water	Total
49236	PROPHAM, RECOVERABLE, WATER, FILTER, GF,0.7U, UG/L	UG/L	Water	Standard
38538	PROPOXUR, WATER, DISSOLVED, UG/L	UG/L	Water	Dissolved
49387	PYRENE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
34469	PYRENE, TOTAL WATER, UG/L	UG/L	Water	Total
49392	QUINOLINE, DRY WEIGHT, SEDIMENT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
49961	RADIATION, ALPHA, GROSS, AS TH-230, 2SGMPRCEST, SUSPENDED, SEDIMENT, PCI/G	PCI/G	Sed/soil	Suspended
49960	RADIATION, ALPHA, GROSS, AS TH-230, SUSP SEDIMENT	PCI/G	Sed/soil	Suspended
49965	RADIATION, BETA, GROSS ASCS-137, 2SGMPRCEST, SUSPENDED, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
49964	RADIATION, BETA, GROSS, AS CS-137, SUSPENDED SED	PCI/G	Sed/soil	Suspended
76001	RADIUM 226, 1 SIGMA PRC EST, DISSOLVED,WATER,PCI/L	PCI/L	Water	Dissolved
75943	RADIUM 226, 1 SIGMA PRC EST, SUSPENDED, SEDIMENT	PCI/G	Sed/soil	Suspended

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09510	RADIUM 226, DISSOLVED, PLANCHET COUNT	PCI/L	Water	Dissolved
09511	RADIUM 226, DISSOLVED, RADON METHOD	PCI/L	Water	Dissolved
75944	RADIUM 226, SUSPENDED, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
11504	RADIUM 226 + RADIUM 228,TOTAL,COUNTING ERROR PC/L	PC/L	WATER	Calculated
09507	RADIUM 226 IN SEDIMENT (PC/G OF DRY SOLIDS)	PCI/G	SED/SOIL	Total
09503	RADIUM 226, DISSOLVED	PCI/L	WATER	Dissolved
09501	RADIUM 226, TOTAL	PCI/L	WATER	Total
76000	RADIUM 228, 1 SIGMA PRC EST, DISSOLVED, WATER,PCI/L	PCI/L	Water	Dissolved
75948	RADIUM 228, 1 SIGMA PRC EST, SUSPENDED, SEDIMENT	PCI/G	Sed/soil	Suspended
75937	RADIUM 228, SUSPENDED, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
81366	RADIUM-228, DISSOLVED (PCI/L AS RA-228)	PCI/L	Water	Dissolved
76002	RADON 222, 1 SIGMA PRC EST, TOTAL, WATER, PCI/L	PCI/L	Water	Other
82303	RADON 222, TOTAL IN WATER, PCI/L	PCI/L	Water	Total
00500	RESIDUE, TOTAL (MG/L)	MG/L	Water	Total
00515	RESIDUE, TOTAL FILTRABLE (DRIED AT 105C),MG/L	MG/L	Water	Dissolved
00530	RESIDUE, TOTAL NONFILTRABLE (MG/L)	MG/L	Water	Suspended
70300	RESIDUE,TOTAL FILTRABLE (DRIED AT 180C), MG/L	MG/L	Water	Dissolved
00520	RESIDUE, VOLATILE FILTRABLE (MG/L)	MG/L	WATER	Dissolved
00535	RESIDUE, VOLATILE NONFILTRABLE (MG/L)	MG/L	WATER	Suspended
34947	SCANDIUM, SEDIMENT, BOTTOM DEPOSITS, <63, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
77350	SEC-BUTYLBENZENE TOTAL WATER,UG/L	UG/L	Water	Total
50279	SEDIMENT, SUSPENDED, FLOW-THROUGH CENTRIFUGE	MG/L	Water	Total
01148	SELENIUM, BOTTOM DEPOSITS (MG/KG AS SE DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01145	SELENIUM, DISSOLVED (UG/L AS SE)	UG/L	Water	Dissolved
29847	SELENIUM, SEDIMENT, SUSPENDED UG/G	UG/G	Sed/soil	Suspended
01146	SELENIUM, SUSPENDED (UG/L AS SE)	UG/L	Water	Suspended
01147	SELENIUM, TOTAL (UG/L AS SE)	UG/L	Water	Total
49254	SELENIUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
01323	SELENIUM, POTENTIALLY, DISSOLVED, WATER MG/L	MG/L	WATER	Dissolved
49068	SELENIUM, TOTAL, WATER, TCLP MG/L	MG/L	WATER	Total
50112	SELENIUM,ICAP TEST METHOD, TOTAL RECOVERABLE MG/L	MG/L	WATER	Total
34952	SELENIUM,SED,BOT,<63,DRY SIEVE,LAB,TOTAL	MG/KG	SED/SOIL	Total
34950	SELENIUM,SED,BOT,<63,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Total
00981	SELENIUM,TOTAL RECOVERABLE IN WATER AS SE UG/L	UG/L	WATER	Total
71101	SESTON, ASH FREE WEIGHT (MG/L)	MG/L	Water	Other
71100	SESTON, TOTAL, MG/L	MG/L	Water	Total
00955	SILICA, DISSOLVED (MG/L AS SI02)	MG/L	Water	Dissolved
00956	SILICA, TOTAL (MG/L AS SIO2)	MG/L	WATER	Total
01078	SILVER, BOTTOM DEPOSITS (MG/KG AS AG DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01075	SILVER, DISSOLVED (UG/L AS AG)	UG/L	Water	Dissolved
34957	SILVER, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
29850	SILVER, SEDIMENT, SUSPENDED,UG/G	UG/G	Sed/soil	Suspended
01076	SILVER, SUSPENDED (UG/L AS AG)	UG/L	Water	Suspended
01077	SILVER, TOTAL (UG/L AS AG)	UG/L	Water	Total
49614	SILVER TCLP, ICP, TOTAL, WATER MG/L	MG/L	WATER	Total
49255	SILVER, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
01304	SILVER,POTENTIALLY DISSOLVED WATER MG/L	MG/L	WATER	Dissolved
34957	SILVER,SED,BOT,<63,DRY SIEVE,LAB,TOTAL	MG/KG	SED/SOIL	Total
34955	SILVER,SED,BOT,<63,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Total
01079	SILVER,TOTAL RECOVERABLE IN WATER AS AG UG/L	UG/L	WATER	Total
39761	SILVEX, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39762	SILVEX, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39763	SILVEX, SUSPENDED FRAC. OF WATER, UG/L	UG/L	Water	Suspended
39760	SILVEX, TOTAL WATER, UG/L	UG/L	Water	Total

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39046	SIMAZINE IN, BOTTOM DEPOS	MG/KG	Sed/soil	Calculated
04035	SIMAZINE, DISSOLVED, WATER, TOTAL RECOVERABLE UG/L	UG/L	Water	Dissolved
39025	SIMAZINE,COULSON CONDUCTIVITY,WATER, UG/L	UG/L	Water	Total
04030	SIMETRYN, DISSOLVED, WATER, TOTAL RECOVERABLE UG/L	UG/L	Water	Dissolved
00931	SODIUM ADSORPTION RATIO	NO UNITS	Water	Other
91053	SODIUM, DISOLVED (UG/L AS NA)	UG/L	Water	Standard
00930	SODIUM, DISSOLVED (MG/L AS NA)	MG/L	Water	Dissolved
00932	SODIUM, PERCENT	PERCENT	Water	Calculated
34962	SODIUM, SED, BOT DEP,<63, DRY SIEVE, LAB, TOTAL, PERCENT	PERCENT	Sed/soil	Total
00929	SODIUM, TOTAL (MG/L AS NA)	MG/L	Water	Total
00933	SODIUM, PLUS POTASSIUM (MG/L)	MG/L	Water	Total
34960	SODIUM, SED,BOT,<63,WET SIEVE,FIELD,TOTAL	PERCENT	SED/SOIL	Calculated
82035	SODIUM, TOTAL UG/L (AS NA)	UG/L	WATER	Total
81373	SOLIDS IN SEDIMENT SAMPLEPERCENT DRY WEIGHT	PERCENT	SED/SOIL	Calculated
70348	SOLIDS, SETTLEABLE ML/L	OTHERS	OTHER	OTHER
70299	SOLIDS, SUSP. - RESIDUE ON EVAP. AT 180 C (MG/L)	MG/L	WATER	Suspended
70301	SOLIDS, DISSOLVED-SUM OF CONSTITUENTS (MG/L)	MG/L	Water	Calculated
70303	SOLIDS, DISSOLVED-TONS PER ACRE-FT	TON/A-FT	Water	Standard
70302	SOLIDS, DISSOLVED-TONS PER DAY	TONS/DAY	Water	Dissolved
47004	SOLIDS, TOTAL DISSOLVED (ELECT-CONDUCTIVITY) MG/L	MG/L	Water	Dissolved
99914	SOLIDS, TOTAL SUSP (GRAVIMETRIC), COURSE FRACTION,	MG/L	Water	Suspended
99913	SOLIDS, TOTAL SUSP (GRAVIMETRIC), FINE FRACTION, MG/L	MG/L	Water	Suspended
49901	SOLIDS, TOTAL SUSP (GRAVIMETRIC), SUSPENDED, WATER	MG/L	Water	Suspended
70287	SOLIDS, VOLATILE, UNFILTERED, AT 180 DEG C, MG/L	MG/L	Water	Total
70287	SOLIDS, VOLATILE, UNFILTERED, AT 180 DEG C, MG/L	MG/L	Water	Total
90095	SPECIFIC CONDUCTANCE	UMHOS/CM	Water	Other
00095	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)	UMHOS/CM	Water	Standard
00094	SPECIFIC CONDUCTANCE,FIELD (UMHOS/CM @ 25C)	UMHOS/CM	Water	Standard
00065	STAGE, STREAM (FEET)	FT	Water	Other
00004	STREAM WIDTH (FEET)	FT	Water	Standard
83509	STREAM, WIDTH METER	M	Water	Standard
01080	STRONTIUM, DISSOLVED (UG/L AS SR)	UG/L	Water	Dissolved
34967	STRONTIUM, SED, BOT DEP, <63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
35040	STRONTIUM, SUSPENDED, SEDIMENT UG/G	UG/G	Sed/soil	Suspended
01082	STRONTIUM, TOTAL (UG/L AS SR)	UG/L	Water	Total
49244	STRONTIUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
49071	STRONTIUM, TOTAL, WATER, TCLP	MG/L	WATER	Total
34965	STRONTIUM,SED,BOT,<63,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Total
77128	STYRENE, TOTAL WATER,UG/L	UG/L	Water	Total
00945	SULFATE, TOTAL (MG/L AS SO4)	MG/L	Water	Total
00154	SULFATE (AS S) WHOLE WATER, MG/L	MG/L	WATER	Total
81612	SULFATES IN SEDIMENT SAMPLE	MG/KG	SED/SOIL	Total
00746	SULFIDE, DISSOLVED (MG/L AS S)	MG/L	Water	Dissolved
00745	SULFIDE, TOTAL (MG/L AS S)	MG/L	Water	Total
30308	SULFUR, SEDIMENT, SUSPENDED,PERCENT	PERCENT	Sed/soil	Suspended
00049	SURFACE AREA IN SQUARE MILES	NO UNITS	Water	Standard
34791	SURFACTANTS, AS CTAS, EFFLUENT MG/L	MG/L	E	Dissolved
80154	SUSPENDED SEDIMENT CONCENTRATION, EVAP. AT 110C	MG/L	Water	Suspended
80155	SUSPENDED SEDIMENT DISCHARGE (TONS/DAY)	TONS/DAY	Water	Other
70331	SUSPENDED SEDIMENT, % FINER THAN .062MM SIEVE DIA	PERCENT	Sed/soil	Suspended
70332	SUSPENDED SEDIMENT, % FINER THAN .125MM SIEVE DIA	PERCENT	Sed/soil	Suspended
70333	SUSPENDED SEDIMENT, % FINER THAN .250MM SIEVE DIA	PERCENT	Sed/soil	Suspended
70334	SUSPENDED SEDIMENT, % FINER THAN .500MM SIEVE DIA	PERCENT	Sed/soil	Suspended
70335	SUSPENDED SEDIMENT, % FINER THAN 1.00MM SIEVE DIA	PERCENT	Sed/soil	Suspended

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
34790	SURFACTANTS, AS CTAS, WATER	MG/L	WATER	Total
70337	SUS SED FALL DIA(DISTLD WATER)%FINER THAN .002MM	PERCENT	Sed/soi	Suspended
70338	SUS SED FALL DIA(DISTLD WATER)%FINER THAN .004MM	PERCENT	Sed/soi	Suspended
70339	SUS SED FALL DIA(DISTLD WATER)%FINER THAN .008MM	PERCENT	Sed/soi	Suspended
70340	SUS SED FALL DIA(DISTLD WATER)%FINER THAN .016MM	PERCENT	Sed/soi	Suspended
70341	SUS SED FALL DIA(DISTLD WATER)%FINER THAN .031MM	PERCENT	Sed/soi	Suspended
70331	SUSPENDED SED SIEVE DIAMETER,% FINER THAN .062MM	PERCENT	Sed/soi	Suspended
70336	SUSPENDED SED SIEVE DIAMETER,% FINER THAN 2.00MM	PERCENT	Sed/soi	Suspended
99913	SUSPENDED SEDIMENT CONCENTRATION (GRAVIMETRIC), FINE FRACTION	MG/L	WATER	Suspended
99914	SUSPENDED SEDIMENT CONCENTRATION (GRAVIMETRIC) COARSE FRACTION	MG/L	WATER	Suspended
39741	T (2,4,5-), BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39742	T (2,4,5-), FILTERED, WATER, UG/L	UG/L	Water	Dissolved
39743	T (2,4,5-), SUSPENDED, WATER, UG/L	UG/L	Water	Suspended
39740	T (2,4,5-), TOTAL WATER, UG/L	UG/L	Water	Total
34977	TANTALUM, SEDIMENT, BOTTOM DEPOSITS,<63, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
70301	TDS, SOLIDS, DISSOLVED-SUM OF CONSTITUENTS (MG/L)	MG/L	Water	Calculated
70303	TDS, SOLIDS, DISSOLVED-TONS PER ACRE-FT	TON/A-FT	Water	Standard
70302	TDS, SOLIDS, DISSOLVED-TONS PER DAY	TONS/DAY	Water	Dissolved
47004	TDS, SOLIDS, TOTAL DISSOLVED (ELECT-CONDUCTIVITY)	MG/L	Water	Dissolved
82670	TEBUTHIURON, 0.7 UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
00020	TEMPERATURE, AIR (DEGREES CENTIGRADE)	DEG C	Air	Standard
00021	TEMPERATURE, AIR (DEGREES FAHRENHEIT)	DEG F	AIR	Standard
00010	TEMPERATURE, WATER (DEGREES CENTIGRADE)	DEG C	Water	Total
00011	TEMPERATURE, WATER (DEGREES FAHRENHEIT)	DEG F	Water	Total
82665	TERBACIL, 0.7 UM FILTER, TOTAL RECOV, WATER,UG/L	UG/L	Water	Standard
82675	TERBUFOS, 0.7 UM FILTER, TOTAL RECOV, WATER,UG/L	UG/L	Water	Standard
04022	TERBUTHYLAZINE, DISSOLVED, WATER, TOTAL RECOV, UG/L	UG/L	Water	Dissolved
49278	TERPHENYL,D14-, DRY WEIGHT, SIEVE	PERCENT	Sed/soil	Calculated
77353	TERT-BUTYLBENZENE TOTAL WATER, UG/L	UG/L	Water	Total
77562	TETRACHLOROETHANE (1,1,1,2-), TOTAL WATER, UG/L	UG/L	Water	Total
34516	TETRACHLOROETHANE (1,1,2,2-), TOTAL WATER, UG/L	UG/L	Water	Total
34475	TETRACHLOROETHYLENE,TOTAL WATER, UG/L	UG/L	Water	Total
81607	TETRAHYDROFURAN, TOTAL WATER, UG/L	UG/L	Water	Total
34480	THALLIUM, DRY WEIGHT, BOTTOM DEPOSITS, MG/KG	MG/KG	Sed/soil	Calculated
01057	THALLIUM, DISSOLVED (UG/L AS TL)	UG/L	Water	Dissolved
49955	THALLIUM, SUSPENDED, SEDIMENT UG/G	UG/G	Sed/soil	Suspended
01059	THALLIUM, TOTAL (UG/L AS TL)	UG/L	Water	Total
00982	THALLIUM, TOTAL RECOVERABLE IN WATER AS TL UG/L	UG/L	WATER	Total
49072	THALLIUM, TOTAL, WATER, TCLP MG/L	MG/L	WATER	Total
82681	THIOBENCARB, 0.7 UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
75997	THORIUM 230, 1 SIGMA PRC EST,DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
75952	THORIUM 230, 1 SIGMA PRC EST,SUSP, SEDIMENT,PCI/G	PCI/G	Sed/soil	Suspended
26503	THORIUM 230, DISSOLVED	PCI/L	Water	Dissolved
75939	THORIUM 230, SUSPENDED, SEDIMENT, PCI/G	PCI/G	Sed/soil	Suspended
75936	THORIUM 232, 1 SIGMA PRC EST, SUSP, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
75999	THORIUM 232, 1 SIGMA PRC EST,DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
75976	THORIUM 232, DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
75953	THORIUM 232, SUSPENDED, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
34982	THORIUM, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
82365	THORIUM, DISSOLVED IN WATER	UG/L	WATER	Dissolved
82366	THORIUM, SUSPENDED IN WATER	UG/L	WATER	Suspended
34980	THORIUM,SED,BOT,<63,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Dissolved

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
01100	TIN, DISSOLVED (UG/L AS SN)	UG/L	WATER	Dissolved
34985	TIN,SED,BOT,<63,WET SIEVE,FIELD,TOTAL	MG/KG	SED/SOIL	Dissolved
34987	TIN, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL UG/G	UG/G	Sed/soil	Dissolved
01150	TITANIUM, DISSOLVED (UG/L AS TI)	UG/L	Water	Dissolved
34992	TITANIUM, SED, BOT DEP,<63, DRY SIEVE, LAB, TOTAL, %	PERCENT	Sed/soil	Dissolved
30317	TITANIUM, SEDIMENT, SUSPENDED, PERCENT	PERCENT	Sed/soil	Suspended
01152	TITANIUM, TOTAL (UG/L AS TI)	UG/L	Water	Total
49395	TOLUENE, 2,4-DINITRO-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
49396	TOLUENE, 2,6-DINITRO-, DRY WEIGHT, SIEVE	UG/KG	Sed/soil	Calculated
34010	TOLUENE, WATER, GC-MS, HEXADECONE EXTR., UG/L	UG/L	Water	Total
81951	TOTAL ORGANIC CARBON (TOC), SEDIMENT DRY WT MG/KG	MG/KG	Sed/soil	Calculated
99893	TOTAL PHOSPHORUS, DISSOLVED	MG/L	Water	Dissolved
99891	TOTAL PHOSPHORUS, TOTAL	MG/L	Water	Total
39403	TOXAPHENE, BOTTOM DEPOSITS (UG/KG DRY SOL.)	UG/KG	Sed/soil	Calculated
39401	TOXAPHENE, FILTERED FRAC. OF WATER, UG/L	UG/L	Water	Dissolved
39400	TOXAPHENE, TOTAL WATER, UG/L	UG/L	Water	Total
49355	TOXAPHENE, WET WEIGHT,TISSUE,WHOLE ORG,RECV	MG/KG	SED/SOIL	Dissolved
49351	TOXAPHENE,DRY WEIGHT,SEDIMENT,SIEVE	PERCENT	WATER	Calculated
34546	TRANS-1,2-DICHLOROETHENE, TOTAL, WATER, UG/L	UG/L	Water	Total
34699	TRANS-1,3-DICHLOROPROPENE TOTAL, WATER UG/L	UG/L	Water	Total
00077	TRANSPARENCY, SECCHI DISC (INCHES)	IN	Water	Standard
00078	TRANSPARENCY, SECCHI DISC (METERS)	M	Water	Standard
49701	TRANSPARENCY, SECCHI DISK, WATER FT	FT	Water	Standard
82678	TRIALLATE, 0.7 UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
77652	TRICHLORO-1,2,2-TRIFLUOROET (1,1,2-), TOTAL WATER	UG/L	Water	Total
50283	TRICHLORO-1,2,2-TRIFLUOROETHANE (1,1,2-), WATER, UNFILTERED, N2ATM PG/KG	PG/KG	Water	Total
99941	TRICHLORO-1,2-DIFLUOROETHANE (1,2,2-), UG/L	UG/L	Water	Standard
77613	TRICHLOROBENZENE (1,2,3-), TOTAL WATER, UG/L	UG/L	Water	Total
34551	TRICHLOROBENZENE (1,2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
34506	TRICHLOROETHANE (1,1,1-), TOTAL WATER, UG/L	UG/L	Water	Total
34511	TRICHLOROETHANE (1,1,2-), TOTAL WATER, UG/L	UG/L	Water	Total
39180	TRICHLOROETHYLENE-TOTAL WATER-UG/L	UG/L	Water	Total
34488	TRICHLOROFLUOROMETHANE, TOTAL WATER, UG/L	UG/L	Water	Total
50281	TRICHLOROFLUOROMETHANE, WATER, UNFILTERED, N2 ATM,PG/KG	PG/KG	Water	Total
34621	TRICHLOROPHENOL (2,4,6-),TOTAL WATER, UG/L, UG/L	UG/L	Water	Total
77443	TRICHLOROPROPANE (1,2,3-), TOTAL WATER, UG/L	UG/L	Water	Total
49235	TRICLOPYR, RECOVERABLE, WATER, FILTERED, GF,0.7U,UG/L	UG/L	Water	Standard
82661	TRIFLURALINE, 0.7UM FILTER, TOTAL RECOV, WATER, UG/L	UG/L	Water	Standard
77222	TRIMETHYLBENZENE (1,2,4-), TOTAL WATER, UG/L	UG/L	Water	Total
77226	TRIMETHYLBENZENE (1,3,5-), TOTAL WATER, UG/L	UG/L	Water	Total
77221	TRIMETHYLBENZENE(1,2,3-), TOTAL WATER, UG/L	UG/L	Water	Total
39787	TRITHION, BOTTOM DEPOSITS, DRY SOLIDS, UG/KG	UG/KG	Sed/soil	Calculated
39786	TRITHION, TOTAL WATER, UG/L	UG/L	Water	Total
07000	TRITIUM (1H3), TOTAL (PICOCURIES/LITER)	PCI/L	Water	Total
75985	TRITIUM, 1 SIGMA PRC EST, TOTAL, WATER, PCI/L	PCI/L	Water	Standard
99914	TSS, SOLIDS, TOTAL SUSP (GRAVIMETRIC), COURSE FRACT	MG/L	Water	Suspended
99913	TSS, SOLIDS, TOTAL SUSP (GRAVIMETRIC), FINE FRACTION	MG/L	Water	Suspended
49901	TSS, SOLIDS, TOTAL SUSP (GRAVIMETRIC), SUSP, WATER	MG/L	Water	Suspended
00070	TURBIDITY, (JACKSON CANDLE UNITS)	OTHERS	Water	Other
82078	TURBIDITY, FIELD NEPHELOMETRIC TURBIDITY UNITS,NTU	NTU	Water	Total
00076	TURBIDITY, HACH TURBIDIMETER (FORMAZIN TURB UNIT)	NTU	Water	Standard
00075	TURBIDITY, HELLIGE (PPM AS SILICON DIOXIDE)	MG/L	Water	Other

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
82079	TURBIDITY, LAB NEPHELOMETRIC TURBIDITY UNITS, NTU	NTU	Water	Total
75992	URANIUM 234, 1 SIGMA PRC EST, DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
75941	URANIUM 234, 1 SIGMA PRC EST, SUSPENDED, SED, PCI/G	PCI/G	Sed/soil	Suspended
22610	URANIUM 234, DISSOLVED, PCI/L	PCI/L	Water	Dissolved
75942	URANIUM 234, SUSPENDED, SEDIMENT PCI/G	PCI/G	Sed/soil	Suspended
75994	URANIUM 235, 1 SIGMA PRC EST, DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
75947	URANIUM 235, 1 SIGMA PRC EST, SUSPENDED, SED PCI/G	PCI/G	Sed/soil	Suspended
22620	URANIUM 235, DISSOLVED, PCI/L	PCI/L	Water	Dissolved
75975	URANIUM 235, SUSPENDED, WATER PCI/L	PCI/L	Water	Suspended
75991	URANIUM 238, 1 SIGMA PRC EST, DISSOLVED, WATER PCI/L	PCI/L	Water	Dissolved
22603	URANIUM 238, DISSOLVED, PCI/L	PCI/L	Water	Standard
75940	URANIUM 238, SUSPENDED, SEDIMENT, PCI/G	PCI/G	Sed/soil	Suspended
80015	URANIUM, DISSOLVED, EXTRACTION FLUOROMETRIC, PCI/L	PCI/L	Water	Dissolved
80020	URANIUM, DISSOLVED, EXTRACTION FLUOROMETRIC, UG/L	UG/L	Water	Dissolved
75990	URANIUM, NATURAL, 1 SIGMA PRC EST, DISS, WATER,UG/L	UG/L	Water	Calculated
75993	URANIUM, NATURAL, 1 SIGMA PRC EST, TOTAL, WATER	UG/L	Water	Total
22703	URANIUM, NATURAL, DISSOLVED	UG/L	Water	Dissolved
28011	URANIUM, NATURAL, TOTAL,UG/L AS U	UG/L	Water	Total
35002	URANIUM, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
35046	URANIUM, SUSPENDED, SEDIMENT UG/G	UG/G	Sed/soil	Suspended
04113	URANIUM-238, 2 SIGMA PRECISION, DRY WT, SEDIMENT	PCI/G	Sed/soil	Calculated
22612	URANIUM 235,IN SEDIMENT	MG/KG	SED/SOIL	Total
75962	URANIUM 238,1 SIGMA PRC EST,SUSP,SEDIMENT	PCI/G	SED/SOIL	Suspended
75940	URANIUM 238,SUSPENDED,SEDIMENT	PCI/G	SED/SOIL	Suspended
49257	URANIUM, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
22708	URANIUM, NATURAL TOTAL MG/L	MG/L	WATER	Total
22703	URANIUM, NATURAL, DISSOLVED	UG/L	WATER	Dissolved
80010	URANIUM,DISS.,BY DIRECT FLUOROMETRIC METHOD	PCI/L	WATER	Dissolved
01085	VANADIUM, DISSOLVED (UG/L AS V)	UG/L	Water	Dissolved
35007	VANADIUM, SEDIMENT, BOTDEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
29853	VANADIUM, SEDIMENT, SUSPENDED UG/G	UG/G	Sed/soil	Suspended
35000	URANIUM, SED, BOT, <63, WET SIEVE, FIELD, TOTAL	MG/KG	SED/SOIL	Total
04113	URANIUM-238, 2 SIGMA PRECISION, DRY WEIGHT, SED	PCI/G	SED/SOIL	Total
01087	VANADIUM, TOTAL	UG/L	WATER	Total
49465	VANADIUM, BIOTA, TISSUE, LIVER, DRY WEIGHT, RECV	MG/KG	TISSUE	Total
35005	VANADIUM, SED, BOT, <63, WET SIEVE, FIELD, TOTAL	MG/KG	SED/SOIL	Total
00055	VELOCITY, STREAM FT/SEC	FT/SED	WATER	Calculated
39175	VINYL CHLORIDE, TOTAL WATER, UG/L	UG/L	Water	Total
49273	WATER PRESENT, DRY WT, TISSUE/BIOTA, LIVER RECV	PERCENT	WATER	Calculated
00041	WEATHER (WMO CODE 4501)	NO UNITS	Other	Standard
00009	X-SEC. LOC. (FT FROM LEFT BANK LOOKING DOWNSTREAM)	FT	Water	Other
81551	XYLENE, TOTAL WATER, UG/L	UG/L	Water	Total
85795	XYLENE, META & PARA, WATER, TOTAL, UG/L	UG/L	Water	Total
34020	XYLENES, WATER, GC-MS, HEXADECONE EXTR., UG/L	UG/L	Water	Total
49421	XYLENOL, 3,5-, DRY WEIGHT, SIEVE, UG/KG	UG/KG	Sed/soil	Calculated
35017	YTTERBIUM, SED, BOT DEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
35012	YTTRIUM, SED, BOT DEP,<63, DRY SIEVE, LAB, TOTAL, UG/G	UG/G	Sed/soil	Dissolved
01093	ZINC, BOTTOM DEPOSITS (MG/KG AS ZN DRY WEIGHT)	MG/KG	Sed/soil	Calculated
01090	ZINC, DISSOLVED (UG/L AS ZN)	UG/L	Water	Dissolved
35022	ZINC, SEDIMENT, BOT DEP,<63, DRY SIEVE, LAB, TOTAL	UG/G	Sed/soil	Dissolved
29855	ZINC, SEDIMENT, SUSPENDED, UG/G	UG/G	Sed/soil	Suspended
01091	ZINC, SUSPENDED (UG/L ZN)	UG/L	Water	Suspended
01092	ZINC, TOTAL (UG/L AS ZN)	UG/L	Water	Total
49245	ZINC, DRY WEIGHT, TISSUE/BIOTA, RECV	MG/KG	TISSUE	Total
50117	ZINC, ICAP TEST METHOD, TOTAL RECOVERABLE	MG/L	WATER	Total

STORET CODE	PARAMETER NAME	UNIT	MEDIA	ANALYSIS TYPE
01303	ZINC, POTENTIALLY DISSOLVED WATER MG/L	MG/L	WATER	Dissolved
35020	ZINC, SED, BOT, <63, WET SIEVE, FIELD, TOTAL	MG/KG	SED/SOIL	Total
01094	ZINC, TOTAL RECOVERABLE IN WATER AS ZN UG/L	UG/L	WATER	Total
01160	ZIRCONIUM, DISSOLVED (UG/L AS ZR)	UG/L	WATER	Dissolved

APPENDIX E QUERYING DATA USING MICROSOFT ACCESS

This procedure will enable you to query any field in any combination and filter data to get the results you want.

A FEW IMPORTANT THINGS TO KNOW

The relationships and some basic queries are already set up in the "Live WQDB.mxd" project in access. The linked WQDB tables are located under the "Tables" object on the left. Relationships between the tables can be viewed by clicking the relationship button .  .

Many of the existing queries are based off of the query called SW-BASIC.

Two important fields have been added. NewResult and NewDetectionLimit are numeric fields while Result and Detection Limit are text fields. Use the NewResult and NewDetectionLimit fields when running queries that require numbers (like Arsenic > 0.01 mg/L).

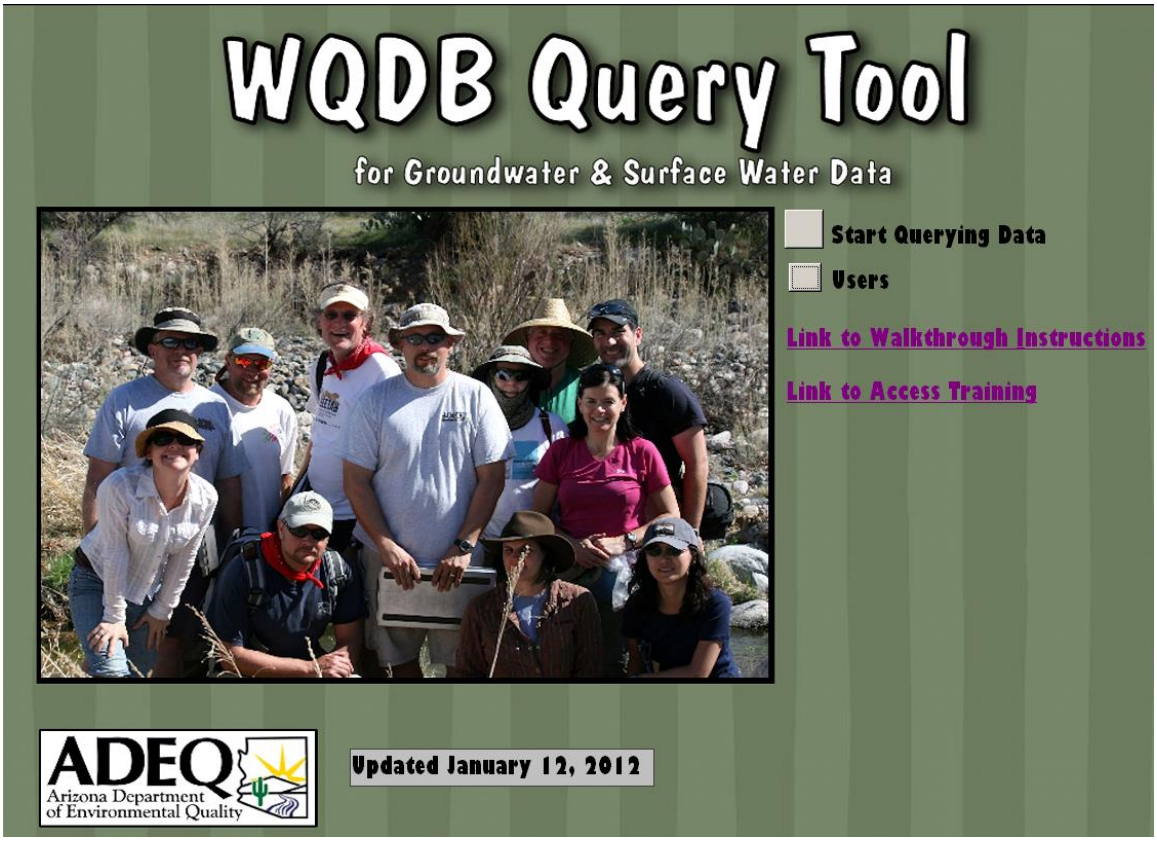
This query tool uses a naming convention to make finding a query easier. SW = Surface Water. GW = Groundwater. zz = a subquery.

BASIC NAVIGATION

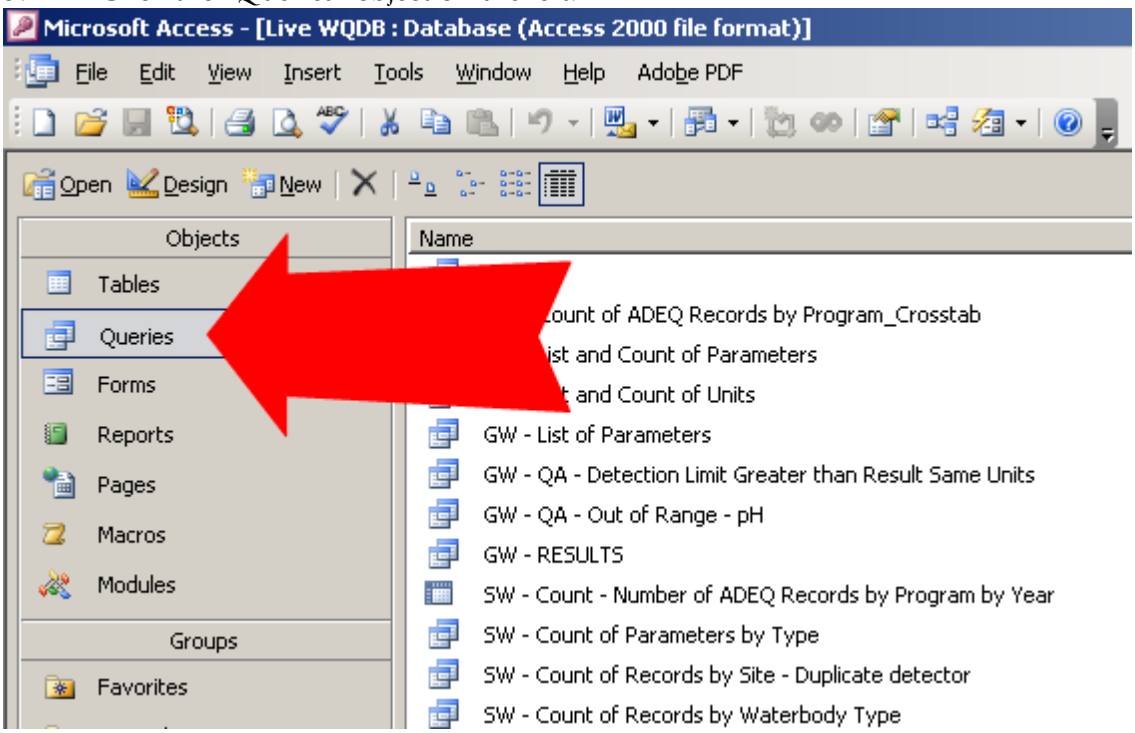
1. Navigate to "Live WQDB.mdb" located at J:\WQD\Surface Water Section\Monitoring Unit

Save a copy of the Live WQDB.mdb to your computer so that you don't muck up things for other users.

2. Open the "Live WQDB". You'll see a splash screen with some useful links when you start the database. Click "Start Querying Data".

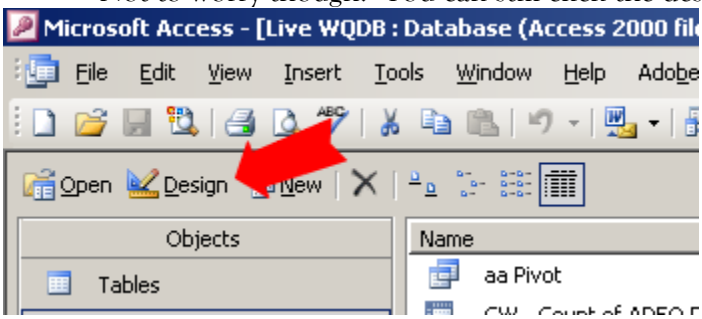


3. Click the "Queries" object on the left.

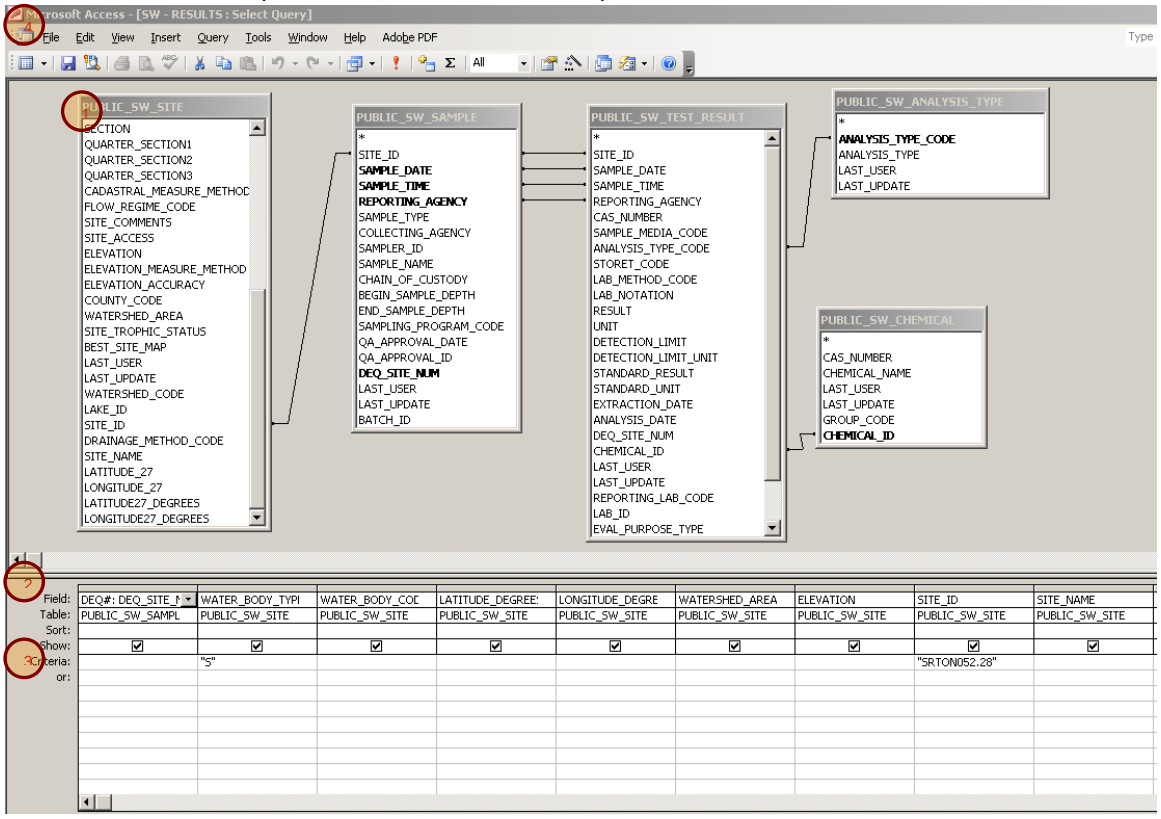


4. Single Click the SW – BASIC for surface water data or single click GW – BASIC for groundwater data.

5. Click Design. This allows you to specify criteria. If you double clicked you run the query. Not to worry though. You can still click the design button (upper left).



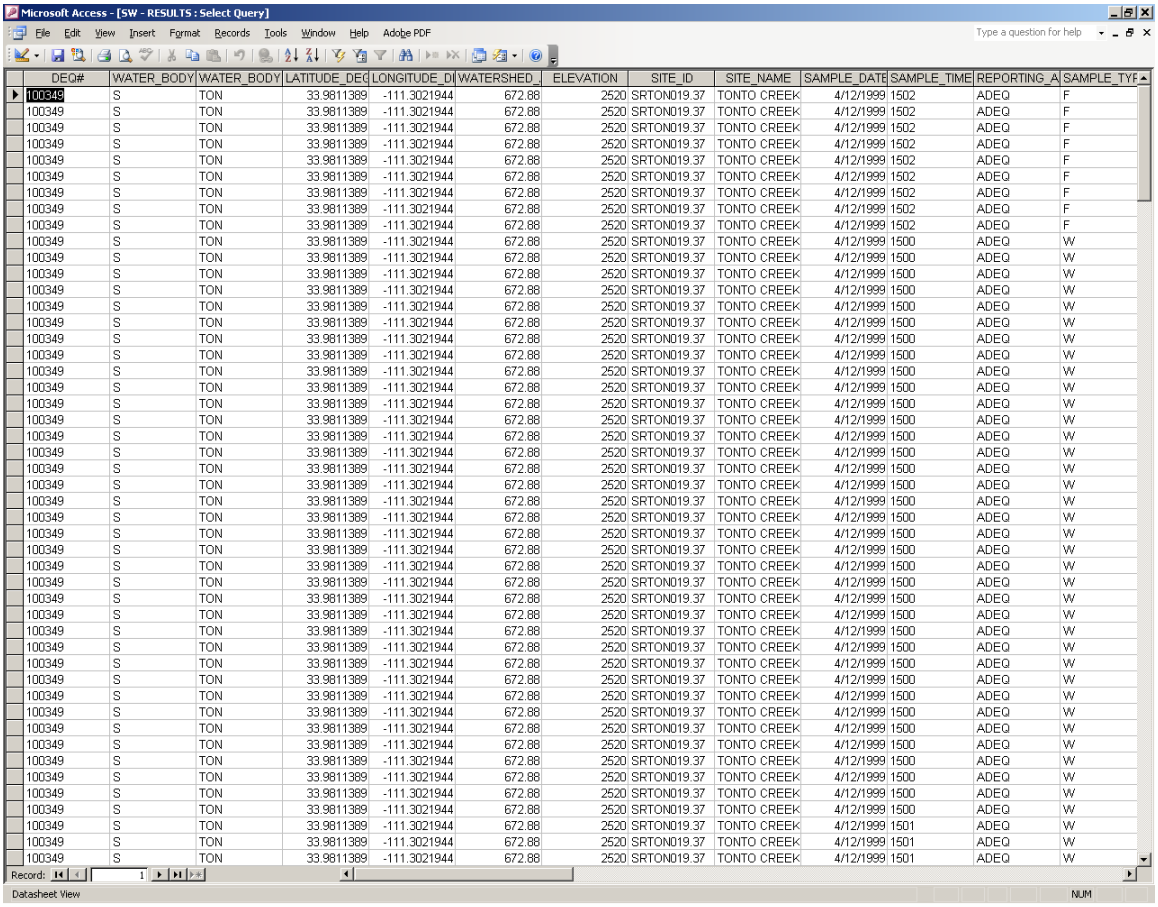
6. Access takes you here. These are the key features.



Features:

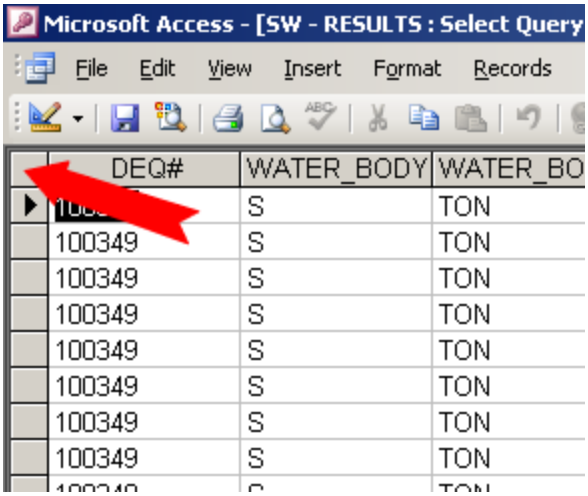
1) Tables in the query and how they are related. All available fields are listed.
2) Fields in your query. Common fields are already populated. Do you want one that isn't listed? Just drag and drop a field from the tables above (1) down to the fields below (2)
3) Criteria. This row lets you pick how to filter the data. The example above will query data that has a water body code of "S" for stream for the site_ID SRTON052.28. See "Examples of criteria" below for additional information.
4) This button runs your query. 

7. This is what you see when you run your query.



8. To return to your query you can click the design button  .
9. To export your data to excel select all the records by clicking on the upper left hand cell.

Don't do this if you have more than 66,000 records. Excel 2003 can't handle that much data on one sheet.



10. Copy the data by hitting CTRL+C. Depending on the amount of data selected this may take a minute or two.
11. Paste it into excel CTRL+V.

Always check your query against the WQDB and make sure that the records match up. If your relationships are wrong, your query will be too. Also missing data can impact your query. For example if staff don't enter "AMB" for the sample program, you will not get all the available data.

APPENDIX F BASIC DATA MANIPULATION

The WQDB, Microsoft Query and the Water Quality data warehouse will give you data in a row format such as:

SITE_ID	Date	LN	Result	RESULT	UNIT	CHEMICAL_NAME
LCBEN002.57	11/15/2006	ND				ALKALINITY, PHENOLPHTHALEIN
LCBEN002.57	11/15/2006		0.039	0.039	MG/L	AMMONIA AS NITROGEN
LCBEN002.57	11/15/2006	ND				ANTIMONY - TOTAL
LCBEN002.57	11/15/2006	ND				ANTIMONY - DISSOLVED
LCBEN002.57	11/15/2006	ND				ARSENIC, INORGANIC
LCECL021.13	11/14/2006		137	137	UMHOS/CM	LAB SPECIFIC CONDUCTIVITY
LCECL021.13	11/14/2006		160	160	UMHOS/CM	FIELD SPECIFIC CONDUCTIVITY
LCECL021.13	11/14/2006		44	44	FT	STREAM WIDTH
LCECL021.13	11/14/2006	ND				SULFATE
LCECL021.13	11/14/2006		6	6	MG/L	SUSPENDED SOLIDS / SEDIMENTS

TABLE 1. Unformatted data from the WQDB in a row format.

It is helpful to manipulate this kind of data into a tabular format so that each column is a different parameter. This enables easy analysis using programs such as Arc Map and SYSTAT (TABLE 2).

SITEID	SAMPDATE	HARDCACO3 (mg/L)	ALKCACO3 (mg/L)	CA-T (mg/L)	CHLORIDE (mg/L)	DO- (mg?l)	DO- (%)
LCBEN002.57	11/15/2006	85.0	110.0	21.0	ND	9.00	79.9
LCBEN002.57	4/5/2007	64.0	77.0	15.0	ND	8.29	75.6
LCBEN002.57	5/9/2007	58.0	73.0	13.0	ND	9.33	73.2
LCBRB000.27	11/14/2006	58.0	57.0	11.0	0.5	10.03	106.3
LCBRB000.27	5/1/2007	39.0	37.0	8.3	ND	11.41	107.1
LCBRB000.27	5/16/2007	50.0	52.0	11.0	ND	7.39	89.4
LCBRB006.74	11/28/2006	77.0	76.0	16.0	0.5	8.90	88.3
LCBRB006.74	6/18/2007	43.0	46.0	9.0	ND	8.83	93.2
LCCHC060.61	11/15/2006	120.0	130.0	30.0	0.5	9.46	97.3
LCCHC060.61	4/25/2007	81.0	87.0	20.0	12	11.15	117.0
LCCHC081.26	11/15/2006	120.0	130.0	29.0	0.5	7.37	71.9

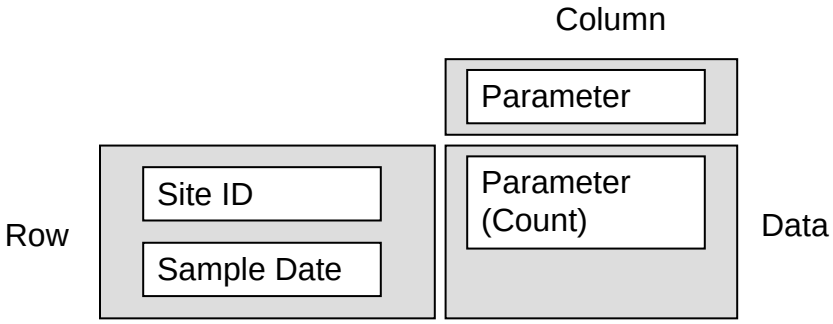
TABLE 2. Formatted data in a tabular or columnar format after it has been manipulated.

GETTING THE DATA INTO THE "RIGHT" FORMAT

Excel has a powerful tool called a Pivot Table. This tool enables you to organize large quantities of data quickly. One limitation of a Pivot Table is that it really wants to summarize data, which isn't something we want when it comes to displaying results for water chemistry. In order to work around this issue each parameter must be made to be unique. For example, you must distinguish between total and dissolved antimony or field and lab specific conductivity to make this transformation work. We could use STORET numbers to accomplish this, but the problem is that no one knows what that number means without looking it up in a table. This method gives you a descriptive name for each parameter that we'll use later.

MAKING EACH PARAMETER UNIQUE

1) In Excel, add a new column to the right of "CHEMICAL NAME" and call it "Parameter".
2) Sort by lab method code.
3) Add the formula =CONCATENATE(N2, " ",H2). This should combine the "chemical name" field with the "analysis type". This solves problems with total and dissolved metals.
4) Use the fill down function (CTRL+D) to add to all selected records. Select the column Parameter. CTRL+C. Right Click. Paste Special. Check "values". Paste. This gets rid of the formula.
5) Sort by "EVAL_PURPOSE_TYPE".
6) Concatenate "Parameter" with "Eval_Purpose_Type". This solves duplicate versus regular samples.
7) Use the fill down function (CTRL+D) to add to all selected records. Select the column Parameter. CTRL+C. Right Click. Paste Special. Check "values". Paste. This gets rid of the formula.
8) Concatenate "Parameter" with "Lab_Method_Code".
9) The goal is to verify that each chemical name is unique. Create a pivot table from your data by going to "Data" → "Pivot Table and Pivot Chart Report". Go through the wizard using the default settings (as long as all of your data is selected you should be ok). Set up the pivot table the following way. **All the numbers should be 1**. If not then double click on the number greater than one to see what the problem is. If you are not very familiar with how pivot tables work, you can get up to speed at: http://office.microsoft.com/en-us/training/CR061831141033.aspx



ADDING A NEGATIVE TO THE LONGITUDE FIELD

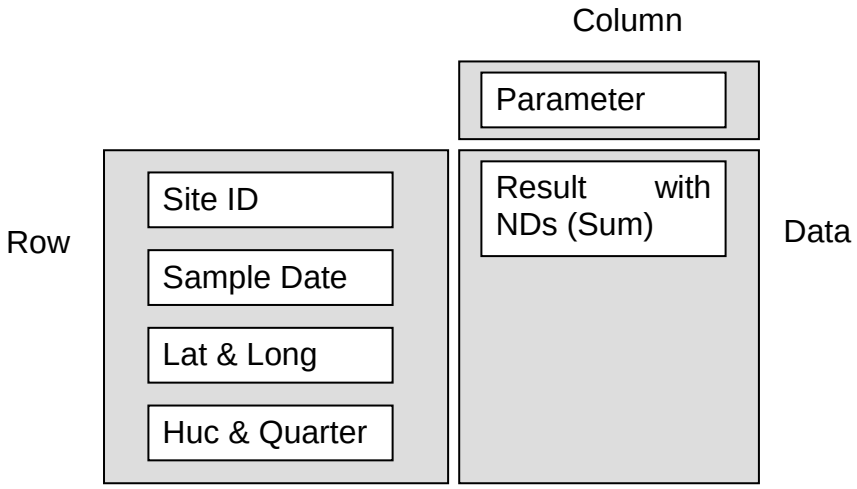
ArcMap likes to have a negative value for the longitude field.

1) Add a column to the right of "LONGITUDE_DEGREES". Call it "Longitude"
2) Insert the formula "=-B2". Fill down. Replace formulas with values.
3) Delete the "LONGITUDE_DEGREES" column.

If you are going to use the data for statistical analysis you should consider how to handle your non-detect values now. Some people use 50% of the detection limit and place use that value when running statistical tests. USGS has developed a more complicated procedure for dealing with this problem. Statistical analysis is beyond the scope of this procedures manual.

CREATE A PIVOT TABLE TO DISPLAY YOUR RESULTS

1) Select all records.
2) Create a pivot table from your data by going to "Data" → "Pivot Table and Pivot Chart Report". Go through the wizard using the default settings (as long as all of your data is selected you should be ok). Set up the pivot table the following way. We use the "sum" function because there is only one value in each cell, which is why it was important to create unique records earlier. You could also use the average function.



3) Hide all totals and grand totals by right clicking on them and clicking "hide".

PREPARING TO IMPORT YOUR DATA

1) Copy the values in the Pivot Table to a new sheet. CTRL+A, CTRL+C, go to new workbook. Right click, Paste Special. Check Values (this is the important part). Paste.
2) Delete extra rows (rows 1 to 3).
3) Format the cells for each column and pick the maximum number of decimal points displayed for each column. Format the date as a number with no decimals.
4) Fill down all the site_IDs, dates, lat and longs for each site.
5) Change each parameter name to something simple and short such as in TABLE 3. Note all Duplicates with DUP as a suffix. Pick shorter names for all habitat values.

From WQDB and Excel	Change to:
LATITUDE_DEGREES	Latitude
Longitude	Longitude
SAMPLE_DATE	SampleDate
ALKALINITY, PHENOLPHTHALEIN TOTAL	Alk-Pheno
AMMONIA AS NITROGEN TOTAL	NH3
ANTIMONY DISSOLVED	SbD
ANTIMONY TOTAL	SbT
ARSENIC, INORGANIC DISSOLVED	AsD
ARSENIC, INORGANIC TOTAL	AsT
BERYLLIUM AND COMPOUNDS DISSOLVED	BeD
BERYLLIUM AND COMPOUNDS TOTAL	BeT
BORON (BORON AND BORATES ONLY) TOTAL	BT
CADMIUM DISSOLVED	CdD
CADMIUM TOTAL	CdT

From WQDB and Excel	Change to:
CALCIUM CARBONATE STANDARD	HardCOCO3
CALCIUM CARBONATE TOTAL	AlkCOCO3
CALCIUM TOTAL	CaT
CARBONATE TOTAL	CO3
CHLORIDE TOTAL	Cl
CHROMIUM TOTAL	CRT
COPPER DISSOLVED	CuD
COPPER TOTAL	CuT
FLUORIDE TOTAL	FT
HARDNESS (CACO3 + MGCO3) CALCULATED	HardCal
HYDROGEN CARBONATE TOTAL	HCO3
KJELDAHL NITROGEN TOTAL	TKN
LEAD AND COMPOUNDS (INORGANIC) DISSOLVED	PbD
LEAD AND COMPOUNDS (INORGANIC) TOTAL	PbT
MAGNESIUM TOTAL	MgT
MANGANESE TOTAL	MnT
MERCURY, ELEMENTAL DISSOLVED	HgD
MERCURY, ELEMENTAL TOTAL	HgT
NITRATE + NITRITE TOTAL	NitrateNitrite
NITRATE AS N TOTAL	Nitrate
NITRITE AS N TOTAL	Nitrite
PH TOTAL	pHLab
PHOSPHORUS TOTAL	PT
POTASSIUM TOTAL	KT
SELENIUM AND COMPOUNDS TOTAL	SeT
SODIUM TOTAL	NaT
SPECIFIC CONDUCTIVITY STANDARD	SpCondLab
SULFATE TOTAL	SO4
SUSPENDED SOLIDS / SEDIMENTS SUSPENDED	SSC
SUSPENDED SOLIDS / SEDIMENTS SUSPENDED - COARSE FRACTION	SSCCourse
SUSPENDED SOLIDS / SEDIMENTS SUSPENDED - FINE FRACTION	SSCFine
TOTAL DISSOLVED SOLIDS DISSOLVED	TDSLab
ZINC DISSOLVED	ZnD
ZINC TOTAL	ZnT
E. COLI FIELD	Ecoli
STREAM WIDTH FIELD	StreamWidth
DEPTH FIELD	StreamDepth
FLOW FIELD	Flow-ft/s
CROSS-SECTIONAL AREA FIELD	Crossarea
E. COLI FIELD TOTAL	Ecoli
TEMPERATURE FIELD STANDARD	Temp-Air
TEMPERATURE FIELD TOTAL	Temp-Water
DISSOLVED OXYGEN FIELD DISSOLVED	DO-mg/l
DISSOLVED OXYGEN FIELD STANDARD	DO-%
TOTAL DISSOLVED SOLIDS FIELD DISSOLVED	TDS-Field
SPECIFIC CONDUCTIVITY FIELD STANDARD	SpCond-Field
PH FIELD TOTAL	Ph-Field

From WQDB and Excel	Change to:
TURBIDITY FIELD STANDARD	Turbidity

6) Maximize all column widths.

IMPORTING DATA INTO ARCMAP

1) Select the Latitude and Longitude columns.
2) Select all the data you want to export.
3) Save the file as a DBF4 file. DBF's are very picky. Here are some things to keep in mind:
   A) Maximize all columns and make sure your column names are unique and under 8 characters
   B) Make sure you specify the number of decimal places for each column.
   C) Make sure all results are displayed as numbers
   D) If you are importing a column that has a blank value at the top and it is supposed to be numeric you will need to put a "0" at the top. Otherwise it will be converted into a text file. You will need to remember a "0" is equivalent to a blank when displaying your data. In other words, only values with a nonzero number were sampled.
4) Open your map in ArcMap. Be sure you already have stuff loaded such as the watersheds. This establishes the datum in NAD83.
5) Using Arc Catalog, import the DBF file into arcmap by dragging and dropping into the layers panel.
6) Right click on the table in the layer panel in ArcMap and select "Display X Y Data". Longitude should be in the x field, latitude in the y field.
7) All of our data is in NAD83. Under "Coordinate System of Input Coordinates" select Edit. Click Geographic Coordinates → North America → North American Datum 1983. Click OK on all screens.
8) Your data should be displayed on the map. If not you may need to readjust column names in the DBF table or format the lat/long fields correctly. Sometime you need to tinker with it to get it to load properly.
9) Once you get it loaded you should create a shapefile and make it permanent. To do this right click on the newly displayed cover. Select Export Data. Chose a great place on your computer and name the shapefile. You can now remove the DBF table from your map.

IMPORTING DATA INTO SYSTAT

1) Open SYSTAT. Make sure your Excel file is closed or SYSTAT won't be able to open it.
2) Go to "File" > "Open" > Data.
3) Select "excel" for the file type. Pick the excel file you saved earlier. Pick the sheet with the formatted data. Remember don't try and import the pivot table. You want to import the table with the data already formatted.

APPENDIX G SEPTIC SYSTEM DETECTION USING OPTICAL BRIGHTENERS

Monitoring for optical brighteners can be used to determine whether inadequate septic systems or other domestic wastewater discharges are impacting surface water quality. Optical brighteners are fluorescent white dyes that are added to almost all laundry soaps and detergents and are therefore found in domestic wastewaters that include laundry effluent. When optical brighteners are applied to cotton fabrics, they absorb ultraviolet rays in sunlight and release them as blue rays. These blue rays interact with the natural yellowish color of cotton to give the appearance of being "whiter than white."

Optical brighteners are removed from surface water by absorption onto soil and organic materials and by photo decay (exposure to sunlight). The recovery of optical brighteners in surface water or ground water is direct evidence that the cleansing of wastewater is ineffective.

It is recommended that discharge measurements be taken when deploying the sample kits.

EQUIPMENT

The following equipment is needed to collect optical brightener samples:

Equipment	Use
Rigid, non-metal or vinyl coated racks	Holds cotton pad in the water
Stakes and ties	Secure racks in the stream and secure pad in the rack
Cotton pads	Collects optical brighteners
Hammer	Pound stakes into stream bed
Disposable gloves	When handling racks and pads
Waders or rubber boots (optional)	
Flagging	Mark sites – have to locate a week later
Knife	Remove ties or fishing line
Plastic bags	For cotton pads once collected
Waterproof marker	Label plastic bags with sample site info
Black plastic lined box or other darkened container	Transportation of samples back to lab
Monofilament line (fishing line) and pins	Drying cotton pads
Ultra-violet light, darkened room (Colilert reading equipment works well)	Look for fluorescence

Before going in the field, check that equipment is clean and that the cotton pads and equipment do not fluoresce under ultra-violet light conditions.

PLACEMENT

Optical brightener sampling is best suited for small streams and drainages under base flow conditions (primarily ground water). Larger volumes of water (ponds, lakes, rivers, or runoff conditions) will likely dilute the concentration of optical brighteners to such a degree that it cannot be qualitatively detected. This is a presence / absence test.

Use disposable plastic gloves to secure a cotton pad in a clean wire rack using plastic ties.

Use metal stake, ties, or monofilament fishing line so the sampling rack holding the cotton pad will remain:

- Securely in place while allowing water to easily pass through it.
- Submerged within the flow of water for the next week.
- In a shaded location (sunlight naturally decays the brighteners).
- Almost invisible to a casual passerby.

Mark the site with flagging tape so you will be able to find it in a week. Avoid placing the kits where a passerby may notice it, as they may tamper with the equipment.

The optical brightener sample is generally exposed for seven (7) days to allow sufficient time for contact with optical brighteners. If background interference (sediment, algae, rust) or drying conditions occur, the exposure time can be shortened. The exposure time can also be lengthened.

SUPPORTING DATA

The reliability and sensitivity of this testing procedure, and conditions needed to detect optical brighteners in Arizona's surface waters, are still being evaluated; therefore, other supporting data and information will be needed to properly interpret the optical brightener positive/negative tests. Collect and record the following additional information:

- Flow data at each site when placing the sample kits.
- *E. coli* bacteria samples.
- Total nitrogen (TKN + nitrite/nitrate) and total phosphorus.
- Weather conditions when setting and information concerning weather during the time the kits were exposed.
- Change in flow during the week (qualitative only).
- Field observations concerning sources.

If this is a new site, record latitude and longitude and other site access information needed to locate the site.

Photo document the site, taking upstream and downstream photos when setting out and when collecting the samples.

SAMPLE RETRIEVAL AND PROCESSING

Use single use gloves when handling the samples. Rinse the pads in the surface water to remove excess sediment. If pads have become frail, rinse them while they remain in the rack.

Gently remove the cotton pads, place them in plastic bags, and label the bags with site information. Label should show location, day of placement, and day of removal.

Place pads in a dark place during transportation (remember sun will degrade the brighteners).

Directions indicate that pads should be dried overnight on monofilament line. Be sure that pads remain labeled. Watch out for cross-contamination as most labeling papers and cotton string contain whiteners.

DATA ANALYSES AND INTERPRETATION

View each pad under ultra-violet fluorescent light in a dark room on a clean table. Turn off lights, close doors, and take all measure possible to prevent ambient light from entering the analyses room.

Compare each pad to a non-exposed sampling pad and a pad exposed to optical brighteners as a control.

Report results as:

- Positive (fluorescence – it glows),
- Negative (no fluorescence – just like the control), or
- Inconclusive.

In some instances only a portion of the pad will fluoresce. This is usually due to uneven exposure of the pad to the dye in the watercourse. It should be considered positive.

Specks or spots of fluorescence on the sample or control pads are likely due to paper or cotton dust and do not indicate a positive result.

When in doubt, call it “inconclusive”.

Record results on the Optical Brightener Data Sheet.

The presence or absence of optical brighteners in a stream can be used to determine TMDL implementation or Water Quality Improvement Grant Project effectiveness.

However, the absence of optical brighteners should be interpreted based on supporting evidence such as flow conditions, bacteria samples, potential sources, and precipitation. For example, higher stream flows could have diluted dyes, resulting in negative tests.

ADEQ Optical Brightener Data Sheet

Monitoring Project Name: _____
Surface Water(s): _____
Date Equipment Placed: _____ Date Equipment Retrieved: _____ Days in Stream _____
Method of flow: _____ NAD for Lat/Long _____
Monitoring Staff: _____
Comments: _____

Site Name	Site IDs	Latitude Longitude	Flow (cfs)	Bacteria Results (CFU)	Optical Brightener (Pos/Neg/Inconclusive)	Field Observations

APPENDIX H FLOAT SWITCH CONSTRUCTION

The current basic float switch design used to trigger deployed autosamplers is outlined below, see FIGURE 1 for complete float switched housed on two-inch well casing. The design is open to refinement and redesign based on specific project needs.

Materials needed for one float switch
Float Switch (Grainger part number 4YM35)
2" PVC slotted well screen (1.5-2' length)
1" PVC cap
5/32" drill bit
3/8" drill bit
#6 1.5" length screw with nut, wing nut, and washer

Tools Needed
Drill
Radial saw
Screwdriver
Pliers

Construction
Float switch assembly
Drill 3/8" hole in bottom of 1" PVC cap;
Thread float switch into hole- should screw in; if loose use glue/caulking/sealant to affix to cap;
Drill 5/32" hole into upper third of 1" PVC cap;
Insert #6 screw through hole so that the threads are exposed on the outside of the cap; and
Tighten nut onto screw- if loose the wing nut will not tighten properly.

Well Casing
Use a radial or circular saw to cut slot in solid portion of well casing leaving approximately 2-3" on both sides of the slot.

Complete Assembly
Insert float switch assembly into well casing by placing exposed screw threads through the slot in the well casing; and
Place washer and wing nut onto screw threads and tighten.

FIGURE 1. Float switch assembly installed into well screen PVC pipe

FLOAT SWITCH INSTALLATION

Float switches are intended to enable autosampler programs as water levels rise causing the float to complete the circuit. The float switches are connected to the autosamplers via half cables (ISCO part # 790 and Sigma part #541), normally 25' in length. The half cables are connected directly to the float switch wires or via a two-wire junction wire. The ISCO half cables consist of only two wires whereas the Sigmas contain six (6). It does not matter how the ISCO half cables are connected to the two wires on the float switch. However, when using the Sigma half cables, the blue and black wires must be connected to the float switch wires.

The float switch consists of a donut-shaped float that moves up and down a rod with a retaining clip on the bottom. The ISCO and Sigma autosampler programs are triggered when the circuit created by the half cable and float switch is either opened (ISCO) or closed (Sigma). In order to change whether the circuit is opened or closed under "dry" conditions, the donut-shaped float can be removed, reversed and reinstalled. A test trigger should be conducted to ensure that the float switch is functioning properly prior to final installation and during maintenance events.

The float switches are placed in the stream bottom and set to trigger the autosampler when the water level rises sufficiently to engage the float. The float switch assembly can be mounted on either a bedrock outcrop (preferred) or on a masonry brick or garden paver using 2" fence post mounting brackets. Ideally access to the float switch assembly will be unobstructed after installation. Periodic cleaning and maintenance may be needed. Mounting to rock or brick requires a hammer drill, masonry drill bit, generator, sledge hammer, anchor bolts and nuts, and an appropriately sized wrench. Prior to installation proper authorization shall be received in writing from the land owner or managing entity.

APPENDIX I GENERAL LEVEL LOGGER MAINTENANCE FIELD PROCEDURES

Needed items

- Laptop
- Communication cable
- Extra battery
- Equipment keys
- Field notebook
- Calibration check pipe

Download/maintenance instructions

- Update laptop clock to cellular phone or GPS unit
- Open appropriate program
- Record device serial number in field notebook
- Note time difference between logger and laptop in field notebook
- Download historical data, note number of records in field notebook
- Save data to file, note file path in field notebook
- Check file; verify it contains data
- Delete historical data from logger
- Clear memory and resynchronize clock
- Check and note real-time reading in field notebook
- If needed change battery and note in field notebook, reconnect to laptop and verify proper operation

Upon return to office

- Transfer files to desktop or data disk
- Delete data from laptop

Notes to make in field notebook include:

- Device serial number
- Time difference of equipment to laptop
- Number of records in memory
- Data file name
- Note actions taken: Memory cleared, resynchronize clock
- Battery status (if equipped)
- Real-time reading
- General notes- changed battery, observations, etc.

APPENDIX J AUTOSAMPLER DEFAULT AND RECOMMENDED PROGRAM SETTINGS FOR TMDL STORM SAMPLING

The following values are presented as provisionally-recommended program settings for Sigma 900 and ISCO 6712 samplers used in storm water sample collection. Site and/or project-specific objectives may differ from the assumptions underlying this template; consequently, site or project-specific settings may need to deviate from the settings presented here. The sampler is advised to use this guide as a generic template from which a sampling collection program may be constructed consistent with the sampler's objectives.

Sigma 900 Max
Main Menu → Setup → Modify All Items →

Number of Bottles:	24
Bottle Volume:	1000 ml
Intake Tube Length:	Set for project site location
Intake Tube Type:	3/8" Vinyl
Program Lock:	Disabled
Program Delay:	Disabled
Sample Collection:	Time proportional
Interval:	1 hr 00 min- determined by project needs
Take First Sample:	Immediately
Deliver Each Sample to All Bottles?:	No (or Set for project objectives)

Choose a Method of Distribution: Bottles per Sample (or Set for project objectives)

Bottles per Sample:	2
Liquid Sensors:	Enabled
Sample Volume:	1000 ml
Intake Rinses:	1 (variable)
Sample Retries:	3 (variable)
Site ID:	Not Necessary / Bypass

Do you wish to access the Advanced Sampling Features?: Yes
↓ to Setpoint Sampling and Select

Setpoint Sampling:	Enabled
Type of Control:	Start on Setpoint
Input Channel:	External Control
Delay when input becomes active:	00:01 (hrs:min) (or Set for project objectives)

Loaded Program:	1
RS232 Baud Rate:	Not Necessary / Bypass

External Control: Delay: 1 minute
Installed Memory: Not Necessary / Bypass
External Power: Not Necessary / Bypass
Memory Mode: Not Necessary / Bypass
Program Complete Output: Not Necessary / Bypass
Special Output: Not Necessary / Bypass
Upset Sampling: Not Necessary / Bypass

ISCO 6712 Program
Program Name: Not necessary / Bypass
Length Units: ft
Number of Bottles: 24
Bottle Volume: 1000 ml
Suction Line Length: Set for project site location
Auto Suction Head: Keep as default
Number of Rinses: Set from 1-3
Number of Retries: Set from 1-3
One-part Program: Yes
Time Paced/Flow Paced:

Time paced
Distribution: Sequential
Sample Volume: 1000 ml
Enable: None programmed
Enable: Once enabled stay enabled
Enable: 0 pauses and resumes
No delay to start: Keep as default

APPENDIX K BORDER AREA CONTACT INFORMATION

TUCSON SECTOR STATIONS

Ajo Station
850 North Highway 85
Ajo, AZ 85321-9634
Phone: (520) 387-7002
Fax: (520) 387-6620
Area of Responsibility: The Ajo Station is located nine miles south of Ajo, Arizona, along State Route 85, and approximately 120 miles west of the Tucson Sector headquarters. The international border and the Lukeville Port of Entry lie approximately 27 miles south of the station.
The Ajo area of responsibility encompasses a total of 64.3 miles along the international border and nearly 7000 square miles of operational area. The border area begins at the Papago Farms on the Tohono O'Odham Nation, continuing west through the Organ Pipe Cactus National Monument and the Lukeville Port of Entry, and ends south of the Granite Mountains on the Cabeza Prieta National Wildlife Refuge at the Pima County / Yuma County line.

Casa Grande Station
396 Camino Mercado
Casa Grande, AZ 85222
Phone: (520) 836-7812
Fax: (520) 423-2341
Area of Responsibility: Currently (April, 2007), the Casa Grande Station patrols 44.2 miles of linear border on the Tohono O'odham Nation. Casa Grande Agents also patrol the Eloy and Phoenix metropolitan areas. Agents are assigned to Sky Harbor Airport and the Phoenix Metro bus stations and respond to other Arizona cities such as Globe, Apache Junction, Oracle Junction, and San Manuel.

Douglas Station
1608 S. Kings Highway
Douglas, AZ 85607
Phone: (520) 805-6900
Fax: (520) 805-8080
Area of Responsibility: The Douglas Station is one of eight stations in the Tucson Sector that ensures the successful implementation of the service's Southwest Border Strategy. The Douglas Station's area of responsibility (AOR) covers 40.5 linear miles of the International Border with Mexico and includes over 1450 square miles of mountainous terrain, with a few small valleys to the north of the International Border.

Naco Station
2136 South Naco Highway
Bisbee, AZ 85603

Phone: (520) 432-5121
Fax: (520) 432-5219
Area of Responsibility: The Naco Border Patrol Station's area of responsibility (AOR) is located within Cochise County in south east Arizona covering approximately 1,175 square miles. This includes 32.5 miles of International Boundary with the areas of Agua Prieta, Sonora, Mexico, Naco, Sonora, Mexico, and Cananea, Sonora, Mexico. The station's AOR commences near Paul Spur west of Douglas, Arizona, continuing west through the San Pedro River Valley to the crest of the Huachuca Mountains in the Coronado National Forest. The AOR includes the cities and towns of Sierra Vista, Arizona, Hereford, Arizona, Palominas, Arizona, Huachuca City, Arizona, Whetstone, Arizona, Tombstone, Arizona, Bisbee, Arizona and Naco, Arizona. The Naco Border Patrol Station is also responsible for sections of Arizona State Highways 92, 80, 90, and 82 with a temporary highway checkpoint near milepost 304 on Highway 90.

Nogales Station
1500 West La Quinta Road
Nogales, AZ 85621
Phone: (520) 761-2400
Fax: (520) 761-2628
Area of Responsibility: As of May, 2007, the Nogales Border Patrol Station has become the largest Border Patrol Station in the United States. Agents are tasked to patrol 1,100 square miles of rough terrain, including 32 miles of International Border. Nogales Station's area encompasses many urban areas like Nogales, Rio Rico, Tubac, Patagonia, Amado, and Green Valley. The Coronado National Forest is also a large part of the western sector of Nogales area of responsibility.

Sonoita Station
PO Box 37 (mailing)
3225 Highway 82
Sonoita, AZ 85637
Phone: (520) 455-5051
Fax: (520) 455-5807
Area of Responsibility: The Sonoita Station is located near the junction of State Routes 82 and 83 in Santa Cruz County. The station lies approximately 25 miles north of the international border and about 49 miles southeast of the Tucson Sector Headquarters. The Station is responsible for patrolling 24.3 linear miles of international border and an overall area that encompasses nearly 1,000 square miles. This area stretches from the Patagonia Mountains in the west, to the Huachuca Mountains in the east, and near Interstate 10 to the north.

Tucson Station
2430 S. Swan Road
Tucson, AZ 85711
Phone: (520) 514-4700
Fax: (520) 514-4760
Area of Responsibility: The Tucson Station is a very unique station. It is considered a linewatch station, responsible to patrol the border east and west of Sasabe, Arizona. Because it is located 68

miles north of the international border, it is also considered an interior station with responsibility for the vast majority of Pima County.

Willcox Station
530 East Grant Street
P.O. Box 909 (For mail)
Willcox, AZ 85643
Phone: (520) 384-4424
Fax: (520) 384-4092
Area of Responsibility: The Willcox Station does not have responsibility for a border area but is located in a geographically strategic position to conduct traffic operations on a variety of routes of egress throughout the corridor. U.S. Interstate 10, Highways 80, 191, and 90 all travel through the Willcox AOR. Willcox also conducts sign-cutting, sensor response, night scope operations, and ranch patrol.

YUMA SECTOR

Yuma Station
4151 S. Avenue A
Yuma, AZ 85365
Phone: (928) 341-2800
Fax: (928) 344-1184
Area of Responsibility
The station has 48 miles of Sonora land border, 10.75 miles of Baja California land border, and 15.25 miles of Baja California river border, for a total of 74 miles.

CORONADO NATIONAL FOREST

Douglas Ranger District
1192 West Saddleview Road
Douglas, AZ 85607
(520) 364-3468
(520) 364-6667 FAX

Nogales Ranger District
303 Old Tucson Rd.
Nogales, AZ 85621
(520) 281-2296
(520) 281-2396 FAX

Safford Ranger District
711 14th Avenue, Suite D
Safford, AZ 85546
(928) 428-4150

(928) 428-2393 FAX

Santa Catalina Ranger District
5700 N. Sabino Canyon Rd.
Tucson, AZ 85750
(520) 749-8700
(520) 749-7723 FAX

Sierra Vista Ranger District
5990 S. Hwy. 92
Hereford, AZ 85615
(520) 378-0311
(520) 378-0519 FAX

COUNTY SHERIFFS

Cochise County
Benson Patrol District
126 West 5th Street
Benson, Arizona 85602
(520) 586-8150

Bisbee Patrol District
205 North Judd Drive
Bisbee, Arizona 85603
(520) 432-9500

Douglas Patrol District
661 G Avenue
Douglas, Arizona 85607
(520) 805-5670

Sierra Vista Patrol District
100 Colonia De Salud, Suite 106
Sierra Vista, Arizona 85635
(520) 803-3850

Willcox Patrol District
450 South Haskell Avenue
Willcox, Arizona 85603
(520) 384-7050

Pima County
Green Valley District Office
601 N. La Canada Drive

Green Valley, Arizona 85614-3440
Phone (520) 351-6711

Santa Cruz
1250 N Hohokam Dr
Nogales, AZ 85621
Tel: (928) 761-7869

Yuma
District 1 – Foothills
13190 E. South Frontage Road
Yuma, AZ 85367
Tel: (928) 342-1477
Fax: (928) 345-1164

District 2 – Westside
3620 W. 8th Street
Yuma, AZ 85364-2585
Tel: (928) 782-3192

BUREAU OF LAND MANAGEMENT

Safford Field Office
711 14th Avenue
Safford, AZ 85546-3337
Phone: (928) 348-4400
Fax: (928) 348-4450

Tucson Field Office
12661 East Broadway
Tucson, AZ 85748-7208
Phone: (520) 258-7200
Fax: (520) 258-7238

Yuma Field Office
2555 East Gila Ridge Road
Yuma, AZ 85365-2240
Phone: (928) 317-3200
Fax: (928) 317-3250

Lower Sonoran Field Office
21605 North 7th Avenue
Phoenix, AZ 85027-2929
623-580-5500
Fax: 623-580-5580

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