# APPENDIX D

## *MONITORING REQUIREMENTS FOR MPCA INTEGRATED ASSESSMENTS*

# MONITORING REQUIREMENTS FOR MPCA INTEGRATED ASSESSMENTS

## *I. Introduction*

Many volunteer monitoring groups are interested in having the data they collect used by the MPCA for assessing water quality. To use this data in these formal assessments, you must meet certain requirements to ensure the data are accurate, precise, complete and representative of the environmental conditions. This appendix identifies the requirements for data to be used by the MPCA in the integrated assessments for Clean Water Act reporting.

The scope of this document includes monitoring methods and data requirements for assessing surface waters for the following pollutants (or "parameters"):

| **Pollutant category** | **Parameters** |
|---|---|
| Those with toxicity-based standards | Un-ionized ammonia, chloride |
| Conventional pollutants and water quality characteristics | Dissolved oxygen, pH, turbidity, temperature |
| Bacteria in surface waters | *E. coli* bacteria |
| Eutrophication of lakes (effects of excess nutrients) | Total phosphorus, chlorophyll-*a*, Secchi disk transparency |
| Impairment of the biological community | Various metrics related to the health of the stream community, used to calculate an Index of Biological Integrity |
| Supporting water quality data (These help verify assessments based on the parameters listed above.) | Total suspended solids (TSS), total Kjeldahl nitrogen, nitrite-nitrate nitrogen, conductivity, 5-day biochemical oxygen demand, alkalinity |

This document will not address the methods or requirements for sampling metals or organic pollutants (other than mentioning them in passing), as these requirements are more complicated than for the other pollutants. This does not mean that you cannot monitor for metals or organics; the MPCA simply suggests that groups interested in this sort of monitoring meet with MPCA staff to discuss the associated requirements and expectations in depth.

Also note that this Appendix will not cover flow monitoring. While flow-monitoring data is used as supplemental data to assessments, it is not required. Because flow monitoring can be complicated, if you are interested in flow monitoring, contact MPCA staff for in-depth information on setting up and maintaining a flow-monitoring station.

If you follow the requirements identified here, you can be assured that the data you collect, that meets quality assurance requirements, will be used by the MPCA for water quality assessments. This does not guarantee a specific outcome of the assessment. For example, in some cases, even though minimum data requirements are met, there may not be sufficient data available to complete a reliable assessment due to high variability or lack of representative data.

The MPCA uses all available data that meets quality assurance requirements, and also employs professional judgment as a formal step in the assessment process. Professionals include the people who take samples and measurements in the field and the biologists, hydrologists and

statisticians who analyze the data. A professional review of available data can extract the most value from small data sets.

Note also that a major aspect of monitoring the MPCA must consider when reviewing data for use in assessments is the *purpose* for which the data were collected. For example, samples collected to characterize "events" such as the effects of storm runoff on a river may not be suitable, if used alone, to characterize the overall water quality of the river. It is important that data be used and interpreted correctly; the professional review process helps ensure that this happens.

Finally, someone who can represent the organization that collected the data will need to be involved in the professional review process. To appropriately interpret the data, in addition to the purpose for which data were collected, the MPCA will consider timing and magnitude of exceedances, seasonality of exceedances, flow regime, knowledge of naturally occurring conditions and known point and non-point influences in the watershed.

## *II. Background – Integrated Assessments (formerly 305(b) and 303(d) assessments)*

The federal Clean Water Act (CWA) requires states to assess their water resources to determine if they meet designated beneficial uses. “Beneficial uses” refer to desirable uses that a lake or stream should support, such as domestic consumption, aquatic life, aquatic recreation (swimming), agriculture and wildlife, industrial consumption and aesthetics.

To determine the level of beneficial use support, the MPCA compiles available monitoring data and compares them to water quality standards developed to protect the designated use in question. If sufficient data are available for a lake or stream segment, a preliminary assessment of full support or non support of the applicable beneficial uses is made for each relevant parameter.

For streams, a professional judgment group is assembled to review the preliminary assessments. Using their knowledge of the stream systems and the measurement methods, they determine a final assessment of the level of support for each beneficial use.

- Fully supporting
- Not supporting
- Insufficient data to assess

A lake or stream segment assessed as “fully supporting” is considered to be non-impaired for the sampled parameters, while one assessed as “not supporting” is considered impaired for at least one parameter. In some cases, the data is not sufficient to clearly determine if the lake or stream segment is fully supporting or not supporting the beneficial use and the “insufficient data to assess” category is assigned.

The difference between a beneficial use support assessment and a determination of impairment reflects two related elements of the CWA. Section 305(b) requires states to develop a biennial

report to Congress that identifies the beneficial use status of all surface waters statewide. Section 303(d) requires states to identify and list impaired waters. This information is combined to produce the integrated report.

To track improvements in the assessment and listing process and to clarify the requirements, the MPCA completes a guidance document for each assessment cycle. (see *Guidance Manual for Assessing the Quality of Minnesota Surface Waters: For the Determination of Impairment 305(b) Report and 303(d) List*, MPCA, October 2007; available on-line at http://www.pca.state.mn.us/publications/wq-iw1-04.pdf). The guidance is periodically updated to reflect changes affecting assessment and listing, including changes to state and federal policies. This appendix excerpts some of the information from the Assessment Guidance and also includes information about monitoring procedures that is not found in the Assessment Guidance.

## *III. Assessment Basics*

River and stream assessments are generally assessed based on the water's ability to support the beneficial uses of aquatic life, aquatic consumption and aquatic recreation. “Aquatic life” assessments are based on parameters such as conventional pollutants, toxic pollutants and biological community impairment. “Aquatic consumption” assessments are based on fish consumption advice issued by the Minnesota Department of Health to citizens who eat the fish they catch. “Aquatic recreation” assessments have been based on fecal coliform bacteria data, but the MPCA is transitioning to the use of E. coli data in accordance with EPA requirements. Volunteers are encouraged to begin collecting only E. coli data. River and stream assessments in Minnesota are determined for river "reaches" or “segments,” which are first determined by the water classification (class 2A, 2B, 2Bd, 2C, or 7) and then by other considerations such as extending from one tributary to another. Currently segment length is determined using the 1:24,000 scale National Hydrography Dataset (NHD).

Lake aquatic recreation assessments are based primarily on the trophic, or nutrient enrichment, status of the lake and its relation to the ability of the lake to support primarily swimming and aesthetics. The assessments are based on summer Secchi transparency, total phosphorus, and chlorophyll-*a* combined with ecosystem expectations based on measurements from similar lakes. Aquatic recreation assessments are generally completed for an entire lake, but may at times be relevant to only a portion of the lake. In those cases the assessment is applied only to the identified portion such as a bay or basin of a lake.

Lakes may also be assessed for an aquatic consumption beneficial use, where the primary data used is fish consumption advice. In most cases an aquatic consumption assessment will apply to the entire lake since it is assumed that fish can swim to all portions of a lake.

## *IV. Data requirements for assessment*

MPCA requirements for assessment monitoring involve three general categories:

- *How much* monitoring data are needed to complete an assessment
- *How* the sampling and laboratory analysis must be conducted

- *What* quality assurances and quality control practices must be followed and documented to assure the MPCA and its stakeholders that the data is credible and its use for assessment purposes is appropriate

Table 1 identifies the quantity and timeliness requirements for assessment data and supporting water quality data. Section V then identifies the methods to follow when sampling for assessment purposes and the quality assurance and quality control requirements for assessment monitoring.

Note that while Table 1 lists the *minimum data requirements* for a water body to be considered for assessment, this is often not *enough* for an assessment to be completed. It is critical that the data used in an assessment be representative of the quality of the water body in question. To achieve this, measurements must be taken in various seasons, flow conditions, etc. This is difficult to accomplish if the monitoring effort is designed to gather minimum measurements (since it is not uncommon to miss a sampling date or two due to weather, equipment problems, lab issues, etc.).

Because of this, the MPCA designs its monitoring efforts with a target of acquiring much more than the minimum number of values. This helps ensure the data are representative of the water body and that an assessment can be reliably completed. You should also design your monitoring effort to go beyond the minimum requirements.

**Table 1: Summary of Data Needed for Water Quality Assessments: 305(b) Report and 303(d) List[1,2]**

| Pollutant Category | Parameters (or steps) | Period of Record | Minimum Number of Values |
|---|---|---|---|
| Pollutants with toxicity-based standards | Un-ionized ammonia (total ammonia, pH & temperature) [3], chloride | Most recent 10 years | 5, within a 3-yr. period[4] |
| Conventional pollutants and water quality characteristics | Dissolved oxygen, pH, turbidity (including total suspended solids and transparency tube), temperature | Most recent 10 years | 20 (over at least 2 years for turbidity, suspended solids and transparency tube) |
| Swimming safety indicator bacteria | Escherichia coli bacteria[5] impairment determination via monthly geometric mean or individual max. values[6] | Most recent 10 years | 5 per month (to calculate mean); at least 3 months |
| Eutrophication of lakes (effects of excess nutrients) | Total phosphorus (TP), chlorophyll *a*, Secchi disk transparency | Measurements collected from June to Sept. over the most recent 10-year period | At least one TP, Secchi disk or chlorophyll *a* measurement |
| | | Measurements collected from June to Sept. over the most recent 10-year period | At least 8 measurements (8 separate sampling dates) for each of TP, Secchi disk & chlorophyll *a* |
| Impairment of the biological community | Index of Biological Integrity[7] | Most recent 10 years | Can be based on a single biological monitoring event on a given reach |
| Supporting water quality data | TSS, total Kjeldahl nitrogen, nitrite-nitrate nitrogen, conductivity, 5-day biochemical oxygen demand, alkalinity, stream TP | Most recent 10 years | As available; These measurements provide supporting information for determining assessments |

[1]For more details, including exceedance thresholds, see *Guidance Manual for Assessing the Quality of Minnesota Surface Waters: For the Determination of Impairment*, MPCA, October 2007 (MPCA Assessment Guidance), http://www.pca.state.mn.us/publications/wq-iw1-04.pdf .

[2]This table does not include metals or organic pollutants due to the complexity of sampling for those parameters. Those interested in sampling for metals or organics should consult the MPCA Assessment Guidance and MPCA monitoring staff.

[3]The measurement of un-ionized ammonia requires that total ammonia, temperature and pH all be measured at the site (un-ionized ammonia concentrations are then calculated based on this data).

[4]If more than one sample was taken within a four-day period the values are averaged (usually an arithmetic mean is appropriate) and the four-day average is counted as one value in the assessment.

[5]Fecal coliform has been replaced by *E. coli* as the indicator bacteria used for assessments. While that will necessitate a change in analytical methods, the sample collection methods will remain the same.

[6] State water quality standards for bacteria in water for swimming are set for both a geometric mean of values collected in a given month, and for single exceedances. Assessment methodology allows for aggregation by calendar month across multiple years within the assessment data period. The data set must span at least three months, preferably June-September.

[7]For macroinvertebrate monitoring, data used for 303(d) listing must be based on identification to the genus level. Family-level identification is sufficient for use in 305(b) assessments and as supporting data for 303(d) listing.

## V. Developing and implementing a monitoring plan for CWA assessments

As indicated earlier, for the MPCA to use data in CWA assessments, it is critical that the monitoring is designed to meet the requirements for the integrated assessment methodology. These requirements help ensure that the data are accurate, precise, complete and representative of the environmental conditions. The first step in fulfilling these requirements is to carefully plan out your monitoring effort, following the guidelines identified in this Appendix.

If you are interested in having your data used by the MPCA for assessment purposes, prior to beginning the sampling effort, you must complete a monitoring plan that contains all the applicable elements of a Quality Assurance Project Plan (QAPP). The QAPP is a written plan that:

- Provides background information
- Identifies objectives for your project
- Details your project's standard operating procedures in the field and lab
- Outlines project organization
- Addresses issues such as training requirements, instrument calibration and internal checks on how data are collected, analyzed, and reported

The QAPP helps ensure that the samples you collect and analyze, the data you store and manage, and any reports you write are of high enough quality to meet project and data user needs.

A QAPP is extremely valuable to the volunteer monitors, project leaders, and the data users to ensure that the data collected is of a certain confidence and meets the objectives of the project. You can use the QAPP to make sure you are following proper procedures and collecting data that meet the project objectives and will be credible to decision-makers. Also, referencing a QAPP and showing how it was followed can also help you answer questions from other groups concerned about the reliability of your data.

QAPPs can vary in their level of detail, depending on the nature of the work you are doing and how you intend to use the data. Any group that is interested in and capable of monitoring for assessment purposes is capable of developing a general QAPP for their monitoring effort to document the monitoring plan and ensure that the results obtained are of the type and quality needed and expected. The QAPP should be reviewed periodically to ensure that its content continues to be valid and applicable to the program over time.

Guidance on how to complete a QAPP can be found in EPA's document, *The Volunteer's Guide to Quality Assurance Project Plans,* September 1996, EPA-841-B-96-003, available on-line at http://www.epa.gov/owow/monitoring/volunteer/qappcovr.htm . This Appendix also provides many of the elements needed to develop a QAPP for CWA assessment monitoring (e.g., the monitoring methods and quality assurance/quality control procedures necessary for assessment monitoring, later in this Section).

## A. Location

A critical initial step in planning a monitoring effort to collect data for integrated assessments is deciding where to collect samples. River assessments are conducted for river reaches and lake assessments for an entire lake (unless the lake is very complex or "bayed"). It is important to clearly identify the sampling site on a map, and collect precise locational data (e.g., global positioning system [GPS] readings) for each site so the MPCA can be sure of the exact locations.

In many natural lakes in Minnesota, it is adequate to sample at one primary site, typically the site of maximum depth. You will need to sample at multiple sample sites if the lake is "bayed" or has a complex shoreline. The MPCA applies the following criteria to determine whether a water body is a lake:

- The water is listed in Minnesota Department of Natural Resources (MDNR) Bulletin 25
- It is not listed as a wetland in the MDNR Public Waters Inventory
- It is 10 acres or larger
- It has a hydraulic residence time of at least 14 days

Collect river/stream samples at a point where the water is well mixed and is most likely to represent the water quality of the reach that is to be assessed. The goal is to get a sample that represents the overall characteristics of the stream at that site.

## B. Analytical methods

Another element of up-front planning involves selecting the procedures and methods that you will use to collect and analyze the samples. All analyses must be completed according to methods approved by EPA for your specific monitoring purpose. For example, if you are interested in sampling for total phosphorus and providing the data to the MPCA for CWA assessments, you must use an EPA-approved method that is appropriate for the type of water you are sampling (ambient surface water), and that will be able to detect the concentrations you expect to find. Table 2 lists some of the EPA-approved methods and holding times (length of time the sample can be stored before analysis) for the parameters that you are likely to sample. This information is derived from EPA's regulation 40 CFR part 136, table IB and table II, which can be accessed on-line at http://www.gpoaccess.gov/cfr/index.html .

For water quality sampling, depending on the parameter, you can collect data through the use of a field meter, field kit, or you can collect water samples and transport them to a laboratory for analysis. Note that the EPA-approved list includes methods for both laboratory analysis and field measurements. Consult with MPCA staff if you have questions about selecting an EPA-approved method for a specific parameter.

Some parameters are best measured through the use of a field meter due to the need for short (or no) holding times, or because a field meter is generally easier to use than a field kit or lab analytical method. The parameters where use of a field meter is recommended are temperature, dissolved oxygen, pH and turbidity.

Field analysis kits exist for a wide variety of water assessment parameters. The kit manufacturer provides a water analysis handbook that describes in detail how to use the kit in the field. The handbook also contains information as to whether the field analysis is equivalent to the EPA method or to a Standard Method. For example, for the analysis of alkalinity, the manufacturer's handbook may contain the following or similar information: "Scope and Application: For water, wastewater, and seawater. Adapted from *Standard Methods for the Examination of Water and Wastewater, 2320 B.* USEPA accepted."

If you will be using a laboratory for chemical analyses, the MPCA requires that the lab be certified by the Minnesota Department of Health (MDH). You will find a list of certified labs and information about the certification process on MDH's web site at http://www.health.state.mn.us/divs/phl/cert/index.html . All certified laboratories must be audited by MDH at least once every three years. The audit provides a determination on whether the laboratory is capable of analyzing each of the analytes (parameters) for which it is seeking certification. Certification assures the data user that the laboratory is capable. Without the certification, users may have less confidence in the quality of data produced. Please note that "users" can include not only the organization collecting the data, but also other organizations and individuals who use the data.

It is also important to determine that the kits, meters and/or laboratory methods you are using have appropriate measurement ranges and the minimum detection limits necessary to achieve project objectives. You will have to select appropriate field meter(s) or field kits, or contact the laboratory before you sample to ensure it has the necessary equipment and methods to achieve the project's detection limits.

A **minimum detection limit** (or reporting level) is the lowest concentration of a parameter that an analysis method can measure. For example, there are several approved methods that a lab can use to analyze total phosphorus (TP) in a water sample. One method detects concentrations of 1 mg/L or greater. Most Minnesota lakes, however, particularly those in Northeastern Minnesota, have TP concentrations lower than 1 mg/L, making this method inappropriate for these lakes.

**Table 2. EPA-Approved[1] Analytical Methods Suggested by the MPCA.**

| Parameter | EPA method | Standard Method | Other EPA approved methods | Preservation | Max. Holding Time (before analysis) |
|---|---|---|---|---|---|
| Un-ionized Ammonia[2] | 350.1/350.2/350.3 | 4500-$NH_3$ G | | $H_2SO_4$ to pH < 2, Cool to 4° C | 28 days |
| Chloride | 325.2/ 325.3 | 4500-Cl E | | None | 28 days |
| Dissolved Oxygen (DO)[3] | 360.1/ 360.2 | 4500-O G | | None | Immediately (i.e. measure in the field) |
| Temperature | 170.1 | 2550 | | None | Immediately (i.e. measure in the field) |
| pH | 150.1/ 150.2 | 4500-$H^+$ B | | None | Immediately (best if measured in the field) |
| Turbidity | 180.1 | 2130 B | | Cool to 4 °C | 48 hours (best if measured in the field) |
| Escherichia coli | /1603, 1604// 1103.1 | 9222B// 9221B & 9221F/ 9222B & 9222G | Colilert®, Colilert-18®/ mColiBlue-24® (Hach 10029)// | Cool to 4 °C | 6 hours[4] |
| Total Phosphorus | 365.1/365.2/365.3 | 4500-P F | | $H_2SO_4$ to pH < 2 | 28 days |
| Chlorophyll *a* | -- | 10200 H | | Cool to 4 °C, keep in dark | 28 days (shorter if not field-filtered) |
| Total Suspended Solids | 160.2 | 2540 D | | Cool to 4° C | 7 days |
| Total Kjeldahl Nitrogen | 351.2/ 351.3 | 4500 N | | $H_2SO_4$ to pH < 2, Cool to 4° C | 28 days |
| $NO_2/NO_3$ Nitrogen | 353.2 | 4500-$NO_3$ F | | $H_2SO_4$ to pH < 2, Cool to 4° C | 28 days |
| Conductivity | 120.1 | 2510 B | | Cool to 4° C | 28 days |
| Alkalinity | 310.1/ 310.2 | 2320 B | | Cool to 4° C | 14 days |
| 5-Day Biochemical Oxygen Demand ($BOD_5$) | 405.1 | 5210 B | | Cool to 4° C | 24 hours[5] |

[1]From 40 CFR part 136, table IB: http://www.gpoaccess.gov/cfr/index.html, or *Standard Methods for the Examination of Water and Wastewater*, 20th Edition, 1998, American Public Health Association.

[2]Record sample pH and temperature. Analyze for Total Ammonia nitrogen. Consult pH vs. temperature chart to determine percent of sample that is un-ionized.

[3]DO via Winkler Method: 360.2; no preservative; analyze immediately. Sample may be 'fixed' with 2-mL $MnSO_4$ + 2-mL alkali-iodode-azide + 2-mL $H_2SO_4$. Fixed sample may be held for 4-6 hours out of direct sunlight. Because this method requires considerable "technique," volunteer monitors are encouraged to use a field DO meter (*Standard Methods* 4500-O G) rather than the Winkler Method.

[4]As short as possible, with a maximum of 24 hrs.

Prior to sampling, you should also develop field data sheets tailored to the project objectives. Information important to the MPCA includes the collector's name, site ID, site description, date, time, depth of sample (typically for lakes), parameters to be tested, calibration results, field notes and observations (e.g. weather, unusual conditions, land-use surrounding site and any departures from the field methods). Use these data sheets during every sampling event to ensure you collect the needed information each time.

## C. Water sampling methods

Sampling involves either the in-stream or in-lake measurement of a parameter, or the collection of a sample for later analysis at a laboratory. The sampling method and size of the sample container will vary, depending on the parameter(s) to be analyzed and the lake or stream conditions (such as stream width, depth and flow rate). This section details sampling procedures for lakes and streams, including considerations for sample preservation and transport to the lab.

### *1. Sampling for Conventional Pollutants and Nutrients*

Two main methods for sampling water quality are: in-field measurements using field meters; and collecting samples for laboratory analyses. The following paragraphs detail methods for each sampling type.

#### *a. Field Meters*

When completing an analysis in the field using a field meter (such as a dissolved oxygen, pH or turbidity meter), it is important to follow the manufacturer's instructions for calibrating the instrument. Proper calibration is essential to make sure the meter is reading accurately. Be sure to note the calibration data on the field sheet, including the instrument reading before and after calibration, to check for measurement drift (note that calibration frequency depends on the meter/parameter being measured). This will serve as a check that the calibration was done, and that the meter was functioning properly. You will also need calibration information to complete a quality assurance assessment report prior to submitting the data to the MPCA (see section E). The box below provides general information on the use of a field dissolved oxygen meter, which is the most common type of field meter used.

**Dissolved Oxygen Meter General Instructions**

**Meter Preparation**
- Inspect the probe; replace electrolyte and membrane as needed
- Turn the meter on and check the battery
- Allow the probe to stabilize for at least 60 minutes (20 min. in a pinch) before calibration

**Calibration**
- Calibrate meter according to manufacturer's instructions
- Enter maintenance and calibration information into the instrument's log book. Note: periodically check the probe temperature readings against a precision grade thermometer.

**Testing Sample**
- Place probe in sample
- Turn on stirrer unit or continuously stir sample with the probe
- Record test result once the instrument's readings stabilize

**Re-calibration**
- Do at the end of the sampling run. If this is an all-day sampling run, do a recalibration check midway through the day.
- Follow manufacturer's calibration instructions
- Record re-calibration check data. This check will allow you to determine, if the data is reliable.

***a***

***b. Sampling (for laboratory analysis)***

While a few parameters can be measured using field meters (e.g., dissolved oxygen, pH, temperature), many require that you collect a sample and transport it to a laboratory for analysis. Sample collection breaks down into three general steps: bottle and equipment preparation, sampling and sample preservation and transport. Following are MPCA requirements for each of these steps.

i. Bottle and equipment preparation

Most labs will provide bottles for sample collection. If sample bottles have been precleaned by a laboratory or a manufacturer, you do not need to rinse with the sample water before collection. Always follow bottle preparation directions from the lab. If the bottles are not cleaned ahead of time by a lab, then clean them with a detergent (phosphorus-free if sampling for phosphorus) and tap water and rinse several times with distilled or deionized (DI) water. (Note: Do this only for non-metal, inorganic and nutrient parameters. Use special bottle cleaning procedures when sampling for metals or organic parameters. Contact the MPCA for guidance on cleaning procedures for metals or organics sampling.)

Just prior to sampling (i.e., while at the sampling site), clearly label each bottle with the site name, date, time, sample depth and collector's initials. Also record this information on the field data sheet.

Clean sampling equipment that contacts sample water (including the sampling device(s) and any container used to subdivide samples) with phosphorus-free detergent and rinse with DI water before each day's sampling if there is any visible dirt or foreign material. If the sampling equipment is visibly clean and free from dirt, then simply rinse with DI water at the beginning of the day's sampling for non-metal inorganic and nutrient parameters. Rinse the sampling equipment thoroughly three times with stream/lake water at each site before water is collected to transfer to sample bottles. Use special cleaning procedures when sampling for metals or organic parameters; contact the MPCA for more information.

ii. Sampling lakes

As indicated earlier, in many natural lakes in Minnesota it is adequate to sample at one site, unless the lake is "bayed" or has a complex shoreline. Check with the MPCA (St. Paul or regional offices) to see if there are existing monitoring sites on your lake before you begin your monitoring. Each lake sampling date, which may include data averaged together from one or more sampling sites on a lake, is considered a single sample for assessment purposes.

Typically, you collect surface water samples from the upper, well-mixed layer of water using an "integrated" sampler. This is a PVC tube with an inside diameter of 3.5 cm (1.4 inches), 2 meters long (6.5 feet), with a stopper at one end. It will fill a 2-liter bottle, and is used to collect water samples for the majority of the chemical analyses.

To collect a sample, rinse the tube three times with lake water, and then lower it vertically into the water until it submerges, and fills. Stopper the top end (think of putting your finger over the end of a straw in a glass of soda). Then pull the tube out of the lake. The pressure caused by capping the end holds the water in the sampler until it can be released into a rinsed, 2-liter sample bottle by loosening the stopper. (Note: The pressure often doesn't hold for long, so be quick in transferring the lower end of the sampler from the lake to the sample bottle.) With this procedure, you obtain an "integrated" 2-liter sample of the upper two meters of the lake, which provides a representative sample of lake water quality in the summer. Shake the sample in the 2-liter bottle and subset into individual bottles and preserve as per lab requirements for nutrient and chlorophyll-*a* analyses.

If you are going to take a bottom sample to measure phosphorus, use a discrete depth sampler (such as a Van Dorn or Kemmerer sampler). A dissolved

oxygen/temperature profile and a Secchi disk reading are also recommended for lake sampling.

iii. Sampling rivers and streams

Collect stream samples at a point that is most likely to represent the water quality of the site. Because stream flow characteristics at a site change considerably from low- to high-flow conditions, you must decide on the best specific location at the site during each visit. Note the location you choose and the factors you consider in your choice.

**What if you see a pollution source at the site?**

If a localized source of pollution, such as sediment from a storm sewer inlet or field runoff, is visible at a sampling location it may be tempting to collect the sample in the "plume" to document the problem. It is important to remember, however, when sampling for CWA assessments that the results will be used to characterize the water quality of the stream throughout the reach. Sampling within the problem zone would invalidate the results because it would not be representative of the whole stream. In such a situation, sample outside the localized problem zone, in a well-mixed area that better represents the entire stream reach.

In addition, consider collecting additional samples in the problem zone. You can use this along with additional sampling or information to help characterize and resolve the problem through sharing the data and discussing solutions with landowners and local watershed officials.

The goal is to get a sample that represents the overall characteristics of the stream at that site. Sample rivers and streams at a point where the water is well mixed, in such a way as to avoid contamination from surface film or flotsam, bottom sediments and airborne particulates from sampling equipment or bridge decks. If a site is poorly mixed across the stream use a method besides a grab sample or choose another site that is well mixed. For example, if safe access to a stream prohibits sampling in a well-mixed location, consider taking multiple samples/measurements along the stream cross-section, noting the position along the stream width for each sample. Note that sampling for total suspended solids (TSS) is particularly vulnerable to effects from an inadequately mixed site, as TSS can vary considerably across a stream's width and depth.

Collect a stream grab sample at a middle depth in the water column without disturbing streambed materials or collecting floating materials from the water surface. If sample water is to be collected directly in the sample bottle, to collect the sample, lower the bottle mouth-down to a point below the water surface and then turn it upstream. Always collect the sample upstream of yourself to avoid contaminating the sample (i.e., stand with the sample bottle upstream of your body). During winter, take care to keep ice and snow out of the sample (particularly if sampling through a hole cut in the ice), since this can impact the analytical results. You can make in-field measurements of pH, dissolved oxygen, temperature, conductivity and turbidity.

In some cases the stream current is too swift or the water is too deep to safely collect a sample by wading (a general rule is that if stream depth (in feet) multiplied by its velocity (in feet per second) is greater than your height (in feet), then **DO NOT WADE**!). In this situation, you can collect a sample from shore by extending a sampling bottle connected to a pole to the well-mixed area of the stream, or by lowering a bottle or sampling device from a bridge.

iv. Sample preservation and transport

Some lab analyses, such as those for total phosphorus, require chemical preservation of the sample in the field to ensure that the sample conditions do not change between the time when the sample is collected and when it is analyzed. Other samples may require field filtration or additional treatment prior to sample transport. It is important to follow lab directions for field preservation or filtration to help ensure the validity of the analysis.

The laboratory that provides the sample bottles often also provides the sample preservative. For example, if the sample must be preserved at a pH < 2, the laboratory will provide a small vial of $H_2SO_4$ for this purpose. The lab will provide one vial of preservative for each sample bottle that requires it.

Most samples must also be cooled to 4 °C immediately following sample collection. Do this by placing the sample bottles in a cooler full of ice. Note that some methods do allow for samples to be frozen until analysis; contact the MPCA for more information on this alternative.

Be sure to make arrangements with the laboratory prior to each sampling trip to ensure they are prepared to receive the samples. Keep in mind that certain parameters have very limited holding times within which the analysis must take place for the measurement to be valid. Establish a clear plan for transporting samples to the laboratory to ensure they arrive well before the holding time expires. In addition, use a chain-of-custody form to identify samples and record all transportation and storage information as samples are collected, transported to the lab, analyzed and disposed.

### *2. Bacteria Sampling*

Because bacteria occur naturally in and on humans, take extra care to avoid contamination during collection, preservation, storage and analysis of indicator bacteria samples (i.e., samples analyzed for *E. coli*). Take these simple, but critically important, precautions to avoid contamination:

- Follow the lab's direction for sample containers
- Do not use a container that has a loose cap or any other opening
- Avoid touching the inside of the cap, bottle or bag while filling with sample water

- Ensure that the sample container is tightly closed while being transported to the lab in a cooler

Indicator bacteria in surface water can be as variable as the distribution of suspended sediment because bacteria commonly are associated with solid particles. It is very important that you collect samples in a well-mixed area of the stream to obtain representative data. As with other grab samples, collect the sample at a middle depth in the water column without disturbing streambed materials or collecting floating materials from the water surface.

If the stream is well mixed and the stream depth and/or velocity permit safe wading, collect a sample by the hand-dip method described below. While it is acceptable to collect a sample with a clean, rinsed, non-sterile water sampler and pour it into the sterile bottle, it is preferable to sample directly into the sterile bottle or bag when possible.

*Hand-dip method*

1. Open a sterile sample bottle. Hold the bottle near the base, with hand and arm on downstream side of bottle. If using a sterile sample bag, skip this step (the bag will be opened underwater).
2. Without rinsing, plunge the bottle opening downward, below the water surface. Allow the bottle to fill with the opening pointed slightly upward into the current. If using a bag, open, fill and close the bag below the water surface without disturbing the bed materials.
3. Remove the bottle with the opening pointed upward from the water and tightly cap it, allowing about 1 to 2 inches of headspace (empty space between the water sample and the bottle cap). This procedure minimizes collection of surface film and avoids contact with the streambed.
4. If sampling the stream from the shore or a bridge (using a sample bottle on a pole or rope), rinse the sampling device three times with stream water before collecting the sample. Avoid contacting the stream water or the inside of the sample bottle or bag when transferring the water from the sampling device to the bottle/bag.
5. Be sure to collect a sampler blank before taking the stream sample (see Section VII for further information on sampler blanks, including collection procedures).

Use the same sample collection procedure regardless of the type of bacteria being monitored. The laboratory performing the analysis will provide sterile sample bottles that contain sodium thiosulfate crystals to neutralize any halogen present in the sample (the presence of halogen can be lethal to any bacteria in the sample). It is critical when monitoring bacteria that you keep the sample bottle sterile. The container size you use will depend on the sample amount you need for the bacteria analysis method chosen and for other analyses. Remember to wash your hands thoroughly after collecting samples suspected of containing fecal contamination. Also, be careful not to touch your eyes, ears, nose or mouth until you've washed your hands.

## D. Biological sampling methods

The MPCA uses biological monitoring in addition to chemical monitoring of pollutants, for integrated assessments. A number of volunteer groups are involved in biological monitoring and interest in it continues to grow.

This section focuses on the methods and quality assurance needs for monitoring biological communities. In general, biological monitoring involves collecting a sample of the biological community in question (i.e., fish, macroinvertebrates, plants), identifying the organisms found in that sample and comparing the organism numbers and types, habitat conditions and other characteristics (or metrics) to established indices.

A key component of this monitoring is the level of detail employed when identifying the sampled organisms. The Indices of Biological Integrity (IBIs) currently completed or under development by the MPCA are based on genus-level identification of organisms, which is necessary for data to be used for 303(d) listing. Family-level monitoring results can be used as supporting data in the 303(d) listing process, which means that while these data are not sufficient by themselves to result in an impairment determination, they can be used to support and verify determinations based on other parameters identified in this Appendix. In the future, the MPCA may develop a regional, family-level invertebrate IBIs that volunteer monitors in Minnesota can use. This "citizen" IBI will be developed once a large enough data set is available to allow for significant state coverage. It will be a useful tool for identifying potential candidates for 303(d) listing (which would then require follow-up monitoring).

The MPCA is using IBIs based on fish and invertebrate communities in rivers and streams in water quality assessments. While IBIs have been developed for a few basins, they will be developed for all streams and rivers by 2009. Sampling fish communities in lakes is done by the Minnesota Department of Natural Resources (DNR) as part of their responsibility to manage a sport fishery. They are also developing IBIs for a few lake types.

As for wetland monitoring, the MPCA has developed sampling protocols and tools for macroinvertebrate and plant assemblage data. Guidance for listing can be found in the 2008 Listing Guidance (http://www.pca.state.mn.us/publications/wq-iw1-04.pdf). Find additional information on wetland monitoring on the MPCA's biomonitoring web page (http://www.pca.state.mn.us/water/biomonitoring/).

### *Rivers and Streams*

#### ***a. Sampling fish***

The MPCA has guidance for the assessment of streams in Minnesota using fish assemblage data. However, this process requires expensive equipment and a permit from the DNR. If you have an interest in using MPCA protocols to collect and interpret fish assemblage data, contact the MPCA's river and stream biological monitoring staff at (651) 296-7215.

***b. Sampling Invertebrates***

**When to Sample:** Sample in the late summer/early fall, primarily during September. Flood and drought events can have strong effects on macroinvertebrate community structure; therefore, sample streams under stable, base flow conditions. Delay sampling in streams following high-flow events until stable conditions return. If a stream is known to have been dry at an earlier date in the sample year, do not sample it.

**Sampling Reach Determination:** It is important to collect a sample representative of the stream reach selected. Once a reach is established, walk its entire length to determine the presence and abundance of productive macroinvertebrate habitats. The reach length should be adequate to cover the entire range of hydrological and morphological conditions for the stream in the area of interest. The MPCA uses a stream reach that is 35 times the average stream width, with a maximum of 500 meters and a minimum of 150 meters, which has been determined to provide a representative characterization of most streams. It is typically not necessary to sample the entire reach for invertebrates. The important thing is that you sample all major habitat types (e.g., riffles, rocky substrates, woody debris, etc.). Collecting an adequate sample normally requires walking 150-200 meters of stream length, although sometimes you must cover a much longer distance to sample the range of available habitats.

**Benthic Sampling Technique:** The tools the MPCA is developing for stream assessment are based upon samples collected using a qualitative multi-habitat sampling technique. For data to be assessed using the invertebrate IBIs developed by the MPCA, it must be collected in a similar fashion. Data collected using a riffle-sample, hester-dendy sample or other sampling technique will be considered adequate for the purposes of listing in the future if it can be demonstrated that current assessment tools are transferable to this type of data or if new scientifically defensible assessment tools are developed.

Take a *qualitative multi-habitat (QMH)* sample at each sampling location. The only sampling gear you need is a D-Frame dip-net (D-net) with a 500-micron mesh size. Take care to ensure that as many invertebrates as possible are collected for each area sampled. Always hold the net downstream of the sampling area. When collecting a QMH sample in conditions of negligible flow, sweep the net repeatedly in upstream fashion to ensure that as many invertebrates are collected as possible.

You collect the qualitative multi-habitat sample to characterize the overall diversity of the sample reach. Sample macroinvertebrate habitats in proportion to their existence in the defined stream reach. For example, if 20 percent of the invertebrate habitat consists of woody debris, then take 20 percent of the samples from woody debris habitats. You will not sample fine sediment substrates. Collect samples in a downstream-to-upstream fashion. Collect twenty sampling efforts, or sweeps, and

composite them in a 500-micron mesh sieve bucket. Label samples and preserve in 100%-denatured ethanol.

Consider these five habitats when sampling: 1) riffles or shallow, fast-flowing runs, 2) undercut banks and overhanging vegetation, 3) submerged or emergent aquatic macrophytes, 4) snags and woody debris, and 5) leaf packs.

A sample effort is defined as taking two D-net samples in a common habitat. Take a D-net sample by placing the net on the substrate and disturbing an area equal to the square of the net width (approximately 1ft²) directly in front of the net opening. Each effort should cover approximately 0.18m² of substrate and the total area sampled should be approximately 3.6$m^2$.

This process becomes complicated when dealing with multi-dimensional substrates like weed beds and woody debris. Following is a description of each habitat and how to sample:

*Riffle/Rocky Substrate*. This category covers rocky substrates with fast-flowing water. Runs often have suitable rocky substrates and should not be excluded from sampling. To sample riffles, firmly and squarely place the D-net on the substrate downstream of the area to be sampled. If the water is shallow enough, disturb the area directly in front of the net with your hands, taking care to wash large rocks off directly into the net. If the water is too deep for this, it is adequate to kick the substrate in front of the net.

*Aquatic Macrophytes*. This category includes any vegetation found at or below the water surface. This includes emergent vegetation because all emergent plants have stems that extend below the water surface, serving as suitable substrate for macroinvertebrates. You should not sample the emergent portion of these plants. Sample submerged plants with an upward sweep of the net. If the net fills with weeds, vigorously hand-wash or jostle them in the net for a few moments and then discard. Sample emergent plants with horizontal and vertical sweeps of the net until you feel that the area being swept has been adequately sampled.

*Undercut Banks*. This category covers shaded, in-bank or near-bank habitats, away from the main channel, that typically are buffered from high flows. These banks can vary in the extent of undercutting. Many banks appear undercut, but when investigated, prove not to be. For these reasons, prod banks to determine how deeply they are undercut. Treat overhanging vegetation the same way. Sample with upward thrusts of the net, while beating the undercut portion of the bank or the overhanging vegetation to dislodge any clinging organisms.

*Woody Debris*. This category includes any piece of wood found in the stream channel. Consider logs, tree trunks, entire trees, tree branches, and large pieces of bark and dense accumulations of twigs as snags. Root-wads are masses of roots extending from the stream bank. Use best professional judgment to determine what a

"sampling effort" is. It is acceptable to approximate the surface area available for sampling for larger tree trunks or branches, while giving a "best guess" for the sample area of masses of smaller branches and twigs. Given their variable nature, there is not one best method for sampling snags. As the diameter of wood gets larger, it is easier to sample the surface area more directly using a hand or tool to gently wash the surface of the wood. As the diameter of the wood gets smaller and the density of branches becomes greater, it is more efficient to kick or beat the woody debris.

*Leaf Packs.* Leaf packs are dense accumulations of leaves typically present in the early spring and late fall. You will find them in deposition zones, generally near stream banks, around logjams or in current breaks behind large boulders. Take a leaf pack sample near the surface of the leaf pack, since sweeping to the bottom of every leaf-pack could create a disproportionately large amount of sample volume being collected for a given area. Due to the timing of the sampling (i.e., late summer/early fall), leaf packs are generally not dominant enough to be included in a sample.

Take care in areas near bridges or high pedestrian traffic to avoid sifting through shards of broken glass or sharp metal. Use a hard tool such as a screwdriver to dig through the coarse substrate when sampling in areas where sharp substances are likely to be found.

***c. Laboratory sample processing***

Once the sample is brought into the lab, separate the macroinvertebrates from the rest of the sample. Do this by sorting through the sample in the lab and "picking" out the macroinvertebrates. QMH samples are sub-sampled to 300 organisms. To accomplish this, remove a minimum of 300 macroinvertebrates from the sample, then remove the remaining large and/or rare organisms. Do not combine the two sub-sample components (300 organisms and large/rare organisms) until the data are analyzed.

Have ten percent of each sample checked for "picking efficiency" by an independent stream biologist to make sure that most of the macroinvertebrates were removed for identification. Once you finish picking, the biologist will count the number of macroinvertebrates remaining in the original sample (i.e., the sample remnant). If the biologist finds the number of macroinvertebrates in the sample remnant exceeds ten percent of the total number of macroinvertebrates you picked out, the picked sample remnant is reprocessed. When new volunteers start, check their entire samples until they are able to find 95% of all target organisms in a sample, after which they can pick independently.

All organisms are identified to the genus level (if possible) for data used for 303(d) listing. Family-level identification is acceptable for data used in 305(b) assessments; as a screening tool for 303(d) listing (follow-up monitoring is needed to collect genus-level data for rivers and streams targeted by the screening-level analysis); or

as supporting data for 303(d) impairment determinations based on other parameters identified in this Appendix. Five percent of all samples identified are checked for proper taxonomic characterization by an independent stream biologist. An independent taxonomist should resolve taxonomic discrepancies. For taxonomic comparisons, maintain a reference collection that contains identified invertebrates that have been verified by an independent, professionally trained taxonomist.

## *E. QA/QC requirements*

Data used in impairment decisions must be of reliable quality. There are many opportunities for the introduction of errors – from field sampling, to lab analysis, to data assessment and all the steps in between. Therefore, it is difficult to overstate the importance of spelling out quality assurance and quality control (QA/QC) protocols for each step along the way and the need to carefully adhere to them. This applies to the data generated by the MPCA and data used from outside parties.

This section identifies the QA/QC protocols that must be followed and documented for physical and chemical monitoring data to be considered for assessment purposes. Section V-D, above, identifies the QA/QC protocols for biological monitoring. Note that, while all data collected following the procedures identified in this Appendix will be considered by the MPCA when developing its assessments, data that do not meet QA/QC tests may not be used in the final assessments.

### *1. Field Quality Control Checks*

Quality control checks serve three main purposes:

1) They provide a "feedback loop" to those performing and managing the monitoring effort. For example, unacceptable concentrations of an analyte in a sample blank signals that the sample was contaminated, which points to the need to better adhere to existing monitoring procedures or improved procedures.

2) Quality control checks allow for the assessment of the quality of the data produced by the monitoring effort. This allows those interested in using the data to determine if the data meets their quality objectives.

3) Quality control data can tell water resource managers something about the lake or stream being monitored. For example, consistent variations in duplicate samples, even with documented adherence to protocols, can indicate variability in the lake or stream conditions. This information can help interpret the data used in the assessment process.

For biological sampling, use appropriate internal quality control checks. As noted in the previous section, a 10 percent review of "picking efficiency" for new volunteers is incorporated into the sampling until competency is documented. Five percent of all samples identified are checked for proper taxonomic characterization by an independent stream biologist. An independent taxonomist should resolve taxonomic discrepancies.

Maintain a reference collection containing identified invertebrates that have been verified by an independent, professionally trained taxonomist, for taxonomic comparisons.

For water samples, during each sampling season, make sure at least 10% of samples taken are sampler blanks and at least 10% are field duplicates, as specified in the paragraphs below. The more uncertainty around the data collection, the more quality control checks you should complete. For example, a sampling effort by teams of monitors (rather than a consistent sampling team throughout the sampling season) may benefit from taking additional field duplicates (beyond the 10% minimum) to document uniform data collection methods and further demonstrate data credibility. It is not required that you take sample blanks or sample duplicates at each sampling site. The purpose of the field duplicate is to assess the reproducibility of the sampler's sampling technique and the laboratory's analytical technique. The purpose of the sampler blank is to assess the sampler's effectiveness at cleaning the sampling device.

***a. Sampler Blanks***

A sampler blank (also commonly referred to as a rinsate blank or equipment blank) is a sample of deionized (or distilled) water that is rinsed through the sampling device and collected for analysis. Containers used to store the deionized (DI) water should only be used to store DI water to eliminate possible contamination from other uses. You can usually obtain DI water from the lab doing the sample analyses. If the DI water is not from a laboratory or provider that can assess the purity of the water, then also provide one bottle blank of the DI water with every sampling trip.

The first step in collecting a sampler blank is to decontaminate the sampling device the same way you collect your regular samples. For example, if you rinse three times with the lake/stream water, then do this in exactly the same manner with the DI water before you collect the blank. Try to eliminate as much of the rinse water from the sampling device as possible. To collect the blank, fill the sampling device with DI water and transfer the water to the appropriate collection bottles. Handle the device as close to your normal sampling procedure as possible (agitate the sampling device in the same manner, try to leave the water in the sampling device for the same amount of time and collect the same volume of water).

For bacteria sampling, collect and analyze field blanks to document that sampling equipment has not been contaminated. **Before** collecting the water sample, process field blanks as follows:

1. Rinse sampling equipment and containers with sterile buffered water.
2. Process DI water through sampling equipment and into sterile sample bottle. If no growth is observed when the field blank is analyzed, collect the sample using sterile procedures.

***b. Field Duplicates***

A field duplicate is a second sample taken immediately after an initial sample in the exact same location. Field duplicates assess the sampler's precision, laboratory precision and possible temporal variability. Collect the duplicate sample in the exact same manner as the first sample, including the normal sampling equipment cleaning procedures. It is important that you clearly label field duplicates as such in the field to ensure there is no confusion once the samples are transported to the lab or after the results are received.

In the case of field water quality measurements (such as dissolved oxygen profiles or turbidity meter readings), also collect duplicate measurements at 10% of the locations. To perform a duplicate field water quality measurement, remove the meter sensor from the lake or stream for at least several minutes, so that the sensor readjusts to the lake/stream conditions once it is reinserted into the water. If the instrument readout is unstable (i.e., the reading is bouncing around), check the meter batteries and calibration before making another reading.

***2. Laboratory Quality Control Checks***

All labs certified by the Minnesota Department of Health are required to develop and maintain quality control (QC) procedures and checks to ensure the credibility of the analyses they are performing. While the quality control checks are the lab's responsibility, it is important for you to understand what is required, and to require your lab to report its quality control data along with the sample analyses, so you can check on your lab's performance. Following are the minimum lab quality control checks that must be completed and evaluated if data is to be used for assessment purposes:

**Monitoring laboratory performance**

It is a good idea for you to periodically check your lab's QC performance as results are reported. This way, if the lab is having problems you will recognize that and ensure the problems are addressed before a whole season of data must be flagged as unreliable due to poor lab performance. You should require your lab to report the results of lab QC checks along with sample results and to note whether the data quality objectives were met. Review these reports to ensure that your lab is performing as required for the project.

- 10% laboratory duplicates
- 10% matrix spikes
- 10% method blanks on all samples.

***3. QA/QC Reporting***

Write a Quality Assurance Assessment Report after the data collection is complete. Prepare the report so that the project coordinators and the data's end users know how to interpret and use the final data. Include an assessment of quality control data to determine if the data quality objectives required by the CWA assessment process were met. Also include adherence and deviation from approved field and lab protocols.

Evaluate your QA/QC data as follows:

- Sampler blanks: The concentration of the parameter being analyzed should not be detected in the blank sample at above the minimum detection limit.
- Field duplicates: Examine the results of these duplicates by calculating the relative percent difference (RPD) between the duplicate samples. The lower the RPD, the more precise the sampling performance. Calculate RPD using the following equation:

$$RPD = (|Result\ 1 - Result\ 2|)/((Result\ 1 + Result\ 2)/2) \times 100$$

To assist volunteer monitoring project managers with quality assurance review of datasets, Table 3 contains assessment variables and an expected maximum relative percent difference for each.

In addition to an analysis of the QA/QC data, you should also include in the Quality Assurance Assessment Report a discussion of error introduced by other factors such as sampling design (e.g., collecting too few samples or sampling over too short a time period), weather events while sampling, instrument performance issues, etc. Field notes are a valuable source of information for acknowledging and estimating additional sources of error in the monitoring results.

**Table 3. Water Quality Parameters and Expected Relative Percent Difference for Use in CWA Assessments.**

| Primary Parameter | Supporting Parameter | Maximum Expected Relative Percent Difference |
|---|---|---|
| Un-ionized Ammonia | | 10% |
| Chloride | | 20% |
| Temperature | | 0.3° C |
| Dissolved Oxygen (DO) | | 0.1 mg/L |
| pH | | 0.3 pH unit |
| Turbidity | | 30% |
| Fecal Coliform | | 30% |
| Total Phosphorus | | 30% |
| Chlorophyll-a | | 30% |
| Total Suspended Solids | | 30% |
| | Total Kjeldahl Nitrogen | 30% |
| | $NO_2/NO_3$ Nitrogen | 10% |
| | 5-Day Biochemical Oxygen Demand ($BOD_5$) | 30% |

### *4. Data Submittal*

You can find information on submitting data for inclusion in the MPCA Water Quality Database (which the MPCA uses for assessments) on the MPCA's web site at http://www.pca.state.mn.us/water/storet.html . Keep in mind that it is important to contact the MPCA when setting up a data management system (i.e., before beginning to enter data into a spreadsheet or database system) to ensure it is compatible with the Water Quality Database. This will minimize the steps that must be taken to load your data into the database at the end of the monitoring season or when the sampling effort is completed.

Before you enter data into the database, establish geographic and hydrographic identifiers for sampling locations. When a sampling location is established, identify the type of water body, such as lake, stream, wetland, well or treated effluent. Also, enter specific collection and lab methods associated with the data, and the results of QA/QC checks. This information allows potential users of your data to decide whether it meets their data quality objectives. See Section 5 of the Volunteer Monitoring Guide for additional information on submitting data to the Water Quality Database.

## *VI. Resources*


1. Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998. (**Note:** This document is not available on-line (except through a paid service), but you can find it at college/university libraries and many state and local water management agencies).
2. USEPA, agency-wide quality system documents, http://www.epa.gov/quality/qa_docs.html
3. Water Analysis Handbook, 4th Edition, 2002, Hach Company.
4. National Environmental Methods Index, http://www.nemi.gov
5. U.S. Geologic Survey, http://water.usgs.gov/
6. Guidance Manual for Assessing the Quality of Minnesota Surface Waters for the Determination of Impairment 305(b) Report and 303(d) List, Minnesota Pollution Control Agency, Environmental Outcomes Division, October, 2007. http://www.pca.state.mn.us/publications/wq-iw1-04.pdf
7. Field Manual for Water Quality Sampling, http://cals.arizona.edu/AZWATER/awr/apr95/apubs.html
8. Code of Federal Regulations, Title 40 – Protection of the Environment, Chapter 1 – Environmental Protection Agency, Part 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants, http://www.gpoaccess.gov/cfr/index.html
9. Minnesota Pollution Control Agency, Quality Assurance Program, http://www.pca.state.mn.us/programs/qa_p.html
10. State of Washington, Dept. of Ecology, Water Quality Program, http://www.ecy.wa.gov/programs/wq/wqhome.html