Monitoring Mine-Impacted Streams

Illinois Coal Country Teams

Volunteer Handbook

First Edition (2010)

prairie rivers network

SIERRA CLUB
FOUNDED 1892

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Introduction

Welcome to the volunteer monitoring program that allows Illinois Coal Country Teams to investigate a few of the chemical and physical aspects of water quality in mine-impacted streams. Through this program we encourage you to develop your own goals for your monitoring, design and implement a monitoring plan that would best achieve those goals, and share the information you collect with other volunteers around the state. Because we are offering this program as a tool that you can tailor to meet your monitoring needs, this document is a combination manual and workbook. We strongly encourage you to think through the several site-specific components described in this manual as soon as possible to make your monitoring as effective and exciting as possible.

Value of the Data Collected

Your monitoring kit is not comprised of the most sophisticated equipment that money can buy. However, if you use good techniques, the data you collect can be very useful in answering important questions. This data should help you identify places with relatively good water quality as well as places where water quality is poor and may be causing problems for fish and other aquatic life.

Illinois EPA is not currently using volunteer monitoring data for any regulatory purposes, but the data is still important for the Agency. If you identify problems through your sampling, you should report them to IEPA immediately; they may be able to conduct subsequent monitoring with more sophisticated equipment to confirm and further investigate the problem. If IEPA is not able to respond with additional monitoring, you may also wish to hire a consultant to do more sophisticated monitoring.

Contacts

For more information on the program, contact Prairie Rivers Network at 217-344-2371 or info@prairierivers.org or Cindy Skrukrud at 815-675-2594 or cindy.skrukrud@sierraclub.org.

Your Monitoring Plan

As mentioned above, you can tailor your monitoring program to investigate water quality issues in a way that is meaningful and helpful for you. You are encouraged to think about why you want to conduct monitoring. Your sampling program should then be designed to best achieve those goals within the time and resource constraints of your practical lives. In designing your program, you will need to decide where you need to sample, how frequently you need to sample, and which tests will be most important. Record this information on the Monitoring Plan worksheet, available in Appendix D.

Do not feel intimidated or burdened by the monitoring design considerations. If you want to start by simply testing under the bridge near your house, get out and do that. You and your watershed organization can develop more detailed plans as you refine your goals for the program. Prairie Rivers Network and Sierra Club staff are also available to assist your organization in tailoring your program to meet your needs.

I. Your Watershed

Before developing the sampling plan for your watershed, it is helpful to know what types of land uses and activities are found in the watershed that might affect water quality. Please write a description of the watershed that you will be sampling, and include the description on the Monitoring Plan worksheet. Use maps, surveys, personal contacts and online tools to identify land uses, discharges and other activities in the watershed that may affect water quality. Prairie Rivers Network and Sierra Club also recommend you complete a Watershed Survey Visual Assessment every few years as changes in the characteristics of the watershed occur. This survey form is included as Appendix C.

II. Goals

Articulating clear reasons for participating in your monitoring program will help you motivate yourself and the members of your group to stick with the program and feel rewarded as you begin achieving your goals. Setting goals for your monitoring program also helps you determine which monitoring tests to perform, where to perform them, and how often. A few possible goals for your monitoring program are offered for your consideration below. Please identify which ones are important for your program and/or write additional goals on the Monitoring Plan worksheet.

- Raise local awareness of the quality of local waters.
- Increase local interest in the protection of our watershed.
- Investigate potential impact of a mine pollution source.
- Increase interest and participation in our watershed organization.
- Identify potentially impaired waters in our watershed.
- Identify successful mine remediation projects in our watershed.
- Identify priority areas for better protection.
- Document trends in water quality over a long term.

- Compare water quality in our streams to water quality in other streams around the state.

III. Site Selection

You and your watershed organization should identify the locations which you will monitor. We encourage you to consider the following factors when selecting sites. Don't be too ambitious in the beginning; taking on more than you have time to do may cause frustration and burn out.

- *Safety*. Is there safe, convenient access to a flowing section of the stream? Can you safely reach the site year round?
- *Do you have permission to monitor the site?* If you plan on monitoring a site that is on private property, landowner permission must be obtained.
- *Will data from your sites allow you to satisfy your goals?* For example, if you would like to increase awareness of local water quality, it may be useful if you have at least one site to which you can easily bring local officials and local media. If you are trying to determine the effects of a pollution source, you will want to select sites both upstream and downstream of the source.
- *Is the site representative of the watershed?* This is important if you are trying to collect data that is representative of the watershed. However, if you are trying to assess the impact that localized activities may have on water quality, this is not as important.
- *Is there enough space at the site to conduct the monitoring?* After training, you should know what kind of space you need on site.
- *Are any other groups monitoring the site?* If somebody is already monitoring at the site, your time may be better spent at other sites.
- *Can the site be identified on a map and on the ground?* People using the information need to know where the site is and what activities occur in the watershed near it. It is also important to be able to locate the site for safety reasons.
- *Does the site have water in it all year long?* Since monitoring will take place during all seasons, choose at least some sites that have water year round.

<u>Once chosen, write a 1-2 sentence description of your monitoring site(s) on the Monitoring Plan worksheet.</u> Include details such as road intersections, bridge crossings, natural features, where to park, and how to access the sampling site. When accompanied by a map and site sketch, your site description should allow anyone viewing your monitoring plan to find and access your site.

IV. Monitoring Frequency and Timing

Because chemical and physical quality of streams varies considerably depending on several factors including weather, season, time of day, and activities in the watershed, choosing the frequency and timing of your sampling requires careful consideration. Your goals may help you make these decisions. For example, if you are trying to determine the impact that stormwater has on water quality, you should be sure to collect data during dry periods and after rainfalls. If you would like to compare your data to data collected in other streams or document long term trends in your waters, you need to collect data frequently enough to capture multiple weather conditions and times of day in each season. At a minimum, we ask that you collect and submit data at least quarterly. Prepare an anticipated monitoring schedule and tests to be conducted and record this on your Monitoring Plan.

V. Parameters

Your kit contains the equipment necessary to collect data on temperature, pH, total suspended solids, acidity, iron, chloride, and conductivity. These are all important parameters, and we ask that you conduct each of these tests at your sites at least quarterly. Materials and instruction are provided for simplistic stream flow monitoring as well. This is also an important parameter, but it may require more time than you have available. If determining stream flow becomes too time consuming and is not critical to your goals, you may wish to conduct this test less frequently.

As with the other elements in your monitoring plan, your goals may suggest that you focus your attention on specific parameters. If you are investigating the affect that runoff from an abandoned mine may be having, you may want to collect turbidity data before and after several rainfalls in one season. If you want to explore pH fluctuations during one day, you may want to perform the pH test in both wet and dry , cold and hot periods. You may also want to purchase equipment to test for additional parameters that may have specific significance in your watershed.

Safety First!

You have chosen safe, convenient, and accessible sites to monitor; you have decided when to monitor; and you have identified the tests you plan to conduct. Now you are ready to go out and start collecting data. Before you leave the house, though, remind yourself and your sampling partners of the following safety instructions.

General Safety Precautions

- Monitor with at least one other individual. Never monitor alone.
- Always let someone else know where you are going.
- Someone in the group should bring a cell phone. If no one is able to, know the location of the nearest telephone and the number.
- Know where the nearest medical center is and be able to direct emergency personnel to your sampling site.
- Each person should have a medical form with emergency contacts, insurance information, and pertinent health information
- Have a first aid kit handy.
- Know the weather reports: don't go sampling if severe weather is predicted, and cease sampling if weather gets stormy.
- Park in a safe location, out of the way of other drivers
- Put wallet and keys in a safe place. (Water tight bag tied to your belt is a good idea. Locked in the car is a bad idea, particularly for the keys.)

Protecting yourself while in the stream

- Wear foot protection; don't go monitoring barefoot. Boots or old tennis shoes are recommended.
- Make sure your tetanus shot is up to date.
- Wear a life jacket in deep water. Don't wade into swiftly flowing areas.
- Avoid getting stream water in your eyes, nose, mouth, or any breaks in your skin.
- If the stream water looks peculiar or has a strong odor, exercise extreme caution. Avoid contact with the water by using waders and gloves. Be sure to wash hands thoroughly. You may wish to bring antibacterial gel in your kit to use after sampling at each site. Otherwise, be very careful and do not eat or touch your face until you are able to wash your hands with soap and clean water.

Protecting yourself and your equipment

- Be familiar with the test procedures before you begin. Obey all precautions.
- Read the label on each reagent container before use for precautions or antidote information.
- Review the Material Safety Data Sheets (MSDS) for the reagents contained in your kits. These sheets can be found online at www.hach.com under the sidebar heading "Tools".
- The Illinois Poison Control Center number is (800) 222-1222. If you suspect poisoning

by a Hach reagent (the acidity kit), call Hach's 24 hour poison line at (303) – 623-5716.

- Avoid contact between reagent chemicals and eyes, nose, mouth, and skin. Use gloves to protect hands.
- Never use your fingers to cover test tubes during shaking or mixing; use caps or stoppers.
- If a spill occurs, try to collect the contaminated sediment in a plastic bag and dispose of it properly.
- Before and after tests, rinse test tubes and sample bottles 3 times with distilled water. Dry outsides as well as your hands.
- Do not interchange caps from different containers, and keep all reagent containers tightly closed.
- Keep kits and kit contents away from prolonged exposure to the sun. Store kits (especially reagents) at room temperature, keeping them away from extremely high temperatures and freezing temperatures.
- Pay attention to expiration dates on reagents. Notify Prairie Rivers Network or Sierra Club of any upcoming expiration dates.

Disclaimer: These are safety recommendations to be considered by volunteer monitors during their monitoring activities. However, Prairie Rivers Network and Sierra Club make no representations that these recommendations will protect individuals from injury or harm to property. Participation in this monitoring program is voluntary, and Prairie Rivers Network and Sierra club make no representations that any of its employees or agents will be present to monitor the manner in which the work is performed. Prairie Rivers Network and Sierra Club have no knowledge of the training or experience of persons who may be participants in this program or the types of conditions that may be encountered by participants.

Equipment List

Included in Kits:

2 ERTCO Armored Pocket Thermometer
EcoTestr pH 2 Waterproof Pocket Tester
3 Nalgenes of pH Standard Solutions (plus additional pillow packs)
Hach Acidity Test kit
Hach Iron Test Strips (and standard solution)
Hach Chloride Test Strips (and standard solution)
EcoTestr EC Low Waterproof Pocket Tester (and calibration solution)
Ohio Sediment Stick
Tape measure
Scissors
Sampling jars
One pair gloves
Tennis ball
String
4 Stakes
Rubbing Alcohol
Distilled Water
Volunteer Monitoring Handbook with data sheets

Not Included but Recommended:

First Aid Kit
Disinfecting gel
Watch or Stopwatch
Paper Towels
Pencil(s)
Distilled or clean tap water
Plastic bag for garbage
Waders or shoes to go into the stream (optional)

Procedures

General Practices

Before going out, be sure that you wash your sample bottles and jar with phosphate-free detergent and rinse them very thoroughly with tap water. Use a pipe cleaner to ensure that all dirt particles are removed during cleaning.

Before collecting stream water for your chemical tests, rinse your jar with stream water at the sampling site several times. When collecting your sample, submerge the jar in flowing water upstream of where you are standing and upstream of any areas through which you have walked. Fill the jar with water collected approximately halfway between the bottom of the stream and the surface of the water. Hold the bottom of the jar so that the water does not flow through your hand as it fills the jar. Do not touch the sample water or put anything in the sample water.

Before beginning your chemical tests, rinse your sample bottle three times with sample water by pouring it out of the jar into the bottle. Be extremely careful to avoid contaminating reagents as you conduct the tests.

Standard Operating Procedures

Each of the following tests must be performed at the site immediately after collection. Each chemical test should be conducted at least twice. If the results of the two tests are not similar, repeat the test a third time.

The order of testing is not crucial, but we recommend you proceed in the following order to maximize efficiency and accuracy.

Recommended order of testing

1. Water observations
2. Temperature (air, then water)
3. pH
4. Conductivity
5. Iron
6. Chloride
7. Acidity
8. Total Suspended Solids
9. Stream Flow

1) Water Observations

These observations are somewhat subjective, but do provide useful information. Note on the data sheet (Appendix B) the water color and odor, any floating substances, and substances coating the streambed.

Materials

Rinse jar

White sheet of paper (a page from the handbook works well)

Procedure

In order to see the color of the stream water accurately, collect a sample of water in the rinsing jar and place a white sheet of paper under or behind it. Use this sample to note the water odor as well.

2) Temperature

Materials

Armored pocket thermometer

Procedure

Take air temperature first. Hold thermometer in the shade for 1 or 2 minutes, or until the thermometer reading is steady, before reading the temperature.

Hold thermometer directly in the stream for 1 or 2 minutes, or until the thermometer reading is steady, before reading the water temperature.

3) pH

Materials

EcoTestr pH 2 Waterproof Pocket Tester
Calibration solution

Procedure

Calibration: This tester allows up to 3-point calibration. Start with pH 7.0 buffer • Press **on/off** button to power on. You will be using the cap of the probe to hold the buffer. Before you calibrate, rinse the cap with the buffer solution. Immerse sensor in about 20 mm of buffer and stir gently. Wait for displayed value to stabilize at or near pH 7.0 • Press **cal** button to enter calibration sequence. **CAL** will flash momentarily and then show a flashing default reading • To complete the first calibration point, press **hold/ent** button to confirm (**Ent**). Rinse probe and cap with distilled water. If necessary, proceed to next buffer value (pH 4.0 or pH 10.0) and repeat the calibration procedure to obtain your second and third calibration point • To abort calibration, press **cal** button to escape (**ESC**). You have successfully calibrated the instrument.
Note: If no button is pressed for 15 seconds, tester will automatically confirm calibration.

pH Testing: Remove cap and press **on/off** button to turn on the tester • Dip the sensor in at least 20 mm of test solution • Stir once and let the reading stabilize. Note the pH value • Press **hold/ent** button to hold (**HO**) the reading. Annunciator will flash to indicate reading is in hold mode. Press **hold/ent** again to cancel (**HC**) the hold mode • Press the **on/off** button to shut tester off.
Note: Tester automatically shuts off after 8.5 minutes of non-use to conserve batteries.

Maintenance: Rinse the sensor in tap water after use. In harsh samples, take readings quickly, then rinse sensor immediately afterwards with de-ionized water to remove residues and prevent electrode contamination.

Useful Notes: • To avoid cross-contamination, rinse sensor between samples and buffer with de-ionized water • To maintain tester accuracy, use tester regularly or calibrate at regular intervals as required • For long-term storage, fill the cap with 20 mm of storage solution (NOT de-ionized water), and replace cap*. This will keep the sensor conditioned and ready for next use.

Changing Batteries: To remove batteries, lift up front battery cover and hold in position before lifting two sides of the pocket clip (Figure 1). Remove old batteries and replace with fresh ones. Note polarity as shown in battery compartment. No re-calibration is required after battery change since tester's non-volatile memory function retains calibration.

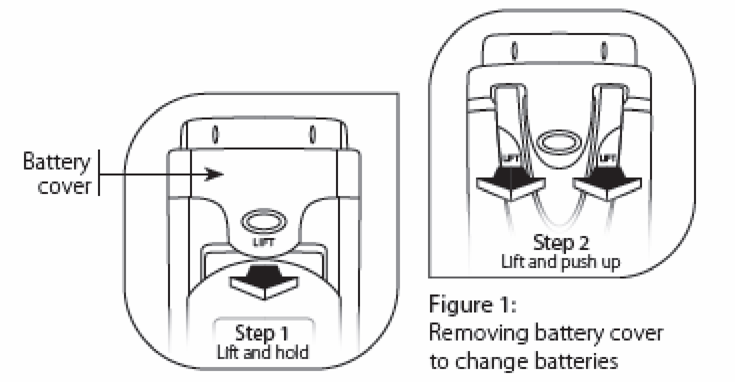


Figure 1:
Removing battery cover
to change batteries

Error Messages: bAt – Batteries are weak and need replacement. **Err –** Wrong or bad buffer value (out of range) and/or the sensor is failing. Use fresh buffer. **Or/Ur –** Over or Under range signal or sensor is contaminated/damaged/not fully immersed.

Reset Option: Reset option allows you to restore the calibration back to factory default settings • Press **on/off** to turn off tester • Press and hold **hold/ent** button and then switch on using the **on/off** button. The display shows a flashing **rSt** (reset) • Press **hold/ent** button again to confirm (**Ent**) reset or press the **cal** button to escape (**ESC**) reset option.

4) Conductivity

Materials

EcoTestr EC Low Waterproof Pocket Tester
Calibration Solution

Procedure

Testing:

1. Remove the cap and press the power button to turn on the tester.

2. Rinse cap and probe with distilled water.
3. Pour test solution into the cap.
4. Dip sensor fully into the test solution.
5. To hold reading, press “**hold/ent**”. Screen flashes “**HU**” once, then displays measurement with blinking unit (**µS**) to indicate that tester is in the hold mode. Press “**hold/ent**” again to cancel hold mode (**HC**).
6. Press the power button to shut the tester off.

Note: Tester automatically shuts off after 8.5 minutes of non-use to conserve batteries.

Calibration: The tester is factory calibrated. However, to ensure accuracy, it is recommended to recalibrate the probe before every session of use.

1. Soak sensor for 10 minutes in alcohol to remove stains/oils. Rinse in clean water and blot sensor dry.
2. Press the power button to turn on the tester.
3. Dip the sensor fully into standard solution and wait for the value to stabilize.
4. Press “**cal**” to enter the calibration sequence. Display flashes “**CAL**” momentarily and then shows a flashing default reading.
5. Press and hold “**hold/ent**” to scroll to the standard solution value.
   *Note: Each press of “**hold/ent**” moves the number up by 10. If you pass your target number, keep pressing the button and you’ll eventually cycle back to it.*
6. When you reach 1410, release “**hold/ent**” and wait for auto confirmation.
7. To abort calibration, press “**cal**” to escape (**ESC**).
8. You have successfully calibrate the instrument.

Maintenance: Clean the stainless steel sensor by periodically rinsing them in alcohol for 10-15 minutes. Rinse the sensor in clean after each use.

Useful Note: To avoid cross-contamination, rinse between samples and calibration standards with distilled water.

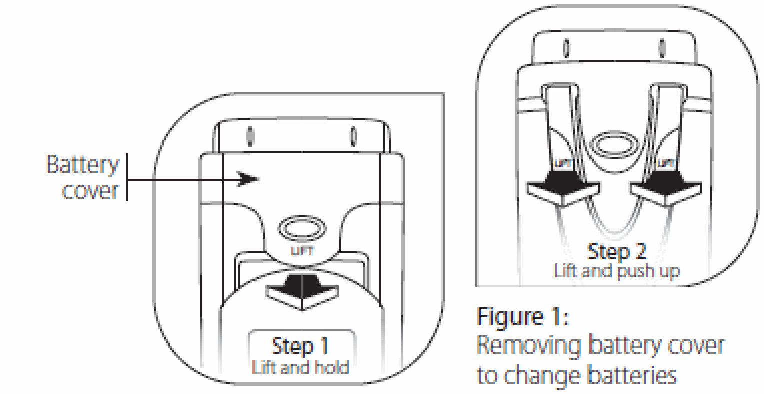
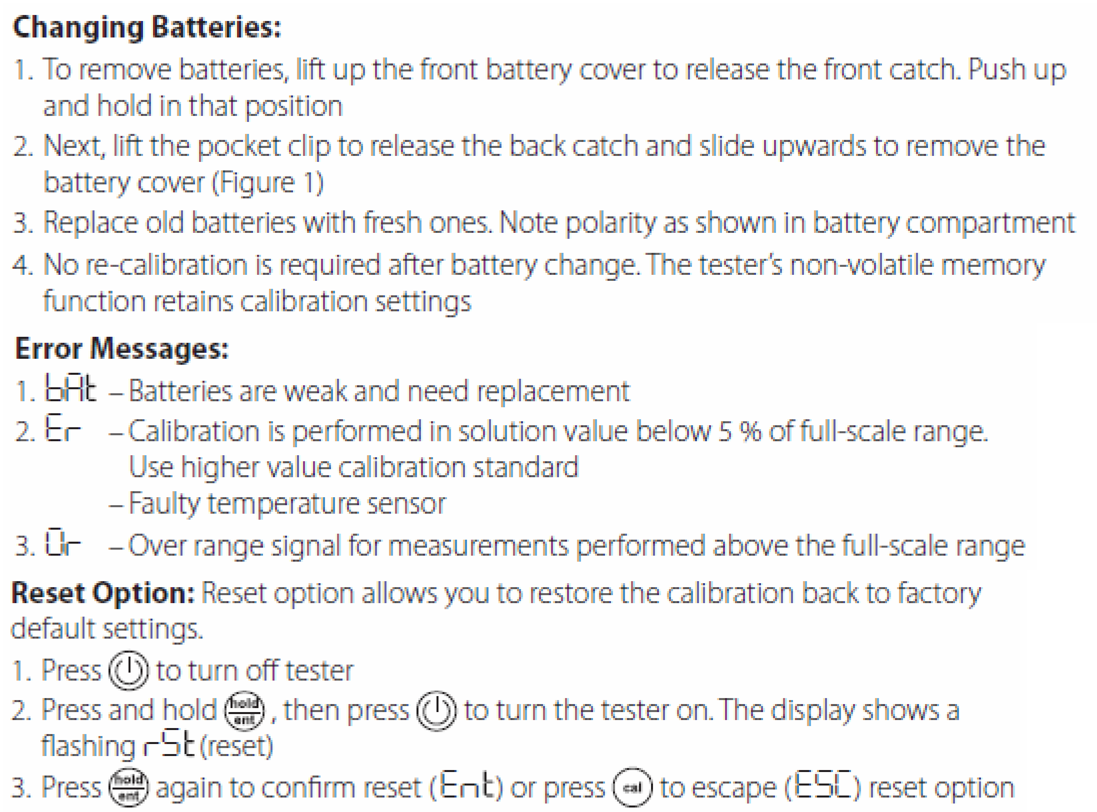


Figure 1:
Removing battery cover
to change batteries



Changing Batteries:

1. To remove batteries, lift up the front battery cover to release the front catch. Push up and hold in that position
2. Next, lift the pocket clip to release the back catch and slide upwards to remove the battery cover (Figure 1)
3. Replace old batteries with fresh ones. Note polarity as shown in battery compartment
4. No re-calibration is required after battery change. The tester's non-volatile memory function retains calibration settings

Error Messages:

1. bAt – Batteries are weak and need replacement
2. Er – Calibration is performed in solution value below 5 % of full-scale range. Use higher value calibration standard
   – Faulty temperature sensor
3. Or – Over range signal for measurements performed above the full-scale range

Reset Option: Reset option allows you to restore the calibration back to factory default settings.

1. Press ⏻ to turn off tester
2. Press and hold hold ent, then press ⏻ to turn the tester on. The display shows a flashing rSt (reset)
3. Press hold ent again to confirm reset (Ent) or press cal to escape (ESC) reset option

5) Iron

Materials

Hach Iron Test Strips
Standard Solution

Procedure

1. Fill sample vial HALF FULL with sample water. Open one foil packet and add powder contents to vial. Cap vial and shake rapidly for 5 seconds. Remove cap.
2. Dip a test strip into sample vial and rapidly move back and forth underwater for 15 seconds. Remove and shake access water from test strip.
3. Immediately compare test pad to the color chart on the test tab bottle and record results. Estimate results if color on test falls between 2 color blocks.
4. Rinse sample vial with tap water after each use.

Note: Keep cap on tight between uses. Store at room temperature.

6) Chloride

Materials

Hach Chloride Test Strips

Standard Solution

Procedure

1. Rinse sampling jar with water sample, then collect actual sample solution.
2. Remove a titrator from bottle and replace cap immediately.
3. Insert lower end of titrator into solution. Do not allow solution to reach the yellow completion band at top of titrator.
4. Allow solution to completely saturate wick of titrator. Reaction is complete when yellow band turns dark (should take 3-5 minutes).
5. Note where the tip of the white chloride peak falls on the numbered Quantab scale. This represents the Quantab unit value.
6. Refer to the table on the bottle to convert Quantab units into salt concentration.

Note: Titrators will become defective if exposed to too much light. Close cap IMMEDIATELY after removing titrator.

7) Free Acidity

Materials

Hach Acidity Test kit

Procedure

High Range (0-400 mg/L)

1. Fill the plastic measuring tube level full with the water to be tested. Pour the contents of the tube into the square mixing bottle.
2. Use the clippers to open one Bromcresol Green-Methyl Red Powder Pillow. Add the contents of the pillow to the mixing bottle and swirl to as shown in Figure 1.
3. If the water turns gray-blue, blue or green, the free acidity is zero.
4. If the water turns pink, add the Sodium Hydroxide Standard Solution drop by drop, holding the dropper vertically. Count each drop until the water just begins to turn grey-blue.
5. The free acidity of the water, expressed in mg/L as calcium carbonate (CaCO3), is equal to the number of drops of Sodium Hydroxide Standard Solution used times 20.
6. To express the results in grains per gallon as calcium carbonate divide the mg/L results by 17.1.

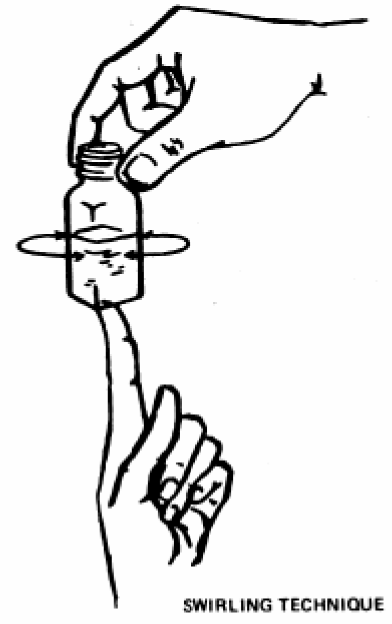


Figure 1

Low Range (0-100 mg/L)

1. Fill the bottle to the 23 mL mark with the water to be tested.
2. Use the clippers to open one Bromcresol Green-Methyl Red Powder Pillow. Add the contents of the pillow to the mixing bottle and swirl to as shown in Figure 1.
3. If the water turns gray-blue, blue or green, the free acidity is zero.
4. If the water turns pink, add the Sodium Hydroxide Standard Solution drop by drop, holding the dropper vertically. Count each drop as it is added. Swirl the mixing bottle after each drop. Continue adding drops until the water just begins to turn gray-blue.
5. The free acidity of the water, in mg/L as calcium carbonate (CaCO3), is found by multiplying the number of drops of Sodium Hydroxide Standard Solution by 5.
6. To express the results in grains per gallon as calcium carbonate divide the mg/L results by 17.1.

Total Acidity Test (0-400mg/L)

1. Fill the plastic measuring tube level full with the water to be tested. Pour the contents of the tube into the square mixing bottle.
2. Add one drop of Phenolphthalein Indicator Solution to the mixing bottle and swirl to mix.
3. If the water turns pink, the total acidity is zero.
4. If the water remains colorless, add the Sodium Hydroxide Standard Solution

drop by drop, holding the dropper vertically. Count each drop as it is added. Swirl the mixing bottle after each drop. Continue adding drops until the sample just begins to turn slightly pink.

5. The free acidity of the water, expressed in mg/L as calcium carbonate (CaCO3), is equal to the number of drops of Sodium Hydroxide Standard Solution used times 20.
6. To express the result in grains per gallon as calcium carbonate divide the mg/L results by 17.1.

Warning: *The chemicals in this kit may be hazardous to the health and safety of the user if inappropriately handled. Please read all warnings before performing the test and use appropriate safety equipment.*

Note: Sodium Hydroxide Standard Solution 0.035N slowly absorbs carbon dioxide when exposed to air, causing partial loss of strength. The Sodium Hydroxide Solution should be checked periodically to assure correct strength.

8) Total Suspended Solids

Materials

Ohio Sediment Stick

Procedure

1. Position the stick near the center of the stream halfway in between the surface and the bottom of the streambed, with its open end upstream to fill with water.
2. Holding the stick in your shadow and perpendicular to the ground, pour out water until you can just see the 0.4 inch black dot target on the tube bottom.
3. Rock the tube as needed to keep material suspended.
4. Read the height of the water column from the markings on the stick to the nearest 1/4” (inch).
5. Repeat this procedure once more.
6. Use the table on the following page to estimate total suspended solids. Table is based on Anderson and Davic, 2001.

Stick(in)	TSS(mg/l)	Stick(in)	TSS(mg/l)	Stick(in)	TSS(mg/l)
0.5	1751.2	10.0	33.7	24.0	10.6
1.0	701.9	11.0	29.7	25.0	10.1
1.5	411.2	12.0	26.5	26.0	9.6
2.0	281.4	13.0	23.8	27.0	9.1
2.5	209.6	14.0	21.6	28.0	8.7
3.0	164.8	15.0	19.7	29.0	8.3
3.5	134.5	16.0	18.1	30.0	7.9
4.0	112.8	17.0	16.7	31.0	7.6
4.5	96.6	18.0	15.5	32.0	7.3
5.0	84.0	19.0	14.4	33.0	7.0
6.0	66.1	20.0	13.5	34.0	6.7

7.0	53.9	21.0	12.7	35.0	6.5
8.0	45.2	22.0	11.9	> 36.0 =	< 5.0
9.0	38.7	23.0	11.2		

9) Stream Flow

Time constraints may prohibit you from monitoring stream flow each time you go out to sample. We recommend that flow be monitored at least 2 times a year, depending on your investigative goals. If the stream is really fast, it may be unsafe to cross it. Do not attempt to do this test under such conditions.

Materials

Tape Measure
Yard stick or sediment stick
Tennis ball or bobber
Watch with second hand or a stopwatch
4 stakes
String

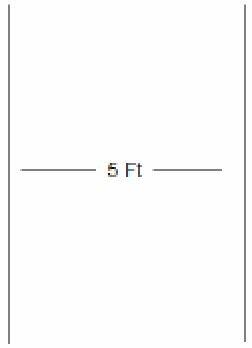
Procedure

Important Equations for Calculating Flows

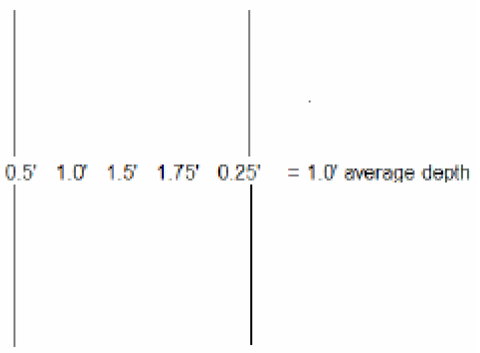
Flow in Cubic Feet per Second (cfs) = Cross Sectional Area (csa) X Water Velocity (v)
Cross Sectional Area (csa) = Stream Width (w) X Average Stream Depth (d)
Flow in Gallons per Minute (gpm) = Flow in Cubic Feet per Second (cfs) X 448.8

Small Streams (< 5 ft across) and Large Discharges:

Step 1. Measure the stream's width in feet.

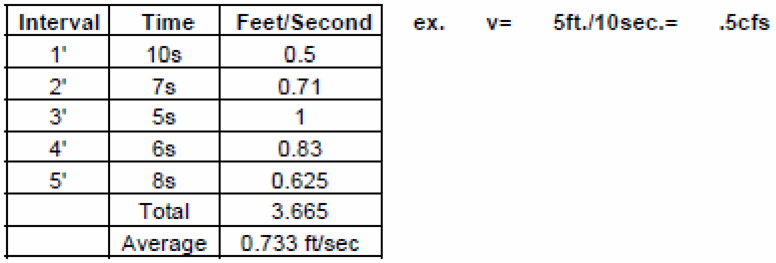


Step 2. Measure the stream's average depth by taking a depth (in feet) at every foot interval and averaging.



Step 3. Measure the stream's velocity with either a flow probe or by using the bobber and stopwatch technique.

Bobber and Stopwatch Technique
1. Lay out a tape measure along bank to a selected length (in this example 5 ft)
2. Time how quickly a bobber (or an orange works great too) takes to flow those 5 ft at every 1 ft interval across the stream and then average.

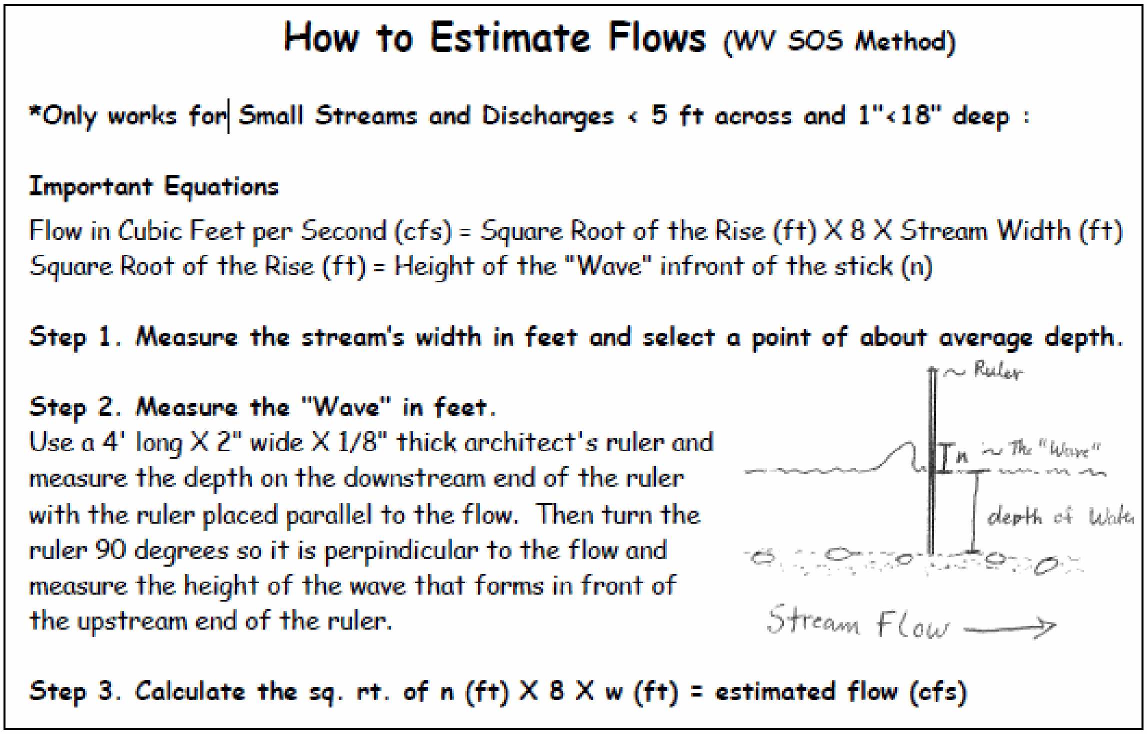


Interval	Time	Feet/Second
1'	10s	0.5
2'	7s	0.71
3'	5s	1
4'	6s	0.83
5'	8s	0.625
	Total	3.665
	Average	0.733 ft/sec

ex. v= 5ft./10sec.= .5cfs

Step 4. Calculate w (ft) X d (ft) X v (ft/sec) = f (cfs)

Example: 5' w X 1' d X 0.733'/s v = 3.66 cfs
Or
3.66cfs X 448.8 = 1644.852 gpm



How to Estimate Flows (WV SOS Method)

***Only works for Small Streams and Discharges < 5 ft across and 1"<18" deep :**

Important Equations

Flow in Cubic Feet per Second (cfs) = Square Root of the Rise (ft) X 8 X Stream Width (ft)
Square Root of the Rise (ft) = Height of the "Wave" infront of the stick (n)

Step 1. Measure the stream's width in feet and select a point of about average depth.

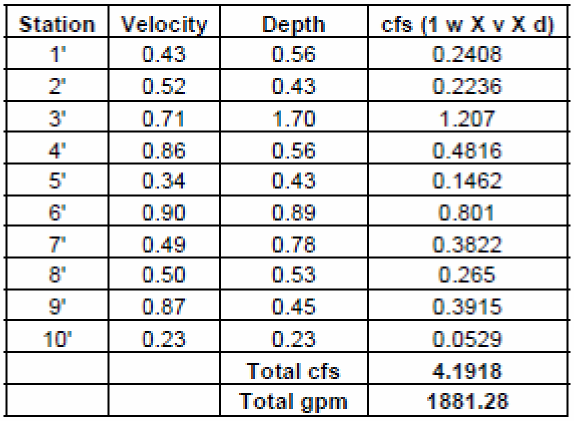
Step 2. Measure the "Wave" in feet.
Use a 4' long X 2" wide X 1/8" thick architect's ruler and measure the depth on the downstream end of the ruler with the ruler placed parallel to the flow. Then turn the ruler 90 degrees so it is perpindicular to the flow and measure the height of the wave that forms in front of the upstream end of the ruler.

Step 3. Calculate the sq. rt. of n (ft) X 8 X w (ft) = estimated flow (cfs)

Larger Streams (> 5 ft across)

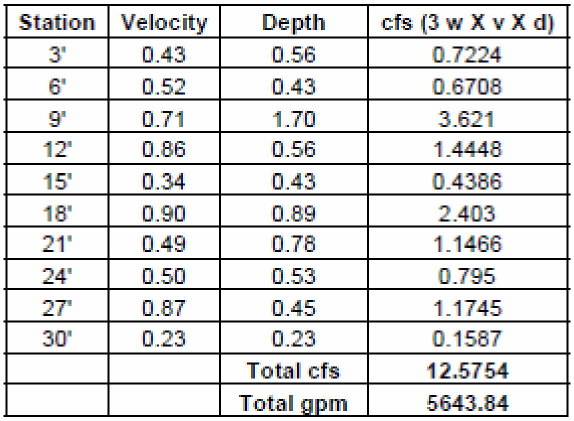
Very similar to how you calculate flow in a small stream, except you may want to be more precise by taking a velocity and depth at every 1-3 ft intervals across the stream.

Example 1:
10 ft wide stream – take width and depth at every foot interval across stream then add every cfs.



Station	Velocity	Depth	cfs (1 w X v X d)
1'	0.43	0.56	0.2408
2'	0.52	0.43	0.2236
3'	0.71	1.70	1.207
4'	0.86	0.56	0.4816
5'	0.34	0.43	0.1462
6'	0.90	0.89	0.801
7'	0.49	0.78	0.3822
8'	0.50	0.53	0.265
9'	0.87	0.45	0.3915
10'	0.23	0.23	0.0529
		Total cfs	**4.1918**
		Total gpm	**1881.28**

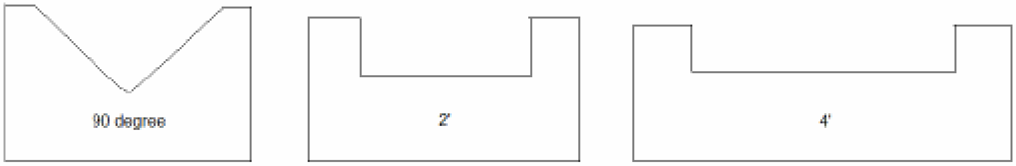
Example 2:
30 ft wide stream – take width and depth at every three foot interval across stream the add every cfs.



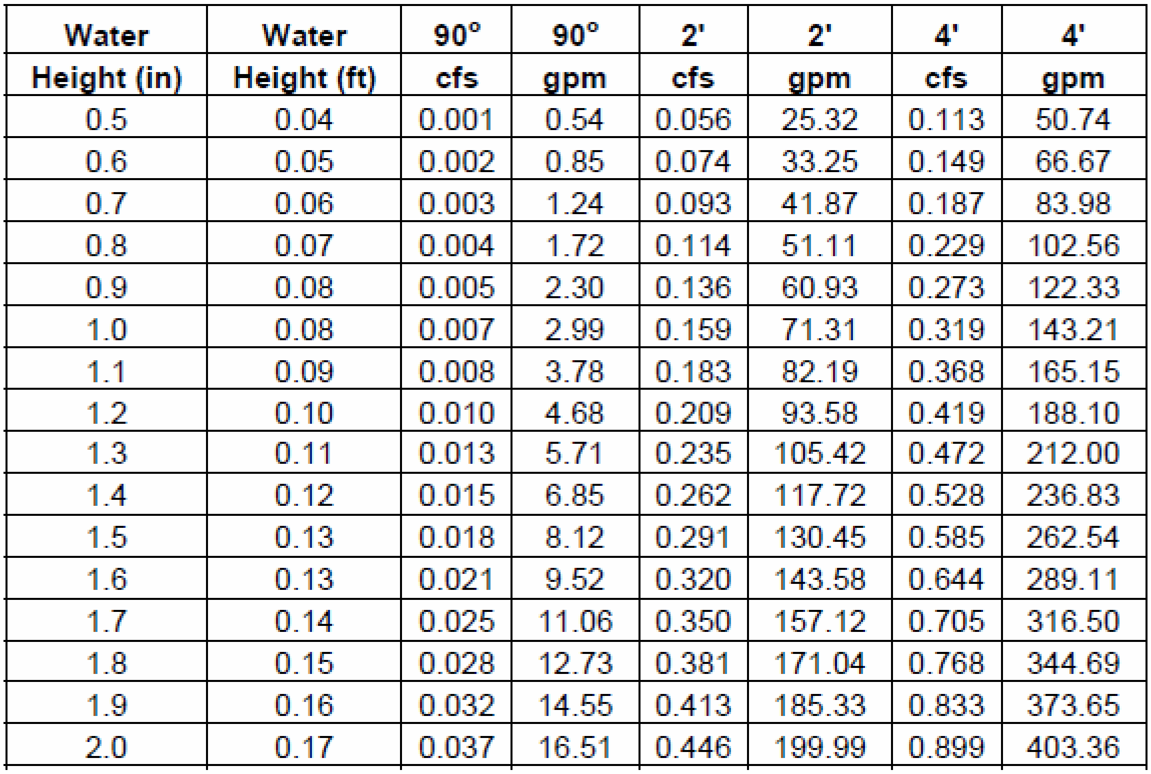
Station	Velocity	Depth	cfs (3 w X v X d)
3'	0.43	0.56	0.7224
6'	0.52	0.43	0.6708
9'	0.71	1.70	3.621
12'	0.86	0.56	1.4448
15'	0.34	0.43	0.4386
18'	0.90	0.89	2.403
21'	0.49	0.78	1.1466
24'	0.50	0.53	0.795
27'	0.87	0.45	1.1745
30'	0.23	0.23	0.1587
		Total cfs	**12.5754**
		Total gpm	**5643.84**

Small Discharges:

90° or 2 ft and 4 ft rectangular weirs

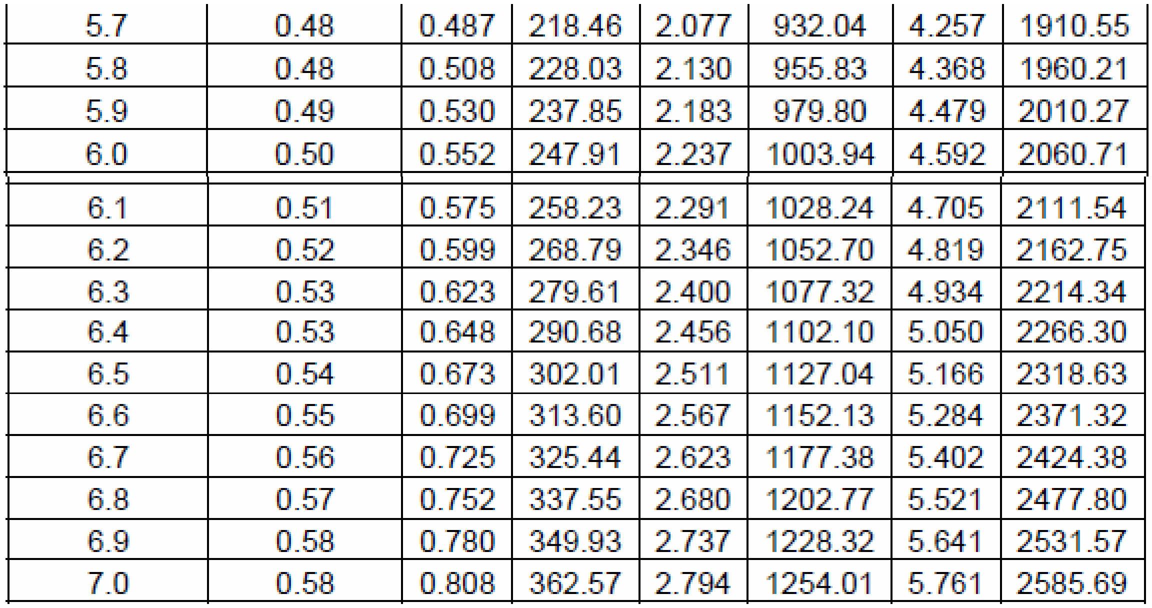


Step 1. Measure height of water over notch in inches or feet and use chart to figure out flow.



Water Height (in)	Water Height (ft)	90° cfs	90° gpm	2' cfs	2' gpm	4' cfs	4' gpm
0.5	0.04	0.001	0.54	0.056	25.32	0.113	50.74
0.6	0.05	0.002	0.85	0.074	33.25	0.149	66.67
0.7	0.06	0.003	1.24	0.093	41.87	0.187	83.98
0.8	0.07	0.004	1.72	0.114	51.11	0.229	102.56
0.9	0.08	0.005	2.30	0.136	60.93	0.273	122.33
1.0	0.08	0.007	2.99	0.159	71.31	0.319	143.21
1.1	0.09	0.008	3.78	0.183	82.19	0.368	165.15
1.2	0.10	0.010	4.68	0.209	93.58	0.419	188.10
1.3	0.11	0.013	5.71	0.235	105.42	0.472	212.00
1.4	0.12	0.015	6.85	0.262	117.72	0.528	236.83
1.5	0.13	0.018	8.12	0.291	130.45	0.585	262.54
1.6	0.13	0.021	9.52	0.320	143.58	0.644	289.11
1.7	0.14	0.025	11.06	0.350	157.12	0.705	316.50
1.8	0.15	0.028	12.73	0.381	171.04	0.768	344.69
1.9	0.16	0.032	14.55	0.413	185.33	0.833	373.65
2.0	0.17	0.037	16.51	0.446	199.99	0.899	403.36

2.1	0.18	0.041	18.62	0.479	214.99	0.967	433.81
2.2	0.18	0.047	20.88	0.513	230.33	1.036	464.96
2.3	0.19	0.052	23.30	0.548	246.00	1.107	496.82
2.4	0.20	0.058	25.88	0.584	262.00	1.179	529.34
2.5	0.21	0.064	28.62	0.620	278.31	1.253	562.53
2.6	0.22	0.070	31.53	0.657	294.92	1.329	596.37
2.7	0.23	0.077	34.60	0.695	311.83	1.406	630.84
2.8	0.23	0.084	37.85	0.733	329.03	1.484	665.93
2.9	0.24	0.092	41.27	0.772	346.52	1.563	701.62
3.0	0.25	0.100	44.87	0.812	364.29	1.644	737.91
3.1	0.26	0.108	48.65	0.852	382.32	1.726	774.79
3.2	0.27	0.117	52.61	0.893	400.63	1.810	812.23
3.3	0.28	0.126	56.76	0.934	419.19	1.894	850.24
3.4	0.28	0.136	61.09	0.976	438.02	1.980	888.81
3.5	0.29	0.146	65.62	1.018	457.09	2.068	927.91
3.6	0.30	0.157	70.34	1.062	476.41	2.156	967.55
3.7	0.31	0.168	75.26	1.105	495.97	2.245	1007.72
3.8	0.32	0.179	80.38	1.149	515.77	2.336	1048.41
3.9	0.33	0.191	85.69	1.194	535.80	2.428	1089.60
4.0	0.33	0.203	91.21	1.239	556.06	2.521	1131.30
4.1	0.34	0.216	96.94	1.285	576.54	2.615	1173.49
4.2	0.35	0.229	102.87	1.331	597.25	2.710	1216.16
4.3	0.36	0.243	109.02	1.377	618.17	2.806	1259.32
4.4	0.37	0.257	115.38	1.424	639.31	2.903	1302.95
4.5	0.38	0.272	121.95	1.472	660.65	3.001	1347.05
4.6	0.38	0.287	128.75	1.520	682.21	3.101	1391.61
4.7	0.39	0.302	135.76	1.569	703.96	3.201	1436.62
4.8	0.40	0.319	142.99	1.617	725.92	3.302	1482.09
4.9	0.41	0.335	150.45	1.667	748.07	3.405	1527.99
5.0	0.42	0.352	158.14	1.717	770.42	3.508	1574.33
5.1	0.43	0.370	166.05	1.767	792.96	3.612	1621.11
5.2	0.43	0.388	174.20	1.817	815.68	3.717	1668.31
5.3	0.44	0.407	182.57	1.869	838.59	3.823	1715.94
5.4	0.45	0.426	191.19	1.920	861.69	3.930	1763.98
5.5	0.46	0.446	200.04	1.972	884.96	4.038	1812.43
5.6	0.47	0.466	209.13	2.024	908.41	4.147	1861.29



5.7	0.48	0.487	218.46	2.077	932.04	4.257	1910.55
5.8	0.48	0.508	228.03	2.130	955.83	4.368	1960.21
5.9	0.49	0.530	237.85	2.183	979.80	4.479	2010.27
6.0	0.50	0.552	247.91	2.237	1003.94	4.592	2060.71
6.1	0.51	0.575	258.23	2.291	1028.24	4.705	2111.54
6.2	0.52	0.599	268.79	2.346	1052.70	4.819	2162.75
6.3	0.53	0.623	279.61	2.400	1077.32	4.934	2214.34
6.4	0.53	0.648	290.68	2.456	1102.10	5.050	2266.30
6.5	0.54	0.673	302.01	2.511	1127.04	5.166	2318.63
6.6	0.55	0.699	313.60	2.567	1152.13	5.284	2371.32
6.7	0.56	0.725	325.44	2.623	1177.38	5.402	2424.38
6.8	0.57	0.752	337.55	2.680	1202.77	5.521	2477.80
6.9	0.58	0.780	349.93	2.737	1228.32	5.641	2531.57
7.0	0.58	0.808	362.57	2.794	1254.01	5.761	2585.69

Troubleshooting

After you run a chemical test, you may see values that you did not expect. Be sure to run each test twice, and if you get two very different measurements, run the test a third time. If you suspect that the values you have measured are incorrect, you can check your equipment by running the test using distilled water instead of stream water.

Prairie Rivers Network and Sierra Club will retrain any volunteer who suspects their ability to sample is faulty. Also, if a stream continues to have abnormal chemical levels, Prairie Rivers Network and/or Sierra Club will sample the stream using more sophisticated equipment and determine the problem and what action to take.

Data sheets and submittal

Data is recorded on the data sheet provided, found in Appendix B. The data sheet must be completed at the site and time of testing. The names of all volunteers participating in the sampling are recorded on the data sheet with contact numbers for at least one trained individual. It is suggested that volunteers make a copy of the completed data sheets to keep with their own records before turning them in.

Please send a copy of the data sheets to:

Prairie Rivers Network
1902 Fox Drive
Champaign, IL 61820-7378

Prairie Rivers Network will store this copy in its offices.

Sources of Information

Many concepts and tests included in this program are adapted from other monitoring programs including Alabama Water Watch, Missouri Stream Teams, Eastern Pennsylvania Coalition for Abandoned Mine Reclamation, the Lake Soil and Water Conservation District of Painesville, Ohio, and the Delaware Stream Watch. Several USEPA documents were used as well, including *Volunteer Stream Monitoring: A Methods Manual*.

Further Investigations

The next few charts indicate pollutants and their possible causes or results. Keep in mind that the following charts are not complete nor conclusive. The test protocols we use are not all accepted by the Illinois Environmental Protection Agency. They are basic tests that help to increase the knowledge of our volunteers, their communities, and help to show trends in watersheds. They are not meant to definitively locate pollutants and problems. If you do suspect that one of these sources are polluting your stream at unhealthy levels, contact the Illinois EPA, telling them what you have found and asking them to do further testing.

	Fertilizer	**Industrial Waste**	**Oil Spills**
Dissolved Oxygen	Low due to algal blooms caused by increased nutrients from fertilizer applications	-	-
pH	High due to algal blooms	Low due to acids	-
Total Alkalinity	-	-	-
Nitrate Nitrogen	High due to fertilizer applications, causing algal blooms	-	-
Phosphate	High due to fertilizer applications, causing algal blooms; exceptionally high caused by commercially fertilized lands (ie golf courses, parks, lawns, and crop fields)	-	-
TSS	-	-	-
Water Color	Green or blue-green due to algal blooms	Reddish due to increased iron concentration	-
Water Odor	-	-	Petroleum
Surface Coating	Scum due to algal blooms	Foam due to acids	Oily
Streambed Coating	Green or brown due to algal blooms	Yellow due to acids	-

Chloride	High due to fertilizer	High due to acids	-
Iron	-	High due to industrial waste	-

	Sewage Treatment Plant	**Septic System**	**Livestock**
Dissolved Oxygen	Low due to algal blooms caused by increased nutrients	Low due to algal blooms caused by increased nutrients	Low due to algal blooms caused by increased nutrients from manure applicataions
pH	High due to algal blooms; low due to incompletely treated sewage	High due to algal blooms; low due to poorly functioning septic systems	High due to algal blooms
Total Alkalinity	-	-	-
Nitrate Nitrogen	High, excess causing algal blooms	High, excess causing algal blooms	High due to manure applications, causing algal blooms
Phosphate	High, excess causing algal blooms	High, excess causing algal blooms	High due to manure applications, causing algal blooms
TSS	High due to turbid discharges	-	-
Water Color	Green or blue-green due to algal blooms; milky due to turbid discharges	Green or blue-green due to algal blooms	Green or blue-green due to algal blooms; milky due to livestock waste
Water Odor	Rotten egg, sewage, or musky due to incompletely treated sewage; chlorine due to over-chlorinated effluent	Rotten egg, sewage, or musky due to poorly functioning septic system	Sewage due to livestock waste
Surface Coating	Scum due to algal blooms	Scum due to algal blooms	Scum due to algal blooms
Streambed Coating	Green or brown due to algal blooms; black or grayish-white due to incompletely treated sewage	Green or brown due to algal blooms; black or grayish-white due to poorly functioning septic system	Green or brown due to livestock waste and/or algal blooms; black due to concentrated livestock waste
Chloride	High due to over-chlorinated effluent	-	-
Iron	-	-	-

	Automobiles, Residential Areas	**Wetlands and Waterfowl**	**Erosion**
Dissolved Oxygen	Low due to urban street runoff	-	When riparian vegetation is removed, Low due to release of sediments and loss of shade
pH	Low due to acid rain caused by automobile emissions	-	-
Total Alkalinity	-	-	-
Nitrate Nitrogen	High due to storm drain runoff	-	-
Phosphate	-	High due to drained wetlands	-
TSS	-	-	High due to increase in sediments caused by removal of vegetation or development, construction, quarries, mining, and agricultural areas with poor management practices for preventing soil erosion
Water Color	-	Milky due to large waterfowl population	Muddy due to increase in sediments
Water Odor	Petroleum due to waste oil runoff from urban streets	Rotten egg due to nearby wetlands	-
Surface Coating	Oily surface coating from urban street runoff	-	-
Streambed Coating	-	-	-
Chloride	High due to winter salting of roads	-	-
Iron	-	-	-

	Landfills	Dead Organisms (if no algal blooms, may indicate toxic pollution)	Mining
Dissolved Oxygen	Low due to algal blooms caused by nutrient runoff	-	-
pH	High due to algal blooms and/or acids in runoff	-	Low due to coal mining
Total Alkalinity	-	-	-
Nitrate Nitrogen	High due to nutient runoff, causing algal blooms	-	-
Phosphate	High due to nutient runoff, causing algal blooms	-	-
TSS	-	-	High due to upstream mining runoff
Water Color	Green or blue-green due to algal blooms; reddish due to runoff	-	-
Water Odor	-	Fishy due to dead fish (look under algal mats)	-
Surface Coating	Scum due to algal blooms	-	-
Streambed Coating	-	Black	-
Chloride	-	-	-
Iron	-	-	High due to discharge

Appendix A

Parameter Information and Investigation

To make sense of the data that you collect, it is useful to know a little more about the parameters that you are measuring, and some of the effects that different discharges or land uses may have on these parameters. The following information is provided to assist you in determining whether your data suggests good or poor water quality. It also should help you begin to identify reasons why the water quality may be poor, which in turn should help you identify steps that need to be taken to improve water quality. If you find that Illinois water quality criteria are not met in your stream, contact Prairie Rivers Network.

Temperature

Background

Temperature is an important parameter to measure because it effects the rates of chemical reactions. Biological reactions such as photosynthesis and metabolic rates of aquatic organisms are affected by temperature. Different organisms survive better at different temperatures; every organism's biological reactions are optimal at specific temperatures.

Stream and river temperatures are affected by the air temperature, removal of trees and shade, soil erosion, and also thermal pollution from power plants or storm water runoff (water entering the stream at higher temperatures than the water already present).

Temperature of air and water will be taken in degrees Celsius.

Illinois Water Quality Criteria

At the time of this printing, the Illinois water quality criteria prohibit "abnormal temperature changes that may adversely affect aquatic life," and state that the "rise above natural temperature shall not exceed 2.8º C." The criteria further state that water temperature at representative locations shall not exceed 17.7º C during the months December through March, and shall not exceed 33.7º C during April through November.

A good way to apply the first part of this rule is to test a stream above and below a point of discharge. If the discharge causes the water temperature to rise more than 2.8º C, there may be a violation. If you suspect this, be sure to test above the discharge at a number of places, at the discharge, and below the discharge at varying distances.

If you suspect a problem, monitor more frequently. If your first temperature measurement was taken in the morning, return in the afternoon to determine the temperature at the warmest time of day. Collect additional data for several days to determine if the exceedance is an ongoing problem. Many consistently measured data points are more reliable and valuable than one or two data points.

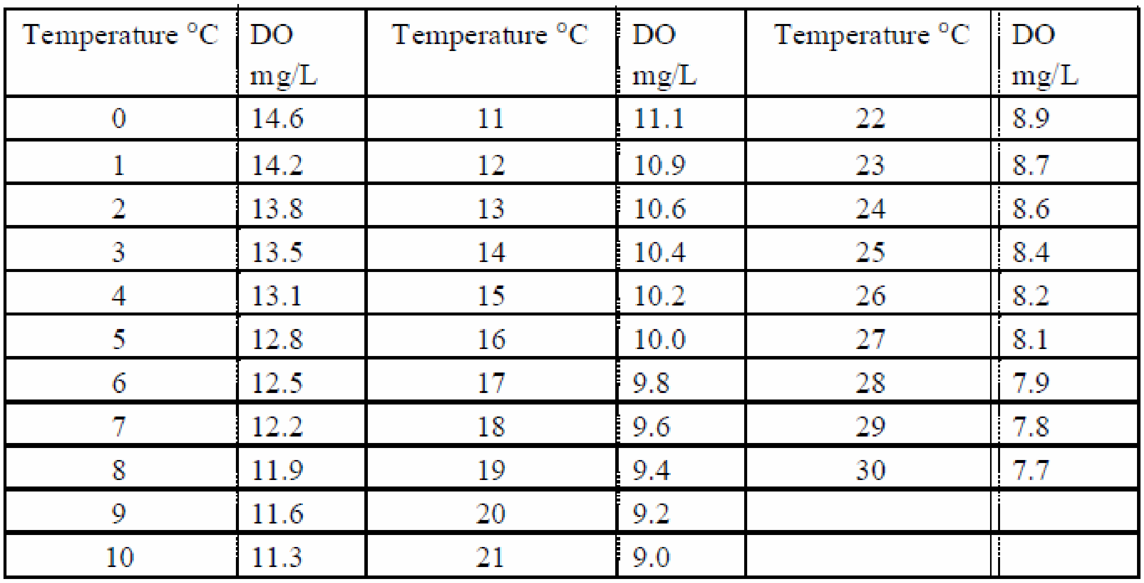
Dissolved Oxygen (DO)

Background

Nearly all organisms require oxygen for survival. Through the churning action of running water as well as plant photosynthesis, oxygen is transferred from the air into water in its dissolved form. Aquatic organisms can use it for respiration, decomposition, and other biochemical reactions. When oxygen levels in a stream are very low, below 1.0 or 2.0 mg/L, most organisms will not survive. Levels greater than 5.0 or 6.0 mg/L are generally considered supportive of growth and survival.

The oxygen levels in a stream are dependent on other chemicals in the water, temperature, plant and animal respiration and decomposition. Wastewater from sewage treatment plants, industrial wastewater, failing septic systems and storm water runoff from farmland, feedlots, and urban streets often contain organic materials. The decomposition of these materials by microorganisms in the stream requires oxygen, decreasing the amount of oxygen available to fish and macroinvertebrates. Other factors that can cause a change in DO levels are the presence of dams and removal of vegetation. Water released by a dam from the bottom of a lake or reservoir often has very low DO levels, while water released from the top sometimes contains an excess of oxygen. The removal of vegetation reduces shade and decreases the protection from erosion. These together can increase the water temperature and reduce DO levels.

DO levels vary throughout a 24-hour period as well as seasonally. Aquatic plants and algae produce oxygen during daylight hours and take oxygen up during dark hours which causes in-stream concentrations to be highest in the afternoon and lowest just before dawn. Excess nutrients such as phosphorus cause these fluctuations to be very dramatic. The following table shows saturation oxygen concentrations in water with very low salinity at barometric pressure of 760 mm Hg. Use this table to determine if the dissolved oxygen in your sample is greater or less than saturation. If the dissolved oxygen concentration is greater than saturation on a warm day, you should return to the site early in the morning to determine if the concentration falls below the criterion.



Temperature °C	DO mg/L	Temperature °C	DO mg/L	Temperature °C	DO mg/L
0	14.6	11	11.1	22	8.9
1	14.2	12	10.9	23	8.7
2	13.8	13	10.6	24	8.6
3	13.5	14	10.4	25	8.4
4	13.1	15	10.2	26	8.2
5	12.8	16	10.0	27	8.1
6	12.5	17	9.8	28	7.9
7	12.2	18	9.6	29	7.8
8	11.9	19	9.4	30	7.7
9	11.6	20	9.2		
10	11.3	21	9.0		

DO is measured in milligrams per liter, which is equivalent to parts per million (ppm) dissolved oxygen.

Illinois Water Quality Criteria

At the time of this printing, dissolved oxygen water quality criteria state that concentration should not be less than 6.0 mg/L during 16 hours each day, and it should never fall below 5.0 mg/L during any part of the day.

Between the hours of 9 AM and 9 PM, dissolved oxygen levels will probably be at their highest. Be aware that values under 6.0 mg/L during these hours may be problematic. Because dissolved oxygen can vary substantially during a 24 hour period, if you suspect a problem, return to the site as early in the morning as you can (before dawn if possible), to determine the oxygen concentrations at their lowest point in the day. Also continue to monitor the site for several days at similar times.

pH

Background

pH is a measurement of logarithmic concentration of hydrogen (H^+) and hydroxide (OH^-) ions in a sample of water. At pH=7.0, hydrogen and hydroxide ions are at equal concentrations and the water is deemed neutral. At pH values of less than 7, more hydrogen ions are in solution and the water is acidic. Likewise, at pH values of 7 to 14, the water is alkaline with more hydroxide ions. Because the scale is logarithmic, a difference of 1.0 unit in pH represents a 10-fold change in acidity or alkalinity. For example, a pH of 5 is 10 times more acidic than a pH of 6, and a pH of 4 is 100 times more acidic than a pH of 6.

Most aquatic organisms prefer a range of 6.5-8.0, but some organisms prefer more acidic or alkaline environments. Often in water with a low pH, toxic elements, such as metals, are more soluble and therefore more toxic to aquatic organisms. On the other hand, ammonia is more toxic to aquatic organisms at a high pH. Most organisms do not respond well to sudden or drastic changes in pH.

Acid rain, rocks and soils, wastewater discharges, and algae and plant growth can affect pH. Emissions of nitrogen oxides and sulfur dioxides, often from automobiles and coal-fired power plants, can result in acid rain or snow. The geology of the watershed determines how well the water can deal with acidic elements and thus the pH of the water. Presence of algae and plants in the water cause pH to fluctuate slightly during the day because carbon dioxide, which is taken up during photosynthesis and released during night time respiration, forms some acid when dissolved in water.

Illinois Water Quality Criteria

At the time of this printing, Illinois State water quality criteria require that pH should be between 6.5 and 9.0 except for natural causes.

If your waters have a pH of less than 6.5 or greater than 9.0, examine and research the geology of the area before assuming the causes are unnatural.

Alkalinity

Background

Alkalinity measures the water’s ability to neutralize, or buffer, acids. Ions enter the water and neutralizing compounds (alkaline compounds such as bicarbonates) remove the ions and lower the water’s acidity. Without these neutralizing compounds, acid entering the stream would cause drastic changes in pH, to which most organisms do not respond well.

A stream’s alkalinity is highly influenced by rocks and soils. Limestone deposits cause a high amount of alkaline compounds to enter the water, and streams that pass through them are able to neutralize acids very well because of this. Rainfall, snowfall, and some industrial wastewater discharges also influence alkalinity.

Alkalinity is measured in milligrams per liter (mg/L) $CaCO_3$.

Illinois Water Quality Criteria

There is no criterion for alkalinity.

Alkalinity can be used to help understand the geology of your stream. According to BASIN, Boulder, Colorado’s environmental information outreach program, for freshwaters, measurements of 20-200 mg/L are generally normal. Higher measurements are not problematic. When alkalinity falls below 10 mg/L, that can indicate that a stream has poor capability to buffer acids entering it. Acidic discharges in these waters would be more dangerous than in streams with high alkalinity.

Nitrate-Nitrogen

Background

Nitrogen is an essential component of life. Organic nitrogen is found in proteins and cells of all living things. Inorganic nitrogen exists as gas, nitrates, nitrites, or ammonia. Nitrates are essential plant nutrients and are commonly found in water. In excess they can contribute to an overabundance of aquatic plant growth and algal blooms, leading to dramatic fluctuations and low levels of dissolved oxygen. Under certain conditions, high concentrations of nitrates can become toxic to warm-blooded animals. Infants are particularly susceptible and should not drink water that is high in nitrate.

Excess nitrates found in water come from poorly functioning septic systems, wastewater from sewage treatment plants, runoff from fertilized yards and agricultural land, and livestock manure.

Nitrates are measured in milligrams per liter (mg/L), which is equivalent to parts per million (ppm).

Illinois Water Quality Criteria

Illinois water quality criteria require that for waters used for public water supply, nitrate-nitrogen shall not exceed 10 mg/L. There is no criterion for waters that are not used for public water supply. However, IEPA uses a threshold of 7.8 mg/L of nitrate-N as an indicator of excessive nitrate, and the statewide average concentration is approximately 3.9 mg/L nitrate-N.

Orthophosphate

Background

Phosphorus is typically the limiting nutrient for plant growth in Illinois. Because it is limiting, even small increases can have a dramatic impact on streams and rivers, causing excessive plant and algal growth, lowered dissolved oxygen levels, and sometimes death of some aquatic animals. The most easily used, and therefore most problematic, form of phosphorus is *orthophosphate*.

An increase in phosphorus can be caused by wastewater from sewage treatment plants, runoff from fertilized lands (farmland, parks, lawns, and golf courses), runoff from land treated with animal manure, drained wetlands, or failing septic systems.

The Stream Team kit can be used to determine the amount of orthophosphate (PO_4) and the amount of phosphorus (P) that is in the form of orthophosphate, referred to as orthophosphate-P or PO_4-P. These are measured in parts per million (ppm), or mg/L. Note that orthophosphate-P is only one form of phosphorus. Therefore, the concentration of total phosphorus would be higher than the concentration of orthophosphate-P.

Illinois Water Quality Criteria

At the time of this printing, Illinois water quality criteria require that total phosphorus shall not exceed 0.05 mg/L in lakes and reservoirs, or in a stream at the point where it enters a lake or reservoir. IEPA does not currently have phosphorus criteria for flowing waters, but it anticipates adopting criteria by 2008. The IEPA does use 0.61 mg/L of total phosphorus as a threshold for excessive phosphorus concentrations. The statewide average total phosphorus concentration is approximately 0.38 mg/L. Since orthophosphate-P is only a portion of the total P, a typical concentration of orthophosphate-P is less than 0.3 mg/L.

Total Suspended Solids

Background

Total suspended solids (TSS) is a measure of the amount of suspended particles in a water sample. Most often TSS measurements are taken using a filter that is dried in an oven and weighed, giving an exact measurement. The use of the Ohio Sediment Stick provides an estimate of TSS with a reasonable degree of accuracy without a filter and drying oven. High TSS prevents light from reaching submerged vegetation, in turn slowing photosynthesis and the release of oxygen into water from plants. This can cause plants to die, and these together can result in low dissolved oxygen levels. Also, particles making up TSS absorb sunlight, increasing the water temperature. High TSS can also limit visibility for fish catching food, interfere with fish gills, smother fish and insect eggs, and destroy habitat.

The substances contributing to TSS include soil, algae, microorganisms, and decaying matter. In faster flowing streams, the amount of total suspended solids are sometimes greater, while in slower moving streams solids can settle to the bottom faster and TSS measurements are lower.

An increase in TSS is often caused by soil erosion from development, construction, quarries, gravel mining, or agricultural areas that have not adopted good management practices to prevent soil erosion.

Illinois Water Quality Criteria

Illinois currently has no water quality criteria for total suspended solids, but the State considers measurements greater than 116 mg/L to be potential cause for stream impairment.

Using the Ohio Sediment Stick, this corresponds to less than 4.0 inches.

Stream Flow

Background

Stream flow is a measurement of the volume of water that moves over a designated point over a certain period of time. Flow affects water quality because during high flows, rivers receiving continuous pollution discharges have a greater capacity to dilute the wastes compared to small, slower streams. Velocity is closely related to flow and increases as the volume of water in the stream increases. Different organisms prefer living in streams with different velocities; some organisms need fast flowing habitats while others prefer quiet pools. The amount of silt and sediment carried by the stream is also determined by stream velocity. In slower streams, sediment will settle quickly at the bottom while in faster streams sediment will be kept suspended longer. Also, because of the greater churning action in faster moving streams, dissolved oxygen levels are often higher than in slow moving streams.

Irrigation and industrial activities that withdraw water from streams can dramatically decrease stream flow. Dams used for electric power often block stream flow and then release it in a surge.

The float method is the most common way for volunteers to measure stream flow.

Stream flow is measured in cubic feet per second (ft$_3$/sec)

Water Observations

The appearance and odor of the stream also can help you identify potential sources of pollution. The following interpretations of water observations are adapted from the Delaware Stream Watch *Technical Monitoring Volunteer Manual*.

Water Color

Clear – Colorless and transparent, clear water may indicate good water quality.
Milky – Cloudy white or gray and not transparent, a milky appearance may be indicative of excess bacteria and/or total suspended solids.
Green/Blue-green – Green to blue-green, the water may appear nearly black. This

may be the result of algal blooms, which are caused by an increase of nutrients released into the stream.

Reddish – Ranging from orange to red, this color may indicate acids draining into the water or the presence of synthetic dyes.

Brown/Tea – This color ranges from yellow brown to dark brown. Water that is a dark tea color is commonly called “black water” and indicates tannic acids released from decaying plants. This occurs naturally each fall when trees drop leaves.

Muddy – Light brown and cloudy, this is often caused by the sediment depositing during erosion or entering the stream from construction sites or other disturbed areas.

Water Odor

Rotten Egg – A sulfurous smell can indicate sewage pollution, since hydrogen sulfide gas is a product of sewage decomposition, though it can also be due to plant or algae decomposition.

Sewage – This can indicate the release of human waste material, untreated domestic sewage or livestock waste, though it can also be due to plant or algae decomposition.

Chlorine – This may indicate that a sewage treatment system effluent is over-chlorinated or is not properly de-chlorinated.

Fishy – This may indicate the presence of excessive algal growth or dead fish

Musky – This may indicate the presence of untreated sewage, livestock waste, algae, or other conditions.

Petroleum – This may indicate an oil spill from marine or terrestrial sources.

Surface coating

Scum – Usually resulting from algal blooms, a scum coating may indicate a high nutrient input from fertilizer or other organic matter.

Foam – Usually white or brownish-white, a small amount of foam will often occur naturally below an area of turbulence. However, iridescent bubbles can indicate the presence of detergent.

Oily – A multicolored reflection on the water surface can occur naturally as a result of decay or deposition of iron oxide, but it can also indicate oil floating in the stream.

Streambed coating

Orange-red – If in suspension, an orange-red streambed coating often occurs with an oily surface coating. This indicates that iron in groundwater is being oxidized as the groundwater seeps to the surface, resulting in naturally occurring iron oxide. Iron is also associated with mining operations.

Green – This will probably be caused by algae growing on the stream bottom.

Black – This is common in brackish waters, indicating low availability of oxygen and often resulting from decaying organic matter.

Brown – Some algae may be brown or yellowish brown. Excessive algae growth can be caused by a high amount of nutrients.

Grayish-white – This is often observed as cottony masses that could be sewage fungus.

Yellow – This may indicate sulfur entering the stream.

Quick Reference Safe Levels Chart

Parameter	**Concern Range**	**Safe Range**
Water Temperature	Above 63°F (Dec – Mar), Above 93°F (Apr – Nov)	Below 63°F (Dec – Mar), Below 93°F (Apr – Nov)
pH	0-6.4, 9.1-14.0	6.5-9.0
Conductivity	Greater than 500 µS/cm	Less than 500 µS/cm
Iron	……………………	……………………
Chloride	Greater than 500 mg/L	Less than 500mg/L
Acidity	……………………	……………………
Total Suspended Solids	Above 116.0 mg/L	unknown

Citing for Chloride: IL State Water Quality Survey 35 IAC

Appendix B

Volunteer Monitoring Data Sheet

Trained Volunteer(s)____
Other Volunteer(s)____
Name of stream or river___________________________ County________________
Site Number/Location ____
____
Basin______________________ Date_________ Time (start)________ (stop)_______

Current Weather
Clear/Sunny___
Overcast___
Showers (intermittent rain)___
Rain (steady rain)___
Storm (heavy rain)___

Recent Weather
Clear/Sunny___
Overcast___
Showers (intermittent rain)___
Rain (steady rain)___
Storm (heavy rain)___

VISUAL DATA

Water conditions

Water Color
clear___
milky___
green/blue-green___
reddish___
brown/tea___
muddy___
other (specify)
____

Water Odor
rotten egg___
sewage___
fishy___
chlorine___
musky___
petroleum___
none___
____

Surface Coating
scum___
foam___
oily___
none___
____

Streambed Coating
orange-red___
green___
black___
brown___
grayish-white___
yellow___
none___
____

Aquatic Vegetation

Algae Abundance
most places___
some spots___
none or very rare___

Algae Location
streambed___
surface___

Algae Colors
brown___
dark green___
light green___

Other Aquatic Plants
most places___
some spots___
none or very rare___

CHEMICAL DATA – *all measurements (except temperature) should be taken twice*
Parts per million (ppm) is equivalent to milligrams per liter (mg/L)
Use chart in standard operating procedures to find mg/L in total suspended solids.
Record inches and mg/L.

Parameter	**Measurement 1**	**Measurement 2**	**Measurement 3 (in necessary)**
Air Temperature (℃)			
Water Temperature (℃)			
pH			
Turbidity Tube Reading (inches) Total Suspended Solids (mg/L)	Inches mg/L	Inches mg/L	Inches Mg/L
Acidity (mg/L)			
Iron			
Chloride			
Conductivity			

STREAM FLOW

Small streams (less than 5 ft across)- find velocity and depth at one foot intervals

Large streams (greater than 5 ft across)- find velocity and depth at one to three foot intervals- depending on the size of the stream

Stream's width in ft ______
Stream's average depth in ft ______
Stream's velocity in ft/sec ______

Calculate: width (ft) x average depth (ft) x velocity (ft/sec) = FLOW (cfs)

__________ x __________ x __________ = __________

Stream Flow Worksheet

Station (foot interval)	**Velocity**	**Depth**	**Cfs (width x velocity x depth)**

Problems/Notes/Observations

____

____

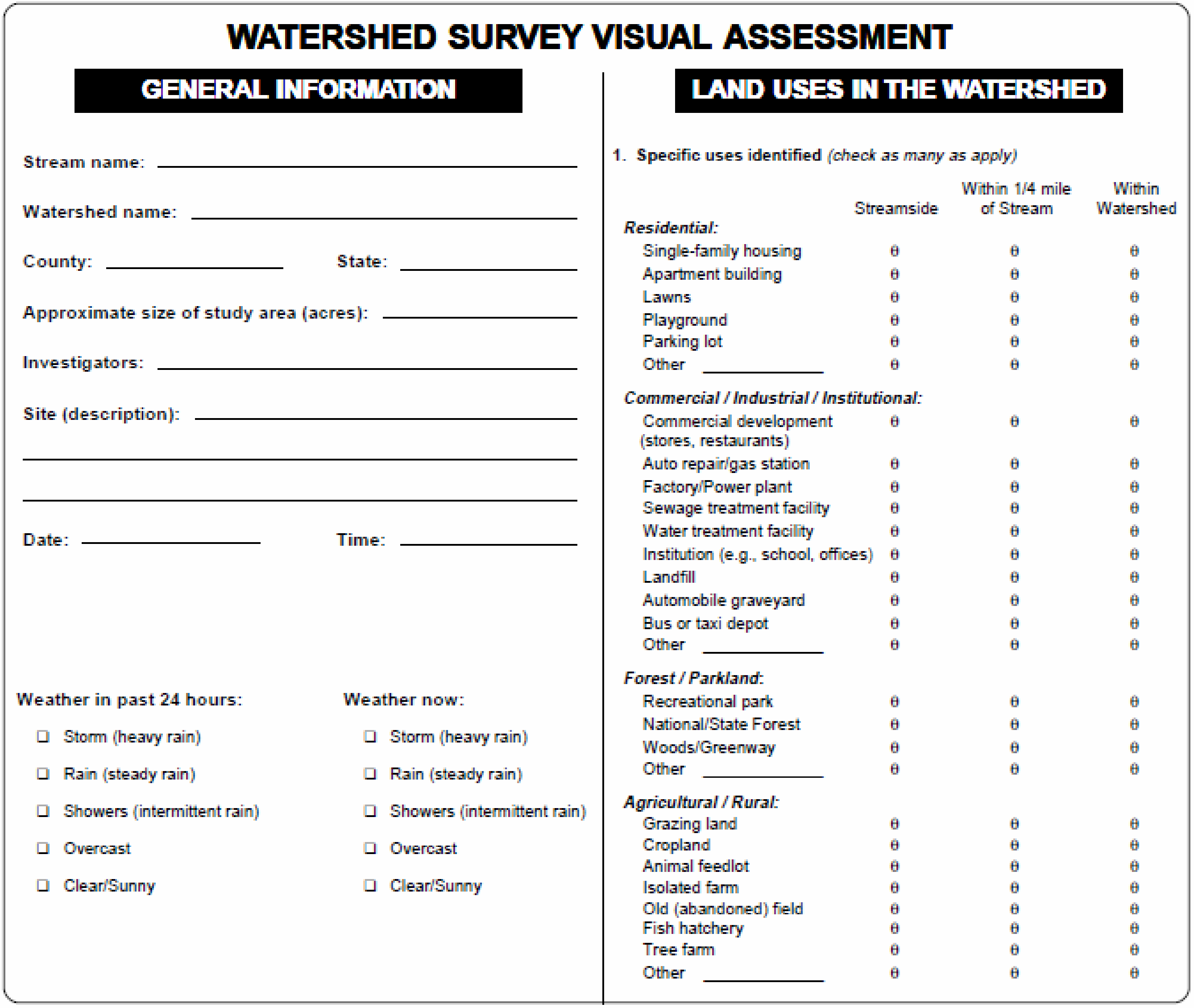
____

____

____

Appendix C

Watershed Survey Visual Assessment



WATERSHED SURVEY VISUAL ASSESSMENT

GENERAL INFORMATION

Stream name: ____________________

Watershed name: ____________________

County: __________ State: __________

Approximate size of study area (acres): __________

Investigators: ____________________

Site (description): ____________________

____

____

Date: __________ Time: __________

Weather in past 24 hours:

- ☐ Storm (heavy rain)
- ☐ Rain (steady rain)
- ☐ Showers (intermittent rain)
- ☐ Overcast
- ☐ Clear/Sunny

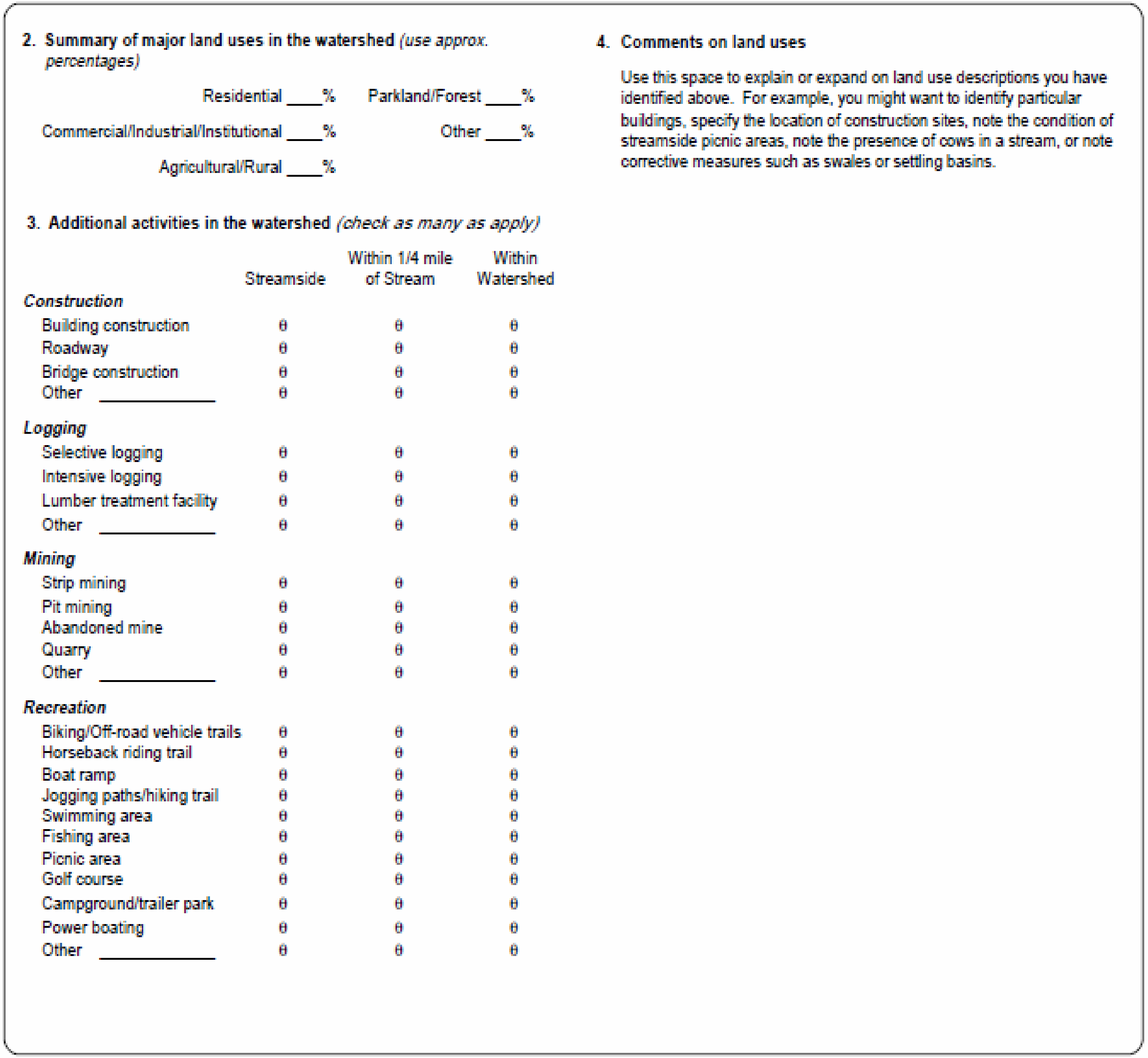
Weather now:

- ☐ Storm (heavy rain)
- ☐ Rain (steady rain)
- ☐ Showers (intermittent rain)
- ☐ Overcast
- ☐ Clear/Sunny

LAND USES IN THE WATERSHED

1. **Specific uses identified** *(check as many as apply)*

	Streamside	Within 1/4 mile of Stream	Within Watershed
Residential:			
Single-family housing	○	○	○
Apartment building	○	○	○
Lawns	○	○	○
Playground	○	○	○
Parking lot	○	○	○
Other __________	○	○	○
Commercial / Industrial / Institutional:			
Commercial development (stores, restaurants)	○	○	○
Auto repair/gas station	○	○	○
Factory/Power plant	○	○	○
Sewage treatment facility	○	○	○
Water treatment facility	○	○	○
Institution (e.g., school, offices)	○	○	○
Landfill	○	○	○
Automobile graveyard	○	○	○
Bus or taxi depot	○	○	○
Other __________	○	○	○
Forest / Parkland:			
Recreational park	○	○	○
National/State Forest	○	○	○
Woods/Greenway	○	○	○
Other __________	○	○	○
Agricultural / Rural:			
Grazing land	○	○	○
Cropland	○	○	○
Animal feedlot	○	○	○
Isolated farm	○	○	○
Old (abandoned) field	○	○	○
Fish hatchery	○	○	○
Tree farm	○	○	○
Other __________	○	○	○



2. Summary of major land uses in the watershed *(use approx. percentages)*

Residential ____% Parkland/Forest ____%

Commercial/Industrial/Institutional ____% Other ____%

Agricultural/Rural ____%

3. Additional activities in the watershed *(check as many as apply)*

	Streamside	Within 1/4 mile of Stream	Within Watershed
Construction			
Building construction	☐	☐	☐
Roadway	☐	☐	☐
Bridge construction	☐	☐	☐
Other ____________	☐	☐	☐
Logging			
Selective logging	☐	☐	☐
Intensive logging	☐	☐	☐
Lumber treatment facility	☐	☐	☐
Other ____________	☐	☐	☐
Mining			
Strip mining	☐	☐	☐
Pit mining	☐	☐	☐
Abandoned mine	☐	☐	☐
Quarry	☐	☐	☐
Other ____________	☐	☐	☐
Recreation			
Biking/Off-road vehicle trails	☐	☐	☐
Horseback riding trail	☐	☐	☐
Boat ramp	☐	☐	☐
Jogging paths/hiking trail	☐	☐	☐
Swimming area	☐	☐	☐
Fishing area	☐	☐	☐
Picnic area	☐	☐	☐
Golf course	☐	☐	☐
Campground/trailer park	☐	☐	☐
Power boating	☐	☐	☐
Other ____________	☐	☐	☐

4. Comments on land uses

Use this space to explain or expand on land use descriptions you have identified above. For example, you might want to identify particular buildings, specify the location of construction sites, note the condition of streamside picnic areas, note the presence of cows in a stream, or note corrective measures such as swales or settling basins.

GENERAL STREAM AND WATERSHED CHARACTERISTICS

5. **Note the number of hydrologic modifications** *(structures that alter natural stream flow):*

None ________ Waterfalls ________
Dams ________ Stream fords ________
Bridges ________ Beaver dams ________

6. **Note the approximate length of stream that is affected by the following:**

Stream diversion ________ feet or ________ miles
Stream straightening ________ feet or ________ miles
Concrete streambank/bottom ________ feet or ________ miles

7. **Check the categories that best describe the general appearance of the stream:**

Litter:

- ☐ No litter visible
- ☐ Small litter occasionally (e.g., cans, paper)
- ☐ Small litter common
- ☐ Large litter occasionally (e.g., tires, carts)
- ☐ Large litter common

Erosion:

- ☐ No streambank erosion or areas of erosion very rare; no artificial stabilization
- ☐ Occasional areas of streambank erosion
- ☐ Areas of streambank erosion common
- ☐ Artificial streambank stabilization (e.g., rip rap) present

Special Problems *(note in detail in comment section below):*

- ☐ Spills of chemicals, oil, etc.
- ☐ Fish kills
- ☐ Wildlife, waterfowl kills
- ☐ Flooding
- ☐ Periods of no flow

8. **Comments on general stream characteristics (e.g., date and size of fish kill, increased rate of erosion evident, litter most evident after storms)**

PIPE AND DRAINAGE DITCH INVENTORY

In this section, provide information on pipes and drainage ditches found on the banks or in the stream. These pipes/ditches can be abandoned or active. Note this basic information for each pipe or drainage ditch you observe. Attach additional pages to this form.

9. This information applies to a:

☐ Pipe ☐ Drainage ditch ☐ Other __________

10. Location of pipe/ditch:

☐ In stream ☐ In streambank ☐ Near stream

Describe location:

11. Pipe/Ditch # (for mapping/locational purposes) ________________

12. Identify type of pipe (check one)

- ☐ Industrial outfall
- ☐ Sewage treatment plant outfall
- ☐ Storm drain
- ☐ Combined sewer overflow
- ☐ Agricultural field drainage
- ☐ Paddock or feedlot drainage
- ☐ Settlement basin/pond drainage
- ☐ Parking lot drainage
- ☐ Unknown
- ☐ Other ____________________

13. Approximate Diameter of Pipe: _________ inches or

_________ feet

14. Describe the discharge flow:

Rate of Flow: ☐ None ☐ Intermittent ☐ Trickle
☐ Steady ☐ Heavy

Appearance: ☐ Clear ☐ Foamy ☐ Turbid
☐ Oily sheen ☐ Colored _________________

Odor: ☐ None ☐ Rotten eggs/sewage ☐ Chemical
☐ Chlorine ☐ Other _________________

15. Describe the streambank/stream below pipe or drainage ditch:

- ☐ No problem evident
- ☐ Sewage litter (e.g., toilet paper)
- ☐ Litter (e.g., styrofoam, cans)
- ☐ Eroded
- ☐ Lots of algae
- ☐ Other ____________________

16. Comments on pipes and drainage ditches

Use this space to explain or expand on information provided on pipes and discharges you have identified above. For example, you may want to identify particular facilities, or discuss in more detail the condition of the stream below the discharge.

Appendix D

Monitoring Plan Worksheet

I. Watershed Description

II. Goals

III. Sites to Monitor (also attach a map)

IV. Anticipated Monitoring Schedule (including tests to be conducted)