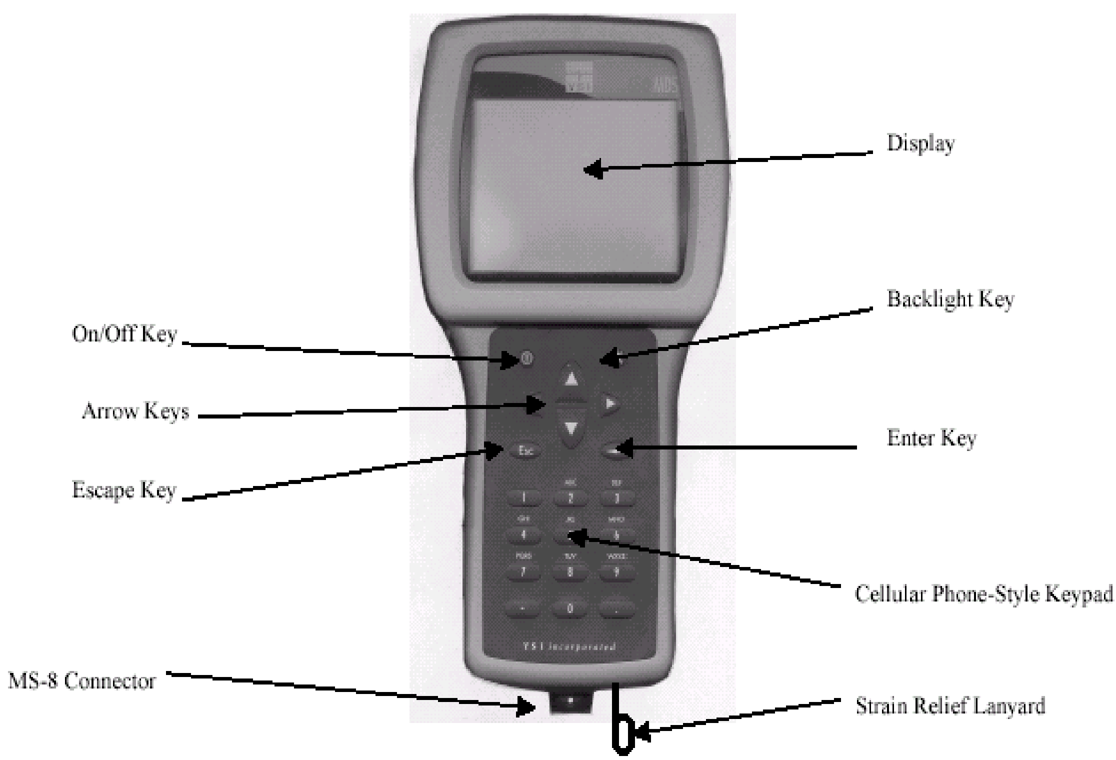
Using the YSI 650 MDS Handheld

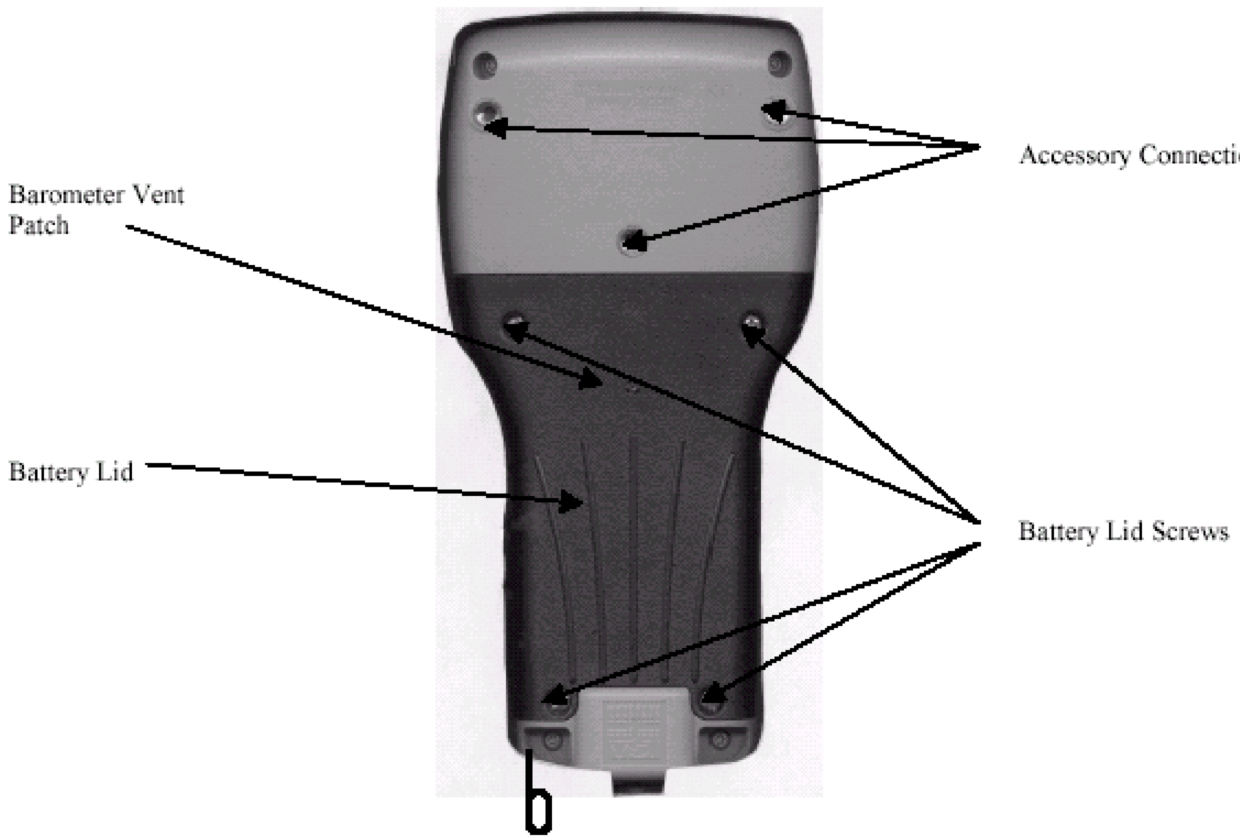
The basic layout of the 650 MDS handheld display:

650 Front View



Note that the YSI 650 keypad consists of 20 keys as shown in the diagram above. There are four function keys, up, down, right and left arrow keys and an alpha/numeric keypad. The top left key that has a green circle and line, ⓘ, is the ON/OFF key. The top right key, ☼, activates the display backlight. The **Escape** key is labeled (Esc) and (↵) is the **Enter** key.

Using the Barometer Vent and Battery Compartment

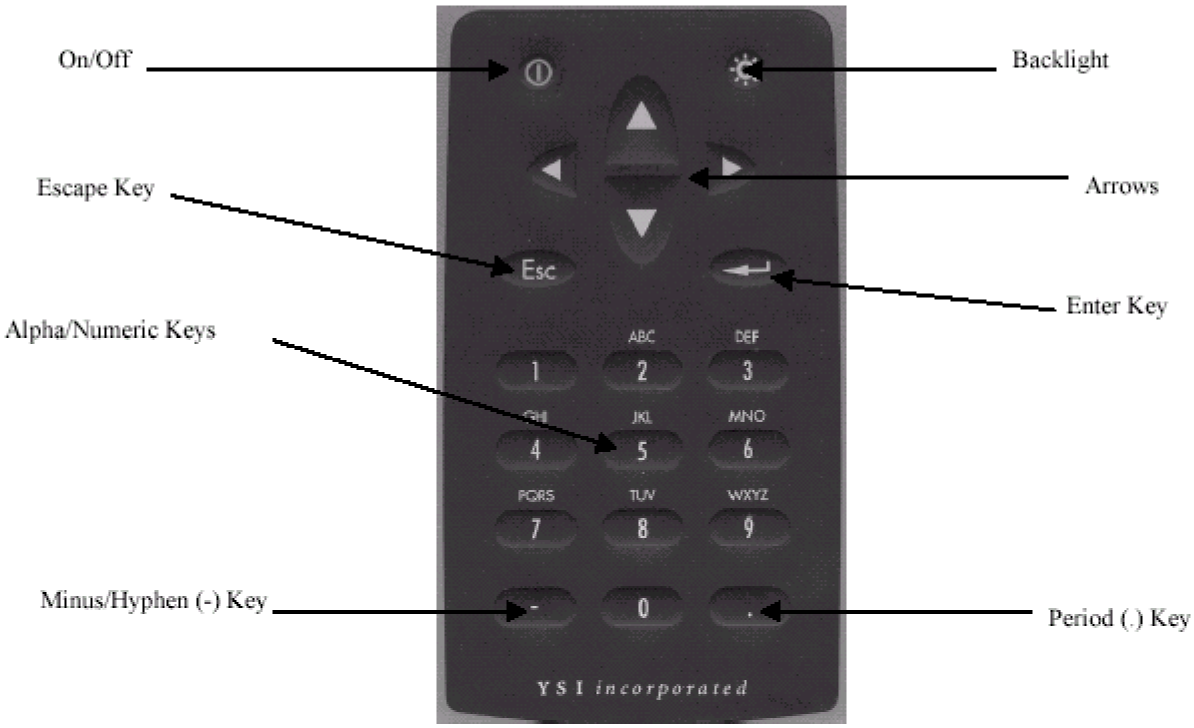


Note that the back of the case contains the battery lid that is attached to the main case with four captive screws and has three fittings for attachment of the ultraclamp and tripod accessories. In addition, the battery lid has a hole that is covered with water-impermeable patch for venting of the optional barometer.

CAUTION: The barometer-venting patch is resident on the inside of the battery lid. Removal of or damage to this patch will result in water leakage into the battery compartment.

The short cord with loop (lanyard) which is attached to the bottom of the case is attached to the strain relief of the sonde cable. Simply open the D-ring, pass the lanyard loop through the opening, and then close the D-ring.

Understanding the Keypad



The **Enter** key always the user to proceed forward into other menus and screens. While the **Esc** key allows the user to move backwards through the menus and screens.

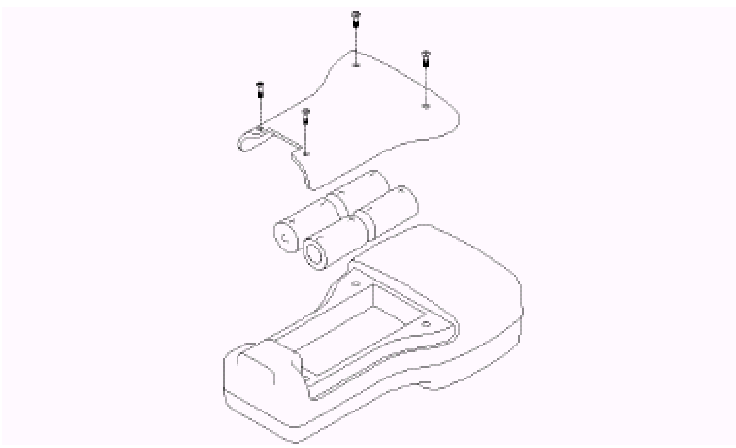
The numbers and characters that work with them:

1 -- 1
2 – ABC2abc2
3 – DEF3def3
4 – GHI4ghi4
5 – JKL5jkl5
6 – MNO6mno6
7 – PQRS7pqrs7
8 – TUV8tuv8
9 – WXYZ9wxyz9
0 -- 0

These are used when numbers or letters are required for entry. Numbers will be available only when they are needed. If you are saving data to the handheld to be downloaded, you will use letters to create file names when collecting and storing sampling data to the 650 MDS handheld.

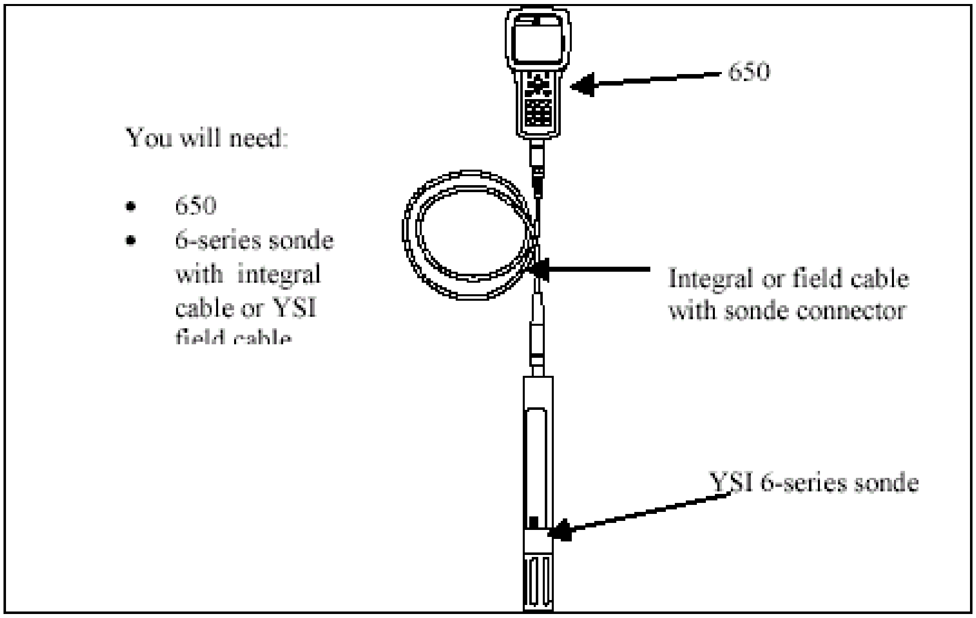
Changing Batteries in the 650 MDS

Four C cells install easily into the back of the 650. Follow the instructions and diagrams below to install the batteries properly:



- Using a Phillips or slotted screwdriver, loosen the 4 captive screws on the battery lid and then remove the battery lid completely.
- Insert the cells between the battery clips, being sure to follow the polarity (+ and -) as indicated on the bottom of the battery compartment.
- Make certain that the gasket is properly installed on the battery lid before reinstallation.
- Reinstall battery lid and tighten the 4 captive screws securely and evenly using a Phillips or slotted screwdriver. Do not overtighten.

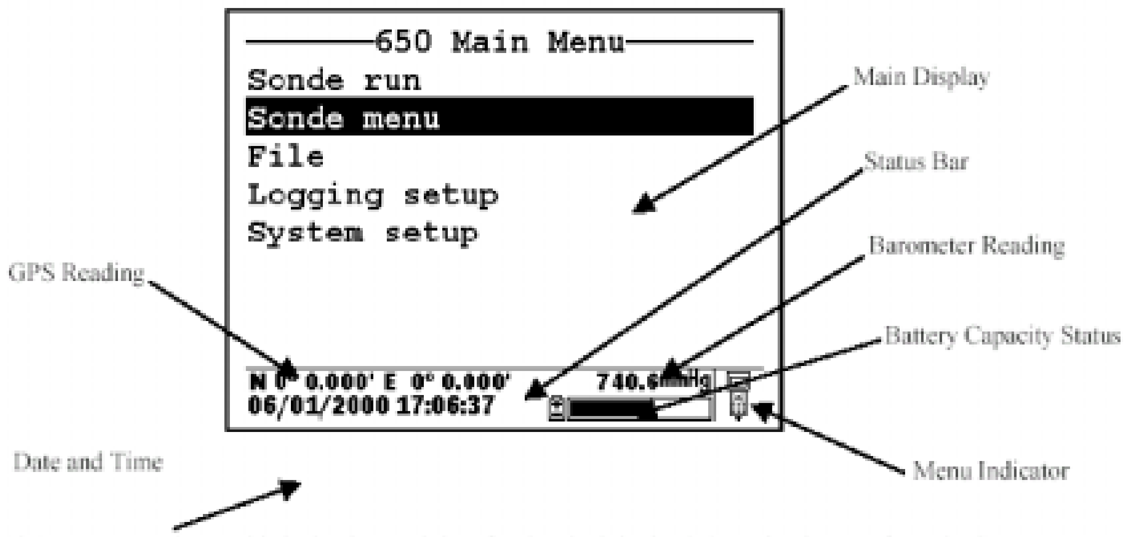
Connecting the 650 MDS to Your Sonde



To connect the handheld to the sonde just line up the end of the cable with the end of the handheld. (**Note**: The cable can only connect to the handheld in one way). Once you slide the two ends together, just twist the locking swivel on the cable until it locks into place (the silver pegs on the handheld should be viewable through the holes on the locking collar). At this time also connect the silver hook on the cable to the strain relief lanyard on the handheld. This will take tension off of the cable and prevent excessive wear.

Turning on the 650 MDS and Understanding the Views

To turn the instrument on press the green circular button the top left corner. After pushing the button, the following screen should be displayed.



2.10.1 Date and Time. This is the date and time for the clock in the 650, set by the user from the **System setup** menu as described above. The date and time entries are updated in real-time in the Status Bar.

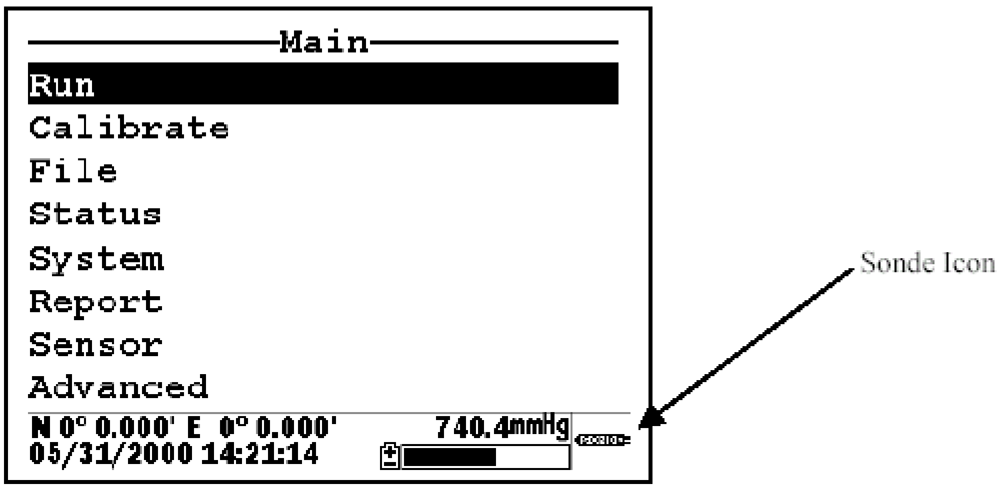
2.10.2 GPS Reading. This value will be present only if a user-supplied GPS unit with NMEA 0183 format is connected to the 650 by the optional YSI 6115 cable. The setup of a GPS interface is described in more detail in Section 3.8 below. Once properly connected to a GPS instrument, the values displayed in the Status Bar are updated in real-time as the system is moved from location to location.

2.10.3 Barometer Reading. This value is the current local barometer reading in units selected by the user in the **System setup** menu. The value is can be used simply as a meteorological parameter or can be used in calibration of sonde dissolved oxygen sensors. The barometer reading is NOT corrected to sea level and is updated in real-time.

2.10.4 Battery Capacity Status. The graphic indicator shows the portion of the battery capacity that is remaining, either for the 4-C cell configuration or for the optional rechargeable battery pack. If a 6117 rechargeable battery pack is in place, a "NiMH" label will appear as part of the indicator. During charging of the battery pack, the black portion of the icon will pulse horizontally until charging is complete. In addition, the entire battery indicator will flash when your batteries are almost exhausted and require replacement (C-cells) or recharge (optional rechargeable battery pack).

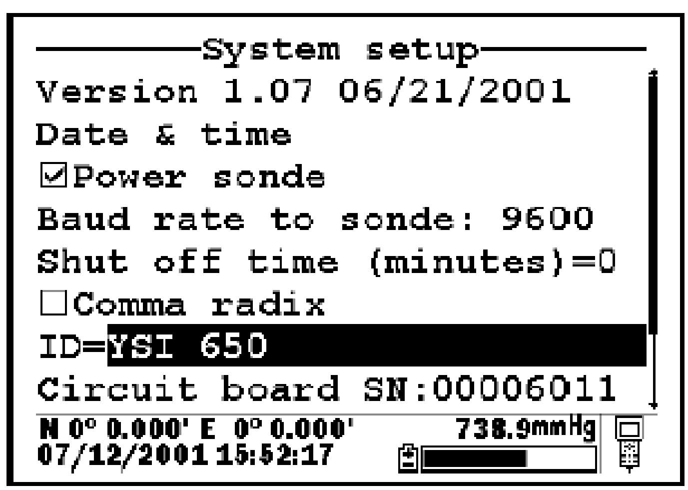
2.10.5 Menu Indicator. This icon is located in the lower right portion of the Status Bar and provides a guide as to whether the menu on the display of the 650 originates in the sonde or the 650 itself. The icon shown in the figure above represents a 650 menu; if the menu on the display had originated in the sonde, the Status bar would display a sonde-like icon as shown below.

Learning to Calibrate the Barometer

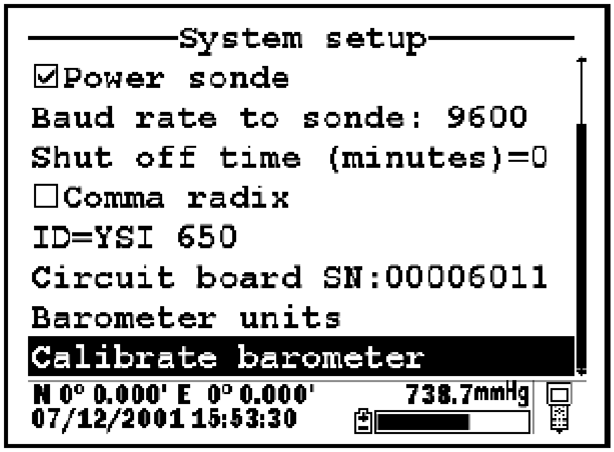


Sometimes you will be required to calibrate your barometer on your 650 MDS these instructions and pictures should aid in this process. This should be performed outside, with the known Barometric Pressure.

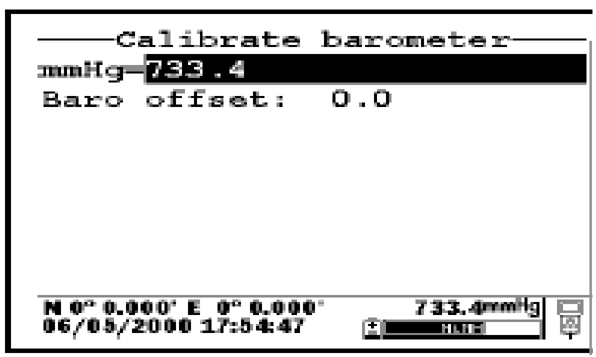
1. With your handheld turned on select **System setup** from the Main Menu. You will see a menu like this:



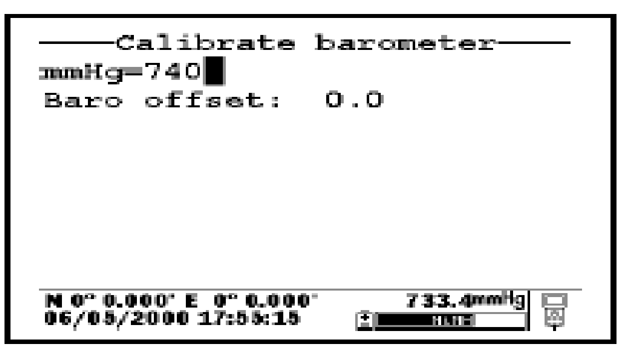
2. Next, scroll down through the menu to **Calibrate barometer**.



3. Press the **Enter** Key. Here you will have to know the outside barometric pressure in whichever standard you are using – typically mmHg. Enter the barometric pressure in the window similar to the one below. In order to ensure the most accurate reading, allow the handheld to adjust to outside temperature and pressure for a few minutes before taking the reading.



4. The screen below can be generated by entering the current pressure and pressing **Enter.** The offset value is used when returning it to factory settings. When you are finished, press the **Esc** button to return to the previous menu.

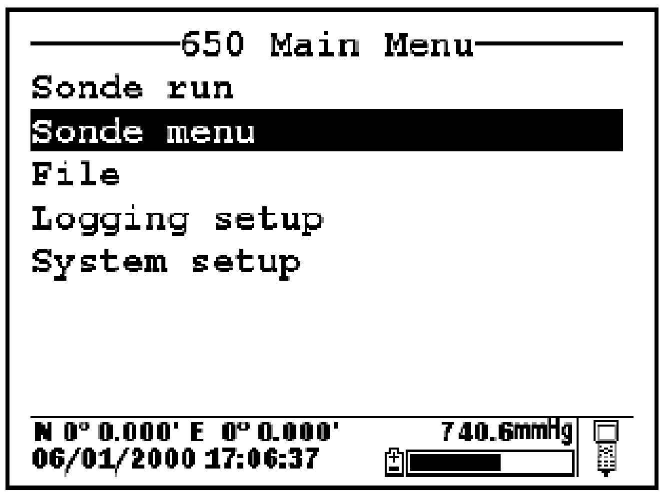


Calibrating and Running the 600 QS Sonde with your 650 MDS Handheld

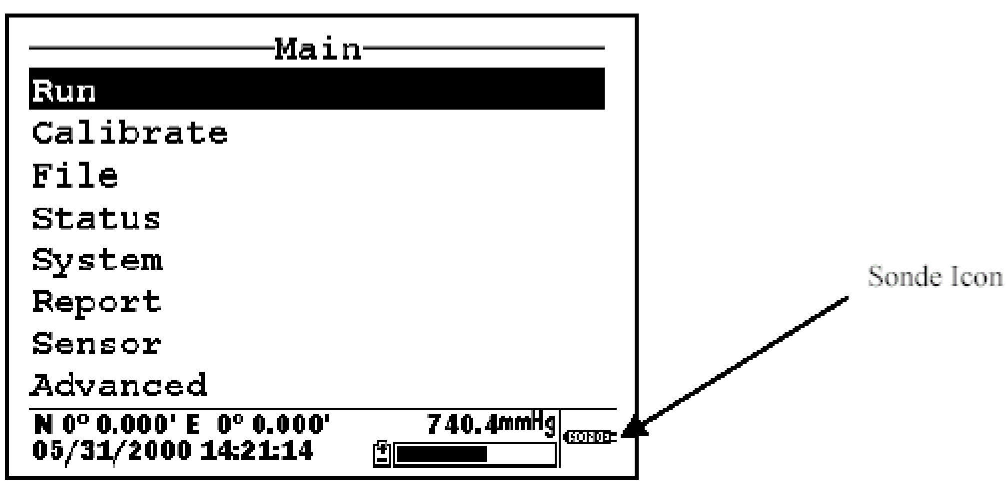
In this section learn how to calibrate the sonde when connected to the handheld and how to run the sonde to receive measurements.

Calibration

1. With your handheld on, scroll down to the title **Sonde menu**. Then press the **Enter** key.



2. The handheld will make a sound that indicates that you are actively connecting to the sonde and its menus. Once connected, a screen like this will appear:

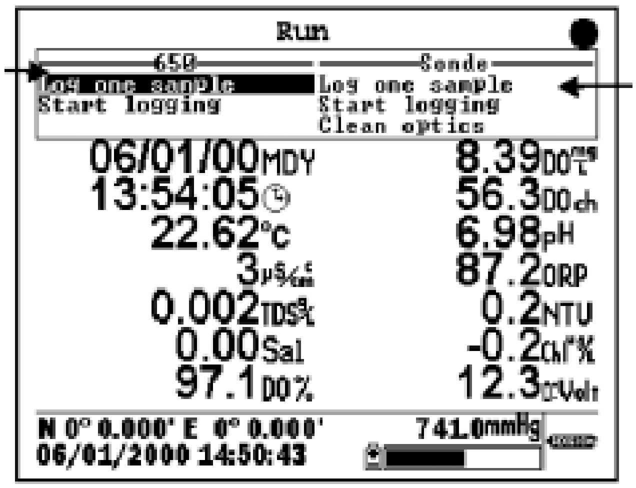


** The sonde icon indicates a connection to the sonde.*

3. To calibrate just scroll to the word **Calibrate** and press the **Enter** key.
4. The screen will then show a list of items that can be calibrated (Conductivity, Dissolved Oxygen and pH). Scroll to the desired item, and press **Enter**. Follow the set of instructions for calibration of each.

Running Your Sonde to Obtain Readings

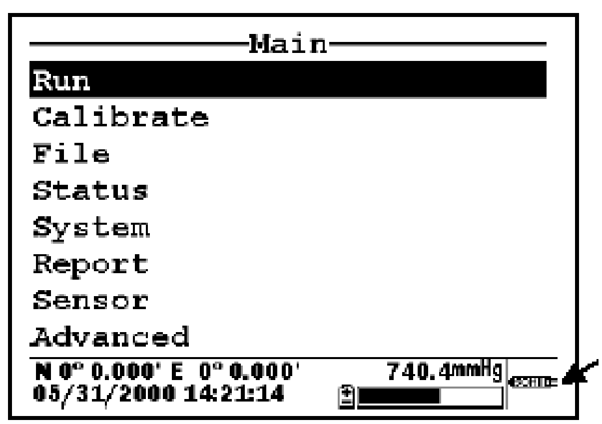
Under the **Sonde Menu** scroll to the word **Run** and press **Enter**. A screen that looks similar to the one below will appear.



This screen shows all the parameters being measured. It may take a few minutes to settle to the river values being tested. Write or save the number. Exit the menu by pressing **Esc** and returning to the previous menu.

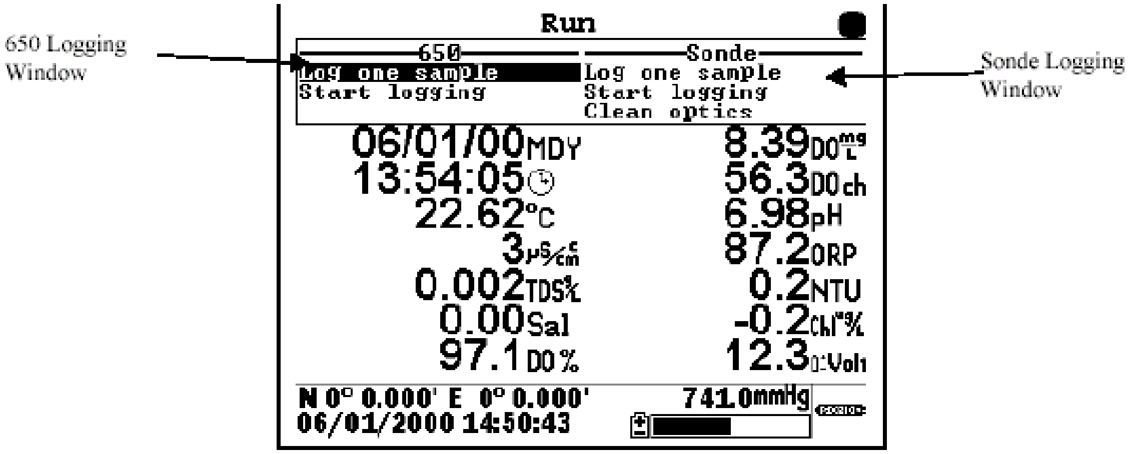
Saving Sampling Points to the 650 MDS

The 650 MDS handheld and the 600 QS sonde being used contain built-in memory, which allows the user to save and download information from the field onto the computer. To begin, select **Sonde run** from the main menu once the sonde is connected. This will generate the screen below. Next, select the word **Run**.



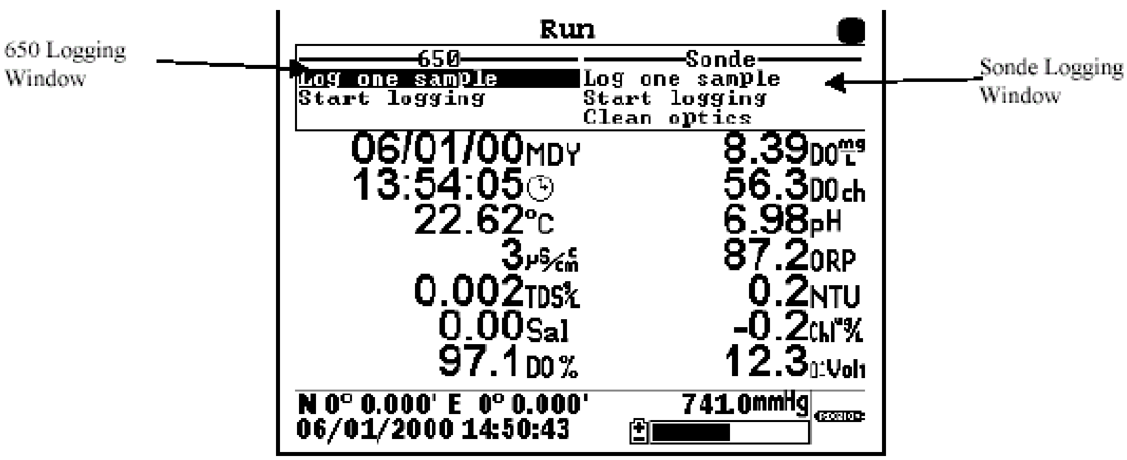
With the sonde connected and the handheld on, select **Sonde run** from the main menu, and the adjacent menu will appear.

In this window select the word **Run.** The following menu will open, which shows the parameters and also serves as a place to store information.



How To Save The Data On The Screen To The Handheld

With the above screen showing and once all the parameters are holding steady, select the words **Log one sample** from the menu on the top of the screen, under the numbers 650. This will save all the data on the screen to the memory of the 650 MDS.

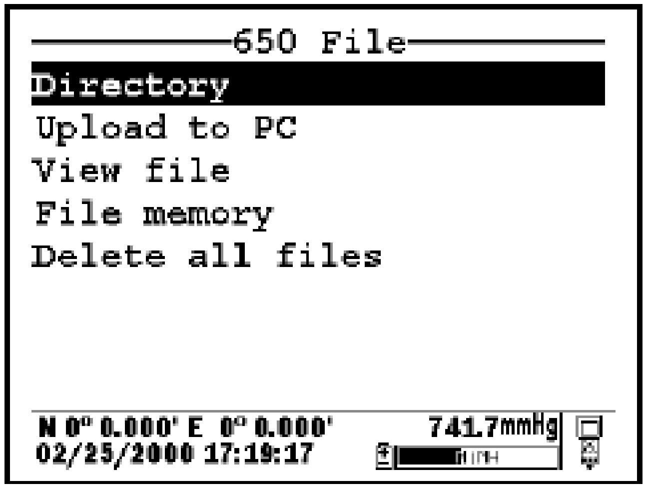


A screen will ask for a filename. Enter the name or number of the site being sampled on the keypad and press **Enter**. Next, using the right arrow on the directional keys, select **OK** and press **Enter**.

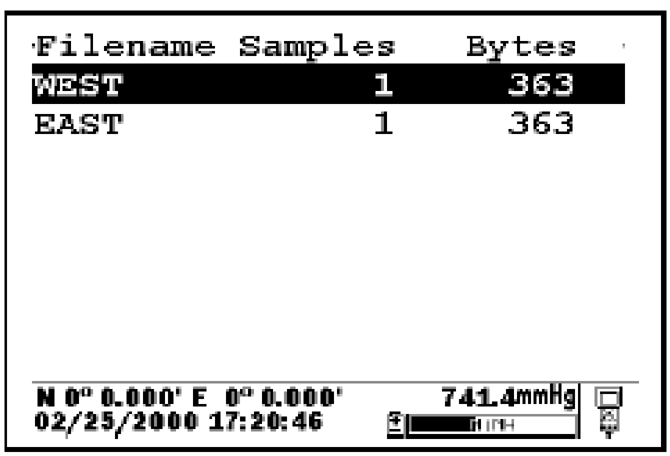
A sampling screen will appear and the words **Sample logged** will flash at the top of the screen. Once the words stop flashing, the sample has be saved. Move to the next site.

To View the Saved File or Files

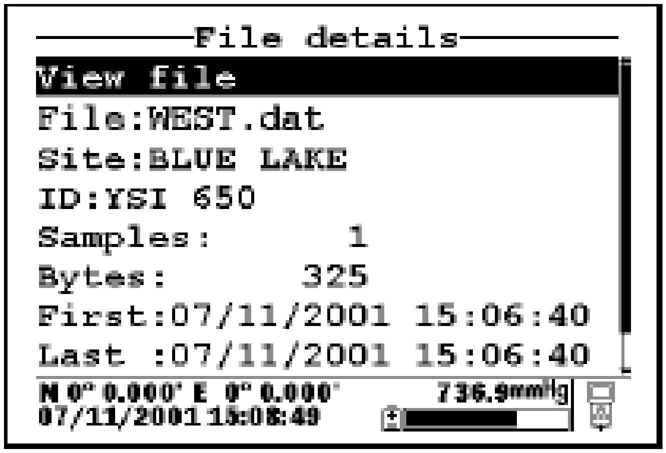
First with the handheld on (it is not necessary to have the sonde attached), scroll down ,select **File** from the main menu and press the **Enter** key. The following screen will appear.



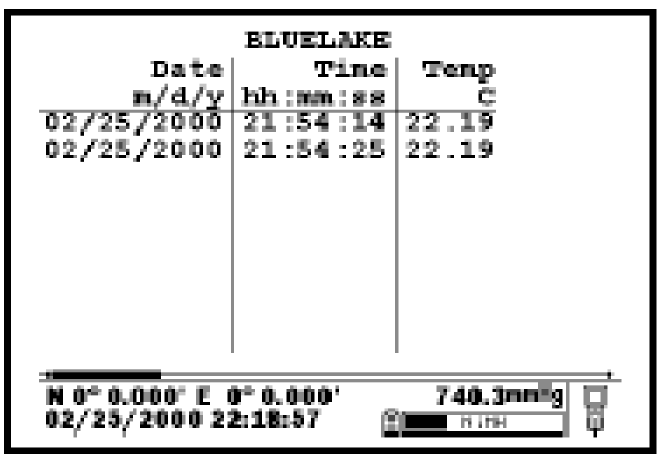
From this menu select the word **Directory** and press **Enter**. The following window will appear with the saved filenames.



Select a file and press **Enter**. The name of the file, the number of samples, and the date and time will appear.



To see the values from the site select the words **View File** and press **Enter**. A new window with data such as date, time and temperature will be displayed as in the sample below.



To view more data scroll over using the left and right arrow keys; to leave this menu, use the **Esc** key to move back. By clicking on **View File**, you will be able to view the any downloaded files and observe the values received from the river.

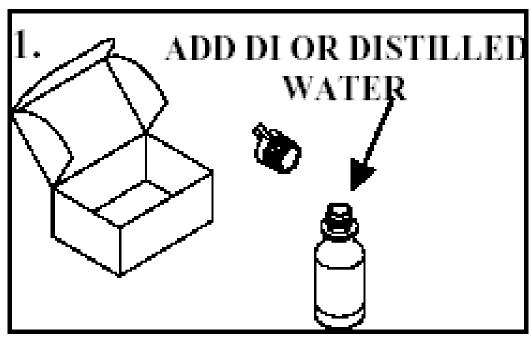
Using the YSI Probe

Field measurements including pH, dissolved oxygen, temperature, conductivity and transparency will be measured at each sampling location. Conductivity, pH, water temperature and dissolved oxygen, will be measured by using the YSI meter or equivalent meters and methods. More detailed information on YSI meter functions can be found in the YSI Environmental Operations Manual for their 6-Series Sondes. Field measurements will be recorded on datasheets and placed in a field notebook. Probes should be rinsed with water from the site being sampled.

Installing the Dissolved Oxygen (DO) Membrane

The dissolved oxygen probe is shipped with a protective dry membrane on the sensor tip, held in place by an O-ring. Remove the O-ring and membrane. Handle the probe with care as it is very important not to scratch or contaminate the sensor tip.

Unpack the YSI 6562 DO Probe Kit and follow the instructions below.



1. Open the membrane kit and prepare the electrolyte solution. Dissolve the KCl in the dropper bottle by filling it to the neck with deionized or distilled water and shaking until the solids are fully dissolved. After the KCl is dissolved, wait a few minutes until the solution is free of bubbles.

2. Remove the protective cap and the dry membrane from the YSI 6562 DO probe.

3. Hold the probe in a vertical position and apply a few drops of KCl solution to the tip. The fluid should completely fill the small moat around the electrodes and form a meniscus on the tip of the sensor. Be sure no air bubbles are stuck to the face of the sensor. If necessary, shake off the electrolyte and start over.

4. Secure a membrane between your left thumb and the probe body. Always handle the membrane with care, touching it only at the ends.

5. With the thumb and forefinger of your right hand, grasp the free end of the membrane. With one continuous motion, gently stretch it up, over and down the other side of the sensor. The membrane should conform to the face of the sensor.

6. Secure the end of the membrane under the forefinger of your left hand.

7. Roll the O-ring over the end of the probe, being careful not to touch the membrane surface with your fingers. There should be no wrinkles or trapped air bubbles. Small wrinkles may be removed by lightly tugging on the edges of the membrane. If bubbles are present, remove the membrane and repeat steps 3 through 8.

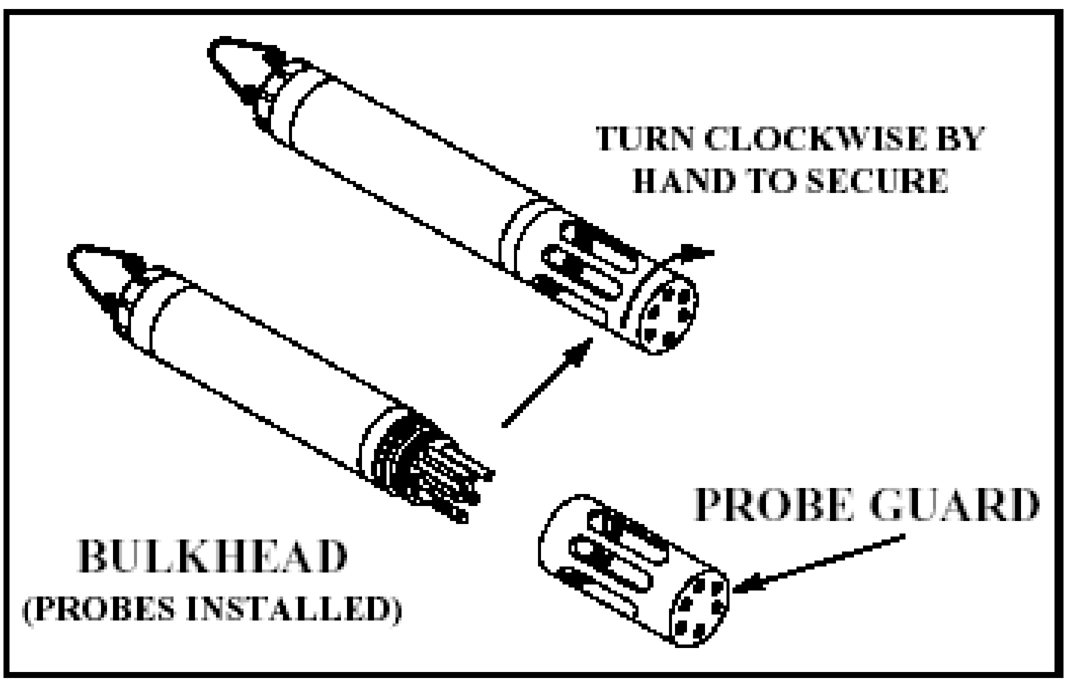
8. Trim off any excess membrane with a sharp knife or scissors. Rinse off any excess KCl solution, but be careful not to get any water in the connector.

TIP: You may find it more convenient to mount the probe vertically in a vise with rubber jaws while applying the electrolyte and membrane to the sensor tip.

Installing The Probe Guard

Included with each sonde is a probe guard. The probe guard protects the device during calibration and measurement procedures. Once the probes are installed, attach the guard by aligning it with the threads on the bulkhead and by turning the guard clockwise until secure.

CAUTION: Be careful not to damage the DO membrane during installation of the probe guard.



Getting Ready To Calibrate

Calibration Tips:

1. If you use the calibration cup for dissolved oxygen (DO) calibration, make certain to loosen the seal to allow pressure equilibration before calibration. The DO calibration is a water-saturated air calibration.

2. The key to successful calibration is to insure that the sensors are completely submersed when calibration values are entered. Use recommended volumes when performing calibrations.

3. For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the sonde. You may wish to save old calibration standards for this purpose.

4. Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.

5. Have several clean, absorbent paper towels or cotton cloths available to dry the sonde between rinses and calibration solutions. Shake the excess rinse water off of the sonde, especially when the probe guard is installed. Dry off the outside of the sonde and probe guard. Making sure that the sonde is dry reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration.

6. If you are using laboratory glassware for calibration, you do not need to remove the probe guard to rinse and dry the probes between calibration solutions. The inaccuracy resulting from simply rinsing the probe compartment and drying the outside of the sonde is minimal.

7. If you are using laboratory glassware for the 600R, 600XL and 600XLM, remove the stainless steel weight from the bottom of the sonde by turning the weight counterclockwise. When the weight is removed, the calibration solutions have access to the sensors without displacing a lot of fluid. This also reduces the amount of liquid that is carried between calibrations.

8. Make certain that port plugs are installed in all ports where probes are not installed. It is extremely important to keep these electrical connectors dry.

CONDUCTIVITY

Conductivity Calibration Tips:

1. Calibrate conductivity first in order to avoid any contamination of the standard.

2. Never calibrate with conductivity standards that are less than 1.0 ms/cm. These standards are easily contaminated and can be interfered with by outside noise sources (RF, etc.)

3. Pre-rinse the sensors with a small amount of the calibration standard to eliminate contamination.

4. Insure that the conductivity probe is completely submerged 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 opening.

5. If the sonde should report **Out of Range**, investigate the cause. Never override a calibration error message without fully understanding the cause. Typical causes for error messages are incorrect entries, for example, entering 1000 microsiemens instead of 1.0 millisiemens (**Note**: The sonde requires the input in millisiemens). Low fluid levels and air bubbles in the probe bore are other common causes of calibration errors.

6. When the calibration has been accepted, check the conductivity cell constant which can be found in the sondes advanced menu under **Cal Constants**. The acceptable range is 5.0 +/- 0.45. Numbers outside of this range usually indicate a problem in the calibration process or the use of a contaminated standard.

This procedure calibrates conductivity, specific conductance, salinity and total dissolved solids. For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the water you are preparing to sample. However, using standards less than 1 mS/cm is not recommended. For example, when testing fresh water, use a 1 mS/cm conductivity standard.

Before proceeding, insure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid crosscontamination of standard solutions with other solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP probes, particularly if you are employing standards of low conductivity.

Carefully immerse the probe end of the sonde into the solution. Gently rotate and/or move the sonde up and down to remove any bubbles from the conductivity cell. The probe must be completely immersed past its vent hole. Using the recommended volumes from the table in the previous subsection should insure that the vent hole is covered. Allow at least one minute for temperature equilibration before proceeding.

From the calibrate menu, select number **1-Conductivity** to access the conductivity calibration procedure and then number **1-SpCond** to access the specific conductance calibration procedure. Enter the calibration value of the standard you are using (mS/cm at 25π C) and press **Enter**. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

Observe the readings under **Specific Conductance** or **Conductivity**. Once they show no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to return to the calibrate menu. Finally, rinse the sonde in tap or purified water and dry.

Dissolved Oxygen With Autosleep Off

Discrete Sampling:

Preparing a sonde for use in a spot sampling/profiling application is the same as the preparation used in unattended monitoring. The sonde must be checked and calibrated and in addition, your handheld terminal (610/650) or PC must be charged and made ready for the field. Sampling can be tough on the equipment, being bounced around in small boats, exposed to temperature extremes, shock and vibration, can cause parameters like dissolved oxygen and pH to reflect calibration shifts during the course of the day. Field technicians need to be aware of this and must be able to make adjustments for any drift that might occur. Other parameters on the sonde like conductivity, depth, turbidity, and chlorophyll are less likely to be affected and usually do not signal any drift during normal daily field use. In order to insure the highest quality data, we must have the ability to pre- and post- calibrate dissolved oxygen during the day.

Conducting this procedure properly is actually quite simple if you follow the instructions below.

1. Always prepare the equipment the day before the expected field study. Membrane changes should be done the day prior to the study to minimize any drift.

2. The transfer of the sonde from the storage/calibration to the sensor guard puts the sonde and sensors at risk during the process. Usually, this is when most accidents occur, so it is best to avoid removing the protective sensor guard when in the field. We will carry the sonde in a 5 gallon pail and the sonde will be wrapped in a wet white towel that covers the entire unit. The towel being wrapped around the sonde will protect it during transport from shock and vibration and will keep the sonde in the perfect saturated environment for our pre and post calibration checks.

3. When arriving on site, turn on the sonde and allow it to warm up for approximately 4 to 5 minutes. Next, check the DO output. It should measure saturation in your local environment or barometric pressure setting, plus or minus the instrument's tolerance of 2 percent. If you should find that the DO has drifted, then simply recalibrate on the spot and record the amount of drift that was witnessed.

4. The sonde will then be deployed and the measurements automatically taken. Remember to allow the sonde a few minutes to equilibrate to the water temperature before taking the reading. Once the data has been collected, wrap the sonde again in the wet towel and perform a dissolved oxygen post calibration. Again, the sonde should return to saturation, plus or minus the tolerance of 2 percent, within a few minutes.

5. If you are logging the information, it is recommended that you store this pre- and post-calibration data in the actual site datafile. Otherwise, if you are manually recording the data, record the information in your log sheet. This assures anyone who might look at the records at a later time that the sonde was indeed calibrated and working correctly. The additions of these steps add very little time to the collection process and can actually save time when unexpected results are witnessed.

Calibration Tips for Dissolved Oxygen

Unattended Monitoring Preparation:

1. If the DO probe anodes are darkened or gray in color, recondition with the 6035 reconditioning kit.

2. Install a new membrane, making sure that it is tightly stretched and wrinkle free.

   Caution: If you remove the DO probe from the sonde, be sure to inspect the probe port for moisture. Remove any moisture droplets from the connector area. Also verify that the probe is clean and dry with a small amount of silicone grease applied to the O-ring before it is reassembled.

   Note: DO membranes will be slightly unstable the first three to six hours after they are installed, which is why it is recommended to conduct the final calibration after this period.

3. Go to the sonde's report menu and enable the **DO Charge**. Now go to the **Run** menu and start the sonde in the **Discrete Run** mode at a 4-second rate. Allow the sonde to run (or burn-in) for at least 10 minutes. After approximately 5 minutes, record the DO charge, which should register 50 +/- 25.

4. After the burn-in is complete, go to the sonde's advance menu and confirm that the RS-232 autosleep function is enabled. If the sonde is to be connected to an SDI-12 data logger, then the SDI-12 autosleep must be enabled as well. Wait sixty seconds before proceeding to Step 5.

5. Start the probe in the **Discrete Run** mode at a 4-second rate. Record the first 10 percent of the dissolved oxygen numbers, which must be listed with the highest number first, descending to the lowest, according to each 4-second sample. It does not matter if the numbers do not reach 100 percent, it is only important that they have the same high to low trend. If you have a probe that starts at a low number and steadily climbs upwards, then the sensor may be problematic and shouldn't be used.

Note: Initial power-up may cause the first two DO samples to produce low readings; therefore, it is recommended to disregard low numbers in this position.

6. The probe is now ready to be calibrated. Set the sonde into the calibration cup with approximately 1/8 inch of water or use the wet towel method, if you prefer. Do not allow water to touch the membrane, and allow the sonde to sit in this saturated environment for at least 10 minutes before beginning the DO calibration process.

   Warning: The sonde must be idle, or not in the **Run** mode, for five minutes prior to starting the DO calibration.

   Calibrate the sonde in DO %. Be sure to enter your local barometric pressure in mm/hg.

7. When the calibration is completed go to the sonde's advanced menu, select **Cal Constants**, and record your data under **DO Gain**. The gain should be 1.0 with a range of -0.3 to +0.5. Now the probe should be successfully calibrated and prepared for the unattended study. As with the other parameters, any warning messages displayed by the sonde during the calibration are cause for concern and must be investigated before deploying the sonde.

DO Sampling Preparation:

If you intend to conduct discrete sampling, turn the autosleep option off and follow the following instructions for DO calibration.

To calibrate the oxygen probe, select the **Dissolved Oxygen** option from the calibrate menu. The sub-menu will offer the option of calibrating in terms of percent saturation or mg/L. For water-saturated air, the percent saturation option is generally recommended. Calibrating in either term will automatically yield the calibration results of the other.

When using the percent saturation mode, be certain that the sensor has been thermally equilibrated in water-saturated air and that the sensor has stabilized prior to starting the calibration routine, particularly after a membrane change. Relieve pressure in the cup if necessary. Remember, the calibration cup is designed to be airtight and must be loosened if used as a calibration chamber.

Next, follow the screen prompt and enter the local barometric pressure in mm/Hg, (inches Hg x 25.4), press **Enter**, then monitor the stabilization of the DO readings. After no changes have occur for approximately 30 seconds, press **Enter** to confirm the calibration. Then, as instructed, press **Enter** again to return to the calibrate menu.

For the mg/L mode, calibration is carried out in a water sample which has a known concentration of dissolved oxygen, usually determined by a Winkler titration. For this calibration procedure, the sensor should be immersed in the water. After thermal equilibration, enter the known mg/L value, press **Enter** and the calibration procedure will begin with similar viewing of stabilization and confirmation of calibration as for the percent saturation mode above.

NOTE: If you have resurfaced your DO sensor, we recommend running the probe continuously for 15 to 30 minutes or until adequate stability is realized. After a membrane change only, run the probe continuously for three to four minutes, or until good stability is realized.

pH Sampling and Calibration

When selecting number **4 – ISE1-pH**, you will be given the choice of 1-point, 2-point, or 3-point calibrations for pH sampling.

Select the **2-point** option to calibrate the pH probe using only two calibration standards. In this procedure, the pH sensor is calibrated using a pH 7 buffer and pH 4 buffer. A 2-point calibration procedure (as opposed to a 3-point procedure) can save time if the pH of the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a 2-point calibration with pH 7 and pH 4 buffers is appropriate. Conducting a 3-point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.

To begin the calibration, immerse the sonde in one of the buffers and enter the actual pH value. Press **Enter** and the screen will display real-time readings that will allow you to determine when the pH sensor has stabilized. Pressing **Enter** will confirm the calibration. Following the instructions on the screen, place the sonde in the second pH buffer, input the pH value, press **Enter** and view the stabilization of the values on the screen in real time. After the readings have stabilized, press **Enter** to confirm the calibration. Then, as instructed, press **Enter** again to return to the calibrate menu.

Calibration Tips for pH:

1. Go to the sonde's report menu and turn on the pH mv output. This will allow the sonde to display the millivolts or the probes raw output, as well as, the pH units during the calibration process.

2. Recondition the probe if a slow response in the field has been reported. The procedure can be found in the sonde manual under the Sonde Care and Maintenance section.

3. In most cases, a 2-point calibration is all that is required. Bracket the expected in-situ pH values; use the 3-point calibration if the measurement area pH is unknown.

4. Calibrate the pH. Insure that the temperature probe is in solution with the standard, record the pH millivolts at each calibration point.

5. The millivolts help tell us the present status of the probe; a good set of numbers to use are as follows:

   Buffer 4 = + 180 +/- 50 mv
   Buffer 7 = 0 +/- 50 mv
   Buffer 10 = - 180 +/- 50 mv

The ideal numbers when a probe is new range between 0 and 180, but as the probe begins to age, the numbers will move and shift to the higher side of the tolerance.

NOTE: After recording the pH millivolts for the calibration points, you must determine the slope of the sensor. This is done by determining the difference between the two calibration points that were used, for example, if we recorded a +3 mv for buffer 7 and a –177 for the 10 buffer then the slope would be 180. The acceptable range for the slope is 165 to 180. Once the slope drops below a span of 165, the sensor should be taken out of service.

Never override any calibration errors or warnings without fully understanding the reason for the message. Additionally, proper storage of the sensor when not in service will greatly extend the life of the probe.

Taking Readings

IMPORTANT MESSAGE!
WHAT IF THERE IS NO RESPONSE TO A KEYSTROKE?

To save power, the sondes will power down automatically if no interaction from the keyboard occurs for approximately 60 seconds when an Autosleep function (RS232 or SDI12) is activated in the **Advanced Setup** menu. When the software is in this "sleep" mode, the first subsequent keystroke simply "wakes it up" and has no visible effect on the display. The next keystroke after the unit is "awakened" will be input to the software in the intended manner. Thus, if you press a key after the sonde has been inactive for some time and nothing seems to happen, press the key again.

1. Select number **1-Run** from the main menu to begin taking readings or either to set or verify the parameters required for a study. There are two options in the run menu as shown below.

```
---------------Run setup---------------
1-Discrete sample   2-Unattended sample

Select option (0 for previous menu): 1
```

2. Select number **1-Discrete sample** from the run menu. The discrete sample menu will be displayed. Discrete sampling is usually used in short term, spot sampling applications when the user is present at the site and the unit is attached to a data logger or laptop PC. It may also be used in the vertical profiling of a lake or river, where the user lowers the sonde incrementally into the water to acquire data for a few minutes at each depth.

```
------------Discrete sample------------
1-Start sampling
2-Sample interval=4
3-File=
4-Site=
5-Open file

Select option (0 for previous menu):
```

3. Select number **2 - Sample Interval** to type a number that represents the number of seconds between samples. The maximum sample interval is 32767 seconds (9+ hours). The factory default sample interval is four seconds and works best for most discrete sampling applications.

   Select number **3 -File** to enter a filename with a maximum of eight characters. This is the file to which you will log readings.

   If you started sampling without entering a filename, the default name NONAME1 will be assigned to your file. Whenever you press 1-LOG last sample or 2-LOG ON/OFF from the menu, NONAME1 will be opened during sampling. If this happens, and you want to restart the file with a different name, press **5-Close file** and rename the file.

   Select number **4-Site** to assign a site name with a maximum of 31 characters This allows you to enter the name of the site where you are sampling.

   When you select number **5-Open File**, a file is opened and the number 5 changes to **Close File**. When you are finished logging data to the file, press **5-Close File** and number 5 changes back to **Open File**.

4. Now select number **1-Start sampling** to start discrete sampling.

   The following prompt will appear just below the screen header:
   1-LOG last sample, 2-LOG ON/OFF, 3-Clean optics.

   By entering **1–LOG last sample**, a single line of data can be logged to flash disk (sonde) memory and the following message will be displayed: **Sample logged.**

   By entering **2-LOG ON/OFF**, a set of data can be logged to memory and the following message will be displayed: **LOG is ON, hit 2 to turn it OFF, 3-Clean optics.** Press **2** again to terminate logging.

Care, Maintenance And Storage

This section describes the proper procedure for storage of the sensors that will maximize their lifetime and minimize the time required to get the sonde ready for a new application. This section will describe interim or short-term storage between applications where the sonde is being used at a regular interval (daily, weekly, biweekly, etc.). and long term storage, (e.g., over-thewinter), where the sonde will not be used on a regular basis for several months.

In the descriptions and instructions below, it is assumed that the user has retained the vessels (bottles, boots, etc.) in which the individual sensors were stored on initial delivery. If these specific items have been misplaced or lost, they can be replaced by contacting YSI Customer Service. Alternatively, the user may have similar (and equally acceptable) storage equipment on hand even though it was not part of the original YSI package. Common sense should be the guide on substitution of storage vessels.

Sonde Care And Maintenance

The YSI 6570 Maintenance Kit is available for use with your sonde. The kit includes several items that will be helpful or necessary to perform the proper routine maintenance on your sonde. The 6570 Maintenance Kit includes two types of O-rings (for probes and cable connector), probe/installation/replacement tools, two cleaning brushes for the conductivity sensor, O-ring lubricant and a syringe for cleaning the depth sensor port. The 6570 Maintenance Kit can be ordered from any authorized YSI dealer, or directly from YSI.

When caring for your sonde, remember that the sonde is sealed at the factory and there is never a need to gain access to the interior circuitry of the sonde. In fact if you attempt to disassemble the sonde, you would void the manufacturer's warranty.

Cable Connector Port

The cable connector port at the top of the sonde should be covered at all times. While communicating with the sonde, a cable should be installed and tightened in place. This will assure that a proper connection is being made and prevent moisture and contaminants from entering.

When a communications cable is not connected to the cable connector port, the pressure cap supplied with the instrument should be securely tightened in place.

If moisture has entered the connector, dry the connector completely using compressed air, a clean cloth, or paper towel. Apply a very thin coat of lubricant from the 6570 Maintenance Kit to the O-ring inside the connector cap before each installation.

Probe Care And Maintenance

For best results, we recommend that the KCl solution and the Teflon membrane at the tip of the 6562 probe 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 6562 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 the fine sanding disks which are provided in the 6035 reconditioning kit.

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.

CAUTION: Be sure to: (1) Use *only* the fine sanding disks provided in the 6035 maintenance kit in the resurfacing operation, and (2) Sand in a direction parallel to the gold electrode. (***Caution:*** Not adhering to either of these instructions can seriously damage the electrodes.)

Conductivity/Temperature Probes

The openings that allow fluid access to the conductivity electrodes must also 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 to 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.

pH Probes

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 (either 6561 or 6565) and the platinum button (6561). Next, use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor.

CAUTION**:** When using a cotton swab with the 6561 or 6565, 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.

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. Gently clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the acid.

3. 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 approximately one hour, stirring occasionally.

If biological contamination of the reference junction is suspected or if previously-listed procedures do not yield a satisfactory response, perform the following additional cleaning step:

1. Soak the probe for approximately one hour in a one-to-one dilution of commercially-available chlorine bleach.

2. Rinse the probe with clean water and then soak for at least one hour in clean water, stirring occasionally to remove residual bleach from the junction. (If possible, soak the probe for period of time longer than one hour in order to be certain that all traces of chlorine bleach are removed.) Then rerinse the probe with clean water and retest.

3. 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 reinstallation.

Field Protocols & Tasks

Data Recorder and Assistant

For each sample date:

- Record sampling organization information and individual names of sampling team.
- Record general phenology notes pertaining to watershed area of sites being monitored.

For each site:

- Enter site name, waterbody being sampled, date and time.
- Record lab required information on sample bottle(s) for each site (site, time, parameters, sampling personnel, preservative, etc.)
- Enter site observations: erosion, vegetation status, wildlife, land use, cultivation, wind direction/speed), et al.
- Hold field air thermometer at waist level in the shade of your body or locate in similar shaded spot. Allow 2 to 3 minutes to come to equilibrium. Record and report this reading to the nearest tenth of a degree Celsius in the data recorder.
- Enter data as it is provided by other team members. Ensure field datasheet is fully filled out before leaving site.

At the end of the sampling run:

- Fill out Chain of Custody form if samples will be shipped to a certified lab for analysis.
- Review datasheets for missing items and make final general observations about sample run.

Depth, Width, Temperature Recording Team Tasks

- Lower weighted tape to bottom of stream. Record and report this reading to the nearest tenth of a foot to the data recorder.
- Calculate overall depth and 60 percent depth for sampling. [(Bottom-Surface) x 0.60 = sample depth)]
- If staff gage is present, record the stage level of the gauge.
- Measure width of stream. Record and report this reading to the nearest tenth of a foot in the data recorder.
- Take photo reference of the site from fixed positions – upstream, downstream, etc. – on a monthly, seasonally, or significant event-related basis.
- Draw a site diagram (see separate instructions). This may be conducted annually or seasonally.

Water Sample Collection Team

- Label required number of sample bottles to be collected at the site (sample site, date, time, parameters, preservative and collector's initials)
- Obtain depth of stream from data recorder and make mark on rope of sampler which would be at the water surface when the collection container is 3/5 of way down from surface.
- Set up Van Dorn or Kemmerer samplers in open position.
- Lower sampler to river and submerge three times to rinse sampler with water from site being sampled. Then lower sampler to marked depth and release messenger to trigger closing of sampler.
- Retrieve sampler and fill containers that will be sent to lab for analysis. (Is note needed here re: triple rinsing containers with sample water except for phosphorus samples.
- Add preservative as per lab instructions to appropriate samples. Mix well by inverting and pack in coolers with ice.
- Collect additional samples as needed to fill bottles to use later for turbidity sampling and for transparency tube.

Turbidity/Transparency Tube Team

- Use water from sample retrieved from waterbody to fill glass vial for turbidity reading. (**Note**: Be sure the sample is mixed and sediments have not settled.)
- Wipe vial dry with Kim-wipe. Wipe vial with silicone oil, and place in turbidimeter.
- Use water from sample retrieved from waterbody to fill glass vial for turbidity reading. Stand with the sun at your back, close light shield, and press **Read**. Once the reading stops flashing, record the result.
- Release water until you can just make out a pattern, then record the depth.
- Slowly release more water until the cross-pattern of the screws in the bottom becomes clearly visible. Record depth.
- Now average the two depth readings to obtain the transparency tube reading.
- If pattern is visible when the tube is full, record ">100cm."
- Assess Recreation Suitability, Appearance, and Stream Condition and report results in data recorder.

YSI Sonde Team

- Deploy sonde in stream and attempt to locate at 6/10ths depth.
- Allow to stabilize – preferably a minimum of 5 minutes. Record readings. Between sampling, re-insert sonde in calibration cup with wet sponge or wrap in wet towel.
- See Using the YSI Probe section for more information.

Visual Watershed Survey

The visual watershed survey may be divided into two distinct parts:

- A one-time background investigation of the stream and its watershed. (To do this, volunteers research town and county records, maps, photos, news stories, industrial discharge records and oral histories.)
- A periodic visual assessment of the stream and its watershed. Because land and water used can change rapidly and because the natural condition of the stream might change with the seasons, it is best to visually assess the stream or stream segment at least three times per year:
    - Early spring, before trees and shrubs are in full leaf and when water levels are generally high
    - Late summer, when trees and shrubs are in full leaf and when water levels are generally low
    - Late fall, when trees and shrubs have dropped their leaves but before the onset of freezing weather

In addition, you might wish to spot-check potential problem areas more frequently. These include construction sites, combined sewer overflow discharges, animal feedlots, or bridge/ highway crossings. If polluted runoff or failing septic systems are suspected, schedule a survey during a heavy rainfall. If a stream is diverted for irrigation purposes, surveys during the summer season will identify whether water withdrawals are affecting the stream. It is important to survey the stream at approximately the same time each season to account for seasonal variations. You might find it productive to drive through the watershed once a year and to walk the stream (or the stream's problem sites) at other times.

Visual assessments are surveys where the volunteers observe water and land conditions, land and water uses, and changes over time. These observations are recorded on maps and on visual assessment datasheets and passed to the volunteer coordinator, who can decide whether additional action is needed. Volunteers might themselves follow up by reporting on problems such as fish kills, sloppy construction practices, or spills they have identified during the visual assessment.

These types of assessments have the most value if the same area is assessed each time. This allows you to become familiar with baseline conditions and land and water uses and better able to identify changes over time. They also help you identify and follow up on problems like fish kills, sloppy construction practices and spills in addition to becoming familiar with how the community uses and values the resource.

To conduct a visual watershed survey, you will need:

- A local road map and a reference topographic map with the watershed boundary clearly marked.
- Base map to record land uses, land characteristics, stream obstructions, sources of pollution and landmarks. .
- Relevant information from the background investigation.
- A pencil and a camera with film.

Before the Visual Watershed Survey

Researching the stream is generally a one-time activity that can yield valuable information about the cultural and natural history of the stream and the uses of the land surrounding it. This information can also be valuable to build a sense of importance of the stream among members of the community, identify activities in the watershed with a potential to affect the quality of the stream, design your own monitoring program and develop a list of sites and parameters to be monitored.

The background investigation can be conducted at any time of year and can take as little or as much time as you wish to devote to it. At minimum, key information on land uses, water uses, watershed boundaries and discharges should be maintained in a written form for program use and to orient new volunteers. Maps, photographs and any available information on previous water quality studies in the watershed will prove to be of value over time. When you have collected the information, compile it in a written document such as a scrap book to share with the community.

Outline your watershed boundary on a topographic map. This will be your base map. Use a copy machine to enlarge the map so you have more space for comments. You may redraw the watershed denoting significant features such as streams, roads, buildings, vegetated areas and other important information. Affix this map to a stiff piece of paper or cardboard, or lay a sheet of acetate paper on the the topographic map and use that to record features. Mark the locations of main roads, residential areas, industries, businesses, farms, parks, schools, churches and any other land uses you might be familiar with which have an effect on water quality on the topographic map.

To begin, determine what you want to know about your stream. Include the following types of information:

- Location of the stream's headwaters, its length, where it flows from and where it flows to
- The name and boundaries of the watershed it occupies, the population in the watershed and the communities in the watershed
- Industries and municipalities that discharge into the stream
- Current uses of the stream (swimming, water supply, irrigation, cattle watering, etc.)
- Historical land uses
- History of the stream, and if it has been altered, indicate how.

Any of these types of information should prove valuable to the monitoring program, and you may well uncover other important sources of information. At a minimum, the investigation should yield information on the size of the stream, watershed boundaries and general land use in the area.

How to Research Your Stream

Stream, headwaters, length, tributaries, final stream destination and watershed boundaries are best determined using maps. Of greatest value are the U.S. Geological Survey 7-1/2 minute topographic maps on 1:24,000 scale where 11 inches equals 4 miles. At varying degrees of resolution, they depict major road and political boundaries, developments, streams, tributaries, lakes and other land features. These maps are available through U.S. Geological Survey Offices. Information about ordering these maps is available on the U.S. Geological Survey web site at www.usgs.gov, or call 1-800-USA-MAPS. These maps are also available at many commercial locations, such as sporting good stores.

Road maps, state maps and county maps may also prove helpful. Minnesota's 80 rural counties each have Local Water Plans, which show maps of major watersheds and provide comprehensive information about local water resources. The county Local Water Planner generally works at the county courthouse, or the county soil and water conservation district. The Minnesota Board of Water and Soil Resources maintains a directory of Local Water Planners in Minnesota and other local water managers. Call the Board at 612-296-3767 to obtain a copy of this directory.

Other sources of information about rivers include:

- Minnesota Department of Natural Resources (DNR) or North Dakota Game and Fish:
  Ask for fish surveys from the river, or other information related to its management. Minnesota Department of Natural Resources has also promoted watershed management activities recently; there may be a project near you.

- Minnesota Pollution Control Agency (PCA) or North Dakota Department of Health:
  Ask for information about water discharges to the river. Minnesota Pollution Control Agency has several water quality assessment programs for lakes, which may encompass rivers. The Citizen Lake Assessment Program is a one-season survey of water quality and assesses sources of water to the lake, including rivers. Clean Water Partnerships are two-part investigations and protection of water quality. These programs may have been implemented in your community. The regional Minnesota Pollution Control Agency office can also tell you the locations of long-term ambient water quality monitoring sites. The North Dakota Department of Health and Minnesota Pollution Control Agency also fund assessments and implementation projects (319 projects).

- North Dakota State Water Commission: Ask for information such as surface water withdrawal

- Regional planning agencies: May have land use maps.

- Industries with a permit to discharge to the river are required to monitor water quality of effluent. Some may have other information about the river, such as biological surveys.

- Municipalities withdrawing water or discharging to the river are required to monitor water quality.

- Determine land ownership on your river by reviewing tax records in the county assessor's office. Several federal agencies own and manage land in, including the U.S. Forest Service, the National Park Service, U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service. Indian tribes also manage land held in trust for members of the bands. The reservation business office usually has information about natural resources within the reservation boundaries. Depending on ownership, nonprofit agencies may have information about your river. For example, the National Audubon Society is interested in the well-being of the state's Wildlife Refuges, managed by the U.S. Fish and Wildlife Service. The Nature Conservancy is interested in state Scientific and Natural Areas, especially those located on prairies.

- Historical land uses and history of a stream is information that may take some legwork to uncover. Local historical societies, libraries and newspaper archives are good places to start. Look for historical photos of the area and stories about fishing contests, fish kills, spills, floods and other major developments which may affect the stream. For example, many of Minnesota's rivers were channelized when the state was first settled. Some of the channelization benefited the logging industry, which moved logs to sawmills via rivers; in fact, proximity to rivers was a criteria in judging the value of a stand for harvest.

- Long-time residents are another invaluable source of information and history of your stream. People who fished or swam in streams in their youth may have witnessed how the stream has changed and may remember industries or land use activities of the past that may have affected the stream. For example, people once harvested hay along the floodplains of the Mississippi. Button-making from clams found in the Crow Wing River and its tributaries once thrived in the central part of the state.

Other activities:

- Get copies of existing reports that include your river. Examples include your state's water quality standards, state water quality assessment reports, river basin plans, special studies, etc.
- Determine the classification of and designated uses associated with your river.
- Identify your river's special attributes and uses and potential threats to these uses and values. What are the existing river uses? What and where are the activities that threaten these river uses and values?
- Take oral histories from people in your town. Ask questions such as: What do you remember the river being like when you were my age? How has the river changed since you were young? What are your feelings about the river today?
- Drive through your watershed and observe and record changes in the river.

During the Visual Watershed Survey – the Bigger Picture

The purpose of driving (or walking) the watershed is to get an overall picture of the land that is drained by your stream or stream segment. It will help you understand what problems to expect in your stream and it will help you know where to look for those problems.

As with all other monitoring activities, you should undertake your watershed drive or walk with at least one partner. If you are driving, one of you should navigate with a road map and mark up the base map and field sheet with relevant discoveries with the other partner drives. You might want to pull over to make detailed observations, particularly near stream crossings. (**Remember:** never enter private property without permission.)

As you drive or walk the watershed, look for the following:

- The "lay" of the land: Become aware of hills, valleys and flat terrain. Does any of this area periodically flood?

- Bridges, dams and channels: Look for evidence that the community has dealt with the stream and its flood potential over the years. Are portions of it running through concrete channels? Is it dammed, diverted, culverted, or straightened? Where the road crosses the stream, is there evidence of erosion and pollution beneath bridges? Is the streamflow obstructed by debris hung up beneath bridges?

- Activities in the watershed: Look for land use activities that might affect your stream. In particular, look for construction sites, parking lots, manicured lawns, farming, cattle crossings, mining, industrial and sewage treatment plant discharges, open dumps and landfills. Look for the outfalls you identified in your background investigation. Also look for forested land, healthy riparian zones, undisturbed wetlands, wildlife and the presence of recreational users of the stream such as swimmers or fishermen.

Use all of your senses to observe the general water quality condition. Does the stream smell? Is it strewn with debris or covered with an oily sheen or foam? Does it flow quickly or sluggishly? Is it clear or turbid? Are the banks eroded? Is there any vegetation along the banks? If you see evidence of water quality problems at a particular site, you might want to investigate them in more detail. Drive or walk upstream as far as you can and try to identify where the water quality problem begins.

Use your Watershed Survey Form to record your findings. Always be as specific as possible when noting your location and the water conditions you are observing. Draw new maps or take pictures if that will help you remember what you are observing. Don't be afraid to take too many notes or draw too many pictures. You can always sort through them later.

Take note of the positive conditions and activities you see, as well as negative ones. This, too, will help you characterize the stream and its watershed. Look for such things as people swimming or fishing in the stream; stable, naturally vegetated banks; fish and waterfowl; or other signs that the stream is healthy.

After your Watershed Survey

The last step of the watershed's survey visual assessment is to review the maps, drawings, photos and field datasheets you have assembled for your stream or stream segment. What is this information telling you about problem sites, general stream conditions, potential for future degradation and the need for additional action? In most cases you will find that you have put together an interesting picture of your stream. This picture might prompt additional monitoring or community activity, or could bring potential problems to the attention of water quality or public health agencies in your area.

When reviewing your data, be sure maps are legible and properly identified. Photos should have identifiable references, and field datasheets should be filled out completely and accurately.

Post-field Activities

Reflecting on Your Data - Turning it into Action

So, does your stream have good water quality? Why or why not? Can you make a judgment at this point? Turning you data into action requires two steps, converting your data into information and then using this information to create action plans.

Reflecting on the data collection process:

Natural systems, such as streams, are inherently variable because their water quality changes due to climate, temperature, stream flow and many other factors. Variability exists in our data collection procedures, as well. Each of us measures and interprets differently. Our differing ability to judge colors, distances and amounts affects the quality of data we collect. For example, we use a color comparator (color wheel) to determine the concentration of nitrogen in the water. One of us may judge the color differently than another and therefore determine a different nitrate concentration. Or, perhaps the equipment was faulty or used incorrectly. These differences can lead to variability in monitoring results.

Reflecting on the data collection process:

Turning data into useful information is another step in the monitoring program. Once you have managed and interpreted your data, you will be able to develop clear action strategies and effective presentations.

> Managing Data involves entering data into spreadsheets and creating creating a data summary using graphs and tables that enables you to view your data as a whole.
>
> Interpreting Data involves posing a series of questions about your data. Your answers to these questions should then be organized as finding and conclusions. From these, you can develop recommendations for action.
>
> Presenting Information entails relating your findings, conclusions and recommendations in a form that best tells the story of your river. This story can be told using text, tables and graphs that are organized into a written report or oral presentation.

Illustrating Your Data

It can be challenging to interpret your data in raw form. The data will appear even more confusing to those who were not involved in its collection. Both your group and outside audiences will better understand the meaning of your data if it is presented in graphical form (it will be much more interesting to look at, too). This section will help you to chart and graph data. The next section, Reflecting on Your Data, will help you to interpret it. To decide which forms of data illustration best suits your purpose, ask yourself the following questions.

How do you summarize your data?

The first step in illustrating data is to organize it. You may want to first enter data by hand onto a ledger or graph paper and then transfer the information to a computer spreadsheet program (Excel, Lotus 1-2-3, Quattro Pro). Computer spreadsheet programs will help you to summarize and analyze the data. They will also allow you to create charts and graphs directly from the spreadsheet.

What's the first step in presenting our data?

After organizing your data, summarize it in table form. You might want to include the maximum and minimum values, which establish your range, and the mean, or average value. Make notations on your chart, if necessary, to help you to interpret your data later on. A table may be the final form for your data. Developing a table may also prove a useful first step in creating a graph.

How do you want to represent your data?

There are many ways to present your data, but the two most common are pie charts and 2-dimensional graphs.

Do you want to see how values change over time or distance?

Two-dimensional graphs (like line graphs and bar graphs) show how values change over time or from one site to another. These graphs have an x-axis and a y-axis. The x-axis represents the independent variable – a constant, such as time and date – that is not influenced by other factors. The y-axis, or the dependent variable, changes in response to other factors. An example of a dependent variable is water temperature. Continuity of data is an important difference between line and bar graphs. Line graphs assume data points are connected to each other and show a continuous trend. Bar graphs are used when data points are not connected.

Do you want to look at relationships between parameters?

You can place the values for two or more parameters on the same graph to investigate a possible relationship. Graphically illustrating these relationships will help you interpret your data later. Notice that this graph has two y-axes – one for temperature and one for dissolved oxygen. The x-axis, which represents time, is the independent variable for both.

Red River Basin Background

The Red River Basin is located near the geographic center of the North American continent. The basin includes portions of Minnesota, North Dakota and South Dakota, as well as parts of the Canadian Province of Manitoba. The Red River Basin land area encompasses nearly 45,000 square miles. Roughly one-third is located in Manitoba. The remaining two-thirds are located in portions of North Dakota, Minnesota and a small part of South Dakota. The basin's hydrology is characterized by northward flow, low north-south relief and a high degree of anthropomorphic alterations. All these factors contribute to an incredibly complex hydrology in the Red River Basin.

The Red River not only marks the border between North Dakota and Minnesota, but it also marks the international border between the United States and Canada. At the city of Winnipeg, Manitoba, the Red River is joined by the Assiniboine River, a major tributary draining southwestern Manitoba and southeastern Saskatchewan. The Red River terminates at Lake Winnipeg in Manitoba, Canada. Lake Winnipeg is about 250 miles long and drains from its northern end through the Nelson River northeastward to Hudson Bay.

The name Red River was first applied by the Ojibway Indians to the outlet stream of Lower Red Lake, Minnesota, flowing westward toward Grand Forks, North Dakota, and then northward to Lake Winnipeg. The idea that the Red Lake River formed the headwaters of the Red River is not unreasonable since it is a major tributary to the Red River. The name Red River of the North was given to the river to distinguish it from the Red River in Louisiana.

The elevation at Wahpeton is 943 feet (287 meters) above sea level. At Lake Winnipeg, the elevation is 714 feet (218 meters). The difference is only 229 feet (69 meters) over a distance of about 545 river miles (877 kilometers). The slope of the river averages less that one-half foot per mile (0.09 meters per kilometer), varying from about 1.3 feet per mile (0.25 meters per kilometer) near Wahpeton and Breckenridge, to 0.2 feet per mile (0.04 meters per kilometer) near the Manitoba border. The slope continues at 0.2 feet per mile (0.04 meters per kilometer) from Emerson to Ste. Agathe and then increases slightly to 0.38 feet per mile (0.07 meters per kilometer) from Ste. Agathe to the mouth at Lake Winnipeg. During major floods, the entire valley becomes the floodplain. In 1997, the Red River spread to a width of about 25 miles (40 kilometers) in Manitoba.

The Red River Basin includes not only the old lake bed (Red River Valley) but also about 28,000 additional square miles, for a total of about 45,000 square miles. Of the total, nearly 40,000 square miles are located in the United States. The Red River Basin constitutes an area roughly the size of Pennsylvania or Mississippi. The total drainage area is shared by Manitoba, North Dakota, Minnesota and South Dakota, in the amounts of 11, 47, 41 and 1 percent, respectively.

Three distinct land forms – drift prairie, flat plains and hills – are found in the Red River Basin. Each is a result of glacial activity about 10,000 years ago when ice hundreds of feet thick scoured the landscape and meltwater carried soil and boulders to new locations. East of a north- south line drawn about 30 miles east of the main stem of the Red River the country is hilly heavily timbered. West of such a line it is open drift prairie, nearly treeless except along streams and where shelterbelts have been planted. In the middle are the flat plains of the Red River Valley. Most reports on the Red River basin name nine major subbasins on the North Dakota side of the Red River, ten on the Minnesota side and five in Manitoba for a total of 24.

The Red River of the North

From its origin, the Red River of the North meanders northward for 394 miles to the Canadian border, a path that is nearly double the straight-line distance. The Red River of the North normally receives over 75 percent of its annual flow from the eastern tributaries as a result of regional patterns of precipitation, evapotranspiration, soils and topography. Most runoff occurs in spring and early summer as a result of rains falling on melting snow or heavy rains falling on saturated soils. Lakes, prairie potholes and wetlands are abundant in most physiographic areas outside of the Red River Valley Lake Plain. Dams, drainage ditches and wetlands alter the residence time of water, thereby affecting the amount of sediment, biota and dissolved constituents carried by the water.

The area drained by the Red River of the North is a part of the Hudson Bay drainage system. Through its center runs the Red River of the North, at times meandering lazily within its banks, at times spreading out over the surrounding flat lands for miles. The Otter Tail River in Minnesota, which is usually though of as a tributary, is in fact, the main extension of the Red River and comprises the true source and headwaters area.

Climate

The Red River Basin has a sub-humid to humid continental climate. Moderately warm summers, cold winters and rapid changes in daily weather patterns are characteristic of the region. Marked fluctuations in weather are common as the result of passing weather fronts and shifting high and low pressure systems. Temperatures have ranged from a maximum of 118°F in August, to minimums of -55°F in January and February. The annual mean temperature is about 40°F. Temperatures of 85°F to 95°F are common in summer, with temperatures dropping to -35°F in winter.

Precipitation

About three-fourths of the basin's precipitation occurs during April through September and almost two-thirds come during May, June and July. November through February are the driest months, with precipitation averaging about one-half inch per month. Most summertime precipitation comes from thunderstorms. Average annual precipitation in the basin ranges from 17 inches per year in the west to 24 inches in the southeast. The overall average for the basin is 20.5 inches. Within any given year, for any given part of the basin, precipitation can vary from as little as 8 inches during drought years to more than thirty-six inches. Some parts of the basin receive abundant moisture in the same year that other parts experience drought.

Hydrological Characteristics

Rivers of the Red River Basin flow toward Hudson Bay. Although headwaters of northern tributaries occur in an extensive area of wetland, peat bogs and marshes, which provide natural flood storage, the flat topography of the lower basin makes flooding a major problem in the valley. Relatively small channels flow through a broad, flat floodplain, defined primarily by the ancient lake bed left by Glacial Lake Agassiz, not by the existing rivers. Spring flood waters can extend for miles over municipalities and agricultural lands. Draining of upland areas and prairie marshes and channelization has added to the problem. The most damaging floods on record occurred in 1950, 1966, 1979 and 1997. The 1979 flood resulted in property damage totaling $43.7 million; the flood damage figure far exceeds that. So far, the cost of the 1997 floods is estimated at $19 billion.

Land Use in the Red River Basin

Prior to settlement, the Red River Basin was a mosaic of intermixed upland and wetland habitats that provided a host of landscape and watershed functions. Pre-settlement habitats included meandering streams and rivers w ith riparian areas of forests along the water’s edge. Prairie consisted of tall native grasses (e.g. Big bluestem (*Andropogon gerardii vitman*), Indian grass (*Sorgastrum nutans*) and Switchgrass (*Panicum virgatum*)) and a rich array of forbs. A transition area between these habitats consisted of grasses, forbs, trees, small shrubs and numerous shallow wetland areas with interspersed prairie.

The Red River Basin’s landscape has changed considerably since pre-settlement times. What was once a vast sea of native tall and short-grass prairie ecosystem intermixed with meandering streams and numerous lakes and wetlands has changed to a complex system of geometric fields, drained wetlands and straightened waterways. These alterations allowed farmers to fully capture the productivity of the region’s rich soils.

Because of these man-made alterations, the Basin is arguably one of the most productive agricultural regions in the world. Accordingly, land use in the Basin is predominantly agricultural.In the U.S., roughly 82 percent (8.4 million hectares) of the Basin’s 10.1 million hectares is used for agriculture and rangeland. Approximately 14 percent (1.4 million hectares) is comprised of forests, lakes and wetlands.

About the same landuse allocations exist in Manitoba. Most of the Manitoba portion of the Red River Basin is developed and used primarily for agriculture. Over 89 percent of the land is developed for agricultural purposes. Like the U.S. portion of the Red River Basin, Manitoba’s land cover is developed for agriculture because of the incredible productivity of the soils. During the Red River Basin’s recent history, human activities have straightened natural waterways and converted most of the pre-settlement landscape from native prairie and wetlands to farmland. Unfortunately, many farming practices associated with intensive agricultural production often degrade water quality, accelerate wind/water soil erosion and fragment the habitat resource.

Although the number of farms throughout the Red River Basin is decreasing, there is a continuing trend towards larger single farm operations and a greater emphasis on production-based farming. It is expected that agriculture will continue to be the mainstay of the regional economy, and farming is expected to dominate the future landscape of the Red River Basin. Accordingly, we can expect today's non-point threats to water resources from current landuse practices to remain in the future.

Ecoregions

Ecoregions share similar topographies, soils, vegetation, hydrology, climate and land uses.

Various plant and animal species prefer different habitat conditions and therefore establish distinct communities in areas that provide preferred conditions. Large areas that contain similar communities of plants and animals, topography, hydrology, climate and land use are called ecoregions.

The state monitored water quality at least impacted sites in each ecoregion (except Driftless where no least impacted sites could be found; the state recommends comparison to North Central Hardwoods) for 15 years and determined surface water quality for those locations. The results represents "obtainable" water quality for Minnesota. Because least impacted sites were measured, these sites represent what water quality should be in the ecoregion with a minimum of impact to the water bodies. Thus, water quality monitoring results can be compared to this information. The state recommends that comparisons be made to the 75th percentile of the ecoregion study, to take into account the natural variability of water quality within an ecoregion.

Ecoregions in the Red River Basin:

- Red River Valley: Relatively flat; fine or clay soils dominate. Low population density. Cultivation of marginal land and removal of shelter belts leading to increases in suspended sediment (turbidity). It is one of the largest, truly flat landscapes in the world (roughly the size of Denmark). The fall in elevation from Wahpeton to Lake Winnipeg is only 233 over a distance of about 545 river miles. The slope of the main stem of the Red River averages about one-half foot per mile. Over 80 percent of this region is cultivated, predominately with small grains. Streams in this ecoregion represent an important natural resource. Many of the streams in the Red River Valley have been increasing in nitrate and suspended solids concentrations in the past 12 years. This assessment and the intensive land use in the ecoregion suggest nonpoint source pollution problems in the Red River Valley.

  Counties: Clay, Kittson, Marshall, Norman, Pennington, Polk, Red Lake, Traverse, Wilkin

- Northern Wetlands: Flat, soils dominated by organic peats. Very low population density. Half forested, one-third water or marsh. Very little agricultural use (less than 20 percent). Represents approximately 10 percent of the state. Forestry and wood product industries are major employers. The lakes and streams in this ecoregion generally have good water quality.

Counties: Beltrami, Koochiching, Lake of the Woods, Roseau

- Northern Lakes and Forests: Gentle slopes and some hilly areas. Soil dominated by sand and silt. Generally low population density with some urbanized areas. Forested with some agriculture, mining and urban development. Covers one-third of the state's area and is the largest of the seven ecoregions. This area has extensive stands of second growth forest and contains 46 percent of the state's lakes. Stream density is low.

  Historic and contemporary land use activities are associated with recreation, extraction of minerals and timber harvest. For these activities, the intensity of land use can be high; however, these activities are confined to small areas within the ecoregion.

  Streams in this ecoregion are of two types. The streams draining into Lake Superior generally are short and have steep gradients. These characteristics account for the highly variable water levels reflected in the streams' annual hydrograph. Elsewhere in the ecoregion, streams generally connect the numerous lakes and are, therefore, relatively stable in terms of annual flow.

  Historic logging, followed by extensive fires, have greatly altered stream water quality. An entirely altered litter chemistry (chemistry of materials on the forest floor) is evidence of the water quality effects of these early land use practices. Despite this history, stream water quality is generally considered good and very little seasonal variation occurs. Stream water quality problems would likely be confined to isolated areas and involve nutrients and suspended materials.

  Counties: Aitkin, Carlton, Cass, Clearwater, Cook, Crow Wing, Hubbard, Itasca, Lake, Pine, St. Louis

- North Central Hardwoods: Irregular topography, plains and rolling hills. Soils dominated by sand and silt. Population density relatively low in northwest and very high in southeast. Mixed land use with forests in northeast and primarily agricultural land uses in southwest.

  About 50 percent of the ecoregion is cultivated and there is also a high population density in the southeastern part of the ecoregion. Stream water quality may be deteriorating as suggested by a slight increase in suspended solid concentrations over the past 12 years. This ecoregion contains about 40 percent of Minnesota's lakes. Of the assessed lakes, 51 percent fully support swimmable uses, 16 percent partially support, and one-third do not support designated uses. The water quality trend in lakes and streams suggest that this ecoregion is sensitive to and is being impacted by non-point source pollution.

Counties: Anoka, Becker, Benton, Carver, Chisago, Douglas, Hennepin, Isanti, Kanabec, LeSueur, Mahnomen, Meeker, Mille Lacs, Morrison, Otter Tail, Pope, Ramsey, Rice, Scott, Sherburne, Stearns, Todd, Washington, Wright

- Northern Glaciated Plains: Flat terrain with silty soils characterize this primarily agricultural region. About 11 percent of the region features pastures and open land, but agricultural uses, chiefly the cultivation of corn and soybeans, account for more the 83 percent of land use in this sparsely-populated area.

  There is very little forested area in this ecoregion with 80 percent of the land area cultivated. Streams in this ecoregion have increased concentrations of nitrates and suspended solids. This region is home to 855 or about 7 percent of all of Minnesota's lakes. Although most of the lakes are quite shallow and rather large, the majority (85 percent) do not support swimmable uses. Both lakes and streams in the Northern Glaciated Plains are being impacted by non-point source pollution.

  Counties: Big Stone, Chippewa, Grant, Lac Qui Parle, Lincoln, Lyon, Pipestone, Rock, Stevens, Swift, Yellow Medicine

	NLF	NCH	RRV	NMW	NGP	WCB
Cond.	270	340	658	250	1100	790
pH	7.9	8.1	8.3	7.9	8.2	8.2
TSS	6.4	16.1	56.5	17.2	65.5	57.5
T.Ammon.	0.20	0.22	0.29	0.20	0.31	0.39
NO_2NO_3	0.09	0.29	0.20	0.08	0.52	5.62
T.Phosph.	0.052	0.170	0.322	0.092	0.271	0.340
Fec.Col.	20	330	230	50	700	790
TempC	17.6	20.0	19.9	17.2	20.5	19.2
Turbid.	4.3	8.5	23.0	10.0	23.7	22.0
BOD5	1.7	3.4	4.2	2.2	4.5	5.6

TABLE: Water Quality of Least Impacted Streams by Ecoregion (at 75th percentile). Based on Storet stream water quality data for the period 1970-1985. Minnesota Pollution Control Agency, 1988

In North Dakota, there are 2 major ecoregions:

- Northern Glaciated Plains: The Northern Glaciated Plains ecoregion is characterized by a flat to gently rolling landscape composed of glacial drift. The sub-humid conditions foster a grassland that would be characterized somewhere between the tall and shortgrass prairie. High concentrations of temporary and seasonal wetlands create favorable conditions for duck nesting and migration. Though the till soil is very fertile, agricultural success is subject to annual climatic fluctuations.

- Lake Agassiz Plain: Glacial Lake Agassiz was the last in a series of proglacial lakes to fill the Red River Valley since the beginning of the Pleistocene Era. The Lake Agassiz Plain is composed of thick lacustrine sediments underlain by glacial till. It is extremely flat and has fewer lakes and pothole wetlands than neighboring ecoregions. The historic tallgrass prairie has been replaced by intensive agriculture. The preferred crops in the northern half of the region are potatoes, beans and wheat. While soybeans and corn are predominant mainly in the south, sugar beets are grown throughout the Lake Agassiz Plain.

Local Water Quality Trends

Trends in stream water quality over time are detected by statistical analysis of monitoring data. No clear statewide trend exists for Minnesota rivers over the last 20 years, but trend analyses show local increases in some constituents and decreases in others.

Increases are due primarily to population pressures, decreases to improved treatment facilities and nonpoint control practices or to closing of facilities and reductions in agricultural activities. A decreasing trend in dissolved nutrients in the Minnesota River may be attributable to reductions in agriculture because of the droughts of the 1980s. Increases in chloride concentrations in the Minnesota River and the North Fork Whitewater River probably resulted from road deicing and may be associated with population increases.

In Minnesota, the ability of rivers to support numbers and kinds of fish and other organisms generally increases from northeast to southwest. For fish, the range is from 20 pounds per acre in the northeast to 400 pounds per acre in the southwest. This broad range can be attributed to the variable acidity and alkalinity of the source waters. The limestone sediments blanketing the southwest yield hard, relatively fertile water with high pH, while the peatlands and bedrock of northeastern Minnesota yield softer, more acidic and relatively infertile water.

In the Red River Basin, dissolved solids and alkalinity are high, probably because of geologic conditions. Sediments left behind by ancient glaciers and lakes are 200 to 300 feet thick. Sandy soils rich in clay and silt predominate in the west, while poorly drained organic soils and peat are common in the Basin's headwaters. During low flow, when recharge comes largely from groundwater seepage, water chemistry reflects that of the glacial drift aquifer system. Concentrations of dissolved chemical constituents are normally low during spring run-off and after thunderstorms. Population in the Basin is sparse and land use is predominately agricultural. Nitrogen concentrations are fairly low except in the south where streams drain corn-dominated cropland. Elevated total nitrogen and total phosphorus concentrations are normal, and some persistent pesticides, such as atrazine and 2,4-D have been detected. However, pesticide concentrations rarely approach drinking water or ambient water-quality standards.

The primary pollutants causing aquatic life use impairment in the Red River Basin are silt, nutrients and organic material. Some sources of nutrients include riparian grazing and unregulated concentrated livestock feed operations.Stream habitat degradation and stream flow alteration are other significant causes of aquatic life use impairment in the Basin. Stream habitat degradation can be caused by riparian area grazing, lowhead dams, channelization and excessive snagging and clearing. Stream flow can be altered by upstream reservoir management and the appropriation of water for municipal, industrial, irrigation, and other uses.

Pathogens, as indicated by fecal coliform baceria, are the primary cause of recreation use impairment. Sources of elevated fecal coliform bacteria concentrations in the Red River Basin are livestock feeding operations, riparian area grazing and urban run-off.

Water Quality Issues

The Minnesota Pollution Control Agency performed water quality assessments for selected rivers and lakes in the Red River Basin in 1996. River assessments based on monitoring of streams and surveys of resource managers showed significant water quality problems in the basin. Impairment of streams was found to be caused primarily by high levels of sediment and bacteria and low levels of dissolved oxygen. Habitat alterations have also degraded Red River Basin streams.

While agriculture and food processing are the engines that drive much of the economy of the Basin, they and their accompanying drainage and urbanization are also often regarded as the primary sources of non-point and point-source water pollution. Concerns also exist that the quality and quantity of ground-water are being threatened by irrigation, landfills, failing septic systems, abandoned wells and leaking underground storage tanks.

Known Water Quality Impairments

The Clean Water Act requires states to monitor and assess their waters and provide documentation of impairments in reports submitted to the respective regional United States' Environmental Protection Agency (EPA)offices.The U.S. Environmental Protection Agency compiles these state reports in a report to the United States Congress (USGO 1988). The Clean Water Act addresses water quality impairments through a Total Maximum Daily Load (TMDL) Program (USGPO 1988). TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards and an allocation of that amount to the pollutants sources (U.S. Environmental Protection Agency 2003). States are required to "list" impaired waters in a report (the "303d" list) and develop TMDLs for these waters. Both North Dakota and Minnesota have Red River Basin waters listed on their "303d list" as impaired.

The Minnesota Pollution Control Agency has identified a total of 42 impaired river or stream reaches in the Red River Basin. Thirty reach impairments include turbidity, nutrients and bacteria with reach lengths ranging from 10 to 100-miles (Figure 4). Another dozen stream reaches have been listed as not meeting designated uses due to biological integrity impairments.

North Dakota has identified over 30 basin reaches as impaired ranging in length from seven to 158 miles. Impairments include aquatic life, exotic plant species, sediment, absence of habitat, flow alterations, organic enrichment, low dissolved oxygen and ammonia. Like Minnesota, Several of these impaired reaches are upstream from critical municipal water intake structures including Grand Forks, East Grand Forks, Fargo and Moorhead.

Although Manitoba has no Federal or Provincial requirements to legally “list” impaired waters, the province recently completed a long-term total nitrogen and phosphorous trend analysis. Manitoba Conservation used data from 46 long-term water quality monitoring stations on 33 different waterways in Manitoba to conduct statistical trend analysis. Fifteen of these stations, all of which are located upstream from lake Winnipeg, are located in the Red River basin. Of these 15 stations, nine had statistically significant increasing trends for total nitrogen and 12 had significant trends for increasing phosphorous.

Manitoba’s Nutrient Management Strategy was developed to manage nutrients and other pollutants in Manitoba’s waters. The province’s strategy was developed because of concerns over the potential eutrophication of Lake Winnipeg, the receiving body for Red River waters in Canada. Preliminary investigative work pertaining to nutrient loading issues indicated current Manitoba Surface Water Quality Objectives did not inadequately address nutrient loading problems in the prairies of Manitoba. The strategy (still in draft form) outlines steps necessary to control nutrient loading from point sources and non-point sources in Manitoba using both regional-based and receiving-waters objectives to derive numeric nutrient objectives.

Source	Associated Pollutant
Cropland	Turbidity, phosphorus, nitrates, temperature, total solids
Pasture	Fecal coliform, turbidity, phosphorus, nitrates, temperature
Industrial discharge	Temperature, conductivity, total solids, toxics, pH
Septic systems	Fecal bacteria, nitrates, phosphorus, dissolved oxygen/ biochemical oxygen demand, conductivity, temperature
Sewage treatment plants	Dissolved oxygen and biochemical oxygen demand, turbidity, conductivity, phosphorus, nitrates, fecal bacteria, temperature, total solids, pH
Construction	Turbidity, temperature, dissolved oxygen/biochemical oxygen demand, total solids and toxics
Urban runoff	Turbidity, phosphorus, nitrates, temperature, conductivity, oxygen

Water Management Functions and Regulatory Authorities

States and provinces routinely monitor their water resources to ensure applicable policies, laws, and regulations are met and the public's water resource interest is protected. Jurisdictions recognize waters as public domain and develop use and type classification criteria for these public waters. Minnesota, North Dakota and Manitoba have used similar rationale to develop designated uses and water quality standards. The only subtle difference is how the standards and uses are implemented. Whereas North Dakota and Minnesota have designated uses and standards written into state law; Manitoba incorporates their designated uses and water quality standards via provincial policy.

In all jurisdictions, water classification language characterizes the various types of waters designated as "public" in the states and provinces. Each classification is assigned a use or series of uses that describes how the water is used by the public. For example, public waters may be designated for municipal, industrial or agricultural uses. Governments may also assign an aquatic life use to public waters. Aquatic life uses protects fish, macroinvertebrate communities and other aquatic biota.

In order to assure designated uses are met, states and providences apply water quality criteria to each of the designated uses. Water quality criteria are developed in two separate, yet integrated, forms: numeric and narrative.Numeric criteria are separated into two categories: maxima and minima. These identify the desired numeric concentrations of certain constituents in public waters and are usually portrayed as maximum or minimum allowable levels in the waterbody. Narrative criteria are often referred to as the "free froms." These are the minimum acceptable standards for surface waters. Narrative criteria attempt to describe the desired aesthetic characteristics of public waters. For example, in its "General Water Quality Standards", the State of North Dakota requires all waters of the state to be "free from substances attributable to municipal, industrial, or other discharges or agricultural practices that will caused the formation of putrescent or otherwise objectionable sludge deposits."

Section 305b of the Clean Water Act requires States to periodically assess, at least every two years, the condition of their public waters and submit a report (named the 305b report) to Congress on the extent to which the beneficial uses of the state's rivers, streams, lakes, reservoirs and wetlands are met. In order to fulfill the requirements of the 305b report, ambient programs were implemented to assess the general character of the state's water and to monitor permitted discharge compliance. Data from these activities include chemical and biological measurements. Manitoba has no federal reporting requirements; however, Manitoba Conservation does submit a "State of the Province" report to the provincial government. The next report is currently being prepared and will be ready for review later in 2003.

Conducting beneficial use attainment assessments often requires more spatial resolution than existing ambient monitoring programs can provide. Although considerable resources have been expended to conduct ambient monitoring activities in the various jurisdictions, the general consensus is that these efforts, while useful in monitoring permitted discharge compliance, have limited use for determining trends or making beneficial use assessments in a significant number of stream miles.

Summary of Water Management Functions and Regulatory Authority

At the Local Level:

- Watershed Districts: On the Minnesota side of the Red River, local water management is the responsibility of watershed districts. Eleven districts, including the state's largest district, the Red Lake Watershed District, have been established in the basin under authority of the Minnesota Watershed Act of 1955. They are governed by a board of managers appointed by the boards of county commissioners and are empowered to develop long-range plans, regulate activities affecting water resources, acquire property rights and construct and finance improvement projects. An ad valorem (according to value) tax levy, not to exceed one mill on each dollar of assessed value of all taxable real property within the district, provides funds for general administrative expenses and for the construction and maintenance of projects.

- Red River Watershed Management Board (RRWMB): Legislation passed in 1976 made it possible for the watershed districts to form the RRWMB for the purpose of instituting and financing flood damage reduction projects within the boundaries of member watershed districts. This legislation also allowed member watershed districts to levy up to two mills ad valorem tax. One-half of the tax collected is retained by each district for projects within the district, while the other half is transferred to the RRWMB for projects which provide benefits to the Red River's main stem.

- Soil & Water Conservation Districts (SWCD): SWCD boundaries are usually those of the county for which they are names. Each district in Minnesota is governed by a five-member board of supervisors, elected at-large by eligible voters within the district. Districts receive state money to administer numerous conservation programs through the Minnesota Board of Water and Soil Resources .

- Water Resource Districts (WRD): Boards of water managers, appointed by the county commission for staggered terms of three years, are responsible for water management activities within basin Water Resource Districts. Boards may, at the discretion of the county commissioners, have three or five managers. WRDs engage in a wide range of management activities and finance their operations in one or more of the following ways: General district-wide mill levy (not to exceed four mills), special assessments against property benefitted by a project or activity, user fees imposed and collected for the services provided by a project, revenue bonds, and state or federal cost-sharing.

- Conservation Districts: In the province of Manitoba, conservation districts are responsible for local water management. The borders of conservation districts are generally the boundaries of the drainage basin of the major river of the area. Conservation districts routinely deal with soil conservation and management, conservation demonstrations/experiments, water management and conservation and a host of other activities. Each district is a corporate body and is governed by boards of local representatives. Special property tax levies are the source of a portion of the district's funds, but a majority of the funds are provided by the province in forms of grants.

At the State and Provincial Level:

Minnesota:

- Minnesota Department of Natural Resources (DNR): The Minnesota Department of Natural Resources serves Minnesotans through seven distinct but related divisions: Forestry, Minerals, Fish and Wildlife, Enforcement, Parks and Recreation, Trails and Waterways, and Waters. Overall responsibility for water management is assigned to the Division of Waters. For example, five major regulatory programs are administered by the division, including: protected waters and wetlands, dam safety, floodplain management, shoreland management, and surface and groundwater appropriation.

- Minnesota Pollution Control Agency (MPCA): This Minnesota state agency has broad regulatory powers related to surface and ground-water quality, solid waste disposal, disposal of wastes or surplus water in wells or sumps, municipal waste treatment systems and cleanups of accidental spills.

- Department of Health: The state agency is federally funded and, among other things, is charged with ensuring that public drinking water meets safe drinking water standards.

- Geological Survey: Minnesota's Geological Survey, which is a part of the University of Minnesota, is responsible for the investigation and mapping of the state's geology.

- Board of Water and Soil Resources (BWSR): The BWSR assists local units of government in natural resource management. The 17-member board is made up of three county commissioners, three soil and water conservation district supervisors, three watershed district representatives, three citizen members, and five nonvoting members. The BWSR is responsible for the review and approval of county comprehensive water plans.

- Environmental Quality Board (EQB): This is Minnesota's principal forum for discussing environmental issues. The current 15-member board is composed of a chairperson and five citizen members appointed by the governor, the commissioners of the State Departments of Agriculture, Health, Natural Resources, Public Service and Transportation; the Commissioner of the Pollution Control Agency; the Chair of the

Board of Water and Soil Resources; and the directors of the Office of Strategic and Long Range Planning and the Office of Waste Management. The EQB provides the public with an accessible forum for debating and discussing the environmental policies and decisions of state government. It also serves as a mechanism for coordinating the actions of major state agencies and evaluating the impact of their decisions on the environment. It also provides the governor and the legislature with a tool for working on those environmental issues and problems that are not addressed by one of the state's other environmental agencies.

North Dakota:

- State Water Commission (SWC): SWC consists of the governor, the Commissioner of Agriculture and seven other members appointed by the governor to provide regional representation. Its divisions of Administration, Atmospheric Resources, Planning and Education, Water Appropriation and Water Development direct a variety of programs including enforcement and inspection, construction and maintenance, data collection, aquifer identification and monitoring, engineering feasibility studies, technical assistance to water resource district boards, quantification of water rights, inventory of groundwater and surface water resources, and State Water Plan updating and maintenance.

- SWCNorth Dakota Department of Health: The Municipal Facilities Division consists of three primary programs designed to assist municipalities and other political subdivisions in the maintenance of public health and safety. The Water Quality Division administers a number of programs including: Surface Water Monitoring, Nonpoint Source Pollution Management, Groundwater Protection, Wellhead Protection, Underground Injection Control, North Dakota Pollutant Discharge Elimination System Permits, Feedlots and Septic Tanks. The North Dakota Department of Health Division of Water Quality has developed supporting documentation for all monitoring activities and established statewide quality assurance and quality control practices. This documentation provides the supporting framework and technical documentation for the monitoring activity.

- North Dakota Game and Fish (North Dakota G& F): North Dakota Game and Fish is responsible for the management of the state's fisheries, wildlife areas and wetlands.

Manitoba:

- Manitoba Water Resources (MWR): MWR constructs and operates water control works on designated provincial waterways. The Water Rights Act establishes the branch's role in the use and control of surface water and groundwater including administration of a priority-of-use program, the licensing of water users, setting fees, and the regulation of drainage activities.

- Manitoba Water Service Board: The Manitoba Water Service Board was created to assist in the provision of water and sewage facilities to the residents of rural Manitoba.

At the Federal Level:

- Natural Resource Conservation Service (NRCS): The NRCS is a technical agency of the U.S. Department of Agriculture. The NRCS has cooperated with local and state agencies in implementing several flood damage reduction measures and conservation practices

- Fish and Wildlife Service (FWS): The FWS administers two habitat preservation programs which directly impact the on an area's water resources. The first program involves fee title purchases of land for waterfowl management purposes. A second program involves leasing certain valuable habitat acres. The latter program forbids landowners to drain, tile or fill wetlands; however, landowners may hay, graze or farm wetlands under lease when they are dry from natural causes.

- Geological Survey (USGS): The USGS provides technical services and assists local units of government in identifying and resolving water problems. The USGS conducts regional aquifer studies and maintains a network of streamflow and lake level gages. The agency's data collection and management services are used at all levels of government in making water management decisions.

- Army Corps of Engineers (COE): The COE has broad authorities pertaining to dredge and fill activities, streambank protection, snagging and clearing, and other flood control measures.

- National Park Service (NPS): The NPS makes grants available to local units of government to fund outdoor recreation projects. These 50 percent matching funds are administered by the Minnesota Minnesota Department of Natural Resources and the North Dakota Parks and Recreation Department.

- Environmental Protection Agency (U.S. Environmental Protection Agency): The U.S. Environmental Protection Agency is charged with mounting a coordinated attack on the environmental problems of air and water pollution, managing solid and hazardous wastes under Superfund, regulating pesticides, toxic substances, and in some cases, radiation and noise. Functions include setting and enforcing environmental standards; conducting research on the causes, effects and control of environmental problems; and assisting states and local governments.

- Environment Canada: Environment Canada is given the responsibility for preserving and enhancing the quality of the environment by promoting harmony between citizens and their environment.

For Further Study

Why Do We Protect Rivers?

"Whether by snowshoe in winter or a hike in the spring, with canoe paddle, fly rod,
or shotgun in the fall – to those who would listen, the river is a magic music box.
To those who would observe, the pattern of color and movement paint a picture
that is a masterwork resulting from millions of years of nature's efforts,
yet dynamic and ephemeral. Minnesota is rich with streams and river resources that,
beyond economic utility, make up our living environment,
delight our senses and indeed, form and mold our culture."

Tom Waters, *The Streams and Rivers of Minnesota*

Rivers are important parts of our natural and human landscape. A river connects the soils, plants and animals of its watershed. It also connects people who live upstream and downstream. It provides a community its power, its drinking water and a place for recreation. Nationally, rivers such as the Mississippi, the Ohio and the Columbia have shaped our history.

The crisis facing America's rivers was described in *Entering the Watershed: A New Approach to Save America's River Ecosystems*, written by Bob Doppelt, Mary Scurlock, Chris Frissell and James Karr and published by Island Press in 1993:

- The degradation of America's riverine systems and the depletion of riverine-riparian biodiversity have reached alarming levels. Not one riverine system in America has been spared. Fisheries, surface and groundwater quality and quantity produced by watershed ecosystems and entire aquatic food chains are at risk nationwide.

- Only a few examples are needed to understand the extent of the crisis. In the 20 years since the enactment of the Clean Water Act and the National Wild and Scenic Rivers Act, almost 50% of the nation's waters still fail to meet water quality standards when biological criteria are used. Less than 2% of the nation's river miles even qualify for Wild and Scenic designation, leaving more than 98% of the miles with no protection options.

- From one-third to three-fourths of aquatic species nationwide are rare to extinct and aquatic species are disappearing at a faster rate than terrestrial species. An estimated 70 to 90 percent of natural riparian vegetation, vital to maintaining the integrity of riverine-riparian ecosystems and biodiversity, has already been lost or is degraded due to human activities nationwide. Seventy percent of the nation's rivers and streams have been impaired by flow alteration.

- The jobs and food resources once provided by the commercial and recreational fisheries nationwide have been decimated in this century. For example, two-thirds of the fishes of the Illinois River (Illinois) have experienced major population declines or disappeared from that watershed since 1850 and the commercial catch of the river, second in commercial catch to the Columbia River early in this century, declined to near zero over a decade ago. The Missouri River commercial fishery has declined by 80 percent since 1945 . . .

- How would our nation respond if our agricultural productivity were reduced by three-quarters or were eliminated altogether?

- Despite expenditures of at least $473 billion to build, operate and administer water pollution control facilities since 1970, the nation's water resources continue to decline in both quality and quantity. Soil in America is eroding at the rate of 4 billion tons per year and soil erosion costs the nation an estimated $3.2 billion each year. About one-third of the soil eroded by water from agricultural land enters streams and other bodies of water, annually causing $2 to 9 billion in off-site damage to water-related activities, such as recreation, water storage, irrigation and navigation.

  In short, almost every segment of our society has been affected by and pays heavy direct and indirect ecological, financial and job-related costs for the degradation of America's riverine systems and biodiversity, whether they are aware of it or not. (Executive Summary, p. xxi-xxiii).

In the more narrow sense, water quality standards are the entities, both numeric and narrative, that define acceptable conditions for the protection of the uses we make of waters of the state. Minnesota R. ch. 7050 identifies seven beneficial uses for which surface waters are protected, as listed below (the numbers 1 – 7 are not intended to imply a priority rank to the use classes).

Use Class	Beneficial Use
Class 1	Drinking water
Class 2	Aquatic life and recreation
Class 3	Industrial use and cooling
Class 4A	Agricultural use, irrigation
Class 4B	Agricultural use, livestock and wildlife watering
Class 5	Aesthetics and navigation
Class 6	Other uses
Class 7	Limited resource value waters (not fully protected for aquatic life due to lack of water, lack of habitat or extensive physical alterations)

Class 2 waters are further divided into subclasses as follows:

Class 2A	Cold water fisheries, trout waters
Class 2Bd	Cool and warm water fisheries, in addition these waters are protected as a Source of drinking waters
Class 2B	Cool and warm water fisheries (not protected for drinking water)

Class 2C	Indigenous fish and associated aquatic community
Class 2D	Wetlands

Specifically, a numerical water quality standard is a safe concentration of a pollutant in water, associated with a specific beneficial use. Ideally, if the standard is not exceeded, the use will be protected. However, nature is not that simple, and the Minnesota Pollution Control Agency must use a variety of tools in addition to numerical standards, like biological monitoring, to fully assess beneficial uses.

How We Use Rivers

(Source, *Minnesota's Rivers*, University of Minnesota Water Resources Center, publication pending)

Generally, water use is understood to mean use of water diverted or withdrawn from a stream channel. Drinking water supply, agricultural irrigation, power plant cooling and industrial food processing are examples of such uses. In Minnesota, water appropriation permits are required for all users withdrawing more than 10,000 gallons per day or one million gallons per year. As a condition of the permit, the holder must annually report the volume of water withdrawn, within 10 percent accuracy, to the Minnesota Department of Natural Resources. The Minnesota Department of Natural Resources uses these individual reports, among other purposes, to create reports summarizing water use in Minnesota.

Water withdrawals that do not require a permit and annual reporting are estimated every five years by the U.S. Geological Survey and are published in the Minnesota section of the *National Water Summary.*

In 1990, 1,088 billion gallons of water use withdrawals were reported to the Minnesota Department of Natural Resources. Approximately 81 percent of withdrawals (876 billion gallons) came from surface water sources. Some surface water is withdrawn from lakes, primarily Lake Superior, but most comes from rivers or reservoirs on rivers.

Total surface water use has remained essentially stable since 1980, though there were shifts in water uses. The use of surface water for agricultural irrigation and public supply has declined from a high in 1980. Industrial water use also decreased, while use in power generation has increased.

All off-stream uses consume some water, but not all the water withdrawn for use is lost to the river or waterbody. Some portion of the withdrawal is usually returned to the source. The portion used or “consumed” is called the consumptive use. In Minnesota, irrigation use is considered to be almost totally consumptive, but power plant cooling water use is considered nearly totally non-consumptive.

Power Generation (excluding hydropower)

The largest volume of surface water withdrawals reported in 1990 and 1991 were for power plant cooling. Minnesota's thermoelectric power plants withdrew 697 billion gallons of surface water in 1990 and 693 billion gallons in 1991. Of this, about 90 percent was returned to its source. This means that while power plant withdrawals make up about 79 percent of total surface water withdrawals, water consumption by power plants constitutes less than 8 percent of total surface water withdrawals.

Public Supply

Public supply includes water distributed to domestic, commercial, small industrial and public users. It does not include self-supplied domestic users or those served by small water companies (those with fewer than 25 customers), but almost none of these, or less than 1 percent, uses surface water.

Consumptive use varies with the seasons – a larger percentage of public supply water is consumed through evaporation during the summer months, by landscape irrigation and other outdoor uses of water. While Minnesota has experienced tremendous growth in public supplies since the 1950s, use of surface water sources for public supply has actually decreased substantially since reaching a peak in 1980.

Industrial and Mining

The industrial water use category includes mining and milling activities, paper and forest product operations, and food processing. It does not include smaller industrial facilities that receive their water from public water suppliers. Approximately 75 percent of the water used in industry is withdrawn from surface water sources. Water consumption varies depending on the type of process, but for Minnesota as a whole, industrial consumptive use was estimated to account for 62 percent of withdrawals in 1985.

The industrial use responsible for the largest surface water withdrawals is mining. In 1985, these activities withdrew 99 billion gallons of surface water (a national maximum). Other industrial activities, such as metal, paper, pulp and chemical processing, used 39 billion gallons in the same year. In 1990, the amounts of surface water withdrawn for mining and other industrial activities totaled 44 billion gallons and 34 billion gallons, respectively. The decrease in industrial process withdrawals between 1985 and 1990 follows a trend that began in the 1960s.

Agricultural

Irrigation is the primary agricultural water use. The Minnesota Department of Natural Resources's irrigation category includes major crops, orchard and nursery irrigation, as well as some uses that are not agricultural, such as landscaping, and cemetery and golf course irrigation. Non-irrigation agricultural uses are primarily stock watering and on-farm water uses. Non-irrigation uses are generally so small that they do not require a Minnesota Department of Natural Resources permit and, therefore, are not reported.

In 1951, 90 percent of irrigation water came from surface streams and lakes, but by 1980, surface diversions supplied less than 12 percent of irrigation water uses. Between 1980 and 1985, surface water withdrawals for irrigation increased from 6.6 to 28.5 billion gallons, mostly because due to increased production of wild rice. In 1985, Aitkin, Beltrami, Cass, Clearwater and Polk counties contained 90 percent of the world's wild rice paddies. Surface water withdrawals for irrigation decreased to less than 13.7 billion gallons in 1990, or just less than 24 percent of total irrigation withdrawals. The decrease may be attributed in part to increased competition from California-grown wild rice, although wild rice irrigation still accounted for 70 percent of irrigation from Minnesota's surface water in 1990.

Other

The Minnesota Department of Natural Resources has a water use category called "other." This category contains such permitted water uses as large-scale heating and cooling operations; dewatering operations for mines, quarries and construction projects; and water level maintenance. In 1990, these uses accounted for 31.8 billion gallons or 36 percent of surface water withdrawals.

Use Category	Surface Water Use Billion Gallons	Total Water Use Billion Gallons	Surface Water Percentage of Total
Power generation	692.9	694.1	99.8
Public supply	60.2	170.4	35.3
Industrial processing	89.3	115.0	77.7
Irrigation	13.0	59.4	58.4
Other	30.5	52.2	58.4
Total	885.9	1091.1	82.2

In-stream or On-stream Uses

In-stream or on-stream uses are activities that depend on the water in the stream channel. These uses usually depend on the maintenance of at least a minimum level of flow. In general, these uses are documented, not on the basis of water used, but on some other measure. These uses may generate commercial revenue for the user, as with commercial fishing enterprises, or they may provide other values, such as endangered species protection. Some uses, such as sport fishing, provide both commercial revenue and non-commercial recreational value.

While in-stream uses do not require water be withdrawn from the channel, they may require alteration, stabilization, or protection of the channel itself. A good example of this kind of use is commercial navigation.

Commercial Navigation

Minnesota's navigable riverways are part of the national shallow draft navigation system, with its 22,000 miles of river channel. ince the 1930s, the upper river system in Minnesota has been maintained to accommodate vessels with 9 feet of draft (defined as the depth of water a barge requires to float when loaded).

The U.S. Army Corps of Engineers maintains the channel by dredging. Regular dredging is required to keep the channels open mainly where fast moving tributaries meet the main river and deposit their sediment in shoals. The Corps also maintains the lock and dam facilities that lift and lower river traffic a total of 179 feet from the Iowa border to Minneapolis. The locks on the Minnesota portion of the river system were built to accommodate barges up to 290 feet long, 50 feet wide, carrying up to 3,000 tons of cargo.

Commercial navigation includes both freight and passenger traffic. Freight traffic generates significant economic returns to the state and country. Major freight movements to and from Minnesota's 58 active river terminals include the transporation of grain, coal, liquid and dry fertilizer, iron and steel, sand and gravel, crude oil and petroleum products, newsprint, and all types of heavy general cargo.

The McKnight Foundation reported (*The Mississippi River in the Upper Midwest: Its Economy, Ecology and Management*, Minneapolis 1996) that the navigation system reflects the economic uses of the Mississippi's greater watershed, transporting about half the region's grain crop each year. River barging is a low-cost means of transporting commodities. However, 85 percent of the navigation's system cost is paid by taxpayers, making it the nation's most heavily subsidized form of commercial transportation.

Recreational Navigation

Access to the state's water for boating is considered a basic right for Minnesotans, and recreational boating is one of the largest uses of Minnesota's large rivers. There are 2,850 miles of river designated as canoe and boating rivers and more than 2,300 state-maintained public access ramps and drop-in points. Fishing and hunting are also popular uses of the state's rivers.

Drainage Basin	Canoe and Boating Route
Red River of the North	Red Lake River, Red River of the North
Rainy River	Big Fork, Little Fork, Vermilion
St. Louis/ Lake Superior	St. Louis, Cloquet
Upper Mississippi	Mississippi, Pine, Crow Wing, Rum, North Fork of the Crow
St. Croix	St. Croix, Kettle, Snake
Minnesota	Minnesota
Des Moines	Des Moines
Lower Mississippi	Cannon, Straight, Zumbro, Root

How Does Your Community Affect the River?

Technical information has an important place in making decisions about the environment, but protecting the environment is not just about technical issues. It's also about the values that people hold. It may be a technical question for a scientist to determine if a particular chemical causes cancer. It is a value judgment, however, for people to decide if they want themselves and their children exposed to that chemical.

Donald F. Harker and Elizabeth Ungar Natter. *Where We Live: A Citizen's Guide to Conducting a Community Environmental Inventory.* Washington, D.C.: Island Press: 1995 (p. 3).

Your volunteer monitoring program is founded on your community's goals for using the river. This section is designed to help the community assess the impact of its uses on the river.

Communities use rivers intensively. For example, the headwaters of the Mississippi River are found in Minnesota. Even though the river flows through an Indian reservation, a national forest and several state parks in its headwaters portion, it is still subject to spills of hazardous materials. The Mississippi River Defense Network reports that there are 3,300 locations in the Headwaters stretch – or nearly 7 sites per mile – on on the Mississippi north of the Twin Cities where the river is susceptible to spills from hazardous materials. These sites include 18 pipelines. Seven of these carry petroleum products, and 11 serve as sewage mains in Bemidji, Grand Rapids, Brainerd and other communities. Aboveground storage tanks in Grand Rapids contain 655,000 gallons of petroleum products. There are 1,300 underground storage tanks near the river. These potential spill sites are of special concern since the river is the source of drinking water for a quarter of the state's population.

There are numerous federal and state regulations governing transportation, storage, use and disposal of materials that have been deemed hazardous. Yet, the use of these chemicals is important to the economic well-being of our communities. It is appropriate for citizens to understand how these chemicals are regulated and how they affect water quality. The U.S. Coast Guard estimates that only about 10 percent of spilled material is recovered, which makes protection of chemicals, prevention of spills, and quick, local response when a spill occurs all the more important.

Harker and Natter's book describes an intensive inventory and audit of the manufacture, transportation, use and disposal of chemicals in a community. It also includes information on how to measure the impact of chemicals on natural resources. Pollution occurs for several reasons, and in their book, Harker and Natter outline the following:

- Pollution occurs out of ignorance and habit. An example is not considering or knowing that pouring motor oil on the ground may pollute somebody's well.

- Pollution caused by low regulatory standards and/or lax enforcement. Regulatory agencies have a responsibility to protect the health of citizens and the environment by establishing a regulatory framework of protective standards and seeing they are met.

- Pollution that is blatantly illegal. 'Midnight dumping' waste on the side of a road, in an old strip mile, in a river, or in the air to avoid the cost of proper disposal is blatantly illegal.

- Pollution that occurs because of our lifestyle choices. Individuals can make choices such as whether to buy a container that can be reused or recycled rather than thrown away. Many choices are not easy because little or no information is available to consumers on the best choice, or the market has not provided any good choices.

In short, there is illegal pollution, but there is also pollution occurring out of ignorance or lack of awareness of alternatives. In the latter case, it is often necessary to educate the public, more staunchly enforce existing laws, or persuade people to adopt practices to reduce pollution.

For every use of the river, there are associated impacts to its environment. In order to understand how your community affects the river, you should identify each of these uses. Through data collection, you can work to identify potential impacts to the river based on uses. Understanding how use of the river affects the environment will help guide your interpretation of water quality. Remember that much of what affects water quality – such as the amount of available sunlight or composition of the atmosphere – are beyond the control of your volunteer monitoring program or your community.

Monitoring Performance of Local Industry

Is there an industry located in your community that withdraws or discharges to the river? If so, it will have a permit for that use with either the Minnesota Department of Natural Resources (surface water withdrawal), the Minnesota Pollution Control Agency (water discharge), or the North Dakota Department of Health (surface water withdrawal and drainage). You can also obtain copies of such permits and check the industry's compliance with permit requirements over time.

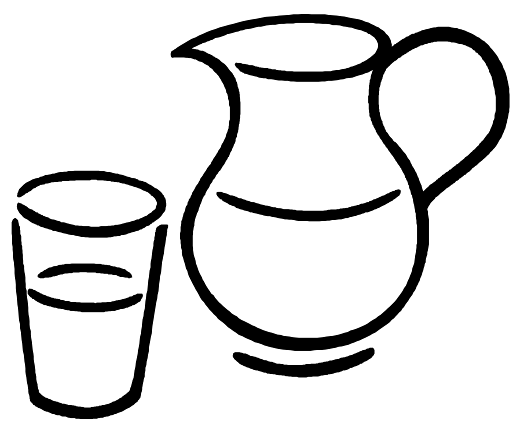
Ask the industry for a tour of the facility and an opportunity to meet with the environmental compliance officer. That individual can explain how the industry meets its federal and state requirements. If the industry is discharging to the river, it is performing some of the tests described in this volume. However, while your volunteer monitoring program monitors ambient water quality, the industry monitors the quality of its discharge. It is not possible to directly compare results between your program and the industry's monitoring.

Monitoring Performance of Drinking Water Treatment Plants

Do you know where your drinking water comes from? Many people do not! In Minnesota, only about one-third of the state's residents receive drinking water from surface water, with many drawing water from the Mississippi River. The availability of groundwater for municipal drinking water is a growing problem in Minnesota, especially in western Minnesota and in the Twin Cities metropolitan area.

Visit Your Municipal Drinking Water Treatment Plant to Determine:

- Where does your water come from?
- How many households receive municipal water?
- How many gallons of water per 24 hours is your plant rated to deliver?
- What is the average demand per month and what are the peak months?
- Is the operation complying with state and federal regulations?
- Who monitors water quality at the facility and what training or certification do they have?
- Is there a storm sewer system?
- Are there controls to prevent untreated water from entering the system?
- Is there adequate water to meet current and future demands?
- Is there a map of the distribution system?
- What contaminants are tested for in raw and finished water?



Monitoring Performance of Municipal Wastewater Treatment Plants

People have discharged wastes to rivers for thousands of years, and, as a result, the health of our rivers has suffered. St. Cloud State University was built along the banks of the Mississippi River during a time when the river carried diseases, such as cholera. Consequently, the buildings face away from, and not toward, the river. We have come a long way in restoring the health of our rivers by regulating how municipal wastes are discharged.

Today, the discharge of wastes to a river is governed by state and federal standards as set forth in the Clean Water Act. Visit your municipal wastewater treatment plant to determine how your community meets those standards. You will want to obtain a map of the collection and discharge system and find out:

- How many households (and individuals) are served by the system?
- How many gallons of sewage per 24 hours the plant is rated to treat?
- What organic loading is the plant is rated to treat?
- What is the average flow per month? (peak months, low months)
- Are they in compliance with state and federal regulations?
- What industrial wastewater is treated at the plant?
- Is there an approved pre-treatment program?
- How many certified plant operaters do they employ?
- Who runs their compliance tests, and what are their quality control procedures?
- What is the emergency plan for breakdowns or spills?
- Are there combined stormwater and sewer lines?
- Is stormwater treated?

How We Protect Rivers

The Clean Water Act:
In 1972, Congress enacted the Clean Water Act "to restore and maintain the chemical, physical and biological integrity of the Nation's waters." It is the national goal of the Clean Water Act that all of our waters should be safe for fishing and swimming. To date, only 66 percent of our waters meet this goal. To achieve such an ambitious goal, Congress understood that a variety of programs would be necessary to attack the many types of pollution entering our waters. Pollutants enter the water by one of two avenues:

- Point Sources: Sources with an identifiable, concentrated discharge point, including large industrial sources and sewage treatment plants, and
- Polluted Run-off: Run-off after storms or irrigation containing pesticides, manure, fertilizers, oil and gas and other types of pollution from farms, ranches, streets and parking lots, suburban lawns and other large area sources.

Industrial Point Sources . . .
Setting Permissible Amounts of Pollution

The Clean Water Act has established a partnership between federal and state agencies to control the discharge of pollutants from large point sources through a 4-step process.

1. The U.S. Environmental Protection Agency develops national guidelines for the control of industrial pollution discharges based on the "Best Available Technology" that is economically achievable. These national standards regulate and apply to entire industrial categories.

2. Individual states, *not* the U.S. Environmental Protection Agency, determine and designate the desired beneficial uses for waterways in their state and establish the water quality standards necessary to make the waterbody clean enough for the designated use. Designated uses include fishing, swimming, boating, wildlife habitat, agriculture and industry.

3. Sewage treatment plants must meet basic levels of treatment, commonly referred to as "secondary treatment," which use biological processes to transform disease-causing organisms into harmless matter. The federal government has provided billions of dollars in grants and loans to state and local governments to construct sewage treatment plants that can meet this standard.

4. All industrial and sewage treatment plants must obtain a permit that specifies the type of state water quality standards and sewage treatment standards that apply to that amount of pollutants they may discharge. These permits specify industry-wide technology sources. They are reviewed and renewed every five years to account for improvements in technology. This type of permitting program is active in 39 states. It is this sort of permitting system that holds dischargers accountable. The federal government, state governments and citizens can sue sources that violate their permits.

Antidegradation

To ensure waters that are currently safe for fishing and swimming stay that way, new sources of pollution are carefully reviewed to ensure they will not degrade the waterbody. Pristine waters, such as headwaters in our National Parks or wilderness areas, can be designated by states to receive special protection.

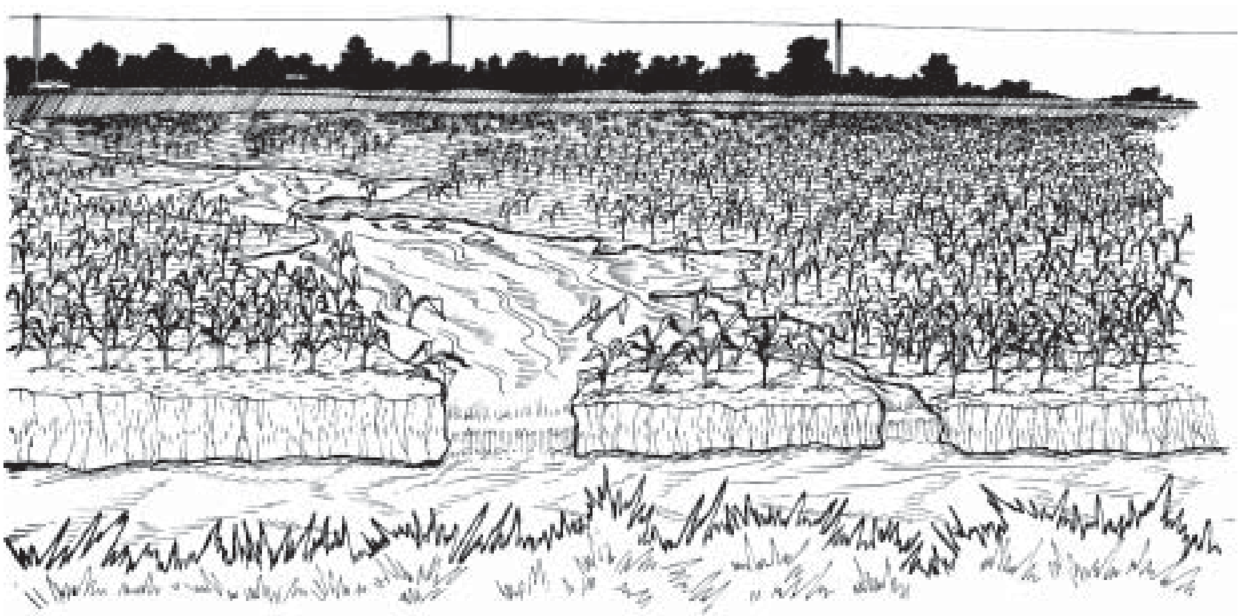
Urban Stormwater

Urban stormwater is a significant source of water pollution. Under current law, heavy industries and cities with a population of at least 100,000 must have stormwater discharge permits that establish minimum requirements for preventing stormwater pollution. Smaller cities do not have to take any action for another six years.

These permits are pollution control plans, rather than specific numerical limits for each pollutant. However, dischargers are held accountable for complying with their requirements.

Polluted Run-off

Polluted run-off from agriculture, forestry, mining and other sources is the largest remaining source of water pollution. Under current law, states are required to plan and utilize cost-effective "best management practices" by landowners at the earliest practical date. Requirements for individual landowners who cause pollution are yet weak and unenforceable.



Concentrated Animal Feeding Operations

One source of water pollution that is becoming increasingly significant is the growth of large feedlots and factory farms. These "concentrated animal feeding operations" cause phosphorus, pathogens and nutrients from animal waste seeping into surface and groundwater. Currently the U.S. Environmental Protection Agency regulates these operations as point sources, but enforcement has been lax.

Summaries of Federal Environmental Protection Laws

Most of the information we have about environmental impacts in communities is due to requirements set by federal laws designed to protect the air and water and to manage waste. Most state laws are tied to federal laws. A considerable amount of this information is compiled by industries that use chemicals or discharging wastes in your community. Although this information indicates how well a facility meets its own environmental requirements, it does not indicate how healthy the air or water is.

Emergency Planning and Community Right-to-Know Act (EPCRA):
There are two parts to this law. The Community Right-to-Know portion of the law gives citizens and government the right to review information on the use of hazardous chemicals in their communities. The Emergency Planning portion of the law requires local governments to create local emergency plans. The law requires a state emergency response commission to designate emergency planning districts. In Minnesota, these are the 87 counties, and each has a designated emergency manager. This individual is responsible for planning for spills, but is not responsible for the actual clean-up of spills. The Minnesota Emergency Response Commission (612-297-7372) is responsible for providing answers to right-to-know questions. North Dakota's Division of Emergency Management, which provides similar information, can be contacted by calling 701-328-4589.

Clean Water Act:
The Clean Water Act is the basic law controlling water pollution. It establishes the authority for state and federal governments to set water quality criteria which guide the discharge of municipal or industrial effluent into rivers.

Local governments can operate publicly-owned treatment works. Industries that discharge to such treatment works are not required to obtain permits from the federal or state governments. Instead, the local government is required to have a state or U.S. Environmental Protection Agency-approved "pretreatment" program. Under a pretreatment program, local governments are supposed to issue and enforce permits for discharges from industries to the treatment works with limitations that will ensure that the treatment plant, in turn, can comply with its own permit. In Minnesota, the Pollution Control Agency enforces the discharge of water and sets permit standards.

The Clean Water Act also provides a great deal of authority to the states. Under current law, states have the right to veto any federal permit or license that threatens state water quality. These permits include Section 404 dredge and wetlands permits and hydroelectric power licenses.

The Clean Water Act also regulates wetlands. The U.S. Army Corps of Engineers, the Minnesota Department of Natural Resources, U.S. Environmental Protection Agency, North Dakota Game and Fish, North Dakota Department of Heath, Water Resource Districts and Soil and Water Conservation Districts enforce these provisions.

Clean Air Act:

This act requires the U.S. Environmental Protection Agency to set national ambient water quality standards for air pollutants which endanger public health or welfare. Each state has a plan to implement the national standards for carbon monoxide, particulates, sulfur dioxide, nitrogen dioxide, hydrocarbons, ozone and lead. The Clean Air Act sets standards for stationary sources (industry, smokestacks) and for mobile sources (cars), for 189 toxic air pollutants, and for acid rain. The Pollution Control Agency administers the Act in Minnesota, and the Department of Health administers it in North Dakota.

The Resource Conservation and Recovery Act (RCRA):

This act establishes a tracking system for hazardous wastes, from manufacture to disposal. It also required U.S. Environmental Protection Agency to establish standards for the operation of hazardous waste landfills, incinerators, storage and other treatment and disposal facilities, and for the handling of hazardous waste by those who manufacture it. This act also requires states to develop solid waste management plans.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA - Superfund):

This act provides for the clean-up of abandoned toxic dumpsites and those substances which must be reported to the federal U.S. Environmental Protection Agency. It also established standards for who would be responsible for the clean-up of hazardous wastes, including generators, transporters and brokers.

Safe Drinking Water Act:

This act requires the U.S. Environmental Protection Agency to set, and public drinking water suppliers to meet, regulations concerning Maximum Contaminant Levels (MCLs) of a number of pollutants. The act also requires public water suppliers to meet certain treatment requirements, such as filtration. Contaminants governed by the act include toxic organic chemicals, pesticides, metals and some compounds created in the purification process itself. The standards are based on health risk assessments and the feasibility of attaining those standards, including cost and treatment technology considerations. Certain exceptions for meeting the standards are allowed.

The act calls for state wellhead protection programs and also protects groundwater by regulating the underground injection of wastes. Most recently, the act provided states with the authority to protect their sources of drinking water.

RED RIVER BASIN
WATER QUALITY MONITORING
VOLUNTEER JOB DESCRIPTION

FUNCTION:
The Water Quality Monitoring Volunteer will retrieve water samples from specific sites, record field data, bring the water sample to the correct lab, record visual assessment of site. Water Quality Monitoring Volunteers may work in teams.

ACCOUNTABILITY:
The Water Quality Monitoring Volunteer is accountable to the regional coordinator.

DUTIES AND RESPONSIBILITIES:
- Calibrate equipment
- Arrive at site
- Set up safety cones and put on safety vests
- Retrieve water samples
- Complete **Field Datasheet** using YSI meter, tape measure and transparency tube
- Complete **Photographic Record** using digital camera

QUALIFICATIONS/REQUIREMENTS:
- Must attend water quality monitoring training
- Must be able to follow directions and procedures
- Must have transportation to sampling sites

TIME REQUIRED:
- Chemical sampling one time per month during ice-free conditions at specific sites.
- Visual assessment of specific sites completed once in early spring and once in late fall.

BENEFITS AVAILABLE TO THE VOLUNTEER:
- Learn water quality monitoring skills
- Collect data that will be used to communicate the health of our rivers and protect them
- Involvement in the community
- Meet new people
- Support of River Keepers

CALIBRATION WORK SHEET

Date of Calibration: ____________________ Technician:______________________________________

DO membrane changed? Y N

Note: Should wait 6 to 8 hours before final DO calibration, run sensor for 15 minutes in Discrete Run to accelerate burn-in.

Turbidity wiper changed? Y N Wiper parks ≈ 180° from optics? Y N

Chlorophyll wiper changed? Y N Wiper parks ≈ 180° from optics? Y N

Note: If either the turbidity or the chlorophyll probe will not park correctly, change the wiper.

Record battery voltage: ________________

Record the following diagnostic numbers after calibration:

Conductivity cell constant	______	Range: (5.0 ± .45)
pH MV Buffer 4	______	Range: (180 ± 50 MV)
pH MV Buffer 7	______	Range: (0 MV ± 50 MV)
pH MV Buffer 10	______	Range: (-180 ± 50 MV)

Note: Span between pH 4 and 7 and 7 and 10, milli-volt numbers should be ≈ 170 to 180 MV

DO charge	______	Range: (50 ± 25)
DO gain	______	Range: (1.0 - .3 to + .5)

Record Calibration Values

	Actual	Sonde after Cal
Conductivity	______	______
pH 4	______	______
pH 7	______	______
pH 10	______	______
ORP	______	______
Depth	______	______
Turbidity	______	______
Turbidity	______	______
Chlorophyll	______	______
Chlorophyll	______	______
DO	______	______

DISSOLVED OXYGEN SENSOR OUTPUT TEST (after DO calibration probe in saturated air)

The following tests will confirm the proper operation of your DO sensor. The DO charge and gain must meet spec before proceeding.

610/650– Turn off the 610/650, wait 60 seconds. Power up 610/650 and go to the **Run** mode, watch the DO % output; it must display a positive number and decrease with each 4 second sample, eventually stabilizing to the calibration value in approximately 60 to 120 seconds. **(Note:** You can disregard the first two samples, as they can be affected by the electronics warm-up.)

PC – Stop discrete and unattended sampling. Confirm that auto-sleep RS-232 is enabled (found in Advanced Menu under Setup). Wait 60 seconds. Start discrete sampling at 4 seconds. Watch the DO % output, it must display a positive number and decrease with each 4 second sample, eventually stabilizing to the calibration value in approximately 40 to 60 seconds. (**Note:** You can disregard the first two samples, they can be affected by the electronics warm-up.)

The **ACCEPT/REJECT** criteria is as follows:
The DO output in % must start at a positive number and decrease during the warm up. Example: 117, 117, 114, 113, 110, 107, 104, 102, 101, 100, 100. Should the output display a negative number or start at a low number and climb up to the cal point, the probe is rejected and must not be deployed.

______ACCEPT ______ REJECT

Notes:

Field Supply Check List

_____ Clipboard and pen/pencil

_____ Field datasheets for field notes & data recording

_____ Cooler (and ice, if necessary) for carrying sample bottles and supplies

_____ Permanent marker for marking bottles as needed and marking stage level reference

_____ 250-ml poly bottles for pH, conductivity, turbidity, nitrate, and total phosphorus testing. Bring one pair of bottles per site, plus a pair for duplicate and another pair for field blank

_____ Thermometers – one for air temperature and one for water temperature

_____ Distilled water – one gallon for field blank processing

_____ Sampling Device: Van Dorn, Kemmerer, or bridge sampler

_____ YSI meter

_____ Turbidimeter

_____ Hip boots or waders for collecting low flow samples, if needed

_____ Tape measure with weight for measuring stage level of river

_____ Electrical tape if marking river depth on sampling device

_____ Transparency tube

_____ Digital Camera

_____ Whirl-packs or 100-ml poly bottle (only if collecting fecal coliform samples)

_____ Orange or other equivalent flotation device, tape measure and a watch

_____ Kim-wipes and wash bottle with distilled water (if taking field measurements with meters)

_____ Traffic cones and safety vests

Detailed Site Description

Sampling Site Name/ID: ____

Name of River/Stream: ____

GPS (Latitude & Longitude): ____

____

____

GPS Unit: ____

Elevation: ____

Site Location Description: ____

____

____

____

____

____

____

____

____

____

Field Datasheet

Date: ____________________ Sampling Site: ________________________ Time: ________________

Sampling Team (first and last names): ________________________ ______________________

____________________ ________________________ ______________________

____________________ ________________________ ______________________

PARAMETERS			
Water Temperature (°C or °F)		Salinity	
Specific Conductance (mS/cm)		DO (%)	
Conductivity (mS/cm)		DO (mg/L)	
TDS (mg/l)		PH	
Turbidity (NTUs)		Flow (cubic ft./second)	

Width: ____

Dissolved oxygen meter used: ____

Turbidimeter used: ____

How obtained flow: ____

Stage Level	
Bottom (ft/in.)	
Surface (ft/in.)	
Depth (ft/in.)	

Transparency Tube	
First (cm)	
Final (cm)	
Average (cm)	

WEATHER CONDITIONS

	Air Temperature (°C or °F)	Wind Speed (mph)	Precipitation (inches)	Other conditions (clear, sunny, overcast, heavy rain, sprinkles)
Today:				
Previous two days:				

Visual Watershed Survey

Use check marks to indicate presence. Check all that apply

Water Smell	
Rotten eggs	
Chlorine	
Sewage	
Other	

Water Appearance			
Green		Foamy	
Tea		Scummy	
Muddy		Other	
Clear		Other	

Substrate Composition (fill in percent of coverage, must total 100)			
Clay/mud		Cobbles (2-10" in diameter)	
Sand (less than .1" in diameter)		Boulders (over 10" in diameter)	
Gravel (.1 – 2" in diameter)		Organic debris	

Overhead Canopy (percentage of stream width covered by overhanging grasses, shrubs and trees, totaling 100)			
< 5%		50-75%	
5-25%		>75%	
25-50%			

Adjacent Land Use (fill in percent, totaling 100)			
Industrial		Cropland	
Commercial		Pasture	
Residential		Riparian edge	
Park		Other	

Left Bank - facing upstream (fill in % coverage, totaling 100)			
Grass/no shrubs		Mixed ages	
Young trees/shrubs		Unvegetated	
Mature trees		Other	

Right Bank - facing upstream (fill in percentage of coverage)			
All grass/no shrubs		Mixed ages	
All young trees/shrubs		Unvegetated	
All mature trees		Other	

Does the river appear to be straightened or manipulated by humans? ______ Yes or ______ No

Describe: ____

Upstream Dam? ? ______ Yes or ______ No

Do you see pipes emptying directly into or near the water? _____ Yes or _____ No

How many? ____________________________________

What do they appear to discharge? ________________________

Photographic Record

Photo ID #	Location (site, facing upstream or downstream, etc.)	Description (include names, activity and/or objects)

Field Datasheet Instructions

Use these instructions as a guide to assist you in completing the Field Datasheet.

Fill in the information requested. Most of it is self-explanatory.

Date:
Write down the day, month and year you are sampling.

Sampling Site:
Write down the name of this site.

Time:
In military notation, record the time you arrive at and the time you leave the site.

Sampling Team:
Write down the first and last names of all people sampling.

Conducting Sonde Measurements:
Place the sonde in the water at the exact spot you'll be collecting water. Make sure the sonde is at the appropriate depth, as stated in the volunteer manual. Wait for the probe to stabilize. Write down the numbers for the following parameters or store them in the sonde's memory and download later:

- Water temperature:
- Specific conductance
- Conductivity
- TDS
- Salinity
- DO%
- DO mg/l
- pH

Conduct Turbidity Measurements:
Use the Turbidometer as per the volunteer manual to obtain the turbidity result.

Flow:
Co-location of the site with a USGS gaging station is best. Be sure to use a reliable flow meter.

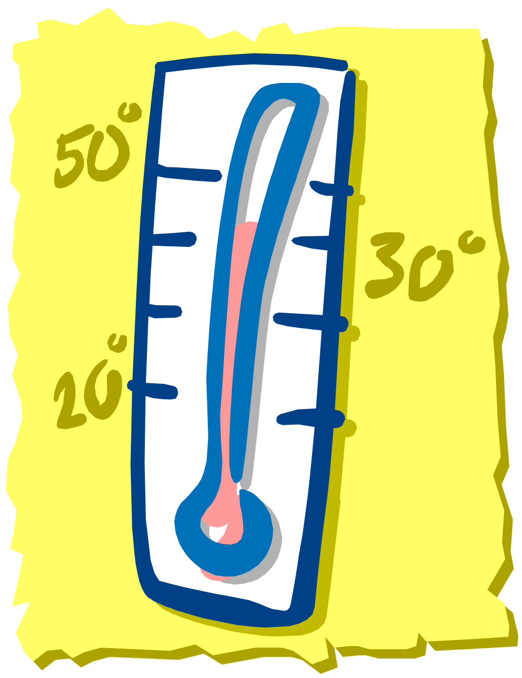
Stream Width:
Measure the width of the river where you are collecting. Use a tape measure or pace it off and measure your paces. Note if the value is an actual measurement or an estimate based on pacing or visual assessment. Make sure width measurement is perpendicular to stream (not diagonal as bridge may be).

Transparency Tube:

First – Release water until you can just make out the symbol on the bottom of the tube. Record water level.
Final – Release a bit more water until the screw is visible. Record water level.
Average – Record the average of the two depths to the nearest centimeter.

Weather Observations:
Past weather will affect volume of flow, turbidity, temperature and other factors in your stream. An unusual weather event may also produce unusual or inconsistent results.

Air Temperature:
Before you go into the field, calibrate your thermometer by immersing it in ice water and taking a reading (it should read 32° F or 0° C*). ???* Take the temperature in the shade.



Wind Speed:
Record when available.

Precipitation:
Record when available.

Other Conditions:
Examples include leaves falling, trees budding out, etc.

Water Appearance:
Water appearance is often the most obvious water quality indicator the people notice. However, it is not a precise indicator of stream health and is best considere in combination with other data collected. Indicate each of the following that apply.

Green – Slightly greenish water results from the presence of microscopic plants or algae and usually indicates healthy conditions. An overabundance of algae (phytoplankton) often produces a deep green color. Heavy nutrient loads from fertilizers (agriculture, golf courses, lawns), animal waste (feeding operations) and poor sewage treatment often promote heavy amounts of algae.

Tea – This color is often the results of significant decaying organic matter in the stream. Streams that drain wetlands may be stained a very dark brown.

Muddy – High amounts of sediment may produce a deep brown color, and usually indicate upstream erosion. Consider stream type and location, amount of sediment, recent storms, or seasonal events such as snowmelt.

Clear **–** Most people associated clear water with healthy waters, but clear waters may very well be polluted with colorless substances. Very clear water without any living organisms may indicate a severe pollution problem.

Foamy **–** If foam is a grayish color and fairly thin – less than 6 inches high – it may be the result of natural oils, soil particles and pollen in the water. Heavy foam (more than 6 inches off the surface of the water) may be the result of detergents or animal waste run-off.

Scummy **–** Often the result of floating algae or decaying plant material.

Water Smell:
Indicate each of the following that apply.

Rotten Egg **–** A sulphurous smell which often indicates sewage or animal waste pollution. Anaerobic decomposition processes and minerals delivered from sulphur springs also emit this smell.

Sewage **–** May indicate raw sewage, animal waste or heavy algal accumulation and decomposition.

Chlorine **–** May result from heavy chlorination of treated sewage.

Other **–** Make note of any other distinguishable odor.

Substrate Composition:
Estimate what the bottom of the river covered with either within a “transect area” or the entire bottom.

Overhead Canopy:
What percentage of the river is covered by overhanging grasses, shrubs and trees? This shading plays an important role in keeping the water cool in the heat of the summer.

Adjacent Land Use:
This is the land area immediately adjacent to the stream bank. Think in terms of about a quarter of a mile on either side of the stream channel. Indicate each of the following that apply.

Industries **–** Industrial facilities may represent a direct, or point-source, of pollution. The presence of sewage, chemicals or heated water are all potential causes of point-source pollution.

Commercial - Strip malls and other retail businesses are often associated with large parking lots and imperious surfaces which may contribute to non-point source pollution through storm sewers.

***Residential* –** Fertilizers and pesticides applied to lawns often find their way into local streams during rain storms. Faulty septic tanks may contribute to increased bacteria levels and nutrients in streams. Oil and household chemicals are other common impacts.

***Park* –** Large, green spaces can contribute to non-point source pollution as excess fertilizers and run-off from hard surfaces can drain into streams.

***Cropland* -** Agricultural production areas where soil and excess chemicals may flow into the river through poor farming practices.

***Pasture* –** Overgrazing can potentially deliver organic matter and nitrates to the stream. Excessive grazing of the riparian zone may damage vegetation, causing increased erosion and loss of shading by woody plants.

***Riparian Edge* –** Healthy, well-vegetated banks stem the flow of nutrients and organic matter to streams.

Left and Right Bank:
Note the percentage of the stream bank in the various categories of vegetation. This section should equal 100 percent.

Indicate upstream dams:
If there are upstream dams, indicate their location and their distance from your sampling location. Notate in river miles.

Does the river appear to be straightened?
Uniform depth, uniform rock-lined banks and a suspiciously straight channel often indicates that the river has be artificially straightened. This is usually done near roads or houses to keep floodwaters out of this area.

Do you see pipes emptying directly into or near the water?
If so, note the location and number.

Photographic Record:
Completing a photographic record of your sampling site could prove valuable in the future. The object is to document change over time – geologic time. Erosion is an example of what you could see over time. This photographic record will become part of history as will your water quality data. When photographing your station, pick a consistent direction or angle to take the picture and include large permanent structures, if possible. Take pictures of things that you notice are different.

Temperature Conversion Chart: Fahrenheit-Celsius

Temp °F	Temp °C	Temp °F	Temp °C	Temp °F	Temp °C	Temp °F	Temp °C
32.0	0.0	50.0	10.0	68.0	20.0	86.0	30.0
32.5	0.3	50.5	10.3	68.5	20.3	86.5	30.3
33.0	0.6	51.0	10.6	69.0	20.6	87.0	30.6
33.5	0.8	51.5	10.8	69.5	20.8	87.5	30.8
34.0	1.1	52.0	11.1	70.0	21.1	88.0	31.1
34.5	1.4	52.5	11.4	70.5	21.4	88.5	31.4
35.0	1.7	53.0	11.7	71.0	21.7	89.0	31.7
35.5	1.9	53.5	11.9	71.5	21.9	89.5	31.9
36.0	2.2	54.0	12.2	72.0	22.2	90.0	32.2
36.5	2.5	54.5	12.5	72.5	22.5	90.5	32.5
37.0	2.8	55.0	12.8	73.0	22.8	91.0	32.8
37.5	3.1	55.5	13.1	73.5	23.1	91.5	33.1
38.0	3.3	56.0	13.3	74.0	23.3	92.0	33.3
38.5	3.6	56.5	13.6	74.5	23.6	92.5	33.6
39.0	3.9	57.0	13.9	75.0	23.9	93.0	33.9
39.5	4.2	57.5	14.2	75.5	24.2	93.5	34.2
40.0	4.4	58.0	14.4	76.0	24.4	94.0	34.4
40.5	4.7	58.5	14.7	76.5	24.7	94.5	34.7
41.0	5.0	59.0	15.0	77.0	25.0	95.0	35.0
41.5	5.3	59.5	15.3	77.5	25.3	95.5	35.3
42.0	5.6	60.0	15.6	78.0	25.6	96.0	35.6
42.5	5.8	60.5	15.8	78.5	25.8	96.5	35.8
43.0	6.1	61.0	16.1	79.0	26.1	97.0	36.1
43.5	6.4	61.5	16.4	79.5	26.4	97.5	36.4
44.0	6.7	62.0	16.7	80.0	26.7	98.0	36.7
44.5	6.9	62.5	16.9	80.5	26.9	98.5	36.9
45.0	7.2	63.0	17.2	81.0	27.2	99.0	37.2
45.5	7.5	63.5	17.5	81.5	27.5	99.5	37.5
46.0	7.8	64.0	17.8	82.0	27.8	100.0	37.8
46.5	8.1	64.5	18.1	82.5	28.1	100.5	38.1
47.0	8.3	65.0	18.3	83.0	28.3	101.0	38.3
47.5	8.6	65.5	18.6	83.5	28.6	101.5	38.6
48.0	8.9	66.0	18.9	84.0	28.9	102.0	38.9
48.5	9.2	66.5	19.2	84.5	29.2	102.5	39.2
49.0	9.4	67.0	19.4	85.0	29.4	103.0	39.4
49.5	9.7	67.5	19.7	85.5	29.7	103.5	39.7

Community Views on River Survey

How does the community use the river?

Have any of these uses changed over time?

Do any of these uses conflict?

What do people think about the river?

Why is this river important and to whom?

What do you want to know about the river?

What do you want to tell other people about this river?

Manual Reviewers

Pam Skon, North Dakota Department of Health

Wayne Goeken, Red River Watershed River Watch

Joe Courneya, Red River Basin Institute

Charlene Crocker, Energy and Environmental Research Center

Steve Hofstad, Clay Soil and Water Conservation District

Molly McGregor, Minnesota Minnesota Pollution Control Agency

Tina Laidlaw, U.S. Environmental Protection Agency

Danni Halvorson, Red River Watershed River Watch

Chris Klucas, Red River Basin Institute

Other Key Contacts:

- Dave Rush, Red River Riparian Project
- Mike Ell, North Dakota Department of Health

Glossary

Accuracy is a measure of the confidence in a measurement. The smaller the difference between the measurement of a parameter and its "true" or expected value, the more accurate the measurement. The more precise or reproducible the result, the more reliable or accurate the result.

Acre-Feet: (af) is the quantity (volume) of water needed to cover one acre to a depth of one foot and is equal to 43,650 cubic feet or about 326,000 gallons.

Ambient: Pertaining to the current environmental condition

Altitude: How many feet something is above sea level.

Cfs: A measurement unit expressing a rate of discharge. One cfs is equal to the discharge in a stream cross-section one foot wide and one foot deep, flowing with an average velocity of one foot per second.

Calibration: All analytical equipment should be calibrated according to the manufacturer's instructions. Three common techniques are the calibration blank, calibration standards and calibration to a reference device:

Calibration Blank: A calibration blank is de-ionized water processed like any of the samples and used to "zero" the instrument. It is the first "sample" analyzed and used to set the meter to zero. This is different from the field blank in that it is "sampled" in the lab. It is used to check the measuring instrument periodically for "drift" (the instrument should always read "0" when this blank is measured). It can also be compared to the field blank to pinpoint where contamination may have occurred.
Assessment of Results: The results of periodic checks should be "0".

Calibration Standards: Calibration standards are used to calibrate a meter. They consist of one or more "standard concentrations" (made up in the lab to specified concentrations) of the indicator being measured, one of which is the calibration blank. Calibration standards can be used to calibrate the meter before running the test, or they can be used to convert the units read on the meter to the reporting units (for example, absorbance to milligrams per liter).

Channel: The section of the stream that contains the main flow.

Channelization: The straightening of a stream; this is often a result of human activity.

Comparability is the extent to which data from one study can be compared directly to either past data from the current project or data from another study. For example, you may wish to compare two seasons of summer data from your project or compare your summer data set to one collected 10 years ago by state biologists. Using standardized sampling and analytical methods, units of reporting and site selection procedures helps ensure comparability.

Effluent: Waste material discharged into the environment, including waters.

Deionized water: Water that has had all of the ions (atoms or molecule) other than hydrogen and oxygen removed.

Designated Use: The legal use for a waterbody, including drinking, recreation. Water quality standards are designed to support a waterbody's designated use. U.S. Environmental Protection Agency recommends that the states and tribes achieve and protect the following uses: aquatic life support, fish consumption, shellfish harvesting, drinking water supply, primary contact recreation – swimming, secondary contact recreation and agriculture. All state waters are segmented and each reach is assigned one or more designated uses.

Detection limit is a term applied to monitoring and analytical instruments as well as methods. In general, detection limit is defined as the lowest concentration of a given pollutant your methods or equipment can detect and report as greater than zero. Readings that fall below the detection limit are too unreliable to use in your data set. Furthermore, as readings approach the detection limit (that is, as they go from higher, easier to detect concentrations to lower, harder to detect concentrations) they become less and less reliable. Manufacturers generally provide detection limit information with high-grade monitoring equipment such as meters.

Discharge: The outflow of water. Discharge or streamflow from a drainage basin are measured in terms of cfs and acre-feet.

Distilled water: Water that has had most of its impurities removed.

Downstream: In the direction of a stream's current; in relation to water rights, refers to water uses or locations that are affected by upstream uses or location.

Duplicate samples: Obtained when two samples are taken from the same site, at the same time, using the same method and independently analyzed in the same manner. These types of samples are representative of the same environmental conditions. Duplicates can be used to detect both the natural variability in the environment and that caused by field sampling methods. Duplicate samples are used to determine total (both sampling and laboratory) precision.

Ecoregion: Geographic areas that are distinguished from others by ecological characteristics such as climate, soils, geology and vegetation.

Effluent: Wastewater discharge

Erosion: The wearing down or washing away of the soil and land surface by the action of water, wind or ice.

Equipment Calibration: All analytical equipment should be calibrated according to the manufacturer's instructions. Three common techniques are the calibration blank, calibration standards and calibration to a reference device:

External Quality Control: A set of measures that involves laboratories and people outside of the program. These measures include performance audits by outside personnel, collection of samples by people outside of the program from a few of the same sites at the same time as the volunteers and splitting some of the samples for analysis at another lab.

Field Blank: Is a "clean" sample, produced in the field, used to detect analytical problems during the whole process (sampling, transport, lab analysis). To create a field blank, take a clean sampling container filled with distilled or deionized water to the sampling site. Other sampling containers will be filled with water from the site. Except for the type of water in them, the field blank and all site samples should be handled and treated in the same way. For example, anything you add to the sample should be added to the field blank, such as preparing the sample with reagents for analyzing dissolved oxygen, or adding preservative. When the field blank is analyzed, it should read as analyte-free or, at a minimum, the reading should be a factor of 5 below all sample results.

Field Blank: Also known as a "trip blank". This is distilled water (use Glenwood brand, if possible, or use the same brand consistently), poured into a sample container in the field as if it were a river sample. Field or trip blanks are usually collected at 10 percent of the sampling sites. This blank should be run as a regular sample, not as a zero blank for calibration. It will be used for all analysis including invertebrate counts, fecal coliforms and chemical analysis. The results should be "0".

Field Sample: This is the water sample that will be recorded as "official results". One field sample is tested for each of the sample site identified by the monitoring group.

Floodplain: The low area of land that surrounds a stream and holds the overflow of water during a flood.

Grab Sample: Sample is collected in some type of container by dipping the container in the water and filling it to some pre-determined level.

Ground water: Found below the ground's surface in zones of saturation where all the pores of a material are filled with water under pressure greater than atmospheric pressure. The top of such a zone is the water table.

Headwaters: The source of a stream.

Impaired waters: Waters that fail to meet applicable water quality standards or to protect designated uses.

Internal Quality Control: A set of measures that the project undertakes among its own samplers and within its own lab to identify and correct analytical errors. Examples include lab analyst training and certification, proper equipment calibration and documentation, laboratory analysis of samples within known concentrations or repeated analysis of the same sample and collection and analysis of multiple samples from the field.

Monitoring: To gather information about the health of a river by observing, collecting and analyzing information about its parts.

Nonpoint Source Pollution: Refers to pollution sources that are diffuse and do not have a single point of origin. Run-off from agriculture, forestry and construction sites are examples.

Outfall: The pipe through which industrial facilities and wastewater treatment plants discharge their effluent into a waterbody.

Point Source Pollution: Refers to pollution resulting from discharges into receiving waters from any discernible confined and discrete conveyance such s a pipe, ditch or sewer.

Precipitation: Water falling, in a liquid or solid state, from the atmosphere to earth.

Protocol: Defined procedure.

Quality assurance (QA): Refers to the overall management system which includes the organization, planning, data collection, quality control, documentation, evaluation and reporting activities of your group. QA provides the information you need to ascertain the quality of your data and whether it meets the requirements of your project. QA ensures that your data will meet defined standards of quality with a stated level of confidence.

Quality control (QC): Refers to the routine technical activities whose purpose is essentially error control. Since errors can occur in either the field, the laboratory or the office, QC must be part of each of these functions. QC should include both internal and external measures. For most projects, there is no set number of field or laboratory QC samples which must be taken. The general rule is that 10 percent of samples should be QC samples.

Replicate samples are obtained when two or more samples are taken from the same site, at the same time, using the same method and independently analyzed in the same manner. When only two samples are taken, they are referred to as duplicate samples. These types of samples are representative of the same environmental conditions. Replicates (or duplicates) can be used to detect both the natural variability in the environment and that caused by field sampling methods.

Riparian Zone: The vegetative area on each bank of a body of water that receives flood waters.

Riprap: Rocks used on an embankment to protect against bank erosion.

Representativeness: The extent to which measurements actually depict the true environmental condition or population you are evaluating. A number of factors may affect the representativeness of your data. For instance, are your sampling locations indicative of the waterbody? Data collected just below a pipe outfall is not representative of an entire stream. Minimizing the effects of variation is critical in the development of your sampling design.

Sediment: Solid material that is transported by, suspended in, or deposited from water; it includes chemical and biochemical precipitates and decomposed organic material such as humus.

Split sample: One sample that is divided equally into two or more sample containers and then analyzed by different analysts or labs. Split samples are used to measure precision. Samples should be thoroughly mixed before they are divided. A sample can be split in the field, called a field split, or in the laboratory, a lab split. The lab split measures analytical precision while the field split measures both analytical and field sampling precision.

Standard: Any known concentration or value for a parameter being tested. Standards are provided for high and low ranges for pH, conductivity, turbidity, (each tested using electronic meters) and nitrate nitrogen and total phosphorus, testing using a spectrophotometer.

Stream bank: Includes both an upper and a lower bank. The lower bank normally begins at the normal water line and runs to the bottom of the stream. The upper bank extends from the break in the normal slop of the surround land to the normal high water line.

Streamside cover: Includes any overhanging vegetation that offers protection and shading from the stream and its aquatic inhabitants.

Stream vegetation: Includes emergent, submergent and floating plants. Emergent plants include plants with true stems, roots and leaves with most of their vegetative parts above the water. Submergent plants also include some of the same types of plants, but they are completely immerged in the water. Floating plants are detached from any substrate and are therefore drifting in the water.

Stream Flow: The volume of water passing a point expressed in cubic feet or meters per second. Flow affects the rivers physical characteristics, such as erosion and sedimentation, bottom composition, amount of the bottom covered with water, etc.

Substrate: Refers to a surface. This includes the material comprising the stream bed or the surfaces which plants or animals may attach or live upon.

Surface Water: found in lakes, potholes, rivers and streams.

Topographic Map: A map with lines to show the height or altitude of hills, valleys, mountains, etc. Each line connects points at the same altitude.

Tributaries: A body of water that drains into another, typically larger, body of water.

Urban runoff: Comes form city streets, parking lots, sidewalks, storm sewers, lawns, golf courses and building sites. Common pollutants include sediment, nutrients, road salts and petroleum products.

Volunteer Monitoring: Community-based, citizen-based or volunteer water quality monitoring is the ongoing analysis of certain indicators of water quality by trained individuals over time with a particular concern for the health of the river or waterbody being monitored.

Water Quality: The water quality of a river is a combination of all of its physical, chemical and biological characteristics.

Water Quality Criteria: Describes the conditions that support the designated use either numerically or through narrative. Conditions are described for various water quality indicators.

Water Quality Standards: Regulations set up by state and tribal governments. They are a compilation of several types of goals which include designated beneficial uses for surface water, water quality criteria that describe the water quality conditions required to support those uses and anti-degradation provisions to protect existing water quality.
Narrative Water Quality Standards - Specifically, a narrative water quality standard is a statement that prohibits unacceptable conditions in or upon the water, such as floating solids, scums, visible oil film, or nuisance algae blooms. Narrative standards are sometimes called ‘free froms’ because they often deal with very fundamental and basic forms of water pollution. The association between the standard and beneficial use is less well defined for narrative standards than it is for numerical standards; however, most narrative standards protect aesthetic or aquatic life beneficial uses. Because narrative standards are not quantitative, the determination that one has been exceeded typically requires a “weight of evidence” approach to data analysis showing a consistent pattern of violations. There is an unavoidable element of professional judgment involved in using narrative standards to determine impairment. As such, the descriptions of the methodologies for determining impairment due to violations of narrative standards requires more discussion than determining impairment of numeric standards

Wastewater (sewage) Treatment Plant: A place where used water (from toilets, washing machines, industries) is pumped to be cleaned and purified before it is returned to local waterways.

Watershed: An area of land where all water drains, or ‘sheds’, to the same river, reservoir or other body of water; also called a drainage basin.