Hudson Basin River Watch

Guidance Document

helping to coordinate monitoring efforts throughout the watershed

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River Network Mission Statement:

to help people understand, protect and restore rivers and their watersheds

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Hudson Basin River Watch Mission Statement:

to improve the water quality of the Hudson River and all its tributaries through education, community involvement, and stewardship

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HUDSON BASIN RIVER WATCH BACKGROUND & WHO'S INVOLVED

What is Hudson Basin River Watch?

Hudson Basin River Watch (HBRW) is an association of students, teachers, citizen volunteers, environmental organizations, and water resource agencies whose mission is to improve the water quality of the Hudson River and all its tributaries through education, community involvement, and stewardship. The vision is simultaneously local and bioregional: people are learning about and taking care of their own streams with the unifying principle of one whole and magnificent watershed from Mt. Marcy and the Mohawk River to New York City.

Hudson Basin River Watch project objectives are to train volunteers how to identify Hudson Basin water quality problems; to monitor the physical, biological, and chemical characteristics of Hudson Basin waters; and to use the information in river restoration and protection efforts.

Hudson Basin River Watch is a project in process. We began with multi-disciplinary education for all ages, and are now involving community leaders all over the Basin in an effort to build a truly collaborative, quickly responsive and effective river monitoring and protection program.

Hudson Basin River Watch is a project of the Open Space Institute, Inc., and is funded in large part by the New York State Department of Environmental Conservation Hudson River Estuary Program, the Hudson River Improvement Fund, other foundations and other donations.

The Hudson River Basin (included in the 9 Hydrologic Unit Codes 02020001-02020008 and 02030101) is located in eastern New York State and small parts of New Jersey, Connecticut, Massachusetts, and Vermont. It extends from New York City northward approximately 300 river miles to the central Adirondack Mountains and westward approximately 100 miles to the Mohawk River headwaters near Utica. The lower river is one of the most productive estuaries on the Eastern Seaboard and is tidal for 153 miles north to the Troy Federal Lock and Dam. The Hudson Basin has a diverse population of 4 million people. Approximately 8% of the land use is urban and residential, 25% is agricultural, 62% is forested, and 5% is open water and "other." Primary water uses include irrigation and drinking water supply, commercial transportation, wastewater drainage, wildlife habitat, commercial and sport fishing, and recreation.

Hudson Basin River Watch Participants

Starting in 1990 in the Upper Hudson with several schools, the Adirondack Park Visitors Interpretive Center and Battenkill Conservancy-NY, Hudson Basin River Watch now includes over 100 schools, volunteer groups, environmental organizations and water resource agencies from the Adirondacks to New York City. River Network, Inc., the national river protection organization, is an essential and leading force behind the technical training program. The New York District Office of the United States Geological Survey has provided important start-up funding and critical advisory assistance. The Hudson River Improvement Fund has continued significant grant support and valuable guidance since 1996. In April 1999 The New York State Department of Environmental Conservation (NYS DEC) Hudson River Estuary Program awarded Hudson Basin River Watch a three-year contract to administer the citizen volunteer water-quality monitoring project throughout the Hudson River Estuary. In March 2000 HBRW signed an addendum to the NYS DEC contract to expand volunteer monitoring in Catskill and Croton regions of the New York City Watershed.

Since our first Hudson Basin Volunteer Monitoring Conference at Teatown Lake Reservation on May 22, 1997, and a follow-up gathering at Norrie Point Environmental Education Center on March 30, 1999, many other key supporting organizations have joined the Hudson Basin partnership including: Catskill Center for Conservation and Development, Dutchess County Environmental Management Council, Hudson River Valley Americorps, Hudsonia, Hudson River Sloop Clearwater, Institute for Ecosystem Studies, Riverkeeper, Stroud Water Research Center, Teatown Lake Reservation, Westchester Community Foundation, Westchester County Department of Planning, Youth Resource Development Corporation, and many county Soil & Water Conservation Districts. For a complete listing see the following HBRW Steering Committee, Regional Coordinators, Resource Partners, and Monitoring Groups.

Hudson Basin River Watch Vision

Hudson Basin River Watch aims to improve the water quality of the Hudson River and all its tributaries through education, community involvement and stewardship. As an emerging national model for river monitoring and protection programs on a watershed scale, the keys are science education, working partnerships with existing organizations, and building community through networking and action. The vision is:

- **Local and specific** - people knowing and caring for their own rivers and mountains intimately...endlessly.
- **Watershed and bioregional** - a clearly connecting perspective from Mt. Marcy to New York Harbor.
- **Graceful and Harmonious** - a coordinated network of autonomous teams, many based in schools and partnered with local private interests, nonprofit organizations and government agencies.

The focus is on action: scientific monitoring, restoration and protection in each local Hudson Basin community. With hundreds of volunteer groups and thousands of River Watchers we will ensure rapid and lasting Hudson River protection.

Hudson Basin River Watch Model

The HBRW model consists of "Regional Coordinators" who serve the role of supporting and coordinating local efforts in their area. Regional Coordinators review data from their groups and work with county Water Quality Coordinating Committees and NYSDEC regional offices to follow up on questions, concerns, and verifications. Groups can send their data to their Regional Coordinators via the HBRW website at www.hudsonbasin.org .

Regional Coordinators also communicate and coordinate with each other, so that the unifying principle of one whole watershed links all local groups together. The website strengthens this process by facilitating communication and data exchange between groups. There is also a Steering Committee that provides leadership and helps to keep the network active and activities connected. Through the Steering Committee and other networking activities, HBRW keeps connected to other groups concerned with the health of the Hudson River and its watershed.

Hudson Basin River Watch Regional Coordinators

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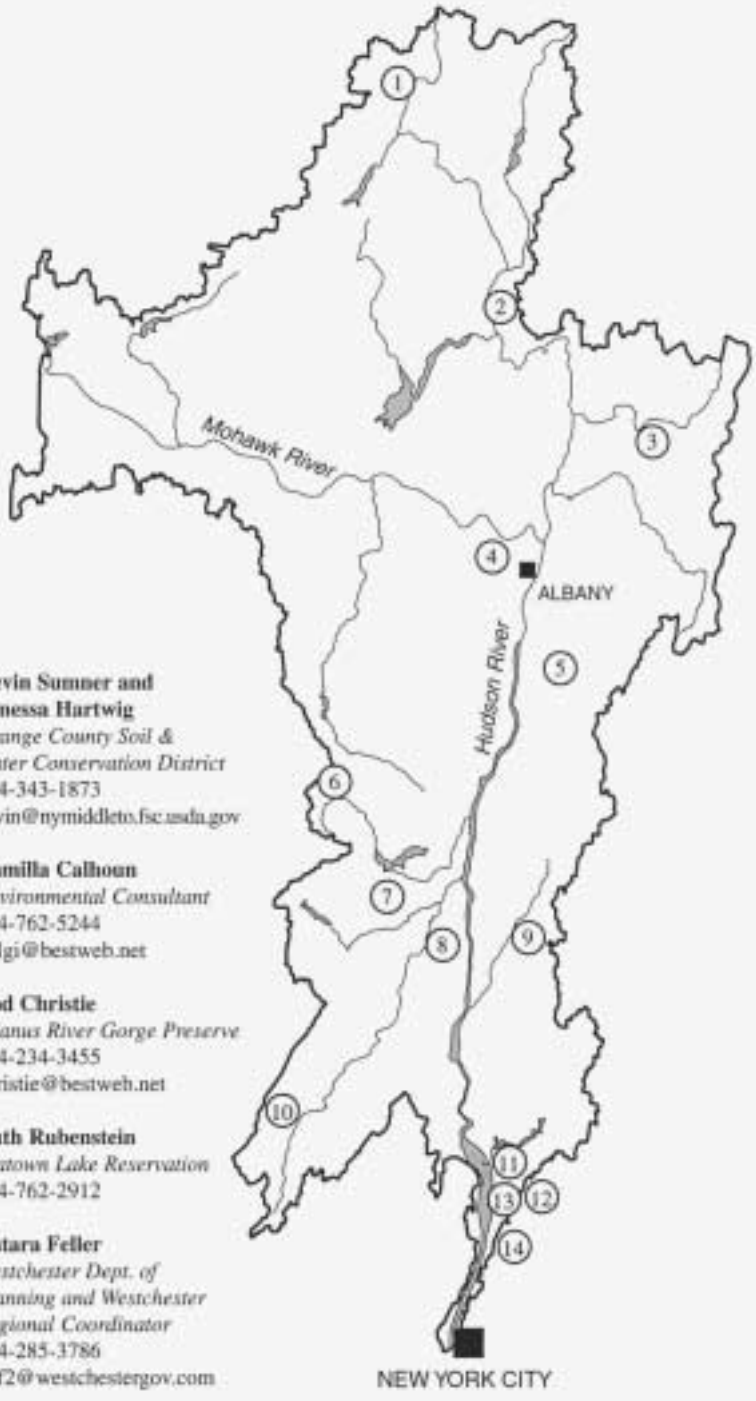


Hudson Basin River Watch Website: www.hudsonbasin.org

Starting in 1990 with several schools coordinated by the Adirondack Park Visitors Interpretive Center and Battenkill Conservancy-NY, the Hudson Basin River Watch, now includes over 100 schools and dozens of supporting organizations and agencies.

Below is a list of those involved in creating our network. We invite you to join in the network and share your vision for how we can work together!

HBRW Steering Committee and Regional Coordinators

* Sandra Bureau and Marilyn Broome, Adirondack Park Visitors Interpretive Center
* Doug Reed, HBRW Director and HBRW Upper Hudson Regional Coordinator
Sharon Behar, River Network
Ward Freeman, U.S. Geological Survey
Beth Waterman, NY State Department of Environmental Conservation
* Martha Cheo, HBRW Mid-Hudson Coordinator
* Rick Fritschler, Ulster County Environmental Management Council
Chuck Nieder, Hudson River National Estuarine Research Reserve
Nordica Holochuck, NY Sea Grant
* Rod Christie, Mianus River Gorge Preserve
Barbara Dexter, SUNY Purchase
* Camilla Calhoun, Earthworks, LLC
* Aaron Bennett and Nathan Chronister, Catskill Center for Conservation and Development
* Barbara Kendall & Dave Burns, Dutchess County Environmental Management Council
Amy Waterman, NYC Department of Environmental Protection
* Kelly Nolan, Environmental Study Team and Capital District Regional Coordinator
* Kevin Sumner & Tanessa Hartwig, Orange County Soil and Water Conservation District
* Susan Jenks, Columbia County Soil and Water Conservation District
* Natara Feller, Westchester Dept. of Planning and HBRW Westchester Coordinator

* = HBRW Regional Coordinator

HBRW Network Resource Partners

Adirondack Park Visitors Interpretive Center
Albany Institute of History and Art
Battenkill Conservancy-NY
Battenkill Watershed Council
Black Rock Forest Consortium
Catskill Center for Conservation and Development
Hudson River Sloop Clearwater
Dutchess County Environmental Management Council
Dutchess Land Conservancy
Frost Valley YMCA
Hudson River Environmental Society
Hudson River Improvement Fund of the Hudson River Foundation
Hudson River National Estuarine Research Reserve
Hudson River Valley AmeriCorps
Hudson Valley Regional Council
Institute of Ecosystem Studies
Lower Esopus River Watch
Mohonk Preserve
NYC Department of Environmental Protection
NY / NJ Baykeeper
NYS Soil & Water Cons. Districts Albany Co., Dutchess Co., Columbia Co., Essex Co., Greene Co., Orange Co., Rensselaer Co., Saratoga Co., Schenectady Co., Warren Co., Washington Co., and New York City
Olive Natural Heritage Society
Open Space Institute
Orvis
Riverkeeper
River Network
Scenic Hudson
Southeastern NY Water Supply Advisory Council
Trout Unlimited, Clearwater Chapter
Ulster County Environmental Management Council
US Environmental Protection Agency
US Fish and Wildlife Service, Wallkill River National Wildlife Refuge
US Geological Survey
Vermont Institute of Natural Science
Wallkill River Task Force
Westchester County Planning Department
Youth Resource Development Corporation AmeriCorps
Rensselaer Polytechnic Institute
Dutchess County Community College
Hudson Valley Community College
Adirondack Community College
SUNY Albany
SUNY Purchase
Marist College
Bard College
Bank Street College
American Museum of Natural History

School-Based Monitoring Groups

Headwaters and Upper Hudson River:

- Albany High School
- Arlington Memorial High School
- Bolton Central School
- Burr & Burton Seminary
- Darrow School
- Glens Falls High School
- Greenwich Central School
- Hadley-Luzerne Central School
- Johnsburg Central School
- Long Lake Central School
- Minerva Central School
- Newcomb Central School
- Salem Central School
- Schalmont High School
- Schroon Lake Central School
- Schuylerville Central School
- Warrensburg Central School

Mid-Hudson River & Catskills

- Alden Place Elementary
- Arlington High School
- Bulkeley Middle School
- Catskill Bruderhoff School
- Chatham High School
- Circleville Elementary School
- Circleville Middle School
- Cornwall Elementary School
- Cornwall High School
- Delaware Academy Elementary School
- Downsville Central School
- Edson Elementary School
- Ellenville Elementary School
- FD Roosevelt High School
- Gilboa-Conesville Central School
- Haviland Middle School
- Henry H. Wells Middle School
- Highland Elementary School
- Highland Middle School
- Highland High School
- Hunter-Tannersville Elementary School
- Icabod Crane High School
- Kingston High School
- LaGrange Middle School
- Linden Avenue Middle School
- Margaretville Central School
- Millbrook Junior / Senior High School
- Monhagen Middle School
- Montgomery Elementary School
- Most Precious Blood School
- New Paltz Middle School
- New Windsor Elementary School
- Orange-Ulster BOCES
- Phoenicia Elementary School
- Pine Bush elementary School
- Poughkeepsie High School
- Rhinebeck Junior / Senior High School
- Robert Graves Elementary School
- Rondout Valley High School
- Roxbury Central School
- South Kortright Central School
- Scott M. Ellis Elementary School
- Townsend Elementary School
- Tri-Valley Central School
- Van Wyck Junior High School
- Wallkill High School
- Wappingers Falls Junior High School
- Warwick Valley High School
- Windham-Ashland-Jewett Central School
- Valley Central High School
- Zena Elementary School

Lower Hudson River

- Burroughs Junior High School
- Crittenden Middle School
- Edgemont Junior High School
- Fox Lane Middle School
- John Jay Middle School
- Lincoln High School
- Mildred Strang Middle School
- Museum Junior High School
- North Rockland High School
- North Salem Middle School
- Pearl River High School
- Pleasantville Middle School
- Rippowam Cisqua School
- Van Cortland Middle School
- PS 22, Yonkers
- R.E. Bell Middle School
- Scholastic Academy
- The Harbor Academy
- Walkabout School
- Westlake Middle School

Citizen Groups

- Beacon Stream Team
- Environmental Study Team
- Northeast Community Center
- Rhinebeck Stream Team
- Saw Mill Audubon Society
- Olive Natural Heritage Society
- Wallkill River Task Force
- Wappinger Creek Watershed Planning Committee

Goals

This document was designed in response to goals set by the participants of the first Hudson Basin gathering in May 1997 and by the stated needs of others who were interviewed. It was created to:

- Develop coordination and standardization between all groups involved with monitoring in the basin, whether for educational or resource management purposes, while encouraging and adapting to regional and local differences.
- Improve the ability of groups to compare and use their information.
- Improve the ability of groups to generate data that can be used by New York State Department of Environmental Conservation (NYS DEC) and local communities for management purposes.

This document will help to coordinate HBRW group efforts with the NYS DEC "Waterbody Inventory" (WI) which assesses the quality of the state' s waters. Part of that inventory is the "Priority Waterbody List," (PWL) which documents information about water bodies with known water quality impacts. Because DEC has limited staff to cover the many miles of rivers in the state, they have called upon HBRW groups and others to provide more information for the WI/PWL.

The Tiers

Water quality monitoring protocols are organized into three tiers. The higher the tier, the more stringent the protocol is, leading to a different data use. All three tiers can be used to provide information for the WI/PWL or for educational purposes only:

Tier 1 is an introductory investigation to document that a river segment is "not impacted," or that there are "possible" problems impacting waterbody uses. Such "possible" problems need further verification.

Tier 2 is a preliminary assessment to document that a waterbody is supportive of its uses, or that there are "suspected" problems impacting waterbody uses. Additional verification by DEC is a possibility, but not always required for inclusion in the PWL.

Tier 3 is a rigorous assessment that can be used to document "known" problems and conclude that the use of the waterbody is impaired. Additional verification by DEC is not necessary, but DEC should be consulted in the early stages of designing the study.

Refer to the chart "Overview of Tiered Protocols" for a synopsis of the protocols for each of the tiers. All three tiers include a physical survey/habitat assessment and some level of biological monitoring. Tiers 2 and 3 also include chemical monitoring.

How to Use this Document

The system of tiered protocols balances standardization with flexibility in an effort to meet all HBRW groups' needs. Participants can pick and choose protocols from a menu of options; you don' t need to measure every indicator included in a tier, and you can use protocols from more than one tier in the same study. For example, if you' re a macro invertebrate expert but a chemistry novice, you can use the Tier III biological protocol with the Tier II chemistry protocol.

But your level of expertise is not the only criteria to use in choosing a tier and parameters to measure. More importantly, what you measure and which tier you choose depends on what' s going on in your part of the watershed and what your goals are. What are the threats to the water quality in your area? What ecological information is important for you to gather? What does your group hope to gain from their experience? Who is going to use your data? All these questions, and more, will determine what you measure. You may choose to measure only one indicator or simply perform visual surveys if that is the key focus in your region.

The tiers described in this document are a framework of suggestions to help you focus your program and connect participants throughout the watershed. If you choose to use other methods or indicators, you are still welcome to be a part of the Hudson Basin network.

Where to Start?

We recommend that you start with a study design, using the guidance in the "Study Design" section of this document. Once you have established a study design, then you can pick and choose which indicators and which tier best fits your situation.

Hudson Basin River Watch
Overview of Tiered Protocols

	Tier 1 **Introductory Investigation**	**Tier 2** **Preliminary Assessment**	**Tier 3** **Rigorous Assessment**
DEC Approved Use	Document that a river segment is either "not impacted," or that there are "possible" problems impacting waterbody issues. Such "possible" problems need further verification.	Document that a waterbody is supportive of its uses, or that there are "suspected" problems impacting waterbody uses. Additional verification by DEC is a possibility, but not always required for inclusion in the Priority Waterbodies List.	Document "known" problems and conclude that the use of the waterbody is impaired. Additional verification by DEC is not necessary, but DEC should be consulted in the early stages of designing study.
Physical / Habitat	SITES: *Physical/Habitat Survey* SEGMENTS: *Streamwalk Segment Survey* (adapted from Dutchess EMC)	*Physical Survey/Habitat Assessment:* Ranking of habitat factors OPTIONAL: *Stream Bottom Survey*: Simplified Wolman pebble count and average of 10 cobble embeddedness *Flow*: Float method, 9 velocity trails, 1 cross section	*Physical Survey/Habitat Assessment:* Same as Tier 2 *Stream Bottom Survey:* Same as Tier 2 *Flow*: Same as tier 2, or flow meter depending on study design
Benthic Macroinvertebrates (BMI's) Sampling Method: 8" x 18" kick net, 500-600 microns (0.5-0.6 mm) mesh, 1 composite sample of 2 fast & 2 slow areas in a riffle, 0.5 m^2 area (2 replicates for tiers 2 and 3)			
	Screening Criteria for Non-Impacted Streams: Live analysis, presence/absence of 5 major groups, estimate relative abundance	*Live or preserved analysis of 100 organism sub-sample*: Identify, sort and count individuals within major groups; sort and count (but not identify) EPT families. Calculate: Major Group Biotic Index, Major Group % Composition, EPT Richness Estimate	*Preserved analysis of 100 organism sub-sample*: Identify, sort and count individuals within families and functional feeding groups Calculate: Major Group % Composition, Family biotic Index, Family EPT Richness, Total Family Richness, Organism Density, % Dominance, Feeding Group % Composition, community Similarity Index

Hudson Basin River Watch - Overview of Tiered Protocols

Chemical Indicators	Tier 1 Introductory Investigation	Tier 2 Preliminary Assessment	Tier 3 Rigorous Assessment
PH	*pH paper strips* (1-14, by 1) or color comparator	*Pocket Meter* (1-14, by 0.1) HACH pocket pal or better*	Same as Tier 2
DO	None	*Modified Winkler Titration*, LaMotte microburet (0-20 by 1 ppm)*, OK: Hach drop count*	*Modified Winkler Titration*, HACH digital titrator (0-20 by 0.1 ppm)*
Nitrate-Nitrogen (NO_3-N)	None	*Zinc Reduction*, LaMotte color comparator (0, 1, 2, 4, 6, 8, 10, 15 ppm)*, OK: Cadmium reduction, HACH colorwheel or LaMotte color comparator (0-10 ppm)*	*Cadmium Reduction*, standard curve, HACH DR700 or 800 series colorimeter (0-30 by 0.1ppm)*, DR890 better for lower range (0-5), spectrophotometer even better.
Ammonia-N	None	Still Researching	Still Researching
Orthophos-phate (PO4)	None	*Ascorbic Acid Reduction*, HACH color wheel (0-5 by 0.5 ppm); OK: LaMotte color comparator with axial reader (0.2, 0.4, 0.6, 0.8, 1.0, 1.5, 2.0 pm)	*Ascorbic Acid Reduction*, with standard curve, HACH DR700 or 800 series colorimeter (0-2.5 by 0.01 ppm); spectrophotometer even better.
Chloride	None	*Silver Nitrate Titration*, LaMotte microburet (0-200 by 4ppm); OK: HACH drop count (0-100 by 5 ppm; 20-400 by 20 ppm)	Still Researching
Total Alkalinity	None	*Sulfuric Acid Titration*, LaMotte microburet (0-200 by 4.0 ppm)*	*Sulfuric Acid Double Endpoint Titration*, HACH digital titrator (10-4000 by .1 ppm)*
Conductivity	None	*Meter*, Corning PS17 or better (0-1990 mS/cm by 10)*	Same as Tier 2
Bacteria	None	Still Researching; in meantime, check existing data and/or collect samples for health department or other agency to analyze	*Membrane filtration using mTEC or mFC*
Turbidity	None	*Nephelometer*	Same as Tier 2
Solids	None	Total Settleable: *Hach Imhoff settling cone* Total Suspended*: Filtered, oven-dried & weighed.*	Same as Tier 2

*These meet the GLOBE Program requirements.

DESIGNING YOUR RIVER STUDY

What is a Study Design?

The process of choosing what, where, how, and when to monitor your river is called a study design. Your study design is the most important step in your whole project. The study design process will help you to decide which tier to use, and what indicators to choose within each tier for your program to answer the questions and interests you have about your river.

The bottom line of a monitoring study is to make sure that you have a question you are exploring. This chapter will guide you in how to go about picking appropriate questions and then how to design a study that will help you to explore that question.

A study design will help to avoid these common problems:

- spending time and money on equipment and procedures that are inappropriate for your purposes;
- looking for the wrong things at the right places or the right things at the wrong places;
- not answering the question you asked, answering a question you did not ask, or, worst of all, not answering a question at all;
- not knowing how to interpret your data, because you didn't have a question or focus when you started your study;
- finding that others are reluctant to use your data, since they do not know how good the data are or how they can be used.

Who Should Do A Study Design?

We recommend that <u>everyone</u> who has a monitoring program go through a study design process.

<u>Regional or county resource organizations</u> (such as Environmental Management Councils, Soil & Water Conservation Districts, Planning Departments, etc.) are in a great position to design a study for their region. An essential role of an HBRW Regional Coordinator is designing a study for their region.

<u>School groups, town conservation committees, and other citizen groups</u> can develop programs that help implement a part of their Regional Coordinator's study design. Or they can design their own study to best fit their needs.

A Note for School Teachers: *Even if your primary goal is to teach students hands-on science rather than to gather useful data, the study design process will help you in today's climate of meeting state science standards. Science involves making observations, asking questions, making predictions, and designing experiments to test hypotheses. A study design is all of these things; having one will ensure that your monitoring program is an engaging, inquiry-based science project. The "Study Design Worksheet" at the end of this section is designed specifically to help students apply the scientific method to a watershed study.*

It is important to find out from local agencies and organizations what they are doing and interested in so you can coordinate and plug into existing work and prevent "reinventing" the wheel. Contact your town, county and state agencies or organizations to find out about existing efforts (soil and water conservation districts, water quality coordinating committees, environmental management councils, Cornell Cooperative Extension, DEC, etc.). In some cases, you may need to use other protocols than what appears in this document if your local resource agencies have specific data needs that differ.

Study Design Steps

The following section will describe the steps we recommend to create a study design. The "Study Design Worksheet" at the end of this section will help you to compile and record this design.

Step 1 - Watershed Inventory

Step 2 - Why are you monitoring? Define your questions.

Step 3 - Define your data uses and users. Which tier do they fit into?

Step 4 - Choose indicators that address your question and data use goals. Define your QaQc for each indicator.

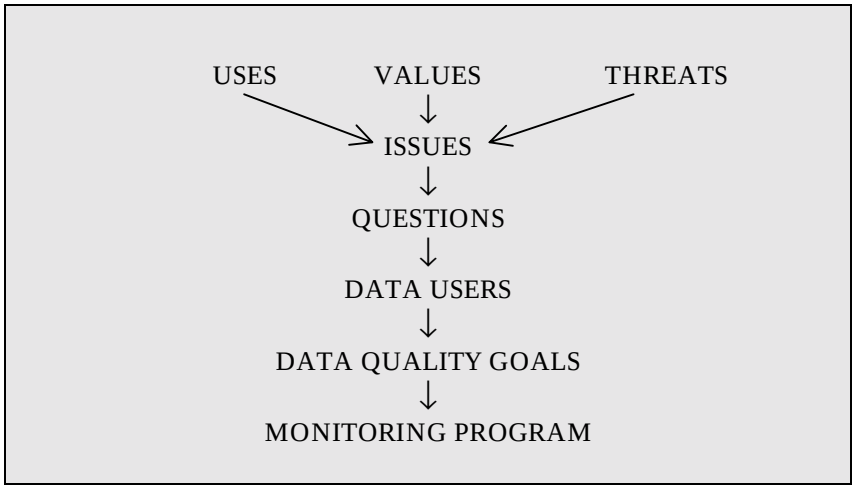
Step 5 - Where will you monitor?

Step 6 - When will you monitor?

Step 7 - Who will do what tasks?

STEP 1 Watershed Inventory

The purpose of a watershed inventory is to learn about the current uses, values and threats to the water resources of your watershed. This will help you identify key issues that your study questions can focus on.



There are many different ways to perform a watershed inventory. Below are some ideas for the kinds of information you might want to gather in an inventory. A more complete list of information to gather, a "Watershed Inventory Checklist," is included at the end of this section. This checklist also provides suggestions for where you can obtain sources of information you'll need to conduct a watershed inventory.

In general, there are two ways to gather information: 1) Research and interviews to find existing information, and 2) Field inventory to document what's actually happening out in the watershed.

1. **Research:**

   The following are some of the important research items to include in your watershed inventory.

   - Use maps and aerial photos to:
     - Delineate watershed and obtain basic watershed information
     - Calculate percentage for different land uses and how they have changed over time
     - Record the location of specific uses, values and threats that you learn about through your research
     - In urban or developed areas, map where the storm water outfalls are. You can obtain storm water watershed maps from your public works department

- Get copies of existing reports that include your river.

  DEC information about surface waterbodies in the state is available from the Rotating Intensive Basin Studies (RIBS) Reports, Waterbody Inventory and Priority Waterbody List (WI/PWL), 305(b) Report, and 303(d) List (see the description of NYS DEC Water Quality Reports and how to order them at the end of this section). If DEC does' t have much information documented about your river or river segment, don' t be discouraged; in fact, DEC encourages HBRW groups to monitor sites and rivers for which there is a lack of Information or poor documentation. If your river isn't listed in the PWL as an impaired waterbody, you may want to conduct a preliminary study to see if it should be. Or if your river is listed as an impaired waterbody, your study could try to verify the information or improve the level documentation that appears in the PWL. In addition to DEC reports, find out if any local agencies have completed river basin plans, watershed assessments, special studies, etc., so you can coordinate your efforts with theirs.

- Find out the legal classification of and designated uses associated with your river. Look over your state' s water pollution control law and/or the water quality standards to find out what the designated use of your river segment is. For each designated use, specific water quality criteria are set. Find the criteria that are set for your river segments and fill out the "Water Quality Standards Worksheet." There is a brief overview of the NY State Standards with this worksheet, but it is important to obtain a copy that has more detail than this. Contact your regional DEC office.

- Identify your river's special attributes and uses and the threats to these uses and values.

  What are the existing river uses? What is special about the river (its values) and where? What and where are the activities that threaten these river uses and values? Have any of these activities been determined to be causing problems?

Uses

- Swimming
- Irrigation
- Waste assimilation
- Fishing
- Public water supply
- Canoeing/Kayaking

Values

- Aquatic life habitat
- Scenic quality
- Unique natural features
- Flood storage
- Wildlife habitat
- Ecosystem functions

Threats/Problems

- Channel alterations
- Sedimentation
- Combined sewer overflows
- Conflicts among uses
- Loss of riparian vegetation
- Pollution discharges
- Polluted runoff
- Loss of habitat
- Flow alterations

Examples of Uses, Values, and Threats

- Survey people in your watershed to identify river uses, special attributes, and problems.
- Know what municipalities govern your watershed and find out about land use ordinances and past, present and future zoning.
- Find out if there is a Natural Resource Inventory completed for any or all portions of your watershed. Contact your county environmental management council or planning department.
- Research any flora or fauna studies that might provide indications of land use changes or ecological health. Contact the NY Natural Heritage Program, local Audubon societies, other conservation groups, garden clubs, etc. Ask about vegetation surveys , bird surveys, lake studies, and studies of native, endangered and invasive species.

2. Field Inventory:

No matter how much information you dig up in your research and interviews, the best way to really know what's going on in your watershed is to get out into the field and make first-hand observations. Use your maps and researched information as a guide. Check out key features in your watershed. You might want to start at the headwaters and finish at the mouth of your river, noticing how natural characteristics and human land uses change from up to downstream. Verify the uses, values and threats you learned about in your research and interviews. No doubt you'll witness other ways the waterbody is being used, valued and threatened. Use part III, "Are your watershed uses & values threatened?" in the "Watershed Inventory Checklist" as a guide for identifying possible problematic areas and issues. Note the locations of key observations by marking them directly on your maps.

A Note for School Teachers: *If for the sake of logistics, convenience, access and/or safety, you have already selected a site (e.g. the stream in the schoolyard so you don' t have to depend on busses), then your study design process will be a bit different than what is outlined in this manual. You have already determined step 5 "Where will you monitor" before you have completed Step 1 "Watershed Inventory." Part of the purpose of the watershed inventory is to help you determine where to monitor, based on issues and questions that come up as a result of the inventory. However, if you already have a site, the watershed inventory is still an important part of the study design process. The more students know about the watershed upstream from their site, the better they will be able to come up with questions and hypotheses for their study.*

The Watershed Inventory will help you guide your students through the watershed inventory process. Your HBRW Regional Coordinator may be able to help gather the materials your students will need to complete the Watershed Inventory (maps, aerial photos, existing studies, etc.). The Regional Coordinator may also be able to help you plan a "watershed tour" to take your students around the watershed by bus or other vehicle. At each predetermined stop, students can make observations about natural features and human land uses. This type of field trip will give them a broader perspective of the river and concrete experiences that will help them make inferences about the potential impact of various land uses on water quality. If you are not able to take your students on such a trip, a slide show is perhaps the best substitute.

STEP 2 Why Are You Monitoring? Define your questions and decide the indicators you will use.

Your watershed inventory will yield a lot of useful information that you can use to design your study. Some questions you come up with may be able to be answered with further research, and some might entail monitoring. Pick a list of questions that interest you and then assess which ones meet your organization' s goals or class purpose and which ones you can answer in your program. Then you can choose the indicators that are best suited for answering your chosen question(s).

No matter what you study, a physical assessment is essential for helping you analyze your data on selected indicators. You may decide to design a monitoring program that focuses solely on observing and recording physical characteristics such as surrounding land uses, bank erosion, degree of shading, and presence of pipes emptying into the water. Certain problems, such as sediment, may be better documented by frequent observations than by infrequent (though precise) measurements.

Types of Studies

Depending on the questions you want to ask, this manual suggests four kinds of water quality studies:

1. Water Quality Standard Surveys determine whether a river meets selected state water quality standards for its designated uses.
2. River Characterizations obtain baseline information on your river.
3. Impact or Improvement Assessments measure the impact on a river of a particular human alteration or land use, or the improvement from a remediation activity.
4. Ecological Studies may determine the effect that natural variation of river or watershed features has on different parameters, measure how a particular parameter changes daily or seasonally, or answer a multitude of other questions.

Refer to the table "Study Design Questions & Indicators to Study" on the next page for a sample list of some of the questions that might interest you on the Hudson, and the indicators you would measure to address each type of question. The questions are listed by type of water quality study. The list of questions for the "Impact / Improvement Assessment" section of the chart are based on common impacts in the Hudson River Watershed and the improvement activities that are used to address them.

Study Design Questions & Indicators to Study

TYPE OF STUDY	SAMPLE STUDY DESIGN QUESTIONS	INDICATORS TO STUDY *(Do physical survey/habitat assessment for all studies)*
Water Quality Standards Survey Could be done at one site or segment.	▪ Is the waterbody supportive of its uses / values? If not, at what level are they impaired? ▪ Does the segment meet water quality standards for the indicator measured?	Choose indicators specific to the designated uses of your site / segment. For swimming, measure fecal coliform bacteria. For all classifications C and above, aquatic life is a "use" - measure Benthic Macroinvertebrates (BMI's).
River Characterization Needs to be done over several sites or segments.	▪ How do factors (BMI' s, dissolved oxygen, phosphorus, etc.) change from headwaters to mouth?	Choose the indicator(s) that are of most concern.
	▪ Where in the watershed are the uses / values impaired?	Same as for "Water Quality Standards Survey"
Impact/Improvement Assessment Need to sample just up and downstream of the suspected impact; also at a recovery site further downstream.	▪ Is there pesticide runoff or groundwater leaching from the ***apple orchard*** that is having an impact? ▪ Are best management practices on the orchard improving the water quality?	BMI, pH, dissolved oxygen, conductivity; send samples to a lab to measure specific pesticides
	▪ Does cow manure from the ***dairy farm*** have an impact? ▪ Are best management practices on the dairy farm improving the water quality? ▪ Does the sewage treatment plant / septic system have an impact? ▪ Is the sewage treatment plant upgrade improving the water quality?	Phosphate & nitrate (if slow moving stream or tributary to a lake), ammonia, dissolved oxygen, bacteria, BMI, total settleable solids
	▪ Is the ***construction site*** or ***gravel mine*** causing erosion / sedimentation or harming BMI habitat? ▪ Are erosion / drainage control measures, detention ponds decreasing sedimentation?	BMI, embeddedness, turbidity, total suspended solids, total settleable solids; document storm events
	▪ Is the ***lack of riparian vegetation*** or ***forestry operation*** causing increased runoff, erosion / sedimentation, high temperatures / low oxygen, degraded habitat? ▪ Is the re-vegetation project and buffer strips improving the water quality and habitat?	BMI, embeddedness, turbidity, total suspended solids, total settleable solids, temperature, dissolved oxygen; document storm events
	▪ Is storm water runoff from the ***developed area*** having an impact? ▪ Are the storm water BMP' s improving the water quality?	Phosphate & nitrate (if slow moving stream or tributary to a lake), conductivity, temperature, BMI, bacteria

Study Design Questions & Indicators to Study		
TYPE OF STUDY	**SAMPLE STUDY DESIGN QUESTIONS**	**INDICATORS TO STUDY** *(Do physical survey/habitat assessment for all studies)*
Impact/Improve-ment Assessment	▪ Is the ***golf course*** impacting the stream? ▪ Are the BMP' s to reduce nutrient runoff improving the water quality?	Phosphate & nitrate (if slow moving stream or tributary to a lake)
	▪ Is there leaching from the ***landfill*** that is impacting the water quality? ▪ Are the drainage control measure, detention ponds improving the water quality?	BMI, pH, dissolved oxygen, conductivity
Ecological Study These types of questions will help you better understand the river ecosystem and the dynamics that occur; they will influence the results of other studies.	<u>Dissolved oxygen & temperature questions</u>: ▪ Do oxygen and temperature vary daily or seasonally? ▪ Do low flow / high temperature conditions in the summer support trout?	<u>Dissolved oxygen, temperature:</u> ▪ Sample at different times of day or year; in different seasons, sample at same time of day ▪ Sample in summer: sample in morning most important, could also sample in afternoon for comparison
	<u>BMI questions</u>: ▪ Do BMIs change with different substrate types? ▪ What habitat limitations might be affecting the BMI community? ▪ How does the BMI community at a site change seasonally? ▪ What is the composition of functional feeding groups? Do they change with habitat differences / seasonally? ▪ Does the BMI community respond as the river continuum concept would predict? ▪ Do BMI densities increase with nutrient increases? ▪ How well does the sub-sample represent the whole sample?	<u>BMI, stream bottom survey</u>: ▪ Sample at different substrate types ▪ Sample at different habitat conditions ▪ Sample in different seasons; perhaps before and after emergences ▪ Analyze feeding groups; sample at different habitat conditions / seasons ▪ Sample at different locations along the river continuum ▪ Sample at sites prone to nutrient increases; measure nitrate and phosphate ▪ Sort and identify the entire sample in addition to a random sub-sample and compare
	<u>Storm water / runoff questions</u>: ▪ How do storm events affect sediment and nutrient loading? ▪ How do storm events affect water clarity or sediment loading? ▪ Do chloride levels increase after a road salting event? ▪ Are phosphate, (or nitrate, chloride, etc.) levels higher during spring runoff? ▪ How does the pH of a highly buffered stream differ from the pH of a poorly buffered stream after a storm event?	<u>Measure before, during and after a storm / runoff event</u>: ▪ Phosphate, nitrate, embeddedness, total suspended and / or settleable solids, flow ▪ Turbidity, total suspended or settleable solids, embeddedness, flow ▪ Chloride, flow ▪ Phosphate (nitrate, chloride, etc.), flow ▪ pH, alkalinity, flow

STEP 3 Define Your Data Uses and Users. Which tier do they fit into?

Many of the questions above can fit into more than one tier. You will need to decide what degree of sensitivity and accuracy you need. From this, you'll be able to choose a tier. Each tier has recommended protocols for the indicators you choose. In general, the higher the tier, the greater the degree of sensitivity, accuracy, and precision. Impact/improvement assessment questions generally fit best in tiers 2 or 3.

To be able to define the degree of sensitivity, accuracy and precision it is important to identify how you want to use your data and who will use it. Each tier in this guidance manual relates to different data uses.

Data Use by Individuals

Perhaps the most valuable use of your data is to share it with land and business owners in your watershed. They are the true "resource managers"—they make the small-scale land use decisions that affect your watershed daily. If you find a problem, suggest methods and offer resources on how to improve the situation rather than simply pointing a finger.

Data Use by DEC

All three tiers can be used to report data to DEC for their use in updating the WI/PWL. In this report, DEC uses three levels of documentation: "possible," "suspected," and "known." The three HBRW tiers fit roughly into these levels of documentation:

Tier 1 is an introductory investigation to document that a river segment is "not impacted," or that there are "possible" problems impacting waterbody uses. Such "possible" problems need further verification.

Tier 2 is a preliminary assessment to document that a waterbody is supportive of its uses, or that there are "suspected" problems that likely impact waterbody uses. Additional verification by DEC is a possibility, but not always required for inclusion in the PWL.

Tier 3 is a rigorous assessment that can be used to document "known" problems and conclude that the use of the waterbody is impaired. Additional verification by DEC is not necessary, but DEC should be consulted in the early stages of designing the study.

For river segments where DEC lacks information, tier 1 can serve as a preliminary study to see if the river segment should be listed on the PWL. Tier 1 findings provide a

screening that can flag possible problems for follow-up investigations with tier 2 or 3 methods or by DEC.

For river segments where DEC' s level of documentation is "possible," tier 2 can be used to increase the level of documentation to "suspected," or even to "known," if confirmed by tier 3 methods or DEC.

Tier 3 provides the highest level of documentation; DEC does not need to confirm, but it is important that they were involved in the formation of the study design.

Data Use by Local Agencies/Organizations

If any regional, county or more local level agencies / organizations are involved in watershed management efforts that involve your river, they may be very interested in your data. Check with them to determine the tier that fits best for their purposes. In some cases, you may need to use other protocols than what appears in this document if your local resource agencies have specific data needs that differ.

Data Use by Local Town or City Officials

HBRW recommends that you share your data with your local town or city officials. Municipal planning boards have the most control over local land uses that occur in your watershed; they should know about your efforts to monitor your river. Even if your data does not indicate problems, a presentation to your municipal planning board can educate them about the importance of healthy watersheds and make a pitch to them to help prevent future potential problems.

STEP 4 Choose Indicators That Address Your Questions and Data Use Goals. Define the Quality Assurance Quality Control (QaQc) for each indicator.

You may use the same tier for all your indicators, or use different tiers for each indicator. Once you choose a tier for a particular indicator, you can use the protocol suggested for it in this manual.

Quality assurance / quality control (QaQc) measures are those activities that you undertake to demonstrate the accuracy and precision of your monitoring. These include internal checks performed by your program and external checks performed by an outside lab. Common elements include collecting duplicate samples at the same site, splitting your sample in half and analyzing both halves, running a blank (de-ionized water) test that should read zero, and sending a split sample to an outside lab who runs the same tests. Another QaQc idea is to have teams of students become experts on running a specific test that they perform at each site.

See the "Quality Assurance Quality Control" section at the end of this document (after the chemistry section) to help define how you will perform QaQc.

STEP 5 Where Will You Monitor?

For a river characterization study, sampling sites should include a variety of locations representing the range of conditions in the watershed.

For an impact assessment study, three sites should be chosen to "bracket" the impact:

a) a reference or control site immediately upstream of any potential impact;
b) an impact site immediately downstream of the alteration (at the point where the impact is completely integrated with the water);
c) a recovery site downstream of the impact (where the water has at least partially recovered from the impact).

It is very important that all the sites be as similar as possible in every respect except for the impact being assessed.

A water quality standards study allows you the flexibility to have one site or many. Try to choose sites that reflect the uses and values that are indicated for the classification of your river.

A Note for School Teachers: *You might want to start with considering what sites you can get to or access safely, and design a study around where you can study, as mentioned in the "Watershed Inventory" section of this chapter.*

STEP 6 When Will You Monitor?

Decisions about what times of day and year, and how frequently to sample are dependent on the questions you ask about your river. For example, if you want to know how oxygen or phosphate changes over a yearly cycle in the river, sample on dates throughout the year. If you are concerned with swimming, sample only in the summer. For a characterization study, try to sample in a range of weather conditions.

For most studies that involve comparisons of different sites or that track one site over time, it is important to collect samples at the same time of day each time you sample. Otherwise, there may be natural daily fluctuations of certain indicators, such as dissolved oxygen, that will influence your data results.

For some studies, sampling around storm events is helpful or even vital. If you are conducting an impact assessment of a sewage treatment plant that you suspect overflows during storms, you would want to sample above and below its outfall before and after storm events. For many questions having to do with sedimentation and erosion, it is also important to sample around storm events, because that is when much of the erosion and sediment loading occurs. If you plan to conduct storm sampling, you will have to create a way to inform your sampling team about appropriate timing for sampling each event.

The best times of year to sample for benthic macroinvertebrates are in the early spring before the emergence of the adult forms of the insects (mayflies, blackflies, etc.) or in the fall before leaf drop, which is after the time the community was most stressed (the lower flows and higher temperatures of summer).

STEP 7 Who Will Do What Tasks?

How will you organize your sampling? If you are a teacher, will you organize your students into teams for each indicator, or will all students measure every indicator? If you are a community program, will you have volunteers collect samples and bring them to a central place to be processed? If so, who will run the tests?

Quite often there are different volunteers who run each test in the lab, rather than every person doing each test in the field. For benthic macroinvertebrates, community groups often invite the volunteers back for evening sessions picking and sorting the organisms. Sometimes you can ask a college class to do this for you, or to take your samples and identify them in further detail.

Regardless, it is a good exercise to decide how each task in your program will be accomplished. The more people that are involved in your program, the greater the visibility and ownership there is for your organization, and the more interest there is in the river.

A Final Note for School Teachers: *School programs can be limited by when and where they can sample. When designing your study, be aware of these limitations and gear your study goals accordingly. You will most likely flip back and forth between what you are interested in knowing and your limitations before you arrive at a study that works for your situation. Smaller groups of students (e.g. environmental clubs) often continue the study and work with community volunteers to explore more specific questions. Also remember that studies evolve with time. Each year, you will make adjustments to refine your program. In our experience, it takes three years for a new program to run smoothly.*

Study Design Worksheet

Observation and/or Problem (Discovered in your watershed inventory)

Study Question (What question(s) do you want to answer with your monitoring program?)

Hypothesis (A testable explanation)

Prediction (If the hypothesis is true, then you would predict that…….)

Experimental Design

1. Describe how you will test your hypothesis.

2. Define your data uses and users – which tier do they fit into?

3. For each indicator that you will need to measure, describe methods, including QAQC.

Indicator	Methods (HBRW Tier)	QaQc

4. Where and when will you carry out the necessary tasks?

5. Who will do what tasks?

Study Design Worksheet - *Example*

Observation and/or Problem
Wappinger Lake is eutrophic

Study Question
Where are the high nutrient levels coming from?

Hypothesis
Route 9 storm drains contribute more to the problem than the watershed upstream of the lake

Prediction
Nutrient loading from Route 9 storm drains is greater than nutrient loading in the creek just upstream from the lake.

Experimental Design
1. Describe how you will test your hypothesis.
Measure phosphate & nitrate concentrations and flow of water coming from Route 9 storm drains and in creek just above lake. Calculate loading values (loading = concentration x flow) and compare.

2. Define your data uses and users – which tier do they fit into?
Dutchess County Environmental Management Council and Wappinger Creek Watershed Planning Committee. They will accept either Tier II or Tier III data.

3. For each indicator that you will need to measure, describe methods, including QAQC.

Parameter	Methods (HBRW Tier)	QAQC
NO3-N	*Zinc reduction color comparator (Tier 2)*	*Make sure all reagents are current.* *Thoroughly wash all sampling bottles and glassware.* *Test NO3-N kit with known standard.* *Use known PO4 standards to develop calibration curve for DR890 colorimeter.* *Because sampling will not be done right away in the field, use Dutchess EMC' s method for preserving the sample with for later analysis.* *Split sample and give to Dutchess EMC to analyze for comparison.* *Perform 1 field replicate and 1 lab duplicate for each site.*
PO4	*DR890 colorimeter (Tier 3)*	
flow	*Extrapolate flow of creek from USGS data* *Measure flow from pipes with a known volume container and a stop watch*	

4. Where and when will you carry out the necessary tasks?
The day after a rainstorm of at least 1 inch. Sample at storm drain pipes and from creek at road crossing upstream from lake.

5. Who will do what tasks?
Because storm sampling is important for this study, students will not be able to do the sampling unless they can walk there from the school (need prior notice to arrange a field trip). However, teachers can still carry out this study with students. Take them on a field trip of the watershed, the creek, and the lake to learn about and observe the situation. If possible, recruit and train a parent and student willing to take samples the day after the next rainstorm. Otherwise, a teacher, Americorps Member or a community volunteer can do the sampling.

----------**Students can analyze the samples in the classroom**.----------

Watershed Inventory Checklist

Much of this inventory can be completed through research and interviews to find existing information. The place to start is with your county's water quality committee (if one exists). This committee is usually comprised of representatives from county agencies such as the soil and water conservation district, environmental management council, department of health, and department of planning. You may find after you make a few contacts that there is already a lot of research and activity focused on your watershed. However, no matter how much information you dig up, the best way to really know what's going on in your watershed is to get out into the field and make first-hand observations.

I. What and where is your watershed?	**Useful tools/resources:**
1. Define the watershed that will be the focus of your monitoring program (name of river/watershed). 2. Pathway to the Hudson (or Atlantic Ocean). 3. Headwaters (note highest elevations). 4. Mouth (note elevation). 5. Other topographical features. 6. Length of the main stream/river. 7. Major tributaries/sub-basins in the watershed. 8. Major wetlands & lakes in the watershed. 9. If your study will not cover the entire watershed, describe the area that your study will focus on (if you know). 10. Number of square miles in your watershed (you may need to delineate your watershed' s boundary to determine this. If you already have sampling sites chosen, delineate just the watershed area defined by your most downstream site). 11. Towns/cities/counties/states within the watershed. 12. Weather patterns (especially annual rainfall and seasonal rainfall patterns) in your watershed.	▪ Topographic maps available from USGS Information Service, Box 25286, Denver, CO 80225 (http://mapping.usgs.gov) or often from your county soil and water conservation district. ▪ Road maps of your area. ▪ "Delineating the Boundaries of Your Watershed," from the *Streamkeepers Field Guide*, available from the Adopt-A-Stream Foundation, Everett, WA, (425) 316-8592. ▪ GIS maps may be available from your county water quality committee, environmental management council, or planning department. ▪ National and local weather service.

II. How is your watershed used and valued?	**Useful tools/resources:**
1. NYS DEC classification of your river segment(s). 2. Sewage treatment plants or other major SPDES permits.	▪ State stream classification maps and charts, state water quality standards, and SPEDES permit information available from your local DEC regional office.
3. Estimates of how much of your watershed area is urban, rural and forested. 4. Zoning in the watershed. 5. Recent trends in land use changes. 6. Recent trends in population growth or decline.	▪ Aerial photos available from your county planning department or USDA Farm Service Agency office. ▪ Zoning maps and information from your local town hall. ▪ GIS land use maps may be available from your county environmental management council or planning department. ▪ Procedures on how to estimate land use percentages from aerial photos: Activity 8 in *SWEAP* curriculum, available from IES, 914-677-5359. ▪ Population statistics from your county planning department.
7. Major sources of drinking water (aquifers, reservoirs, etc.).	▪ Maps and information from your county health department and county water agency (if one exists).
7. Key fish species and fishing areas.	▪ Information from your local DEC regional fisheries office. ▪ Information from surveying local fishermen.

8. Swimming areas. 9. Other recreational uses and areas. 10. Important scenic areas.	▪ Information from your county health department on officially regulated public swimming areas. ▪ Information from surveying local residents about unofficial swimming areas, other recreational uses, and scenic values of your watershed. ▪ Information from town, county and state parks and recreation departments, local hiking groups, sporting clubs, and environmental organizations (such as Scenic Hudson, 914-473-4440). ▪ Greenway Council for the Hudson River Valley, 518-473-3835. ▪ Department of State Scenic Areas of Statewide Importance Program, 518-474-5290. ▪ NYS Department of Transportation Scenic By-Ways Program, 518-457-4460.
11. Key wildlife habitats and species.	▪ Same sources as II.9 and 10 plus studies and information from the NYS Natural Heritage Program, your local chapters of The Nature Conservancy and Audubon Society, and the wildlife technicians in your local DEC regional office.
12. Predominant agricultural activities.	▪ Information from your county soil and water conservation district and Cornell Cooperative Extension.
13. Other watershed uses & values.	▪ Information from surveying local residents.

III. Are your watershed uses & values threatened?	**Useful tools/resources:**
1. Areas of riparian habitat loss. 2. Potential impacts from non-point source pollution, such as stream bank erosion, urban and agricultural runoff, storm drain pipes, septic problems, etc. 3. Potential impacts from point source pollution. 4. Potential flood hazard areas. 5. Areas where the flow and channel of the river has been altered (e.g. dams, dikes, extensive culverting, etc.). 6. Other threats.	▪ NYS 305(b) Report, Priority Waterbodies List for your portion of the Hudson Basin, and any other studies more specific to your watershed, available from NYS DEC Division of Water, (518) 457-7130. ▪ Maps of storm drain pipe locations available from town or county public works. ▪ Information about SPDES permit violations available from your local DEC regional office. ▪ Maps of floodplain management zones available from town hall or county planning. ▪ Information from surveying local residents. ▪ OBSERVATIONS MADE THROUGH A WATERSHED FIELD INVENTORY: field check as many of the potential impact areas you discover when researching and use your field inventory to find any other potential threats not gleaned from existing information, interviews, or surveys.

IV. Are there watershed protection activities underway in your watershed?	**Useful contacts:**
1. Groups formed to do watershed watching, stream monitoring, or watershed management planning. 2. Best management practices (urban or agricultural) that have been implemented or planned.	▪ County soil and water conservation districts. ▪ County environmental management councils. ▪ County office of Cornell Cooperative Extension. ▪ Local environmental organizations.
3. Land conservation projects.	▪ Local land conservation organizations.
4. Local town or county ordinances that protect waterways through buffer zones, erosion control regulations, etc.	▪ Town halls. ▪ Town conservation committees. ▪ County planning departments.

New York State River Classifications & Water Quality Standards

(A brief overview—for more complete and up to date info, obtain a copy from NYS DEC)

New York State River Classifications

Class A Drinking, cooking, contact recreation (swimming), fishing, fish propagation and survival (aquatic life)
AA-Special: No discharge into water, no wastes or solids attributable to sewage, industrial, or wastes.
All other Class A: Can be treated to meet drinking water standards.

Class B Primary and secondary contact recreation, fishing, fish propagation and survival (aquatic life).

Class C Fishing, fish propagation and survival (aquatic life). Can be suitable for contact recreation, but may be limited.

Class D Fishing. Cannot support fish propagation due to natural conditions such as streambed and flow. Suitable for fish survival. Contact recreation may be limited.

New York State Water Quality Criteria for Surface Freshwater

Parameter	Class	Standard	Guideline for a Healthy Stream
PH	A,B,C	between 6.5-8.5	
	D	between 6.0-9.0	
DO	A-Special	6.0 mg/L	
	A, B, C	Trout spawning, 7.0 mg/L Trout waters, never < 5.0/L, daily ave. 6.0 Non-trout, never < 4.0 mg/L, daily ave 5.0	
	D	Not less than 3.0 mg/L	
Temperature		No standard	Trout, ≤ 70°F (21.1°C) Non-trout, <80°F(26.7°C)
Total phosphorus (P) *(multiply by 3 for ortho-phosphate)*		"None that will result In growths of algae, weeds, and slime that will impair uses" No numerical standard	> 0.05 mg/L impact likely > 0.1 mg/L impact certain (especially if slow moving area or upstream from lake)
Nitrate-nitrogen (NO_3-N)	A	10 mg/L	
	B, C, D	"None that will result in growths of algae, weeds, and slime that will impair uses"	Natural levels generally < 1 mg/L
Ammonia-nitrogen	(NH_3-N)	No standard	0.10 mg/L
Alkalinity		No Standard	0-5 mg/L endangered or critical 5-10 mg/L highly sensitive 10-20 mg/L sensitive 20 mg/L not sensitive
Chloride	A	250 mg/L	
	B, C, D	No standard	Natural levels generally <50 mg/l)
Conductivity	freshwaters	No standard	Generally 150-500 □S/cm, salt water much higher
Fecal Coliform	A, B, C, D	< 200 colonies/100 mL	
Turbidity	A, B, C, D	"No increase that will cause a substantial visible contrast to natural conditions"	
Suspended and settleable solids	A, B, C, D	"None from sewage, industrial wastes or other wastes that cause deposition or impair the waters for their best usages"	

Water Quality Standards Worksheet

Name of Stream: _____

Description of stream site or segment: _____

_____

What is the NYS DEC classification of your stream?	**What are the corresponding uses of your stream?**

What are the corresponding Water Quality Criteria for each parameter?
(If no criteria, list guidelines for a healthy stream)

pH	Dissolved Oxygen	Temperature	Phosphorus *(indicate whether total P or PO_4 as P)*	Nitrate-Nitrogen	Ammonia-Nitrogen
Alkalinity	**Chloride**	**Conductivity**	**Fecal Coliform Bacteria**	**Turbidity**	**Suspended or Settleable Solids**

Notes:

New York State Department of Environmental Conservation (NYSDEC) Water Quality Reports

Use these reports to gather information about your river. To obtain them contact: NY State Department of Environmental Conservation, Division of Water, 50 Wolf Road, Albany, NY 12233-3508. Phone: 518/457-3656. Fax: 518/485-7786.

The data and information in the RIBS Reports is used to update…

Rotating Intensive Basin Studies (RIBS) Reports

Water Quality Data Reports for Individual Large Drainage Areas of New York State.

These reports summarize the results of the DEC Division of Water RIBS ambient surface water monitoring program. The RIBS Sampling Program incorporates the chemical analysis of water column and bottom sediment, and the biological monitoring of macroinvertebrate communities and analysis of tissue samples, ambient toxicity testing, fisheries evaluations and other monitoring activities to produce an integrated assessment of water quality. The RIBS Program conducts intensive monitoring in about 20% of the state in each year, with coverage of the entire state within a 5 year period.

WI/PWL information for the entire state is summarized and compiled to generate…

Waterbody Inventory and Priority Waterbodies List (WI/PWL) Reports

Summary Reports of Water Quality Assessment Information for Large Drainage Areas.

These reports provide an inventory of specific waterbodies in the state and summarizes more general water quality conditions, the degree to which the waterbodies support a range of uses, and progress toward the identification of problems, sources and improvements. Where the RIBS Reports are more technical, the WI/PWL Reports provide more of a water quality *scorecard.* The assessment information in the WI/PWL represents the best judgment of DEC Division of Water staff, based on input from a variety of sources (from both within and outside DEC).

*A subset of waterbodies identified as **not** supporting designated uses makes up...*

The Section 305(b) New York State Water Quality Report

Biennia/Report to USEPA Describing the Current State of New York Waters.

Section 305(b) of the federal Clean Water Act requires each state to assess and report on the health of their waters every two years. The 305(b) process is the principal means by which USEPA, and the public, evaluate the degree to which waters of the state support appropriate uses (such as drinking water, swimming, and aquatic life), and progress toward achieving water quality goals.

The New York State Section 303(d) List

A Biennial List of Problem Waters in New York State.

More specifically, Section 303(d) of the Federal Clean Water Act requires states to develop and submit a list of waters for which required technology based pollution controls are not stringent enough to attain or maintain compliance with applicable state water quality standards. This list identifies waters as priorities for total maximum daily load (TMDL) development a more complex, watershed strategy to reduce pollutant loadings and protect/restore water uses.

NYS DEC Regional Contacts

REGION	AREA COVERED	CONTACT PERSON & OFFICE LOCATION	PHONE
Region 2	New York City	Brian Mitchell Long Island City	718-482-4933
Region 3	Rockland / Westchester Counties north up to and including Ulster / Dutchess Counties	Joe Marcogliese Tarrytown	845-332-1835
Region 4	Greene / Columbia to Rensselaer County and including the Mohawk River west to and including Montgomery County	Fred Sievers Schenectady	518-357-2380
Region 5	Upper Hudson River	Bill Wasilauski Warrensburg	518-623-1200
Region 6	Mohawk River in Herkimer / Oneida Counties	Skip Shoemaker Utica	315-793-2747

PHYSICAL SURVEY

Overview

The physical survey is an essential component of any monitoring program. In fact, simply performing and documenting a physical survey can be an excellent monitoring project. You can perform a physical survey as background information to help design a monitoring program, as the core part of your program, or every time you sample as the foundation for understanding the chemical and biological indicators.

A physical survey should be conducted at each monitoring site for a 200' segment that extends up and downstream from your sampling site (your sampling site bisects the 200' segment).

The characteristics you observe provide an important context for the other indicators you measure. Data about a stream are useless without some key pieces of information. For example, for water chemistry indicators the past weather is important. If the sampling occurs during or immediately after a storm event, you might see an increase of certain indicators (non-point pollution). If there has been a long dry spell, then that tells a different story for your findings (high bacteria and no storms, might indicate point source pollution).

It is essential that you perform a survey of the primary habitat characteristics every time you sample macroinvertebrates. A difference in findings may be due to a difference in habitats between sites.

The physical surveys included in this document provide you with a focused way to look at:

- weather conditions
- water appearance
- stream banks and channel
- habitat characteristics: riffles & pools (flow pattern), stream bottom composition, embeddedness, velocity, shelter for fish
- flow (volume and velocity of water in the stream)
- riparian zone
- land use around your site

An Important Note: Many of the observations that comprise a physical survey involve making estimates. To keep the estimations consistent between sites, have the same people estimate for each site.

Equipment and Materials Needed

Thermometer, tape measure (50' preferable) or string marked in 1-foot (or meter) increments, yard (or meter) stick, an orange, waders, watch (stop watch or second hand), clipboard; a U.S.G.S. topographic map would be helpful. Flow meter may be required for Tier 3.

Details on Each Tier

Tiers 2 and 3 use the same "Physical Survey / Habitat Assessment" form. Tier 3 requires two additional field surveys to evaluate the stream bottom habitat and to measure the flow (separate survey forms are provided). These are optional for tier 2. Tier 3 may require measurement of flow with a flow meter, depending on your study.

The "Physical Survey / Habitat Assessment" form for tiers 2 and 3 includes a habitat assessment that ranks the site on a scale from "excellent" to "poor." Not only does this help you evaluate your site, but it enables you to compare qualitatively different sites. If sites score differently, then most likely the macroinvertebrate communities will also differ. You can also use the habitat assessment as a way to choose sites for a macroinvertebrate sampling. If you are comparing human impact on macroinvertebrates and water quality in your watershed, you should choose sites that are as similar as possible. If your question involves studying what type of benthic macroinvertebrates live in different habitats, then you need to choose sites that show a diversity of habitat.

Tier 1 is a simple physical / habitat survey. Future drafts of this guidance document may include for tier 1 a simplified version of the tier two and three habitat assessment.

Physical/Habitat Survey

Assess a 200 foot segment up and down stream from your sample site.

Name(s)_____ Date_____ Time_____

School/Group_____ Stream_____ Site_____

Weather: Today_____ ***Temperature:*** Air_____ ŋP

Past 2 days: _____ Water_____ ŋP

Stream Width: The stream is on average _____meters wide and _ meters deep.

Water Level: Compared to the height of the stream channel, the water level seems relatively: _____high _____medium _____low

Water Appearance/Odor

☐ clear ☐ tea-brown ☐ milky ☐ other (describe): ☐ unusual odor (describe):

☐ foam ☐ multi-color ☐ muddy

Velocity: Average time it takes to flow 3 meters: a) 3 meters / _____ sec = v1 _____

(0.15-0.75 m/sec is optimal for BMI collection sites) b) 3 meters / _____ sec = v2 _____

AVERAGE: _____ m/sec

Habitat Features:

The site has:	Many	Some	Few or None
Riffles (fast areas, <2' deep)			
Runs (fast areas, >2' deep)			
Pools (slow areas, >2' deep)			
Glides (slow areas, <2' deep)			
Shelter for fish (logs, stumps, and/or undercut banks)			
Patches of aquatic plants			

Substrate Size: Rank the substrate sizes from most common (1) to least common (6)
(Cobbles are optimal for macroinvertebrates)

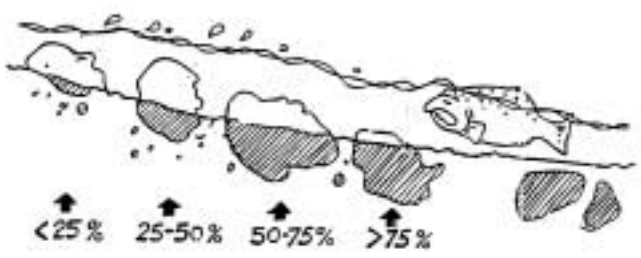
Silt/Clay/Mud (makes the water cloudy if disturbed)	**Sand (up to 0.1")**	**Gravel (0.1-2")**	**Cobbles (2-10")**	**Boulders (>10")**	**Bedrock** (solid rock covering the stream bottom)

Cobble Embeddedness:

Pick up several cobbles (if present) to estimate the average embeddedness of your site:

Average Embeddedness: _____%

(50% embeddedness indicates doubtful habitat for many macroinvertebrates, trout and egg survival)



Natural Vegetation extends beyond the banks for: _____ < 6 yards ___6-12 yards

(if the 2 banks are different, evaluate the worse side**)** _____ 12-35 yards ___> 35 yards

Stream Banks: They are:	In no or few areas	In some areas	In many areas
Covered with vegetation			
Eroding			
Mowed			
Artificially protected			

Human Impacts and Land Uses*: (check boxes that are present)*

- ☐ Stream channel altered
- ☐ Storm drain pipes
- ☐ Sewage treatment plant pipes
- ☐ Dams
- ☐ Farms
- ☐ Recreation
- ☐ Garbage
- ☐ Stores
- ☐ Culverts
- ☐ Mining
- ☐ Roads
- ☐ Industry
- ☐ Houses
- ☐ Logging
- ☐ Other:

Describe how they may be impacting the stream:

Site Drawing:

Draw a "birds-eye" sketch of the 200' long segment of your river up and downstream from your stream site, recording specific physical and habitat features, including:

1. Your sampling sites—include where you collected water quality and macroinvertebrate samples and measured velocity and cross section area.
2. In-Stream Habitat – riffles, pools, runs, large woody debris, boulders, organic material, aquatic plants, overhanging vegetation, etc.
3. Streambanks – steep & gently sloping areas, naturally vegetated areas, bare, eroding, clear-cut, or mowed areas, artificially protected areas, etc.
4. Channel – wide & narrow areas, meanders, shaded & exposed areas, unnatural alterations, dams, culverts, etc.
5. Human Land Uses – roads, houses, driveways, parking lots, storm drain pipes, sewage pipes, factories, farms, livestock crossings, recreational use, logging, etc.

Indicate direction of streamflow with arrow

Physical Survey / Habitat Assessment

Assess a 200 foot segment up & down stream from your sample site

Name(s)_____ Date_____ Time_____

School / Group_____ Stream_____ Site_____

Weather: Today: _____ ***Temperature:*** Air

ῆP _____

Past 2 days: _____ Water

ῆP _____

Sampling Site Type (Select one from each row)									
Stream Size	Headwater Tributaries (<20 cfs)			**Creeks and Streams (20-150 cfs)**				**Larger Rivers (>150 cfs)**	
Gradient	FAST (primarily riffle)			VARIED (pools and riffles)				SLOW (low gradient)	
Surrounding Land Use	Forested		Agricultural		Residential			Urban	
	dense	sparse	pasture-land	crop-land	rural	village	suburban	resident-ial	commercial / industrial

Stream Width: The stream is on average _____meters wide and _ meters deep.

Water Level: Compared to the height of the stream channel, the water level seems relatively: _____high _____medium _____low

Water Appearance/Odor:

Turbidity substantially greater than natural conditions: ☐ Yes ☐ No

Describe_____

Oily film, grease globules, or unusual odor or color present ☐ Yes ☐ No

Describe:_____

Algae or Weed Growth: Substantially greater than natural conditions: ☐ Yes ☐ No

Describe_____

Average Velocity: Average time it takes to flow 3 meters: a) 3 m / _____ = v1 _____

b) 3 m / _____ = v2 _____

AVERAGE: _____ m/sec

OR record average velocity from flow data sheet: _____

(0.15 – 0.75 m / sec is optimal for BMI collection sites)

Upstream Dam: ☐ Yes ☐ No How far up stream: _____

Assessment Factors: Circle the box that best applies for each assessment factor.

Assessment Factor	Excellent	Good	Fair	Poor
Riffle Size	Well-developed riffle, as wide as stream & as long as 2x stream width;	Riffle as wide as stream but riffle length < 2x stream width	Riffle not as wide as stream and length < 2x stream width	Riffles or run virtually nonexistent
Substrate Size	Cobble predominates; boulders, gravel common	Cobble less abundant; boulders and gravel common	Gravel, boulders or bedrock prevalent; some cobble	Large boulders and bedrock or sand & silt prevalent; cobble lacking
Shelter for Fish	Snags, submerged logs, undercut banks, or other stable habitat are found in over 50% of the site	Snags, submerged logs, undercut banks, or other stable habitat are found in 30-50% of the site	Snags, submerged logs, undercut banks, or other stable habitat are found in 10-30% of the site	Snags, submerged logs, undercut banks, or other stable habitat are found in < 10% of the site
Embeddedness (for tier 3, use "Stream Bottom Survey")	Rocks in stream <25% embedded; very little sand, silt, or mud	Rocks 25-50% embedded; can easily turn over rocks	Rocks 50-75% embedded and firmly stuck in sediments	Rocks >75% embedded; bottom mostly sand, silt, or mud
Flow Pattern (deep is > 2 ft)	All 4 patterns present: slow / deep, fast / shallow fast / deep, slow / shallow	Only 3 of 4 flow patterns present	Only 2 of 4 flow patterns present	Dominated by 1 flow pattern
Channel Alteration	Stream straightening, dredging, artificial embankments, dams or bridge abutments absent or minimal; stream with meandering pattern	Some stream straightening, dredging, artificial embankments, or dams present, usually near bridge abutments; no recent channel alteration	Artificial embankments present to some extent on both banks; and 40-80% of stream site straightened, dredged, or otherwise altered	Banks shored with gabion or cement; over 80% of the stream site straightened and disrupted
Stream bank cover and stability *	Banks stable; no evidence of erosion; bank covered by vegetation or rock	Moderately stable; small areas of erosion; most of bank covered by vegetation or rock	Largely unstable; almost half of bank has areas of erosion or is not covered by vegetation or rock	Unstable, eroded; < half of bank covered by vegetation or rock, or rock slumping into creek
Disruption of riparian bank coverage* (land bordering stream bank)	Mature trees and vegetation; most growing naturally; no disturbance by forestry, grazing, or mowing	Trees, woody plants, soft green plants dominate; some disruption but not affecting full plant growth potential	Obvious disruption; patches of bare soil, cultivated fields or closely cropped vegetation are the norm	Not much natural vegetation left or it has been removed to 3" or less in height
Width of riparian vegetation zone*	More than 35 yards wide; human activities have not impacted zone	Zone 12-35 yards wide; marginal impact from human activities	Zone 6-12 yards wide; impact from human activities evident	Zone <6 yards; lots of nearby human activities
Litter	No litter (metal or plastic) in area	Very little litter; accidentally dropped	Litter fairly common; purposely dropped	Lots of litter present; obviously dumped

*if the two banks are very different, assess the worse side

Given the assessment above, how would you rate your habitat? _____

Describe how land uses / human activities may be impacting the stream:

Site Drawing:

Draw a "birds-eye" sketch of the 200' long segment of your river up and downstream from your stream site, recording specific physical and habitat features, including:

1. Your sampling sites—include where you collected water quality and macroinvertebrate samples and measured velocity and cross section area.
2. In-Stream Habitat – riffles, pools, runs, large woody debris, boulders, organic material, aquatic plants, overhanging vegetation, etc.
3. Streambanks – steep & gently sloping areas, naturally vegetated areas, bare, eroding, clear-cut, or mowed areas, artificially protected areas, etc.
4. Channel – wide & narrow areas, meanders, shaded & exposed areas, unnatural alterations, dams, culverts, etc.
5. Human Land Uses – roads, houses, driveways, parking lots, storm drain pipes, sewage pipes, factories, farms, livestock crossings, recreational use, logging, etc.

Indicate direction of streamflow with arrow

HBRW Tier 3
(optional for Tier 2)

Stream Bottom Survey

Name(s)_____ Date_____ Time_____

School/Group_____ Stream_____ Site_____

Substrate refers to the materials on the stream bottom. The sizes of stream bottom materials at a site will determine what types of macroinvertebrates live there. For example, crayfish prefer to hide beneath large boulders and aquatic worms burrow in fine silt. ***Cobbles***, the rocks between 2 and 10 inches in diameter, are the most optimal for benthic macroinvertebrates. When cobbles on the stream bottom are covered up with silt and sand, they are ***embedded***. The more cobbles are embedded, the less habitat is available to the macroinvertebrates that live in the spaces beneath the cobbles. Embeddedness also hinders trout egg laying and survival. Follow the procedure below to calculate percent substrate size and cobble embeddedness:

1. Set up 2-4 transects across the stream, in riffle habitats.
2. Starting at the water' s edge, take one step at a time toward the opposite bank. With each step, reach over the toe of your wader with your forefinger without looking down and feel the substrate material closest to your large toe (could be mud or sand; does not have to be a rock). Pick it up (if possible), measure its size, and mark a tally in the appropriate column in the "Substrate Size Table" below.
3. If the substrate is a cobble, be careful as you pick it up out of the stream bottom so you can estimate what percent it is covered up by silt or sand. Feel with your fingers for edge of the cobble where it emerges from the silt or sand, and keep your fingers on that edge as you pick it up. Often there will be a "bathtub ring" line on the cobble where the level of the silt or sand was. There is also often algae growing on the top surface of the cobble down to that line. Estimate the percent that the cobble is embedded and check the appropriate box in the "Cobble Embeddedness Table" below.
4. Continue until you have sampled 25 substrate sizes and 10 cobbles.
5. In the "Substrate Size Table," total the tallies for each substrate type and record these numbers in the second row. Calculate the % of each substrate size by dividing the number of tallies by 25 and multiplying by 100.

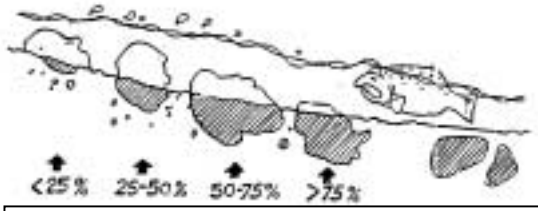
Substrate Size Table

Substrate Type	**Silt/Clay/Mud** (makes the water cloudy if disturbed)	**Sand (up to 0.1")**	**Gravel (0.1-2")**	**Cobbles (2-10")**	**Boulders (>10")**	**Bedrock** (solid rock covers stream bottom)
Tallies						
# of Tallies						
Percent						

Cobble Embeddedness Table

Cobble #	**0-25%**	**25-50%**	**50-75%**	**75-100%**
1				
2				
3				
4				
5				
6				
7				
8				
9				

Based on your results, estimate the average embeddedness of the whole site:



Average Embeddedness: _____ %
(record on physical survey/habitat assessment form)

(50% embeddedness indicates doubtful habitat for many microinvertebrates, trout and egg survival)

HBRW Tier 2 & 3

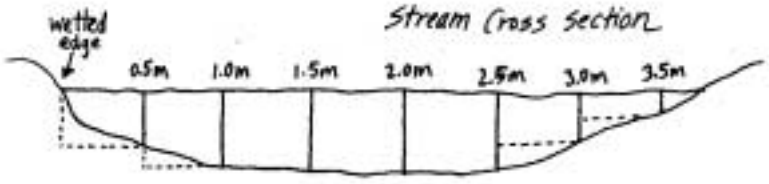
Flow Worksheet

Name(s)_____ Date_____

School/Group_____ Stream_____ Site_____

Area of the Stream's Cross-Section:

1. Stretch a tape measure from wetted edge to wetted edge.
2. At 0.5 meter intervals, across the entire width of the stream, measure the depth (in meters) and record in the table at right. (If stream is more than 10.5m wide, measure in 1m intervals).
3. Each segment you measured is like a small rectangle (see diagram below). The area of each rectangle equals its depth times its width. Since the width of each rectangle is 0.5 meter, the area of each rectangle is 0.5 x its depth, in square meters. (



interval (m)	depth (m)	interval (m)	depth (m)
wetted edge	0	5.5	
0.5		6.0	
1.0		6.5	
1.5		7.0	
2.0		7.5	
2.5		8.0	
3.0		8.5	
3.5		9.0	
4.0		9.5	
4.5		10.0	
5.0		10.5	

4. The total cross section area of the stream is estimated by adding up the areas of all the rectangles. This is the same as adding up all the depths you measured and multiplying by 0.5. Record your total cross section area estimate in the box at right. (If measured at 1m intervals, simply add the depths).

Sum of depths _____

x .5 =

Total Cross Section Area _____

Velocity of the Stream's Water:

1. Record the distance of the marked course
2. Time the number of seconds it takes the float to travel the distance of the marked course. Do this 9 times and average (3 times on the left side of the stream, 3 times in the center of the stream, and 3 times on the right side of the stream). Record results in the table at right and then calculate the average time.
3. Calculate the average velocity by dividing the distance of the course by the average time.

Distance _____ m

Average Velocity _____ m/sec

Left side	
Center	
Right side	
SUM:	
Avg. Time: (sum/9)	sec.

Flow:

The flow, or discharge of the stream, is the volume of water that moves past a site in a certain amount of time. Calculate the flow by multiplying the total cross section area by the average velocity and record below.

Average Velocity		Cross Section Area		FLOW		Compare to USGS Data
_____ m/sec	**x**	_____ m^2	**=**	_____ m^3/sec	**x 35.32 =**	_____ ft^3/sec

NOTES:

BENTHIC MACROINVERTEBRATE SAMPLING AND ANALYSIS

Overview

The following is a brief overview of Benthic Macroinvertebrate (BMI) sampling and analysis. Each section provides detailed instructions and worksheets.

Sampling

The sampling procedure is the same but the analysis procedures vary for each tier.

Macroinvertebrates are collected from a riffle site using an 18" x 8"rectangular net, mesh size 500-600 microns (0.5 -0.6 mm). Approximately 0.55 square meters of the stream bottom are sampled for each of 2 replicates. For deep water or muddy bottom sites, you will need to use artificial substrates, or alternative collection methods. Consult with your Regional Coordinator or local resource provider to help determine the best collection mechanism given your specific site.

Analysis

The following is a brief overview of the analysis procedures for each tier. The next section of the manual provides more detailed directions. Each of the two replicate samples at a site should be analyzed separately, then averaged.

Tier 1 Summary **BMI**

Streamside, qualitative survey of live samples. Used for an introductory investigation of a watershed. Results can document if a stream is "non-impacted," but follow-up is needed to document impacted sites. The simple physical / habitat survey is essential.

Method:

Live samples are assessed for:

- Presence / absence of 5 orders (Use the worksheet "Screening Criteria for Non-impacted Streams," at the end of this section)

Rationale:

Mayfly, stonefly, caddisfly and beetle orders are less pollution tolerant. The presence of all 4 of these orders, with an absence or scarcity of worms (very tolerant) indicates non-impacted streams. This method is not for quantitative analysis.

Tier 2 Summary BMI

Quantitative survey of either live or preserved samples using identification to order, or major group. Used to identify preliminary warning signs that water quality standards are not being met and ecosystem health is threatened.

The "Physical Survey / Habitat Assessment" is essential for your study. It is more complex than tier 1 and also used for tier 3. Samples can be analyzed live or preserved; preserved samples lend themselves to a more accurate analysis.

Method:

After samples are collected they are either preserved or analyzed live.

A sub-sample of 100 organisms (or the entire sample) is picked and sorted into major groups. These are identified to order and counted to calculate the:

- Major Group Biotic Index
- Major Group Percent Composition
- EPT Richness Estimate (an estimate of the number of different kinds of mayfly (**E**phemeroptera), stonefly (**P**lecoptera), and caddisfly (**T**ricoptera)

Rationale:

Major Group Biotic Index:

Different types of macroinvertebrates have a different tolerance to pollution. By counting the number of different types you collect and multiplying by the pollution tolerance of each, it is possible to arrive at a biotic index. In general, the more pollution intolerant organisms you find, the higher the biotic index, and the less impacted your stream.

Major Group Percent Composition:

Even healthy streams have pollution tolerant organisms. The percent of these organisms in the total sample will change with different sites, habitats, and different water qualities. Calculating percent composition gives you a good picture of the community at a particular site. You can use this to compare 2 different sites or compare your site to a reference community established by the DEC. A higher percent composition of pollution tolerant organisms suggests more impact than a higher percent composition of pollution sensitive organisms.

EPT Richness

EPT Richness is the number of different kinds of mayfly (**E**phemeroptera), stonefly (**P**lecoptera), and caddisfly larva (**T**ricoptera).

The EPT' s tend to be particularly sensitive to pollution. Therefore, less impacted streams generally have a higher EPT Richness. The EPT Richness can be a useful indicator of stream health and a way to compare 2 or more different sites. In tier 2, the EPT Richness you measure is an estimate because you do not identify the taxa to the family level; instead you simply distinguish between different taxa within each of the three major groups.

Tier 3 Summary BMI

Method:

Quantitative survey of preserved samples using identification to family level of the mayfly, stonefly and caddisfly orders. Tier 3 analysis is similar to tier 2, with a few additions and modifications. These are described below:

1. Samples **MUST BE PRESERVED**.
2. The mayfly, stonefly and caddisfly groupings are identified to family level (not just sorted as like / different).
3. Additional metrics possible (choose ones that fit your needs):
   - Organism density
   - Family level biotic index (requires identification to family level for all BMI groups)
   - Total family richness
   - % Model Affinity
   - % Composition of Functional Feeding Groups
   - Pinkham and Pearson Community Similarity Index
   - Dominants in common
4. The "Physical Survey / Habitat Assessment" requires a stream bottom survey and flow measurement.

Rationale:

The biotic index can be calculated more accurately using family values. Within the mayfly, stonefly and caddisfly orders, there is large variation of pollution tolerance values. Identification to the family level takes this variation into account. For example, a study of Morris Brook in New Hampshire showed improvement of the BMI community after best management practices were implemented on a dairy farm. This improvement was best seen at the family level.

How To Collect Benthic Macroinvertebrate Samples

This section describes the procedure to collect benthic macroinvertebrates at wadeable riffle areas using a net. The collection procedure is the same for all tiers. If your site is too deep or very muddy, please check with your Regional Coordinator or local resource provider to help you develop an appropriate alternative collection method using an artificial substrate or other method.

Overview

Two replicate samples are collected in a riffle. Each replicate sample is a composite of collections from 2 fast current (0.5 to 0.75 m/sec., 1.5 to 2.5 feet per second) and 2 slow current (0.15-0.5 m/sec., 0.5 to 1.5 feet per second) spots in the riffle. Approximately 0.55 square meters of the stream bottom are sampled for each replicate. The samples are either preserved or analyzed in the field immediately depending on the tier you choose.

The net used for this collection is Nitex cloth mounted on a metal frame attached to a wooden or aluminum pole. The opening measures 8' X 18." *The mesh size for the net must be no smaller than 500 microns (0.5 mm) and no larger than 600 microns (0.6 mm).*

Collecting Benthic Macroinvertebrates

Step 1: Assemble Collection Equipment and Supplies

	Essential Items	**Purpose**
	☐ Collection Field Sheets	For permanent record of collection
	☐ Clipboard	To hold field sheet
	☐ Collection Net: 18"' X 8"" w/ 0.5-.6 mm mesh size	To catch dislodged organisms during collection
	☐ Forceps	To pick critters off net and sieve bucket
	☐ 4-6 inch deep white trays	To observe live samples for picking
	☐ White ice cube trays	To sort live critters into groups
	☐ Float (orange or grapefruit)	To measure current velocity
	☐ Stop Watch	To measure current velocity
	☐ Tape Measure (50' minimum) or 50' string marked in 10' sections	To measure segment length, width, and velocity
Essential for tiers 2 and 3 only	☐ 1 qt. Mason Jars w/ Rubber Seal Lids	To hold preserved samples
	☐ 90% de-natured Ethyl Alcohol	To preserve samples
	☐ Labeling Tape and Pencils	To label sample containers
	Optional Items	**Purpose**
	☐ Waders or high boots	To keep your feet dry
	☐ Arm-length Gloves	To protect hands during collection
	☐ Sieve Bucket (#30 mesh) preservation	To help collect and transfer samples for
	☐ Soft, Nylon Bristle Brush	To scrub critters off rocks
	☐ USGS Topographic Map	To help locate collection sites
	☐ 5-gallon Bucket	All purpose container
	☐ Life Jackets	For safety in deeper water

Step 2: Go to your site and identify a riffle for collection.

Step 3: Measure a 200' segment that contains the riffle habitat from which the sample will be collected.

Step 4: Conduct physical survey (choose the level appropriate to your study) for this 200' segment.

Step 5: Choose suitable general collection areas in the riffle from the bank. For each replicate, choose 4 spots, 2 with high current (1.5 to 2.5 feet per second) and 2 with slow current (0.5 to 1.5 feet per second).

A Note For School Teachers: *Here is an example of how you might organize students for collecting BMI' s: Divide a group of 8 students into two teams of 4. Each team of 4 students is responsible to collect one replicate sample. Divide each team into 2 pairs of students. One pair collects from 2 high velocity spots, the other from 2 low velocity spots . Combine collections from both pairs of students within a team as one replicate sample. Make sure that no pair of students is collecting directly upstream of another, so that organisms they dislodge might be carried into another team' s net. If you have more than 8 students out at the stream at a time, have other students carry out other tasks, such as the physical survey and other aspects of your study.*

Step 6: Wade to the first general collection area, choose the first specific collection spot to place the net, and get into position.

Step 7: Have 1 person place and hold the net, facing upstream, on the river bottom at the collection spot.

Step 8: Have another person dislodge the organisms from a rectangular area of the stream bottom as wide as the net and 1 foot back from the opening so that the organisms are carried into the net. Pick up and rub and / or brush off the rocks and dig into the river bottom.

First, pick up the larger rocks in the rectangle upstream of the net and, holding them inside the net, vigorously rub them all over with your hands to dislodge organisms clinging to the surface. If you have a sieve bucket, place rocks in the bucket to rub them more thoroughly with a brush. If you don' t have a sieve bucket, be thorough with your hand rubbing. Place rocks aside when finished rubbing.

When you've rubbed off all the rocks and placed them aside or in a sieve bucket, use your feet or a hand trowel to dig down as far as possible into the river bottom in the same rectangular area to dislodge burrowing organisms. If you find any more rocks, treat them as in the step above.

Step 9: When you've finished at this spot, carefully lift the net out of the river and prepare to move to the next one. *Leave the sample in the net* . Repeat Steps 6 through 8 until you've sampled 2 high velocity and 2 low velocity spots in the riffle. This is your sample.

Step 10: If there is a lot of sediment in your sample, try to remove as much as possible. This can be done easily with a sieve bucket by placing your sample in the bucket, submerging the bucket partially in the stream, and swirling. If you don' t have a sieve bucket, submerge your net partially in the stream and gently swirl to rinse sediments out of the net (be careful not to lose any of your sample).

Step 11: Bring the sample to shore and transfer the contents of the net (and sieve bucket, if you used one) to a 4-6 inch deep white tray with water for live analysis or a wide mouth glass jar of 90% ethyl alcohol for preservation. Make sure the entire sample is submerged in alcohol (not exposed to air). Tightly cap the jar and label with the site #, date, replicate, and sampler names. Your sample will keep until you are ready for analysis.

Step 12: Repeat steps 6-11 for a second replicate.

Analysis of Benthic Macroinvertebrate Samples

Tier 1 BMI

Streamside Analysis

Procedure

1. Place the sample in a large white tub with a few inches of water (enough to cover all the items in your sample). If you have a large amount of debris, you might shake each piece thoroughly under the water to dislodge the organisms, and then remove it from the tray. Take time to look at your sample without disturbing it for at least 5 minutes—you will begin to notice the widest variety of organisms if you keep the water still.
2. Collect an assortment of the organisms you find, using forceps, and sort them into white ice cube trays or petri dishes (putting likes with likes).

   BE SURE TO LOOK FOR ALL SIZES OF ORGANISMS—NOT JUST THE BIG, INTERESTING ONES!
3. Complete the worksheet "Screening Criteria for Non-Impacted Streams" by checking the sample for the presence or absence of the 5 orders (mayfly, stonefly, caddisfly, beetles, and worms).
4. Repeat steps 1-3 for your second replicate.

Tier 2 **BMI**

Analysis with a Preserved Sample

Note that each replicate is preserved and analyzed separately.

Procedure

1. Mark a shallow (1" or less), white tray into 12 equal size squares with a permanent marker. Fill tray with water.
2. Pour the first replicate sample into a 30 mm sieve, pouring off the alcohol.
3. Rinse the macroinvertebrates in the sieve with water.
4. Place the sample in the tray and spread out evenly.
5. Randomly choose a square and pick all the organisms in that square. As you pick them, sort them using petri plates.
6. Pick at least 1/4 of the squares in the tray.
7. If you do not have at least 100 organisms picked after picking the first 3 squares, continue picking a square at a time, until you have at least 100 organisms. This is your "sub-sample." Note: Pick the entire square once you start—do not pick 1/2 a square!
8. Go to the instructions below, "Steps for Both Live and Preserved Samples."

Analysis With a Live Sample:

Note that each replicate is analyzed separately.

Procedure

Using live samples for analysis is not as accurate a method as preserving a sample. Perform the analysis immediately, using the following steps:

1. Place the first replicate sample in a large white tub with a few inches of water (enough to cover all the items in your sample). If you have a large amount of debris, you might shake each piece thoroughly under the water to dislodge the organisms, and then remove it from the tray.
2. Collect an assortment of the organisms you find and sort them in white ice cube trays or petri dishes (putting likes with likes).

   BE SURE TO LOOK FOR ALL SIZES OF ORGANISMS—NOT JUST THE BIG, INTERESTING ONES!

   One way to do this might be to pick a line and collect any organism you find along that line. Try to collect at least 100 organisms. This is your "sub-sample."
3. Go to the instructions below, "Steps for Both Live and Preserved Samples."

Steps for Both Live and Preserved Samples:

Procedure

1. Once you have at least a 100 sub-sample (or have picked the entire sample), review the sorting that you have done and organize the categories more accurately.
2. Identify and sort organisms in your sub-sample to the order / major group level. Use a dichotomous key in addition to the "BMI Sorting Worksheet" to ensure proper identification.
3. Within each order, try to distinguish between different taxa, putting likes with likes, and sort organisms accordingly. The "BMI Sorting Worksheet" provides some examples of taxa commonly found in the Hudson Basin that are relatively easy to identify. For taxa not pictured, make up your own description (e.g. furry-gilled, mottled color, etc.) and write it in the "other" box for the appropriate order.
4. Count the number of organisms you have for each taxa and record on the "BMI Sorting Worksheet" by marking a tally in the appropriate box next to the picture (or your own description) of each taxa.
5. To calculate an EPT Richness estimate, add up the number of different mayfly, caddisfly and stonefly taxa found. Count the number of boxes that have tallies, NOT the tallies. Record the EPT richness estimate in the box at the bottom right hand corner of the "BMI Sorting (&EPT Richness) Worksheet."
6. Transfer your data to the "BMI Major Group Biotic Index Worksheet" and the "BMI Major Group Percent Composition Worksheet" and calculate these metrics.
7. Repeat steps to analyze the second replicate sample.
8. Report your results on the "BMI Data Reporting Sheet."

Tier 3 BMI

This tier uses similar procedures for Tier 2, "Analysis with a Preserved Sample," with additional steps.

Procedure

After you have identified the major groups in the sample using the directions in "Analysis with a Preserved Sample" follow the steps below.

1. Use a picture key (such as the one from River Network's Living Waters) to identify most of the families except for the mayflies, stoneflies and caddisflies.
2. Place any organisms you cannot identify in to an "unknown" compartment.
3. Use a family level dichotomous key (found in Aquatic Entomology by McCafferty or in Living Waters) to identify the mayflies, stoneflies, and caddisflies to the family level.
4. Count and record the number of organizms in each family on the "Benthic Macroinvertebrate Family Level Identification" worksheet.
5. Repeat for each replicate.

Living Waters, by River Network has more detailed directions , pages VIII12-16

Recommended Metrics

Below is an overview of each; for more detailed directions, see Living Waters, pages IX12-23.

1. **EPT Family Richness:** Add the number of mayfly, stonefly and caddisfly families present (in which you found and entered at least one organism on the "BMI Family Level Identification Worksheet"), including an "other" that you were not able to identify to family). Record your result on the "BMI Data Reporting Sheet."

2. **Family Biotic Index:**
   1. Calculate the following for each family: the average density for each family (average number of organisms found in your replicates) X the pollution tolerance.
   2. Add the results for all the families of the step and divide by the total number of organisms you picked.
   3. The result is the biotic index.
   4. Record on the "BMI Data Reporting Sheet."

Optional Metrics

Choose those that most meet your needs. Record your results on the "BMI Data Recording Sheet."

1. **Total Family Richness**: The total number of macro invertebrate families represented in the sample.
2. **Organism Density:** An estimate of the total number of individuals in the sample based on the number of organisms picked from a certain number of squares. Calculate the average density for each family and sum them to find the total average number of organisms picked (A). Divide the number of squares picked by the number of squares in the tray to find the % of squares picked (B). Divide the A by B to find the organism density for the sample.
3. **Major Group Percent Composition:** Same as Tier 2.
4. **Percent Composition of the Dominant Family:** Identify the family in the sample with the most organisms picked. Divide the number of organisms picked in this family by the total number of organisms picked in the sample to find the % composition of the dominant family.
5. **Percent Composition of Functional Feeding Groups**: The % composition of collectors, scrapers, shredders, and predators. The feeding group for each family is listed on the "BMI Family Level Identification Worksheet." Add the average density (average number of organisms picked in each family) for all families in each functional feeding group. Calculate the % composition of each feeding group by dividing the average density of each feeding group by the total average number of organisms picked (and multiply by 100).
6. **Community Similarity Index**: This shows the degree of similarity between two sites, based on a comparison of dominant families. See Living Waters for instructions.

HBRW Tier 1

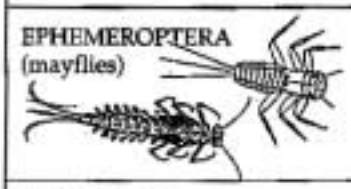
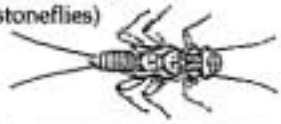
Benthic Macroinvertebrate Screening Criteria for Non-Impacted Streams

Name(s)_____

School / Group_____ Date_____

Stream_____ Site_____ Replicate _____

Make a check in each box where your stream site meets the criteria. If your stream site does not meet a certain criteria, explain why in the "Description" box.

BMI Order	Criteria	put a (✓) if criteria is met	Description
EPHEMEROPTERA (mayflies) 	must be numerous at least 3 species present		
PLECOPTERA (stoneflies) 	must be present		
TRICHOPTERA (caddisflies) 	must be present, but not more abundant than mayflies		
COLEOPTERA (beetles) 	must be present		
OLIGOCHAETA (worms) 	must be absent or sparse		

The stream site is: ☐ **Non-Impacted** – all 5 boxes are checked
☐ **Possible Impact** – at least one of the 5 boxes is not checked (needs further study to confirm)

adapted from the NYS DEC

HBRW Tiers 2-3

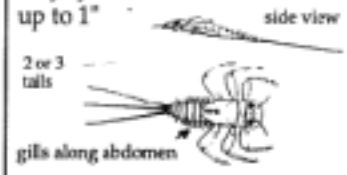
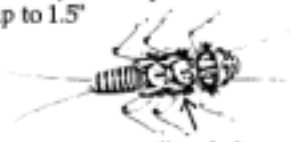
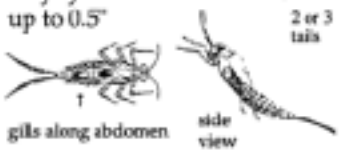
Benthic Macroinvertebrate Sorting (& EPT Richness) Worksheet

Name(s)_____

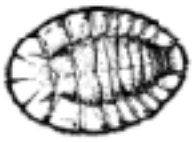
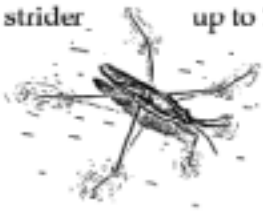
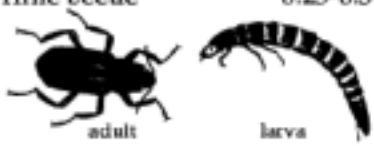
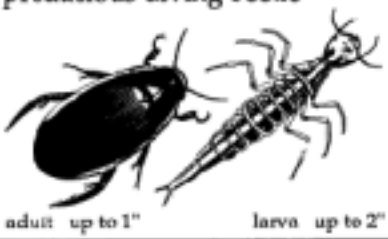
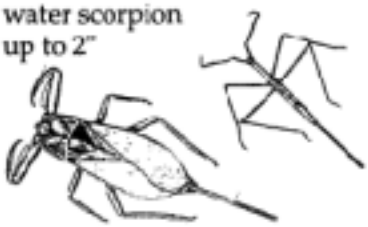
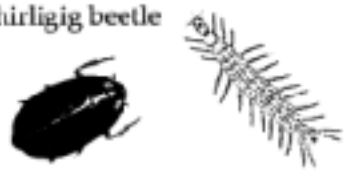
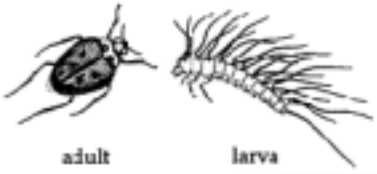
School / Group_____ Date_____

Stream_____ Site_____ Replicate _____

1. Sort and identify organisms to the level of order (stoneflies, caddisflies, beetles, true bugs, etc). Within each order, try to distinguish different taxa and sort organisms accordingly.
2. Count the number of organisms of each taxa and mark a tally in the appropriate box next to the picture of the taxa. For taxa not pictured, make up your own description, write it in the "other" box for the appropriate order, and indicate with a tally the number of organisms found for that taxa.
3. To calculate an EPT Richness estimate, add up the number of different mayfly, caddisfly and stonefly taxa found. Count the number of boxes that have tallies, NOT the number of tallies. Record the EPT Richness estimate in the box at the bottom right hand corner of the page.
4. Use the data from this sheet to fill out the "Percent Composition" and "Biotic Index" worksheets.

MAYFLY LARVAE	CADDISFLY LARVAE	STONEFLY LARVAE
mayfly larva - flatheaded up to 1" 	caddisfly larva - netspinner up to 1" 	stonefly larva - predator up to 1.5" 
mayfly larva - brushlegged up to 1" 	caddisfly larva - stone case up to 1" 	stonefly larva - small shredder up to 0.5" 
mayfly larva - spiny crawler up to 0.75" 	caddisfly larva - square wooden case up to 0.75" 	stonefly larva - other
mayfly larva - small minnow up to 0.5" 	caddisfly larva - fingernet up to 0.5" 	**EPT RICHNESS:** >10 = non-impacted 6-10 = slightly impacted 2-5 = moderately impacted <2 = severely impacted
mayfly larva - other	caddisfly larva - other	

Benthic Macroinvertebrate Sorting Worksheet

water penny beetle larva up to 0.5" 	water strider up to 1.5" 	midge larva up to 0.5" 
riffle beetle 0.25-0.5" 	giant water bug up to 1.5" 	blackfly larva up to 0.5" 
predacious diving beetle 	water scorpion up to 2" 	cranefly larva up to 4" 
whirligig beetle 	backswimmer up to 1" 	mosquito larva up to 0.5" 
crawling water beetle 0.25-0.5" 	water boatman up to 1" 	watersnipe fly larva up to 0.75" 
other beetles	other true bugs	other true flies

Note: Size does not include tails

Benthic Macroinvertebrate Sorting Worksheet

snail - flat spiral

snail - left opening

snail - right opening

fingernail clam up to 0.5"

other mollusks

Dobsonflies, Fishflies, & Alderflies

dobsonfly larva up to 4"

gill tufts at base of each "hair"

fishfly larva up to 1.5"

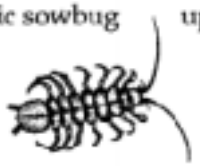
no gills

alderfly larva up to 1"

scud up to 0.5"

crayfish up to 6"

aquatic sowbug up to 0.75"



other crustaceans

Aquatic Worms

aquatic earthworm up to 2"

flatworm (planarian) up to 0.75"

leech up to 2"

other worms

dragonfly larva - clubtail up to 1.25"

dragonfly larva - skimmer up to 1.5"

dragonfly larva - darner up to 2"

damselfly larva up to 1.25"

3 oar-shaped tails (gills)

damselfly larva up to 1.25"

3 tails (gills); middle one shorter

other dragonflies/damselflies

TAXA RICHNESS:
(the total number of different kinds of macroinvertebrates)

Note: Size does not include tails

HBRW Tier 2

Benthic Macroinvertebrate Major Group Biotic Index Worksheet

Name(s)_____
School / Group_____ Stream_____
Date(s) Sampled_____ Site_____ Replicate _____

Major group	A # of Organisms in Sub-sample	B Assigned Biotic Index	C Biotic Value for Group
Mayfly		10	
Stonefly		10	
All Caddisfly except net spinner		10	
Dobsonfly		10	
Riffle Beetle		8	
Water Penny Beetle Larvae		10	
Beetle Larvae (not above)		8	
Crane Fly		8	
Net Spinner Caddisfly		7	
Gilled Snail		7	
Scud		5	
Clam		8	
Alderfly		6	
Crayfish		6	
Dragonfly		6	
Damselfly		6	
Black Fly		6	
Midge		6	
Snail		4	
Sowbug		2	
Leech		2	
Aquatic Worm		0	
TOTALS	D		E

Instructions: (Try to pick up at least 100 individual organisms.) Using the "BMI Sorting" worksheet, count the number of organisms for each major group identified in your sub-sample and record in column A. Sum the total of that column and record in D. Multiply the number of organisms in each Major Group by the assigned biotic index value (see column B) and record the results in column C. Sum the total of that column and record in E. To get the Biotic Index Score, divide E by D, then multiply result by 10.

Biotic Index Score= $\frac{\text{E total biotic value}}{\text{D total \# organisms in your sample}}$ X 10 =

Biotic Index:	>79 non-impacted	60-79 slightly impacted	40-59 moderately impacted	<40 severely impacted

HBRW Tier 2

Benthic Macroinvertebrate
Major Group Percent Composition Worksheet

Name(s)_____

School / Group_____ Stream_____

Date(s) Sampled_____ Site_____ Replicate _____

Calculating Percent Composition

$$\% \text{ Composition} = \frac{\#\text{ individuals of major group}}{\text{total }\#\text{ individuals in sub-sample}} \times 100$$

Major group	# individuals of major group		total # of all organisms in sub-sample		Percent Composition
Mayfly		÷		x 100 =	
Stonefly		÷		x 100 =	
Caddisfly		÷		x 100 =	
Midge		÷		x 100 =	
Beetle		÷		x 100 =	
Worms		÷		x 100 =	
Others		÷		x 100 =	

Total # in sub-sample [ ] This is "D" from "Major group biotic index" worksheet

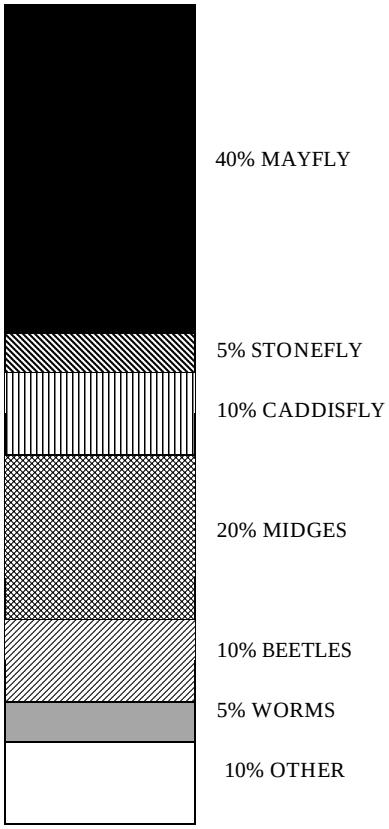
Steps:

1. Try to pick at least 100 organisms or ¼ of your sample. This is your sub-sample. See directions in the analysis section for more details.
2. Fill in the number of individuals you have identified in each group from your sub-sample using the "BMI Sorting" worksheet.
3. Sum the total number of organisms in your sub-sample.
4. For each major group, divide the number of individuals for that group by the total number in your sub-sample. Multiply by 100 to calculate percent composition.
5. Graph the percent composition in the "Graphing Percent Composition" worksheet to compare sites, and use your results to compare your site with the reference community for NY State.

HBRW Tier 2

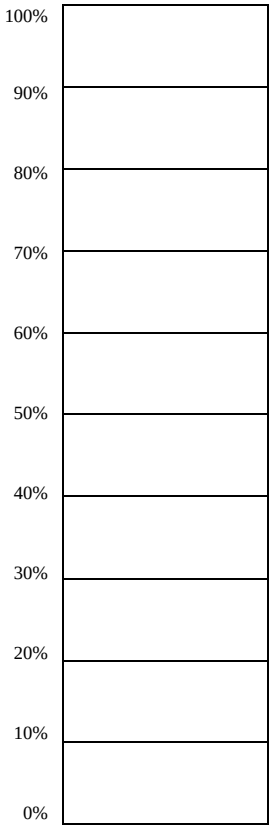
Graphing Percent Composition Worksheet

NY "model community"



Your Sample:

(color in appropriate %'s)



HBRW Tier 3

Benthic Macroinvertebrate Family Level Identification Worksheet

Site#: _____ **River/Stream** _____

Date Sampled: _____ **Name(s)** _____

Date of Lab Work _____ **Total # Squares in Tray Grid** ☐

Replicate #		1	2	3		
Families in Major Groups	T	D	D	D	Aver. D	General FFG*
EPHEMEROPTERA (Mayflies)						
Baetidae	4					GC/SC
Baetiscidae	3					GC
Caenidae	7					GC
Ephemerellidae	1					GC/SC
Ephemeridae	4					GC
Heptageniidae	4					SC/GC
Leptophlebiidae	2					GC
Metretopodidae	2					GC
Oligoneuriidae	2					FC
Polymitarcylidae	2					GC
Potomanthidae	4					GC
Siphlonuridae	7					GC
Tricorythldae	4					GC
Subtotal Ephemeroptera						
PLECOPTERA (Stoneflies)						
Capniidae	1					SH
Chloroperlidae	1					GC/PR
Leuctridae	0					SH
Nemouridae	2					SH
Peltoperlidae	0					SH
Perlidae	1					PR
Perlodidae	2					PR
Pteronarcyidae	0					SH
Taeniopterygidae	2					SH
Subtotal Plecoptera						

Replicate #		1	2	3		
Families in Major Groups	(1)	D	D	D	Aver. D	eneral FFG*
TRICHOPTERA (Caddisflies)						
Brachycentridae	1					FC/CG
Glossosomatidae	0					SC
Helicopsychidae	3					SC
Hydropsychidae	4					FC
Hydroptilidae	4					GC/SC/SH
Lepidostomatida	1					SH
Leptoceridae	4					GC/SH/PR
Limnephilidae	4					SH/SC/GC
Molannidae	6					SC
Odontoceridae	0					SH
Philopotamidae	3					FC
Phryganeidae	4					SH
Polycentropodida	6					FC/PR
Psychomyiidae	2					GC
Rhyacophilidae	0					PR
Sericostomatidae	3					SH
Subtotal Trichoptera						
DIPTERA (True Flies)						
Athericidae	2					PR
Blephariceridae	0					SC
Ceratopogonidae	6					PR
Chironomidae	7					ALL
Empididae	6					PR
Simuliidae	6					FC
Tabanidae	6					PR
Tipulidae	3					CG/PR/SH
Subtotal Diptera						

Key to Column Headings:

T = Family Pollution Tolerance Values

D = Density (# of individuals in family)

D = Average Density (average of D's for the 3 replicates)

FFG = Functional Feeding Groups (Use the followng codes):

SC = Scraper

FC = Filtering Collector

GC = Gathering Collector

PR = Predator

SH = Shredder

*** Note:** these are designations generalized for the families. When genus/species level information is available, these designations should be adjusted to reflect the FFG of the dominant taxon within the family or allocated among the FFG of the taxa actually present.

Benthic Macroinvertebrate Family Level Identification Sheet

MEGALOPTERA (Dobsonflies, alderflies, fishflie						
Corydalidae	0					PR
Sialidae	4					PR
Subtotal Megaloptera						
LEPIDOPTERA (Moths)						
Pyralidae	5					SH
Subtotal Lepidoptera						
COLEOPTERA (Beetles)						
Dryopidae	5					SC
Elmidae	4					GC/SC/SH
Psephenidae	4					SC
Subtotal Coleoptera						
ODONATA (Dragonflies, damselflies)						
Aeshnidae	3					PR
Calopterygidae	5					PR
Coenagrionidae	9					PR
Cordulegastridae	3					PR
Corduliidae	5					PR
Gomphidae	1					PR
Lestidae	9					PR
Libellulidae	9					PR
Macromiidae	3					PR
Subtotal Odonata						
AMPHIPODA (Scuds)						
Gammaridae	4					GC
Talitridae	8					GC
Subtotal Amphipoda						

ISOPODA (Sowbugs)						
Asellidae	8					SH/GC
Subtotal Isopoda						
DECAPODA (Crayfish)						
Cambaridae	6					GC
Subtotal Decapoda						
OTHER (non-families w/ tolerance values)						
Class Oligochaet	8					GC
Class Hirudinea	10					PR
Class Gastropoc	7					SC
Class Pelecypoc	7					FC
Unidentified						
Subtotal Other						

TOTALS		

Total # of Squares Picked From Each	**1**	**2**	**3**

* From Macroinvertebrate Sample Processing Record

REFERENCES:

Family pollution tolerance values from:

1) EPA (Hilsenhoff)

2) CT DEP and VT DEC taxa lists

Family functional feeding groups from:

1) Cummins & Wilzbach,

2) Merrit & Cummins,

3) Hoffman (CT DEP Taxa list)

Benthic Macroinvertebrate Data Reporting Sheet

Name(s) _____

School/Group _____ Stream _____

Date(s) Sampled _____ Site _____ Replicate_____

Sampling Method Used (please check):

☐ Hudson Basin River Watch: Tier 1____ Tier 2____ Tier 3____

☐ Other (describe how sampled & analyzed including: mesh size, size of area, sample size):_____

_____

Type of sample: ☐ Preserved ☐ Live sample

QaQc : check the QaQc measures you performed:

- ☐ Used an 8' x 18' net (not a kick seine or a D-net)
- ☐ Used a net with mesh size .5-.6 mm
- ☐ Collected 2 replicates
- ☐ Checked net & sample thoroughly for smaller organisms?
- ☐ Or made sure smaller organisms were represented in analysis?
- ☐ Used an outside expert for taxonomic verification of your samples
- ☐ Other: describe _____

TIER 1 Screening criteria: ☐ non-impacted ☐ "possible" impact-further study recommended

TIER 2

% Composition

	Replicate	
	1	2
Mayfly		
Stonefly		
Caddisfly		
Midge		
Beetle		
Worms		
Others		

EPT Richness

Replicate		Level of Impact
1	2	

Major Group Biotic Index

Replicate		Level of Impact
1	2	

TIER 3

Family EPT Richness _____ Total Family Richness _____

Family Biotic Index _____ Organism Density _____

Major Group % Composition (use Tier 2 chart)

Dominant Family _____ % Composition _____

Feeding group % Composition: Shredders_____ Collectors_____

Scrapers_____ Predators_____

Community Similarity Index _____

Benthic Macroinvertebrate Data Interpretation: Some Guidelines

How you approach interpretation depends on your study question and the tier that you used. Interpretation mostly involves more than a simple "yes or no, impacted or not?" type of response. Have fun trying to tell the story of what you find—use the physical / habitat survey information to try to explain your data. You will generate more questions that will become great guides for future studies. Also, remember to save and use each year' s data. The story of your river will begin to unfold with more depth as you begin to compare each year. The "Data Analysis Water - Quality Standard Survey" worksheet provides an example of one way to analyze results from a Water Quality Standard Survey (both benthic microinvertebrates and chemical indicators).

Tier 1

This is a basic screening tier that tests for presence / absence of 5 orders of invertebrates. This screening can test for a non-impacted community. If a site does not meet these criteria, you cannot necessarily conclude that it is impacted; further study is recommended. The DEC is interested in knowing areas with non-impacted river communities as well as areas that require further study.

Questions to ask when reviewing the data:

a) How might the habitat (in particular the bottom composition and embeddedness) affect the benthic community?
b) Does any single taxon appear to dominate the sample (>50% of individuals visible in the field)?
c) If so, what might be causing this? If not, does the sample appear to have a relatively balanced composition?

Tier 2

For this tier you will have a number of metrics to use to tell the story of the water quality of your river. The major group biotic index and the EPT richness provide a more detailed assessment of impact than tier 1, from non-impacted to severely impacted. The percent composition allows for a more rich understanding of the dynamics of the macroinvertebrate community, as does EPT richness.

Percent Composition: Look for a large increase / decrease of any major group and note whether the increase / decrease is occurring with a pollution tolerant or intolerant group. As an example, a large increase of the percentage of midges might indicate an impacted site. Non-impacted sites have a healthy percentage of the pollution tolerant organisms, but they should not be in the majority.

EPT Richness: A reference number for EPT is 12 for a healthy site in the mid-reach of a watershed. The EPT richness will be very dependant on habitat—be aware that for small headwater streams, the EPT will be very low because there is not a large amount of species diversity present in these streams. Some of the EPT species may

be very small. Your EPT richness will be lower than it should be if you overlook them while sorting and identifying.

Biotic Index: DEC considers a biotic index of greater than 79 to indicate a non-impacted site. The major group biotic index is a less rigorous assessment of stream health than the EPT richness because it does not consider the variation in pollution tolerance among EPT families—all the mayflies are given the same tolerance values, for example. You may find that your EPT richness value indicates a higher level of impact than your biotic index value. If you come up with a high biotic index value due to an abundance of only one or two EPT species, you may want to take the extra step of trying to identify those species to family level to determine their pollution tolerance.

The interesting part of interpreting this data is that not all of the metrics you study will always be consistent with each other—exploring the reasons for your findings makes for a fun and interesting study. Remember that streams are complex ecosystems, and many natural and human-caused factors may influence your results.

Tier 3

This tier uses a similar approach to Tier 2, but involves more metrics and a more detailed view. Decide what metrics are important for your study question and display them in a way you can observe trends. See River Watch Network's *Living Waters* for more specific information.

EPT Family Richness: Generally, the more EPT families, the better the water quality or the better the habitat. However, some pristine headwater streams may be naturally low in richness, due to a relative lack of food and generally lower abundance of organisms. For most sites, there should be 10-12 estimated or identified families.

Family Biotic Index: The results are interpreted as follows:

0.0-3.75	No Impairment
3.76-4.25	Very Good
4.26-5.00	Good
5.01-5.75	Fair
5.76-6.50	Fairly Poor
6.51-7.25	Poor
> 7.25	Very Poor

Note that for the family level biotic index, the higher the value, the poorer the water quality, but for the major group biotic index it is the opposite.

Optional Metrics:

Total Family Richness:

Organism Density:

Major Group % Composition: (same as Tier 2)

Dominant Family % Composition:

Functional Feeding Groups % Composition:

Community Similarity Index:

To be completed at a later date. See Living Waters for information in the meantime.

Presenting Your Data

Displaying your data is an essential part of being able to interpret it. Examples of graphs you might want to make are included in this next section describing ways to use the metrics for analyzing different types of studies:

For Water Quality Standards Survey (one site):

What level of impact does the biotic index and EPT richness indicate for your site? What might explain your results? How does the percent composition of your site compare to the NYS DEC reference community? What might explain these differences? (habitat, stream reach, water quality, time of year, weather....)

Graph the percent composition and compare it to a model community for New York State.

Remember that for all DEC stream classifications above D, aquatic life is considered a "use." If the BMI community is impacted, then a designated use is impaired. See the section on "Data Reporting—Tying it all Together" for more information about how you can use your results to document a level of impairment for the DEC Priority Waterbodies List.

For Impact/Improvement Assessment:

How did the benthic macroinvertebrate community change above and below the impact/improvement? What might explain these differences if any? How similar are the habitats?

- Graph percent composition of major groups for the upstream, downstream, and recovery sites.
- Create a table that allows you to compare the biotic index and EPT richness for the three sites on a given date.

For River Characterization Survey:

How does the benthic macroinvertebrate community (percent composition, EPT richness, biotic index) change from upstream to downstream? What might explain these changes?

- Graph percent composition of major groups arranged from upstream to downstream sites for each sampling date.
- Create a table that allows you to compare the biotic index and EPT richness for each site on a given date.

CHEMICAL INDICATORS

Overview

This section contains the protocols for the sampling and analysis for a variety of indicators. Choose those indicators that are important for your study. Generally, chemical indicators give a "snapshot" of the river. They tell us what is in the water at the place and time it was measured. They do not give us information about what happened in the past or why something is happening now.

Sampling

The sampling procedure is the same for all indicators except for dissolved oxygen. For dissolved oxygen, use the sampling bottle provided in your kit. For all other indicators, use high density polyethylene (HDPE) or polypropylene (PP) bottles or disposable "Whirl-Pak" bags. Collect water from the main current, holding the bottle or whirl-pak bag opening mid-way between the surface and the bottom, facing upstream. See the section entitled "How to Collect a Water Sample" for more detailed instructions.

Analysis

The protocols and equipment for analysis differ with each indicator and tier. The chart below provides an overview, including sample volume, holding time, and methods. Sample volumes listed will provide you with enough for 2 duplicates (see "Quality Assurance Quality Control" section) as well as some room for error. Note that tier 1 does not include any chemical protocols except pH. The following section of this manual provides detailed protocol instructions, listed by indicator and tier.

Remember, you are welcome to participate in the Hudson Basin River Watch Network if you choose to use procedures other than in this document!

A Note on Units: Many indicators are measured in milligrams per liter (mg/L), which is the same as parts per million (ppm).

Indicator	Tier	Sample Volume	Holding Time	Method
PH	1	100 mL	24 hours refrigerated	paper strips (color wheel/ comparator ok)
	2 & 3			meter or Hach pocket pal
Dissolved Oxygen	2	60 mL	"fix" with first 3 reagents immediately in field; store in dark and analyze within 8 hours	Modified Winkler Titration – LaMotte microburet (Hach drop count ok)
	3	100 mL	Same as Tier 2	Modified Winkler Titration – Hach digital titrator

Nitrate Nitrogen	2	25 mL	48 hours refrigerated	Zinc Reduction with LaMotte color comparator (Cadmium Reduction w/Hach color wheel ok)
	3	50 mL	Samples can be held for up to 48 days if preserved by acidifying sample with sulfuric acid to pH2. If your sampling days are < 48 days apart, you can save time by analyzing more than 1 day at the same time using the same standard curve.	Cadmium Reduction with Hach DR700 or 800 series colorimeter or a spectro-photometer. Use of standard curve for calculating concentrations.
Orthophosphate	2	25 mL	48 hours refrigerated	Ascorbic Acid Reduction using LaMotte color comparator
	3	50 mL	Samples can be held for up to 28 days if preserved by acidifying sample with sulfuric acid to pH2. If your sampling days are < 28 days apart, you can save time by analyzing more than 1 day at the same time using the same standard curve.	Ascorbic Acid Reduction with Hach DR700 or 800 series colorimeter or a Spectrophotometer. Use of standard curve.
Chloride	2	50 mL		Silver Nitrate Titration, LaMotte microburet or Hach drop count.
	3			Being researched
Alkalinity	2	25 mL	14 days at 4 degrees C	Sulfuric Acid Titration, Lamotte microburet (Hach drop count ok)
	3	250 mL		Double Endpoint Titration, Hach digital titrator
Conductivity	2-3	50-100 mL	28 days refrigerated	Direct measurement with a conductivity meter
Turbidity	2-3	50 mL	48 hours refrigerated	Direct measurement with a nephelometer

Here are two additional indicators you might choose. Ask for the advice of your local soil and water conservation district or HBRW Regional Coordinator to decide if these are indicators that make sense for your program.

Total Settleable Solids	2-3	Imhoff Settling Cone
Total Suspended Solids	2-3	Filtered, oven dried and weighed

How to Collect a Water Sample

The way you collect your sample can have a tremendous influence on your results. It' s important to collect samples so that they are representative of the water your are monitoring. That means that they should be collected in places that are typical of the site you' re sampling and that your sampling procedure should not introduce more of the indicator you are measuring into your sample than is actually in the water. For example, if you' re collecting a sample to measure turbidity, you should not stir up the bottom where you' re sampling, this might add additional sediment into the bottle and will give a higher measure of turbidity than is actually in the river. It is also important to collect all your samples in exactly the same way, so that you can accurately compare your results. It is essential, therefore, that all sample collectors follow the same sampling procedures outlined below. To sample for dissolved oxygen, see the oxygen section of this document as the collection procedure and container is different.

Water Sample Containers and Sample Volume

Collect water samples in high density polyethylene (HDPE) or polypropylene (PP) bottles or disposable "whirl-pak" bags. If you are using tier 2, a 500 ml bottle is more than enough volume to analyze one sample for every indicator. If you are using tier 3, you may need a little more than 500 ml to analyze every indicator. Refer to the sample volume information in the chart provided in the beginning of this section to determine how much water to collect to run the tests for the indicators you plan to analyze. The sample volumes listed in the chart will provide you with enough sample for analyzing 2 *lab duplicates* (see "Quality Assurance Quality Control" section) as well as some room for error.

If you plan to analyze 2 field replicate samples for a site (see "Quality Assurance Quality Control" section), you will need to use two separate sampling containers to collect each replicate sample.

All sample bottles should be washed with non-phosphate soap, scrubbed with a bristle brush, rinsed with warm tap water until soap disappears (about 6 times) and then rinsed 3 times with de-ionized water. (De-ionized is more pure than distilled water and thus better to use for final rinsing). If you plan to analyze a sample for phosphorous**,** ***your sample bottle should be washed with acid instead of soap*** to ensure you remove possible contamination that could affect your results. Or you can acid-wash a separate, smaller sampling bottle or use a whirl-pak bag to collect the phosphorous sample.

Before you sample, label your containers with the following information:

Stream _____ Site _____ Date _____ Time _____
Name of Collector _____

Where To Sample

In general, sample away from the riverbank in the main current. Choose whichever method allows you to sample the main current most easily: wading, boat, shore, or from a bridge. In any case, avoid sampling surface water or stagnant water! The outside curve of the river is often a good place to sample since the main current tends to hug this bank. In shallow stretches, wade into the center current carefully to collect the sample. If wading is not possible, tape your sample bottle to an extension pole or use a boat. Reach out from shore or boat as far as safely possible to collect the water sample.

How To Sample

1) If you are wading: Approach the sampling spot from downstream. Try to disturb as little bottom sediment as possible. In any case, be careful not to collect water that has sediment from bottom disturbance. Stand facing upstream. Collect the water sample on your upstream side.

   If you are collecting a sample by boat: Approach the sampling spot from downstream. Carefully reach over the side and collect the water sample on the upstream side of the boat.

2) Remove the cap from the bottle just before sampling . Avoid touching the inside of the bottle or the cap.

3) Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down and plunge it into the water, facing upstream. Hold it 8” to 12” beneath the surface or mid-way between the surface and bottom if it is shallow.

4) Turn the bottle underwater into the current and away from you. In slow-moving river reaches, push the bottle underneath the surface and away from you in an upstream direction.

5) Empty the bottle and repeat step 4. (This will remove any rinse water left over from washing the container.)

6) Fill the bottle completely and recap the bottle carefully – remember, don’ t touch the inside!

8) Fill out a physical survey field sheet every time you sample.

9) If you plan to collect samples and analyze at a later date, be aware of the maximum holding time for each indicator. This information appears in the chart in the beginning of this “Chemical Indicators” section.

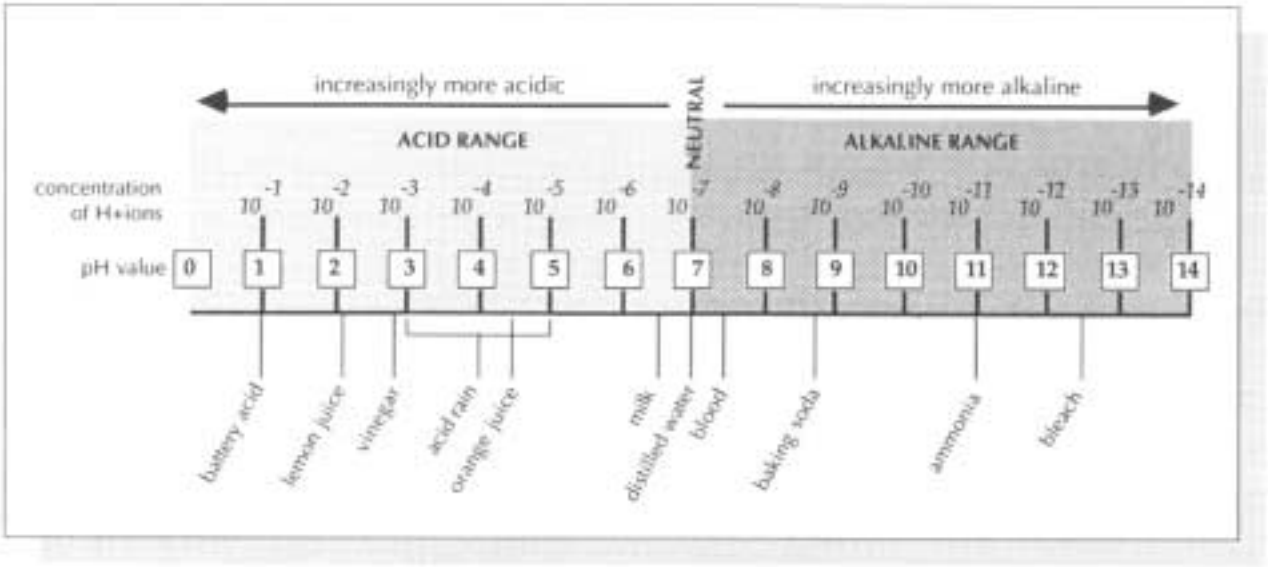
PH

Background

What is pH? pH is a measure of the acidity of a solution. Acids produce hydrogen ions (H+) and bases produce hydroxide ions (OH-) in solution. Water molecules ionize (break apart) and produce hydrogen and hydroxide ions in equal numbers. When another compound enters the water, the ions of water and the ions of the compound react with each other leaving an unequal number of hydrogen and hydroxide ions. If the solution has more hydrogen ions, it is acidic; if it has more hydroxide ions, it is basic.

Why Measure pH? Many fish and invertebrates are sensitive to high (above 8.6) and low (below 6.5) pH levels. Recently, because of air pollution, precipitation in the Northeast US tends to have low pH. This is called "acid rain." At low pH' s the bones of fish may become soft and the fish are unable to lay eggs successfully. Fish gills become clogged with mucus and the fish has difficulty getting oxygen into its bloodstream.

PH Scale Diagram



Levels: Optimal Range for most life: 6.5-8.2
NYS DEC Standard for Class A, B, C waters: 6.5-8.5

Analysis

Tier 1 — pH

Method	Range	Increments	Company/Cat. #
Paper strips (color wheel/ comparator ok)	1-14	1 or 0.5 pH units	VWR #EM-9590-3

Procedure

Use pH paper strips (or a color wheel/comparator kit. The most accurate paper strips are pH strips, universal range, EM CholorpHast (company and catalog number listed above).

Take a beaker into the middle of the stream, rinse a few times and bring a sample of water back to shore. Dip paper strips into beaker and wait a minute. Compare color of strip to pH chart and record. Repeat for second replicate.

Tier 2-3 — pH

Method	Range	Increments	Company/Cat. #
A quality meter using standard calibration methods or the Hach Pocket Pal	0-14 pH	0.1	Hach #44350-00

! **WARNING: If this meter gets completely submerged by water (e.g., if someone drops it in the stream) it will not work again.**

Procedure

1. Wash all glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2. Calibrate the meter (see instructions below).
3. Pour sample into a beaker at least 2 inches deep.
4. Slide the on/off switch on the top of the meter to on.
5. Remove the protective cap from the bottom of the meter.
6. Immerse the bottom of the pocket pal 1-3.5 inches into the water sample.
7. Using the meter, gently stir the sample for several seconds. Then hold the meter still in the sample (still 1-3.5 inches immersed) and let the display stabilize.
8. Record the pH value on the "Chemical Data Reporting Sheet."
9. Rinse the bottom of the meter (the probe) with de-ionized water before measuring a second replicate or other samples.
10. Follow instructions below for proper storage of meter.

Calibrating the Meter

The pocket pH meter should be calibrated before you take it out to the stream. Prepare a 7.0 pH buffer solution. Use the pocket meter to read pH. If necessary adjust with a small screwdriver through the hole in the back to a 7.0 reading. Use a pH 4.0 or 10.0 buffer solution and repeat calibration. If you have a different meter, use the directions that are associated with your meter.

Storing the Meter

The pocket meter (as with all probes) will perform better and last longer if the glass bulb electrode does not dry out. Place a cotton ball with several drops of 7.0 pH buffer solution in the protective cap when storing. If possible, soak the electrode in tap water for a few minutes each week to recondition it. If you haven't used the meter in awhile and it has dried out, soak the electrode in a 7.0 pH buffer solution for about an hour before using to make sure the bulb has re-hydrated. Never soak the electrode in de-ionized water for an extended amount of time as this may leach metals from the probe.

Alkalinity

Background

What is Alkalinity? Alkalinity is a measure of the capacity of water to neutralize (or buffer) inputs of acids. A river' s alkalinity is dependent on the type of soil and bedrock through which it flows. Therefore, it can vary greatly from watershed to watershed naturally. The lower the alkalinity the lower the ability to buffer. Alkalinity is measured in milligrams per liter of calcium carbonate.

Why Measure Alkalinity? Alkalinity is important because it protects against pH changes from acid inputs and thus affects the waters' ability to support life. Human caused inputs of acid into a river are mainly acid deposition (rain, snow, and dry particles), wastewater discharges, industrial discharges, and acid mine drainage.

Levels (Alkalinity as CaCO3):

Acidified:	0
Critical:	0-2 mg/L
Endangered:	2-5 mg/L
Highly sensitive:	5-10 mg/L
Sensitive:	10-20 mg/L
Not sensitive:	20 or higher mg/L

Analysis

Tier 2 — Alkalinity

Method	Range	Increments	Company/Cat. #
Sulfuric Acid Titration LaMotte microburet (Hach drop count ok).	0-200 mg/L	4 mg/L	LaMotte #4491-DR

Procedure

1. Wash ALL glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2. Fill glass titration tube with sample water to the 5 mL line..
3. Add one BCG-MR tablet to the tube and swirl to mix.
4. Depress the plunger of the titrator (looks like a syringe) to expel air.
5. Insert titrator into the plastic fitting of alkalinity reagent B bottle.
6. To fill titrator, invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale
   NOTE: A small air bubble may appear in the titrator. Expel the bubble by partially filling the titrator and pumping the reagent back into the inverted bottle. Repeat this pumping action until bubble disappears.
7. Turn the bottle right side-up and remove titrator WITHOUT

depressing plunger.

8. Insert the tip of titrator into the opening of the titrator tube cap as shown in kit directions. Slowly depress plunger to dispense one unit' s worth of the reagent.
9. Gently swirl tube to mix.
10. Continue adding individual units of alkalinity reagent until the sample turns from blue to purple-red, and the color change holds.
11. The alkalinity of your sample is read directly from the scale on the titrator, in ppm, as shown at right. Record the results as mg/L $CaCO_3$ on the "Chemical Data Reporting Sheet." **NOTE**: If no color change occurs by the time the plunger tip reaches the bottom of the scale, refill the titrator to the zero mark and continue titrating. Record your final test result as the sum of both titration amounts.
12. If no additional tests are to be made, discard any extra reagent from the titrator into your waste container; DO NOT put back into the original reagent bottle.
13. Remove the plunger from glass barrel, thoroughly rinse both with de-ionized water and store separately.

Tier 3 Alkalinity

Method	Range	Increments	Company/Cat. #
Double Endpoint Titration with Hach digital titrator	0-720 mg/L	0.1 mg/L	Hach digital titrator with appropriate reagents and equipment bought separately (see equipment list).

Summary of Method: Titration with sulfuric acid is performed using a digital titrator and pH meter. *(River Network adaptation of method used by the University of Massachusetts Acid Rain Monitoring Program.)* First, a 100 mL sample is poured into a beaker and the pH is recorded. Sulfuric acid is added until the pH reaches 4.5. The amount of sulfuric acid added is recorded. Additional sulfuric acid is added until the pH is 4.2. This is recorded as well. An equation is applied to determine total alkalinity as mg/L $CaCO_3$.

Procedure

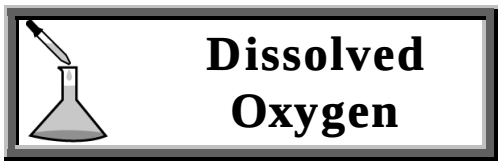
1. Wash ALL glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2. Calibrate the pH meter (see instruction in pH section).
3. Bring all field samples to room temperature. (Let them sit for 1 hour with the cap on). Measure 100 mL of the water sample and pour immediately into the 250 mL beaker with a magnetic stirrer or stir manually. Make sure to rinse the graduated cylinder with de-ionized water in between measuring 100 mL of each sample.
4. Rinse the electrode well with de-ionized water.

5. Place the pH pen or electrode into the sample. Stir the sample. Read and record the temperature and pH in the appropriate columns on the data sheet. Rinse the electrode well with de-ionized water.
6. Insert a clean delivery tube into the 0.16N Sulfuric Acid titration cartridge and attach the cartridge to the titrator body.
7. Over a sink, hold the titrator with the cartridge tip pointing up. Carefully turn the delivery knob to eject all of the air and a few drops of titrant. Check for air bubbles in the tube. Reset counter to 0 and wipe the tip.
8. **If the pH of the sample is less than 4.5, skip to step 14 below.**
9. Insert the delivery tube into the beaker containing the sample. Turn the delivery knob while stirring the beaker continuously until the pH meter reads 4.5. The pH can change quite suddenly, so add drops slowly. Be sure to allow the meter to stabilize as you add the acid. Record the number of digits used to achieve this pH on the lab sheet. **Do not reset counter. If you overshoot by adding too much acid, skip to step 14 below.**
10. Continue adding acid (titrating) to a pH of 4.2 and record the total number of digits.
11. Apply the following equation to calculate alkalinity:
    Alkalinity (as mg/L $CaCO_3$) = (2a-b) X 0.1
    a = digits of titrant required to get to pH 4.5
    b = total number of digits of titrant required to get to pH 4.2 (which includes digits required to get to pH 4.5)
    0.1= digit multiplier for a 0.16N titration cartridge and a 100 mL sample
12. Record the results as mg/L $CaCO_3$ on the "Chemical Data Reporting" sheet.
13. Rinse beaker and electrodes with de-ionized water before next sample.
14. If the pH of your water sample prior to titration is less than 4.5 **or if you overshot 4.5,** proceed as follows:
    a. Insert the delivery tube into the beaker containing the sample.
    b. Turn the delivery knob while swirling the beaker until the pH meter reads exactly 0.3 pH units less than the initial pH of the sample.
    c. Read and record the number of digits used to achieve this pH.
    d. Apply the equation as in step 11, but "a" = 0 and "b" = the number of digits required to reduce the initial pH exactly 0.3 pH units.
    e. Record the results as mg/L $CaCO_3$ on the "Chemical Data Reporting Sheet."

If the alkalinity is high, you may want to switch to the 1.6 N sulfuric acid for titration after your first sampling. The more concentrated acid allows you to use less of it, but you can continue to use the 0.16 N solution and still get the same final results. If you do switch, the digit multiplier for the equation will be 1.0 (instead of 0.1).

To Perform an Accuracy Check

1. Snap off a 0.5N Alkalinity Voluette Ampule Standard. This is a standard solution that has a known alkalinity.
2. Perform the alkalinity test using this standard:
   a) Pipet 0.1 mL of the standard to the finished sample from above.
   b) Titrate this with more sulfuric acid until the pH returns to 4.2.
   c) Record the number of digits needed.
   d) Repeat steps a-c twice more.
3. Each 0.1 mL addition of standard should require 250 additional digits of 0.16N sulfuric acid titrant. Compare your results with the this number. If the number of digits you got was very different, explore reasons for this difference.



Dissolved Oxygen

Background

What is Dissolved Oxygen? Dissolved oxygen (DO) is a measure of the concentration of oxygen gas that is dissolved in the water. The main ways it enters water are through turbulence and plant photosynthesis. DO is measured in milligrams per liter (mg/L) which is the same as parts per million (ppm).

Why Measure Dissolved Oxygen? Oxygen is essential for all living things. Certain macroinvertebrates, such as most mayflies, caddisflies, and stoneflies, and certain fish, such as trout, require dissolved oxygen levels of at least 6 mg/L. The most oxygen that can be dissolved in water is about 14 mg/L.

When a stream warms up, it loses its ability to hold dissolved oxygen. Other factors such as excess algae or suspended sediment can also lower oxygen levels.

Water can hold a maximum amount of dissolved oxygen at different temperatures (saturation). In our analysis we will calculate the concentration of DO and the percent oxygen saturation. The percent saturation is the amount of DO that is dissolved in the water compared to the optimal amount that you'd expect the water to hold at its given temperature.

Recording the time of day is essential for DO measurements, as the amount will fluxuate throughout the course of a day due to fluctuations in plant photosynthetic activity and water temperatures.

Concentrations:

NYS DEC Water Quality Standards:

Class A-S:	6.0 mg/L
All other class A and B,C:	
Trout Spawning (TS):	7.0 mg/L
Trout Waters (T):	5.0, daily average 6.0
Non-trout:	4.0, daily average 5.0
Class D:	3.0 mg/L

Analysis

Tier 2 — Dissolved Oxygen

Method	Range	Increments	Company/Cat. #
Modified Winkler Titration with LaMotte microburet (Hach drop count ok)	1-20 mg	1 mg	**LaMotte #5860** (or Hach #1469-00)

Note: The instructions below are for the LaMotte microburet kit. If you' re using the Hach drop count method, adapt the instructions to fit your kit.

Procedure

Collect a Water Sample

1 Wash ALL glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2 Carefully wade into the stream. Stand so that you are facing one of the banks. Take and record the temperature of the water.
3 Remove the cap of the sample bottle. Slowly lower the sample bottle into the water so that the top of the bottle is pointing downstream, until the lower lip of the opening is just submerged. Allow the water to fill the bottle very gradually, avoiding any turbulence (this would add oxygen to the sample). When the water level in the bottle has stabilized (it will not be full because the bottle is tilted), slowly turn the bottle upright and fill completely. Keep the bottle under water and allow it to overflow for 2 or 3 minutes to ensure that no air bubbles are trapped in the sample.
4 Cap the bottle while it is still submerged. Examine your sample for air bubbles. If you see any pour out the sample and try again. (You want to sample to oxygen that is DISSOLVED in the water, not oxygen that was in the bottle from the air).

Immediately "Fix" the Sample

5 Add 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide to the sample.
6 Cap the bottle and mix by inverting several times.
7 The brown precipitate indicates that oxygen is present. Allow the sample to stand until the precipitate settles below the shoulder of the bottle.
8 Add a 1.0 g level measure of Sulfamic Acid Powder (for kit code 7414) or 8 drops of Sulfuric Acid (for kit code 5860) to the sample. Cap the bottle and mix until the precipitate and reagent have totally dissolved. The sample will be clear yellow to amber brown if it contains oxygen.
9 Titrate immediately or store in a cool dark place for no longer than 8 hours before continuing.

Titrate the Sample

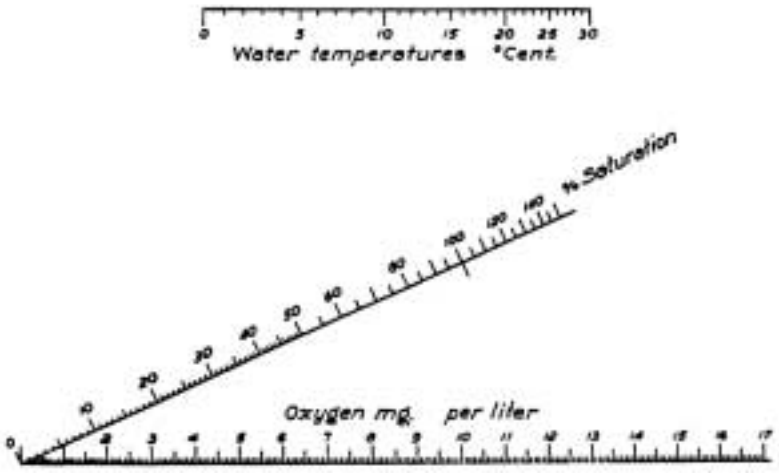
10 Fill the titration tube (not the titrator, which looks like a syringe) to the 20 ml line with the sample. Cap the tube.
11 Depress plunger of the titrator and insert into the Sodium Thiosulfate

bottle.

12 Invert the bottle and slowly withdraw the plunger until the bottom of the plunger is opposite the zero mark on the scale. If small air bubbles appear in the titrator, expel them by partially filling the titrator and pumping the solution back into the reagent container. Repeat until bubble disappears.
13 Turn the bottle upright and remove the titrator. If the sample is a very pale yellow, go to step 17.
14 Insert the tip of the titrator into the titration tube cap.
15 Slowly depress the plunger to dispense one drop at a time of the titrating solution. After each drop, gently swirl the tube during the titration to mix the contents. Continue until the yellow-brown color changes to pale yellow.
16 Carefully remove the titrator and cap. Do not disturb the titrator plunger.
17 Add 8 drops of Starch Indicator solution. The sample should turn blue.
18 Cap the titration tube and re-insert the titrator. Continue titrating until the blue color disappears and the solution becomes colorless.
19 Record the result where the titrator plunger tip meets the scale. Record as mg/L DO on the "Chemical Data Reporting" sheet.
20 Use the oxygen saturation chart to calculate percent saturation and record on the "Chemical Data Reporting Sheet."

Percent Saturation Chart

Instructions: To calculate percent saturation, find the mg/L of oxygen on the lower line and the water temperature on the upper line. Use a straight edge to line up the two readings and record where the straight edge intersects the percent saturation line.



Tier 3 Dissolved Oxygen

Method	Range	Increments	Company/Cat.#
Modified Winkler Method with digital titrator	0-20 mg/L	0.01 mg/L	Hach #20631-00

Summary of Method: A sample is collected in a 300 mL BOD bottle and "fixed" in the field using manganous sulfate, alkaline iodide azide, and sulfamic acid. These react with the sample turning it yellow. A starch indicator is then added to turn the solution blue. Sodium thiosulfate is added incrementally which will turn the solution clear. The amount it takes to turn the solution clear is proportional to the amount of DO in the sample.

Procedure

Collect a Water Sample

1. Wash ALL glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2. Carefully wade into the stream. Stand so that you are facing one of the banks. Take and record the temperature of the water.
3. Remove the cap of the BOD bottle. Slowly lower the BOD bottle into the water so that the top of the bottle is pointing downstream, until the lower lip of the opening is just submerged. Allow the water to fill the bottle very gradually, avoiding any turbulence (this would add oxygen to the sample). When the water level in the bottle has stabilized (it will not be full because the bottle is tilted), slowly turn the bottle upright and fill completely. Keep the bottle under water and allow it to overflow for 2 or 3 minutes to ensure that no air bubbles are trapped in the sample.
4. Cap the bottle while it is still submerged. Examine your sample for air bubbles. If you see any pour out the sample and try again. (You want to sample to oxygen that is DISSOLVED in the water, not oxygen that was in the bottle from the air).

Analyze the Water Sample

5. "Fix" the sample immediately
   a) Remove the stopper and add the contents of one Manganous Sulfate powder pillow and one Alkaline Iodide Azide powder pillow.
   b) Immediately insert the stopper so air is not trapped in the bottle and invert several times to mix. **This solution is caustic, wear gloves or rinse your hands if you get any on them.** An orange-brown flocculent precipitate will form if oxygen is present.
   c) Wait a few minutes until the floc in the solution has settled. Again invert the bottle several times and wait until the floc has settled. This ensures complete reaction of the sample and reagents.
   d) Remove the stopper from one of the samples and add the contents of one sulfamic acid powder pillow. Immediately insert the stopper so air is not trapped in the bottle, and invert several times to mix. The floc will dissolve and leave a yellow color if oxygen is present. If particles are present, shake, turn upside-down a few more times, or use a magnetic stirrer to dissolve as much as possible.
   e) The oxygen is now fixed and can be stored in the dark for up to 8 hours.

If you want to finish the test later in the lab:
Cap the bottle firmly and seal it by pouring a small amount of water into the flared lip area. Place the bottle in a cooler in an upright position.
Record the site # on the bottle and the field sheet.
Transport the bottle in an upright position with the stopper firmly in place in a dark place. Maximum holding time is 8 hours.

6. Insert the 0.2N sodium thiosulfate cartridge into the digital titrator and insert a clean delivery tube into the cartridge.
7. Over a sink, hold the titrator with the cartridge tip pointing up. Turn the delivery knob to eject air and a few drops of titrant. Reset the counter to 0 and wipe the tip.
8. Measure 100 mL (using the graduated cylinder) of the sample volume from the "fixed" sample in the 300 mL BOD bottle and pour into a 250 mL Erlenmeyer flask. Place on a sheet of white paper to clearly see the color of the liquid.
9. Place the delivery tube tip into the solution and swirl the flask while turning the delivery knob. Keep turning the knob until the solution turns a pale yellow color.
10. Add two **full eyedroppers** of Starch Indicator solution and swirl to mix the solution. This will turn the solution dark blue.
11. Continue titrating until the liquid turns clear. Record the number of digits showing on the titrator counter. (Tip: to make sure that you have titrated all your sample, add one more digit to the sample when it appears to turn clear. If you see no additional color change, then subtract one digit from your final count).
12. Use the equation below to calculate mg/L of DO:
    mg/L = digits required X 0.02
    mg/L DO = digits required X 0.02
    (0.02 is the correct digit multiplier for the 0.2N concentration of the sodium thiosulfate cartridge)
13. Calculate Percent Saturation using the Oxygen Saturation Graph above.
14. Record the concentration and the percent saturation on the "Chemical Data Reporting Sheet."

A note about percent saturation: Remember, it is possible to get more than 100% saturation. The sample can be supersaturated in cold water that has a lot of turbulence or in an area where there are a lot of plants or algae on a sunny day (due to photosynthetic activity).

Nitrate - Nitrogen

Background

What is Nitrate? Nitrate (NO 3 -) is the form of nitrogen that is an essential nutrient for plants and animals as a building block for proteins. Nitrate is measured in milligrams per liter (mg/L). In freshwater ecosystems the limiting nutrient is phosphorus, in saltwater ecosystems, nitrate nitrogen is the nutrient in shortest supply.

Why Measure Nitrate? Nitrates are an essential nutrient and found naturally in unpolluted streams and ponds due to the process of plant and animal growth and decay. However, excess nitrates can cause great increases in plant growth and adversely affect the health of aquatic animals and humans. Some effects include: unstable dissolved oxygen, higher water temperatures, changes in habitat. The health impacts for humans of excess nitrates in our drinking water can result in blood poisoning in infants, hypertension in children, and gastric cancers in adults.

Levels:

Typical natural levels for freshwater: < 1 mg/L
Recommended level for trout: < 0.06 mg/L
Sewage treatment plant effluent: ~ 30 mg/L

NYS DEC Water Quality Standards:
Class A: 10 mg/L
Classes B,C,D: None that will result in growths of algae, weeds, and slime that will impair uses.

Analysis

Tier 2 **Nitrate-Nitrogen**

Method	Range	Increments	Company/Cat.#
Zinc Reduction with color comparator	0-15 mg/L	0, 1, 2, 4, 6, 8, 10	LaMotte #3354
OK - Cadmium Reduction with color wheel	0-10 mg/L	1.0	Hach #14161-00
NOTE: HBRW recommends the Zinc Reduction method because it generates less toxic waste.			

Procedure

1. Wash ALL glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2. Fill the test tube to the 5 mL line with sample water.
3. Add one Nitrate #1 tablet to the sample.
4. Cap and mix until tablet disintegrates.
5. Add one Nitrate #2 CTA tablet to the sample.
6. Cap and mix until tablet disintegrates.

7. Wait 5 minutes.
8. Insert Nitrate-Nitrogen Octa-Slide Bar into the Octa-Slide Viewer.
9. Insert test tube into Octa-Slide Viewer.
10. Match sample color to a color standard. Record as mg/L Nitrate Nitrogen on your "Chemical Data Reporting Sheet."

Tier 3 Nitrate-Nitrogen

Method	Range	Increments	Company/Cat.#
Cadmium Reduction with colorimeter or spectrophotometer	Depends on standard curve; 0-2 or 1-10 mg/L	0.01	Hach DR700 or 800 series colorimeter or a spectro-photometer with appropriate equipment and reagents bought separately (see equipment list).

THIS TEST GENERATES CADMIUM WASTE WHICH IS TOXIC AND SHOULD BE DISPOSED OF SEPARATELY!!

***Summary of Method*:** Nitrates are measured using the cadmium reduction method with a colorimeter. First, a standard curve is created using known concentrations of standards. This curve is used to convert absorbance readings of field samples into mg/L of nitrate-nitrogen. Then the reagent is added to field samples and their absorbance is read using a colorimeter or a spectrophotometer . The concentration of each sample is found by plotting absorbance on the standard curve and recording the corresponding concentration in mg/L.

Procedure

Prepare Standard Nitrate-Nitrogen Concentrations for Standard Curve

Prepare standard concentrations within the range of your samples. Below are two charts, one for a low range of 0-2 mg/L and a higher range 0-10 mg/L. If you have concentrations that are higher, make higher concentration standards for your curve.

1. Wash ALL glass and plastic ware with non-phosphate soap, then rinse three times with de-ionized water.
2. Choose range: 0-2 or 1-10 mg/L.
3. Make a stock of nitrate–nitrogen solution appropriate to the range:
    a. *0-2 mg/L:* Prepare a 2 mg/L stock solution. Empty one 2 mL ampule of nitrate-nitrogen standard solution (100 mg/L) into a 100 mL volumetric flask*. Add de-ionized water until the final volume reads 100 mL. This gives you a final stock concentration of 2 mg/L nitrate-nitrogen. Mix well before pouring into sample cell to analyze.
    b. *0-10 mg/L:* Prepare a 10 mg/L stock solution. Empty five 2 mL

ampules of nitrate-nitrogen standard solution (100 mg/L) into a 100 mL volumetric flask*. Add de-ionized water until the final volume reads 10 mL. This gives you a final stock concentration of 10 mg/L nitrate-nitrogen. Mix well before pouring into sample cell to analyze.

The equation to calculate the final concentration of your stock solution from the 2 mL ampules is:

V1 x C1 = V2 x C2
(V=volume; C=concentration)

Example: (5 ampules)(2mL)(100mg/L) = (100 mL)(X)
X = 10 mg/L

*Volumetric flasks are important to use for mixing standards because of their precision.

4. Set out six 10 mL sample cells. Use calibrated volumetric pipets to transfer corresponding volumes of nitrate stock solution to each cell as in the appropriate chart below. Before using each pipet the first time, clear it by filling once with the stock solution and forcing it out. (Do not use your mouth; use a pipet bulb.)

	Standard Concentration (mg/L NO_3-N)	**Volume (mL) of 2mg/L NO_3-N Stock Solution**
0-2 mg/L range	0.0	0
	0.4	2
	0.8	4
	1.2	6
	1.6	8
	2.0	10

	Standard Concentration (mg/L NO_3-N)	**Volume (mL) of 10 mg/L NO_3-N Stock Solution**
0-10 mg/L range	0.0	0
	2.0	2
	4.0	4
	6.0	6
	8.0	8
	10.0	10

The equation to calculate your own standards is A= BC/D
- A: volume of stock solution needed
- B: desired concentration of standard
- C: volume of standard
- D: concentration of stock solution

5. Fill the remainder of each sample cell with de-ionized water to the 10 mL line. Swirl to mix.

Measure Nitrate-Nitrogen of Standards and Samples

1. Measure 10 mL of each sample and your standards into different sample cells.

2. Prepare the colorimeter for the appropriate range nitrate-nitrogen test using the instructions that come with the instrument and adjust the colorimeter to read for absorbance.

3. **Use of gloves is recommended for this part of the test.** Add NitraVer5 pillows one at a time to your standards and samples as follows:

    a. Add the contents of one NitraVer 5 pillow to the standard or sample. Cover with parafilm (very tightly) or a Teflon screw cap. **This powder contains cadmium, be very careful NOT to breathe it**.
    b. Shake vigorously for one minute (be exact!!) Unoxidized particles of cadmium metal will remain in the sample and settle to the bottom of the tube. Shaking time and technique influence your results. Be consistent with each standard and sample.
    c. Wait five minutes to proceed. The DR 800 series colorimeter has a timer programmed into its function. See instrument instructions.

4. Add the contents of one NitraVer5 pillow to your 0.0 standard. This is your blank; use it to zero the colorimeter for all your standards and samples.

5. Read the absorbance of each standard and sample as follows:.
    a. Wipe the sample cell with a kimwipe.
    b. Insert sample cell correctly into the colorimeter and cover.
    c. Read the absorbance by pressing the READ key and record.

Prepare a Calibration Curve and Convert Absorbance to mg/L

1. Make an absorbance versus concentration graph on graph paper:

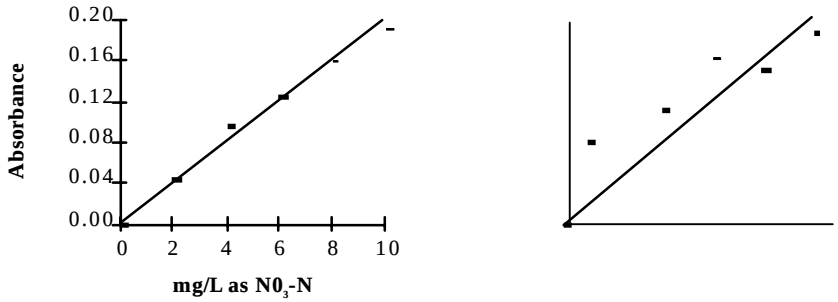
    a. Draw the y-axis (vertical) and label it "absorbance." Mark this axis in increments from 0 to the top of the graph paper (the more spread out your graph, the more accurate).
    b. Draw the x-axis (horizontal) and label it: "concentration: mg/L as NO_3-N." Mark this axis with the concentration of the standards.

2. Plot the absorbance of the standard concentrations on the graph.

3. Draw a "best fit" straight line through these points. The line should touch (or almost touch) each of the points. If it does not, the results of this procedure are not valid. If just one point is far off the line, run that

standard again. If more than one point is very far from the line, re-do the entire set of standards. Adjust for shaking time and method if necessary. See below for examples of a standard curve.

Nitrate-Nitrogen Standard Curve



Acceptable Not Acceptable

4. Convert the absorbance readings of each river sample to mg/L: locate the absorbance on the y-axis, read horizontally over to the curve, and then down to read the concentration in mg/L as NO3-N.

5. Record the concentration on the "Chemical Data Reporting Sheet."

Disposal

Rinse the unoxidized cadmium metal from the test tubes into a clearly marked container for toxic waste pickup. Arrangements should be made with toxic materials handlers for safe disposal.

Orthophosphate

Background

What is Orthophosphate? In aquatic ecosystems, phosphorous occurs mainly in the form of phosphate. Phosphates (PO_4^{-3}) are a plant nutrient found in phosphate containing rocks, soil, and animal wastes. High levels of phosphates can also be found in detergents, cattle feedlot runoff and human sewage effluent. Phosphate is measured in milligrams per liter. Phosphates come in two primary forms: organic and inorganic. Organic phosphate is bound in plants and animals and is not available for plants. Inorganic, or orthophosphate, also known as reactive phosphorous, is the form that is available and required by plants.

Why Measure Orthophosphate? In most fresh waters, phosphate is the nutrient in shortest supply and therefore limits the growth of plants. Any human addition of phosphorus can cause great increases in aquatic plant growth which may result in higher water temperatures, unstable dissolved oxygen, changes in habitat and ultimately a decrease in aquatic life.

Special Considerations: To analyze the most accurate concentration of phosphorus in your river system, measuring total phosphorus is the best approach. This involves an additional step to the procedures below (digesting your sample with acid). The protocols below test for orthophosphate, the amount available in the water column. This concentration underestimates the total amount of phosphorus in your system. Please contact HBRW if you are interested in testing for total phosphorus.

When testing for orthophosphate, be careful to report your measurement with the appropriate units. You can report it "as PO_4" (as phosphate) or "as P" (as phosphorus). The water quality standards use the "as P" measurement.

If your kit measures orthophosphate "as PO_4," then you must divide your amount by 3 to calculate the correct concentration "as P." (Phosphorus as the element P has 1/3 the molecular weight of the phosphate PO_4 compound).

Concentrations:

Wastewater: 5-30 mg/L

NYS DEC Standards:

None that will result in growths of algae, weeds, and slime that will impair uses (no numerical standard).

Guidelines for phosphorus as "P":

- Above 0.05mg/L: impact likely
- Above 0.1 mg/L: impact certain

(especially upstream from a pond/lake or slow moving area where algal blooms may be prevalent)

Analysis

Tier 2 Orthophosphate

Method	Range	Increments	Company/Cat.#
Ascorbic Acid Reduction with Hach color wheel. (LaMotte color comparator with axial reader ok)	Use low range: 0-5 mg/L*	0.5	Hach #2248-00

* If your sample range is higher than 5 mg/L, follow instructions that come with kit to conduct the high range test.

Procedure

1. Wash ALL glass and plastic ware WITHOUT soap, using 0-50 mg/L 6N HCl and then rinse with de-ionized water three times.
2. Fill the test tubes to the lowest line with sample water.
3. Open one PhosVer 3 Phosphate Reagent package and add the contents to one of the tubes.
4. Swirl to mix. Wait at least 1 minute, but no longer than 5 minutes, for color to develop.
5. Put the treated sample into the right opening of the color wheel and the untreated sample (the blank) into the left opening.
6. Hold the color wheel up to a light source and view through the openings in front. Rotate the disc to obtain a color match.
7. Divide the reading by 10 to obtain the mg/L phosphate. Divide by 3 to report the concentration as P and record your result on the "Chemical Data Reporting Sheet."
8. *****If your sample range is higher than 5 mg/L, follow instructions that come with the kit to conduct the high range test, 0-50 mg/L.

Tier 3 Orthophosphate

Method	Range	Increments	Company/Cat.#
Ascorbic Acid Reduction with colorimeter or spectrophotometer.	Depends on standard curve; 0-0.2 or 0.2-1.0 mg/L	0.01	Hach DR700 or 800 series colorimeter or a spectro-photometer with appropriate equipment and reagents bought separately (see equipment list).

Summary of Method: Orthophosphate is measured using the ascorbic acid reduction method with a colorimeter. First, a standard curve is created using known concentrations of standards. This curve is used to convert absorbance readings of field samples into mg/L of orthophosphate. Then the reagent is added to field samples and their absorbance is read using a colorimeter, or a spectrophotometer . The concentration of each sample is found by plotting absorbance on the standard curve and recording the corresponding concentration in mg/L.

Procedure

Prepare Standard Phopshate Concentrations for Standard Curve

Prepare standard concentrations within the range of your samples. Below are two charts: one for a range of 0-0.2 mg/L as P, the other with a higher range of 0-1.0 mg/L as P. If you have a higher concentration, make higher concentration standards for your curve (this will require getting a more concentrated stock solution).

1. Wash ALL glass and plastic ware WITHOUT soap, using 6N HCl and then rinse with de-ionized water three times.
2. Choose a range appropriate for your studies, 0-0.02 or 0-1.0 mg/L as P.
3. Make a stock of phosphate solution appropriate to the range:
   a. *0-0.2 mg/L as P*: Prepare a 0.25 mg/L stock solution. Using a calibrated volumetric pipet, dispense 25 mL of phosphate solution (1 mg/L as P) into a 100 mL volumetric flask*. Add de-ionized water until the final volume reads 100 mL. This gives you a final stock concentration of 0.25 mg/L as P. Mix well before pouring into sample cell to analyze.
   b. *0-1.0 mg/L as P*: Pour about 30 mL of the phosphate solution (1 mg/L as P) into a 50 mL beaker.

The equation to calculate final concentration of your stock solution from the 1 mg/L standard solution is:

$$V1 \times C1 = V2 \times C2$$

(V=volume; C=concentration)

Example: (25mL)(1mg/L as P) = (100 mL)(X)

X = 0.25 mg/L as P

*Volumetric flasks are important to use for mixing standards because of their precision.

4. Set out six 10 ml sample cells. Use calibrated volumetric pipets to transfer corresponding volumes of phosphate stock solution to cells as in the appropriate chart below. Before using each pipet the first time, clear it by filling once with the standard solution and forcing it out. (Do not use your mouth; use a pipet tube.)

0-0.2 mg/L as P range

Standard Concentration (mg/L as P)	Volume (mL) of 0.25 mg/L as P Stock Solution
0.00	0
0.025	1
0.05	2
0.1	4
0.15	6
0.20	8

0-1.0 mg/L as P range

Standard Concentration (mg/L as P)	Volume (mL) of 1.0 mg/L as P Stock Solution
0.0	0
0.2	2
0.4	4
0.8	8
1.0	10

The equation to calculate your own standards is A= BC / D

A: volume of stock solution needed
B: desired concentration of standard
C: volume of standard
D: concentration of stock solution

5. Fill the remainder of each flask or test tube with de-ionized water to the 10 mL line (be precise). Swirl to mix

Measure Phosphate of Standards and Samples

1. Measure 10 mL of each sample and your standards into different sample cells.
2. Prepare the colorimeter using the instructions that come with the instrument and adjust it to read for absorbance.
3. Add PhosVer 3 pillows one at a time to your standard concentrations and samples as follows (start with your standard concentrations):
   a) Add the contents of one PhosVer 3 pillow to the standard or sample. Cover with parafilm (very tightly) or a Teflon screw cap.
   b) Shake for fifteen seconds.
   c) Wait 2 minutes to proceed. The DR 800 series colorimeter has a timer programmed into its function. See instrument instructions.
4. Add the contents of one PhosVer3 pillow to your 0.0 standard. This is your blank; use it to zero the colorimeter for all your standards and samples.

5. Read the absorbance of each standard and sample as follows:

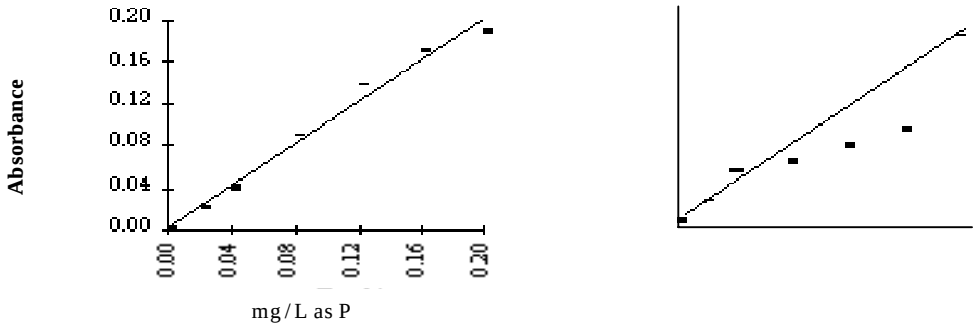
   a) Wipe the sample cell with a kimwipe
   b) Insert sample cell correctly into the colorimeter and cover.
   c) Read the absorbance by pressing the READ key and record.

> **NOTE**: If your samples have high turbidity, it may affect the results. Measure and record the absorbance of a sample without reagent added (shake the sample well before measuring). Subtract this value from the absorbance readings you obtain for each sample you measure with reagent. This will factor out the effect of sample turbidity on your results.

Prepare a Calibration Curve and Convert Absorbance to mg/L

1. Make an absorbance versus concentration graph on graph paper:
   a. Draw the y- axis (vertical) and label it "absorbance." Mark this axis in increments from 0 to the top of the graph paper (the more spread out your graph, the more accurate).
   b. Draw the x- axis (horizontal) and label it "concentration: mg/L as P." Mark this axis with the concentration of the standards.
2. Plot the absorbance of the standard concentrations on the graph.
3. Draw a "best fit" straight line through these points. The line should touch (or almost touch) each of the points. If it does not, the results of this procedure are not valid. If just one point is far off the line, run that standard again. Run the entire set of standards again if more than one point is far from the line. See examples of standard curves below.

Phosphorus Standard Curve



Acceptable Not Acceptable

1. Convert absorbance of field sample readings of each field sample to mg/L: Locate the absorbance on the y- axis, read horizontally over to the curve, and then down to read the concentration in mg/L as P.

2. Record the concentration on the "Chemical Data Reporting Sheet." NOTE: The detection limit for this test is 0.01 mg/L. Report any results less than 0.01 mg/L as "<0.01." Round off all results to the nearest hundredth.

Important Note: If you have samples that have a higher concentration than any of your standards, make a standard that is a higher concentration to extend your graph.

Conductivity

Background

What is Conductivity? Conductivity is a measure of the ability of water to pass an electrical current. Conductivity is affected primarily by the geology of the area through which the water flows and the presence of naturally occurring electrolytes, such as salts. It is measured as micromhos/centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm).

Why measure Conductivity? Each river tends to have a relatively consistent range of conductivity that, once established, can be used as a baseline for comparison with regular measurements of conductivity. Significant changes in conductivity could then be an indicator that a discharge or some other source of pollution has entered a river. A failing septic system, heavy metals, chloride, phosphates and nitrates would all raise the conductivity while an oil spill would lower it.

Levels: The conductivity of freshwater rivers ranges greatly from 50-1,500 µs/cm. Estuaries have a higher conductivity than freshwater due to their salinity.

Analysis

Tiers 2-3 — Conductivity

Method	Range	Increments	Company/Cat.#
Measured directly using a Corning pocket meter	0-2000 microsiemens/cm	1	WVR #34106-838

Procedure

1. Calibrate the meter (see instructions below).
2. Thoroughly wash a 50 ml beaker and rinse three times with de-ionized water.

3. Pour approximately 25 mL of sample into a beaker.
4. Remove the protective cap from the tip of the meter and turn the meter on.
5. Rinse the probe end of the meter with de-ionized water.
6. Put the probe into your sample beaker to a depth of about 1.5 inches. Do not immerse the meter above the level of the display.
7. Stir gently and wait a few seconds to allow the display to stabilize. Read sample.
8. Rinse the probe with de-ionized water.
9. Dispose of your sample (do not return it to the sample bottle).
10. Repeat steps 1-5 until all samples are read. Make sure to rinse the flasks with de-ionized water between each sample.

To Calibrate the Meter

Immerse the probe into a known solution and adjust the reading using the pin hole located next to the pocket clip on the back on the unit. To make the known solution, mix 10 mL of NaCl Standard Solution (1000 µS/cm- Hach # 14400-14) with 90 mL of de-ionized water. Its conductance should be 100 µS/cm.

Turbidity

Background

What is Turbidity? Turbidity is a measure of the scattering of light by particles suspended in the water. Turbidity is one way to measure water clarity. Turbidity is expressed in terms of nephelometric units (NTU' s) as it is measured by a nephelometer or turbidimeter.

Why measure Turbidity? Turbidity is important as an indicator of suspended sediment and its effects on sedimentation over time and distance. Elevated turbidity can affect the river ecosystem in a number of ways, including higher water temperatures, reducing available oxygen. Suspended materials can clog fish gills and provide a place for harmful microorganisms to breed and carry attached pollutants. Particles settling can decrease the amount and type of habitat available for aquatic macroinvertebrates.

Levels: Background turbidity levels vary from < 1.0 NTU to > 50 in larger rivers after a rainfall.

NYS DEC Standards: For all classes, "no increase that will cause a substantial visible contrast to natural conditions."

Analysis

Tiers 2-3 — Turbidity

Method	Range	Increments	Company/Cat.#
Measured directly using a portable turbidimeter			Hach 2100P #46500-00

Procedure

Choose and Orient the Sample Cell

Select one of the three sample cells provided with the meter. Use this cell for all of the samples. Each side of this sample cell may have different optical properties that will yield different turbidity readings. To correct for this, test each cell by rotating it 45 degrees and recording the turbidity reading after each rotation. Place a mark on the side that yields the lowest turbidity reading. Each time you use this cell to measure a sample, place it in the meter with this mark aligned with the raised mark on the meter. Follow the directions in the manual to find the proper orientation of all three sample cells.

Calibrate the Meter

The meter is calibrated at the factory when it is new. After your first sampling season, you should calibrate the meter at the beginning of every season. To calibrate, use formazin solution.

a) Make up formazin dilutions of 800, 100, and 20 NTU using the 4000 NTU stock solution as described in the Hach manual (provided with the meter).

b) Calibrate the meter using steps in the Hach manual.

c) Keep a record of the dates that you calibrate the meter.

Determine the True Value of the Gelex Standards

At the beginning of every sampling season, after calibrating the meter, determine the NTU value of the Gelex standards again. The first time you use the meter, you do not have to calibrate it, but you must determine the NTU value of the Gelex standards. These are used every time you use the meter to check if it has drifted from its calibration.

a) Measure the turbidity of each of the three Gelex standards, following the procedure in the Hach manual.

b) Record these values *in pencil* in the white diamonds on each standard.

Measuring Turbidity

1. Check the calibration of the meter: measure the NTUs of the Gelex standards. If they are off by more than 5% from the values you marked after the last calibration you will need to calibrate the meter using the calibration procedure outlined above.

2. Allow samples to come to room temperature.

3. For the first sample, prepare the sample cell by applying a thin coating of silicone oil with a soft, lint-free cloth. (This masks any scratches, which the meter would read as turbidity).

4. Gently turn over the sample bottle several times to mix the sample. Do not shake the sample – air bubbles are read by the meter as turbidity.

5. Gently and slowly fill a sample cell to the fill line (15 mL) with a portion of the sample. If you must handle the sample cell, handle it only at the top to avoid smudging the lower part of the cell (which the meter would read as turbidity). Cap the cell.

6. Check the sample in the cell for air bubbles and condensation. If there are air bubbles, uncap it and let it sit for a few moments before measuring. If the air bubbles persist, try refilling the sample cell more slowly. If they still persist, use the degassing kit to remove them. If condensation forms on the outside of the cell, wipe it off with a Kimwipe or lint-free cloth. If it immediately reforms, allow the sample to come to room temperature.

7. Set the meter to "auto range" (see page 28 of the Hach manual).

8. Insert the sample cell into the turbidimeter and line up the orientation mark on the cell with the raised tab on the meter. Record the reading in the

"replicate 1" column of the "Chemical Data Reporting" sheet. Remove the sample cell from the meter and pour it out.

9. Rinse the sample cell 3 times with de-ionized water and shake out remaining water drops inside the cell.

10. Repeat steps 4-9 using the **same sample**: Record the reading in the "replicate 2" column of the "Chemical Data Reporting" sheet. Remove the sample cell from the meter. Calculate the average of the two readings and record in the average column. Repeat this for every sample.

NOTE: If the turbidity of the sample is above 40 NTU, it must be diluted and read again. Follow the instructions in the Hach manual to do this.

Sections on the following indicators will be completed in later versions of this manual:

Chloride

Ammonia-Nitrogen

Total suspended Solids

Total Settleable Solids

Fecal Coliform Bacteria

Chemical Data Reporting Sheet

Name(s)_____ School/Group_____

Stream _____ Date(s) Sampled _____ Site_____

Today's weather conditions: ☐ clear ☐ cloudy ☐ light rain ☐ heavy rain ☐ other_____ Temperature: Air ____°C

In the past 24 hours, there was: ☐ light rain ☐ heavy rain ☐ snow ☐ other:_____ Water ____°C

Flow (indicate fast reading here and calculated reading below): ☐ high ☐ medium ☐ low

	Field Replicates							
	1		**2**		**Average**	**Tier**	**Notes**	**Circle Method Used**
Lab Duplicates	*1*	*2*	*1*	*2*				
pH								pH paper (1-14, by 1), color comparator, pocket meter (1-14, by 0.1), meter
Alkalinity (mg/)								*Sulfuric Acid Titration*, LaMotte microburet, *Sulfuric Acid Double Endpoint Titration*, HACH digital titrator
Chloride (mg/l)								*Silver Nitrate Titration* LaMotte Microburet, HACH drop count:
Turbidity								Nephelometer
Conductivity								meter or other:
Nitrate-Nitrogen as N or NO_3* (circle one)								*Zinc Reduction*; LaMotte color comparator. *Cadmium Reduction* HACH colorwheel or LaMotte color comparator, HACH DR700 or 800 colorimeter or spectrophotometer. Standard curve? yes no
Ortho-Phosphate as PO_4 or P** (circle one)								*Ascorbic Acid Reduction*, HACH color wheel (0-5 by 0.5 ppm), LaMotte color comparitor with axial reader, HACH DR700 or 800 series colorimeter or spectrophotometer. Standard curve? yes no
Lab Duplicates	*1*	*2*	*1*	*2*				
Dissolved Oxygen (mg/l)								*Modified Winkler Titration*: LaMotte micro-buret, HACH drop count, HACH digital titrator
Dissolved Oxygen (% Saturation)								
Other: add units)								

Describe your QaQc procedures here:

NOTE: *Nitrate-Nitrogen: report as NO_3-N (NO_3-N = NO_3/4.4) **Orthophosphate: report as P (P = PO_4/3)

Interpreting Your Chemical Data: Some guidelines

Data interpretation is the most important part of your monitoring program. Quite often due to time constraints and other factors, programs end up with many data sheets accumulating in the drawer. Here are a few ways to look at your data to begin to tell the story of your watershed. Keep the data you collect over time; the story will begin to unfold with each sampling event.

Start by making a simple table to be able to view your results in one place, rather than flipping through multiple sheets. Then look at your physical surveys. Briefly describe how the physical and habitat conditions of your site may have contributed to your results. Pay careful attention to flow, weather, and time of year. Note these observations on your data table.

Below are some ways to approach and organize your thinking:

- Review your study design question. Display your data in graphs that will help you to assess the information you gathered. Does your data answer your question? What story does it tell about your question? What gaps are there in your information?
- Compare your results to the NYS DEC water quality standards and guidelines. Do any indicators violate standards? The guidelines?
- Compare sites. Graph each indicator on a separate graph with your sites in order of upstream to downstream. Are there any trends? Throughout the years, are any sites consistently higher or lower than other sites?
- Graph each site over time. Do you see any changes? Do seasonal patterns appear?

Follow-up Study

Discuss these questions as a way of deciding what the next steps are:

- What further questions arose from analyzing your results?
- Are there any areas to check more carefully in the future?
- Are there any more detailed studies you would like to conduct?

The “Data Analysis Worksheet—Water Quality Standards Survey” provides an example of one way to analyze results from a water quality standards survey.

Advanced Analysis: Loading

Loading is a concept that is gaining importance for rivers. Loading is the amount of a pollutant that passes by a point in the stream per unit of time.

Currently, the U.S. EPA is working with states to incorporate loading into their management and regulatory systems. States may have to adopt a total maximum daily load (TMDL) for each of their rivers. In other words, they will have to limit the accumulated total of a load throughout the day for selected pollutants.

Loading could be important to consider in your data analysis, depending on your study design. Loading can help you factor out the effect of stream flow on pollutant concentrations. As an example, consider an impact assessment study of a horse ranch conducted by Millbrook High School students in November 1998. There was a 3-fold increase in the phosphate concentration as you moved from the upstream to the downstream site (indicating an impact). However, the impact of the ranch became even more apparent by calculating loading values. There was a 7-fold increase in flow as you moved from the upstream to the downstream site. This means there must have been a 21-fold difference in phosphate loading!

You can calculate the loading for the indicators you measured by using the equation below:

LOADING (grams / day) = CONCENTRATION (mg / L) x FLOW (m3 / sec) x 86,400 *

*(there are 86,400 seconds in 1 day)

To calculate flow, see the "Flow" worksheet in the "Physical Survey" section of this document.

Rationale for the formula used to calculate loading:

LOADING = MASS / TIME

CONCENTRATION = MASS / VOLUME FLOW = VOLUME / TIME

so LOADING = CONCENTRATION x FLOW

$$\frac{(Concentration)mg}{liter} \text{ X (FLOW) } \frac{\text{m}^3}{\text{sec}} \text{ X } \left(\frac{1000liter}{1\text{m}^3} X \frac{1gram}{1000mg} X \frac{86{,}400\text{sec}}{1day} \right) =$$

CONCENTRATION x FLOW x 86,400 = LOADING in grams / day

Data Analysis Worksheet – Water Quality Standards Survey

Name(s) _____

School/Group _____ Date _____

Stream_____ Site _____

According to your data, does the stream violate DEC water quality standards according to the classification of your stream site? Describe.

Does the stream exceed guidelines for a healthy stream? Describe.

Are any of the designated uses of the stream site (drinking water, swimming, aquatic life, etc.) impaired? Indicate the level of impact. (Remember that "aquatic life" is a use. Consider what your benthic data tells you about the level of impairment for this use).

Are any other uses, such as recreation or aesthetics, impaired? To what extent?

Data Analysis Worksheet – Water Quality Standards Survey (continued)

What might be causing the impairments? Include type of pollutant/impact and possible sources. Consider how the physical/habitat conditions may have influenced your water chemistry and macroinvertebrate results.

What else does your data tell you about your stream?

List some ideas for follow-up, such as further questions to study, protection or restoration actions, stewardship projects, etc.

NOTES:

SAFETY

Collecting and analyzing all types of samples requires certain precautions and safety measures. Here are recommended safety procedures to be followed by people collecting and analyzing samples:

- Collect samples with a partner.
- *If you are in doubt as to your ability to safely collect a sample, don' t do it!* Be aware of your own physical limitations and the difficulty collecting samples at certain locations under certain conditions. Don' t collect under difficult conditions.
- Let someone know where you are going and when you expect to return.
- Be careful when pulling off on the side of the road and leaving your car, so as not to endanger yourself or create a traffic hazard.
- Consider leaving your wallet and keys in or around your car so you won' t lose them in the river.
- Bring a stick or pole along for balance when climbing down steep banks or wading.
- Watch out for poison ivy—it likes stream banks!
- High flows can turn even the most placid water into a raging torrent. Don' t attempt to collect a sample if you feel the least bit of risk. *Avoid dangerous situations.* If there is an upstream dam that periodically releases water, the water level may rise swiftly. Be aware of the timing of such releases and avoid getting caught in the middle of the stream during a release. Inform the dam operators of your collection. If there is a conflict, ask if the release can be changed to accommodate you.
- Collecting macroinvertebrate samples requires wading. *Wear waders or at least sturdy soled shoes!* Bring a towel and a dry, warm change of clothes. If any of the people wading in the stream are not strong swimmers, the use of a personal floatation device is strongly recommended.
- If sampling below a wastewater treatment plant, or in waters known to be polluted, wear rubber gloves and wash your hands after exposure.
- If the stream bed is soft and mucky, test it with a pole or stick before putting your full weight on it.
- Use latex gloves and protective eyewear when working with all chemicals and pay special attention to the information included with your reagents.
- Make sure to dispose of waste correctly. **The cadmium in the tier 3 nitrate test has to be disposed of as a hazardous waste**.
- Make sure to read the material safety data sheets (MSDS) that come with all of your reagents.

NOTES:

QUALITY ASSURANCE QUALITY CONTROL (QAQC)

Regardless of which tier you choose, it is important to perform checks and measures that allow you to assess the quality of the information you collect. This will help others to ascertain how much to rely on the accuracy of your data and is a good exercise in the scientific method for students.

General Tips

Glassware Maintenance

Make sure ALL glass and plastic ware is maintained correctly. It should be washed with non-phosphate soap, scrubbed with a bristle brush, and rinsed with warm tap water until soap disappears (about 6 times. It should then be rinsed 3 times with de-ionized water. (De-ionized water is more pure than distilled water and thus is better to use for final rinsing). Phosphorus glassware must be washed without soap using 6N HCl and then rinsed 3 times with de-ionized water. When handling glassware, it should be held from the outside, avoiding contact with the inside.

Reagents

- Replace reagents every year. Outdated reagents will not be as effective.
- Make sure <u>all</u> the reagents in a packet are emptied into your sample and the amount of time listed for the reaction is kept to carefully.

Calibrate Your Meters

Follow the calibration procedures recommended in the instructions for your equipment every time you sample. Fresh standard solutions should be used for calibration. Check with the companies your purchase standard solutions from to make sure you know how long a shelf life they have.

Holding and Handling Indicators

Make sure to follow the instructions included with each indicator with each indicator at the beginning (overview) of the chemistry section.

Analysis

This section lists different ways to perform quality assurance. Depending on your data use, you would perform a combination of some or all of these. Choose a combination of QaQc procedures that works for your purposes. The most basic would be to have at least 1 *field replicate* per sampling day, and 1 *lab duplicate* per sampling day (see

explanations of these terms below). More stringent would be to have at least 1 or more replicates and a duplicate for each site as well as unknowns and *split samples* measured.

Benthic Macroinvertebrate Analysis

Sorting: If using live analysis, make sure your sorters don' t just select the larger, more active organisms. The subsample should represent the entire sample. Make sure smaller organisms such as midge, black fly, and small mayfly larvae are not overlooked.

Taxonomic Verification: Preserve samples and have an independent agent (such as a representative from an university or research organization) check the identification.

Replicates: Collect 2 composite samples for each site and compare your results.

Chemical Analysis

Knowns: Make up a sample using standard solutions or ask a local college or lab to prepare samples of known concentrations. Analyze these samples to make sure your methods yield the known concentration. Teachers can prepare known samples for their students to test.

Unknowns: Have an outside lab prepare samples where they know the concentrations but your testers do not. Teachers can prepare samples for their students to test without telling students what the concentrations are ahead of time.

Split Sample: Take a sample and split it in half. Send one half to another group or outside lab to analyze. Compare the results.

Lab Duplicates: Split each sample into two or more sub-samples to run analysis more than once, using the water from the same sample jar. Compare results.

Field Replicates: Take more than one sample at a site and compare the results between them. You can also have another group take a sample at the same time and have them analyze it to compare results.

Data for DEC Use

HBRW has worked with NYS DEC Division of Water to ensure that the protocols in this manual are designed to yield data that NYS DEC can use for their watershed management efforts. DEC will incorporate data from volunteer monitors in the HBRW network into their "Waterbody Inventory" (WI). Part of the WI is the "Priority Waterbody List" (PWL) which documents information about water bodies with known water quality impacts.

Waterbodies listed in the PWL are described by their "severity of use impairment." The severity of use impairment depends on the how much the known water quality impacts are affecting a waterbody's uses:

PWL Severity of Use Impairment

PRECLUDED: *Frequent* water quality / quantity conditions and / or habitat degradation *prevent all aspects* of the waterbody use.

IMPAIRED: *Occasional* water quality / quantity conditions and / or habitat degredation *periodically prevent* the use of the waterbody, or *limit some aspects* of the uses. Or *frequent* water quality / quantity conditions and / or habitat degredation *discourage* the use of the waterbody.

STRESSED: Waterbody uses are not significantly limited but *occasional* water quality / quantity, conditions and / or habitat *degradation periodically discourage* the use of the waterbody.

THREATENED: Water quality currently supports waterbody uses and the ecosystem exhibits no obvious signs of stress. However, *existing or changing land use patterns* may result in restricted use or ecosystem disruption, monitoring *data reveals increasing contamination*, or the waterbody is a *highly valued resource* deemed worthy of special protection.

Remember that aquatic life is considered a waterbody use for all class A-C waters. Thus if a condition impacts the macroinvertebrate population in a class A-C waterbody, a waterbody use is impacted. The 4 levels of use impairment in the PWL described above roughly correspond to the 4 levels of impact used in the Major Group Biotic Index and EPT Richness metrics from the tier 2 BMI analysis in this manual:

PWL Level of Use Impairment	**Biotic Index/EPT Richness Level of Impact**
Precluded	Severely Impacted
Impaired	Moderately Impacted
Stressed	Slightly Impacted
Threatened	No Impact

Waterbody use impairments listed in the PWL fall under one of three possible levels of "Problem Documentation" depending on how well-founded the data are that determined the impairments:

PWL Level of Problem Documentation

KNOWN: Water quality studies have been completed and *conclude* that the use of the waterbody is restricted to the degree indicated by the listed severity.

SUSPECTED: Anecdotal evidence, public perception and/or specific citizen complaints *suggest* that the use of the waterbody maybe restricted. However, water quality studies that establish an impairment have not been completed or there is conflicting information.

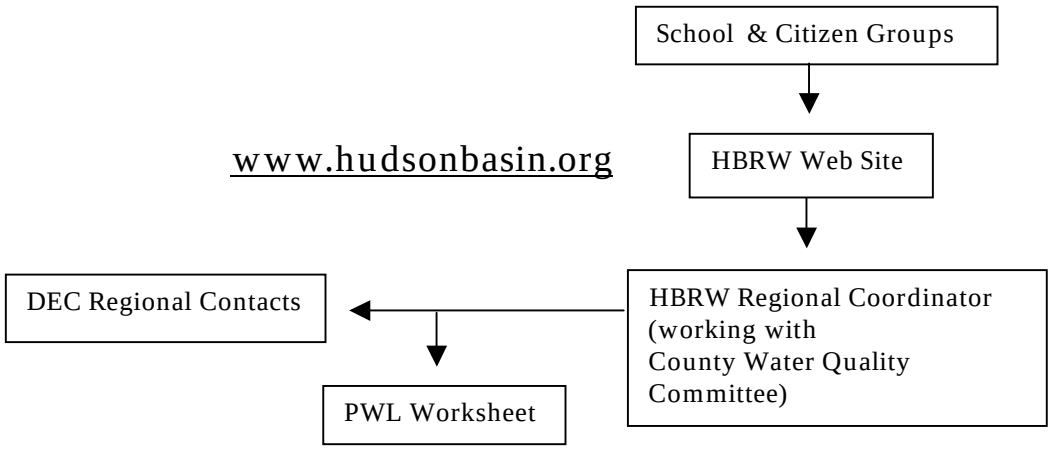
POSSIBLE: Land use or other activities in the watershed are such that the use of the waterbody *could be affected*. However, there is currently very little, if any, documentation of an actual water quality problem.

These levels of problem documentation roughly correspond to the tiers in this manual (see Step 3, "Define Your Data Uses and Users," in the "Study Design" section of this manual for more information):

Tier 1 studies can document "possible" problems that need further verification. Tier 2 can document "suspected" problems, and perhaps even "known" problems, if confirmed by tier 3 methods or DEC. Tier 3 studies provide documentation of "known" problems.

Reporting Your Data

Data flows from HBRW groups to DEC via the HBRW website and HBRW Regional Coordinators. Groups input their data into the website, and/or send their data to their Regional Coordinator. Regional Coordinators review the data, perhaps ask groups for clarification, and use it to fill out DEC's PWL Worksheet (included at the end of this section). The HBRW Regional Coordinator should work closely with their County Water Quality Committee and DEC regional contact to follow up on questions, concerns, and verifications.



NYS DEC Division of Water
Priority Waterbodies List (PWL) Worksheet

Note: Contact your HBRW Regional Coordinator for detailed instructions. Can be filled out without chemical and biological data. Also can be used to document non-impacted conditions.

Date: _____

WATERBODY LOCATION INFORMATION

Segment ID_____

1. Waterbody Name _____
2. Waterbody Type (check) ☐Stream ☐River ☐Lake ☐Reservoir ☐Estuary
3. Water Index Number (WIN) _____
4. Drainage Basin and Sub-basin _____
5. Hydrologic (Watershed) Unit Code __ __ __ __ __ __ __ __ / __ __ __
6. Flow Category (if river segment) _____
7. Affected Length/Area _____ Units (mi, acres)_____
8. Describe Waterbody Segment _____
   _____
9. Waterbody Classification _____
10. Country (primary) _____
10a. Additional Countries _____
11. NYSDEC Region _____
12. Quad Map_____
12a. Quad Num __-___-__ More Quads?_____

WATER QUALITY PROBLEM INFORMATION

13. **Use Impairment/Severity of Water Quality Problem** *Select all that apply*

Waterbody Uses	**Problem Documentation**			
Indicate precluded (**P**), impaired (**I**), stressed (**S**) or threatened (**T**)				
		Known	Suspected	Possible
Water Supply (Class A, AA, GA)	_____	_____	_____	_____
Shellfishing (Class SA)	_____	_____	_____	_____
Public Bathing (Class B, SB or above)	_____	_____	_____	_____
Fishing Consumption	_____	_____	_____	_____
Aquatic Life (Class C, SC or above)	_____	_____	_____	_____
Recreation	_____	_____	_____	_____
Aesthetics	_____	_____	_____	_____

14. **Type of Pollutant(s)** *Select all that apply*. Indicate as known (**K**), suspected (**S**), or possible (**P**). Circle the one primary pollutant type.

_____ **Unknown Toxic**	_____ **Other Inorganics**	_____ **Water Level/Flow**
_____ **Pesticides**	_____ **Nutrients**	_____ **Pathogens**
_____ **Priority Organics**	_____ **Acid/Base (pH)**	_____ **Oil and Grease**
_____ **Nonpriority Organics**	_____ **Silt (sediment)**	_____ **Aesthetics (float, odor, etc)**
_____ **Metals**	_____ **Oxygen Demand**	_____ **Other (describe):**
_____ **Ammonia**	_____ **Salts**	
_____ **Chlorine**	_____ **Thermal Changes**	

15. **Source(s) of Pollutant(s)** Select all that apply. Indicates as known (**K**), suspected (**S**) or possible (**P**). Circle the one primary source type.

POINT SOURCES

_____ Industrial	_____ Combined Sewer Overflows (CSOs)
_____ Municipal	_____ Storm Sewers
_____ Private System	

NONPOINT SOURCES

____ Atmospheric Deposition	_____ Resource Extraction (mining)	____ Petroleum & Chem Leaks /Spills
____ Contam/Toxic Sediments	_____ Landfills/Land Disposal	____ Deicing (Storage/Application)
____ Agriculture	_____ Failing On-site Septic Systems	____ Source Unknown
____ Silviculture	_____ Hydro/Habitat Modification	____ Other (describe):
____ Construction	_____ Stream bank Erosion	
____ Urban Runoff	_____ Road bank Erosion	

16. **Waterbody Problem Description/Documentation/History/Notes**

Attach additional pages as necessary

The narrative description should contain any and all information about the waterbody segment and its water quality problem/impairment including 1) a detailed description of the waterbody and surrounding area, 2) examples/instances of *specific* water use impairments, 3) details regarding the specific pollutant/source of pollutant and relationship to the impairment, 4) any activities currently underway or planned, and 5) references for specific reports, studies, monitoring data and/or other documentation. (see worksheet instructions for further guidance)

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____ **Next Update:** _____

17. **Waterbody Nominated/Form Completed By:**

Name: _____
Affiliation: _____
Address: _____
_____
Phone: _____

Stewardship Project Ideas

Once you've gotten to know your watershed, learned about your river's uses, values and threats, and examined its physical habitat, benthic macroinvertebrate community and/or water quality, there are many activities you can do to protect and/or improve your river's health. The following list of possible stewardship projects are just suggestions to get you inspired. If you come up with other ideas, please share them with your HBRW Regional Coordinator so we can pass them on to others.

- *Conduct a river clean up* to pick up trash along the banks of a section of your river. Contact Scenic Hudson (845-473-4440) to coordinate with their "Great Hudson River Sweep" event that they hold every spring.

- *Stencil storm drains* in your neighborhood that drain into your river. Stencils with messages such as "Dump No Waste, Drains to River" may be available from your county Soil and Water Conservation District, Environmental Management Council, or Planning Department.

- *Produce a brochure* describing your river and its watershed, explaining what people can do to help protect it. Contact your HBRW Regional Coordinator for examples of existing public information brochures.

- *Organize a community "Stream Team"* to do regular shoreline surveys along a length of your river to keep an eye on potential problems that might threaten your river's health.

- *Build an interpretive trail* along your river to provide local residents with an opportunity to learn more about its natural and cultural history while hiking along its shoreline.

- *Survey local residents* in your watershed to find out if they carry out river-friendly homeowner practices, such as proper septic system maintenance, natural lawn and garden care, water conservation, and use of non-toxic household products. Collect information about how to adopt these practices and provide them to your community members.

- *Plant native riparian trees*, shrubs and herbaceous plants in areas along your stream where the banks are bare and eroding. Contact your local Soil and Water Conservation District for technical advice and plant sources.

- *Put up river identification signs* at road crossings or public parks to let the public know of your river and that there are people out there who care about its well-being. (You'll need permission from the agency that maintains the road or park). Hold an art contest for choosing the design to encourage greater involvement in the project.

- *Organize a "Test Your Water Day"* in your town where community residents can bring in samples of their drinking water or samples from their backyard ponds and streams for you to test. Make it a part of a regular, well-attended community event to increase your chances of a good turnout.

- *Keep track of new developments* in your town to make sure they are following required DEC and local government regulations for managing storm water runoff.
- *Make presentations at public meetings*, to town boards and planning boards, to encourage them to consider healthy rivers and clean water in their permitting decisions.

Using Data at the Local Level

Remember that often the most effective use of your data can be at the local level. Share your data with the leaders and landowners of the towns, cities and / or counties that comprise your watershed; they are the true resource managers. Schedule a time for your group to make a presentation at a town meeting so you can share what you've learned about your river with members of your community. Municipal planning boards make land use decisions on a regular basis that may affect your river. Presenting information to your planning board can help encourage them to consider your river's protection when they make decisions about developments in the watershed.

EQUIPMENT LIST

July 2000

Parameter: Alkalinity

Tier	Company	Item	Catalog #	*Each $
2	LaMotte	total alkalinity microburet kit & reagents	4491-DR	$21.10
2	LaMotte	refill reagents - for 4491-DR	R-4491-DR	$9.25
3	HACH	alkalinity digital titrator kit & reagents	20637-00	$153.90
3	HACH	alkalinity standard ampules	14278-10	$20.95

Parameter: Bacteria Contact River Network for info 802-223-3840

Parameter: Chloride

2	HACH	chloride drop count kit & reagents	1440-01	$27.80

Parameter: Conductivity

2, 3	HACH	conductivity standard solution, 100ml	14400-42	7.20
2, 3	VWR Scientific	conductivity meter, Corning PS17	34106-838	62.00

Parameter: Ammonia-Nitrogen (NH_3-N)

2	LaMotte	salicylate kit & reagents	3304	49.95

Parameter: Nitrate-Nitrogen (NO_3-N)

2	LaMotte	zinc reduction kit & reagents	3354	39.95
3	HACH	nitrate reagents for DR/890	21061-69	22.00
3	HACH	nitrate standard, 100mg/L NO_3-N, 20 2 mL ampules	1947-20	20.25

Parameter: Orthophosphate (PO_4)

2	HACH	orthophosphate color wheel kit & reagents	2248-00	54.50
2	LaMotte	orthophosphate axial reader kit & reagents	3121	69.95
3	HACH	orthophosphate reagents for DR890	21060-69	17.30
3	HACH	phosphate standard, 3 mg/L PO_4 (1 mg/L as P), 946 mL	20597-16	17.25

Parameter: NO_3-N and PO_4-P

3	HACH	DR/890 Colorimeter	48470-00	749.00
3	HACH	sample cells, 10 ml, pkg 6 (you may need 2-3 pkgs)	24276-06	15.50
3	HACH	TenSette Pipet, 1 to 10 ml	19700-10	154.00
3	HACH	volumetric flask, 100 ml, class A	14574-42	20.00
3	HACH	gloves, latex, small	25904-01	22.50
3	HACH	HCl, 6N, 500 ml	884-49	11.30
3	HACH	kimwipes	20970-00	3.25

Parameter: NO_3-N, PO_4-P and BMI

3	HACH	wash bottle, 500 ml (for DI water and ETOH)	620-11	4.25

Parameter: Dissolved Oxygen

2	LaMotte	oxygen microburet kit & reagents	5860	37.00
3	HACH	oxygen digital titrator kit & reagents	20631-00	190.75

Parameter: pH

Tier	Company	Item	Catalog #	Each $
1	VWR	pH strips	EM-9590-3	
2, 3	HACH	pH pocket pal	44350-00	42.00
2, 3	HACH	pH 4 buffer, 500 mL	22834-49	6.75
2, 3	HACH	pH 7 buffer, 500 mL	22835-49	6.75

Parameter: Settleable Solids

1, 2, 3	HACH	Imhoff settling cone	2067-00	23.50
1, 2, 3	HACH	stand for Imhoff cone	572-00	54.00

Parameter: BMI

1, 2, 3	WildCo	net, explorer, 18", 600 micron, 40" fixed handle	425-JE54-600	95.00
3	Ben Meadows	forcepts, curved-fine point	300235	3.26
3	Herbach & Rademan	lighted magnifier	MG-104	69.95
3	QC Services	dissecting scope, 56X, built-in light source (optional)	MCB10	600.00
3	VWR Scientific	sieve, #28 U.S. standard	57320-646	28.40
3	VWR Scientific	white trays, 18"x13"x3/4"	62686-363	7.01
3	VWR Scientific	labeling tape, white	36425-023	2.03
3	VWR Scientific	petri plates, 4 compartment, case 500	25380-069	148.07
3	VWR Scientific	glass vials (for preserving), poly-seal caps, case 500	66021-533	133.45
3	VWR Scientific	ethanol, 95%, 4 L (VWR or local Hardware Store)	mk701808	77.50
OPT	Ben Meadows	multiplate samplers	244284	26.00
OPT	Brock Optical	The Magiscope, 20x magnification, with "Lumorod"	model 70	159.00
OPT	Brock Optical	field case for Magiscope		24.00
OPT	CT Valley Biological	magnifying specimen box, 1"	AP36	0.84
OPT	CT Valley Biological	magnifying specimen box, 1.5"	AP37	1.68
OPT	CT Valley Biological	folding pocket magnifier	AP38	2.40
OPT	CT Valley Biological	mini aquarium	A2118	15.00
OPT	CT Valley Biological	deep well projection slides	AP120	45.00
OPT	Nylon Net	seine, 3/16" mesh, 10'x4'	AS3164	23.20
OPT	WildCo	sieve bucket	190-E20	65.30

Parameter: General

1, 2, 3	Ben Meadows	tape measure, 100"/30m	122632	30.25
1, 2, 3	Dick's Sporting Goods	hip waders		19.99
1, 2, 3	HACH	thermometer, (alcohol filled) 20-105^{0}C, armored	1877-01	12.50
2, 3	HACH	goggles, safety, vented	25507-00	5.00
2, 3	HACH	bottles, 250 mL, pkg 12 (for sampling and waste)	14724-56	30.00
OPT	VWR Scientific	gloves, neoprene heavy duty	EW9-430	27.48
2, 3	HACH	de-ionized water, 4 L	272-56	

OPT = Optional *Prices are from 1999 catalogs; current prices may be higher

Company Phone Numbers	
Ben Meadows 1-800-241-6401	Herback & Rademan 1-800-848-8001
Brock Optical 1-800-780-9111	LaMotte 1-800-344-3100
CT Valley Biological 1-800-628-7748	Nylon Net 1-800-238-7529
Dick's Sporting Goods 845-297-4767	VWR Scientific 1-800-821-0800
HACH 1-800-227-4224	WildCo 1-800-799-8301