1. TITLE AND APPROVAL PAGE

Quality Assurance Project Plan for StreamWatch: Volunteer Water Quality Monitoring Program Chemical Action Teams

Stony Brook-Millstone Watershed Association

January 17, 2008

Program Manager	Signature Beth April Name / Date Beth April 1/17/08
Program QA Officer	Signature Beth April Name / Date Beth April, 1/17/08
NJDEP Volunteer Water Quality Monitoring Coordinator	Signature D Dankerfloot * Name / Date 1/17/08 Tier C
NJDEP Project Manager	Signature N/A Name / Date
NJDEP BFBM QA Reviewer	Signature [illegible] Name / Date 1/17/08

This document was prepared to meet Quality Assurance/Quality Control (QA/QC) requirements for Stony Brook-Millstone Watershed Association's (SBMWA) Chemical Action Teams (CATs), the volunteer chemical monitoring part of its existing StreamWatch Program. It documents the standard operating procedures and quality control methods used in the program to deliver reliable and accurate data. This QA/QC work plan is prepared using as reference, the United States Environmental Protection Agency's *US EPA Region 2 Guidance for the Development of **Quality Assurance Project Plans** for Environmental Monitoring Projects* (January 22, 2004). This document has been prepared in an effort to document the QA/QC practices used by SBMWA.

2. TABLE OF CONTENTS

3. DISTRIBUTION LIST

Below are the names and telephone numbers of those receiving copies of this QAPP.

- NAME, TITLE, Office of Quality Assurance, New Jersey Department of Environmental Protection (NJDEP) – (609) 292-3950
- Debra Hammond, Chief, Bureau of Water Quality Standards and Assessment, NJDEP Water Monitoring and Standards – (609) 777-1753
- Danielle Donkersloot, Volunteer Water Quality Monitoring Coordinator, NJDEP Division of Freshwater and Biological Monitoring – (609) 633-9241
- Appropriate representative of agencies that request data from the StreamWatch Program.

4. PROGRAM/TASK ORGANIZATION

A. Program Manager

Beth April, Watershed Specialist, of the Stony Brook-Millstone Watershed Association's (SBMWA) Watershed Management Team, performs management of the StreamWatch Program. The StreamWatch program consists of three areas: Biological Action Teams (BATs), River Action Teams (RATs), and Chemical Action Teams (CATs). Biological Action Teams collect a sample of benthic macroinvertebrates three times a year. River Action Teams walk a stream segment to perform visual and habitat monitoring 4-6 times per year. Chemical Action Teams perform chemical sampling on a bi-weekly basis. The BATs and RATs programs are discussed in further detail in separate Quality Assurance Project Plans. Ms. April is responsible for recruiting, training, and retaining volunteers, quality assurance, data management and analyses, and project planning for StreamWatch. Jennifer Coffey, Director of Watershed Management, provides overall direction for SBMWA's Watershed Management Team.

B. Stream Monitors

Teams of stream monitors, who are responsible for 36 specific sampling sites within the Millstone River Watershed, perform data collection (see Appendix A: Map of SBMWA StreamWatch sites for locations). The monitors are trained under a program developed by SBMWA and set forth in the attached document, *StreamWatch Handbook: Volunteer Water Quality Monitoring Program*. This document also sets forth the study design and standard operating procedures under which the field aspects of this program are performed.

The basic tasks performed by the Stream Monitors are the sampling and analysis of water quality using LaMotte field test kits. Water quality parameters being analyzed include temperature (air and water), pH, turbidity, nitrate-nitrogen (nitrate-N), orthophosphates, and dissolved oxygen. During each sampling event, which is performed on a bi-weekly basis [every other weekend (Friday, Saturday, or Sunday) between 10:00 am and 12:00 pm], the monitors also document qualitative data and observations, such as weather and visual stream conditions. A broader discussion of field sampling and analysis procedures is presented in Sections 10 and 11 of this document.

C. Supporting Resources

Additional StreamWatch Program volunteers perform an assortment of administrative and technical functions, including data management, technical research, data analysis, and quality control. Summaries of the current supporting resources that are essential to this program follow:

- A StreamWatch volunteer performs the data entry of the bi-weekly results from the StreamWatch monitors using a customized Microsoft Access software program maintained at the SBMWA office.
- SBMWA plans to investigate the possibility of a StreamWatch volunteer(s) performing annual field audits of volunteers to ensure proper sample collection and analytical techniques.

5. PROBLEM DEFINITION/BACKGROUND

A. Problem Statement

The New Jersey Department of Environmental Protection (NJDEP), in cooperation with the United States Geological Survey (USGS), currently conducts quarterly water monitoring at thirteen sampling stations in the Millstone River Watershed (see Appendix B: Map of NJDEP Monitoring Sites). NJDEP and USGS sample for conventional parameters (e.g. dissolved oxygen, pH, total phosphorus, total suspended solids, total dissolved solids, sulfate, temperature, chloride, and nitrate) and toxics (e.g. metals, organics, unionized ammonia, radioactivity). In conjunction with biological data collected over several years of monitoring, NJDEP has assessed the impacts of point source and non-point source pollution to the Millstone River and its tributaries.

As concluded by NJDEP, the Millstone River Watershed's severest problem is elevated nutrient concentrations (such as phosphorus), originating primarily from point and non-point sources (New Jersey Integrated Water Quality and Monitoring Assessment Report 2006). This was identified as a particular problem in the summertime when streamflows are lowest. A wasteload allocation study identified sewage treatment plant effluent as the major cause for dissolved oxygen depletion, excess nutrient concentrations, and bacterial contamination.

The predominant non-point pollution sources in the watershed are those associated with suburban development, which is on the increase throughout the Millstone River Watershed. Runoff from construction sites, housing developments, storm sewers, and roads is contributing to excessive sediment and nutrient loading. Septic systems are also believed to be a potential pollution problem throughout the watershed.

Non-point pollution is also associated with agriculture in the form of sediments, nutrients, and pesticides coming from croplands. It is a combination of suburban and agricultural runoff, along with local sewage treatment plant effluent, which is suspected of degrading the waterways in the Millstone River Watershed.

Other non-point pollution sources have been reported in the Millstone River Watershed. Fuel oil spills have occurred in the Upper Millstone River, causing fish kills. Landfills are assessed as problems, both in the upper reaches of the watershed where recreational usage and groundwater are impacted, and in South Brunswick Township where leachate from a municipal landfill has been noted by local authorities as a problem.

Since government agencies cannot monitor all the collective and individual actions that harm our environment, it is important for everyone to play a role in the stewardship of the natural world. The Chemical Action Teams (CATs) of StreamWatch, the first of our water quality monitoring programs, were developed in the spring of 1992 by SBMWA staff as our response to this need.

StreamWatch is a citizen-based monitoring program that engages the watchful eyes and willing hands of volunteers to help monitor and ultimately protect water quality and the environment in the Millstone River Watershed. The heart of this program is based on the need for heightened awareness of the current state of our environment, how it came to be in its current condition, and what can be done to improve the balance between the activities of man and the health of the environment.

Out of necessity engendered from years of unrestrained development, the State of New Jersey has instituted a variety of environmental and land-use regulations that are among the most comprehensive and progressive in the country. These focus not only on the mitigation of past actions, but also on the protection of the existing natural resources. However, because governmental agencies cannot monitor all of the collective and individual actions that impact and degrade the environment, it is essential for everyone to play a role in the stewardship of the environment. This is especially true with regard to non-point source pollution, which is difficult to control through regulatory oversight. Common examples of non-point source pollution are fertilizers, herbicides, pesticides, spilled motor oil, sediment, and animal waste from pets and livestock. StreamWatch focuses on water quality as impacted by these non-point sources.

Environmental respect, and individual and collective responsibility, are the basic principles from which StreamWatch was born. Given the current growth of spirited participation in StreamWatch, these are the principals that will be perpetuated.

StreamWatch is the outgrowth of a nationwide movement of 4,500 citizen-based monitoring programs. Each has arisen in response to the growing concern about water supplies, effects of non-point source pollution, and the lack of Federal, state, or local funds to adequately monitor sites on a consistent basis. With this background, StreamWatch developed four overall project goals:

- To characterize the water quality in the Millstone River Watershed.
- To involve citizens in observing, monitoring, documenting, and reporting surface water

conditions within the watershed.

- To motivate the public to initiate and support change in their uses of the land and drainage systems that will enhance water quality within the watershed.
- To provide quality data to regulators, decision-makers, and other interested parties, as a vehicle for initiating improvement in water quality.

StreamWatch was developed as a natural extension of SBMWA. Under its central mission of preserving the region's environmental quality of life and utilizing a well-established network of resources, SBMWA staff and volunteers developed StreamWatch and based it on national models including the monitoring program established by Alliance for the Chesapeake Bay.

B. Intended Usage of Data

The importance of StreamWatch lies in its long-term scope and regional focus. Prior water quality sampling investigations have been performed in the watershed; however none in a comprehensive or long range study.

With 36 active monitoring stations and a plan for on-going, long-term monitoring, StreamWatch is unique in the Millstone River Watershed. By using standardized sampling procedures, reporting formats, and a carefully designed data management system, the data collected by volunteer citizen monitors is of high enough quality to use as a basis for a water quality assessment. Supplemented and enhanced by data collected in other water quality monitoring efforts in the watershed, the data gathered through StreamWatch can be a very effective tool in protecting and improving the environment within our watershed.

It is important to remember, however, that the field tests that SBMWA volunteers perform cannot yield as accurate and precise results as a water-testing laboratory. Field test kits, in general, can be expected to have an error rate of plus or minus 10%. The data collected under StreamWatch are intended to be most useful as a characterization tool, which will indicate the areas with particularly significant water quality problems. Using this information, it is the ambition of this program to encourage and promote strategies for environmental improvement through individuals, government, and businesses.

Since the StreamWatch Program's inception in 1992 through 1999, SBMWA produced bi-annual reports distributed to all of the public and university libraries and municipalities within the watershed and to the appropriate division at NJDEP. Each report assessed a portion of the larger Millstone River Watershed so that local action could take place and help improve water quality. In 1999, through funding from Clean Water Action Initiative 319(H) Funds and continued funding from 2002-2007 by the William Penn Foundation, SBMWA has performed detailed subwatershed characterization and assessment work that included analysis and summaries of CAT data.

The large size of the Millstone Watershed prompted SBMWA to initiate a project that provided a quicker link from sound characterization and assessment of natural conditions to the implementation of projects that can restore and enhance the natural environment. Subwatersheds in the 20 – 50 square mile range provide an ideal area for characterization and assessment.

Environmental data is collected and analyzed on soil types, geology, land use changes, water quality, rare and/or endangered species, critical habitats, and population changes and then integrated into recommendations for watershed management tools to restore, enhance, or protect water quality. StreamWatch data is regularly included in these reports, which are distributed to municipal officials within the subwatershed and the appropriate NJDEP staff.

Water quality results are also summarized and distributed to all volunteers and interested parties through a quarterly newsletter, *The StreamWatcher*. These parties include municipal officials, other watershed groups, and representatives of NJDEP. In addition, data is distributed to municipal officials through targeted mailings which include data interpretation and recommendations on how the data can be used to enact environmentally proactive ordinances, including stream corridor protection, septic system maintenance, and fertilizer use. The strong relationship that SBMWA has with many municipalities through our Program for Municipal Excellence allows us to be even more effective when sharing our data with local government officials. Through this program, SBMWA partners with municipal officials to help them achieve the vision for their town through passing strong environmental regulations.

6. PROGRAM/TASK DESCRIPTION

A. General Overview of Program

The chemical assessment program began in 1992 and initially involved the monitoring of 17 sites along the Millstone River, Stony Brook, Carnegie Lake, Big Bear Brook, Devil's Brook, Cranbury Brook, Mountain Brook, Duck Pond Run, Harry's Brook, and Honey Brook. Chemical volunteers monitor levels of dissolved oxygen, pH, nitrate-nitrogen, orthophosphates, turbidity, and temperature (air and water) using customized LaMotte test kits. Since its inception, additional sites have been added on Beden Brook, Cruser Brook, Six Mile Run, Ten Mile Run, Peddie Lake, Pike Run, and Honey Lake. The most recent expansion of the program occurred in 2007 when nine sites were added on seven different streams (Millstone River, Cranbury Brook, Shallow Brook, Devil's Brook, Duck Pond Run, Rocky Brook, and Honey Brook). Currently, there are 36 sampling sites located throughout the Millstone Watershed area. Some of these locations coincide with current biological monitoring sites allowing for comparisons to be made between the chemical testing and biological monitoring (See Appendix A: Map of SBMWA StreamWatch Sites). The Biological Monitoring Program is discussed in a separate Quality Assurance Project Plan. Guidelines for collection and analysis are detailed in the document, *StreamWatch Handbook: Volunteer Water Quality Monitoring Program* included in Appendix C and based on the test kit sampling procedures provided by LaMotte Company. The chemical assessment monitors trends in water quality and is used to determine possible problem sites for further analysis.

The Watershed Association conducts initial volunteer recruitment and training annually. Volunteer recruitment occurs all year, while training sessions occur semi-annually. Chemical monitoring is conducted every other weekend (either Friday, Saturday or Sunday) throughout the year. In order to characterize the stream and to create a baseline of data, each of these evaluations is a critical component of the overall study. For informational and educational purposes, volunteers also record characteristics such as water odor and color during each assessment. The volunteer team collects a water sample and performs streamside analysis for temperature, nitrate-N, orthophosphates, pH, turbidity, and dissolved oxygen using LaMotte field kits. Each sample collection and analysis takes approximately two hours to complete. The Saturday dates of the sampling weekends are established in December for the following year and distributed to all volunteers. Volunteers may monitor the Friday before or the Sunday after a Saturday if there is a conflict with the Saturday date. The water sample must be collected between 10:00 am and 12:00 pm to ensure data comparability.

Following each assessment, all data are reviewed and entered into the computerized management system and analyzed. Interim reports of findings are produced and distributed through the quarterly newsletter, *The StreamWatcher*.

B. Program Timetable

Activity	Winter	Spring	Summer	Fall
Volunteer Recruitment	X	X	X	X
Volunteer Training		X		X
Data Collection and Analysis	X	X	X	X
Quality Assurance Evaluation		X		X
Data Reporting	X	X	X	X

7. MEASUREMENT QUALITY OBJECTIVES

A. Data Precision, Accuracy, and Measurement Range

The following table illustrates the precision, accuracy, and measurement range for the CATs program's temperature and chemical measurements.

Matrix	Parameter	Measurement Range	Accuracy	Precision
Water	Nitrate-N	0.2 – 4.0 ppm	±0.1 ppm	±10%
Water	Orthophosphate	0.2 – 1.0 ppm	±0.1 ppm	±10%
Water	Turbidity	1 – 7 units*	1 unit	±10%
Water	Temperature	-5.0 – 50.0 °C	±0.5 °C	±10%
Water	pH	4.5 – 10.0	±0.1 standard units	±10%
Water	Dissolved Oxygen	0.0 – 20.0 ppm	±0.1 ppm	±10%

*Units are approximately defined as follows: 1 unit=25 Nephelometric Turbidity Units (NTU), 2 units=50 NTU, 3 units=100 NTU, 4 units=150 NTU, 5 units=200 NTU, 6 units=400 NTU, 7 units= >400 NTU.

Precision is the degree of agreement among repeated measurements of the same parameter under the same conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been. These LaMotte kit field tests cannot yield as accurate and precise results as a water-testing laboratory. Field tests, in general, can be expected to have an error rate of plus or minus 10%. For the chemical assessment, volunteers do not collect and analyze duplicate samples, with the exception of the dissolved oxygen test. For this test, the analysis is performed twice and the average is reported. The two tests must agree within 0.6 parts per million (ppm) of each other. If they do not agree within 0.6 ppm, the volunteer performs a third test to see if it agrees with one of the first two within 0.6 ppm. The volunteer then averages the two closest results for the final result and disregards the measurement that did not agree within 0.6 ppm. If the third test still does not agree, the results are not valid. The volunteers collect the three water samples at the same time and then perform the analysis. The volunteers record all results plus the average so that both the range and average are documented and reported to the Program Manager. The Program Manager checks all results when the data sheets are handed in, and contacts the volunteer if results do not seem correct based on historical conditions. If necessary, the Program Manager will re-train the volunteers in the proper collection and analytical techniques.

Accuracy is assured in both field collection and sample analysis through standardized sampling efforts conducted by trained volunteers. All field methods used to collect and analyze samples for temperature, pH, turbidity, nitrate-N, orthophosphates, and dissolved oxygen are detailed in the attached document, *StreamWatch Handbook: Volunteer Water Quality Monitoring Program* included in Appendix C. All volunteers are required to attend an annual Quality Assurance/Quality Control (QA/QC) session that employs a single-blind method of evaluating procedures of all monitors. Each volunteer must perform the suite of tests and the results are compared against a known standard for each test. If the results do not agree within 10%, the volunteer must repeat the test until a satisfactory result is obtained. During these sessions, any inaccuracies in analysis can be corrected and equipment and chemicals can be inspected for replacement if needed. Volunteers are instructed to also inspect their chemicals and equipment (axial readers, thermometers, test tubes, etc.) on a regular basis and contact the office for replacements throughout the year. This helps to ensure accuracy and confidence in the reported data.

B. Data Representativeness

Representativeness is a qualitative term that describes the extent to which sampling design adequately reflects the environmental conditions of a site. The representativeness of the data is mainly dependent on randomized locations throughout the Millstone Watershed and that the sampling procedures adequately represent the true condition of the sample site. Monitoring sites are selected based upon the ability of the site to represent the impact on water quality from changes in the upstream drainage area. Sample siting, sampling of water, and use of only approved/documented analytical methods will ensure that the measurement data does represent the conditions at the investigation site, to the extent possible.

It is well known that water flowing past a given location is constantly changing in response to inflow, tidal cycle, weather, etc. Sampling schedules have been designed with respect to frequency, locations, and methodology in order to maximize representativeness, where possible and applicable.

C. Data Comparability

One of the ways that SBMWA ensures comparability between stations and sampling events is that all volunteers are trained in and follow the same standardized protocol established for the StreamWatch Program. These protocols are documented in Appendix C and included in the test kit that accompanies volunteers into the field. All volunteers collect and analyze samples every other Saturday between 10:00 am and 12:00 pm. This sampling time frame was selected to evaluate the data relative to diurnal fluctuation and for technical consistency. If volunteers are unable to perform sampling on Saturday, they are allowed to sample on Friday or Sunday, but must stay within the 10:00 am to 12:00 pm sampling timeframe. Any data collection performed outside these days or times is not included in the database used for analysis.

Volunteers are given maps to specific sites at the sampling locations where data collection is to take place. These maps are included in the binder, which is part of the field sampling kit. This allows comparability over time at the same location.

D. Data Completeness

Completeness refers to the amount of valid data obtained compared to the amount of data collected and analyzed. It is expected that at least 90% of the samples collected will yield acceptable results. Results for nitrate-N, orthophosphates, pH, temperature, and turbidity should fall within the acceptable range (see Measurement Range column in "Data Precision, Accuracy, and Measurement Range" table in Section 7.A; however note that volunteers can also record values of <0.2 for nitrate-N and orthophosphate, <1.0 for turbidity and <4.5 for pH). However, the dissolved oxygen results are not valid if there are not two readings that agree within 0.6 ppm of each other. If data does not meet acceptable quality objectives, it will not be used.

There are no legal or compliance uses anticipated for the CATs data. In addition, there is no fraction of the planned data that must be collected in order to fulfill statistical criteria. It is expected that samples will be collected from at least 85% of the active sampling sites each sampling event unless unanticipated weather conditions prevent sampling. This is due to the fact that there are times when volunteers have a conflict and cannot sample, or may leave the program and cannot be replaced in time for the next sampling event. Therefore, it is expected that samples will be collected from at least 85% of the sites unless weather conditions prevent sampling.

8. TRAINING REQUIREMENTS AND CERTIFICATION

A. Training Logistical Arrangements

All volunteers must attend a training session prior to beginning their sampling. Training of volunteers in field procedures occurs during a four-hour session held on SBMWA's property, which contains a portion of the Stony Brook. The Stony Brook is part of the CATs sampling program and is therefore representative of actual field conditions throughout the Millstone River Watershed (see Element 7.B. above).

The field training focuses on sampling safety, proper water sample collection and field measurement/observation techniques, and how to properly complete all parts of the data sheet.

This is performed with hands-on demonstration of techniques by trained instructors (SBMWA staff or experienced volunteers) followed by volunteers performing those same techniques. Each volunteer is given their own LaMotte test kit so that they can perform and learn the testing procedures for each parameter. Volunteers are also given a binder containing instructions on how to complete the data sheet and perform each test, site maps of the sampling location, sampling dates, emergency contact phone numbers, and background information on the Millstone Watershed and the parameters for which they sample.

B. Description of Training and Trainer Qualifications

Beth April is the Program Manager, QA Officer, Field/Sampling Leader, and Laboratory Manager for the StreamWatch program. She trains volunteers in sampling techniques, writes reports, and reviews all data for quality assurance/quality control of field and laboratory procedures as well as performs data evaluation. Because the staff size at SBMWA is so small, it is not possible to separate these positions. Ms. April, Watershed Specialist, has five years experience in water quality and environmental monitoring for both SBMWA and NJDEP through the Watershed Ambassador Program. She has been trained in U.S. EPA's Rapid Bioassessment Protocols for both macroinvertebrate sampling and habitat assessment. Ms. April represents SBMWA as a member of the NJDEP's Watershed Watch Advisory Network Council, which is working to provide guidance on issues throughout the State related to volunteer water quality monitoring. Ms. April received a BS in Environmental Science and a BS in Natural Resource Management from Rutgers University.

9. DOCUMENTATION AND RECORDS

During training, volunteers are instructed in the proper completion of a field data sheet. Each CATs field data sheet must be completed on-site at the time sampling occurs. These sheets are used to record analytical results and information on weather, water color, water odor, algal growth, and comments on any unusual occurrences found. A sample data sheet is included in the attached document, *StreamWatch Handbook: Volunteer Water Quality Monitoring Program*, found in Appendix C. Volunteers keep a copy of each data sheet with their records. The results are reported to the SBMWA office following sampling via fax, e-mail, or regular mail. E-mailed data sheets are kept electronically and printed so a hard copy may be stored with the other data sheets. Data is maintained in the StreamWatch database and is reviewed by the QA Officer for completeness. Results are compiled in the StreamWatch progress reports. Data sheets are archived after one year and are held for at least five years. Data is also entered into the NJDEP E2 Online Water Quality Monitoring Database.

SBMWA collects the names and contact information for all volunteers during trainings and keeps a record of active volunteers in its StreamWatch database. This database includes the site name for which the volunteer monitors.

10. SAMPLING PROCESS DESIGN

A. Rationale for Selection of Sampling Sites

The following criteria are used when selecting new chemical monitoring sites and apply to the existing sites already in the CATs program.

a. The site should be typical of the part of the stream of interest. A good place for the first sampling site on any tributary is upstream of the juncture of the tributary with a larger stream. Sampling from this juncture tells us the quality of the water being input from the tributary into the larger stream (similar to testing a point source). Additional sites may be down- and upstream of sewage treatment plants, known point and/or non-point sources.

b. The site should be located on a perennial stream (not intermittent) and contain an area deep enough to collect a water sample.

c. The area must be safely accessible for volunteers of all abilities and try to avoid sites with steep, slippery, or eroding banks. The area must also contain a safe place to park.

d. Foreknowledge of the sampling is given to the landowner (if private lands) prior to the start of sampling. Permission to sample is also obtained from the landowner in writing (if private lands).

e. Sampling locations are located in the main river current and away from the banks when possible.

f. A well-documented area/landmark/location has been mapped for easy replication of the same sampling spot over the span of many years.

See Appendix D: CATs Sampling Site Descriptions for a list of sampling sites and information on their location and the rationale for choosing them as sampling sites.

B. Sample Design Logistics
All sampling logistics are outlined in the attached document, *StreamWatch Handbook: Volunteer Water Quality Monitoring Program.* A brief outline is contained in the table below.

	Parameter	Number of Samples	Sampling Frequency	Sampling Period
Chemical	Temperature	1	Every other weekend	All year (January-Dec.)
	Nitrate-N	1	Every other weekend	All year
	Orthophosphate	1	Every other weekend	All year
	pH	1	Every other weekend	All year
	Turbidity	1	Every other weekend	All year

	Dissolved Oxygen	2-3	Every other weekend	All year
Physical	Water color	1	Every other weekend	All year
	Water odor	1	Every other weekend	All year

11. SAMPLING METHOD REQUIREMENTS
All sampling methods are described in the attached document, *StreamWatch Handbook: Volunteer Water Quality Monitoring Program* in "Section II. Chemical Action Teams" and are outlined briefly below.

Parameter	Sampling Equipment	Sampling Method
Temperature	LaMotte Enviro-Safe Armored Alcohol Thermometer	Single observation after waiting 3-5 minutes
Nitrate-N	LaMotte Comparator and Axial Reader, nitrate reducing reagent, mixed acid, 10 ml test tube	Single grab sample
Orthophosphate	LaMotte Comparator and Axial Reader, phosphate reducing reagent, phosphate acid reagent, 10 ml test tube	Single grab sample
PH	LaMotte Octet Color Comparator, wide range indicator, 5 ml test tube	Single grab sample
Turbidity	LaMotte Comparator & 5 ml test tube or LaMotte Turbidity Columns & standard turbidity reagent	Single grab sample
Dissolved Oxygen	LaMotte direct reading titrator	Modified Winkler Titration performed on 2-3 single grab samples

12. SAMPLE HANDLING AND CUSTODY PROCEDURES

All water samples are collected and analyzed in the field. Volunteers are responsible for following the proper techniques for sample collection and analysis per their training and the testing procedures outlined in the *StreamWatch Handbook: Volunteer Water Quality Monitoring Program* document. pH must be analyzed within fifteen minutes of collection, and turbidity must be analyzed immediately after collection. Dissolved oxygen samples must be fixed immediately after collection and can then be analyzed up to eight hours after sample fixation.

13. ANALYTICAL METHODS REQUIREMENTS

The data that are collected by the volunteers include air and water temperature, nitrate-N, orthophosphates, pH, turbidity, and dissolved oxygen. Water odor, water color, weather, and algal growth are also recorded. The analytical methods for each test are detailed in "Section II. Chemical Action Teams" of the *StreamWatch Handbook: Volunteer Water Quality Monitoring Program* included in Appendix C.

14. QUALITY CONTROL REQUIREMENTS

A. Field QC Checks

The StreamWatch program trains its CATs volunteers in the correct visual assessment, sample collection, and sample analysis procedures outlined in *StreamWatch Handbook: Volunteer Water Quality Monitoring Program*. Periodically, experienced volunteers accompany new volunteers in the field to evaluate their collection and analytical techniques and correct any errors found. In 2008, SBMWA plans to explore the possibility of performing field audits where the Program Manager or experienced volunteers accompany all volunteers on one site visit annually to evaluate their performance and correct any errors or inconsistencies with sample collection and analysis.

B. Laboratory/Data Analysis QC Checks

The StreamWatch program employs a single-blind method of evaluating sample testing procedures for all volunteers. It is mandatory for all volunteers to attend a Quality Assurance/Quality Control session once a year. Volunteers are given four opportunities to attend a session (two are offered in the Spring and two are offered in the Fall). At these sessions, volunteers perform each test (temperature, pH, turbidity, nitrate-N, orthophosphates, and dissolved oxygen) on a water sample of a known concentration. Samples for nitrate-N and orthophosphates are prepared by New Jersey Analytical Laboratories at a concentration specified by the Program Manager. The Program Manager prepares standards for pH and turbidity using LaMotte pH buffers and standard turbidity reagent, respectively. The volunteer results are compared to the known standard to determine the accuracy in which they are performing the tests. For temperature and dissolved oxygen, a bucket of water is used as the sample. The Program Manager tests the bucket water for these two tests to determine the known result against which all volunteer results are compared. If the results for any test do not agree within 10%, measures are taken to determine the cause and the volunteer must repeat the test until a satisfactory result is obtained. Any problems with expired chemicals, faulty equipment, or faulty testing procedures are addressed at these sessions so that greater accuracy is ensured moving forward.

In addition, the Program Manager reviews each data sheet upon receiving it. If the result for a parameter seems outside of the acceptable range, the Program Manager will contact the volunteer to ensure that their equipment is working properly and that their chemicals are not expired. The Program Manager will provide replacement equipment and chemicals and re-training as needed.

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

The CATs program performs temperature assessments to increase the amount of information at each site during sampling. The thermometers used are Enviro-safe armored alcohol thermometers. Before usage, the column of each thermometer is inspected for breaks in the liquid and for cracks in the glass. Volunteers also inspect all other sampling equipment before use. Volunteers check to see that the mirror in the axial reader is intact, markings on test tubes are legible, and other comparators are in good working order. Replacement thermometers and other equipment are available at the Watershed Association office. All records and equipment are held at the Stony Brook-Millstone Watershed Association office.

Volunteers are also instructed to check chemical expiration dates on a regular basis. Expiration dates are generally marked on the chemical bottle. In the absence of an expiration date, the method for determining the expiration date is detailed in the *StreamWatch Handbook: Volunteer Water Quality Monitoring Program*. When chemicals are near expiration volunteers contact SBMWA to obtain replacements.

16. INSTRUMENT CALIBRATIONS AND FREQUENCY

Thermometer calibration is completed annually in coordination with Danielle Donkersloot, Volunteer Monitoring Coordinator at NJDEP Watershed Watch Network. This calibration occurs in either January or February. Some calibrated thermometers are stored at the SBMWA office so that the volunteer can be given a calibrated thermometer when their field thermometer is brought in for calibration. This ensures that there are no gaps in data collection. Each thermometer is numbered and then tested against a National Institute of Standards and Technology (NIST) thermometer certified at the NJDEP Office of Quality Assurance lab. The NIST thermometer has a statement of accuracy and correction factor valid for one year. The degree to which each numbered thermometer varies from the NIST thermometer's corrected value is recorded. This information is kept at the SBMWA office, and the Program Manager will adjust volunteer reported temperatures when reviewing field data sheets. For example, if the calibration results find that Thermometer 1 measures temperature 1.0 degree higher than the NIST thermometer value, the Program Manager will subtract 1.0 degree from the temperatures reported by the volunteer using Thermometer 1. The corrected data will be entered into the database. This procedure was implemented in 2007. Prior to 2007, thermometers were not calibrated.

17. INSPECTION/ACCEPTANCE REQUIREMENTS

The CATs program uses LaMotte customized chemical kits for chemical sampling, which include chemicals and equipment for temperature, pH, nitrate-N, orthophosphate, turbidity, and dissolved oxygen. All initial kits are purchased from LaMotte under the supervision of the Program Manager. Replacement equipment (e.g. thermometers, test tubes, axial readers, water sampling bottles) and chemicals are purchased from LaMotte through a local distributor, Weber Scientific. The Program Manager inspects all kits prior to volunteer trainings. Any kit that does not meet standards is replaced. Thermometers are inspected upon arrival by the Program Manager to ensure there are no cracks or separations in the liquid column. Defective thermometers are shipped back to the manufacturer for replacement. In addition, volunteers are instructed to inspect equipment to ensure it is in good working order prior to sampling. Volunteers also check chemical expiration dates and contact the Watershed Association for replacements if equipment is damaged or chemicals are expired. If it comes to the attention of the Program Manager that data was collected using faulty equipment or expired chemicals, this data is not used.

18. DATA ACQUISITION REQUIREMENTS

For the CATs program's chemical assessment analysis, water quality standards are taken from the literature and documentation provided by the NJDEP in the Surface Water Quality Standards, N.J.A.C. 7:9B (available at http://www.state.nj.us/dep/wms/bwqsa/swqshome.html). These standards establish the values for which streams are considered non-polluted and are used to gauge stream health in the Millstone River Watershed. The following table shows the standard used for each test. Values for temperature, nitrate-N, and turbidity should not exceed the value shown. Results for pH should not be outside the range shown. Results for dissolved oxygen should not be below the value shown.

Parameter	Surface Water Quality Standard
Temperature	30^0 Celsius
Nitrate-N	10 parts per million (ppm)
Total Phosphorus*	Streams: 0.1 ppm Lakes: 0.05 ppm
pH	6.5-8.5 Standard pH units
Turbidity	50 NTU
Dissolved Oxygen	4.0 ppm

*The StreamWatch program measures orthophosphate rather than total phosphorus. SBMWA uses the standard for total phosphorus as the criterion for orthophosphate as well, since an orthophosphate value exceeding 0.1 ppm in streams or 0.05 ppm in lakes indicates a water quality problem. The orthophosphate test kits can only measure as low as 0.2 ppm, with results less than 0.2 ppm recorded as <0.2 ppm. Therefore, our test kits cannot determine if the standard of 0.1 ppm is met; however, they can indicate a problem when the result is recorded as equal to or greater than 0.2 ppm.

19. DATA MANAGEMENT

The sampling team inspects field data sheets for completeness before leaving the site. Data sheets are submitted to the Program Manager via e-mail, fax, or mail and reviewed for accuracy and completeness. Within 72 hours, the Program Manager will contact any samplers whose data sheets contain significant errors or omissions. The field data sheets require the volunteers to record the site name, date, time, samplers' names, current weather conditions, water odor, water color, air temperature, water temperature, results for the nitrate-N, orthophosphate, pH, turbidity, and dissolved oxygen tests, algal bloom index, aquatic vegetation index, wildlife observations, floatable observations, and general comments. Significant errors may include, but are not limited to, an air or water temperature that is not within a reasonable range for the time of year, an indication of a weather condition that the Program Manager knows did not occur on the specified date, sampling on a day of the week other than Friday, Saturday, or Sunday, beginning sampling outside of the required 10:00 am to 12:00 pm start range, or using results of the dissolved oxygen test that do not agree within 0.6 ppm of each other. If a problem with air or water temperature is found, the Program Manager will instruct the volunteer to inspect the thermometer to ensure that there are not any cracks or breaks in the liquid column. If a malfunction to the measuring device is found, the inaccurate data will not be used. In addition, data will not be used if collected outside of the acceptable date and time range. Omissions would include a lack of information in any of the above-mentioned fields. If the site name, date, or start time is missing, the Program Manager can contact the volunteer for this information. If any of the other aforementioned information is missing, it cannot be collected for this sampling event, since weather, air temperature, water temperature, water quality chemical measurements, algal growth, water odor, and water color should be representative of the day and time the sample was collected, and could have changed in the time since sample collection.

All data is entered into the computerized database designed for the StreamWatch program by a trained StreamWatch volunteer. Individual results for the dissolved oxygen test as well as the average are entered so that both the average and range of results is available. A copy of the data entry procedures is kept in the office and is available to the volunteer. Integrated within the database are checks preventing erroneous data from being entered. If a value falls out of possible range for the equipment the program refuses to take the data. As a QA/QC check, the Program Manager will review the finalized data for accuracy. All of the data sheets are filed by site after being entered into the database. These sheets are kept in the filing cabinet for one year and then stored in boxes for at least five years in case they are needed. In addition, the data is entered into the NJDEP E2 Volunteer Water Quality Monitoring database and checked for accuracy prior to submission to NJDEP.

20. ASSESSMENT AND RESPONSE ACTIONS

Review of sampling activities is the responsibility of the Program Manager and the Quality Assurance Officer. Experienced, trained volunteers can also perform this task if deemed qualified by the Program Manager or Quality Assurance Officer. Each volunteer must attend an annual Quality Assurance/Quality Control session where the Program Manager evaluates his or her performance (see sections 7.A and 14.B). In addition, SBMWA plans to investigate the possibility of field audits where each volunteer team will have their performance in the field evaluated by one of these individuals annually. Volunteers in need of performance improvement will be re-trained on-site during the evaluation/QA/QC session or as quickly as possible. If errors in sampling techniques are consistently identified, re-training may be scheduled more frequently for that volunteer team. These re-trainings will be scheduled throughout the year, on an as needed basis, and are not limited to the regularly scheduled trainings in April and September. When possible, the re-training will occur before the next sampling date.

All field and laboratory activities may be reviewed by NJDEP quality assurance officers as requested. The SBMWA QA Officer performs systems and data quality audits twice yearly. Any identified procedural problems will be corrected based on recommendations from the QA Officer.

21. REPORTS

Interim reports are produced and distributed through the quarterly newsletter, *The StreamWatcher*. The Program Manager is responsible for all report production and distribution. *The StreamWatcher* is distributed to all volunteers, municipals officials, appropriate NJDEP staff, and other watershed association staff. Reports will also be forwarded to the county, state, regional EPA office, and groups/agencies as appropriate. These reports will consist of data results, interpretation of data (if possible), results of QC audits, internal assessments, and volunteer achievements. SBMWA also completes detailed Subwatershed Characterization and Assessment Reports. These reports utilize StreamWatch data and are distributed to the appropriate municipal officials and NJDEP staff.

22. DATA REVIEW, VALIDATION, AND VERIFICATION

Data is reviewed for compliance with State Surface Water Quality Standards (SWQS). Any data not meeting SWQS is flagged so that follow-up sampling can be performed at that site if deemed necessary.

All StreamWatch and CATs program field data are reviewed by the Program Manager/QA Officer to determine if the data meet quality assurance/quality control plan objectives. Decisions to reject or qualify data are made by the Program Manager/QA Officer.

23. VALIDATION AND VERIFICATION METHODS

As stated in Section 7.A, all volunteers are required to attend an annual Quality Assurance/Quality Control session that employs a single-blind method of evaluating procedures of all monitors. Each volunteer must perform the suite of tests and the results are compared against a known standard for each test. If the results do not agree within 10%, the volunteer must repeat the test until a satisfactory result is obtained. During these sessions, any inaccuracies in analysis can be corrected and equipment and chemicals can be inspected for replacement if needed. Volunteers are instructed to also inspect their chemicals and equipment (axial readers, thermometers, test tubes, etc.) on a regular basis and contact the office for replacements throughout the year. This helps to ensure accuracy and confidence in the reported data.

Upon receiving data sheets, the Program Manager checks them for accuracy. Data is then entered into the StreamWatch database by a volunteer. Once the data has been entered into the database, the QA Officer will check the data against the original data sheets. Errors in data entry will be corrected. Outliers and inconsistencies will be flagged for further review, or discarded. Problems with data quality will be discussed in any reports to data users.

24. RECONCILLIATION WITH DATA QUALITY OBJECTIVES (DQO'S)

As soon as possible after each sampling event and Quality Assurance/Quality Control session, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the program's specifications as stated in Section 7.A, data will be flagged. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration/maintenance/inspection techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be re-trained. Any limitations on data use will be detailed in both interim and final reports, and other documentation as needed.

As stated in Sections 7.A, 14.B, and 23.0, all volunteers must attend an annual Quality Assurance/Quality Control session where their techniques are measured against known standards as a check for accuracy in analytical procedures. If an error of greater than 10% is found, the volunteer must repeat the test until a satisfactory result is obtained. Any problems with expired chemicals, faulty equipment, or faulty testing procedures are addressed at these sessions so that greater accuracy is ensured moving forward. If necessary, the volunteer will be re-trained in sampling collection and analytical techniques.

If failure to meet project specifications for precision and accuracy as stated in Section 7.A is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the NJDEP quality assurance officers for approval. Revisions may include sending a percentage of samples to an outside lab to confirm the accuracy of field results, performing more frequent field audits, and/or having volunteers analyze duplicate samples in the field.

APPENDIX A: MAP OF SBMWA STREAMWATCH SITES

StreamWatch Volunteer Action Teams Site Locations

Cartography by Janel A. Bisacquino, The GIS Center at Stony Brook, May 2007. Project: 2007SWsites.mxd
Data Sources: NJDEP, US Census and SBMWA. This secondary map product has not been verified or authorized by source agencies.

APPENDIX B: MAP OF NJDEP MONITORING SITES

APPENDIX C: STREAMWATCH HANDBOOK

STREAMWATCH

VOLUNTEER WATER QUALITY MONITORING PROGRAM

HANDBOOK

Stony Brook Millstone Watershed Association

31 Titus Mill Road
Pennington, NJ 08534
Phone: (609) 737-3735
Fax: (609) 737-3075
www.thewatershed.org
www.thewatershedinstitute.org
www.giscenter.org

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I. INTRODUCTION

This handbook is designed to assist volunteers involved in conducting basic water quality assessments of the streams and lakes of the Millstone River Watershed as part of the Stony Brook-Millstone Watershed Association's StreamWatch Program. A discussion of clean water, pollution impacts, and a description of our watershed region follow an introduction to the Stony Brook-Millstone Watershed Association. The first section is followed by descriptions of each of the three water quality monitoring components: Chemical Action Teams (CATs), Biological Action Teams (BATs), and River Action Teams (RATs).

A. THE STONY BROOK-MILLSTONE WATERSHED ASSOCIATION

Organization and Programs

The Stony Brook-Millstone Watershed Association, which works to protect a 265-square mile region of central New Jersey, was organized in 1949 with the assistance of the Princeton Garden Club and several concerned citizens. Our mission is to enhance the quality of the natural environment in the area drained by the Stony Brook and the Millstone River. We do this by addressing key issues affecting water quality and land-use, educating residents and students about the ecology of the natural world, and preserving open space by maintaining an 830-acre nature reserve and organic farm. In doing so we've worked with groups throughout the state on significant land-use and water quality issues including the State Drinking Water Quality Standards Act, the Mt. Laurel Decisions, the Water Quality and Watershed Management Rules, and the Freshwater Wetlands Act. Our four areas of priority are:

- *Providing a year-round environmental education program:* Our approach consists of several programs targeted at a variety of audiences - teacher workshops; classes for local school groups; weekend family programs; a six-week summer environmental camp; and cooperative work with Trenton's inner-city children. The program has grown over the past few decades to over 10,000 participants in 400 programs annually.

- *Monitoring issues concerning watershed management, water quality, and land-use:* We are involved in a variety of community issues to determine their impact on the watershed - monitoring water quality through StreamWatch; networking with and educating officials on watersheds through our municipal assessments and Natural Lands Network; restoring streambanks and riverside forests; and reducing nonpoint source pollution through our River-Friendly Golf Course, Business, and Resident Programs.

- *Maintaining as open space, an 830-acre nature reserve:* Our nature reserve in Hopewell Township is open to the public from dawn to dusk, 365 days a year, and is ribboned by ten miles of trails through woodlands, old fields, ponds and along the Stony Brook.

- *Promoting organic farming in our garden state:* A Community Supported Agriculture program has been introduced on our 30-acre organic farm, based on selling "shares" to residents for which they receive a weekly percentage of crops. Our tenant farmer has over 900 families and groups receiving organically grown crops each year.

B. THE MILLSTONE RIVER WATERSHED

What is a Watershed?

A watershed is a geographic region in which all the surface water flows toward a particular river or other body of water. The watershed includes not just the water, but also the land over which the water must travel. Topographical features determine this geographic region. A ridge or other area of elevated land, called the divide, separates one watershed from another. Streams on one side of the divide flow away from streams on the other side.

Streams originate from snowmelt, rainwater, springs and/or groundwater. As water flows overland or percolates through soil, it recharges surface and groundwater supplies, which can be used for drinking water. This process also filters out impurities such as sediments, oil, grease, and bacteria. The concentration of these impurities, the speed and amount of water, the materials the water flows over or through, and the grade of the land all contribute to the ability of a natural system to regenerate itself and maintain good water quality. Human activity has significantly taxed these natural processes by altering land cover and thus increasing concentrations of pollutants.

Watershed Description

The Millstone River Watershed includes an area of 265-square miles that includes most of Mercer and parts of Hunterdon, Somerset, Middlesex, and Monmouth Counties. This area is shown in Figure 1. The Millstone River itself is 38 miles long and flows northwest and then north from Millstone Township in Monmouth County to the Raritan River at Manville Borough in Somerset County. Since the damming of the Millstone River in 1906 to create Carnegie Lake, the Millstone is divided into two main sections: the Upper Millstone, which feeds into Lake Carnegie, and the Lower Millstone which drains Lake Carnegie and flows north to the Raritan River.

The Stony Brook is 21 miles long with headwaters in East Amwell and flowing generally east to feed Lake Carnegie and merge with the Millstone River. Other major tributaries of the Millstone River include Cranbury Brook, Bear Brook, and Beden Brook.

The largest lake in our watershed is Carnegie Lake in Princeton Township, but there are also a number of smaller lakes. Land use is primarily suburban development with agricultural and forested areas. Extensive development has recently occurred in many parts of the Millstone River Watershed.

Watershed Assessment

The New Jersey Department of Environmental Protection (NJDEP) currently conducts water monitoring at five sampling stations five times a year in the Millstone River Watershed. In addition, NJDEP monitors 39 stations for benthic macroinvertebrates. Each of these stations is monitored once every five years. With data collected over several years of monitoring, NJDEP has assessed the impacts of point source and non-point source pollution.

As concluded by NJDEP, the Millstone River Watershed's most severe problem is elevated nutrient concentrations (such as nitrates and phosphates), originating primarily from point sources. This was identified as a particular problem in the summertime when the streamflows are lowest. A recent wasteload allocation study identified sewage treatment plant effluent as the major cause for dissolved oxygen depletion, excess nutrient concentrations, and bacterial contamination.

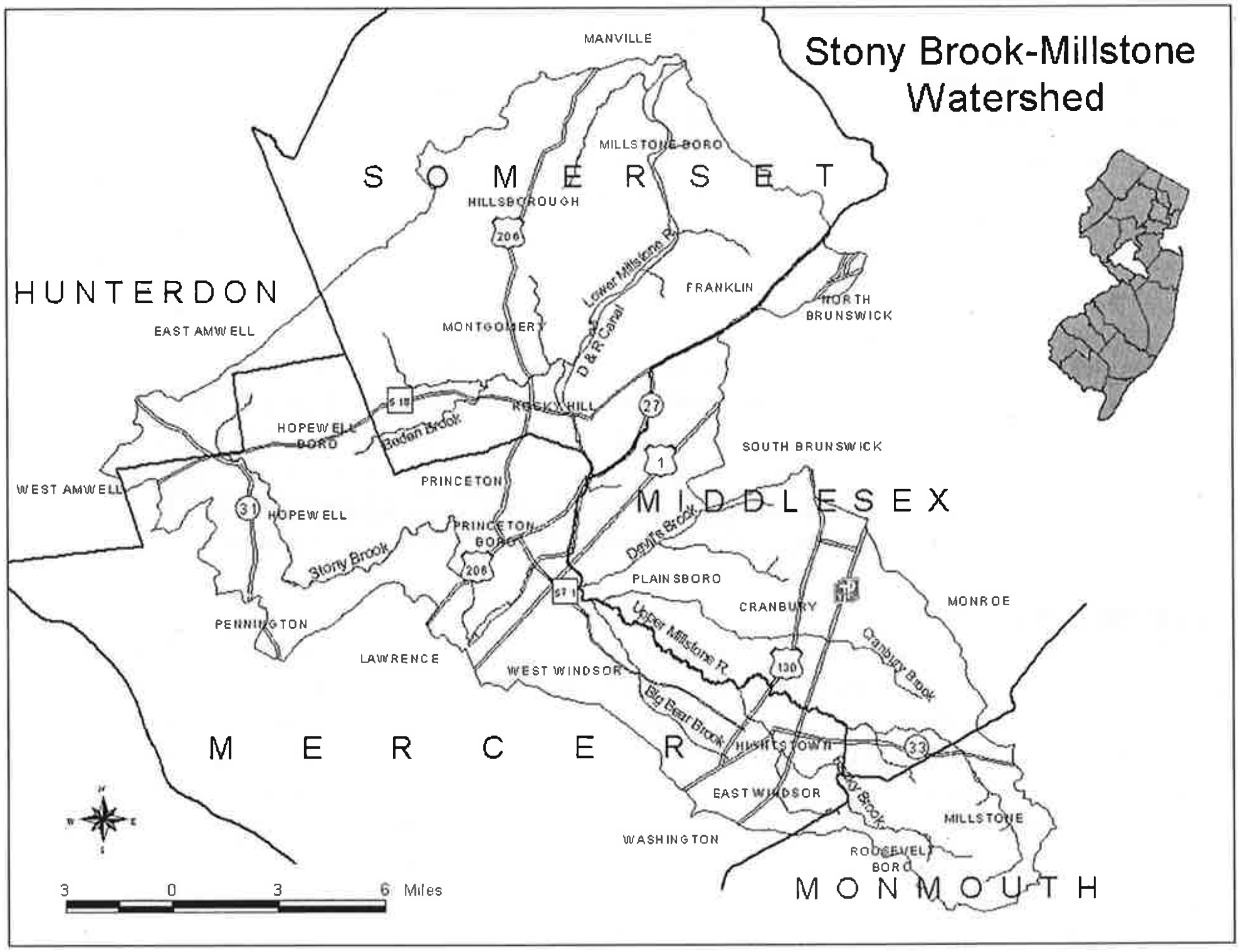


Figure 1: Map of the Stony Brook-Millstone Watershed.

The predominant non-point pollution sources in the watershed are those associated with suburban development, which is on the increase throughout the watershed. Runoff from construction sites, suburban surfaces, storm sewers, and roads is contributing to excessive sediment loading. Septic systems are also believed to be a potential pollution problem throughout the watershed.

Non-point pollution associated with agriculture is limited in this watershed to the regions drained by Etra Lake and Peddie Lake, Cranbury Brook, and the lower reaches of the Millstone River near its confluence with the Raritan River. Sediments, nutrients, and pesticides are suspected of coming from croplands, and are believed to be severe in the East Windsor area where chronic fish kills have occurred. It is a combination of agricultural and urban runoff, along with local sewage treatment plant effluent, which is suspected of degrading the fish communities in the Upper Millstone River.

Other non-point pollution sources have been reported in the Millstone River Watershed. Fuel oil spills have occurred in the Upper Millstone River, causing fish kills. Landfills are assessed as problems, both in the upper reaches of the watershed where recreational usage and ground water are impacted, and in South Brunswick Township where leachate from a municipal landfill has been noted by local authorities as a problem.

C. DISCUSSION OF CLEAN WATER

Water provides the most characteristic feature on the surface of the planet Earth. Oceans cover more than 70% of Earth's surface, and extensive networks of fresh water streams, rivers and lakes drain the remaining land areas. We can't eliminate water, but we can - and we do - divert it, dam it, and rearrange its natural courses. We take it for granted and abuse it.

Our lives depend on water. An average adult requires six to eight cups of water a day, more for those who exercise vigorously or who live in a hot climate. A 10% loss of body water poses significant health risks, and a 20% loss may result in death. Yet, in spite of our dependence upon water, we as a society continue to endanger the quality of this life-sustaining resource.

Clean water is vital to maintaining our food supply. For example, many fisheries, which supply food, fertilizer and animal feed, require good water quality. In addition, researchers continue to develop new pharmaceuticals, medical supplies, and dietary supplements from marine life dependent on good water quality. A complex web of interacting plant and animal species supports all of these commercially valuable species. At each life stage of these organisms, clean water with specific water quality requirements is necessary to ensure survival to the next life stage. In some areas, fish may survive polluted waters long enough to be harvested, although their tissues contain dangerous levels of pollutants, such as PCBs, dioxins, lead, and mercury.

Point-Source Pollution

Point sources of pollution are those direct discharges into waterways emitted from pipes. They include municipal and industrial sewage treatment plants, power plants, and stormwater discharges. These are the simplest sources of pollution to locate and to act against, since the pollution is entering the waterways from one "point". In 1972, the Federal Water Pollution Control Act, commonly known as the Clean Water Act, was enacted. The overall objective was to restore and maintain the chemical, physical, and biological integrity of our nation's waterways. The Act mandated that a comprehensive program be established by the United States Environmental Protection Agency (USEPA) to monitor and control water pollution. The goal was that by 1985 all navigable waters would be free of pollutant discharge. Subsequent to the Act, the New Jersey Pollutant Discharge Elimination System (NJPDES) was established. This required anyone discharging pollutants in the state to obtain a permit specifying the amounts and types of pollution discharged.

Most of these point sources are discharged legally through permits issued under the Clean Water Act and NJPDES. Permits limit the quantities and types of pollutants permitted in wastewater. Permit holders are charged with the responsibility of making sure their actual discharge is in compliance with their permits. Some wastewater dischargers are in compliance with permits at all times, while others frequently are in violation, making routine monitoring of wastewater discharges important.

NJDEP has converted NJDPES into a watershed-based format. The transition to watershed-based planning was a nationwide endeavor undertaken by several different agencies on several different levels. The switch in New Jersey to a watershed-based approach to dealing with point sources of pollution is a transition the Watershed Association supports.

In 1989, the New Jersey legislature passed the Clean Water Enforcement Act (CWEA) that ensures that permit violators are significantly fined when they are not in compliance with their permits. In addition, a citizen action suit provision allows citizens the opportunity to file suit against dischargers who are in violation of their permits. With organization and evidence, citizen groups are able to directly improve water quality.

In addition, in many areas of our watershed, storm water, sewage, and industrial wastes flow through the same system of pipes to treatment facilities. During rainstorms, rainwater mixes with sewage, in many cases overwhelming the capacity of the treatment facilities. Because these facilities can handle only so much volume, overflow devices were designed to divert overflow directly into streams. This system is called a Combined Sewer Overflow (CSO). The NJDEP is funding efforts to convert systems to eliminate CSOs, but problems still exist. After a storm event and during high flow conditions, stream walking will allow us to identify areas where CSOs are a problem within our watershed region.

Non-Point Source Pollution (NPS)

NPS or "people pollution" is that pollution we generate in our everyday lives, which is not discharged via a pipe directly into a waterway. Unlike point sources of pollution, NPS comes from miscellaneous sources and no comprehensive legislation currently exists to regulate it.

Every chemical or waste product that can be carried by rainfall into storm sewers and streams becomes a part of NPS, unless picked up by soil and absorbed or neutralized. Common examples of NPS include: fertilizers, herbicides, insecticides, spilled motor oil and animal waste from pets, wildlife, and farm animals. Other significant sources of NPS include improperly operating septic systems, erosion from construction sites and plowed fields, acid rain and runoff from roadways, and road salting activities. As development occurs, and impervious surfaces (parking lots, streets, sidewalks, rooftops) increase, runoff volumes and velocities increase substantially, significantly impacting levels of NPS and erosion.

A stormwater management program, recently developed by the USEPA and NJDEP, will begin to address NPS by requiring that sites associated with "industrial activities" self-monitor stormwater runoff, thus measuring the concentration of pollutants that may be running off from parking lots and outdoor process areas. Such legislation, as well as active enforcement and cooperation among all levels of government will have to be part of the solution for NPS.

The key, however, is the individual citizen and his or her commitment to a healthy environment. Ultimately, control of NPS will require the voluntary cooperation of individual citizens in lessening their contribution to NPS. Efforts such as good management of septic systems, good farming practices, controlling chemical use on lawns and gardens, and disposing of household chemicals properly are all a part of reducing NPS and protecting our waterways.

Common sources of NPS include:

- *Stormwater runoff* as rain and snowmelt flow over agriculture, industry, logging, construction, mining, contaminated soils, highways, parking lots, and lawns and pick up pollutants.

- *Atmospheric deposition* from acid rain and airborne pollutants.

- *Inflows of groundwater* that are contaminated by pesticides, nitrates, waste from storage and disposal sites, sludge disposal sites, and failing septic tanks.

- *Marine sources* from dumping, dredge spoils, boat hull paints, and marine sanitation devices/heads.

- *Land alterations* due to the filling of wetlands, removal of vegetative cover, increased paved surfaces.

Types of Pollutants

The pollution of waterways is primarily due to human activity and is reflected by a decline in the diversity of aquatic plants and animals. Water pollution can be divided into four interrelated general categories: toxic substances, nutrient pollution, organic wastes, and sediment pollution.

These types of pollutants are not static or separate. They interact with each other and negatively impact biodiversity within our waterways and increase the risk of water degradation in many areas.

Toxic Substances

Toxic substances may enter waterbodies through point and non-point sources - industrial and municipal wastewater dischargers, agricultural and urban land runoff, the leaching of waste materials dumped in the area or through the airborne deposition of pollutants. These substances impair or kill aquatic life, reducing the numbers and diversity of species, thereby disrupting the natural aquatic community. In addition, toxins make the consumption of water and fish unsafe.

The ways in which toxic substances affect living organisms can be divided into four categories:

- *Acute toxicity* causes immediate danger or death.

- *Chronic toxicity* has long-term non-lethal effects, which may alter appetite, growth, metabolism, or reproduction.

- *Bioaccumulation* becomes toxic as substances become concentrated in animal tissues from direct consumption of toxic substances or through consumption of other contaminated animal tissue.

- *Behavioral modification* causes an organism to leave the area or otherwise alter its normal behavior.

Excessive levels of toxins in our watershed have lead to the classification of the majority of our waters as "unfishable" by the NJDEP.

Nutrient Pollution

Aquatic plants require nutrients such as nitrogen and phosphorus for growth, but too much of these nutrients can result in excessive growth of aquatic vegetation and algae. An explosive growth of algae, termed an algal bloom, is the result of nutrient overloading. Such a bloom blankets the water surface and can produce odor and taste problems. In addition, an algal bloom will deplete the oxygen supply in the water as it decomposes. A lack of oxygen in turn will decrease the ability of a waterway to support other forms of aquatic life.

Excessive phosphorus and nitrogen in a waterbody may be the result of wastewater discharges, improperly functioning septic systems, or stormwater runoff from agricultural and residential lands which carries with it pesticides and fertilizers.

Organic Wastes

Most aquatic life needs oxygen to survive. However, water is capable of dissolving only a small amount of oxygen from the surrounding air. Wastes containing organic material require oxygen to decompose. Large accumulations of organic waste use large amounts of oxygen during decomposition, leaving little oxygen for fish, aquatic insects, and other stream inhabitants. Pollution sensitive organisms can disappear from waters polluted by organic wastes, leaving only pollution tolerant organisms like fly larvae, aquatic worms, and leeches. In addition, bacteria levels from human or animal wastes can make water unsafe for swimming and drinking.

Excessive levels of fecal coliform throughout our watershed have lead to the classification of the many waters in our region as "unswimmable" by the NJDEP.

Sediment Pollution

Sediment pollution exists wherever the sediment load of sand, silt, mud, and soil in a waterbody exceeds that of its natural conditions. This occurs where development has stripped away the natural vegetation, removing the soil-binding root systems, creating highly erodible areas. These areas include construction sites, land cleared for housing developments, sand and gravel pits, agricultural lands, urban areas, unpaved roads, and eroding streambanks. Sediment pollution can have a detrimental impact on our waterways and their inhabitants. Excessive sedimentation is a devastating pollutant for aquatic organisms, as it interferes with foraging, predation, and breathing. Suspended sediments also block sunlight, which is the basic energy source for photosynthesis - the primary source of food in an ecosystem. Sediment can impact nutrient pollution, particularly if agricultural chemicals and fertilizers bind with soil particles and are transported to downstream waterways. Gravel bars and islands are formed from sediment deposits, which tend to cause channel changes and accelerate streambank erosion, in addition to increasing the risk of flooding.

II. CHEMICAL ACTION TEAMS
Water Quality Assessment through Measurement of Chemical Parameters

A. INTRODUCTION

StreamWatch is a citizen monitoring program that employs the watchful eyes and willing hands of volunteers to help protect water quality and habitat in the Millstone River Watershed. It was developed after research showed that no public agency was monitoring our waterways on a consistent basis. Since government agencies cannot control all the collective and individual actions that harm our environment, it is important for everyone to play a role in the stewardship of the natural world. The Chemical Action Teams (CATs) of StreamWatch, the first of our water quality monitoring programs, was developed in the spring of 1992 by Watershed staff as our response. Volunteers Lesley Barnhorn and Tim McDermott implemented it that summer.

B. PROJECT GOALS AND OBJECTIVES

StreamWatch has four overall project goals:

1. To characterize the water quality in the Millstone River Watershed, including the Stony Brook and Millstone River, their tributaries, and Carnegie Lake;

2. To involve citizens in observing, monitoring, recording, and reporting stream conditions;

3. To motivate the public to initiate change in their use of the land and drainage systems that will enhance water quality; and

4. To provide quality data to decision-makers which may bring about improvement in water quality.

The goals will be achieved by establishing short and long-term objectives, including the compilation of information gathered by other sources on watershed water quality, the publication of progress reports, sharing of collected data with local government, and conducting educational workshops and seminars on topics such as stream ecology, wetlands protection, and lawn care.

The Role of Volunteers

The basic task that will be performed on a regular basis is the monitoring of water quality by testing six basic water quality parameters: temperature, nitrate, phosphate, pH, turbidity, and dissolved oxygen. Volunteers also collect more qualitative information such as weather and visual stream conditions on each visit to the sampling locations.

Citizens who undertake monitoring of a site in a local stream or lake will become scientists carrying out an ecological study of that site. When analyzed and interpreted, detailed data collected by several individuals at contiguous sites can describe the ecology of an entire watershed. We can answer the question, "What is the quality of water in our watershed? Is water quality improving, becoming more degraded, or staying the same?" And we can then begin to answer the next question, "What actions need to be taken to further protect and improve the quality of our streams and lakes?"

The StreamWatch project is part of an outgrowth of a network of 4,500 volunteer monitoring programs across the country. These volunteer programs are responding to growing concerns about water quality; the effects of pollution; and the lack of local, state, and federal funds to monitor sites on a consistent basis.

The Use of Collected Data

The importance of StreamWatch lies in its long-term commitment and regional focus. Sampling occurs within the watershed by state agencies but not in a comprehensive manner. Since the 1980s, the NJDEP has maintained five sampling locations in our watershed. Additional sampling has occurred in conjunction with activities sponsored by local environmental groups, including the Watershed Association, and has also been undertaken through university research and by local government and private industry. However, with more than 30 monitoring locations and a plan to continue monitoring long-term, StreamWatch is unique in the Millstone River Watershed.

By using standardized sampling procedures, reporting formats, and a carefully designed data management system, the data collected by volunteer citizen monitors is of high enough quality to use as a basis for a water quality assessment. Supplemented and enhanced by data collected in other water quality monitoring efforts in the watershed, the data gathered through StreamWatch can be a very effective tool in protecting and improving the environment within our watershed. Data is shared with volunteers, the public, and municipal officials through our website, newsletter, and targeted mailings. Through our Program for Municipal Excellence, the Watershed Association has a strong relationship with many municipalities and therefore has an avenue to share data with local government and initiate positive change based on the data.

It is important to remember, however, that the field tests that we perform cannot yield as accurate and precise results as a water-testing laboratory. Field tests, in general, can be expected to have an error rate of plus or minus 10%. The data collected is most useful as a characterization tool, which indicates the areas with particularly significant water quality problems.

C. THE MONITORING PROGRAM

The core of CATs is the sampling of waters from streams and lakes in the watershed. The sampling effort focused initially on the two main branches that flow into Carnegie Lake, the Stony Brook and the Millstone River, as well as the lake itself. Sites have been added along Beden Brook, Big Bear Brook, Cranbury Brook, Devil's Brook, Harry's Brook, Honey Branch, Honey Lake, Mountain Brook, Pike Run, Rocky Brook, Shallow Brook, Six Mile Run, and Ten Mile Run.

CATs volunteers perform water quality measurements to determine temperature, pH, dissolved oxygen, concentrations of nitrate and phosphate, and turbidity. Using standardized tests, these measurements are easy to make and reflect to some extent the health of a stream. We use LaMotte field test kits to make these measurements. It is important to handle these test kits with caution! Some of the testing chemicals (reagents) can be hazardous. It is also important to make chemical measurements carefully so that the information obtained is accurate.

Introduction to Sampling Parameters

On each sampling occasion, six basic water quality parameters are tested. In this section, the meaning and significance of each parameter is explained. In the next section, testing procedures for each parameter, as well as general testing patterns, are presented.

Air and Water Temperature

Although temperature may be one of the easiest measurements to perform, it is probably one of the most important parameters to be considered. It dramatically affects the rates of chemical and biological reactions within water. Elevated water temperatures, or thermal pollution, can decrease the capability of water to hold dissolved oxygen, crucial to aquatic organisms. Thermal pollution can also impair feeding, growth, and reproduction and can cause death to aquatic organisms. Fish species vary in the level of thermal pollution they can withstand. Even a small change in temperature can drastically affect a fish's life cycle. Spawning activities, metamorphosis, and migration can be triggered at the wrong time of the year by a slight change in temperature. This, in turn, can decrease or destroy a species' chance of survival.

The temperature in all of the Stony Brook-Millstone watershed streams should be less than 29.4 degrees Celsius. If the stream temperature consistently exceeds these standards, there may be a problem with a lack of stream shading or a discharge of heated water.

During a StreamWatch sampling session, monitors measure both air and water temperature. Air temperature can influence the water temperature greatly, especially where water is shallow. Temperature is reported in degrees Celsius (°C), where 0.0 °C is the freezing point of pure fresh water.

Nitrates and Phosphates

Nitrogen makes up about 80% of the air we breathe. It's an essential component of proteins and is found in the cells of all living things. Inorganic nitrogen may exist in the "free" state as a gas, or as nitrites, nitrates, or ammonia. Organic nitrogen is found in proteins and other compounds. Acceptable nitrate levels for drinking water have been established as less than 10.0 milligrams of nitrate in one liter of water (mg/l). Unpolluted water generally has a nitrate reading of less than 1.0 mg/l. The nitrate test measures nitrate-nitrogen levels in parts per million (ppm). One ppm is equal to 1.0 mg/l.

Nitrates represent the most completely oxidized states of nitrogen commonly found in water. Nitrates in water come from soil, fertilizer runoff, leaky cesspools, sewage treatment plants, manure from livestock animal wastes, and from car exhausts. These nitrates, along with phosphates, become detrimental when they over-fertilize aquatic plants and cause accelerated eutrophication.

Eutrophication is the natural aging process of a body of water. However, an excess of nutrients such as nitrates and phosphates can greatly accelerate this natural process by stimulating excessive plant growth. These plants die more quickly than they can be decomposed, and the dead plant matter builds up. Together with the sediment entering the water, the plant matter results in a filling of the bed of the waterbody making it progressively shallower. Although the process of eutrophication may take hundreds or even thousands of years naturally, human impacts may reduce this time period to tens of years.

pH
A measure of acidity or alkalinity of the water, pH is based on a scale of 0.0 to 14.0 standard pH units. A pH of 0.0 is the most acidic, a pH of 14.0 is the most alkaline, and a pH of 7.0 is neutral. Normal rainwater is actually slightly acidic with a pH ranging from 5.5 to 6.0.

Each organism requires a certain pH range to survive, and most organisms are very susceptible to changes in pH. The pH of unpolluted water depends on the local geology and physical conditions. For example, streams draining wooded swamps usually have a pH between 5.5 and 6.5, while streams in limestone areas may have a pH of 9.0.

Low pH values (high acidity) may be caused by acid precipitation, which results when water vapor in the air becomes acidified and falls to the earth as rain. Acids can also be suddenly released during spring thaw when snow melt occurs, freeing acids concentrated in the ice over the winter months. In addition, acidic conditions may result from effluent discharges from various industries, sewage lagoons, or livestock yards.

High pH values (high alkalinity) may be caused by water treatment plant discharge or raw sewage. Natural growth processes of aquatic and marsh plants can also increase pH significantly. The photosynthetic process undertaken by aquatic plants removes carbon dioxide from the water causing the increase in pH. Therefore in waters with plant life, especially low-velocity or still waters, an increase in pH can be expected in the growing season.

We use a wide-range pH test that measures between 3.0 and 10.5. The pH for all of the watershed's streams should be between 6.5 and 8.5. The buffering capacity of water, or its ability to resist pH change, is critical to aquatic life. Generally, the ability of aquatic organisms to complete a life cycle greatly diminishes as the pH goes above 9.0 or below 5.0.

Sedimentation
Sedimentation is the process by which streams, storm runoff, and other forms of moving water carry sand, silt, clays, organic matter, and other substances into streams and lakes from the surrounding watershed. In general, the amount of material deposited into a lake or stream is directly related to the use of watershed land. Activities that clear the land and expose soil to winds and rain (i.e. agriculture, site development) may greatly increase sedimentation.

Sediment material from the watershed tends to fertilize algae and aquatic plants because essential nutrients are attached to incoming sediment particles. Further, sedimentation can ruin the lake bottom for aquatic insects and bottom dwelling creatures and negatively affect fish spawning beds.

Turbidity measures how much the sediment particles suspended in the water affect the passage of light through the water. The presence of suspended sediment may cause the water to be turbid and brownish in appearance. Suspended particles block light from penetrating into the water and may interfere with the gills of fish and the breathing mechanisms of other creatures.

Dissolved Oxygen
Dissolved oxygen (DO) is one of the most important indicators of the quality of water for aquatic life. It is essential for all plants and animals inhabiting the stream. When oxygen levels in the water fall below about 3.0 – 5.0 parts per million (ppm), fish species become stressed. At a level below 2.0 – 3.0 ppm, they cannot survive. Oxygen is a sensitive constituent because other chemicals present

in the water, biological processes, and temperature exert a major influence on its availability during the year.

Oxygen is transferred directly from the atmosphere into the surface waters by the aerating action of the wind and wave action. It is also added at or near the surface as a by-product of plant photosynthesis. As a result, floating and rooted aquatic plants increase DO levels. Since the existence of plants also depends on the availability of light, the oxygen producing processes occur only near the surface or in shallow waters.

Levels of DO tend to fluctuate daily in streams, falling at night, reaching the lowest level just before dawn, and then peaking in the late afternoon. Such fluctuation occurs mainly because of the photosynthetic processes of aquatic organisms, which are most active in the afternoon. DO levels also vary at different temperatures. As temperatures rise, DO levels fall. Table 1 illustrates this relationship at various temperatures, and gives the maximum concentration of DO that can be found at each temperature.

TABLE 1: Maximum Solubility of Dissolved Oxygen in Water.

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

DO depletion may occur for a variety of reasons. In some cases, a warm water discharge originating from a power plant will reduce the stream water's ability to dissolve oxygen. Perhaps more often, oxygen depletion may occur because of an excess of bacteria, possibly originating from a sewage plant discharge or farmland runoff, or the overgrowth of aquatic organisms such as algae. Most natural streams require at least 5.0 – 6.0 ppm of DO to support a diverse ecosystem.

In the Millstone River Watershed, DO concentrations need to remain above 4.0 ppm at all times to maintain a healthy ecosystem, as indicated by the NJDEP Surface Water Quality Standards.

Algal Bloom and Aquatic Vegetation
The proliferation of algae and aquatic plants is a significant water quality problem in our watershed. Such conditions are signs of man-induced eutrophication. The extremely slow stream velocities present particularly in the Upper Millstone further accelerate the rate of eutrophication.

Algae are photosynthetic plants that contain chlorophyll and have a simple reproductive structure but do not have tissues that differentiate into true roots, stems, or leaves. Some species are microscopic single cells, and others grow as mass aggregates of cells (colonies) or in strands (filaments). Some even resemble plants growing on the lake bottom.

Excessive growth of one or more species of algae is termed a "bloom". Algal blooms, usually occurring in response to an increased supply of nutrients, may give the water an unpleasant taste or odor, reduce clarity, and color a stream or lake a vivid green, brown, yellow, or even red depending on the species. Filamentous and colonial algae are especially troublesome because they can mass together to form scums or mats on the water surface.

Aquatic plants have true roots, stems, and leaves. Like algae they can overpopulate and become a water quality problem in streams and lakes. Aquatic plants may be either "emergent" with stems or leaves that will rise above the surface or "submergent" with all or most of the leaves and stems below the water surface. Many submergents flower above the surface.

As discussed in NJDEP's 1987 study of the Upper Millstone River:

"Most of the watershed is burdened with aquatic vegetation. Frequent algal blooms are the norm rather than the exception in the area impoundments. Carnegie Lake, followed by Peddie Lake leads the way in having the worst eutrophic problems. In addition to algal proliferation, the watershed also supports extensive submerged and emerged aquatic vegetation."

Sampling and Reporting Procedures

General Sampling Procedures
A sampling team (at least two volunteers) must start sampling between 10:00 a.m. and 12:00 p.m. on every other Saturday. A list of sampling dates is mailed to volunteers every winter, or given out on an as needed basis. If sampling cannot be performed on Saturday, it may be performed one day before or one day after the official sampling date (on the Friday or Sunday) starting between 10:00 a.m. and 12:00 p.m.

IMPORTANT NOTE: If neither of the two people responsible for each site is able to sample on a sampling weekend (Friday, Saturday, or Sunday), notify the Watershed Association at (609) 737-3735 as early as possible, or at least by the Wednesday before the sampling date so that an alternate can be scheduled to fill in for you, if one is available.

When sampling, observe the following general procedures:

- If you notice or suspect that an oil or chemical spill, or another significant water pollution incident (i.e. a fish kill) has occurred, contact the NJDEP Action Hotline at 1-877-WARNDEP (or 1-877-927-6337).

- If a personal health emergency occurs while in the field, contact the appropriate police/ambulance number for your township or borough (see Appendix C for a list of phone numbers), and/or call 911. Also, contact the Watershed Association at (609) 737-3735, as soon as possible. The Watershed Association carries liability insurance under a "green umbrella" policy that extends to all volunteers at all sampling locations.

- After you perform the chemical tests, it is imperative that you dispose of the treated sample water properly. Any water that has not been treated with a chemical may be returned to the stream. Water that has been treated should be collected in a disposal bottle, (i.e. a screw-cap plastic bottle) which has been specifically marked "POISON - DO NOT DRINK OR POUR DOWN THE DRAIN". Please do not use beverage containers, as small children may recognize the container as "something good to drink" long before they read the poison warning. You may bring a small disposal bottle to your sampling station and then empty this bottle into a larger one (preferably a laundry detergent jug) kept at home. In this case, proper warnings should be placed on both bottles. The bottles should be stored out of reach of children and brought to the Watershed Association to be properly disposed of and to receive a new bottle, if necessary.

Completing a Monitoring Data Sheet

During each sampling event, a StreamWatch Data Sheet (copy in Appendix A) should be fully completed. Apply the following guidelines when completing the data sheets:

- All data should be recorded in print on original data sheets in ballpoint pen (blue or black ink). Numeric entries should be printed clearly in the spaces provided, one digit in each blank and using the decimal place provided. Mistakes should be indicated by placing a line through the erroneous characters and entering new characters to the right of the lined-out entries and then initialed by the recorder.

- Immediately upon arrival at the sampling station enter the observer's name, station number, date, time, and observations on weather conditions, water color, and water odor. Any variation from the official sampling date (Friday, Saturday, or Sunday) or time (10:00 a.m. – 12:00 p.m.) should be noted by placing a star in the left margin next to the date or time.

- Use the LaMotte test kit to measure the following parameters: temperature, nitrate, phosphate, pH, turbidity, and dissolved oxygen. Always record the test results as you go through each test. Do not rely on your memory.

- Record temperature in degrees Celsius (^{o}C).

- For colorimeter readings, choose the value that is the closest match. If a color is between the 0.2 color value and the 0.4 color value, record as 0.3.

- Choose representative values (between 0 and 2) for the Algal Bloom Index and the Aquatic Vegetation Index. Please do not put intermediate values, such as 0.5 or 1.5, on these two indices.

- Record by type any observations of wildlife and the presence of any floatables (may include fishing gear, sewage-associated debris, domestic debris, natural debris, or other types). Finally, use the comments section to record general observations about the site (particularly note changes or anything unusual), recent notable weather, and any problems you might have had with the sampling procedures. Try to keep comments brief and to the point.

- Retain a photocopy or carbon copy of the data sheet for your own records, and mail the original the following week to:

  StreamWatch
  Stony Brook-Millstone Watershed Association
  31 Titus Mill Road
  Pennington, NJ 08534

  Or fax the data sheet to: (609) 737-3075. You may also obtain an electronic copy of the data sheet and email your results to bapril@thewatershed.org

Sampling Safety

It is extremely important to use the test kits with caution! Some of the chemical reagents have hazardous components and may be harmful if inhaled, contacted through the skin, or ingested. The LaMotte Company supplies Material Safety Data Sheets (MSDS) for each chemical, which list safety information for the specific chemicals. The MSDS will be reviewed during training sessions. If you are concerned about these chemicals, please request a copy of the MSDS for your own further review.

General Precautions

- Read all instructions to familiarize yourself with the test procedure before you begin. Note any precautions.

- Read the label on each LaMotte reagent container prior to use. Some container labels have important antidote information.

- Keep all equipment and chemicals out of the reach of young children.

- In the event of an accident or suspected poisoning, immediately call the New Jersey Poison Control Center at: 1-800-962-1253. Be prepared to give the name of the reagent in question and its LaMotte code number. LaMotte reagents are registered with POISINDEX, a computerized poison control information system available to local poison centers.

Protect Yourself and Your Equipment

- Avoid contact between reagent chemicals and skin, eye, nose, and mouth. Non-disposable gloves are provided with each test kit. In addition, you may wish to purchase disposable lab gloves for sampling.

- Use the test tube caps or stoppers, not your fingers, to cover the test tubes during shaking or mixing.

- We advise that safety goggles or glasses be worn when handling reagent chemicals.

- When dispensing reagent from a plastic squeeze bottle, hold the bottle vertically upside-down (not at an angle) and gently squeeze it (if a gentle squeeze does not suffice, the dispensing cap or plug may be clogged).

- Wipe up any reagent chemical spills, liquid or powder, as soon as they occur. If inside your home, rinse area with a wet sponge, then dry.

- Thoroughly rinse test tubes before each use with the water to be sampled.

- Thoroughly rinse test tubes after each test with either stream water or demineralized water. Dry your hands and the outside of the tubes.

- Tightly close all reagent containers immediately after use. Do not interchange caps from different containers.

- Avoid prolonged exposure of equipment and reagents to direct sunlight or extreme cold. We advise that you keep the LaMotte test kit inside your home (in a place unreachable by small children), rather than in your car or garage.

c. Equipment Re-supply

When you notice a reagent supply getting low, or if it has expired, please call and place an order at the Watershed Association immediately. We try to keep an extra stock of chemicals and equipment but may not have certain items readily available. An order can be placed with the chemical supply company, but it can take up to two weeks. Pick up for re-supplies is located in the main office at the Watershed Association.

To determine if your chemicals have expired, refer to the six-digit lot number located on the lower, left corner of the chemical's label. The lot number records the date of manufacture and identifies the reagent as part of a specific batch produced on that date. The first two digits of the lot number identify the week in which it was produced, while the third digit indicates the year in which it was produced. For example, if the first three digits of the lot number are 324, this indicates that the chemical was produced in the 32nd week of the year 2004. Using this information, along with the chemical's shelf life, allows you to determine when the chemical will expire. Refer to the chart below for the shelf life of the chemicals used in the StreamWatch program.

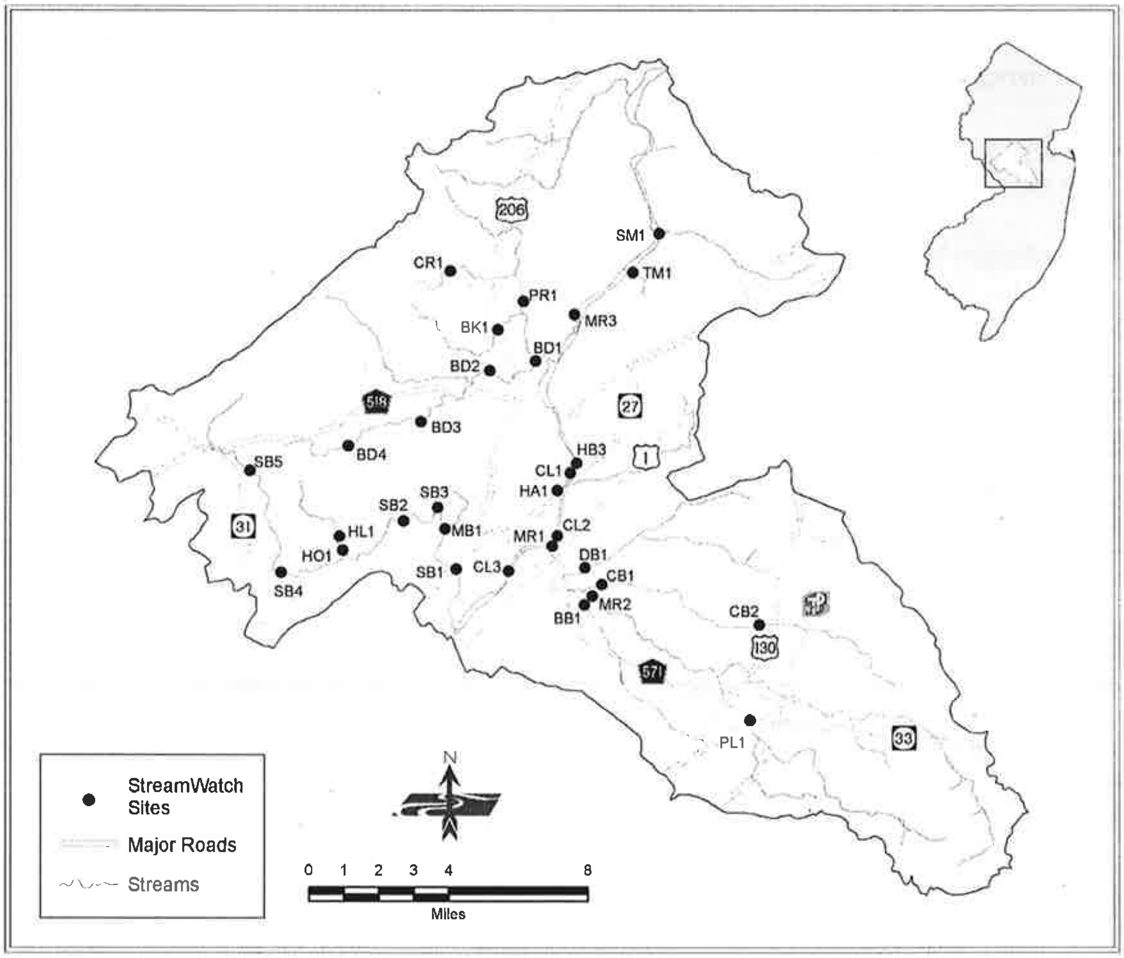
Chemical	Shelf Life
Alkaline Potassium Iodide Azide	3 years
Manganous Sulfate	3 years
Mixed Acid Reagent	3 years
Phosphate Acid Reagent	2 years
Phosphate Reducing Reagent	2 years
Sulfuric Acid	3 years
Sodium Thiosulfate	1 year

Starch Indicator Solution	1.5 years
Wide Range Indicator Solution	2 years

d. Monitoring Stations

More than 30 monitoring stations have been chosen throughout the Watershed. Their locations and the reasons for their selection are located in your site manuals. Figure 2 shows their respective locations on a map of the watershed. Generally, a team of two volunteers is responsible for each monitoring site.

On the first sampling date, the exact location for each sampling event should be determined. Thereafter, all sampling should occur from the selected location. Ensure that the site has reasonable depth to allow sample collection without stirring the bottom.



Cartography and Site Modifications performed by The GIS Center at Stony Brook, December 2006. Data Sources: New Jersey Department of Environmental Protection, New Jersey Department of Transportation and Stony Brook Millstone Watershed Association This secondary map has not been verified or authorized by the source agencies Project: 2006StreamwatchBmQAPP.mxd

Figure 2: Map of the Millstone River Watershed with monitoring sites.

Quality Assurance/Quality Control (QA/QC)

StreamWatch employs a single-blind method of evaluating procedures of all monitors. During the spring and fall we sponsor a series of QA/QC workshops. It is mandatory for all monitors to attend at least one of these sessions. Sampling procedures for all monitors are evaluated against a "known" sample. By doing this early in the sampling year, we can adjust any techniques that do not correspond with training procedures and build greater confidence into the data collected by each monitor.

D. TESTING PROCEDURES

NOTE: These sampling procedures are also located in the manual to be distributed to each team during training. The Volunteer Manual is not needed for work in the field, only to provide background and context to your work. In case of any discrepancies between this manual and the notebook, please use the instructions contained in this manual.

To collect water samples, use the sample bottles provided. A plastic bottle is provided for testing nitrate, phosphate, pH, and turbidity. Three glass bottles are provided for testing dissolved oxygen. Be sure to first rinse the sampling bottle you are using thoroughly in the water you are sampling, making sure not to stir up sediment. As always, when working in or near a body of water, take special care to provide for every detail of your safety. The particular methods for each sampling parameter are described below. All tests should be performed streamside unless inclement weather makes sampling conditions difficult. In this case, the tests for nitrate, orthophosphate, and dissolved oxygen can be completed at home. Tests for temperature, pH, and turbidity must be done in the field regardless of weather conditions.

NOTE: Tests should be conducted individually and in the order specified below for the first 2 to 3 sampling dates. As you become more familiar and comfortable with the procedures, you can begin to "double up" on the tasks involved.

Air Temperature

Before recording temperatures, always inspect the thermometer for breaks in the liquid column. If there are any breaks in the column, the thermometer will not read accurately and needs to be replaced. Locate a shady spot near your sampling station to test the air temperature. You may hang the thermometer on a tree or bush out of the direct sun. Be sure that it does not touch the ground while hanging. Wait 3-5 minutes to allow the thermometer to equilibrate before recording value to the nearest 0.5 ^{o}C.

NOTE: Always record air temperature before water temperature, as the water evaporating off the thermometer may affect the air temperature reading.

Water Temperature

Measure the water temperature in the field with the LaMotte armored thermometer. You may be able to simply place the thermometer in the stream, or you may need to attach a string to the thermometer and tie it down so that the thermometer won't be carried downstream. If possible, hold the thermometer in the stream so that the thermometer does not touch the bottom of the stream. Wait 3-5 minutes and then report temperature to the nearest 0.5 ^{o}C.

NOTE: When holding the thermometer to take the temperature readings, do not hold the thermometer by the bottom, as your body heat will affect the readings.

Nitrate and Phosphate

Both the Nitrate Test and the Phosphate Test use the same testing instruments, the Nitrate-N and Phosphate Comparator and an Axial Reader. The Comparator is similar to those used for pH and turbidity. The Axial Reader is an instrument that attaches to the Comparator and allows readings to be made on faint colors. Instructions for using the Axial Reader with either the Nitrate or Phosphate Test are provided below, followed by specific directions for the Nitrate Test and the Phosphate Test.

a. The Axial Reader

To attach the Comparator and Axial Reader (the test kit comes with them attached), hold the Axial Reader with the two arms extending towards you. Position the Octet Comparator with the color standards facing you directly above the Axial Reader arms. Press the comparator down into the arms of the Axial Reader.

To compare a test sample to the color standards on the comparator:

Step 1. Prepare a test sample in accordance with the instructions for either the Nitrate Test or the Phosphate Test.

Step 2. The Axial Reader contains six slots for test tubes: three on the left side for the Nitrate Test and three on the right side for the Phosphate Test. Place the treated test sample into the Reader's center slot (either the second from the left for Nitrate or the second from the right for Phosphate) depending on the test being performed. On either side of the test sample, place two test tubes (0230) filled to the 10 ml line with untreated water from the stream. When making measurements, leave all tubes uncapped.

Step 3. An ampoule (permanently sealed test tube) of distilled water is inserted into the square hole on the comparator unit, directly in front of the tube with treated sample.

Step 4. Slide the comparator in the reading device so that the top of the comparator is level with the top of the Axial Reader. The Comparator/Axial Reader combination is now ready for comparison of the color of the test sample with the two color standards in the upper half of the comparator. Natural color or turbidity in the test sample is automatically compensated for in the tube arrangement.

Step 5. Place the device so that light shines down through the top of the column of liquid in the sample tubes. Make sure the tubes are uncapped.

- If the color of the test sample is less than the color of the lowest value, the result is recorded as "less than (<)" the lowest value.
- If the color of the test sample matches one of the color standards in the upper half, the result is taken as the value of that color standard (i.e., equals 0.2).
- If the color of the test sample falls between these two values, it is taken as an average of these two values (i.e., >0.2 but <0.4 will = 0.3)

- If the color of the test sample is darker than the color of the top row of color standards, the comparator is moved to a position where the bottom of the Axial Reader is level with the bottom of the comparator. The comparator unit should be moved carefully within the reading device to avoid spilling the contents of the tubes.

b. The Nitrate Test

As the best results are obtained when all solutions are kept close to room temperature (23 °C), perform this test soon after arriving at your station. If inclement weather makes sampling conditions difficult, you may collect a water sample and run the test at home. The test must be run within 8 hours of collecting the water sample.

Step 1. After swishing a test tube (0844) with sample water, fill the test tube to the first line (2.5 ml) with sample water.

Step 2. Add Mixed Acid Reagent (V-6278 or V-6278-J) to the second line (5.0 ml total).

Step 3. Cap and mix. Wait at least 2 minutes before proceeding to the next step.

Step 4. Use the 0.1 g measuring spoon (0699) to add one level measure (avoid excess) of Nitrate Reducing Reagent (V-6279 or V-6279-C) to the tube.

Step 5. Cap and invert the tube 30-40 times in one minute. Wait at least 10 minutes for complete color development.

Step 6. Mix and remove cap before placing tube in the Axial Reader. (Follow directions for using Axial Reader to read result). The result is read in ppm Nitrate-Nitrogen (Nitrate-N).

Step 7. You should make and test a diluted sample if the amount of Nitrate-N is above the detection limit of 1 ppm. See instructions for making diluted water below.

Step 8. Dispose of treated water sample in Disposal Bottle and rinse test tube.

To prepare a nitrate sample diluted by four fold:

Step 1A. After swishing a 10 ml test tube (0844) with sample water, fill the test tube to the first line (2.5 ml) with sample water.

Step 2A. Add water from the Demineralizer Bottle (1152 or 1152-J) to the third line (10.0 ml total). See instructions for making demineralized water below.

Step 3A. Cap and mix thoroughly.

Step 4A. Using a 1.0 ml pipette (0354), transfer one pipette full of diluted sample to a 5 ml test tube (0820), swish, and pour out. Then use the pipette to add 2.5 ml of the diluted sample up to the first line.

Step 5A. Continue with test procedure for Nitrate Test given above beginning with Step 2.

Step 6A. DO NOT FORGET to multiply the observed test result by 4 to obtain the amount of Nitrate-N in the original sample.

To make demineralized water:

Step 1B. Remove cap of the Demineralizer Bottle (1152 or 1152-J) and fill bottle (do not overflow) with tap or distilled water.

Step 2B. Recap, make sure spout is closed, and shake vigorously for 30 seconds.

Step 3B. Open spout, invert bottle, and gently squeeze to dispense the demineralized water.

NOTE: Do not heat water over 100 degrees F, keep the resin covered with water at all times, and leave the bottle fairly full when storing. When the resin completely changes to an amber color, contact the Watershed office to obtain a new bottle.

c. <u>The Phosphate Test</u>

This test determines levels of Orthophosphates only. As it should be run on clear samples only, it is very important that the bottom sediment not be disturbed when collecting water for this sample. The best results are obtained when solutions are kept at room temperature. If inclement weather makes sampling conditions difficult, you may collect a water sample and run the test at home. The test must be run within 8 hours of collecting the water sample.

<u>Step 1.</u> After swishing a test tube (0844 or 0843) with sample water, fill the test tube to the third line (10 ml) with sample water.

<u>Step 2.</u> Use the 1.0 ml pipette (0354) to add 1.0 ml of Phosphate Acid Reagent (V-6282 or V-6282-H) to test sample, then cap and mix. Use the 0.1 g measuring spoon (0699) to add one level measure of Phosphate Reducing Reagent (V-6283 or V-6283-C). Cap and mix until dissolved.

<u>Step 3.</u> <u>Wait at least 5 minutes</u> for the color to develop.

<u>Step 4.</u> Remove the cap from test tube and place in the Axial Reader. (Follow directions for using the Axial Reader to read result). Read result in ppm Orthophosphates.

<u>Step 5.</u> Readings of less than 0.2 should be recorded as <0.2.

<u>Step 6.</u> Dispose of treated water sample in Disposal Bottle and rinse test tube.

<u>pH</u>

The water's pH is measured with a set of two Octet Comparators, each containing eight permanent color standards. One comparator reads a pH of 3.0 - 6.5 (acidic), and the second reads a pH of 7.0 - 10.5 (alkaline). For optimum color comparison, the comparator should be positioned between the operator and a light source, so that light enters through the special light-diffusing screen in the back of the comparator. Avoid viewing the comparator against direct sunlight or an irregularly lighted background. This test must be run in the field within 15 minutes of sample collection.

<u>Step 1.</u> After swishing a 5 ml test tube (0820) with sample water, fill the test tube to the line (5 ml).

Step 2. Add 10 drops of the indicator solution, Wide Range Indicator (2218-G), to the sample in the tube. Hold the dropper bottle vertically (not tilted) to dispense the uniformly sized drops.

Step 3. Cap the tube and invert 5-10 times to mix the contents.

Step 4. Insert tube into comparator and match the color of the test sample against the color standards to obtain pH.

Step 5. Dispose of treated water sample in your Disposal Bottle and rinse test tube with demineralized water.

Turbidity

The Watershed Association currently uses two methods to measure turbidity. Your kit contains either the Turbidity Comparator (4416) or the Turbidity Columns (0835). Turbidity readings must be taken in the field immediately after sample collection. Instructions for each method are described below.

Turbidity Comparator

Step 1. After swishing a 5 ml test tube (0820) with sample water, fill the test tube to the line with sample water.

Step 2. Insert test tube into the Turbidity Comparator (4416). Match the sharpness or "fuzziness" of the lines behind the sample to those behind the turbidity standards.

NOTE: Disregard any color differences between sample and standard. Match sample based on turbidity, rather than color. This means that you are comparing the cloudiness of the sample water to the cloudiness of the standard. Looking at the sharpness or "fuzziness" of the lines behind the sample can help determine the level of cloudiness.

Step 3. Record the reference number of the standard that best matches the sample turbidity. Turbidity of less than 1 should not be recorded as 0. Please record it as <1.

Turbidity Columns

Step 1. Fill one Turbidity Column (0835) to the 50 mL line with sample water. If the black dot on the bottom of the tube is not visible when looking down through the column of liquid, pour out a sufficient amount of test sample so that the tube is filled to the 25 mL line.

Step 2. Fill the second Turbidity Column (0835) with an amount of turbidity-free water that is equal to the amount of sample being measured. Distilled water is preferred; however, clear tap water may be used. This is the "clear water" tube.

Step 3. Place the two tubes side by side and note the difference in clarity. If the black dot is equally clear in both tubes, the turbidity is zero. If the black dot in the sample tube is less clear, proceed to Step 4.

Step 4. Shake the Standard Turbidity Reagent (7520 or 7520-H) vigorously. Add 0.5 mL to the "clear water" tube. Use the stirring rod (1114) to stir the contents of both tubes to equally distribute turbid particles. Check for the amount of turbidity by looking down through the solution at the black dot.

If the turbidity of the sample water is greater than that of the "clear water", continue to add Standard Turbidity Reagent in 0.5 mL increments to the "clear water" tube, mixing after each addition until the turbidity equals that of the sample. Record total amount of Standard Turbidity Reagent added.

Step 5. Each 0.5 mL addition to the 50 mL size sample is equal to 5 Jackson Turbidity Units (JTUs). If a 25 mL sample size is used, each 0.5 mL addition of the Standard Turbidity Reagent is equal to 10 JTUs. See the Table below. Rinse both tubes carefully after each determination with demineralized water.
Step 6. Using the table below, record the amount of JTUs on your data sheet. For the 50 mL size, JTU = Amount in mL x 10. For the 25 mL size, JTU=Amount in mL x 20.

Number of Measured Additions	Amount in mL	50 mL Graduation	25 mL Graduation
1	0.5	5 JTU	10 JTU
2	1.0	10 JTU	20 JTU
3	1.5	15 JTU	30 JTU
4	2.0	20 JTU	40 JTU
5	2.5	25 JTU	50 JTU
6	3.0	30 JTU	60 JTU
7	3.5	35 JTU	70 JTU
8	4.0	40 JTU	80 JTU
9	4.5	45 JTU	90 JTU
10	5.0	50 JTU	100 JTU
15	7.5	75 JTU	150 JTU
20	10.0	100 JTU	200 JTU

Dissolved Oxygen (DO)
Duplicate tests are run on each DO sample to guard against error. If the amount of DO in the second test is more than 0.6 ppm different than in the first test, you should do a third test. **Record all results, plus the average of the two closest results only.** The following procedures are taken from the LaMotte Company's kit instructions for dissolved oxygen. Please note that Steps 1-7 must be completed in the field immediately after collecting the water samples.

Step 1. Thoroughly rinse the Water Sampling Bottle (0688-DO) and the cap twice directly in the stream or pond water to be sampled. Always fill the bottle facing upstream and discard the water downstream.

Step 2. Tightly cap the mouth of the bottle, submerge the bottle to the desired depth in the stream or pond, and remove the cap while the bottle is still submerged. Allow bottle to fill with water by slowly rotating the bottle to an upright position. Be sure that the bottle is filled completely, to the point where it overflows with water.

Step 3. Tap the sides of the submerged bottle to dislodge any air bubbles clinging to the inside of the bottle. Replace the cap while the bottle is still submerged.

Step 4. Retrieve the bottle and examine it carefully to make sure that no air bubbles are trapped inside. Once a satisfactory sample has been collected, proceed immediately with Step 5.

NOTE: Be careful not to introduce air into the sample while adding reagents in Step 5. Simply drop the reagent onto the test sample, cap carefully and mix gently.

Step 5. Add 8 drops of Manganous Sulfate Solution (4167 or 4167-G) and 8 drops of Alkaline Potassium Iodide Solution (7166 or 7166-G) to each sample. Cap the bottle and mix by inverting gently several times. A solid precipitate will form. Allow the precipitate to settle below the shoulder of the bottle before proceeding (precipitate should settle within 3-5 minutes).

Step 6. Add 8 drops of Sulfuric Acid (6141WT-G). Cap and gently shake until the reagent and the precipitate have dissolved. A clear yellow to brown-orange color will develop, depending on the oxygen content of the sample.

Step 7. Repeat Steps 1-6 with the second DO Sampling Bottle.

NOTE: Following the completion of Step 6, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and fixed in the field and then carried back to the place where the test procedure is to be performed. The titration (Steps 8-14) should be completed no longer than 8 hours following fixation.

Step 8. Pour some fixed sample from a Sample Bottle into the titration bottle (0299 or 0608), swish it around, and then dispose in Disposal Bottle. Then fill the titration tube to the **20 ml line** with fixed sample and cap.

Step 9. Fill the Direct Reading Titrator (0377), a small syringe, to the 0 mark with the titrant, Sodium Thiosulfate Solution (4169 or 4169-H). To fill the Titrator, insert the Titrator into the plastic fitting of the titrant bottle, invert the bottle, and slowly withdraw the plunger until the triangle tip of the plunger is opposite the 0 mark on the scale. Then turn the bottle right side up and remove the Titrator.

NOTE: A small air bubble may develop near the plunger of the syringe. Expel the bubble by partially filling the Titrator and pumping the solution back into the inverted Sodium Thiosulfate container. Repeat the pumping action until the bubble disappears.

Step 10. Insert the Titrator into the center hole of the titration tube cap. Add one drop of Sodium Thiosulfate to the test tube; swirl the test tube to mix. Add another drop and swirl the tube. Continue the titration process one drop at a time until the yellow-brown color (close to the color of beer) is reduced to a faint yellow (close to the color of lemonade).

Step 11. Remove the Titrator and cap. Be careful not to disturb the titrator plunger, as the titration begun in Step 10 will be continued in Step 12. Add 8 drops of Starch Indicator Solution (4170) and swirl. Sample should turn dark blue.

NOTE: There is no indicative time to add the Starch Indicator Solution. It does not alter the chemical process of titration. It is added only to make the exact moment of turning the sample from blue to clear more distinct.

Step 12. Replace the cap and Titrator. Continue the titration process (described in Step 10) with the remaining Sodium Thiosulfate, until the blue color just disappears and the sample is perfectly clear. Do not add any more Sodium Thiosulfate than is necessary to produce the color change. Be sure to swirl the test tube during the titration.

Step 13. Read the test result where the plunger tip meets the scale. Record as ppm DO. Do not return extra Sodium Thiosulfate from the syringe to the Sodium Thiosulfate bottle. Rather, dispose of it in your disposal bottle.

Step 14. If the plunger tip reaches the bottom line on the Titrator scale (10 ppm) before the endpoint color change occurs, refill the Titrator and continue the titration. When recording the test result, be sure to include the value of the original amount of reagent dispensed (10 ppm).

Step 15. Carry out steps 8-14 on the second sample bottle. If the amount of DO in the second test is more than 0.6 ppm different than in the first test, you should do a third test. Record the average of the two closest results only.

Step 16. Dispose the excess treated water samples as well as the titrated samples in your Disposal Bottle and rinse the test containers with demineralized water.

Algal Bloom Index and Aquatic Vegetation Index

Record the appropriate value (0,1, or 2) of the index that best describes the condition of your site at the time of monitoring. Refer to the tables below when determining the index.

Algal Bloom Index (ABI)

ABI VALUE	DESCRIPTION
0	*Clear:* No algal blooms visible.
1	*Visible:* Nuisance algae reach a level at which filaments and/or colonies are visible, including widely scattered surface mats or streaks of algae.
2	*Extensive Blooms:* Large portions of the stream or lake are covered by surface mats of nuisance algae. Odor problems possible in localized areas.

Aquatic Vegetation Index (AVI)

AVI VALUE	DESCRIPTION
0	*None:* No vegetation present.
1	*Patchy:* Small colonies or clumps; sparse bottom coverage.
2	*Dense:* Extensive grass beds; lush meadows.

III. BIOLOGICAL ACTION TEAMS

Water Quality Assessment Through Biological Monitoring

A. INTRODUCTION

As an added dimension to water quality testing, the Watershed Association began a biological assessment program during the spring of 1995 to monitor some of the existing CATs sites. This type of monitoring involves testing for the presence of macroinvertebrates within a stream and basing water quality ratings on the abundance and sensitivities of these organisms to pollutants. The advantages of biological assessment include the following:

- Fluctuating environmental conditions can be monitored over time.
- Biological communities can be used as indicators of general ecological integrity.
- Macroinvertebrates are usually abundant in streams and sampling will have no detrimental effect on the community.
- Individuals are easily identified and established tolerance values are available.
- Due to the relatively short life cycle of the organisms within a community, impacts are easily measured and ecological changes can be seen quickly.
- Bio-assessment identifies problems within an area.
- Chemical testing can then be done to determine the exact problem or possibly identify a source.

B. THE BIOLOGICAL SAMPLING PROGRAM

The biological assessment program initially involved the monitoring of sites along the Stony Brook and Beden Brook. The locations coincide with the current CATs sites allowing for comparisons to be made between the chemical testing and biological monitoring. The USEPA in the *Rapid Bio-assessment Protocols for Use in Streams and Rivers* has established the guidelines for collection and analysis. Biological assessment monitors trends in the benthic (bottom dwelling) community and is used to determine possible problem sites for further analysis.

C. GENERAL SAMPLING AND REPORTING PROCEDURES

Sampling collections will be done three times per year, in the spring (March), summer (July), and fall (October). Sampling occurs within a two-week period prior to or on the identification day. The identification schedule is mailed to all volunteers in the winter of each year. Equipment is available at the Watershed Main Office up to two weeks before the sampling date. If you are unable to identify on the designated Saturday or are unable to sample within the sampling period please contact the Watershed Association and an alternate strategy will be arranged.

Sampling Safety

- Each set of equipment will contain a solution of 70% Ethyl Alcohol (a preserving agent) and should be kept out of the reach of children.
- In the event of an accident or suspected poisoning, immediately call the New Jersey Poison Control Center at 1-800-962-1253.
- Avoid contact between the alcohol solution and skin, eye, nose, and mouth. We have lab gloves available for sampling.
- Wipe up any chemical spills immediately with water.
- Avoid prolonged exposure of equipment and solutions to direct sunlight.
- Sampling equipment can be picked up at the Watershed prior to the sampling weekend.
- Do not walk in the streams barefoot or with open cuts.
- If you feel that sampling in the stream will put you at personal risk - DO NOT SAMPLE - but please do notify the Watershed Association of your decision.

Quality Assurance/Quality Control

The BATs program trains its volunteers in the correct habitat assessment, sample collection, and identification procedures according to EPA Rapid Bioassessment Protocol II. BATs are supervised periodically at the collection site and during the identification of macroinvertebrates. Examples of each family collected are stored at the Watershed Association to help in the identification of specimens. Following volunteer identification, 15% of the samples are sent to a lab where they will be re-identified for accuracy. If discrepancies are found between the volunteer and professional identifications, additional information regarding proper identification techniques will be distributed to the volunteers. In addition, Watershed Association staff, or outside staff knowledgeable in macroinvertebrate identification, will supervise volunteers having difficulty at the next identification day and check their samples for accuracy. Watershed Association staff will also check the identifications for all volunteers for problematic families. For example, if a QC check identifies that many volunteers are having difficulties with a Caddisfly family, Watershed Association staff will check all Caddisfly families for accuracy, and point out key identifying characteristics when necessary.

In addition, two parties (another volunteer team or AmeriCorps Watershed Ambassador) will identify 10% of all the samples on each identification day. These samples will be chosen randomly at the identification day. Multiple individuals identifying the same sample provides a check on the accuracy and precision of the identifications. If discrepancies arise between the two identifications, Watershed Association staff will check them.

Field Data Collection Sheets and Data Management

Habitat assessment data sheets are used to record information on ecological conditions, habitat type as well as any unusual occurrences found. Samples are included in Appendix A, as well as in the field notebook. Data sheets should be returned to the Watershed Association the day of identification.

Data will be maintained on the StreamWatch database and will be reviewed by members of the Watershed Association staff. Results are compiled in the StreamWatch newsletter and on SBMWA's website.

D. COLLECTION PROCEDURES

Equipment Needed

Provided by the Watershed Association:

- Collection jar(s)
- Bottle of 70% ethyl alcohol solution
- Kick seine
- Collection pan to place the sample in as it is removed from the kick seine
- Forceps to remove any remaining organisms from the seine
- Thermometer
- Clipboard (for ease of writing)
- Habitat Assessment Data sheets
- Waders
- Meter stick (for stream depth)
- Tape measure
- Rubber gloves
- Float/tennis ball (for stream flow)

Bring your own -

- Pencil (for recording data and notes; pencil will not run if the sheet should get wet)
- Watch (for measuring velocity)
- Change of clothes

Habitat Assessment

A Habitat Assessment Data Sheet is included for a habitat assessment of your site. This information is critical for the analysis of macroinvertebrate data. Complete the data sheet after collecting the macroinvertebrates to avoid disturbance of the site prior to collection.

Composition of River Bed - Estimate the make-up of the streambed, including the percentage of bedrock, boulder, rubble, gravel, sand, silt, and organic matter. The percentage should equal 100 percent. Consider the entire area from the left bank to the right bank, even where water is not present.

Percent Embeddedness - Estimate the percentage of the larger rocks and particles that are surrounded by fine silt and sand.

Depth - Select a spot typical of the sampling area; measure depths at 1-step intervals from bank to bank. If the water becomes too deep, please do not try to measure.

Current Velocity - Measure the time it takes a float/tennis ball to travel 10 feet in each of two fast sections and two slow sections of the sampling area.

Flow - Fill in the percentage of the stream channel that is exposed. The stream channel is measured from the top of the left bank to the top of the right bank.

Overhead Canopy - Stand in the center of the stream and hold your hands straight out to the side. Now move your hands upwards until your outstretched fingertips are pointing to the edges of the canopy. The percentage of 180 degrees that your hands moved from straight out to straight up is the percentage canopy cover. During the winter, estimate what the coverage would be if leaves were present.

Water Odor - Circle the best description of any smells at your site.

Algal Growth - Use the Algal Growth Index to rate the algal growth on a scale of 0 to 2 (see page 27 for description).

Bank Vegetation - Estimate the percentage and type of bank vegetation that is present at your sampling site. Determine left and right bank facing upstream. Grass refers to mowed lawn. Softwoods are evergreen trees, while hardwoods are deciduous trees. Native grasses are put in the herbaceous category.

Collection Methods

Collecting the Organisms

This process should be repeated four times in different parts of the sampling area to acquire a representative distribution. Within the sampling area, select two riffle (fast) areas and two pool (slow) areas. Select riffle areas with different depths, a deep and a shallow. Do the same for the two pool areas. Collect one sample from each area.

Step 1. Approach the collection site from downstream so as not to disrupt the area.

Step 2. One person (the "kicker") should face downstream in the riffle (or pool) area. The second person should face upstream and place the kick seine on the bottom and about 18 inches from the "kicker's" feet. If necessary, place rocks in the bottom of the net to anchor it to the stream bottom. This prevents a gap from forming between the net and the stream bottom that organisms can pass through.

Step 3. The kicker agitates the substrate in the area in front of the opening of the seine by foot for about thirty seconds. Larger rocks can be turned over by hand and rubbed off to remove organisms (be sure this is done under the water so that the current will wash the organisms into the net). The rocks should then be replaced to their original position.

Step 4. Remove the seine from the water with a forward scooping motion to trap the organisms in the net.

Step 5. To get a good overall sample of the area, collection should be done at several spots along the sample area, moving upstream as to not upset any areas that will be sampled later. Sample at least two areas of high velocity and two areas of low velocity.

NOTE: Samples should be obtained in riffle and pool areas where possible. If no riffle or pool areas are present, representative samples should be taken around the site area by agitating substrate and dipping the seine under and around vegetation. Other structures (rocks, logs, etc.) - should be sampled by hand. Visually inspect rocks and logs for attached macroinvertebrates. Gently rub them by hand to collect them in the net. Additionally, rub all surface areas of rocks and logs to capture any macroinvertebrates that may be attached. Rub them underwater, upstream of the net, so that any dislodged organisms float into the net.

Preserving the Sample

Step 1. After collecting each sample, transfer contents of kick seine into collection pan or jar, removing all organisms and vegetation from the net.

Step 2. If using collection pan, you can pour water through seine to wash organisms into pan.

Step 3. Carefully remove any organisms stuck on the net and place in the collection pan or jar (use blunt instrument and forceps if necessary). Large organic material (whole leaves, twigs, and algae) should be rinsed, inspected, and discarded from the collecting pan.

Step 4. Transfer sample from seine or collection pan into jar containing 70% ethyl alcohol to begin the preservation process.

Step 5. Securely fasten the lid and make sure the collection jar(s) is labeled with the site number.

After Obtaining the Sample

Step 1. Rinse seine and collection materials with water to remove any debris.

Step 2. Complete the Habitat Assessment Data sheet.

Identification

The composite sample will be analyzed at the Watershed Association. On the assigned identification day, come to the Watershed Association to begin the identification process. Sampling stations will be set up in the Buttinger Nature Center, Kingsford Room, or the Main Office. The organisms are identified down to family and the results recorded for analysis.

Macroinvertebrate Identification Equipment (Provided by the Watershed Association)

- Sieve
- Bucket
- Labels and pencils
- Small vials
- Lighted magnifiers
- 1" deep white trays divided into 2" grids
- Microscope
- Petri plates
- Forceps
- Wash bottles containing water

- Taxonomic keys and references
- Sample and identification recording sheets

Identification Procedure

Step 1. Prepare the Sample
Place sieve over bucket. Pour the sample through the sieve and wash off sample with water. Remove any small debris (leaves and twigs) and pick off any clinging organisms. Discard all debris. The alcohol will collect in the bucket and be disposed of properly by the Watershed Association.

Step 2. Transfer sample to the tray
Turn the sieve upside down and empty the contents into the tray; tap the sieve several times to remove all macroinvertebrates. Squirt a small amount of water over the sieve to flush organisms into the tray. Cover the tray bottom with about 1/4" water. Evenly disperse the sample over the entire tray.

Step 3. Select a random starting square
Roll a pair of dice (or one 12 sided die) and start with the square corresponding with that number. Using a magnifier use the forceps to pick all of the organisms out of that square. Any organism lying on a line separating two squares is considered to be in the square containing either the majority of its body or the square containing its head.

Step 4. Rough sort as you pick.
As each organism is picked, rough sort it into one of the compartments of a petri dish with other similar organisms. This will make the actual identification much easier.

Step 5. Start the next square
Continue to choose squares with the dice until at least 1/4 of the squares have been picked clean and at least 100 organisms have been chosen. (If 99 bugs have been picked and the square is empty, go on to the next square, and pick all of the bugs out of that square, even though the total will be well over 100. This is to eliminate any possible bias in selection).

Step 6. Begin to identify major groups and families.
Use the picture keys to identify major groups in the sample. Use the dichotomous keys to identify any organism that you are unsure of its family. If there is still any uncertainty as to what family an organism belongs in, place the specimen in a jar marked unknown with the site designation and the sampling date and a more experienced person will identify it later. As you identify each specimen, record it on the macroinvertebrate sample sheet using hash marks. Remember that neither size nor color are distinguishing characteristics!

Step 7. Finishing up
Total the number for each family and record on the sample sheet. Store the identified sample in capped vials with alcohol. Clean up workstation. Although all of the bugs were identified only 100 are used in the metrics. The numbers of bugs above 100 are removed randomly after being identified.

E. BATs DATA ANALYSIS

The data that were collected by the volunteers includes a habitat assessment and macroinvertebrate count. Since there are a large number of influences on the biological community of a stream we have interacted a number of different metrics to assess the condition of each site individually. These include rating each site on its quality as a habitat for macroinvertebrate life and then rating the quality of the community by its representative. These metrics can be easily calculated from the collected data. Finally, the streams can each be rated by comparing the quality of each site on the river to all of the other sites on the same river.

Habitat Assessment

The purpose of the habitat assessment is to rate the various physical influences on the stream community and to pinpoint whether the community is limited by poor habitats rather than by water quality. The forms allow us to assess primary, secondary, and tertiary habitat influences on a macroinvertebrate community. A rating of excellent to good indicates that there should be a healthy macroinvertebrate community present. A rating of fair to poor indicates that the community is impaired by the quality of the habitat.

Rapid Bioassessment Protocol (RPM)

This uses the tolerance of benthic macroinvertebrates to organic enrichments levels assigned to organisms identified to FAMILY level taxonomy. Families are assigned a score of 0 (intolerant) to 10 (tolerant). The biotic index is calculated by multiplying the number of each species by their assigned tolerance level and summing these, and then dividing by the total number of individuals in the sample. The biotic index was designed to measure the stream impairment due to organic waste loading rather than from inorganic inputs (e.g. toxic substances or heavy metals.)

$$FBI = \text{Sum}\,(x_i\, t_i)\ /\ n$$

Where:

FBI = Family Biotic Index
x_i = total number of individuals within each taxon (family)
t_i = tolerance value of a taxon (Using Hilsenhoff's family values)
n = total number of organisms in the sample

Total Taxa Richness

This is simply a measure of the total number of macroinvertebrate taxa identified from a sample collection. The number of taxa represented is an indicator of the general health of the stream. A reduction in taxa types may indicate a pollution stressor. Those taxa that are least tolerant to changes within the stream are the first to disappear when the stream is impacted.

EPT Richness

This measures the number of *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies) families in a collection. These three groups are the most sensitive to changes in water quality. Their absence or presence is a reliable indicator of water quality.

Percent EPT

This is a measure of the percent of the sample that consists of *Ephemeroptera* (mayflies), *Plecoptera* (stoneflies), and *Trichoptera* (caddisflies) families (EPT taxa). This is an indicator of the number of families represented that are known to be sensitive to poor water quality.

Percent Dominance

Diverse number of relatively intolerant taxa that have abundances that are relatively proportional to one another characterizes healthy macroinvertebrate communities. As water quality becomes degraded the less tolerant taxa begin to disappear and an increase in the number of more tolerant species occurs. The percent dominance measures the percentage of the sample that is represented by the family with the most individuals sampled. A high percent dominance means that the sample is not very diverse.

Scoring criteria for Stream Impairment
Taken from NJDEP Criteria for Screening Water Quality in New Jersey Streams

Metric	6	3	0
Modified Family Biotic Index (FBI)	<5	5-7	>7
Total Taxa Richness	>10	10-5	4-0
EPT Richness	>5	5-3	2-0
Percent EPT	>35	35-10	<10
Percent Dominance	<40	40-60	>60

Biological Assessment	Total Score
Non-Impaired	24-30
Moderately Impaired	9-21
Severely Impaired	0-6

Definitions

Non-impaired: Benthic community comparable to other undisturbed streams within the region. A community characterized by a maximum taxa richness, balanced taxa groups, and good representation of intolerant individuals.

Moderately Impaired: Macroinvertebrate richness is reduced, in particular EPT taxa. Taxa composition changes result in reduced community balance and intolerant taxa become absent.

Severely Impaired: A dramatic change in the benthic community has occurred. Macroinvertebrates are dominated by a few taxa that are very abundant. Tolerant taxa are the only individuals present.

IV. RIVER ACTION TEAMS

Monitoring Stream Corridor Health through Visual Assessment

A. INTRODUCTION

A visual survey is an extremely important aspect in monitoring the health and overall quality of a waterway. A visual survey is as the name implies - the periodic observation of features and characteristics of a stream and surrounding areas that provides a basic level of stream health. To accomplish this you will walk along a defined stretch of stream (a beat) observing water and land conditions and uses, and changes over time.

"Beat" Assignments

"Adopting a beat" is one way of carrying out a visual assessment. By adopting a beat you connect yourself to a local waterway and walk a length (or beat) of it on a consistent basis. Each time you walk your beat, you will find yourself becoming more familiar with its course, flow, and details. Familiarizing yourself with your adopted waterway will allow you to detect subtle changes in addition to detecting and documenting unusual observations and possible pollutants. The visual assessment will have added value if the same segment of stream is monitored each time you go out.

We have divided the waterways of our watershed into 2-mile navigable beats. For safety and efficiency purposes we will be assigning partners and beats to all whom are interested in participating. We will provide you with several maps:

- Map of your region with beat(s) and surrounding land-uses delineated;
- Road map that denotes driving directions to your beat and surrounding area you will be surveying;
- Map with access points and a parking area detailed;

You will be asked to create your own base map of your beat to assist in the compilation of data for future visual surveys. The first time you go out, you should concentrate on compiling a base map. This map should include the general shape of your waterway, major road crossings, point sources of pollution, and give an indication of surrounding land use. This base map is for your use. Make several photocopies of it. Each time you go out to your beat, this is the map you will use to mark your observations. A sample base map (Figure 3) is included as a reference (page 50).

Frequency of Monitoring

In order for this project to be a success we ask that you follow certain guidelines regarding how often to monitor. During the course of the year, you are required to survey your beat 4-6 times. After you walk your beat, we request that you submit the official Visual Survey Data Sheet and map to the Watershed Association. These will be forwarded to the New Jersey Department of Environmental Protection on an as needed basis, by Watershed Association staff. The Visual Survey Data Sheets and maps will be kept on file in the Watershed Association's Main Office and entered into a database. Along with the biological and chemical data we are collecting, they will serve as an indispensable resource in determining the overall health and quality of our waterways.

Required Monitoring
In order to lend consistency to the project, we will be monitoring through each season following the schedule as listed below:

Season	Month	Submit Data Forms, Maps, and Photos by:
Winter	February	1st week of March
Spring	May	1st week of June
Summer	July	1st week of August
Fall	October	1st week of November

In addition to seasonal information, flow information is critical. Water flow is a function of water volume and velocity. Flow is important because of its impact on water quality and on the living organisms and habitats in the stream. Large swiftly flowing rivers can receive pollution and be little affected, whereas small streams with low flows have less capacity to dilute and degrade wastes. As such, we request that you survey your beat during a time of high flow and a time of low flow:

- High Flow = Day after a storm event
- Low Flow = After 10 days of dryness

If you can arrange it so that your seasonal surveys and your flow surveys are done at the same time, that's fine (e.g. if you go out in May the day after a storm event, then you have fulfilled both your seasonal and high flow requirements).

Assessing Unusual Incidents
Occasionally, either a citizen or fellow StreamWatcher will notify the Watershed Association of an unusual situation. When this occurs, the Watershed Association will request that you assess the situation by walking your beat as soon as possible. A Visual Assessment Data Sheet and map should be submitted at that time, and, when appropriate, an Incident Report Form should be completed. (Incident Report Form is found in Section F. Reporting Unusual Incidents.)

Individual Investigation
You may want to become more familiar with your beat. We encourage you to walk your beat as frequently as you would like. Each time you venture out, you will become more aware of the surroundings. Again, we do request that each time you walk your beat you send us a Data Sheet and map.

Access and Permission

As previously mentioned, you should have received several maps during training to familiarize yourself with your beat. Be sure to follow these closely. These maps will provide you with information regarding parking areas and access points. These access points have been determined to minimize crossing onto privately owned land.

During training, you will be provided with StreamWatch identification cards. Carry these cards with you while you are conducting your visual survey. If landowners or other individuals approach you on your walk that question your presence, immediately present the card and tell them your affiliation. If a landowner appears to be concerned with your presence, attempt to explain the project. If the landowner does not appear to be satisfied, vacate the property and encourage the property owner to contact the StreamWatch Program at the Watershed Association at (609) 737-3735.

Equipment

Below, please find listed the equipment you will need for your monitoring.

NOTE: Items marked with an asterisk are optional.

Stream Survey Equipment Checklist

- A teammate (for safety and efficiency)
- Maps of your beat (beat map, access map, base map, road map, etc). For the first visual assessment, bring legal-size paper to draw base map.
- Copies of the Visual Survey Data Sheet
- Clipboard
- StreamWatch identification card
- Incident report forms
- Sturdy shoes or boots (waders or hip boots may be useful)
- Binoculars*
- Camera with film
- Foul weather gear (as appropriate)
- Insect repellent
- Pencils (if you use a pen, your data sheet is apt to run)
- Plastic bag for collecting samples from a fish kill or contaminant spill*
- Trash bags for removing litter that you may find*
- Rubber gloves*

B. CONDUCTING A VISUAL SURVEY

The Visual Survey Data Sheet is your primary tool in assisting in the assessment of the health and quality of waters in our watershed region. Please find a sample Visual Survey Data Sheet in Appendix A and a completed sample base map on page 50. This section provides you with a guide to complete the Visual Survey Data Sheet.

On your initial trip, bring with you a legal-size sheet of paper and draw a map. Mark on your map significant tributaries and roadways. This map will be where you mark your coded observations from your Visual Survey Data Sheet. Each time you submit a Visual Survey Data Sheet you must submit a copy of your map. Make sure to keep one clean copy of your map to photocopy as needed.

Using the Visual Survey Data Sheet, record observations regarding any impacts, outfall pipes, surrounding land uses, and general information. Keep your eyes and other senses open for signs of erosion, algal blooms, and any other notable features.

You are encouraged to take photos of your site, showing both good and bad observations. All photographs should be labeled in detail to clearly show what the subject of the photo is and where it was taken.

Coding on Your Map

When locating features from your visual survey on your map, please use a coding system that matches the Visual Survey Data Sheet. For example, when reporting point sources of pollution code the first one that you encounter as H-1 (point sources are section H on the data sheet) and for the second erosion problem you come across as 8-2 (erosion is the eighth element on the data sheet).

NOTE: The headings and letters listed below correspond with those on your Visual Survey Data Sheet.

C. GUIDE TO COMPLETING VISUAL SURVEY DATA SHEET & MAP

Stream Code

When you become a volunteer, you will be assigned a beat that you will monitor. Each beat is coded with a three-letter code denoting the name of the stream that you are assessing and a number denoting the reach. For example, UMR3 is the third beat of the Upper Millstone River.

A. Today's Weather

Weather plays a significant role in water quality, most notably in impacts from precipitation. As rains wash over surfaces and drain into the ground, they can carry pollutants such as road sand and salt, oil from leaking car engines, lawn and farm fertilizers, and other compounds, from the land into streams and drinking water. Precipitation can also affect the visual survey by clouding the water with sediment and pollutants, affecting water clarity, and increasing discharges from point sources.

Make a note of the type of weather that is occurring at the time that you start the visual survey. If the weather changes dramatically from the time you start and the time that you finish (e.g., heavy rains at the start but clear skies at the finish), please make a note in the Comments/Notes section of the Visual Survey Data Sheet.

B. Recent Weather

Not only does the current weather play a role in water quality, but also past weather can influence what is seen during your StreamWalk.

Make a note of the general weather that occurred in the 48 hours previous to your StreamWalk. You can use the Internet, newspaper, or other sources for this information. If weather conditions were very different during the previous two days, note this on your data sheet. For example, if it was bright and sunny one day but rained the next, circle both "strong sunlight" and "raining" on your data sheet.

C. Stream Flow

Flow speed gives an indication on the potential impact to the streambed and streambanks. As water moves faster over the bottom and along the banks, the higher the potential to strip away the soils covering them. Loss of streambed results in loss of habitat for aquatic insects and spawning areas for fish. Streambank erosion can clog waterways further downstream by depositing heavy loads of soil.

Examine the waterbody as you walk and note if the water is moving swiftly or if it is stagnant.

D. Approximate Channel Width

Streams get their appearance from a variety of sources such as gravity, water speed, and water volume. The speed and volume of a stream depends on the width of the stream as it wanders through the land.

Visually estimate the narrowest and widest channel widths over the entire course of your stream beat and note them on your data sheet. You may measure the channel widths if you like, but please note that on your Visual Survey Data Sheet.

E. Approximate Channel Depth

The speed and volume of a stream also depends on the depth of the stream. The stream depth also aids in determining the amount of vegetation that the stream can support. Shallower streams provide sunlight to greater depths than deeper stretches on the stream.

Visually estimate the shallowest and deepest channel depths over the entire course of your stream beat and note them on your data sheet. Make sure you are recording the approximate depth from mid-stream. You may measure the channel depths if you like, but please note that on your Visual Survey Data Sheet.

F. Surrounding Land Uses

The way that the surrounding lands are used is directly related to the quality of waters that wind through them. By determining how the surrounding areas are used, this allows us to gain a better understanding of the ways our waterways are impacted.

Because the potential impacts to local waterways are as varied as the types of land use, the following details as to what to look for are given for each type of land use:

Agricultural: Check for algal blooms associated with the misuse of fertilizers on cropland and orchards, and runoff from manure-laden pastures, feedlots, and compost heaps. Erosion of cropland and over-grazed pastures may lead to sediment pollution. Look for muddy water as a result of sediment pollution.

Construction: Construction practices most often lead to sedimentation of streams as they expose previously covered soils. Erosion and sediment pollution may occur if appropriate control structures are not in place. Look for cloudy or muddy water from sedimentation and for sediment deposition on the streambed.

Forested: Well-forested areas help reduce the volume and speed of runoff by filtering the water through soils and around tree trunks and roots. Loss of forested areas will cause soil erosion to increase and possibly increase impervious surfaces as these areas are prepared for development. Logging, road building, or clear cutting of trees for development may also cause erosion. Look for signs of sedimentation such as cloudy or muddy water.

Industrial: Industrial activities usually impact a stream via point source discharges of wastewater or chemicals. Look for point sources of pollution (remember to fill out the Point Sources section of the data sheet). Watch for discoloration or colored effluent, odors, excessive algal growth, or the deposition of unnatural materials. Take careful note of any unusual incidents downstream and fill out an Incident Report form as appropriate.

Residential: Residential runoff can take many forms, but is usually associated with faulty septic systems or improper lawn-care practices. Poor fertilizing practices, defective septic systems, and dumping of grass clippings may lead to organic enrichment with a resultant algal bloom. Misuse of pesticides and herbicides may cause toxic pollution. If color sheen is noticed on the water surface it may be from automobile oil dumped nearby or it might be a natural by-product of decay from upstream wetlands. Excessive white foam on the water surface may indicate the presence of detergents used to wash cars or clothes.

Sanitary Landfills/Dumps: Anything thrown away by people can end up in a sanitary landfill or dump: pesticides, paint thinners, old batteries, or other potentially damaging waste products. The many different chemicals leaving these sites make it difficult to identify specific pollutants responsible for water quality degradation. Look for signs of runoff from landfills or inflow of contaminated groundwater, such as rusty streaks in the stream bank. Excessive nutrients or toxic substances may be present, so check for algal blooms, fish kills, and other associated occurrences.

Sewage Treatment Plants/Septic Systems: Sewage treatment plants and faulty septic systems most often leak wastes that pollute waterways with organic enrichment, excessive nutrients, and possibly disease-causing bacteria. Watch for excessive algal growth associated with the release of organic matter and nutrients. In addition, keep your eyes open for sewage fungus (white cottony masses on the streambed), grayish water or excessive black silt on the bottom of your stream.

For additional information on physical indicators of pollution and their probable cause, please refer to Appendix B.

G. Litter Concentrations

Litter and debris from both natural and human activities can impact a waterway by smothering fish and insect habitat, leaching toxic metals into the environment, blocking stream reaches, and changing stream flow.

Note the litter that is present in and around the stream. Determine the origin of the litter that you find. Was the litter found in the stream or carried by the stream (water borne), was the litter found in the floodplain surrounding the stream (floodplain accumulation), or was the litter from the surrounding land (from land use)? If possible, carry a trash bag with you when you perform the visual survey so that any trash can be taken away from your beat. For example, an extensive concentration of litter was detected within the floodplain. It is marked on our map as G-2.

H. Point Sources

Point sources come from a fixed location and usually are discharged through a pipe or some other method. Point sources can come from industries, sewage treatment facilities, large livestock feeders, active mines, and other sources. Point source dischargers are required to obtain a permit before releasing wastewater to surface water. Pollutants entering a stream affect it whether or not they are permitted, however.

Take note of any pipes you see leading directly into the water. Note if there is any type of effluent flowing out of the source and whether or not there is an odor. If possible, try to determine the pipe's origin. Describe the point source as best as you can and make any comments on the Visual

Survey Data Sheet. Code and mark the point sources on your map. For example the first pipe you see would be marked as H-1, the second as H-2 and so on.

On our sample map, three pipes were found and labeled as H-1, H-2, and H-3 respectively. For each, information was provided on the data sheet.

D. ASSESSMENT MEASUREMENTS

In order to make your observations valuable to the StreamWatch program, you will be assigning scores to the observations that you will be making in the field. These scores will be summed and calculated into an overall assessment score that will be used to site out the Watershed Association's stream restoration and reforestation efforts and watershed characterizations and assessments.

Each assessment measurement is rated with a value of 1 to 4 with explanations following. A value of 1 indicates a serious water quality problem, while a score of 4 indicates no/minimal problems. Use the score that best fits your observations based on the narrative descriptions. For each assessment element, background information and a description of what to look for are provided. When in doubt about which number to assign, make a note on the data sheet about your doubt. But please still provide the best possible score based upon your observations.

NOTE: Not all assessment parameters will apply to your beat. Some observations may simply not exist in some areas (for example, there are sections of the stream that have no man-made structures). For those parameters, simply mark the score as 4.

1. Flooding

Most stream flows vary naturally throughout the year and according to the weather. Flow also varies as a result of flow regulation and/or obstructions such as dams or levees. This variation may be quite dramatic, with high water levels and flooding conditions during storm events and low flows during the hot and dry periods. Flooding is also important to maintaining the structure of the channel and the physical habitat for animals and plants.

The low flow or "baseflow" during the dry periods of summer or fall usually comes from groundwater flowing into the stream through the stream banks and bottom. Management and land use within the watershed can affect baseflow – loss of infiltration of precipitation, such as from a parking lot, reduces baseflow and increases the severity of high flow events. The withdrawal of water from streams and the placement of dams also change the normal flow patterns. A decrease in baseflow may result in a smaller portion of the channel suitable for aquatic organisms.

What to look for: An active floodplain should be inundated every 1-2 years except during a drought. Evidence of flooding includes high water marks, such as water lines, sediment deposits or stream debris. Look for these on the banks, on the streamside trees or rocks or on other structures such as road pilings.

Low flow conditions can be noted by exposed streambeds; aquatic vegetation attached to rocks or other structures and stream channel sides lacking rooted vegetation.

Regular flooding every	Flooding occurs only	Flooding only once	No flooding; channel

2-5 years; adequate summer flows	once every 5-10 years	every 25 years or summer flows reduced	entrenchment or flooding on 1-year rain events
4	3	2	1

2. Water Odor

Odors are an important indicator of stream health. This element is based on the presence and type of odor or the absence of odor. Odors can be present in the water column and/or the sediment. Many streams will have a characteristic 'natural background' odor. Stronger odors, ranging from musty to ammonia and rotten eggs to the odor of sewage, manure, chemicals or other pollutants will signal potential water quality problems.

What to look for: Stop at a section of stream and note if there is an odor different from the background odors; try to determine if it is musty, ammonia, rotten eggs, sewage, petroleum, chemicals or manure. Also note if the odor is faint or strong. Follow the same procedure with the sediment, scooping material from the streambed surface. Be careful not to come into direct contact with soil contaminated with oil, chemicals, or other possible irritants. Repeat these procedures 2-3 times to ensure you have a representative sample.

None or normal background odors	Slight musty odors	Moderate odor of ammonia or rotten eggs	Strong odor of manure, sewage, chemicals, oil or other pollutants
4	3	2	1

3. Water Color & Clarity

Water color and clarity compares turbidity, color and other visual characteristics of the stream. Turbidity measures how well light travels through water. Soil and organic particles suspended in the water column cause turbidity. Water often shows some turbidity after a storm event because particles are carried by runoff into the stream or suspended by turbulence. The water in some streams may be tea-color. This is particularly true in watersheds with extensive bog and wetland areas. This tea color should not be mistaken for turbidity.

Waters with slight nutrient enrichment may support algal communities, giving a greenish color to the water. While a slight green coloring is not an indicator of serious water quality problems, it suggests that the stream is not in optimal condition. The algae will decrease the depth that light travels. Streams with heavy loads of nutrients will have thick coatings of algae attached to the rocks and other submerged objects. In very degraded streams, floating algal mats, surface scum or other pollutants (such as dyes and other pigments) may be visible.

What to Look for: The deeper an object can be seen the lower the turbidity. This measure should be taken after a stream has had the opportunity to "settle down" following a storm. A healthy stream will not have any excessive foam or oil sheen on the surface. A pea-green color indicates nutrient enrichment beyond what the stream can naturally absorb. Look for unusual coloration in the water; this may be an indication of chemicals entering the stream.

Very clear, or clear but tea-colored; objects visible at 3-6 feet deep (less if slightly colored); no surface water oil sheen or foaming; no noticeable film on submerged objects or rocks	Occasionally cloudy, especially when stirred or after storms, but clears rapidly; objects visible at 1½ - 3 feet; may have slightly green color; no oil sheen or foam on water surface	Considerable cloudiness most of the time, and especially cloudy after storms; objects visible to ½ – 1½ feet; sluggish sections may appear pea-green when not stirred; bottom rocks or submerged objects covered with heavy green or olive-green film; may have some oil sheen or foam on surface	Very turbid or muddy appearance most of the time; objects visible to depth <½ feet; slow moving water may be murky or bright-green or brown/black from decaying algal mats; other obvious water pollutants; may have floating algal mats, surface scum, heavy colored sheen or heavy foam on surface
4	3	2	1

4. Stream Bottom

Stream bottom or embeddedness measures the degree to which gravel, cobbles, boulders and other rock substrate are surrounded by fine sediment. Embeddedness relates directly to the suitability of the stream substrate as habitat for macroinvertebrates, fish spawning, and egg incubation.

What to look for: The primary measure is the depth to which objects are buried by sediment. This assessment is made by picking up gravel or cobble with your fingers. Pull the particle out of the bed and estimate what percent of the gravel or cobble was buried. If the stream has riffles (shallow areas of stream where water flows over rocks/gravel), measure this characteristic at the tail end of a riffle. Some streams have been so smothered by fine sediment that the original stream bottom is not visible. This makes the stream bottom look like a sandy beach and makes it difficult to walk. Test for complete burial of a streambed by probing with a stick or a length of rebar.

Gravel, cobble, and boulder particles are 0-20% surrounded by fine sediment	Gravel, cobble, and boulder particles are 20-30% surrounded by fine sediment	Gravel, cobble, and boulder particles are 30-40% surrounded by fine sediment	Gravel, cobble, and boulder particles are greater than 40% surrounded by fine sediment
4	3	2	1

5. Aquatic Vegetation

The density and type of aquatic vegetation reflects the amount of nutrients in the water and, indirectly, oxygen available for fish and other aquatic animals. High levels of nutrients (nitrogen and phosphorous) promote luxuriant growth of algae and rooted macrophytes. While a little vegetation is normal in most streams and provides food and habitat for aquatic animal life, excessive amounts are not beneficial for most aquatic animals. Nighttime plant respiration and the decomposition of aquatic vegetation cause deteriorating water quality. Healthy streams have a variety of aquatic plant species represented. In unhealthy streams, water molds proliferate, the number of aquatic plant species are limited and fish experience symptoms of oxygen deprivation.

What to Look for: A little aquatic vegetation (floating or attached) may give the water a slight greenish color. If the stream has a cluttered or weedy appearance or if there are algal blooms or algal mats, you can assume the stream is relatively degraded and should be classified either a score of 1 or 2. Ask locals or fishermen you may encounter about signs of fish 'gulping' for air or fish kills. A total absence of aquatic vegetation may also signal serious water quality problems. Dense masses of slimy white, grayish green, rusty brown or black mold on the bottom or green scum on the surface are also strong indicators of a poor stream condition.

Little vegetation, many different species, uncluttered look to water; clear or slightly greenish color along entire course of water	Moderate amount of vegetation; fairly clear or slightly greenish water color	Cluttered weedy conditions; vegetation may be luxurious and green; seasonal algal blooms, greenish water color	Choked, weedy conditions or heavy algal blooms or absence of vegetation; dense masses of slimy white, grayish green, rusty brown or black water mold on bottom; very green scum esp. during periods of algal blooms
4	3	2	1

6. Surrounding Vegetation

This element considers the amount and variety of different types of vegetative cover along the streambank. This measure is another indicator of the ability of the bank to resist erosion or collapse and indicates the potential for uptake of nutrients by streamside vegetation, the control of stream scouring, the provision of stream shading and the input of organic matter into the stream. Banks with full, natural vegetation overhanging the water usually creates the best habitat for fish and macroinvertebrates.

What to look for: In most places, the best bank vegetation condition is complete cover with many different vegetation types. For example, a streambank with a combination of trees and a complete understory cover of shrubs, grass and other herbaceous growth is preferable to one that has only grass or only trees. However, some wet soil areas may not support trees.

The key here is *complete cover* and a *variety of native vegetative types*. Look for areas that lack cover, have been browsed or grazed extensively, have only a few types of vegetation or a lot of exotic non-native plants. Agricultural crop land, pasture, lawn or tree plantations that come all the way to the stream edge lack variety and are less beneficial to the stream than areas that have mixed cover.

More than 90% of the streambank surfaces	70-90% of the streambank surfaces	50-70% of the streambank surface	Less than 50% of the streambank surface

covered by vegetation, including trees, understory shrubs, grasses and herbaceous plants; thick understory with emergent trees; no evidence of vegetation disruption	covered by vegetation, but one class of plants is not well-represented; thin understory with trees dominant; some evidence of vegetation disruption	covered by vegetation; grasses and herbaceous plants dominant; very obvious evidence of vegetation disruption; patches of bare soil or closely cropped vegetation common	covered by vegetation; significant disruption of streambank vegetation evident; man-made rock and/or concrete structures evident.
4	3	2	1

7. Man-Made Structures

Streams naturally meander through a valley bottom. The channel of a stream is the area outlined by the banks and the stream bottom. Often development in the stream's watershed results in a meandering pattern and stream flow changes. These changes may affect the way a stream naturally does its work, such as the transport of sediment, development and maintenance of habitat for fish, aquatic insects and plants, and the transfer of oxygen into the water.

Some of the modifications may not be noticeable to you because they are located upstream and may not be accessible or visible from where you are making the assessment. Some modifications have more impact on stream health than others. For example, channelization and dams affect a stream more than the presence of pilings or other supports for road crossings.

What to look for: Signs of channelization or straightening of the stream; this may include:

- An unnaturally straight stream section
- Unnaturally high berms or embankments on either streamside
- Lack of flow diversity (all flow is at the same depth)

Common structures indicating stream channel changes include:

- Dams
- Irrigation diversions
- Drainage pipes
- Bridge abutments & culverts
- Riprap (rock/concrete set against the streambanks)

In newly channeled reaches vegetation may be missing or appear very different (different species, not as well developed) from the bank vegetation of areas that were not channeled.

Natural channel; frequent bends; no structures, dikes or levees	Evidence of past channelization > 20 years ago; no recent modifications	Riprap present (<50% of reach) or other structures present	Extensive riprap (>50% of reach) or other channel modifications
4	3	2	1

8. Erosion

Erosion measures the existence or potential for detachment of soil from the upper and lower stream banks and its movement into streams. Steep banks are more susceptible to erosion or collapse. Complete vegetative cover helps stabilize the banks; roots from trees, shrubs and even grasses are important in providing bank support. Soil types at the surface and below the surface also determine bank stability. For example, banks with a thin soil cover over gravel or sand are more prone to collapse than are banks in which there is a deep soil layer.

What to look for: Signs of erosion include unvegetated stretches, exposed tree roots, or scalloped edges. Evidence of construction, vehicular or animal paths near the banks or paths that lead directly to the water edge suggests conditions that may lead to bank collapse. Estimate the size or area of the affected bank relative to the total bank area; this can be expressed as a percentage and compared to the descriptions.

Banks stable; erosion or bank failure absent or minimal; little potential for future problems; <5% of bank affected	Moderately stable; infrequent, small areas of erosion mostly healed over; 5-30% of banks in reach have areas of erosion	Moderately unstable; 30-60% of banks in reach have areas of erosion; high erosion potential during floods	Unstable; many eroded areas; "raw" areas frequently along straight sections and bends; obvious bank sloughing; 60-100% of banks have erosion scars
4	3	2	1

9. Riparian Zone Width

This element is the natural vegetation zone width from the edge of the upper streambank out into the floodplain. The riparian vegetation zone performs many beneficial functions, such as:

- Serving as a buffer zone for pollutants entering a stream from runoff
- Controlling erosion
- Dissipating energy during flood events
- Enhancing the physical habitat of the stream
- Being a source of organic material for the stream.

The type, timing, intensity and extent of activities in riparian zones are critical in determining the impact on these areas. Narrow riparian zones and/or riparian zones that have roads, agricultural activities, residential or commercial structures, or significant areas of bare soils have reduced stream protection value.

What to look for: The potential for impact to the stream is the greatest if the disturbance is close to the stream. Therefore, the level of disturbance and distance from the stream are used to score this element. Most riparian areas have had some disturbance; however, unless the disturbance is permanent or is intensive, the riparian areas will usually recover.

Estimate the distance of any disturbance from the stream and note the type and extent of this disturbance at the site. Note if the disturbance is something permanent, such as a parking lot or structure or involves the removal of trees to extend a pasture or lawn. Note if there are well-worn paths, and if these paths lead to the stream. Healthy riparian zones on both sides of the stream are important for the health of the entire system. Examine both sides of the stream. If one side is lacking the protective vegetative cover, the entire reach of the stream will be affected.

Human activity within 100 feet	Human activity within 40-100 feet	Human activity within 20-40 feet	Significant disturbance within 20 feet
4	3	2	1

10. Canopy

Stream shading keeps the water cool and limits algal growth. Streamside vegetation is important because it provides stream surface shading. Cold water has a greater oxygen holding capacity than warm water. When streamside trees are removed, the stream is exposed to the warming effects of the sun, causing water temperatures to increase. This shift in light intensity and temperature will cause certain species of fish, invertebrates and some aquatic plants to decline in number and they may be replaced altogether by species that require or are more tolerant of increased light intensity, reduced amounts of dissolved oxygen, and warmer water temperatures.

For example, trout require cool oxygen-rich waters. Loss of streamside vegetation (and also channel widening) that cause increased water temperature and decreased oxygen levels have been cited as major factors to the decrease in abundance of trout from streams that historically supported them. Increased light and the warmer water also promote excessive growth of submerged macrophytes and algae, which also compromise the aquatic life in the stream. The temperature at the reach you are assessing can also be affected by the amount of shading 2-3 miles upstream.

What to look for: Time of year, time of day, and weather can affect the amount of canopy covering a stream. Therefore, the relative amount of shade is estimated by assuming that the sun is directly overhead and the vegetation is in full leaf-out. First evaluate the shading condition for the reach; then, if possible, determine, by review of aerial photos, StreamWalking, or conversations with other StreamWalkers, shading conditions 2-3 miles upstream.

25-75% of water surface shaded; mixture of shading conditions	>75% shaded; full canopy; same shading condition throughout the reach	THERE IS NO #2 RATING FOR THIS MEASURMENT.	<25% of water surface in reach shaded
4	3	2	1

E. SEVERITY, CORRECTIBILITY, AND ACCESSIBILITY SCORES

To help prioritize future restoration work, all problem sites are evaluated and scored on a scale of 1 to 5 for three separate areas: problem severity, correctability, and accessibility. These scores are subjective and based on your evaluation at the time of the survey. The rating should be viewed as your opinion on the worst problem within a specific problem category and which problems you believe would be the easiest to correct. The scores provide a starting point for more detailed follow up evaluations by Stony Brook-Millstone Watershed Association staff. This is done by reviewing both the data and photographs collected by you and can also involve follow up visits. As additional information about a specific problem site is obtained, the site's severity, correctability, and/or accessibility scores can change.

NOTE: Scores for severity, correctability, and accessibility run from 1 through 5. However, examples for what a score of 1, 3, or 5 might represent are given. Scores of 2 and 4 represent intermediate conditions for each visual measurement.

NOTE: Not all observations from the Visual Survey Data Sheet will get a correctability or accessibility score. Those that do not receive one or both of these scores do not have boxes to be filled out on the Visual Survey Data Sheet.

Severity Score is a rating on how bad a specific problem is relative to other problems in the same problem category. It is used to answer questions such as, where did field crews believe the worst erosion problems were, or where was the largest section of stream with an inadequate buffer? In general, the scoring is based on the overall impression of the survey team of the severity of the problem.

- A score of 1 is for the severest problems that appear to have a direct and wide reaching impact on the stream's aquatic resources. Within a specific problem category, a score of 1 indicates that the problem is among the worst that the field teams have seen or would expect to see. Rating is based on comparison to good and bad sites seen during the surveyed stream beat. Examples would include a discharge from a pipe that was discoloring the water over a long stream stretch (>1/2 mile) or a long section of stream (>1/2 mile) that had incised several feet with unstable banks that are showing signs of eroding at a fast rate.

- Score of 3 is for moderately severe problems that appear to be having some adverse impacts at a specific site. While a rating of 3 would indicate that field crews did believe it was a significant problem it also indicates that they have either seen or would expect to see much worse problems in that specific category. Examples would include a small fish blockage that may be passable by strong swimming fish, but was a barrier to other species, or a site where several hundred feet of stream had an inadequate forest buffer but the banks do have vegetation on them and are stable.

- A rating of 5 is for minor problems that do not appear to be having a significant impact on stream and aquatic resources. A rating of 5 indicates that a problem was present but compared to other problems in the same category it would be considered minor. An example would include an outfall pipe from a stormwater management structure that does not have any erosion problem either at the outfall or downstream.

Correctability Score provides a relative measure of how easily the field teams believe it would be to correct a specific problem. The correctability score can be helpful in determining which problems to initially examine when developing a restoration plan for a drainage basin. One restoration strategy would be to initially target the severest problems that are the easiest to fix. The correctability rating can also be useful in identifying simple projects that can be done by volunteers, as opposed to projects that require more significant engineering efforts.

- Rating of 1 is for minor problems that could be corrected quickly and easily using hand labor, with a minimum amount of planning. These types of projects would usually not need any Federal, State, or local government permits. It is a job that small groups of volunteers (10 people or less) could fix in less than a day without using heavy equipment, and is 200 feet long or less. Examples would be removing debris from a blocked culvert pipe, removing less than two truck loads of trash from an easily accessible area, or planting trees along a short stretch of stream as part of a streambank restoration.

- A score of 3 is for moderate size problems that may require a piece of equipment, such as a backhoe, and some planning to correct. This would not be the type of project that volunteers would do by themselves, although volunteers could assist in some aspects of the project, such as final landscaping. This type of project would usually require a week or more to complete. The project may require some local, State, or Federal government notification or permits, however, environmental disturbance would be small and approval should be easy to obtain.

- A score of 5 is for major restoration problems that would require a large expensive effort to correct. These projects would usually require heavy equipment, significant amount of funding ($100,000 or more), and construction could take a month or more. The amount of disturbance would be large and the project would need to obtain a variety of Federal, State, and/or local permits. Examples would include a potential restoration area where the stream has deeply incised several feet over a long distance (i.e., several thousand feet) or a fish blockage at a large dam.

Accessibility Score is a relative measure of how difficult it is to reach a specific problem site. The field survey team standing at a site, using their field map and field observations makes the rating. While factors such as land ownership and surrounding land use can enter into the field judgment of accessibility, the rating assumes that some access to the site could be obtained if properly requested.

- A score of 1 is for a site that is easily accessible either by a vehicle or on foot. Examples would include a problem site is an open area inside a public park where there is sufficient room to park safely near the site. If heavy equipment was needed, it could easily access the site using existing roads or trails.

- A score of 3 is for sites that are easily accessible by foot but not easily accessible by a vehicle. Examples would include a stream section that could be reached by crossing a large field or a site that was accessible only by 4-wheel drive vehicles.

- A score of 5 is for sites that are difficult to reach both on foot and by a vehicle. Examples would include a site on private land where there are no roads or trails nearby. To reach the site it would be necessary to hike over a mile. If equipment were needed to do the restoration work, an access road would need to be built over a long distance through rough terrain.

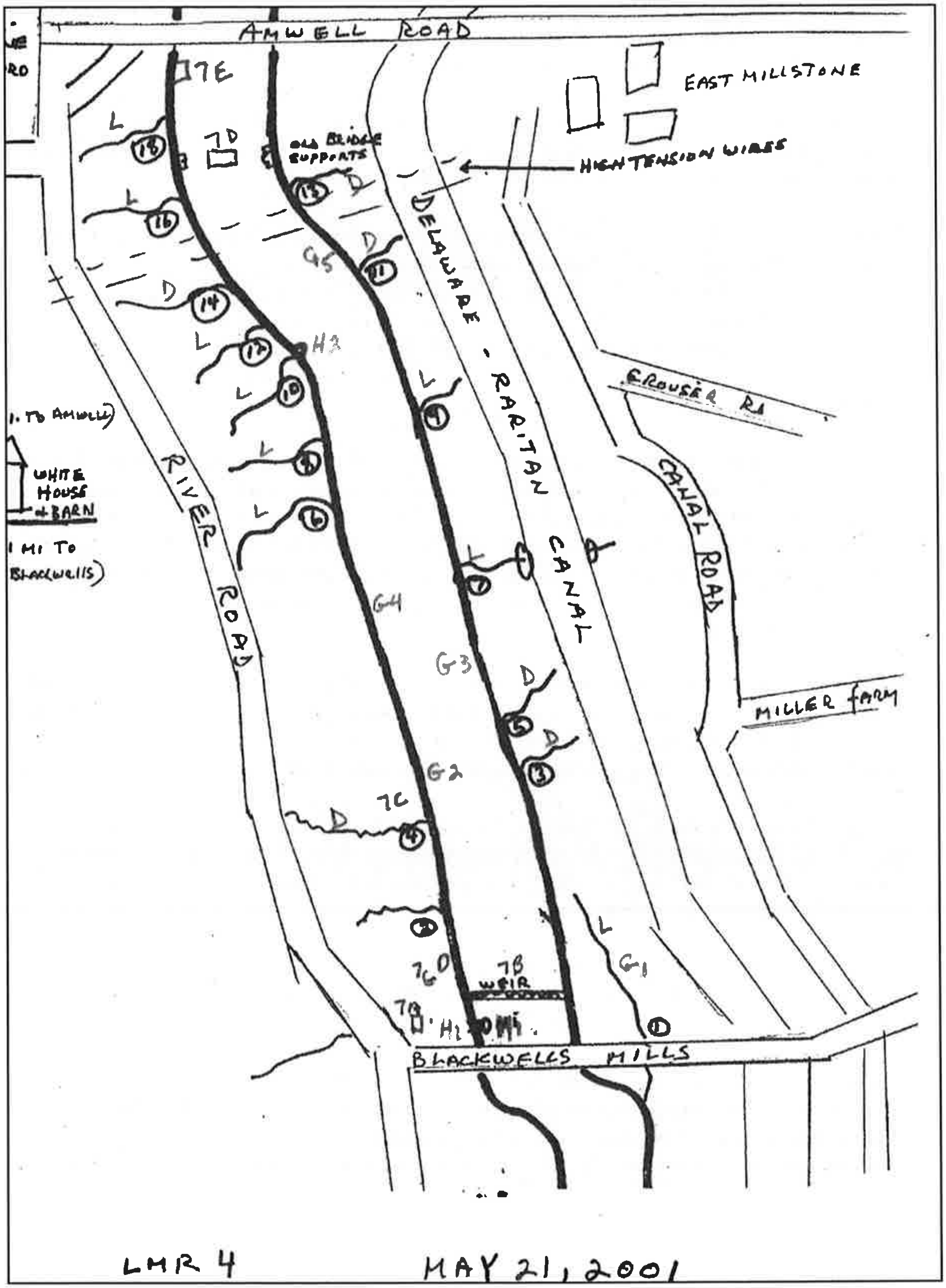


Figure 3: Sample RATs base map.

F. REPORTING UNUSUAL INCIDENTS

Your monitoring work adds to the number of eyes and ears on the waterways ready to detect unusual incidents that should be reported. Reporting suspected pollution, fishkills, and dramatic changes is vital.

Below are listed situations from Delaware Riverkeeper's *StreamWatch Guidelines* that you might encounter:

a. Fish kills:
Observations of numerous dead fish or unusual behavior of fish or macroinvertebrates should be noted under miscellaneous observations. Strange behavior would include numerous fish rising to the surface of the water for air. In the event of a fish kill, note the number and kinds of dead fish, the exact location of the kill and time it was first observed. Even if you are unable to identify the fish, it is helpful to know how many kinds of fish are involved (a single species could indicate that "natural" conditions caused a fish kill). If the kill is on going or very recent, collect 3 or 4 of the freshest fish, wrap them in aluminum foil, or place them into a Ziploc bag and put them on ice. DO NOT FREEZE! Call the NJDEP's Emergency Hotline immediately and notify the Watershed Association as soon as possible.

b. Spills and other suspected pollution:
Any sign of serious pollution or other hazard requiring immediate attention should be reported as soon as possible to the NJDEP Hotline (1-877-WARNDEP) and to the Watershed Association.

c. Soil erosion and sediment pollution:
Serious erosion problems should be reported to your local county conservation district. The USDA Natural Resources Conservation Service and/or the state agency are important resources. You should also alert the local municipality about the problem and as always, notify the Watershed Association.

d. Dredging and filling:
If you witness these activities, they may or may not be illegal. The local municipality or county conservation district usually track wetlands or stream encroachment permits. If not, your regional office of the NJDEP should be contacted (see page 53 for contact numbers). Note when and where the activity occurred. If you can, get the name of the company performing the activity. Be alert for proposed projects or "For Sale" signs, which may involve wetlands, floodplains, ponds, and streams.

e. Dumping:
If you witness illegal dumping into a stream, floodplain or wetland, immediately call the local police department. Local and state police can be most helpful for incidents that require an immediate response such as spills and illegal dumping they are frequently able to contact a spill response team directly from their patrol cars. You will also want to contact the Watershed Association and the NJDEP Hotline in the event of the dumping of any toxic chemicals.

In the event of algal blooms, excessive foam accumulation, sewage fungus/chlorine or rotten egg odor, please contact the Watershed Association.

INCIDENT REPORT FORM

DATE: ______________ TIME: _________ SEGMENT CODE: ___________
LOCATION OF ACCESS POINT: ____
(STREET ADDRESS/ MUNICIPALITY) _______________________________________
WITNESS NAME/ PHONE ____
TODAY'S WEATHER ____
RECENT WEATHER ____

EMERGENCY POLLUTION CATEGORY
If you observe any of the following emergency pollution incidents, immediately contact your local police department or call the NJDEP Environmental Emergency Action line at (877) WARN-DEP.

_____ 1. Colorful liquids (red, blue, yellow, etc.) or liquids accompanied by suds foam or a chemical sheen or odors flowing from an outfall pipe into waterway.

_____ 2. Fish kills or oil slicks and sheens on waterway that may be traceable to a pipe or land source.

_____ 3. Tanker trucks or other vehicles stopped next to manholes or discharging materials into a storm drain.

_____ 4. Dumping or puncturing chemical drums near catch basin or waterway.

_____ 5. Barges or other vessels discharging drums or other materials into the water.

_____ 6. Medical waste, including needles, syringes and vials.

Description:

AGENCY(IES) NOTIFIED: __________________________ DATE: ________________
NAME/ID OF AGENCY REPRESENTATIVE(S) ___________ ______________________
NAME/ID OF INDIVIDUAL REFERRED TO: ___________________________________
CASE NUMBER: ____

REPORT INCIDENT TO APPROPRIATE ACENCIES. CALL IN THIS REPORT TO THE WATERSHED ASSOCIATION (609) 737-3735. BE SURE TO MAIL OR FAX A COPY OF THIS REPORT TO SBMWA-STREAMWATCH DATA CENTER, 31 TITUS MILL RD., PENNINGTON, NJ 08534. FAX (609) 737-3075.

NON-EMERGENCY POLLUTION CATEGORY

_____ 7. Dead vegetation in area, which is otherwise flourishing.

_____ 8. Areas of dead vegetation accompanied by a chemical odor.

_____ 9. Discharge pipes leading from a business, factory or other unknown source into the water.

_____ 10. Surreptitious (hidden) pipes or hoses near waterways.

_____ 11. Junkyards along shorelines

_____ 12. Sunken barges and boats, or decaying piers, pilings and bulkheads.

_____ 13. Abandoned vehicles or appliances.

_____ 14. Large accumulation of solid waste along the shore lines (tires etc.) be specific

_____ 15. Large quantities of floatable objects or solid waste discarded along waterways

_____ 16. Other ____

Description:

FOR THESE NON-EMERGENCY SIGHTINGS, PLEASE CONTACT THE WATERSHED ASSOCIATION AND THE APPROPRIATE NJDEP REGIONAL ENFORCEMENT OFFICE FOR YOUR COUNTY:

CENTRAL BUREAU
Mercer, Middlesex, Monmouth
(609) 584-4200

NORTHERN BUREAU
Hunterdon, Somerset
(973) 656-4099

INDIVIDUAL TAKING COMPLAINT/ID NUMBER:

____

____

____

____

Appendix A
StreamWatch Data Sheets

Appendix B
Physical Indicators of Pollution

In all cases, please mark these indicators on your Visual Survey Sheet and contact the Watershed Association immediately if a serious problem is apparent. Indicators with an asterisk are indicators that are frequently confused with naturally occurring phenomenon.

IF YOU NOTICE	*PROBABLE CAUSE*

WATER COLOR

MUDDY, TURBID WATERS	SOIL EROSION

You Should: Search upstream for disturbed ground left open to rainfall and contact your local Soil Conservation District

*YELLOW/BROWN-DARK BROWN WATER	NATURALLY OCCURING PLANT DECAY

You Should: Take note but move on. This coloration occurs naturally each fall when dead leaves collect in the water. Brownish water can be a result of tannic acid, which is a natural byproduct of bark and leaf decomposition.

GREEN OR BLUE/GREEN WATER	ALGAL BLOOM

You Should: Check upstream for possible fertilizer or manure run-off areas, sewage discharge landfill run-off or septic system failure. If identified, contact the appropriate DEP Office for your region.

GRAY WATER/EXCESSIVE BLACK SILT ON BED	SEWAGE/LIVESTOCK WASTE

You Should: Check surrounding land uses. Contact the appropriate DEP Office for your region, the Watershed Association, and your county health department.

SURFACE OR BOTTOM COATINGS

YELLOW, ORANGE OR RED COLOR STREAKING BED	MINE/INDUSTRIAL POLLUTION LANDFILL LEACHING

You Should: Check surrounding land uses and upstream for industrial wastes or landfill seepage draining into the water body. Contact the Watershed Association.

EXCESSIVE ALGAE	NUTRIENT LOADING FROM SEWAGE OR YARDS

You Should: Examine surrounding land use closely attempting to identify probable source(s). Contact the Watershed Association.

*FISH KILL	ACCOMPANIMENT OF ANNUAL SPAWNING OR INDICATOR OF A SERIOUS PROBLEM

You Should: Use your other senses and knowledge of surrounding uses to determine if the kill warrants serious consideration. Contact the DEP Emergency hotline and your local police. Talk pictures if possible. Check the section in this manual for reporting unusual incidents for further information.

*MULTI-COLOR SHEEN/REFLECTION WITH AN ODOR	BYPRODUCT OF NATURAL DECAY OIL SPILL

You Should: an oily sheen can be a byproduct of natural decay. If accompanied by an odor, what you're seeing is most likely the result of a spill of sorts. Check closely upstream for source; waste oil may have been dumped nearby. If warranted, contact the DEP hotline. If you are unsure, contact the Watershed Association.

*WHITE COTTONY MASSES ON THE STREAMBED	ANIMALS OR SEWAGE FUNGUS

You Should: Use your sense of smell and your knowledge of the surrounding area. Some animals, like bryozoa, could be described as "white cottony masses". Check for sewage and/or other organic pollution. Contact the Watershed Association. You might be referred to the appropriate DEP Office for your region.

*WHITE FOAM ON SURFACE	IF MORE THAN 3" HIGH MOST LIKELY RESULTING FROM USE OF HOUSEHOLD/INDUSTRIAL DETERGENTS IF LESS, MOST LIKELY NATURALLY OCCURING.

You Should: Check upstream for industrial or residential waste being discharged. Foam occurs naturally in healthy water bodies. Foam that accumulates, however, in excess of 3" and which is white, not cream colored, can be an indicator of excessive phosphates. Take pictures if possible, and contact the Watershed Association and the County Health Department.

<u>STREAM ODOR</u>

*ROTTEN EGG ODOR	SEWAGE POLLUTION

You Should: Take note. If recurrent, contact the Watershed Association.

MUSKY ODOR	DECOMPOSITION OF SEWAGE, ALGAE OR LIVESTOCK WASTE

You Should: Contact the Watershed Association.

CHLORINE ODOR	CHLORINE RELEASE FROM SEWAGE TREATMENT PLANT

You Should: Determine surrounding land use and survey for other possible discharge points. Contact the Watershed Association

Source: Delaware Riverkeeper StreamWatch Guidelines

Appendix C
Environmental Emergency/Incident Reporting Phone Numbers

DEPARTMENT OF ENVIRONMENTAL PROTECTION

- Emergency Hotline: 1-877-WARNDEP
  (1-877-927-6337)

Please contact this hotline only if the incident is an emergency requiring immediate attention. Call this number in the case of a fish kill, a spill of waste oil or toxic chemicals, sighting of chemical drums or a case of illegal dumping. Please contact the appropriate staff member at the Watershed Association immediately at (609) 737-3735.

- Non-Emergency Reporting

Central Bureau: Mercer, Middlesex, & Monmouth Counties: (609) 584-4200
Northern Bureau: Hunterdon & Somerset Counties: (973) 656-4099

US FISH & WILDLIFE SERVICE

New Jersey Field Office: (609) 646-9310

SOIL CONSERVATION DISTRICTS

Hunterdon County:	(908) 782-3915 or (908) 788-1397
Mercer County:	(609) 586-9603
Middlesex County:	(732) 683-8500
Monmouth County:	(732) 683-8500
Somerset County:	(908) 526-2701

COUNTY/TOWNSHIP HEALTH DEPARTMENTS

HUNTERDON COUNTY:

East Amwell:	(908) 778-1351
West Amwell:	(908) 778-1351

MERCER COUNTY:

East Windsor:	(609) 443-4000
Hightstown:	(609) 443-4000
Hopewell Borough and Township:	(609) 737-0120
Lawrence Township:	(609) 844-7089
Pennington:	(609) 737-0120
Princeton Borough and Township:	(609) 497-7608
Washington:	(609) 259-3443
West Windsor:	(609) 799-2400

MIDDLESEX COUNTY:

Cranbury:	(908) 494-6742
East Brunswick:	(908) 494-6742
Franklin:	(908) 873-2500
Monroe Township:	(908) 494-6742

North Brunswick:	(908) 494-6742
Plainsboro:	(908) 494-6742
South Brunswick:	(908) 329-4000

MONMOUTH COUNTY:

Manalapan:	(908) 446-3200
Millstone Township:	(908) 294-2060
Roosevelt:	(908) 431-7456

SOMERSET COUNTY:

Hillsborough:	(908) 369-4313
Manville:	(908) 725-2300
Millstone Borough:	(908) 369-4313
Montgomery:	(908) 859-8211
Rocky Hill:	(908) 329-4000

PERSONAL/MEDICAL EMERGENCY NUMBERS

In case of an accident, contact the appropriate emergency number and report the accident as soon afterwards as possible to the Stony Brook-Millstone Watershed Association at (609) 737-3735 (weekdays 9 a.m. to 5 p.m.).

For Poisoning By Chemical Reagents:

Poison Control Center:	(800) 962-1253

[Be prepared to give the name of the reagent in question and its LaMotte code number]

Police/Ambulance:

Hopewell Borough	(609) 737-3100
Hopewell Township	(609) 737-3100
Pennington	(609) 737-2020
Plainsboro	(609) 799-2333
Princeton Borough	(609) 924-4141
Princeton Township	(609) 921-2100
West Windsor	(609) 799-1222

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APPENDIX D
CATs Sampling Site Descriptions

Descriptions of the 36 sampling locations and the rationale behind their selection are provided below. In general, the program strives to include sampling sites throughout all areas of the Stony Brook-Millstone Watershed.

BEDEN BROOK

Station BD1, Beden Brook at River Road
Location: Just past Pike Run Bridge on River Road just north of Route 206. Walk directly back through spring and summer growth to stream.

Rationale: Assess contribution of Pike Run on Beden Brook's water quality. Data from BD1 can be compared to data collected at sites BD2, BD3 and BD4, which are upstream from the confluence with Pike Run and therefore are not affected by contributions from Pike Run

Station BD2, Beden Brook at Opossum Road
Location: Sample just upstream of the old stone bridge on the right bank (facing upstream).

Rationale: Assess the contribution of Rock Brook on Beden Brook's water quality.

Station BD3, Beden Brook at Great Road
Location: As Great Road passes over Beden Brook, before the Cherry Valley Country Club. Sample downstream of the bridge.

Rationale: Assess the contribution from two golf courses located just upstream from the site.

Station BD4, Beden Brook at Aunt Molly Road
Location: At bend as road crosses over Beden Brook just before the sewage treatment plant. Sample upstream of bridge.

Rationale: Create a baseline assessment for Beden Brook, as this site is located near the stream's headwaters.

HONEY BROOK

Station HO1, Honey Brook at Elm Ridge Road
Location: Sample downstream of the Elm Ridge Road bridge on the left bank (facing upstream).

Rationale: To assess the contribution of Honey Brook on Stony Brook's water quality.

Station HO2, Honey Brook at Wargo Road
Location: Sample upstream of Wargo Road. Site is accessible via trial on SBMWA property. This site is located downstream of the pond on SBMWA's property.

Rationale: To assess the contribution of the pond on Honey Brook's water quality.

Station HO3, Honey Brook on SBMWA Property
Location: Sample upstream of the footbridge on SBMWA's pond trail. This site is located upstream of the pond on SBMWA's property.

Rationale: To determine Honey Brook's water quality prior to entering the pond and assess its contribution to the pond's water quality.

Station HL1, Honey Lake at West Shore Drive
Location: Sample from the homeowner's dock at 51 West Shore Drive.

Rationale: To assess the homeowner contributions to the lake resulting from fertilizer use on lawns and gardens as well as pet and animal waste.

MILLSTONE RIVER

Station CL1, Millstone River as it exits Carnegie Lake, below dam
Location: Downstream from the Carnegie Lake dam on the Millstone River. Sample just downstream of the paved pedestrian bridge before the confluence with Heathcote Brook.

Rationale: To measure the effect of Carnegie Lake on the Millstone River as it flows north to the Raritan.

Station MRA, Millstone River at Stillhouse Road
Location: Sample upstream of the Stillhouse Road bridge. This site is located near the Millstone River's headwaters.

Rationale: This site was established in 2007 to expand coverage into the eastern/southern portion of the Watershed and gain a better understanding of the Millstone River's water quality.

Station MRC, Millstone River at Applegarth Road
Location: Sample downstream of the Applegarth Road bridge. Access is through the parking lot of the Applegarth Road Firehouse.

Rationale: This site was established in 2007 to expand coverage into the eastern/southern portion of the Watershed and gain a better understanding of the Millstone River's water quality.

Station MR1, Millstone River at Lake Carnegie
Location: At the mouth of the Millstone River, before it enters Lake Carnegie. This site is located off Mapleton Road, east of Route 1, at the access to the tow-path.

Rationale: To measure the net contribution of the Millstone River on Lake Carnegie.

Station MR2, Millstone River at Millstone Road
Location: On the Millstone River just upstream from the Millstone Road bridge.

Rationale: Indicates water quality before the entrance of any of the main tributaries we are sampling.

Station MR3, Millstone River at Griggstown Causeway
Location: Sample the Millstone River near River Road, upstream of the Griggstown Causeway.

Rationale: To gain a better understanding of the water quality on the Lower Millstone River.

STONY BROOK

Station CL3, Stony Brook at Alexander Road
Location: Sample the Stony Brook upstream of the Alexander Road bridge. Collect sample from the left bank (facing upstream) near the park bench and wooden stairs. This site is near the confluence with Carnegie Lake.

Rationale: To measure the contribution of the Stony Brook on Carnegie Lake.

Station SB1, Stony Brook at Route 206
Location: Approximately 25 feet downstream of the bridge on Route 206.

Rationale: This is a current state monitoring location (Site 01401000). It allows an assessment of Stony Brook water quality before Stony Brook enters Lake Carnegie.

Station SB2, Stony Brook at Province Line Road
Location: At the closed bridge on Province Line Road, which passes over the Stony Brook. The monitoring location is downstream from the bridge.

Rationale: This location is downstream of a tributary that receives discharge from the ETS facility. Assesses impacts from ETS discharge on Stony Brook.

Station SB4, Stony Brook at Pennington-Rocky Hill Road
Location: Near the Pennington-Rocky Hill Road Bridge just east of Pennington. On the downstream side of the bridge

Rationale: To assess Stony Brook water quality after the influence of several tributaries and the impact of the upstream sewage treatment plant.

Station SB5, Stony Brook at upper reaches
Location: Sample near the Mine Road Bridge, upstream of the bridge.

Rationale: May serve as a background for water quality measurements, since this site is located in a relatively undeveloped and undisturbed portion of the Watershed, near the headwaters of the Stony Brook.

VARIOUS STREAMS THROUGHOUT THE WATERSHED

Station BB1, Big Bear Brook at Cranbury Road
Location: On Big Bear Brook, near its confluence with the Millstone. We sample near Cranbury Road, downstream of the bridge, before the tributary's entrance to the Millstone.

Rationale: To measure the contribution of Big Bear Brook to Millstone River water quality.

Station CB1, Cranbury Brook at Maple Avenue
Location: Sample on Cranbury Brook, where it flows out of Plainsboro Pond and crosses Maple Avenue. This location is downstream of Plainsboro Pond.

Rationale: To measure the contribution of Cranbury Brook on the Millstone River. Also, to assess the quality of the stream to determine if the pond is adversely affecting water quality.

Station CB4, Cranbury Brook at Applegarth Road
Location: Sample on Cranbury Brook where it crosses Applegarth Road, upstream of the bridge.

Rationale: This site was added in 2007 to expand sampling coverage into the eastern portions of the Watershed and further assess Cranbury Brook's water quality.

Station CL2, Carnegie Lake across from pumping station
Location: Central Carnegie Lake, right bank, downstream from the entrance of the Millstone River. The sampling location is on the canal tow-path, about a quarter mile up from the parking area off Mapleton Road.

Rationale: To test water quality in Carnegie Lake after the entrance of the Millstone.

Station CR1, Cruser Brook at Route 601
Location: Sample Cruser Brook, upstream of the Route 601 bridge. This site is located downstream of the 3M Quarry.

Rationale: To assess Cruser Brook's water quality and the contribution of runoff from the 3M Quarry.

Station DBA, Devil's Brook at New Road
Location: Sample downstream of the New Road and pedestrian bridges.

Rationale: This site was established in 2007 to expand the site locations into the southern and eastern portions of the Watershed and gain a better understanding of Devil's Brook's water quality.

Station DB1, Devil's Brook at Plainsboro Road
Location: Just upstream of Firmenich as Plainsboro Road passes over the Brook. Sample on the left bank (facing upstream).

Rationale: To create a baseline of Devil's Brook. This site is also just above several industrial discharge points.

Station DP3, Duck Pond Run at Route 1
Location: Sample Duck Pond Run, upstream of the Route 1 bridge.

Rationale: This site was created in 2007 to assess Duck Pond Run's water quality prior to the influence of the highly developed Route 1 corridor.

Station HA1, Harry's Brook at Route 27
Location: Sample Harry's Brook, upstream of the Route 27 bridge. This site is located right before Harry's Brook enters Carnegie Lake.

Rationale: To assess Harry's Brook water quality and its contribution to Carnegie Lake.

Station HB3, Heathcote Brook at D&R Canal
Location: Sample Heathcote Brook from the D&R Canal tow-path, upstream of the Canal. Site is accessible by parking in lot off Route 27 and walking down tow-path.

Rationale: To assess Heathcote Brook's water quality and its contribution to the Millstone River.

Station PL1, Peddie Lake at Franklin Street
Location: Sample Peddie Lake from the bench behind the library on Franklin Street.

Rationale: To assess the water quality in Peddie Lake and its contribution to Rocky Brook.

Station PR1, Pike Run at Montgomery Park
Location: Sample upstream of the red pedestrian bridge in Montgomery Park.

Rationale: To assess Pike Run's water quality as it flows through the park. The park contains athletic fields and many mowed grass areas.

Station RBA, Rocky Brook at Milford Road
Location: Sample Rocky Brook downstream of Milford Road, as it exits Etra Lake.

Rationale: This site was established in 2007 to expand the site locations into the southern and eastern portions of the Watershed and gain a better understanding of Rocky Brook's water quality.

Station SHA, Shallow Brook at Scotts Corner Road
Location: Sample Shallow Brook, upstream of Scotts Corner Road.

Rationale: This site was established in 2007 to expand the site locations into the southern and eastern portions of the Watershed and gain a better understanding of Shallow Brook's water quality.

Station SM1, Six-Mile Run at Millstone River
Location: Six Mile Run, near its confluence with the Millstone River. Sample near the canal, which is just downstream from Canal Road bridge.

Rationale: Assess contributions from Six Mile Run, e.g. to determine the quality of water entering into the Millstone River. Also expands sampling system into the lower Millstone region.

Station TM1, Ten-Mile Run at Canal Road
Location: Ten Mile Run, near its confluence with the Millstone River. Sample on the northwest quadrant between big rock and wing wall, downstream from the Canal Road bridge.

Rationale: Assess contributions from Ten Mile Run, e.g. to determine the quality of water entering into the Millstone River from Ten Mile Run. Also expands sampling system into the lower Millstone region.