Section 4

Data Quality

This section will show you how to:

- Decide how and where samples will be analyzed.
- Establish data quality goals for each parameter you will monitor according to your data user(s) requirements.
- Set goals for the number of samples to be collected and analyzed.

This section may also be of value to you if you want to enhance an education program by teaching the importance of quality assurance and quality control (e.g., learning the value of replicate field samples, teaching scientific processes or understanding variability of results).

Collecting credible data

Assuring data credibility is the primary challenge you may face if you want your data to be used by groups other than your own organization. There are as many different approaches for quality assurance and quality control (QA/QC) as there are different types of monitoring. Keep in mind that the level of data quality you need is relative to what *your* purpose is and who *your* data users are. Data used for one purpose may require "higher standards" than for another purpose, so you should select a level of data quality that is appropriate for *your* particular purpose only.

This Section will teach you how to build QA/QC into your monitoring program, or how to ensure the data you collect will be usable to your data user. If you expect your data to be used by regulatory agencies or decision-makers, you will need to meet criteria accepted by those groups. If nonprofit groups or other organizations will use your data they may have their own set of standards for acceptable data.

Remember, collecting data is time sensitive. In other words, if you make a mistake, you can't go back and correct it, as conditions will never be the same at any other time. The data may not

Using Data of Known Quality

Photo submitted by the PMWP

Members of the Poultney-Mettowee Watershed Partnership (PMWP) were curious to find out whether or not the waters of the Poultney River were safe for swimming. They applied for and received analytical services from the VTDEC, a partnership service of the LaRosa Laboratory.

The LaRosa Analytical Services Partnership requires volunteer monitoring groups like the PMWP to complete a Quality Assurance Project Plan (QAPP). Completing and following this QAPP helps assure the VTDEC and the PMWP that their data will be credible and useful.

The results of their monitoring identified specific reaches (segments) of the Poultney River in agricultural areas that consistently exhibited levels of *E. coli* that exceeded the Vermont Water Quality Standards for recreational waters. Assured that their data were reliable and credible, they were able to approach landowners (farmers) and encourage them to institute agricultural BMPs (Best Management Practices) to reduce the amount of pollutants (i.e., manure, runoff) entering the River. The following summer, monitoring revealed lowered *E. coli* levels in these reaches of the River.

- For more information on the Poultney-Mettowee Watershed Partnership, visit www.vacd.org/pmnrcd/index.html.

be usable for your purposes if you do not collect it correctly the first time.

Communicating with your data user

Again, the best way to ensure you will collect usable data is to check with your data user. It is important to note that in this context "data user" refers to the *primary* user of your data, whom you identify up-front and consult while developing your monitoring plan. Once you finish your monitoring effort and the data is made public, there may be many other groups and individuals who wish to use your data. These "secondary users" will have to decide for themselves if your monitoring purpose and QA/QC practices are acceptable to them. It is impossible to plan for all the potential uses of your data, so you must focus on who *you* primarily want to use your data and consult with them to ensure your data will meet their needs.

> **Quality Assurance/Quality Control (QA/QC)**
>
> Quality assurance refers to the overall management system, including the organization, planning, data collection, quality control, documentation, evaluation and reporting activities.
>
> Quality control refers to the routine technical activities that help you minimize errors. Together, establishing QA/QC helps you produce data of known quality, enhances the credibility of your monitoring activities and ultimately saves time and money. To ensure quality data, both sample collection and laboratory analysis have QA/QC responsibilities.
>
> You must collect samples according to the needs of primary data users and the Standard Operating Procedures (SOPs) you have selected, being aware of:
>
> - Sample containers (sizes and materials).
> - Sample preservation.
> - Sample holding times.
> - Documenting methods and materials used.
> - Sample container handling before and during use to eliminate contamination.
>
> The lab must also follow the analytical SOPs and assure:
>
> - It is using proper analytical procedures.
> - It is documenting calibration procedures/results, analytical results and lab QA/QC analyses.
> - Its instruments are tested with known standards; calibrations should be recorded on lab sheets.
>
> The primary data user has the final responsibility of determining validity based on the monitoring program and analytical QA/QC procedures.

General Quality Assurance/ Quality Control concepts

In this Guide, we will discuss the concepts of building QA/QC into volunteer monitoring projects and the general protocols that scientists look for when setting up QA/QC objectives. If you set data quality objectives and/or develop a Quality Assurance Project Plan (QAPP) before you begin monitoring, you can help ensure all your data are usable for their intended purpose.

Helping your data user

Your data users may not be sure of the monitoring protocols and QA/QC procedures they need in order to be able to use your data. If that is the case, the following are some things to consider that will help you and your primary data users determine acceptable protocols:

- If the primary data users are not sure about data quality needs and QA/QC protocol, try phrasing the question differently and ask what their data quality concerns might be for the water quality parameters you are considering. Use this Section and the examples to identify QA/QC protocols that address those concerns. Then you can present suggested QA/QC protocols to the users to assess their comfort level.

- If the data uses are potentially controversial or involve management decisions with significant financial implications, you need to have the highest confidence in your data.

- Consider your audience or the people who must accept the credibility of the data. Usually people will be more likely to accept results that come from accepted methods and protocols. It will help to do some research to find out the generally accepted scientific methods for sampling the parameters you are interested in, and then reference the source of your methods. *Section 5* of this Guide provides some references for specific methods and sampling designs for Vermont.

- Consider the questions you might get regarding the data you are collecting. Then use this Section and the examples to identify QA/QC protocols that address those questions, such as setting goals for precision, and collecting and running field blanks or replicate samples.

- When in doubt, reach for the highest level of quality you can and build into your program all the QA/QC protocols you can afford. Err on the side of more/better data, using the highest level of QA/QC you can.

Another option is to look for existing volunteer monitoring efforts that are tackling questions similar to the one(s) you hope to address, and ask participants about the procedures they follow and who uses their data. If you can bring an example to your potential primary data user of how similar data has been gathered and used elsewhere in Vermont, you may be able to build a level of understanding and confidence that will allow you to work through data quality questions.

Using a laboratory vs. field kits and meters

Before you decide whether to use a laboratory or Field Kits and meters and kits to analyze your samples, *check with your data user.* In general, Vermont state and regulatory agencies (such as the Water Quality Division) do not accept most data analyzed in the field by test kits or portable meters for several reasons (however, there are some exceptions). One reason is that the field equipment must be meticulously and accurately calibrated and maintained. Unless volunteers can prove they are attaining results from calibrated kits, the data are not considered reliable. Another reason is that most portable kits do not have the ability to detect low concentrations of chemicals, the levels typically found in Vermont's surface waters, as they are designed for monitoring effluents in wastewater treatment plants or other sources of more polluted water.

However, meters and kits could still be used in your monitoring program, depending on your purpose and data user. Today's portable test kits and meters can produce accurate and reliable data, but they must be calibrated and working properly and used in waters appropriate for their detection limits.

It also may be necessary to adopt Standard Operating Procedures (SOPs) for how you will collect and analyze environmental data, especially if your data user is a state or regulatory agency. SOPs are step-by-step directions, including calibration and maintenance procedures for field and laboratory analytical instrumentation. A number of existing manuals provide detailed methods and descriptions, SOPs and even field data sheets. Some of these manuals are listed in *Appendix C*, and a few example field sheets are also included in *Appendix E.*

Using a laboratory

Sending samples to a lab for analysis is the most expensive option, but in some ways, the easiest. *Appendix B* provides guidance for selecting and using a contract laboratory and includes an example price list for common parameters, information on sample preservation and holding times, and local laboratory contact information. Laboratories will typically have already developed laboratory SOPs for analytical methods and QA/QC plans.

When sending samples to a laboratory, pay close attention to sample holding times (the limited time period that a sample can be stored before being analyzed for a certain test) and sample preservation methods. You may want to include a table of holding times, acceptable bottle types and sample preservation methods in your monitoring plan. You can request this information from the laboratory based on the parameter to be analyzed and the method used.

You should also specify detection limits and measurement ranges for each parameter before

Consider Cost and Storage

When deciding whether to use U.S. EPA-approved methods and a contract laboratory, you will need to consider cost (field kits are generally cheaper than contracting with a lab) and whether or not you want to deal with sample preservation and holding time issues. For example, samples collected for *E. coli* analysis need to be cooled to 4 ºC and analyzed within eight hours of being taken.

Photo submitted by the Lewis Creek Association the project starts, to ensure the laboratory has the necessary equipment and methods to achieve the project's detection limits. Consult Table 4-1 for a list of natural ranges for Vermont lakes and streams.

Using field meters

Parameters for which meters are frequently used include dissolved oxygen, temperature, pH, conductivity and turbidity. With field meters, measurements will be taken in the field and you will need to calibrate the meters each time you use them and record all calibration results on your data sheets. It is important to realize that temperature must be measured in the field since it would change during shipment to a laboratory or off-site facility.

Healthy Water, Healthy People Hach Field Meters and Sampling Kit

Using field kits

Field kits are used to monitor water chemistry, including nutrients. These kits generally involve prepackaged containers of chemicals that are used in the field to analyze water samples for particular chemicals. Some field kits involve relatively simple tests that provide general results, while others are more precise. While the use of field kits tends to be less expensive than sending samples to a laboratory, they do require that you spend extra time in the field completing the analysis.

In addition, just as with a contract laboratory, confidence with field kit results increases with the use of QA/QC procedures. In particular, accuracy can be assessed with known standards and precision with replicate analysis of samples. Some things to consider when deciding whether or not to use a field kit (and which one to choose) include:

- What range of concentrations can the kit detect? Some kits detect presence or absence of a chemical, while others can measure within a range of concentrations. Depending on your goals, you may or may not want to use kits or meters that cover the full range of expected values.

- How much time are you willing to spend in the field? With field kits, not only do you collect a sample onsite, but you analyze it too. The use of field kits, however, does avoid the need to transport samples to a lab.

- Would the use of field kits enhance your experience as a volunteer? If your monitoring purpose is education, doing the analysis yourself in the field may help build a better understanding of the water resource and scientific principles.

- How much of an issue is cost? If it is critical that costs be kept to a minimum and if the data are viewed as acceptable, field kits can be a good option because they are often easier on the budget than using a laboratory.

- Keep in mind that sometimes the chemicals used in field kits are hazardous to the environment and the user and therefore must be disposed of properly following analysis.

These are just a few of the things you will need to contemplate when deciding how to analyze the samples you collect. The Town Health Officers, Regional Planning Commissions, VTDEC Watershed Coordinators and/or other volunteer groups are all great sources of advice and guidance on making this decision.

You can find information on field kits, meters and laboratory analysis in the various monitoring manuals referenced throughout this Guide, particularly the U.S. EPA lake, stream and wetland monitoring manuals (see *Section 5*). In addition, *Appendix D* lists some vendors from whom you can purchase field kits, meters and equipment.

Setting data quality goals

Once you have decided whether to use a laboratory or field kits and meters for sample analysis, you must establish data quality goals. There are two basic ways to establish these goals, from your primary data users, and/or from experimentation. Keep in mind that if you fail to meet your goals, you can learn and improve, change your methods or may be able to change your data use and purpose. It should be noted that the need for and use of these data quality objectives will vary depending on the type of monitoring you are doing.

Photo submitted by the Lewis Creek Association

The U.S. EPA has identified five major objectives for water quality data. Your program should set goals to cover these objectives:

Precision- How closely repeated measurements of the same characteristic agree. Precision is determined by calculating the difference between samples taken from the same place at the same time. Minimizing human error plays an important part in assuring precision.

Accuracy- How close your results are to a true or expected value. Accuracy is determined by comparing your analysis of a known standard or reference sample to its actual value.

Table 4-1: Natural Ranges for Water Quality Parameters in Vermont

Indicator	Units of Measurement	Natural Range	General Water Quality Ranges for Recreational (Class B) Waters
Dissolved Oxygen	milligrams per liter (mg/L) % saturation	5-13 60%-125%	Cold water fisheries: not less than 7.0 mg/L and 75% saturation (some exceptions) Warm water fisheries: not less than 5.0 mg/L and 60% saturation (some exceptions)
Alkalinity	mg/L as $CaCO_3$	<1-150	No change from reference conditions that would prevent the full support of the aquatic biota, wildlife, and aquatic habitat uses.
Total Phosphorus	µg/L as TP	<5-100	In rivers, 90% of TP results <46µg/L In lakes, >14µg/L indicates eutrophication
Nitrate	mg/L as NO_3	<0.1-2	Lakes and ponds: not to exceed 5.0 mg/L as NO_3-N Rivers: not to exceed 2.0-5.0 mg/L NO_3-N, depending on flow and Class A or B waters
pH	pH units (standard units)	6.5-8.5	6.5-8.5
Turbidity	Nephelometric Turbidity Units (NTU)	<1-10	Cold Water Fisheries: not to exceed 10 NTU Warm Water Fisheries: not to exceed 25 NTU
Conductivity	microSiemens/centimeter (µS/cm)	50-1,500	Depends on geology of watershed
Bacteria	# colony forming units/100 milliliters (cfu/100 mL)	variable	Drinking Water: 0 (after filtration) Contact Recreation: 77 cfu/100 mL
Aquatic Biota, Wildlife, and Aquatic Habitat	Total number of different species present and total number of individuals of each species present. Often reported as % of species composition.	Conditions vary for each waterbody	No change from reference conditions that would have an undue adverse effect on the aquatic biota, the physical or chemical nature of the substrate or the species composition or the propagation of fish.

Representativeness- How closely samples represent the true environmental condition or population at the time a sample was collected.

Completeness- Whether you collect enough valid, or usable data (compare what you originally planned to collect with how much you actually collected). For example, if 100 samples were to be collected, but only 90 were actually collected, then 90% completeness is documented.

Comparability- How data compares between sample locations or periods of time within a project, or between volunteers.

Precision

Precision is usually assessed with field and laboratory replicate samples. Field replicates are made by collecting two or more samples from the same place at the same time. This simply means you collect a replicate sample in the exact same manner as the first sample (using the normal sampling equipment, cleaning procedures, etc.). The first sample collected should not disturb (or change) the water conditions when a replicate sample is to be taken.

Typically, the number of replicates needed to ensure precision is 10% of the total samples collected (one replicate for every ten samples taken). Each replicate is analyzed and the results theoretically should agree. If these results are not in reasonable agreement, there may be a sampling problem in the field. Laboratory replicates consist of running analyses twice from one particular sample. Results not in reasonable agreement for laboratory replicates suggest a problem in the laboratory.

To determine if your data are credible in terms of precision requirements, calculate the relative percent difference (RPD, a calculation based on the percent difference of the samples) between the samples. The smaller the RPD, the more precise your measurements. A decision about whether the data are usable or not will be based on the data quality goal set for the parameter you are measuring (see side box to the right).

Accuracy

Accuracy reflects how close your results are to a true or expected value. For the purpose of volunteer surface water chemical monitoring, you will use procedures to determine whether or not your equipment is giving accurate results, or if contaminants are being introduced in the sampling and analysis process that may bias results and provide less than accurate results.

Accuracy in water chemistry monitoring

QA/QC sample analyses often include blanks and spikes, as follows:

- **Sampler blanks (analyzing a blank sample having a zero value)**- A sampler blank (also called a rinsate or equipment blank) is a sample of distilled or deionized water that is rinsed through the sampling device and collected for analysis. Results will determine if equipment was properly rinsed or decontaminated from one site to the next and if equipment was properly handled in the field.

  If significant concentrations of the water quality parameter being measured are found in sampler blanks, it could suggest that field equipment is not being properly cleaned between sites. In this case, you will need to determine whether or not the problem could have affected the results of other samples collected that day and previous days.

Calculating Relative Percent Difference

Data quality goals for precision are typically expressed as the **relative percent difference** (RPD). RPD is calculated using the following equation:

RPD = (Result 1 - Result 2) ÷ ((Result 1+ Result 2) ÷ 2) x 100

Take the absolute value of (Result 1 - Result 2) if Result 1 is less than Result 2.

Example:
Volunteers collected a field replicate sample from an agricultural stream in Addison County, which was analyzed for *E. coli* with the following results:

Result 1 = 248 cfu/100 mL
Result 2 = 238 cfu/100 mL

RPD = (248 - 238) ÷ ((248 + 238) ÷ 2) x 100 = 4.1%

This meets the field precision goal for *E. coli* set by the project of ± 30%.

- **Field blanks**- Field blanks are "clean" samples produced in the field. They are used to test for problems with contamination from the time of sample collection through analysis. A field blank is created by filling a clean sample container with distilled or deionized water in the field. When the field blank is analyzed, it should be at or near the parameter detection limit (i.e., little of the substance being analyzed should be found in the field blank sample).

- **Spiked samples (also called matrix spikes)**- One way to assess accuracy of water chemistry samples in the laboratory is to add a known amount of the parameter being measured to a known portion of the sample to get a "spiked sample." The difference between the original measurement of the parameter in the sample and the measurement of the spiked sample should equal (or be close to) the added amount. The difference (expressed as percent recovery of the analyte) indicates your ability to measure the parameter in the laboratory.

- **Method blanks**- A method blank consists of deionized water that is run through the normal analytical method. The method blanks should be clean water and the water quality parameters being assessed should not be detected above the reporting limits. If the water quality parameter being analyzed for is detected in this "clean" water sample, it may suggest that the analytical equipment is not accurate since it did not read the true value.

> **Matrix Spike Calculations**
>
> Percent recovery for matrix spikes is calculated with the following equation:
>
> % recovery = ((C1 - C2) ÷ C3) x 100
>
> C1 = Concentration of spiked sample
> C2 = Concentration of unspiked sample
> C3 = Concentration of spike added
>
> Example:
> Volunteers collected a sample from a stream in Addison County that was analyzed for total phosphorus that yielded the following results from the laboratory:
>
> C1 = 22.7 µg/L C2 = 13.2 µg/L C3 = 10 µg/L
>
> ((22.7 - 13.2) ÷ 10) x 100 = 95% recovery
>
> These results met the data quality goals for total phosphorus of 90 to 110 percent recovery.

Accuracy in biomonitoring

For biological (plant and animal) monitoring, accuracy is addressed through verification of organism identification. The first step in this process is to decide what level you will identify the organisms to (e.g. order, family, genus or species). For macroinvertebrate monitoring, order or family level identification can be useful for increasing awareness about what lives in a stream and performing some basic calculations that provide information about water quality. Genus or species level (very specific) is generally beyond the scope of volunteer macroinvertebrate monitoring. For amphibian and aquatic plant monitoring, species level identification is usually required.

Photo submitted by the LCNRCD

Depending on the rigor of your program, macroinvertebrate monitoring may require verification of identification by a professional aquatic biologist or entomologist familiar with the organisms. Volunteers may sort samples into the predetermined groups and assemble a voucher collection for professional verification. Once the organisms have been positively identified, you will have a reference collection of individuals from each family (or relevant group) for help with identification of unknown organisms in the future.

River Network, located in Montpelier, Vermont, is a great local resource that is nationally recognized for macroinvertebrate identification training. They

also have numerous publications available in print as well as online (fees may apply for services and publications). The River Network publication “Living Waters” is a comprehensive guide to macroinvertebrate monitoring designed for volunteer monitors and school groups.

- Visit River Network online at **www.rivernetwork.org**, or contact them at (802) 223-3840.

For amphibian and aquatic plant identification, there are many keys and field guides available at commercial bookstores that will be useful for species level identification. After consulting a field guide, if you are still unsure of the identification of an aquatic plant, or believe it to be an invasive species, a sample may be sent to the Vermont Water Quality Division for expert identification (please contact the Division before sending to assure proper procedures). The Division can supply pressed plant samples of aquatic invasive species for comparison, and some examples of native plants may be available for distribution. For more information and help with aquatic plant identification, contact the Vermont Water Quality Division at (802) 241-3777.

Representativeness

A number of factors may affect the extent to which measurements actually represent the true environmental condition or population at the time a sample was collected. For example, data collected from a backwater area of a stream may not be representative of the primary flow in the stream. Making sure the data you collect is representative of the waterbody is typically addressed with sampling program design and selection of a monitoring site (see *Section 5*).

Completeness

Completeness is a measure of the number of samples you originally determined you would need, compared to how many you actually collected. For example, in the Lay Monitoring Program (LMP), under the monitoring purpose of *providing lake characterization and assessment,* the program requires a minimum of eight total phosphorus samples, eight chlorophyll-*a* samples and eight Secchi disk readings in a single summer. Less than eight samples collected between June and August would mean the data quality goal for completeness was not met, rendering the data insufficient for calculating a summer mean. Since there are many reasons why samples are not collected as planned, as a general rule, plan to collect several more samples than you actually need.

Comparability

Comparability is the extent to which data can be compared between sample locations or periods of time within a project, or between projects. This is a useful data quality check that essentially asks how your data compares with data that others have found for the same site or for similar conditions. Following the above LMP example, since all volunteers collect data according to the methods outlined in the program's QAPP, the data are comparable from one lake to another and to all past and future data.

THE Volunteer Monitor

The Volunteer Monitor

The Volunteer Monitor is a newsletter that facilitates the exchange of ideas, monitoring methods, and practical advice among volunteer environmental monitoring groups across the nation. It is published twice a year and partially funded under a cooperative agreement by the U.S. EPA. Each issue of the newsletter highlights a different facet of volunteer surface water monitoring. Past topics have included monitoring flora and fauna (plants and animals), urban watershed monitoring, and data management and interpretation. Volunteer monitoring program participants are encouraged to share their information through this newsletter and let the editorial staff know of topics they are interested in learning more about.

- For more information, online issues or to obtain a free subscription by mail, visit www.epa.gov/owow/monitoring/volunteer/vm_index.html.

Other data quality considerations

Although setting goals for the above objectives will help ensure credible data, you also will need to do the following: follow instructions; provide documentation; inspect, maintain and calibrate equipment; and manage data.

Follow instructions- It is easier to follow instructions if they are developed using clear Standard Operating Procedures (SOPs, the detailed procedures for methods used). You should develop SOPs for your project before you go into the field. Many SOPs are already available for sampling and analytical procedures. *Section 5* of this Guide references a number of existing methods manuals that include SOPs.

Documentation- It is important to use and completely fill out data sheets. The same holds true for sample bottle labels, lab sheets (if applicable) and sample drop-off sheets.

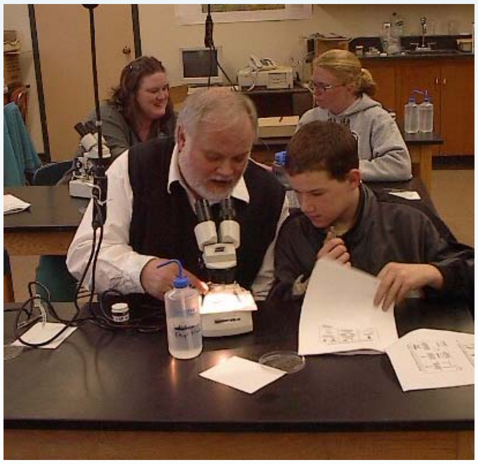
Inspecting, maintaining, and calibrating equipment- Keep field and laboratory equipment in good working condition. Equipment should be regularly inspected and maintained as suggested by the manufacturer. You should calibrate equipment before each use according to manufacturers' directions and test with known standards. Record all calibrations on lab or field sheets. If equipment is used to collect samples for chemical analyses, decontaminate the equipment between sample collections and between analyses. Maintenance, calibration and attention to detail should be designated to one person and not shared by multiple users of the equipment.

Data management- The subject of managing data is covered in detail in *Section 6*. As you collect data, it is a good idea to check the data against your data quality goals throughout the project, so if corrective actions are necessary they can be made before the end of the project. Try to identify a QA/QC project manager who can review the data and compare them with the data quality goals. No data should be entered into a database before the QA/QC manager approves them. If data do not meet the data quality goals set for your project, a decision needs to be made regarding their use and if they should be flagged when they are entered into a database.

Critter Watch Identifies the Need for Greater Accuracy in Macroinvertebrate Monitoring

The Lamoille County Natural Resources Conservation District's (LCNRCD) *Critter Watch* program monitored macroinvertebrates in Foote Brook in Johnson. In the first phase of *Critter Watch,* volunteers collected macroinvertebrates from the Brook and brought them to Lamoille Union High School, where students and adults used the biology classroom's equipment to count and identify the organisms. Experts from both River Network and the VTDEC provided taxonomic verification, which revealed that volunteers' identifications were only 54% accurate.

This unacceptable level of accuracy spurred the LCNRCD to revise and meticulously follow their QAPP in Phase II of *Critter Watch*. As a result, accuracy in identification for *Critter Watch II* soared to over 90%. Although the inaccuracy of data from Phase I rendered it unusable, the greater success was the experience and lessons learned, as they ensured the quality of Phase II and its data.



Critter Watch I and *II* received funding through a grant from the Lake Champlain Basin Program. Approximately 40 volunteers put in more than 450 hours to make *Critter Watch I* and *II* successful. The LCNRCD will use the data from their monitoring to detect any significant changes in the macroinvertebrate community over time and analyze the success of recent stream restoration projects on Foote Brook.

Photos submitted by the LCNRCD

Taking the next step: developing a Quality Assurance Project Plan (QAPP)

A QAPP is a written document that outlines the procedures you plan to use to ensure that the samples you collect and analyze, the data you store and manage and the reports you write are of high enough quality to meet the desired data uses. A QAPP is required for all monitoring efforts funded by the U.S. EPA and for all volunteer monitoring programs supported by the Vermont Water Quality Division.

A QAPP is very thorough and detailed, with elements prescribed and formatted to meet the needs of reviewers and provide some standardization across the country. A QAPP can be extremely valuable to you and the data users to ensure that the data collected is of a certain confidence and meets the goals of the project. You can use the QAPP to make sure you are following proper procedures and collecting data that meet the project goals and will be credible to decision-makers.

The ability to reference a QAPP and provide clear documentation of how it was followed also can help you answer questions from other groups concerned about the credibility of your data. Documenting your monitoring activities will be discussed in greater detail in *Section 5.*

QAPPs are not necessary in every situation, and it does take some time to put one together. Unless you are required to do a QAPP by your data user, you may want to start with a monitoring plan. Completing the Monitoring Design Worksheet included in this Guide will make it easier to move up to a QAPP, as you will have already answered many of the elements required. You may also find that having a completed Monitoring Design Worksheet will be useful in applying for grants or other funding to support your monitoring program.

Now that you have finished reading *Section 4,* return to the worksheet on pages 5-8 to answer the corresponding questions.

The U.S. EPA QAPP has the Following Elements:

1. Title and Approval Page
2. Table of Contents
3. Distribution List
4. Project/Task Organization
5. Problem Identification/Background
6. Project/Task Description
7. Data Quality Objectives for Measurement Data
8. Training Requirements/Certification
9. Documentation and Records
10. Sampling Process Design
11. Sampling Methods Requirements
12. Sample Handling and Custody Requirements
13. Analytical Methods Requirements
14. Quality Control Requirements
15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements
16. Instrument Calibration and Frequency
17. Inspection/Acceptance Requirements for Supplies
18. Date Acquisition Requirements
19. Data Management
20. Assessment and Response Actions
21. Reports
22. Data Review, Validation, and Verification Requirements
23. Validation and Verification Methods
24. Reconciliation with Data Quality Objectives

- For additional information on QAPPs, see *The Volunteer Monitor's Guide to Quality Assurance Project Plans,* EPA 841-B-96-003 available online at www.epa.gov/owow/monitoring/volunteer/qappcovr.htm.
- The Lake Champlain Basin Program has simplified the process of writing a QAPP by creating a generic QAPP for Lake Champlain basin volunteer monitoring groups. It is available online at: www.epa.gov/region01/measure/qapp_examples/pdfs/lcbpqapp71601.pdf.