Massachusetts Inland Volunteer Monitoring General Quality Assurance Project Plan (QAPP)

Version 1.0

For Water Quality Monitoring, Wetland Biological Assessments, And Invasive Species Monitoring

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Acknowledgements

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Disclaimer:

References to trade names, commercial products and manufacturers in this General QAPP does not constitute endorsement by EEA and/or MassDEP

How to Use This General QAPP

A **Quality Assurance Project Plan** (QAPP) outlines the procedures a monitoring project will use to ensure that the samples participants collect and analyze, the data they store and manage, and the reports they write are of high enough quality to meet project needs (EPA 1996).

This General QAPP is intended to serve all organizations participating in the Massachusetts Office of Energy and Environmental Affairs (EEA) Monitoring Grants programs, those who are conducting volunteer monitoring and have an interest in submitting data to the Massachusetts Department of Environmental Protection (MassDEP), and those applying for grants in the future. It may also serve programs collaborating with other state and federal agencies in water quality monitoring activities. The General QAPP contains baseline requirements to be met for various levels of data collection projects, as well as common objectives, parameters, methods and approaches for river, lake, and wetland chemical and biological monitoring. Any group performing these types of monitoring activities can adopt the General QAPP as the project QAPP. (If not adopted, an individual project QAPP is typically required. Types of monitoring activities where an individual project QAPP may be more appropriate include: direct flow monitoring, best management practice (BMP) evaluation, low-level metals and toxic contaminant sampling, fish population sampling, and toxicity testing.)

Individual groups adopting this General QAPP must follow these steps:

1) Carefully review the General QAPP for its contents and to ensure that your program can meet its requirements.
2) Complete the "General QAPP Adoption Form" (AF) found in Appendix 1. This form is made up of a series of templates that must be filled out. Instructions for completing each element of the General QAPP Adoption form are found in the corresponding numbered chapter of the General QAPP. Use caution when copying from the GQ and pasting into the AF to ensure that the information is accurate and relevant to your group. The General QAPP and Adoption Form are simplified by design; more in-depth analysis and decision-making is required to complete the form for your group's objectives and potential.
3) Submit only the General QAPP Adoption From for review and approval by MassDEP (see Chapter 1 for more information). Groups that submit the General QAPP Adoption Form will not be required to develop a stand-alone or individual project QAPP for their respective project.

Guidance on establishing monitoring goals that are specific to a particular program can be found in *The Massachusetts Volunteer Monitor's Guidebook to Quality Assurance Project Plans*, available at: http://www.mass.gov/dep/public/volmonit.htm or by request from MassDEP. For more information, contact Richard Chase, MassDEP (508) 767-2859, richard.f.chase@state.ma.us.

If discrepancies are found between the *Guidebook* and this General QAPP, use information found in the General QAPP. The QAPP guidebook contains advice (See: "How to Use the Guidebook-Timing for Success") on the time required to undertake this process. In general, program planning and development of the General QAPP Adoption Form should begin approximately five to six months prior to beginning the actual sampling program.

Words or phrases shown in ***bold, italicized* type** on the first occurrence in this document are defined in the Glossary in Appendix 8 (excepting uses in Tables of Contents, titles, or summary requirements statements).

Summary of Requirements for Adopting the General QAPP

1) The *General QAPP Adoption Form* must be submitted to MassDEP for review and approval. The General QAPP Adoption Form has been approved once the signature approval page is completed - Please note, recipients of EEA Monitoring Grants must have a Title and Approval Page that has been signed by the grantee and the appropriate MassDEP agency representatives before proceeding with project implementation.

2) Include a Table of Contents containing the 24 elements of the General QAPP in the General QAPP Adoption Form. The Table of Contents must also list (by name) the QAPP's appendices (e.g., such as the analytical laboratory's QA plan and Standard Operating Procedures or SOPs), as applicable.

3) The approved *General QAPP Adoption Form* must be distributed to major project participants.

4) The project must have an organized structure for effective communication and completion of tasks.

5) The *General QAPP Adoption Form* must document sufficient background knowledge, demonstrated need and defined objectives of the proposed monitoring.

6) The *General QAPP Adoption Form* must include a brief project summary (i.e., who, when, where, why and how data collection will occur), including a task calendar.

7) Clear and achievable data quality objectives for each parameter to be measured in the project must be stated in the *General QAPP Adoption Form.*

8) Instruction in all aspects of project data collection and management shall be provided to project participants (as applicable, depending on assigned tasks) and shall be documented, including trainee signatures, trainer(s), dates of training and subject matter.

9) Documentation and record keeping for all project activities related to data collection and data quality shall be implemented for the duration of the project or QAPP approval period.

10) a. The *General QAPP Adoption Form* must discuss measures to be taken to ensure the health and safety of all project participants for the duration of the project.

    b. The *General QAPP Adoption Form* must explain the general thought process behind the sampling plan, as well as provide detailed information regarding the "what, when, how, where and why" that was generally referred to in Element 6 of the General QAPP Adoption Form.

11) All sample collections shall follow group-specific Standard Operating Procedures (SOPs), as contained or referenced in a project-specific *General QAPP Adoption Form*.

12) The procedures used to label, transport, store and track custody of samples must be explained in the project *General QAPP Adoption Form*.

13) All analytical methods used in the project shall be identified in the General QAPP Adoption Form and be based on standardized laboratory methods that are specifically referenced or contained in the project-specific *General QAPP Adoption Form.*

14) Project sampling shall include appropriate field and laboratory quality control samples to assess general data quality issues, as well as specific data quality objectives specified in Element 7 of the project *General QAPP Adoption Form.*

15) The project shall include a systematic process for consistently checking, testing and maintaining instruments and equipment for proper functioning.

16) All instruments used in the project shall be calibrated at a pre-determined frequency to ensure instrument accuracy and precision for the duration of the project (with logbook documentation).

17) The procurement, inspection and acceptance of sampling, analytical and ancillary project supplies shall occur in a consistent, timely manner.

18) The *General QAPP Adoption Form* shall provide detailed information for any non-project data used in developing and implementing the General QAPP Adoption Form or in any other way affecting the project.

19) As detailed in the *General QAPP Adoption Form*, the project shall include a data management system.

20) The project shall have a defined process for identifying and effectively addressing issues that affect data quality, personal safety, and other important project components.

21) The project shall include a reporting mechanism for project data. Reporting shall include raw data, QC data and important metadata.

22) All project data, metadata, and quality control data shall be critically reviewed to look for problems that may compromise data usability.

23) The *General QAPP Adoption Form* shall explain how all project data and metadata are reviewed and approved as usable data (and as un-usable when the data are questionable for any reason).

24) The *General QAPP Adoption Form* shall describe a process (and mechanisms to accomplish it) whereby resulting data are compared to the planned DQOs in the project *General QAPP Adoption Form.*

1. Title and Approval Page

□ General QAPP Requirement #1: The *General QAPP Adoption Form* must be submitted to MassDEP for review and approval. The General QAPP Adoption Form has been approved once the signature approval page is completed. Recipients of EEA Monitoring Grants must have a Title and Approval Page that has been signed by the grantee and the appropriate MassDEP agency representatives before proceeding with project implementation.

See Section 1 of the General QAPP Adoption Form in Appendix 1 for a Title and Approval Page Template.

2. Table of Contents

□ General QAPP Requirement #2: Include a Table of Contents containing the 24 elements of the General QAPP in the General QAPP Adoption Form

3. Distribution List

□ General QAPP Requirement #3: The General QAPP Adoption Form must be distributed to the following major project participants:

Required

- Project Manager
- Monitoring Program Coordinator
- Program Quality Assurance Officer
- Program Participants
- Project Field Coordinator
- Project Lab Coordinator
- Richard Chase, MassDEP QA Officer
  627 Main St., 2nd floor, Worcester, MA 01608
  Phone: (508) 767-2859; Fax: 508-791-4131
  email: richard.f.chase@state.ma.us
- Arthur Screpetis, MassDEP Technical Reviewer
  627 Main Street, 2nd floor, Worcester, MA 01608
  Phone: 508-767-2875; Fax: 508-791-4131
  email: arthur.screpetis@state.ma.us
- Contract analytical lab(s) manager/director
- Agency Project Contact

Recommended

- Other project participants, contacts, ***data users***
- Town/City Governance
- Conservation Commission
- Regional/Local Planning Office
- Technical Advisory Committee (as applicable)

4. Project/Task Organization

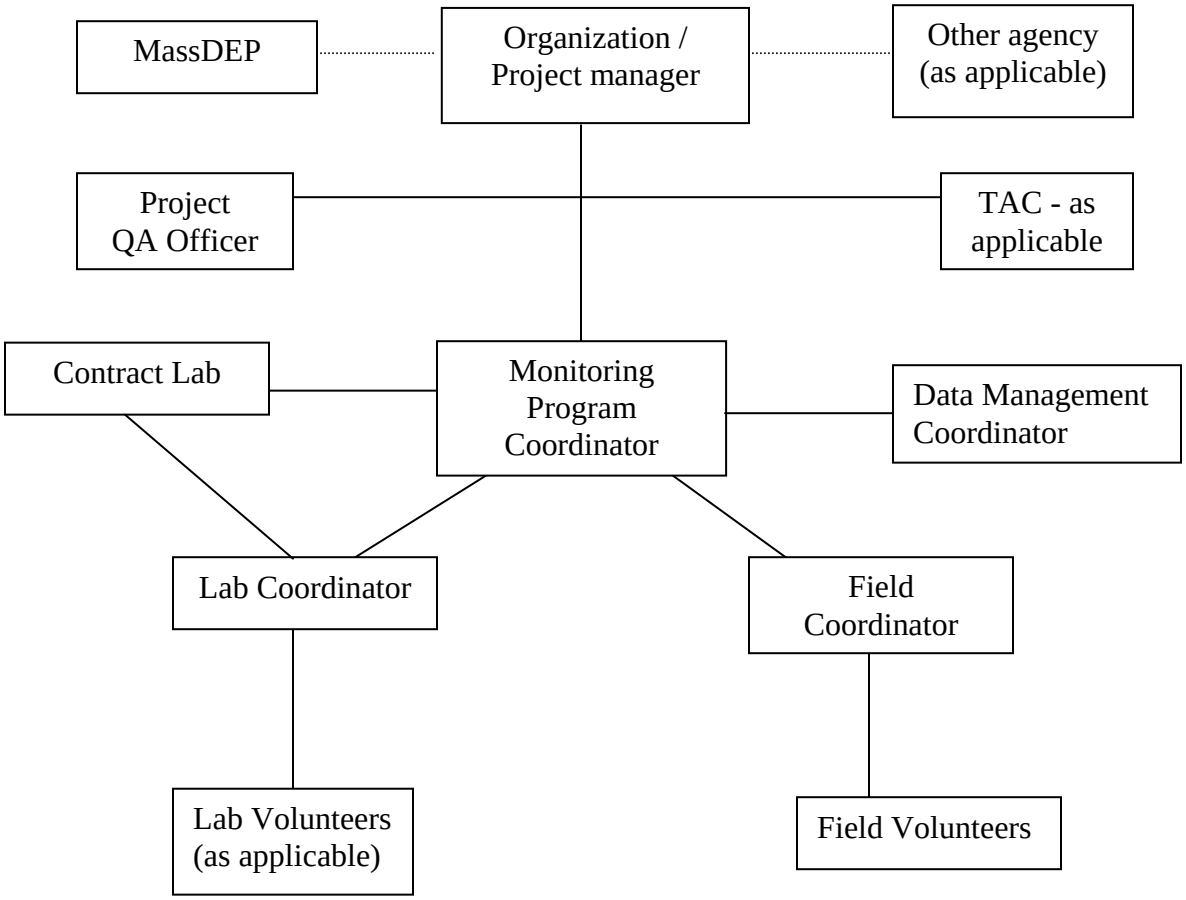
□ General QAPP Requirement #4: The project must have an organized structure for effective communication and completion of tasks.

Table 4.1. Project Organization (typical)

Name(s)	Project Title/Responsibility
Specify in the General QAPP Adoption Form	**Project Manager** – Oversees all aspects of project that incorporate the monitoring program including: fiscal management, project objectives, data uses, program changes, etc.
Specify in the General QAPP Adoption Form	**Technical Advisory Committee** – Program oversight and advice.
Specify in the General QAPP Adoption Form	**Monitoring Program Coordinator** (a.k.a. Monitoring Coordinator) – Volunteer recruitment and training, coordination with TAC (as applicable). Develops General QAPP Adoption Form. Produces monitoring report. Produces or oversees outreach efforts in coordination with project manager.
Specify in the General QAPP Adoption Form	**Lab Coordinator** – Makes arrangements with any lab(s) used to perform analyses according to QAPP. Ensures correct procedures are used, holding times are met, and adequate documentation is provided.
Specify in the General QAPP Adoption Form	**Field Coordinator** – Responsible for training and supervising volunteers in field work; ensures field forms are properly filled out, samples and forms are transported to laboratories as needed; and performs QC checks to make sure procedures are followed or corrected as needed (in collaboration with project QC officer).
Specify in the General QAPP Adoption Form	**Data Management Coordinator** – Maintains the data systems for the program, performs/oversees data entry, and checks entries for accuracy against field and lab forms.
Specify in the General QAPP Adoption Form	**QA Officer** – Runs QA/QC program, ensures that all elements of the project follow QA procedures in the QAPP. Typical duties include: observing volunteers/lab personnel, reviewing and maintaining copies of data sheets and QC records, reviewing draft reports, conducting program review in concert with Monitoring Coordinator, and recommending program changes if needed to ensure compliance with program goals and quality objectives. *Note:* Because of a potential conflict of interest, this person should not fill any of the following roles: Monitoring Program Coordinator, Field or Lab Coordinator. However, this person may be involved in writing the QAPP.
Specify in the General QAPP Adoption Form	**Volunteers** – Conduct sampling, perform field analyses, and assist in laboratory analyses and/or data entry.
Specify in the General QAPP Adoption Form	**Contract Analytical Lab Manager(s)/Director(s)** - Responsible for analytical procedures performed under contract (or other arrangement) with monitoring organization.

Name(s)	Project Title/Responsibility
Specify in the General QAPP Adoption Form	**Agency Project Contact** – Oversees grant administration and ensures reporting requirements are met.
Specify in the General QAPP Adoption Form	**USEPA Quality Assurance Officer** – (only if EPA funding or technical assistance is provided) Reviews General QAPP Adoption Form, as applicable.
Richard Chase	**MassDEP Quality Assurance Officer** – Reads QA reports, reviews General QAPP Adoption Form, confers with program QA officer on ***quality control*** issues that arise during the course of a monitoring program.
Arthur Screpetis, Richard Chase	**MassDEP Technical Reviewer** – Reviews General QAPP Adoption Form.

Table 4.2. Typical Organizational Chart: Lines between boxes indicate who communicates directly with whom.



5. Problem Definition/Background

□ General QAPP Requirement #5: The General QAPP Adoption Form must document sufficient background knowledge, the need for the proposed work, and defined objectives.

The Executive Office of Energy & Environmental Affairs (EEA) supports organizations that monitor watershed resources, coordinates such efforts with state priority projects, and gathers valuable information to support the protection and restoration of important aquatic habitats and natural resources.

Historically, Massachusetts citizen groups active in wetlands and water bodies have conducted monitoring programs including: ground and surface water quality monitoring, ***wetland*** biological assessments, and monitoring for ***invasive species*** to support the protection and restoration of critical natural resources.

This General QAPP addresses monitoring activities related to the following four issues:

1) Water Quality: The Commonwealth's watersheds suffer from a number of impairments to water quality, with over 90% of the impaired waterbodies in Massachusetts containing elevated levels of bacteria or nutrients. Data collected from this effort are intended to assist MassDEP in evaluating waterbodies that have not yet been assessed, documenting water quality ***trends*** necessary for the designation of strategies to remediate the impairment, and evaluating water quality in areas where these strategies are already being implemented.

2) Biological & Habitat Assessment: Biological assessments (e.g. macroinvertebrate, aquatic plant survey, fish sampling) are a direct measure of the health of the aquatic community. They are used to evaluate aquatic life use-support status and to supplement other water quality monitoring and management programs. Biological assessments are considered *response* indicators: measures of integrated or cumulative reactions to exposure and stress, such as elevated temperature or chemical levels, depressed oxygen levels, or altered habitat. Habitat assessments are considered *stressor* indicators, in that they can reveal activities or alterations that affect the aquatic environment, such as: increased sediment, unnaturally changing flow regimes, changes in river channel morphology, and reduced shading.

3) Wetland Health Assessment: Wetland biological assessments are a critical component of the evaluation of development impacts on important aquatic habitats. Evaluation of these impacts requires not only the collection of water quality data, but also an assessment of the biological response of these systems to anthropogenic factors. These assessments will aid the Commonwealth in establishing baseline conditions, measuring the scale of the impacts to these systems, and assessing the response of wetlands to restoration efforts.

4) Invasive Species: Invasive, ***introduced*** species may pose a significant threat to the Commonwealth's freshwaters. According to the Massachusetts Aquatic Invasive Species Management Plan:

"…aquatic macrophytes such as water chestnut and Eurasian water milfoil have become established and are aggressively spreading in lakes and ponds. In addition, common reed and purple loosestrife are rapidly clogging waterways and outcompeting ***native species***. Although the zebra mussel has yet to be documented in Massachusetts, it is found in the Connecticut side of the Housatonic watershed, very close to the Massachusetts border. The Asian clam and other species of aquatic macrophytes such as hydrilla and giant salvinia are causing problems in nearby states and have a reasonable chance of making it to Massachusetts if conditions are favorable." (CZM 2002, pg. 5)

The economic losses associated with invasive species have been estimated at hundreds of millions to billions of dollars nationwide, and more effort is needed to monitor for new infestations. Invasive species monitoring efforts will allow the Commonwealth to better understand vectors of introduction, analyze population dynamics, and eradicate new introductions before they spread.

Volunteer monitoring activities (including studies funded by EEA volunteer monitoring grants programs) typically include one or more of the following objectives:

1) **Provide quality-controlled data that support the assessment and restoration of watersheds and critical habitats** through the implementation of Commonwealth programs such as:
    - i) MassDEP 305(b) Waterbody Health Assessments:
      http://www.mass.gov/dep/water/resources/wqassess.htm
    - ii) MassDEP TMDL development for impaired waters:
      http://www.mass.gov/dep/water/resources/tmdls.htm
    - iii) Clean Water Act Section 319 projects:
      http://www.mass.gov/dep/water/319sum06.pdf
    - iv) Massachusetts Aquatic Invasive Species Management Plan:
      http://www.anstaskforce.gov/Mass_AIS_Plan.pdf
    - v) EEA Watershed Action Plans:
      http://www.mass.gov/envir/water/publications.htm
    - vi) Massachusetts Office of Coastal Zone Management (CZM) Nonpoint Source Pollution Remediation Program:
      http://www.mass.gov/czm/cprgp.htm
    - vii) Commonwealth Beaches Act:
      http://www.mass.gov/legis/laws/seslaw00/sl000248.htm
    - viii) CZM Wetlands Restoration Program:
      http://www.mass.gov/czm/wrp/index.htm
    - ix) Massachusetts Department of Fish and Game, Riverways Adopt-a-Stream Program:
      http://www.mass.gov/dfwele/river/programs/adoptastream/index.htm
    - x) Riverways RIFLS Program:
      http://www.rifls.org/
    - xi) Massachusetts Department of Conservation and Recreation (DCR), Lakes and Ponds Program:
      http://www.mass.gov/dcr/waterSupply/lakepond/lakepond.htm
    - xii) DCR Lakes and Ponds Program, Weed Watchers:
      http://www.mass.gov/dcr/waterSupply/lakepond/weedwatch.htm

2) **Leverage the Commonwealth's funds to increase the collection of quality data.** A common goal of data collection is to produce data of known and documented quality, in support of state monitoring programs, state water body health assessments (305(b)), Total Maximum Daily Load (TMDL) programs, municipal infrastructure improvements, Clean Water Act Section 319 projects, Massachusetts Wetlands Restoration Program projects, to collect baseline information for waters that are currently not assessed, and to advise local-level decision makers and educate the public on the condition of local waters and habitats.

3) **Watershed/Wetlands health assessment.** This objective is to assess the ecological health (which may include water quality, habitat, plants, benthic macroinvertebrates, etc.), relative to the attainment of designated uses as described in the Massachusetts Surface Water Quality Standards (MassDEP 2007). Information objectives may include: addressing specific baseline data needs, monitoring for changes in watershed/wetlands health and evaluating the need for restoration or mitigation efforts. These objectives are typically met by collecting multiple samples per year, at fixed stations for a given number of years. Details are provided in Sections 10 and 11, and in a program-specific General QAPP Adoption Form.

4) **Pollution source identification and impact assessment.** Impacts may be positive (e.g. best management practice or BMP) or negative (e.g. pollution source). This objective is met in two stages: 1) source tracking: as necessary to locate suspected pollution sources, and 2) monitoring known/potential sources with temporal or spatial bracketing of a particular impact on a schedule chosen to capture discharges and, for comparison purposes, periods when or locations where no discharge occurs, as appropriate.

5) **Invasive species assessments.** This objective is to monitor existing invasive species and provide early detection of newly arrived species by gathering quantitative information on introduced species in a variety of habitats. By collecting data on the location of invasive species, state agencies may be better able to determine the extent of an invasion and possible methods for spread prevention and/or eradication.

6) **Public education and outreach.** This objective is to train and engage volunteers in monitoring to develop better understanding of the importance of water resources and to encourage their fellow citizens to take an active role in the preservation and restoration of their local water bodies and watersheds.

7) **Local infrastructure improvements**. This objective is to evaluate the performance of stormwater infrastructure such as settling basins, retention basins, conveyances, outfall pipes, etc.

8) **Other data use objectives**. *Specify in the General QAPP Adoption Form*

Studies funded by EEA monitoring grants or that otherwise provide data to state agencies will have specific reporting requirements. See Section 20 of the General QAPP Adoption Form for further information.

6. Project/Task Description

□ General QAPP Requirement #6: The General QAPP Adoption Form must include a brief project summary (i.e., who, when, where, why and how data collection will occur), including a task calendar.

The type of data that can be collected under this General QAPP includes, but is not limited to:

- Water depth, depth of sample location, depth to water surface from fixed points and staff gage water level readings
- Secchi disk and transparency tube measurements for water clarity/transparency
- Depth of the sample site
- Chlorophyll-*a* concentrations as an estimate of algal populations
- Phosphorus and nitrogen forms to measure nutrient levels
- Turbidity, solids, and conductivity to evaluate the presence of dissolved or suspended materials in the water column
- Dissolved oxygen concentration and percent saturation to determine the amount of oxygen available for aquatic life, and to detect stratification when collected along depth profiles.
- Temperature to determine the suitability of habitat for aquatic life, and to detect stratification when collected along depth profiles.
- Alkalinity and pH to determine if the waterbody is affected by acid deposition
- Presence of invasive plants/animals to track the existence, spread, and/or success of removal efforts.
- Bacteria and viruses to evaluate health risks associated with recreation
- Detection of optical brighteners/fluorescent whitening agents (FWAs), caffeine, and pharmaceutical and personal care product metabolites to indicate the presence of sewage
- Biological monitoring to determine the nature of plant and animal communities and their response to changes in water quality or habitat condition.
- Habitat monitoring to determine suitability of waters for aquatic life, to assess land use impacts on waterways, and to aid in interpretation of biological monitoring data.
- Wetland health assessments, including macroinvertebrates, physical and chemical indicators found in rivers and/or lakes, monitoring of wetland-associated flora and fauna (e.g. amphibians, birds), soils, and vernal pools.

For water quality monitoring under this QAPP, data can be collected at regular intervals throughout the sampling season, the duration of which is determined by the project team. Some data (particularly macroinvertebrate and plant surveys) can be collected once during the sampling season depending upon the goal or purpose of the monitoring. Other data can be collected monthly or weekly. In addition, some data may be collected continuously over a brief period of time, either using landside or instream monitoring devices. Sites are selected to reflect representative, average conditions in a water body – at least one site per river reach of interest, lake, or wetland. In stratified or deep waterbodies, data can be collected vertically such that at least one sample is taken in each vertical segment of interest.

Some impact assessment monitoring may depart from this general schedule in order to temporally bracket discharge periods (e.g. during wet and dry events, before and after changes of land use, before and after installation of pollution control systems, etc.). Impact assessment monitoring of sites of interest

can also be spatially bracketed (e.g. upstream/downstream of suspected pollution sources in rivers, near/far from sources, such as lakes and wetlands).

In general, raw or draft data are typically recorded on field and lab sheets and reviewed for quality control. Final data are transferred to computer spreadsheets and reports, and distributed to the project team (as applicable).

The final data may be compared to state water quality standards or, when no statewide criteria exist, scientific literature such as the US Environmental Protection Agency's ecoregional nutrient criteria: http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/ or other appropriate indices. The Monitoring Coordinator will develop findings and conclusions, which can be incorporated into a study report for dissemination to the QAPP distribution list, the local press, and other stakeholders via paper or electronic media. Final results may also be disseminated at times throughout the sampling season via web sites, press announcements, or at informational kiosks at public water access locations, etc. Data can also be uploaded to EPA's national water quality database: http://www.epa.gov/storet/wqx.html.

Annual Task Calendar

This represents a typical revolving calendar. Some tasks may continue into the following year (e.g. specimen identification, data interpretation and reporting). Specific details are located in the project-specific General QAPP Adoption Form.

Table 6.1 Anticipated Schedule (typical; variable, dependent on individual programs)

Activity	J	F	M	A	M	J	J	A	S	O	N	D
Kickoff meeting with project team	X											
Develop draft General QAPP Adoption Form	X	X										
Finalize General QAPP Adoption Form			X									
Meeting with agency representatives		X	X									
Equipment inventory, purchase, inspection, and testing	X	X	X									
Field training and database-related training session(s)			X	X	X	X						
Meeting with analytical laboratory		X	X	X								
Lab training sessions (in-house analyses)		X	X	X	X	X						
Sampling surveys				X	X	X	X	X	X	X		
Data entry					X	X	X	X	X	X	X	
Data review and validation					X	X	X	X	X	X	X	
Field audit(s)					X	X	X	X	X	X		
Lab audit(s)			X	X	X	X	X	X	X			
Draft report									X	X	X	
Final report										X	X	X
Data uploads to website	X	X	X	X	X	X	X	X	X	X	X	X
Other												
Other												

7. Data Quality Objectives

□ General QAPP Requirement #7: Clear and achievable ***data quality objectives*** for each parameter to be measured in the project must be stated in the General QAPP Adoption Form.

Taken together, ***precision***, ***accuracy***, ***representativeness***, ***completeness***, and ***comparability*** comprise the major data quality indicators used to assess the quality of the program's data. Additional information on these topics can be found in Section 7 of *The Massachusetts Volunteer Monitor's Guidebook to Quality Assurance Project Plans* (Godfrey et al. 2001). See also definitions of data quality objective terms in the glossary of this document, Appendix 8.

Typical **precision** objectives are listed in Table 7.1. Precision is often evaluated in the field by participants taking **duplicate** measurements for at least 10% of samples, where applicable. The frequency of duplicate measurements to be taken for each parameter must be described in Table 14.1.

Typical **accuracy** objectives are also stated in Table 7.1. Procedures used to test or ensure accuracy are described in Table 14.1. While training and ***audits*** help to ensure measurement accuracy and precision, quantitative measures of accuracy for water quality monitoring are usually estimated using laboratory QC data (blank results, ***fortified matrix*** results, ***known*** QC samples, etc). The accuracy of biological sample identifications and assessments can be verified via expert taxonomic review.

Most sampling sites are selected to be **representative** of the waterbody (or in the case of hotspot monitoring, of the pollution source of interest). Sample collection timing and frequency is selected to capture data that are representative of target conditions (e.g. a range of water levels, weather, seasons, etc.).

The **comparability** of the data collected can be assured by using known ***protocols*** and documenting methods, analysis, sampling sites, times and dates, sample storage and transfer, as well as laboratories and identification specialists used so that future surveys can produce comparable data by following similar procedures.

Project monitoring should attempt to maximize the **completeness** of the dataset. At least 80% of the anticipated number of samples are typically collected, analyzed and determined to meet **data quality objectives** for the project to be considered fully successful. In the end, however, any quality-controlled data are usually considered useful in some way. A report detailing the number of anticipated samples, number of valid results, and percent completion (number of valid samples/number of anticipated samples) for each parameter is typically produced.

Detection Limits are defined in several different ways. See Appendix 8 for definitions of ***level of quantitation, lower level of detection,*** and ***instrument, method, practical quantitation*** and ***reporting detection limits***.

Table 7.1. Data Quality Objectives (NOTE: these are example DQOs for common parameters; develop group-specific DQOs for your project)

Parameter	Units	Accuracy [1]	Overall Precision [2] (RPD)	Approx. Expected Range[3]
Total Kjeldahl Nitrogen (TKN)	mg/l	80% - 120% recovery of ***lab fortified matrix (LFM)***	30%	0.01-2
Total Nitrogen (TN), analytical (e.g., USGS I-4650-03)	mg/l	80% - 120% recovery of lab fortified matrix (LFM)	30%	0.01-2
Ammonia (NH_3-N)	mg/l	80% - 120% recovery of lab fortified matrix (LFM)	30%	0.01-0.5
Nitrate-Nitrite as N (NO_3-NO_2-N)	mg/l	80% - 120% recovery of lab fortified matrix (LFM)	30%	0.01-0.5
Phosphorus - all forms as P (TP, PO_4^{3-}, etc)	mg/l	80% - 120% recovery of lab fortified matrix (LFM)	20%	0.01-0.1
Dissolved Oxygen	mg/l	+/- 0.5	< 20% (between field ***duplicate samples*** or readings)	0.10-12
pH	Std. Units	+/- 0.3	< 20% (between field duplicate samples or readings)	4-10
Conductivity (and salinity)	*u*mhos/cm (ppt/psu)	$\pm$ 5% of known QC std.	< 20% (between field duplicate samples or readings)	10–1000 for fresh (0.5-5 psu for fresh/ tidal areas)
Temperature	Celsius (C) degrees	+/- 1C (vs. NIST-traceable for side-by-side measurements)	< 10% RPD (between field duplicate samples or readings)	0-35
Temperature (continuous)	Celsius (C) degrees	+/- 1C (vs. NIST-traceable for side-by-side measurements)	< 10% RPD (between field duplicate samples or readings)	0-35
Turbidity	NTU	90-110% recovery of turbidity std.	$\pm$ 0.5 NTU if less than 1 NTU or 20% RPD if more than 1 NTU	0.10-200
TSS	mg/l	90-110% for lab-fortified blank (LFB)	20%	0.10-100

Parameter	Units	Accuracy [1]	Overall Precision [2] (RPD)	Approx. Expected Range[3]
Water Clarity (via transparency tube)	cm	+/- 1cm	+/- 2 cm for repeated measurements	0 to > 60
Precipitation	inches (rain gage)	+/- 0.1 inch (in general) [1]	< 20% (between two different gages for the same event)	0-3 inches per event
Location by coordinates (GPS)	degrees and decimal minutes (NAD 1983)	+/- 20 feet with Wide Area Augmentation System (WAAS) enabled	Repeated readings, record during maximum satellite coverage	NA
Station depth	meters	+/- 0.1 meter (in general)	< 20% (between two different readers for same "sample")	0-15 meters
Water clarity (i.e. Secchi disk)	meters	+/- 0.1 meter (in general)	< 20% (between two different readers for same "sample")	0-5 meters
Alkalinity	mg/l as CaCO3	80% - 120% recovery of lab fortified matrix (LFM)	20%	-5 to 150
E. coli, Enterococci [4]	Colonies or CFU/100 ml *or* MPN/100 ml	Blanks and negatives show no colonies, ***positives*** show colonies	For $\log_{10}$ transformed field duplicate data: <30%RPD (<50 MPN/ 100mls) <20% (50-500 MPN) <10 %RPD (500-5000 MPN) < 5% (>5000 MPN)	0-1,000,000
Detergents (CHEMets® kit) Visual Method	mg/L	± ½ of each color standard increment	< 30% (between field duplicate samples or readings)	0.01-3
Pharmaceuticals and Personal Care Products[5] (PPCPs), including caffeine	ug/l	40-140% recovery for LFM and LFB (***analyte***-specific)	< 20% (between field duplicate samples)	highly variable
DNA markers for human-specific strains of indicator bacteria[6]	Present or absent	Consistent meeting of expected results (for human waste samples)	Duplication of results for 10% of samples	NA

Parameter	Units	Accuracy [1]	Overall Precision [2] (RPD)	Approx. Expected Range[3]
Optical Brighteners/ Fluorescent Whitening Agents [7] (absorbent pad/UV light method)	Qualitative: positive, moderately positive, weakly positive, non-detect	Weakly positive or non-detect results for blank control pads	Duplicate results within one qualitative unit.	Non-detect through positive
Optical Brighteners/ Fluorescent Whitening Agents (HPLC method)	µg/l	40-140% recovery for ***Lab Fortified Blank***	0-30% between duplicates	Non-detect to 2
Chlorophyll *a*	µg/l (or mg/m^3)	75%-125% recovery for lab QC sample (with known chl a content)	$\pm$ 2.0 if $\leq$ 15 or 20% if > 15	0.01-30
Algae identification (taxonomic)	NA	All preserved specimens accurately identified to species; taxonomic confirmation of voucher specimens by experts.	90% similarity of identifications when examined by another	NA
Algal toxins	ug/l	60-140% recovery for ***Lab Fortified Blank***	< 30% (between field duplicate samples)	Non-detect to 5
Aquatic plant characterization	Individual organism for ID, % area for distribution	All specimens identified to genus or species with positive taxonomic confirmation of ***voucher*** specimens by experts for 100% of samples for first crew survey (% for successive surveys dependent on initial QC)	NA	NA
Invasive species	Individual organism	All specimens identified to genus or species with positive taxonomic confirmation of voucher specimens by experts for 100% of samples for first crew survey (% for successive surveys dependent on initial QC)	NA	NA
Macroinvertebrates (rivers, lakes, wetlands)	Individual organism	95% voucher specimens accurately identified to family or order level, verified by experts.	NA	NA
Macroinvertebrate Sample IBI scores	relative point system	---	Similar percent comparability to reference condition (within 10% and in same impairment class)	NA
Habitat assessment	NA	---	< 20% (in scores for each category between two different volunteers); in practice, discuss to achieve agreement on score.	NA
Stream bank erosion, stream channel shape	Qualitative description or relative point system	---	< 20% different category scores between two different volunteers); in practice discuss to achieve agreement on scores	NA

Parameter	Units	Accuracy [1]	Overall Precision [2] (RPD)	Approx. Expected Range[3]
Riparian vegetation	Qualitative description or relative point system	---	< 20% (in scores for each category between two different volunteers); in practice discuss to achieve agreement on scores	NA
Stream shading	% Estimate	---	< 20% between two different volunteers; in practice discuss to achieve agreement on scores	0-100
Siltation, substrate embeddedness,	Qualitative description or relative point system	---	< 20% (in scores for each category between two different volunteers; in practice discuss to achieve agreement on scores	NA
Sediment Type	Qualitative description; % cover	100% Accuracy of identification evaluated by an expert; use of sieves, settlement tests for confirmation	General agreement among 2 or more volunteers	From fine silt particles to boulder-sized
Stream channel shape: pool, riffle, run, eddy presence	Qualitative description or relative point system	---	< 20% (in scores for each category between two different volunteers); in practice discuss to achieve agreement on scores	NA
Stream width/depth	Feet/meters	80-120% reading taken by scientific advisor/expert	< 20% in scores for each category between two different volunteers; in practice discuss to achieve agreement on scores	NA for width, 0-4 feet depth for wadeable streams.
Stream stage (height) measurement[8]	Feet (or meters, depending on staff gage type)	+/- 0.1 foot (in general for staff gage reading)	< 10% (between readings by two different volunteers)	NA
Stream crossings	Qualitative description	NA	General agreement among 2 or more volunteers	NA
Lake Habitat: Watershed area, lake area, depth, volume, shoreline length	Feet/meters, square feet/meters	+/- 10%	< 10% (between determinations by two different volunteers)	NA
Lake shoreline vegetation, erosion	See riparian vegetation, above.	---	< 20% different category scores between two different volunteers); in practice discuss to achieve agreement	NA
Vegetation Abundance, Density	Percent cover (%)	---	< 20%; in practice discuss to achieve agreement on scores	0-100 % cover,

Parameter	Units	Accuracy [1]	Overall Precision [2] (RPD)	Approx. Expected Range[3]
Land Use	Categorical; e.g., wetland buffers of 30 meters, 100 meters and 1 kilometer	General agreement to best available land use information	NA	NA
Land use/land disturbance	NA	NA	NA	NA
Wetland soils[9]: Redoximorphic features; % coverage, size, contrast	%, mm, qualitative descriptions; relative point system	90% Accuracy of classification, photo documented and evaluated by Scientific Advisor(s)/experts	NA	0 – 100%, <2 to 76mm, faint, distinct, prominent contrast
Wetland Soils: Structure	Granular, blocky, platy, wedge, prismatic, columnar	90% Accuracy of classification, photo documented and evaluated by Scientific Advisor(s)/experts	NA	Granular - Columnar
Wetland Soils: Structure grade	Structureless, weak, moderate, strong	90% Accuracy of classification, photo documented and evaluated by Scientific Advisor(s)/experts	NA	Structureless - strong
Wetland Soils: Grain/Block size	Mm	90% Accuracy of classification, photo documented and evaluated by Scientific Advisor(s)/experts	NA	<2 to >50
Wetland Plants	Individual organism	90% voucher specimens accurately identified to family or order level, verified by experts.	NA	NA
Wetland amphibians and reptiles	Individual organism	90% specimens identified to species, documented by sound recording, verified by Scientific Advisor/expert.	NA	NA
Wetlands: Vernal pool presence: (amphibians, reptiles, invertebrates)	Individual organisms	100% photo documentation accuracy	NA	NA

1) "General" accuracy objectives are estimates assuming a ***true value*** is known and could be tested; all analytical accuracy objectives (i.e., for samples) include non-detectable concentrations in ambient ***field blanks***.

2) For analytical samples, the objective for overall precision is typically based on the relative percent difference (RPD) of co-located, simultaneous duplicates

3) Ranges may vary from those proposed in the General QAPP. Consult your laboratory and scientific advisory committee and insert the appropriate range for your specific study

4) The preferred indicator for freshwaters is E. coli.

5) PPCPs include such human-sources chemicals as caffeine, acetaminophen, cotinine (nicotine metabolite), codeine, triclosan (antimicrobial), ibuprofen, aspirin, coprostanol, sulfamethoxazole, azithromycin, carbamazepine, cholesterol, etc.

6) Polymerase Chain Reaction (PCR)-type testing for marks of human influence (e.g., septic, wastewater) on water quality can include detection of the *Bacteroidetes* bacteria human marker, detection of the *Enterococcus faecium* esp gene and other published methods.

7) Optical brighteners and fluorescent whitening agents are different terms for chemicals that are added to almost all laundry soaps and detergents, and which are therefore useful indicators of potentially ineffective sewage treatment.

8) Due to the complexities involved in accurately estimating streamflow, streamflow measurements (volumetric, cfs) should only be performed by experts. Staff gage readings (that are incorporated into a site-specific stage-discharge curve) are more appropriate for volunteer groups. Streamflow measurement for educational purposes is appropriate.

9) Wetland soils information taken from *Field Indicators for Identifying Hydric Soils in New England*, NEIWPCC, 2004.

10) NA=not applicable; "---"= no data

8. Training Requirements

□ General QAPP Requirement #8: Instruction in all aspects of project data collection and management shall be provided to project participants (as applicable, depending on assigned tasks) and shall be documented, including trainee signatures, trainer signatures, dates of training and subject matter.

All members of the project team are required to attend workshops appropriate to the type of monitoring they will conduct. The Monitoring Coordinator shall ensure that volunteers receive appropriate training by organizing and conducting workshops (securing the services of expert trainers as needed) and/or arranging for volunteers to be trained at workshops held by other qualified personnel or organizations. Volunteers failing to attend required training sessions and/or not meeting expectations shall not participate in data collection under this General QAPP.

The Monitoring Coordinator enters training data into the project database and records the following information: subject matter (i.e. what type of monitoring and procedures are covered), training course title, type of training materials, date and agenda, name and qualification of trainers, and names of participants trained. Examples of training record forms are provided in Appendix 8 of the QAPP Adoption Form.

Biomonitoring requires specific knowledge of species as well as specific sampling protocols for each parameter. Workshops and field trainings are important resources for volunteers, as are proper training materials, to learn the necessary knowledge to conduct sound data collection and documentation. However, supervision by the Field Coordinator of all monitoring activities may be necessary to achieve data quality objectives.

Volunteers monitoring for invasive species shall be trained to identify native species in addition to introduced species that have the potential to become established and invasive in the region. Volunteers shall also be trained in monitoring protocols and be able to document pertinent environmental data for the evaluation site. The Field and Monitoring Program Coordinators may be trained to verify species (or the project team may consist of scientists that are expert at taxonomic species verification).

9. Documentation and Records

□ General QAPP Requirement #9: Documentation and record-keeping for all project activities related to data collection and data quality shall be implemented for the duration of the project.

Field data sheets will be completed on site at the time of sampling. They will include the sample collection date and times, the site name, number and/or location, the type of sampler used, the weather, air and water temperature, and samplers' names. The data sheets will accompany the samples to the drop-off point where the Field Coordinator will collect the samples and data sheets.

Sample Labels will be placed on all sample containers (and/or in containers, in the case of macroinvertebrate and macrophyte samples), and will include the site name, date, time, location, type of sample, and sampler's name.

Chain of custody **(COC) forms** will accompany samples from collection sites to laboratories. Collectors and all individuals who gain custody of the samples until they arrive at a lab will sign COC forms. Information will agree with the label information on the sample bottles. Information such as the ID number, date, time, type of sample, and samplers will be included on the Chain of Custody Form.

Miscellaneous records for **instrument checks, calibrations, and maintenance** will be kept in a logbook.

In addition to field data sheets, **photographs** (digital preferred) shall be taken of each introduced species that is encountered at each evaluation site (i.e. minimum one photo per species per season).

Voucher Collections may be required for species that are more difficult to identify and/or have recently been introduced to the region.

The monitoring organization shall obtain all **scientific collecting permits** required by law.

Training records for all volunteers involved in the project and materials used in the training must be kept.

The electronic project database shall be organized and protected from loss and damage.

10. Sampling Process Design

□ General QAPP Requirement #10a: The General QAPP Adoption Form must discuss measures to be taken to ensure the health and safety of all project participants for the duration of the project.

□ General QAPP Requirement #10b: The General QAPP Adoption Form must explain the general thought process behind the sampling plan, as well as provide detailed information regarding the "what, when, how, where and why" that was generally referred to in Element 6.

Parameters, number and location of sampling sites, sampling time of day, frequency, and season are selected to meet the monitoring objectives listed in Element 5. Typical sampling design components are described below. Project-specific design shall be described in a project-specific General QAPP Adoption Form.

Sampling Safety. Personal safety shall be a primary consideration in all activities, including selection of sampling sites, dates, and training programs. Safety procedures shall include, but not be limited to:

- No sampling shall occur when personal safety is thought to be compromised.
- The Monitoring Coordinator and Field Coordinator shall confer before each sampling event to decide whether adverse weather or other conditions pose a threat to safety of field volunteers, and will cancel/postpone sampling when necessary.
- Sampling shall take place in teams of two or more.
- Samplers shall wear life vests when sampling from boats or wading in waters under difficult conditions.
- Samplers shall wear proper clothing to protect against the elements as applicable, especially footwear and raingear.

When sampling in rivers, samplers shall estimate flow and avoid sampling when river depth (in feet) times velocity (feet per second) appear to equal 5 or greater, e.g. 1.5 foot depth * 4 feet/second velocity = 6 = unsafe conditions!

Design Considerations. Typical sampling design principles for watershed/waterbody health assessments, impact assessments, habitat assessments and introduced species assessments are listed in Table 10.1. These are further broken into subcategories for river, lake, and wetland monitoring as appropriate. When describing project-specific sampling processes in the program's General QAPP Adoption Form, these procedural considerations shall be followed or modified to meet specific monitoring objectives.

A map and detailed descriptions of the sampling locations shall be included in the General QAPP Adoption Form. Photographs and GPS coordinates of sampling sites are also recommended.

Table 10.1. Sampling Approaches (NOTE: these are example approaches; develop group-specific approach and procedures for your project)

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
Rivers and streams	▪ DO ▪ Temperature ▪ pH ▪ Alkalinity ▪ Conductivity ▪ TP ▪ TN/TKN ▪ NH3-N ▪ NO3-NO2-N ▪ *E. coli* bacteria ▪ Enterococci bacteria ▪ Transparency/water clarity ▪ Turbidity ▪ TSS ▪ Other	At least one each for selected reach or tributary	Representative [1] of reach or tributary condition	▪ At least monthly ▪ Minimum three "dry" weather surveys ▪ Pre-dawn or early morning DO especially useful (closer to worst-case conditions)	For bottled samples, at least one field duplicate sample per bottle group [2] per survey Probe calibration (before each trip; in a controlled setting in the lab or in the field)
	Detergents (MBAS)	As needed based on number of possible sources	Below suspected pollution source	1-2 times	At least one field duplicate sample per survey
	Optical Brighteners/ Fluorescent Whitening Agents	As needed based on number of possible sources	Below suspected pollution source	1-2 times	At least one field duplicate sample per survey
	Pharmaceuticals and Personal Care Products (PPCPs)	As needed based on number of possible sources	Below suspected pollution source	1-2 times, after screening/hot spot determination	At least one field duplicate sample per survey
	DNA markers for human-specific strains of indicator bacteria	As needed based on number of possible sources	Below suspected pollution source	1-2 times, after screening/hot spot determination	At least one field duplicate sample per survey
	Macroinvertebrates	At least one each for selected reach or tributary	Representative [1] of reach or tributary condition	Once/year, late summer or fall, or when species of interest are most abundant	Voucher specimens for later identification by expert(s)

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
	Habitat assessment/ shoreline survey/streamwalk: visual land use characteristics	At least one each for selected reach or tributary	Representative [1] of reach or tributary condition	Once/year - spring, summer or fall	At least one duplicate scoring sheet per team per season
	Habitat assessment: Riparian channel condition (erosion signs, condition of riparian vegetation, stream shading, siltation, substrate embeddedness, stream width/depth, riffle/pool ratio, etc.), stream continuity (potential impediments to aquatic wildlife movement)	At least one each for selected reach or tributary. Stream continuity; at each stream crossing	Representative [1] of reach, tributary condition or stream crossing	Once/year - spring, summer or fall	At least one duplicate scoring sheet per team per season
	Stream flow characterization	Follow Mass. DFG Riverways Program RIFLS guidance [3]			
	Precipitation	At least one per watershed, preferably one per sub-watershed or within 10 miles of sampling sites	Capture storm events that influence conditions at sampling sites	Continuous gages preferable. At least sample within 24 hours prior to sampling event.	Check for reasonableness (e.g. values consistent with predicted rainfall); duplicate readings by two personnel; compare with other local rain stations
	GPS: Latitude/Longitude in decimal degrees; NAD83/WGS84 coordinate system	Each sampling site	NA	Once per year to mark site; each visit to sampling site if site is not easily marked (e.g. center of lake or longitudinal river profile)	Repeat readings to verify coordinates, take reading during maximum satellite coverage if possible

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
Lakes and ponds	▪ DO ▪ Temperature ▪ pH ▪ Alkalinity ▪ Conductivity ▪ TP ▪ Reactive P (specify fraction to be analyzed) ▪ TN/TKN ▪ Secchi depth ▪ Chlorophyll a ▪ Station depth	At least one at each mid-lake area or deep spot (>1 for some lobed lakes).	Representative of lake condition. [4] DO, temperature sampled in a depth profile at 1 meter increments Chlorophyll a at the surface (***grab***) or depth-***integrated*** using tube (2X Secchi depth) TP/TN at the surface (~6-12" below water surface) TP and/or reactive P at 1 meter above bottom if DO is < 1mg/l at this depth	At least monthly (April-October).	At least one field duplicate sample per bottle group [2] per survey Probe calibration (if not in the lab just prior to survey)
	Macroinvertebrates	At least one each lake, ≤ 30 meter upslope of outlet, on vegetation bed	Avoid overemphasis of tributary streams; reflect lake processes	At least once per year – summer or fall.	Voucher specimens for later identification by expert(s)
	Invasive species	At least one per basin within lake	Near boat ramp; deepest spot per basin.	At least once per year	Voucher specimens or photo documentation for later identification by expert(s)
	Aquatic plant characterization (qualitative)	Whole lake	areal density and plant type/species maps for lake footprint	Peak growing season (July-August)	Voucher specimens or photo documentation for later identification by expert(s)
	Algae identification (qualitative)		Sample within 0.3M of surface when algae visible in this range; When algae are dispersed through the water column, compositing samples from different depths is acceptable.	Once/year, late summer or fall	Voucher sample for later identification by expert(s)

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
	Algal toxins	At least one per lake	Representative of lake; or where blooms appear or activity is greatest	Monthly, whenever blooms appear or as need arises. Avoid contact with skin. Wear waterproof gloves when sampling and/or immediately wash all areas of the body where water contact occurs.	At least one field duplicate sample per survey
Lake Morph-ometry & habitat	Watershed area, Lake area	NA	NA	Once. Useful to estimate watershed/lake size ratio, retention time	NA – mapping/GIS exercise
	Lake depth	Sufficient sites, transects to locate deepest spot, estimate lake volume,	Locate areas of potential low DO and temperature	Once	10% duplicate readings
	Lake volume		Useful to estimate retention time.	Once	NA
	Lake shoreline length	NA	NA	Once. Combine with land use information to estimate % of lakeshore disturbed	
	Lake shoreline vegetation, erosion	See streambank vegetation, erosion			
Beaches	▪ *E. coli* bacteria ▪ Enterococci bacteria	Follow MassDEP DWM guidance on bacteria sampling at beaches or other applicable guidance [5]			

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
	Parameter(s) determined by suspected impact Examples: ▪ TSS ▪ Bacteria	For rivers, at least two sites (one just upstream and one just downstream of impact/source) For source tracking, numerous samples may be needed to find likely source(s) Outfall pipe or stream sample along shoreline	Proximity to impact or suspected pollution source	Minimum of three times each site, including wet and dry weather For source tracking, "as needed" to locate source(s)	See "Rivers" QC
Watershed / land use	Visual – land use, disturbances	Varies	Identify location of potential impacts.	Once per several years – resurvey if new uses/disturbances appear. Spring surveys advantageous due to less revealing vegetation and more evident impacts of high water table/flows.	Multiple observers compare observations. Photodocumentation
Wetlands	Soils	At least 3	One each: obviously wetland, transitional, obviously upland	Once per site. Avoid recent rains that might saturate soil.	At least one duplicate scoring sheet per team per season. Photodocumentation helpful.
	Plants	One per wetland	Select plot that includes emergent vegetation – if none found, plot should cover wetland edge.	Once per year. Summer, when plants in flower or fruit; if site is wooded, late spring for better flowering.	At least one duplicate scoring sheet per team per season. Photodocumentation.
	Amphibians	At least one per wetland	For calls: at least 500 meters apart.	At least 3 times per season (spring – to capture maximum breeding activity), at least 15 days apart. 3 minutes duration at each site.	At least one duplicate scoring sheet per team per season. Sound recording helpful for calls, photodocumentation for breeding behavior

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
	Vernal pool [6] presence: 1) obligate species method (amphibians, invertebrates); 2) facultative species method (amphibians, reptiles, invertebrates; 3) dry pool method (invertebrates).	One per pool	NA	At least once; several observations preferred to document when pool contains water. Methods 1 and 2 require standing water; method 3 requires no standing water.	At least one duplicate scoring sheet per team per season..

1) i.e. not in stagnant water or backwater areas; not in a pipe outfall or confluence mixing zone; not in highly turbulent flows

2) e.g. "nutrient" bottle group may include TP, TN and NH3-N

3) as contained in MA DFG "RIFLS" QAPP Due to the complexities involved in accurately estimating streamflow, streamflow measurements (volumetric, cfs) should only be performed by experts. Staff gage readings (that are incorporated into a site-specific stage-discharge curve) are more appropriate for volunteer groups. Streamflow measurement for educational purposes is appropriate.

4) i.e. not in atypical areas, but in areas that most approximate the average condition of the lake at the time of the survey

5) DWM CN document # 104.0, see Appendix 2

6) for detailed information on vernal pool determination/certification see: http://www.mass.gov/dfwele/dfw/nhesp/vernal_pools/vernal_pool_cert.htm

11. Sampling Method Requirements

□ General QAPP Requirement #11: All sample collections shall follow group-specific ***Standard Operating Procedures (SOPs)***, as contained or referenced in a project-specific General QAPP Adoption Form.

It is recommended that pre-sampling coordination with a laboratory take place to ensure that proposed sample collection procedures (found in the SOPs) meet the needs of the chosen laboratory.

Table 11.1. General Sample Collection Methods[1]

Survey Type	Sample Type/ Device	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity [2]	Sample Preservation	Maximum Holding Time
River water quality	In-situ (single and/or multi-probes)	▪ DO ▪ pH ▪ conductivity ▪ temperature ▪ other	NA	NA	NA	NA
	▪ Manual grab sample ▪ "Basket" sample [3] ▪ Van Dorn sample [4] ▪ Niskin sample	▪ TKN ▪ TN ▪ TP ▪ NH3-N ▪ NO3-NO2-N	▪ New Whirlpak bag ▪ High density polyethylene (HDPE) ▪ Polypropylene (PP) ▪ Pyrex glass (glass, plastic containers pre-acid-washed with 10% hydrochloric acid)	120 ml per analyte	▪ Freeze immediately ▪ Add H_2SO_4 to pH<2 immediately and refrigerate/ chill to <6°C	▪ 28 days if acidified ▪ Up to six mos. frozen (TP only)
		▪ Fecal coliform ▪ *E. coli* bacteria ▪ Enterococci bacteria	▪ Sterilized HDPE/PP/glass ▪ Whirlpak bag	120 ml per analyte	▪ Sodium thiosulfate if chlorine residual suspected ▪ refrigerate/ chill to <6°C	▪ Transport to lab within six hours ▪ Analyze within 8 hours of collection
		pH, alkalinity	High density polyethylene (HDPE)	300 ml	refrigerate/ chill to <6°C	Deliver to lab ASAP Holding time for alkalinity is 14 days
		TSS	Glass or Plastic	300 ml	refrigerate/ chill to <6°C	seven days
		Turbidity	Plastic	100ml	refrigerate/ chill to <6°C	48 hours

Survey Type	Sample Type/ Device	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity [2]	Sample Preservation	Maximum Holding Time
		Detergents (CHEMets kit)	HDPE or amber glass	500 ml.	▪ refrigerate/ chill to <6°C ▪ dark storage	two days
		Optical Brighteners/ Fluorescent Whitening Agents	Amber glass (no pre-rinsing)	1 liter	▪ refrigerate/ chill to <6°C ▪ dark storage	seven days
		Pharmaceuticals and Personal Care Products (PPCPs), including caffeine	Amber glass	500 ml.	▪ refrigerate/ chill to <6°C ▪ dark storage	24 hours
		DNA markers for human-specific strains of indicator bacteria	Same as for bacteria (although lab may require additional sample bottle prep (such as bleach wash of PS/HDPE container to remove any DNA/RNA) or use of sterile glass containers)			
	Cotton pad sampler (in-situ)	Optical Brighteners/ Fluorescent Whitening Agents	Cotton pads	NA	Keep pads cool and in dark in separate labeled plastic bags	two to three days
	Winkler bottle and reagent kit	Dissolved Oxygen (manual)	"BOD" Bottle	300 ml.	▪ Fix immediately ▪ refrigerate/ chill to <6°C ▪ dark storage	eight hours
	Manual thermometer	Temperature	NA	NA	NA	NA
	Temperature recorder (continuous data logger)	Temperature	NA	NA	NA	NA
	Kick nets	Macroinvertebrates	Plastic bottles or zip-lock bags	N/A	preserved in 90% ethyl or isopropyl alcohol until initial sorting to remove debris; 70% alcohol until ID	six months
	Transparency tube	Water Clarity	Collect into tube directly or pour from a well-mixed, large volume bottle or bucket (on-site)	1-3 liters (for pouring container); depends on tube size	NA	NA

Survey Type	Sample Type/ Device	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity [2]	Sample Preservation	Maximum Holding Time
	Rain gage	Rainfall amount (precipitation)	N/A	N/A	In-situ	N/A
	GPS	Location by coordinates (GPS)	NA	NA	NA	NA
	Visual	Weather and sampling conditions	NA	NA	NA	NA
	Visual	Stream bank erosion, stream channel shape	NA	NA	NA	NA
		Riparian vegetation	NA	NA	NA	NA
		Stream shading	NA	NA	NA	NA
		Siltation, substrate embeddedness,	NA	NA	NA	NA
		Stream Channel shape: pool, riffle, run, eddy presence	NA	NA	NA	NA
		Stream width/depth	NA	NA	NA	NA
		Stream stage (height) measurement [4]	NA	NA	NA	NA
		Continuity (construction type, substrate, velocity, other visual observations taken at stream crossings)	NA	NA	NA	NA
Watershed/ land use	Visual	Land use types; disturbances	NA	NA	NA	NA
Lakes	▪ Manual grab sample ▪ Van Dorn sample [4]	▪ TKN ▪ TN ▪ TP	See above for Rivers			

Survey Type	Sample Type/ Device	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity [2]	Sample Preservation	Maximum Holding Time
	In-situ (instrumentation)	▪ DO ▪ pH ▪ conductivity ▪ temperature	See above for Rivers			
	Secchi disk (w/ viewscope)	Secchi depth Transparency	NA	NA	NA	NA
	Transparency tube	Water clarity	See above for rivers	See above for rivers	NA	NA
	Manual grab	pH, Alkalinity	High density polyethylene (HDPE)	300 ml	refrigerate/ chill to <6°C	Deliver to lab for analysis ASAP (for pH). Holding time for alkalinity is 14 days
	▪ Manual grab sample ▪ Van Dorn sample ▪ Depth-integrated tube	Chlorophyll a	High density polyethylene (HDPE)	1 liter (2 liters if Secchi depth > 3 meters)	Filter on shore, or if delivering unfiltered to lab, refrigerate/ chill to <6°C in dark storage	Unfiltered, fresh-24 hr; Filtered, frozen-21 days; Filtered, forced air-dried-15 days
	Winkler bottle and reagent kit	Dissolved Oxygen (manual)	"BOD" Bottle	60 ml.	▪ Fix immediately ▪ refrigerate/ chill to <6°C ▪ dark storage	eight hours
	Kick nets	Macroinvertebrates	See rivers	See rivers	See rivers	See rivers
	Plankton nets	zooplankton, including larval stages of invasive species)	High density polyethylene (HDPE)	300 ml	alcohol	7 days
	Visual, grab	Macrophytes	Newspapers (wet), zip-lock bags	One per species or one per sample	Refrigerate upon return from sample trip.	Several days
	Grab or depth integrated	Algae or phytoplankton	Brown polypropylene bottle	500ml	refrigerate/ chill to <6°C , preserve with Lugol's solution (Iodine)	8 hours
	Grab	Algal toxins				

Survey Type	Sample Type/ Device	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity [2]	Sample Preservation	Maximum Holding Time
Lake Habitat	Visual	Watershed area, lake area, depth, volume, shoreline length, shoreline vegetation, erosion	NA	NA	NA	NA
Beaches ▪ lakes ▪ rivers	▪ Manual grab sample ▪ "Basket" sample ▪ Van Dorn sample	▪ *E. coli* bacteria ▪ Enterococci bacteria	See above for Rivers			
Wetlands	In situ, quadrats	Vegetation	NA	Dependant on wetland size, extent of study	Only if further species verification needed	NA
	Kick nets	Macroinvertebrates	Labeled zip-lock bags	One per sample collected	preserved in 90% ethyl or isopropyl alcohol; refrigerate until initial sorting to remove debris; vials with 70 -90% alcohol until ID	Less than 6 months; after ID archive vials
Wetlands	Visual	Soils	NA	NA	NA	NA
	Plants	See Lake Macrophytes where?				
	Sound	Amphibians	NA	NA	NA	NA
	Visual	Vernal Pool presence: amphibians, reptiles, invertebrates	NA	NA	NA	NA

1) This Table highlights field sampling specifications that should be contained in group-specific SOPs in greater detail. See Appendix 2 for references to selected field methods (as examples)

2) Coordinate with lab regarding sample volume requirements and other issues

3) The use of buckets to collect samples is not advised, due to the potential for sample contamination. Direct sample collection (i.e., water into sample bottle) is best

4) The use of Van Dorn bottle samplers may introduce contamination of low level phosphorus samples. Wash with P-free soap and DI- rinse thoroughly prior to use and evaluate risk by taking field ***equipment blanks***

Table 11.2. Typical Field Sampling Considerations for common parameters (as may be contained in group sampling SOPs)

Survey Type	Sample Type/ Device	Parameter(s)	Sampling Considerations
River water quality	In-situ probes (instrumentation)	▪ DO ▪ pH ▪ conductivity ▪ temperature ▪ other	Sample at consistent time each day – e.g. 5 AM – 8 AM window. DO is best sampled in the very early morning (to capture "worst case" conditions after darkness). In contract, worst-case summertime temperature conditions typically occur between 5-7 PM. Inspection, maintenance, pre-calibration and post-checking of probes are critical to achieving accurate and precise measurements, especially for DO. Cross-comparisons (in-situ, side-by-side) with other group's probes help to validate SOPs and data.
	Winkler bottle / reagent kit	Dissolved Oxygen (manual)	Sample collected at surface with care to avoid entraining bubbles into the bottle. If bubbles get in, empty and begin again. Sample is fixed immediately on site. Store in dark. Best sampled before sunrise to capture "worst case".
	Manual grab	pH, Alkalinity	Avoid stirring up bottom sediments. Collect sample under water surface. Fill to overflowing. Cap while under water to avoid any air in sample (no air space)
	Thermometer (manual)	Temperature	If collecting from depth (e.g. associated with DO sample), immediately place thermometer in sample water (but not in BOD bottle) upon retrieval from depth. Read within 30 seconds.
	Temperature (continuous logging)	Temperature	Place in a representative location with adequate depth and flow to allow the instrument to remain submerged for the duration of sampling. Take care to firmly secure.
	Transparency tube	Water Clarity	Collect sample directly into tube or into bucket. Swirl bucket well to mix; pour water into transparency tube until bottom symbol not visible. Release water from tube via valve until symbol is visible. Stand with back towards sun if necessary to avoid glare.
	Rain gage	Rainfall amount	Develop and follow an SOP for setup and recording data
	Global Positioning System (GPS)	Location by coordinates	Develop and follow an SOP. Use landmarks, site descriptions in conjunction with GPS coordinates.
	Staff Gage	Relative stream height	See note #2.

Survey Type	Sample Type/ Device	Parameter(s)	Sampling Considerations
	▪ Manual grab sample ▪ "Basket" sample ▪ Van Dorn sample ▪ Niskin sample	▪ TKN ▪ TN ▪ TP ▪ Reactive P ▪ NH_3-N ▪ NO_3-NO_2-N	Triple-rinse container in ambient water immediately prior to sample collection. Care must be taken to avoid contact between fingers and inside surfaces of containers, including bottle caps. New, pre-washed bottles preferred; if not, containers for nutrient samples should be acid-washed and rinsed with deionized water Field filtration (ASAP under controlled conditions) preferred for dissolved nutrient fractions; be clear with lab what fraction to analyze for and report (e.g., for P, DRP vs. TRP vs. TDP vs. other…)
		▪ *E. coli* bacteria ▪ Enterococci bacteria ▪ other "micro" samples	Sterile (new-sealed or autoclaved-sealed) bottle required. Place upright, capped sample bottle under the surface of the water about six inches. Do not rinse bottle. Slowly uncap and let it fill to capacity under the water. With hands away from the bottle opening, bring the bottle up and out of the water, pour sufficient water to leave approximately 1/2 inch air space in the bottle. Cap bottle and tighten. Latex gloves should be worn when sampling in waters suspected of contamination.
		TSS	Avoid disturbing bottom sediments. Leave one inch of air in container to allow shaking before analysis.
		Turbidity	Avoid disturbing bottom sediments. Leave one inch of air in container to allow shaking before analysis.
		Detergents (CHEMets kit)	If different analysts will generate data, make sure to perform inter-analyst comparisons using sample duplicates/***splits***. Using the absorbent pad/uv light method to detect optical brighteners may be more cost-effective, in light of cost of procuring refill reagents.
		Optical Brighteners/ Fluorescent Whitening Agents	Avoid exposure to sunlight.
		Pharmaceuticals and Personal Care Products (PPCPs), including caffeine	See note #1
		DNA markers for human-specific strains of indicator bacteria	Special bottles or preparation for DNA marker analyses may be required by the lab
	Cotton pad sampler	Optical Brighteners/ Fluorescent Whitening Agents	Avoid all direct contact with laundry soaps and detergents for at least 24 hours prior to handling any samplers. Wear disposable gloves when handling pads and sampling devices. Upon retrieval, place pads in *new* plastic bags.

Survey Type	Sample Type/ Device	Parameter(s)	Sampling Considerations
	Kick nets	Macroinvertebrates	When collecting from multiple areas (e.g. fast and slow sections, replicates) sample from furthest downstream location first; then work upstream. When brushing rocks/disturbing sediments, avoid sweeping specimens outside of flow entering net. When sampling streams with high flow fluctuations (e.g. below dams), avoid sites that are usually dry. Disturbed sites take 6-8 weeks to recolonize.
River Habitat	Visual	Stream bank erosion, stream channel shape	Channelization is indicated by long, straight stretches of stream without bends or meanders.
	Visual	Riparian vegetation	Estimate the relative abundance of trees, shrubs, herbaceous (non-woody) plants, grasses, and bare banks.
	Visual	Stream shading	Approximate % of stream shaded by vegetation; estimated from mid-stream perspective.
	Visual	Siltation, substrate embeddedness,	Estimate % of stream area silted; estimate relative abundance of each substrate type (bedrock, boulder, cobble, sand/gravel, silt) throughout survey area; estimate % of cobbles buried in substrate (pick several random cobbles to make estimate).
	Visual	Stream Channel shape: pool, riffle, run, eddy presence	Indicate presence/absence, estimate relative abundance of each water type in survey area
	In Situ	Stream width/depth	Tape measure if feasible: otherwise visual estimate of 3 representative points in study area.
	Visual	Stream Continuity	Follow procedures in *Massachusetts Stream Crossings Handbook*, Riverways Program (see Appendix 2).
Water-shed/land use	Visual	Land use types; disturbances	List instances of and draw on map different land use types and potential pollution / habitat impairment sources. Landowner permission essential if surveying private property. Camera, tape measure helpful. Scale varies; areas with greater variety or more impacts typically require surveys with greater detail .
Lakes	Manual grab sample Van Dorn sample	▪ TKN ▪ TN ▪ TP ▪ Reactive P	See above for Rivers
	In-situ (instrumentation)	▪ DO ▪ pH ▪ conductivity ▪ temperature ▪ other	See above for Rivers

Survey Type	Sample Type/ Device	Parameter(s)	Sampling Considerations
	Secchi disk (w/ or w/o viewscope)	Secchi depth Transparency	Take readings between 10 am and 4 pm. Always sample from the shaded side of the boat and note whether a viewscope was used. Always sample without sunglasses. Note if disk hits bottom or is obscured by weeds. Note also when complete surface cover does not allow or complicates a reading. If surface obstruction can be temporarily cleared, take a reading.
	Transparency tube	Water clarity	See above for rivers
	▪ Manual grab sample ▪ Van Dorn sample ▪ Depth-integrated tube	Chlorophyll a	Specify whether surface grab or depth-integrated. Take depth-integrated (tube) samples at depth 2X Secchi disk measurement.
	Manual grab	pH, Alkalinity	Avoid stirring up bottom sediments. Collect sample under water surface, fill to overflowing, cap while under water to avoid air in sample.
	Winkler bottle / reagent kit	Dissolved Oxygen (manual)	Sample collected 0.5m from bottom using Van Dorn or comparable collection device. Samples may also be collected at surface and at other depths to construct DO profile. Surface sample can be collected with BOD bottle only (no Van Dorn/other sampler), taking care to avoid bubbles. Best sampled in very early morning. Samples are fixed on site.
	Kick nets	Macroinvertebrates	See above for rivers
	Plankton Net	Larval stages of invasive species, zooplankton	Use vertical haul if depth 30 feet or greater; horizontal haul otherwise. Spray bottle used to rinse plankton into collection end. If invasive species found, disinfect net before next use.
	Fixed-area sampler (quantitative) or throw-rake (qualitative) or other	Macrophytes	If possible, collect all parts of plant: roots, stems, leaves, flowers. Make sure all collections are labeled well
	Manual Grab	Algae	Use gloves if toxic bloom suspected, avoid contact with skin
Lake Habitat	Visual	Watershed area, lake area, depth, volume, shoreline length, shoreline vegetation, erosion	See stream habitat surveys. Use of anchor important to minimize drift when taking depth measurements.

Survey Type	Sample Type/ Device	Parameter(s)	Sampling Considerations
Beaches ▪ lakes ▪ rivers	▪ Manual grab sample ▪ "Basket" sample ▪ Van Dorn sample	▪ Fecal coliform ▪ *E. coli* bacteria ▪ Enterococci bacteria	See above for Rivers
Wetlands	In situ, quadrats	Vegetation	Depending on the size of wetland, sampling may take four or more hours. Be prepared with proper clothing, water and food. Do not stay in wetland if thunder and lightning are threatening.
		Land Use	Mapping may be done in the office, but it is necessary to field truth assessment.
	Kick nets	Macroinvertebrates	Understand the particular conditions of the wetland being sampled (i.e. thick mud, current) in regards to monitors' safety. Be prepared and careful.
	Visual	Soils	Sample during growing season, avoid recent saturating rains, avoid previously disturbed sites.
	Sound	Amphibians and reptiles	Night sampling, temperatures > 5^{o}C, 10^{o}C, 17^{o}C respectively for each of 3 sample dates.
	Visual	Vernal pool indicators: Amphibians, reptiles, invertebrates	Any of three methods acceptable for vernal pool identification: obligate species method, facultative species method, or dry pool method.[3]

1) Coordinate with lab regarding sample volume requirements and other issues

2) Due to the complexities involved in accurately estimating streamflowl, measurements using velocimeters should only be performed by experts. Staff gage readings (that are incorporated into a site-specific stage-discharge curve developed by experts) are more appropriate for volunteer groups. Streamflow measurement for educational purposes is appropriate.

3) See *Vernal Pool Certification Guidelines*, Natural Heritage and Endangered Species Program, in Appendix 2.

12. Sample Handling and Custody Requirements

□ General QAPP Requirement #12: The procedures used to label, transport, store and track custody of samples must be explained in the project General QAPP Adoption Form.

Sample handling and custody procedures shall be in compliance with project Standard Operating Procedures (SOPs). If your program consists solely of field measurements, indicate that no sample preservation is necessary and move on to the next section.

Sample container labels can be attached to dry bottles, with the following information: Site ID#, sample type, date and time, preservation (if any), name of sampler, name of organization conducting sample. Macroinvertebrate and macrophyte samples may be labeled in pencil on paper placed in sample container or the samples may be placed in plastic bags and label the outside with permanent ink markers. Examples of labels are found in Appendix 8. Specific steps shall be taken to avoid sample mis-labeling.

All samples shall be handled and transported in accordance with SOPs for each indicator. A summary of these steps is included in Table 11.1. **Chain of custody forms** shall be prepared and completed in all cases. The whereabouts of all samples shall be known at all times.

13. Analytical Methods Requirements

□ General QAPP Requirement #13: All analytical methods used in the project shall be identified in the General QAPP Adoption Form and be based on standardized laboratory methods that are specifically referenced or contained in the project-specific General QAPP Adoption Form.

The submitted General QAPP Adoption Form shall include Standard Operating Procedures (SOPs) written by the laboratory for all methods used. These SOPs may reference a published method (e.g. SM 4500 P), but citing a method alone is not sufficient. Method detection and reporting limits must be ascertained for each analyte from the lab being employed. NOTE: For non-total nutrient analyses, confirm how lab results are reported (e.g., NH_3 vs. NH_3-N, i.e. as N).

If no analytical procedures are conducted in your program, indicate that on the AF and continue with section 14.

Table 13.1. Typical Analytical Methods

Parameter	Method #	Source of Method	MDL (mg/l or as stated)[1]	Special Considerations
Total Kjeldahl Nitrogen (TKN)	EPA 351 (.1, .2, .3 or .4)	EPA	0.05	---
	SM 4500-N_{org} B SM 4500-N_{org} C	Standard Methods, 21st	0.05	---
Total Nitrogen (TN)	SM 4500-N B SM 4500-N C	Standard Methods, 21st	0.05	---
	USGS WRIR 03-4174 (Method I-4650-03)	USGS	0.05	---
Ammonia-Nitrogen (NH_3-N)	EPA 350 (.1, .2 or .3)	EPA	0.02	field (vs. lab) filtration preferred for dissolved fractions, if possible
	SM 4500-NH_3	Standard Methods, 21st	0.01	
Nitrate-Nitrite-Nitrogen (NO_3-NO_2-N)	SM 4500-NO_3 E-I)	Standard Methods, 21st	0.01	field (vs. lab) filtration preferred for dissolved fractions, if possible
	EPA 353 (.1, .2 or .3)	EPA	0.01	
Total Phosphorus (TP) (inc. P fractions, such as total reactive P, dissolved reactive P, total dissolved P, etc., depending on how sample is handled)	SM 4500-P	Standard Methods, 21st	0.01	field (vs. lab) filtration preferred for dissolved fractions, if possible
	EPA 365 (.1, .2 or .3)	EPA	0.01	

Parameter	Method #	Source of Method	MDL (mg/l or as stated)[1]	Special Considerations
E. coli	EPA 1603 (Modified m-TEC)	EPA	* lower reporting limit <10	preferred indicator for fresh waters
	SM 9213-D (MTEC)	Standard Methods, 21st	* lower reporting limit <10	
	SM 9223-B (enzyme substrate)	Standard Methods, 21st	1 MPN/100 mls.	
Enterococci bacteria	EPA 1600 (MF)	EPA	* lower reporting limit <10	preferred indicator for marine waters
	SM 9230	Standard Methods, 21st	* lower reporting limit <10	
	ASTM D6503-99 (enzyme substrate)	ASTM	1 MPN/100 mls.	
Chlorophyll *a*	SM 10200 H	Standard Methods, 21st	1 ug/l	---
Turbidity	EPA 180.1 or SM 2130-B	EPA or SM, 21st	0.2 NTU	---
TSS	SM 2540D or EPA 160.2	EPA or SM, 21st	1 mg/l	---
pH	SM-4500-H	SM, 21st	0.1 SU	in-situ measurement preferred over lab analysis; if lab, fill bottle to top with no headspace
Alkalinity	SM 2320-B	SM, 21st	2 mg/l	---
Hardness	SM 2340-B	SM, 21st	2 mg/l	---
Chloride	SM-4500-Cl-(B)	SM, 21st	1 mg/l	---
Conductivity	SM-2510-B	SM, 21st	1 *u*mhos/cm	---
Dissolved Oxygen	SM 4500-O	Standard Methods, 21st	0.5 mg/l	Ensure reagents are fresh and thiosulfate titrant is standardized prior to beginning titration; Beware of over-running colorimetric end-point
Optical Brighteners/ Fluorescent Whitening Agents	* (solid phase extraction & HPLC)	*	variable (<0.5 ug/l preferred for all FWAs)	---
Caffeine	* (solid phase extraction & GC/MS)	EPA	variable (<20 ng/l preferred)	---
Pharmaceuticals and Personal Care Products (PPCPs)	* (usually solid phase extraction & LC/MS)	*	variable (typically <5 ug/l for most chemicals)	---

Parameter	Method #	Source of Method	MDL (mg/l or as stated)[1]	Special Considerations
DNA markers for human-specific strains of indicator bacteria	* **	* **	---	---
Detergents, surfactants. CHEMets Visual MBAS test # k-9400	SM 5540C, EPA 425.1	EPA, SM 21st	.125 mg/l linearABS	---
Algae identification	SM 10200, Appropriate identification keys or by expert	Standard Methods, 21st.	species	Be cautious with sample handling if toxic algae is suspected
Algal Toxin identification	Microscopic identification; Quicktube Microcystin kits can be used to test for microcystin	Quicktube kits: Envirologix inc. http://www.xygen.com/	Genus: 0.3 ppb for microcystin kit.	microcystin kit semi-quantitative
Benthic Macroinvertebrates	Appropriate identification keys or by expert	NA	Family taxonomic level	Taxonomy level varies by program, objectives objectives, organism
Invasive species	Appropriate identification keys or by expert	NA	Species	---

1) MDLs may vary from those proposed in the General QAPP. Consult your laboratory and scientific advisory committee and insert the appropriate MDL for your specific study.

***** Lab-specific and/or research-based. See Appendix 3 for example lab method references.

** Library-based microbial source tracking (MST) methods have been intentionally left out of this general QAPP in favor of library-independent methods to determine human vs. non-human source organisms for bacterial/pathogen pollution.

NA=not applicable; "---"= no data

14. Quality Control Procedures

□ General QAPP Requirement #14: Project sampling shall include appropriate field and laboratory ***quality control sample***s to assess general data quality issues, as well as specific data quality objectives specified in Element 7 of the project General QAPP Adoption Form.

Water Quality

As a general rule, field quality control samples will be taken for 10% of all water quality samples taken. Example numbers of QC samples required to meet an approx. 10% rate are as follows:

- 1-10 samples taken, 1 QC sample is processed.
- 11-20 samples taken, 1-2 QC samples are processed.
- 21-30 samples taken, 2-3 QC samples are processed.

Specific procedures for taking ambient ***field blank*** QC samples and ***field duplicate*** QC samples shall be stated in the General QAPP Adoption Form.

To the extent possible, **inter-group comparison sampling** employing side-by-side sampling by two or more groups is also recommended. Any plans for this should be stated in the General QAPP Adoption Form.

Lab QC protocols shall be discussed with the lab prior to sampling to ensure acceptability.

Biological Monitoring

Quality control for **biological-type samples and measurements** shall also be discussed and defined prior to sampling (e.g., during training). This may involve duplicate field measurements by two different samplers, peer-review or expert-review of voucher identifications, photo documentation, etc.

Table 14.1. Typical Quality Control Measures

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	Approx. % Field QC Samples
Multiprobe instruments	All types	Pre-survey calibration (before each trip) and post-survey checks, including "zero" DO standard check	3-5 minutes of stable readings logged or recorded	verify repeatability in the field
Single probe instruments	Dissolved Oxygen	Compare with audit samples, Winkler titration method and/or theoretical 100% saturation values "zero" DO standard check	Field duplicates	10%
	pH, alkalinity	***Blind*** audit samples	Field duplicates	10%
	Turbidity	Field/lab blanks, formazin standards	Field duplicates	10%
	Conductivity	Field blanks, QC standard	Field duplicates	10%
	Thermometer, manual and continuous	Compare with NIST-certified or NIST-traceable thermometer (*Identify thermometer and ownership)*	Field duplicates	10%
Water Quality samples – grab	TP, P fractions TN TKN NH_3-N NO_3-NO_2-N	Field: blanks Lab: analysis of lab-fortified matrix (***spiked samples***) and/or lab QC standard	Field duplicates Lab duplicates	10%
	E. coli Enterococci	Negative and ***positive plates***	Field duplicates Lab duplicates	10%
	TSS Turbidity	External audit/QC standard, distilled water lab blank.	Field duplicates Lab duplicates	10%
	PPCPs (inc. caffeine)	Field: blanks Lab: analysis of lab-fortified matrix (spiked samples) and/or lab QC standard	Field duplicates Lab duplicates	10%
	DNA markers for human-specific strains of indicator bacteria	Blind audit samples from different animals	blind audit samples from different animals	min. once per project
	Dissolved Oxygen (Winkler)	Compare with blind QC standards	Field Duplicates	10%
	Chlorophyll *a*	Commercial audit samples	Field Duplicates	10% - 20%

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	Approx. % Field QC Samples
Physical/visual, etc.	Secchi disk Transparency tube	Annual calibration checks of metered line and tube rulings	Field replicates (1-2 analysts)	100%
Physical/visual	Optical Brighteners/ Fluorescent Whitening Agents	Blank pads	Field replicates	10%
Physical/visual	Staff gage measurements	See Section 15	Different personnel conduct side-by-side assessments, compare	100%
Physical, visual, photo documentation	Habitat assessments	NA	Different personnel conduct side-by-side assessments, compare	10%
Visual, photo documentation	Aquatic plants (cover, ID)	2 personnel ID plants separately. Discrepancies/unknowns taken to expert for ID confirmation.	2 personnel conduct separate mappings of same area, compare results, and discuss to resolve differences.	10%
Grab, passive collection, visual, photo documentation	Benthic Macroinvertebrates	IDs verified by external expert. 90% Accuracy of identification when Invertebrate Scientific Advisor examines a minimum of 10% of the original samples	NA	10%
Grab, visual, photo documentation	Invasive species	IDs confirmed by external expert	2 personnel ID specimen separately. Compare.	NA
Grab, visual, photo documentation	Algae	Discrepancies/unknowns taken to expert for ID confirmation.	2 personnel ID algae separately. Compare.	10%
Visual, photo documentation	Vegetation (wetland)	100% Accuracy of identification evaluated by the Scientific Advisor(s)	2 personnel ID plants separately. Compare.	10%
Core/grab, visual	Soils (wetland)	Accuracy of identification evaluated by the Scientific Advisor(s)??	2 personnel evaluate soils separately. Compare	10%
Sound	Amphibians	Sound recording, Advisor ???accompanies for a minimum of 10% observations	2 personnel evaluate separately. Compare	10%
Visual, photo documentation	Amphibians, reptiles	Photo documentation evaluated by scientific advisor/expert	2 personnel evaluate separately. Compare	10%

15. Instrument/Equipment Inspection and Testing

□ General QAPP Requirement #15: The project shall include a systematic process for consistently checking, testing and maintaining instruments and equipment for proper functioning.

Maintenance shall occur as needed. Records of equipment inspection, maintenance, repair and replacement shall be kept in a logbook. In addition to following a manufacturer's recommendations, group-specific SOPs for instrument maintenance and calibration shall be developed and followed.

Table 15.1. Typical Instrument/Equipment Inspection, Testing Procedures

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
Nutrient Sample bottles	Before each use	Visual for integrity, cleanliness.	Acid washed prior to delivery to volunteers
Filtering apparatus (dissolved phosphorus)	Before each use	Proper functioning, clean storage	Spare syringe, spare filters
Filtering apparatus (chlorophyll)	Before each use	Proper functioning, clean storage	Spare filters
Secchi disk, transparency tube, calibrated line	Before each use	Visual for integrity, cleanliness. Fill transparency tube, check for leaks.	Wipe tape after each use. Spare disk, spare tube, spare line
Autoclave (bacteria analysis)	Weekly	Inspect and clean as needed. Spore check is run with a batch to ensure the autoclave is reaching proper temperature and pressure	Clean, lubricate surfaces; maintain water surfaces according to user's manual.
Sample prep equipment (e.g., sealer for Colilert® bacteria method)	Prior to each sampling	Visual inspection, clean, and maintain according to manufacturer's recommendations.	Spare sampler
Incubator (bacteria analysis)	Prior to each sampling	Check temperature with max/min electronic thermometer (traceable to NIST)	Spare batteries, electrolyte
pH Meter	Before each sampling date	Battery life, level of electrolyte, integrity of probe	Spare batteries, electrolyte
Thermometer	Before each sampling date	Visual, breakage/ integrity of column.	Keep spares on hand.

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
Temp logger	Before and after sampling deployment	Visual, battery life, structural integrity	Keep spare instruments and batteries on hand
Multiprobe/other Water Quality Meter	Before each sampling date	Battery life, electrical connections, membrane condition	Spare membranes, batteries
Digital Titrator	Before each sampling date	Proper installation of cartridge, zero reset	Spare cartridges, dispensing tubes
Van Dorn, other sampling device	Before each sampling run	Visual for integrity	Repair, replace as necessary
Electronic balance (solids)	Before each sampling run	Visual - integrity of balance.	N/A
Conductivity meter	Before each sampling date	Battery life	Spare batteries
Turbidity meter	Before each sampling date	Battery life	Spare batteries
Collection rake, rope	Before each collection	Visual for integrity	Repair, replace. Keep spares on hand
Macroinvertebrate kick nets, buckets, sieves	Before each collection	Visual for integrity	Repair, replace. Keep spares on hand
Plankton nets, tow rope	Before and after each sample collection	Visual for integrity, presence of invasive species or debris on equipment	Repair, clean, replace, if invasive species are found on equipment, immerse in 40^{o} C water for 10 minutes
WQ kits (general)	Before each sampling run	Visual for integrity/ proper operation	Repair, replace. Keep spare parts on hand as appropriate
Safety equipment (general)	Before each use	Visual for integrity, cleanness	Repair, replace. Keep spares on hand
Staff gage	Before each field reading	Integrity of installation; debris buildup affecting levels, etc.	Remove any debris; reinstall (and resurvey) if necessary
microscope	Before each use	Visual for proper operation, clean lens	Keep lenses clean. Repair, replace.
Camera (digital/other)	Before each use	Check batteries. Turn on, verify operating properly	Repair, replace. Keep spare batteries on hand.
GPS	Before each use	Check batteries. Turn on, verify operating properly	Repair, replace. Keep spare batteries on hand.
PDA/rugged readers	Before each use	Check batteries. Turn on, verify operating properly	Repair, replace. Keep spare batteries on hand.

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
Light-based instruments (spectrophotometer/ colorimeter/photometer)	Before each use	Visual for proper operation, visual check of sampling cuvettes for scratches, smudges etc.	Repair, clean, replace. Keep spare parts on hand.

16. Instrumentation Calibration and Frequency

□ General QAPP Requirement #16: All instruments used in the project shall be calibrated at a pre-determined frequency to ensure instrument accuracy and precision for the duration of the project (with logbook documentation).

Table 16.1. Typical Instrumentation Calibration Procedures

Instrument	Inspection and Calibration Frequency	Standard of Calibration Used	Corrective Action
Calibrated line (e.g., Secchi, Van Dorn bottle, etc.)	Annually	Tape Measure	Recalibrate or replace with calibrated line
Multi-probe meter	Before each sampling run	Standard solutions, according to manufacturer's recommendations. DO meter: compare against Winkler titration	According to manufacturer's instruction. For DO, replace membrane or correct instrument
pH Meter	Before each sampling run	pH buffers 4.01 and 7 or external standards	Adjust instrument, clean electrodes, replace electrodes
Thermometer	Annually	NIST- certified or NIST-traceable thermometer *(Identify NIST thermometer and ownership)*	Replace or provide correction factor
Temp logger (continuous)	Weekly	According to manufacturer's instructions	Replace or provide correction factor
Multiprobe/other Water Quality Meter	Before each sampling run	Follow manufacturer's instruction.	As applicable
Electronic balance (solids)	Before each sampling run	Use of certified inspection standards	Adjust and recalibrate
Conductivity meter	Before each sampling run	Known Standards	Adjust according to manufacturer's recommendations
Turbidity meter	Before each sampling run	Known standards	Adjust instrument
Light-based instruments (spectrophotometer/ colorimeter/photometer)	Before each analysis run	Known standards	Adjust instrument

* External standards refer to standards of reliable quality obtained from reputable commercial or other supplier. Known standards refer to those where the value is known before calibration.

17. Inspection & Acceptance Requirements for Supplies

□ General QAPP Requirement #17: The procurement, inspection and acceptance of sampling, analytical and ancillary project supplies shall occur in a consistent, timely manner.

Table 17.1. Typical Supplies Inspection, Acceptance Procedures

Supplies	Inspection Frequency	Type of Inspection	Available Parts	Maintenance
Reagents, titration cartridges, alcohol	Before each sampling date	Visual inspection of quantity and expiration date	Spare, fresh reagents/cartridges	Storage according to manufacturer's recommendations, Annual replacement at beginning of sampling season
Calibration Standards	Before each sampling date	Visual inspection of quantity and expiration date	Spare, fresh solutions	
Membranes, filters, bags (e.g. Whirlpak, zip lock)	Before each sampling date	Visual inspection of quantity, integrity	Spares	Storage according to manufacturer's recommendations
Field and Lab sample sheets	Before each sampling date	Visual	Additional copies	---
Waders	Before each sampling date and whenever leaving a body of water	Visual inspection for damage, presence of plant or animal material on waders	Patch kit	Clean after each use, to avoid transporting plant/animal species to other water bodies. Repairs as needed
Life Preservers (PFDs)	Before each use	Visual for integrity	Spares	Keep clean, patch when needed. Repair/Replace straps, buckles if needed.
Sample Bottles	Before each sampling date	Integrity, cleanness and seal for nutrient bottles, verified sterility of bacterial sample bottles, **equipment** or **rinsate *blank*** for reused bottles	One set of spare bottles	Clean after use
Cooler	Before each sampling date	Cleanness, Ice packs	NA	Clean after each use
First aid kit/field kits	Before each sampling date	Visual for integrity, adequate number/amount of all items	Extras all supplies	Replace supplies as needed.
Batteries	Before each sample date	Visual – adequate supply of adequately charged batteries of all types needed for all instruments.	Spares	Recharge rechargeable batteries

18. Data Acquisition Requirements

□ General QAPP Requirement #18: The General QAPP Adoption Form shall provide detailed information for any non-project data used in developing and implementing the General QAPP Adoption Form or in any other way affecting the project.

To verify that any data used by this project but not collected by project personnel are of known and documented quality, and are consistent with project data quality objectives, the following "metadata" will be provided for each data source ("metadata" are defined as the important information associated with sample data; examples include sampling location, date, time, type of sample, etc.):

- Title of document or descriptive name of the information
- Source of information
- Notes on quality of data, including whether it has a QAPP or some other means of demonstrating quality of the data
- As applicable, a statement on planned restrictions in use of the data because of questions about data quality.

Specific information regarding non-project data shall be provided in the project General QAPP Adoption Form.

19. Data Management

□ General QAPP Requirement #19: As detailed in the General QAPP Adoption Form, the project shall include a data management system.

Field samplers shall record data on field sheets, review them, sign and turn them over to the field coordinator. The Field Coordinator will review the sheets and confer with samplers on any needed corrective action. Field samplers will fill out the chain-of-custody form for forwarding the processed samples to the laboratory. Each person who handles or transports samples will also sign the custody form upon receipt of the samples. Chain of custody forms will follow samples to the lab and back to the Monitoring Coordinator by mail or pickup after each analysis run is completed.

Once laboratory analyses are complete, the laboratory personnel will mail lab results to the Monitoring Coordinator or arrange for pickup. The Monitoring Coordinator and/or Data Entry Coordinator will enter raw field and lab data into the project computer system. Computer-entered data are then compared with field sheets for accuracy. The original data sheets will be stored in the organization's office. Disk back-ups and copies of the data sheets will be made and stored in a separate location designated by the Monitoring Coordinator.

Data quality control steps will be taken at several stages, as outlined in Table 19.1. Documentation of data recording and handling, including all problems and corrective actions, shall be included in all preliminary and final reports.

The project General QAPP Adoption Form shall describe any additional program-specific data management systems - e.g. spreadsheets, databases (preferably compatible with Microsoft Excel and Access), statistical or graphical software packages, location of data records (paper and electronic), and examples of forms and checklists.

Table 19.1. Data Management, Review, Validation, Verification Process

Activity	By whom	Corrective action, if needed
Check labels just prior to sampling, to ensure correct labeling of container.	Field sampler	Correct label or change container
At time of sampling, record data, sign field sheets.	Field sampler	Coordinate with sampler on missing/unclear information; correct sheets
Fill out, sign chain of custody (COC) forms for any samples going to lab.	Field sampler	Coordinate with sampler on missing/unclear information; correct sheets
Before turning field sheets over to field/monitoring coordinator, check for reasonableness to expected range, completeness.	Field sampler	Resample if feasible; otherwise, flag suspect data.
Upon receipt of field sheets, recheck for reasonableness to expected range, completeness, accuracy, and legibility. Sign COC form.	Field/Monitoring Coordinator	Confer with field sampler(s) immediately or within 24 hours. Resample if feasible; otherwise, flag suspect data.
Upon receipt of samples, field sheets and COC forms, check to see that sheets and forms correspond to number of samples, condition of samples as stated on COC forms. Sign COC forms. Copies of field sheets and COC forms are made, given to field/monitoring coordinator.	Lab Coordinator, Field/Monitoring Coordinator.	Confer with field/monitoring coordinator. Contact field samplers as needed to locate missing samples, data records. In case of missing/spoiled samples or data records, authorize resembling as needed and feasible. If re-sampling is not feasible, flag all suspect data.
Upon completion of laboratory analyses, fill out lab sheets, including data on QC tests. Review for reasonableness to expected range, completeness. Make copies of lab sheets.	Lab Coordinator.	Re-analyze if possible. If not, confer with monitoring coordinator. Flag all suspect data.
Upon receipt of lab sheets, review for completeness and legibility.	Monitoring/Data Entry Coordinator.	Confer with lab coordinator.

Activity	By whom	Corrective action, if needed
Upon completion of data entry, print out raw data. Compare with field/lab sheets for accuracy.	Data Entry Coordinator or other volunteer. Data entry personnel may review their own work, but a different person than data entry person shall perform the final accuracy comparison.	Re-enter data.
Translate raw data printouts into preliminary data reports: run statistical analyses and/or prepare graphical summaries of data. Check for agreement with QC objectives stated in Tables 7.1. and 14.1. and for completeness.	Monitoring Coordinator/Data Entry Coordinator	Confer with QA Officer. Flag or discard suspect data.
In-season (at least once) and end of season review of collected data sets (individual sample runs and season-total compilations); review for completeness and agreement with QC objectives and DQOs.	Monitoring Coordinator. TAC if applicable. Share with QA Officer.	Flag or discard suspect data. Decide upon any restrictions in use of data with respect to original data use goals. If mechanism is in place to ID suspect data, use footnotes to indicate such data and to describe data use restrictions.

20. Assessment and Response Actions

□ General QAPP Requirement #20: The project shall have a defined process for identifying and effectively addressing issues that affect data quality, personal safety, and other important project components.

The progress and quality of the monitoring program shall be continuously assessed to ensure that its objectives are being accomplished. The Monitoring Coordinator will periodically check to see the following:

a. Monitoring is occurring as planned;
b. Sufficient written commentary and supporting photographs exist;
c. Sufficient volunteers are available;
d. Volunteers have been observed as they sample their sites;
e. Samplers are collecting in accordance with project schedules;
f. Data sheets and custody control sheets are being properly completed and signed;
g. Data are properly interpreted;
h. Plans for dealing with adverse weather are in place;
i. Retraining or other corrective action is implemented at the first hint of non compliance with the QAPP or SOPs;
j. Labs are adhering to the requirements of their QAPP, in terms of work performed, accuracy, acceptable holding times, timely and understandable results and delivery process;
k. Data management is being handled properly, i.e. data are entered on a timely basis, is properly backed up, is easily accessed, and raw data are properly stored in a safe place;
l. Procedure for developing and reporting the results exists.

The Monitoring Coordinator shall confer with the QA Officer as necessary to discuss any problems that occur and what corrective actions are needed to maintain program integrity. In addition, the Monitoring Coordinator and QA Officer shall meet at the end of the sampling season, to review the draft report and discuss all aspects of the program and identify necessary program modifications for future sampling activities. If the program includes a technical advisory committee, the TAC shall be included in these discussions. Corrections may include retraining volunteers; rewriting sampling instructions; replacement of volunteers; alteration of sampling schedules, sites or methods; or other actions deemed necessary. All problems discovered and program modifications made shall be documented in the final version of the project report. If modifications require changes in the Quality Assurance Project Plan, these changes shall be submitted MassDEP for review.

If data are found to be consistently outside the Data Quality Objectives, see Section 7, the Monitoring Coordinator and the TAC (as applicable) shall review the program and correct problems as needed.

21. Reports

□ General QAPP Requirement #21: The project shall include a reporting mechanism for project data. Reporting shall include raw data, QC data and important metadata.

Data that have passed preliminary QC analysis as described in Table 19.1 may be posted on the organization's web site, shared with the local media or at other venues (e.g. kiosks at recreation access sites), and submitted to MassDEP. A caveat will accompany these or any data released on a preliminary basis, explaining that they are for review purposes only and subject to correction after completion of a full data review occurring at the end of the sampling season. Any differences from this approach shall be described in the Adoption Form.

The Monitoring Coordinator will write a final report, with assistance from the QA Officer. This will be sent to the QAPP distribution list. The final report will include (updated as necessary) any tables and graphs that were developed for initial data distribution efforts (i.e. the web site and media), and it will describe the program's goals, methods, quality control results, data interpretation, and recommendations. This report may also be used in public presentations.

All reports, preliminary or final, will include discussion of steps taken to assure data quality, findings on data quality, and decisions made on use, ***censor***, or flagging of questionable data. Any data that are censored in reports will be either referred to in this discussion, or presented but noted as censored.

Reports submitted to state agencies should generally conform to MassDEP guidelines CN 0.74 *Recommended Content of 3rd Party Data*, CN 0.78 *Data Deliverable Guidelines for Grant Projects* and/or other MassDEP guidance. (see appendix 4)

Coordinate with EPA to transmit your data to EPA's electronic water quality warehouse using WQX (http://www.epa.gov/storet/wqx.html).

22. Data Review, Validation and Verification Requirements

□ General QAPP Requirement #22: All project data, metadata and quality control data shall be critically reviewed to look for problems that may compromise data usability.

The Monitoring Coordinator will review field and laboratory data after each sampling run and take corrective actions as described in Table 19.1. At least once during the season, at end of the season and if questions arise, the Monitoring Coordinator will share the data with the QA Officer to determine if the data appear to meet the objectives of the QAPP. Together, they will decide on any actions to take if problems are found.

23. Validation and Verification Methods

□ General QAPP Requirement #23: The General QAPP Adoption Form shall explain how all project data and metadata are reviewed and approved as usable data (and as un-usable when the data are questionable for any reason).

Data validation and verification will occur as described in Table 19.1, and will include checks on:

- Completion of all fields on data sheets; missing data sheets
- Completeness of sampling runs (e.g. number of sites visited/samples taken vs. number proposed, were all parameters sampled/analyzed)
- Completeness of QC checks (e.g. number and type of QC checks performed vs. number/type proposed)
- Accuracy and precision compared to data quality objectives
- Representativeness of samples and resulting data by examining survey metadata for unusual conditions and occurrences that may have impacted the validity of results.

24. Reconciliation with Data Quality Objectives

□ General QAPP Requirement #24: The General QAPP Adoption Form shall describe a process (and mechanisms to accomplish it) whereby resulting data are compared to the planned DQOs in the project General QAPP Adoption Form.

At the conclusion of the sampling season, after all in-season quality control checks, assessment actions, validation and verification checks and corrective actions have been taken, the resulting data set will be compared with the program's data quality objectives (DQOs). This review will include, for each parameter, calculation of the following:

- Completeness goals: overall % of samples passing QC tests vs. number proposed in Section 7
- Percent of samples exceeding accuracy and precision limits
- Average departure from accuracy and precision targets.

After reviewing these calculations, and taking into consideration such factors as clusters of unacceptable data (e.g. whether certain parameters, sites, dates, volunteer teams etc. produced poor results), the Monitoring Coordinator, QA Officer, and TAC members (as applicable) will evaluate overall program attainment.

References:

EPA 1996. The Volunteer Monitor's Guide To Quality Assurance Project Plans. United States Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. Document No. 841-B-96-003. Available: http://www.epa.gov/owow/monitoring/volunteer/qapp/vol_qapp.pdf .

Godfrey P.J., Schoen J., Dates G. 2001. The Massachusetts Volunteer Monitor's Guidebook to Quality Assurance Project Plans. Massachusetts Department of Environmental Protection, Division of Watershed Management. Worcester, MA. Available: http://www.mass.gov/dep/public/volmonit.htm

MassDEP 2007. 314 CMR 4.00: Surface Water Quality Standards. Massachusetts Department of Environmental Protection, Division of Water Pollution Control. Worcester, MA. Available: http://www.mass.gov/dep/service/regulations/314cmr04.pdf

CZM 2002. The Massachusetts Aquatic Invasive Species Management Plan, Massachusetts Aquatic Invasive Species Working Group. Massachusetts Office of Coastal Zone Management. Boston, MA. Available: http://www.mass.gov/czm/invasives/docs/invasive_species_plan.pdf.

Appendices

Appendix 1: General Quality Assurance Project Plan Adoption Form

To fill out a program-specific Adoption Form (AF), you can follow these steps…

- Cut/paste the AF (only) into a blank document and save with a new name (or delete unnecessary parts of this document file).
- Remove the "Appendix 1: General Quality Assurance Project Plan Adoption Form" header from the following page.
- In the footer on the following pages, replace "*General Quality Assurance Project Plan Adoption Form*" with language that describes your program. To edit footers, place the cursor on the Table of Contents page (or a later page). Select "View" from the command menu; select "Header and Footer"; select the "switch between header and footer" button; edit the text that appears there; select "close".
- Fill out the Adoption Form as instructed. Except for checking appropriate boxes, do not change the content of check-box sections, but add additional check-boxes or explanatory text as needed to make it clear what your group intends to do.
- If submitting in PDF format, documents with comments enabled (usage rights) are preferred for review purposes.

Appendix 1: General Quality Assurance Project Plan Adoption Form

General Quality Assurance Project Plan Adoption Form For

Project: _____

1. Signature Page

We, the undersigned, have read and understand the requirements outlined in the General QAPP for Massachusetts Volunteer Inland Monitoring, and establish that this project meets the overall intent and requirements set forth in the General QAPP.

Project Manager

_____

Name Date
Address
Phone: Fax: Email:

Monitoring Program Coordinator

_____

Name Date
Address
Phone: Fax: Email:

Program Quality Assurance Officer

_____

Name Date
Address
Phone: Fax: Email:

_____

Richard Chase, MassDEP QA Officer Date
627 Main St., 2nd floor, Worcester, MA 01608
(508) 767-2859 Fax: 508-791-4131 email: richard.f.chase@state.ma.us

_____

Arthur Screpetis, MassDEP Technical Reviewer Date
627 Main Street, 2nd floor, Worcester, MA 01608
508-767-2875, Fax: 508-791-4131 email: arthur.screpetis@state.ma.us,

2. Table of Contents (must be revised upon completion of the General QAPP Adoption Form)

3. Distribution List (as applicable)

Project Manager: _____

Monitoring Program Coordinator: _____

Program Quality Assurance Officer: _____

Project Field Coordinator: _____

Project Lab Coordinator: _____

Data Management Coordinator: _____

Program Participants:

_____
_____
_____
_____
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_____
_____
_____
_____

Richard Chase, MassDEP QA Officer
627 Main St., 2nd floor, Worcester, MA 01608
Phone: (508) 767-2859 Fax: 508-791-4131
email: richard.f.chase@state.ma.us

Arthur Screpetis, MassDEP Technical Reviewer
627 Main Street, 2nd floor, Worcester, MA 01608
Phone: 508-767-2875, Fax: 508-791-4131
email: arthur.screpetis@state.ma.us

Town/City Governance: _____
Conservation Commission: _____

Regional/Local Planning Office: _____

Other(s):

4. Project Organization and Responsibilities (as applicable)

Table 4.1. Project Organization and Responsibilities

Name(s)	Project Title	Description of Responsibilities
	Project Manager	
	QA Officer	
	Monitoring Program Coordinator	
	Lab Coordinator	
	Field Coordinator	
	Data Management Coordinator	
	Technical Advisory Committee	
	Volunteers	
Richard Chase	MassDEP QA Officer	Reviews General QAPP Adoption Form, reads QA reports, confers with program QA officer on quality control issues that arise during the course of a monitoring program.
Arthur Screpetis	MassDEP Technical Reviewer	Reviews General QAPP Adoption Form.
	Contract Analytical Lab Manager(s)/Director(s)	
ADD MORE ROWS AS NEEDED		

5. Problem Definition/Background

Organizational History and Mission

A brief summary of your organization's history and general goals, why your organization is involved, and what it hopes to accomplish

Monitoring History and Status

A discussion of previous monitoring efforts and the use attainment status for waterbodies of interest, as listed in the MassDEP's Watershed Health Assessments

Monitoring and Data Use Objectives

As specified in the GENERAL QAPP, this project will provide information related to the following issues *(check all that apply)*:

- ❑ Water Quality
- ❑ Biological & Habitat Assessment
- ❑ Wetland Health Assessment
- ❑ Invasive Species (freshwater)
- ❑ Other (specify) _____

As explained in the GENERAL QAPP, the monitoring objectives of this project include *(check all that apply)*:

- ❑ Provide quality-controlled data that support the assessment and restoration of watersheds and critical habitats through the implementation of Commonwealth programs such as (*check all that apply*):
  - ❑ MassDEP's 305(b) water body health assessments and TMDL development for impaired waters
  - ❑ Clean Water Act Section 319 projects
  - ❑ Massachusetts Aquatic Invasive Species Management Plan
  - ❑ EEA's watershed action plans
  - ❑ Commonwealth's Beaches Act
  - ❑ CZM's Wetlands Restoration Program
  - ❑ Riverways Adopt-A-Stream Program
  - ❑ Riverways RIFLS Program
  - ❑ DCR's Lakes and Ponds
  - ❑ DCR's Weed Watchers Program
  - ❑ Other (specify) _____
- ❑ Leverage the Commonwealth's funds to increase the collection of quality data
- ❑ Water body/watershed health assessment
- ❑ Impact assessment
- ❑ Source identification or hot spot monitoring
- ❑ Invasive species assessments
- ❑ Public education and outreach
- ❑ Local infrastructure improvements
- ❑ Other (specify) _____

6. Project /Task Description

Project Description:

A general summary of the project, providing information regarding who does what, parameters to be monitored, when monitoring will occur, number of sites, what happens with the data, and how the data will support program objectives.

Map(s) of Area, Waterbody and Sampling Sites:

Include map(s) of area and pertinent water bodies with sampling site (here or in Element 10).

Table 6.1. Anticipated Schedule *(Mark all major project implementation and completion dates with an X. Add additional project components and deliverables as necessary.)*

Activity	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Kickoff meeting with project team												
Develop draft General QAPP Adoption Form												
Finalize General QAPP Adoption Form												
Meeting with agency representatives												
Equipment inventory, purchase, inspection and testing												
Field training and database-related training session(s)												
Meeting with analytical laboratory												
Lab training sessions (in-house analyses)												
Sampling surveys												
Data entry												
Data review and validation												
Field audit(s)												
Lab audit(s)												
Draft report												
Final report												
Data uploads to website												

7. Data Quality Objectives

To comply with the GENERAL QAPP, the following quality control measures and data quality objectives shall be employed for the _____ project *(check all that apply)*:

<u>Overall sampling precision</u> will be estimated by the following *(check all that apply)*:

- ❑ Taking duplicate field measurements (instruments) for at least 10% of samples.
- ❑ Taking duplicate field samples for at least 10% of samples (for each crew).
- ❑ Lab duplicates
- ❑ Comparison to results of others (for same/similar area/time)
- ❑ Other (*specify):* _____

<u>Accuracy of results</u> will be estimated or confirmed by the following *(check all that apply)*:

- ❑ Analysis of lab QC check samples (single-blind)
- ❑ Analysis of positive/negative controls (e.g., bacteria)
- ❑ Analysis of spiked matrix samples
- ❑ Analysis of lab blanks and lab-fortified blanks
- ❑ Taking ambient field blanks and/or equipment blanks
- ❑ Taxonomic verification of voucher specimens
- ❑ Other *(specify):* _____

<u>Data Representativeness</u> will be met by the following *(check all that apply)*:

- ❑ All sampling sites are selected to be representative of "average" conditions for the water body (or pollution source) at a specific place and time
- ❑ Any abnormal or episodic conditions that may affect the representativeness of sample data are noted and maintained as metadata
- ❑ Results from all sites will not be extrapolated to other, unmonitored, portions of the waterbody or watershed.
- ❑ Sample collection timing and frequency is selected to capture data that are representative of target conditions: (*e.g. wet weather, early morning, etc.).*

  List conditions below:

- ❑ Other *(specify)*_____

<u>Comparability of project data</u> among sites and with that of others will be enhanced by the following *(check all that apply)*:

- ❑ Using established protocols
- ❑ Documenting methods, analysis, sampling sites, times and dates, sample storage and transfer, as well as laboratories and identification specialists used so that future surveys can produce comparable data by following similar procedures.
- ❑ Other *(specify)*_____

<u>Data Completeness</u> goals shall be *(check all that apply)*:

- ❑ At least 80% of the anticipated number of samples will be collected, analyzed and used
- ❑ Tracked by keeping detailed and complete sample and survey records
- ❑ Summarized via a report detailing number of anticipated samples, number of valid results, and percent completion for each parameter
- ❑ Other (*specify*) _____

Additional project-specific information:

Table 7.1. Data Quality Objectives *(as appropriate)*

Parameter	Units	MDL	RDL	Expected Range	Accuracy (+/-)	Precision (RPD)
EXAMPLE: Turbidity	NTUs	0.02	0.1	0-200	90-110% recovery of turbidity std.	± 0.5 NTU if less than 1 NTU or 20% RPD if more than 1 NTU
ADD MORE ROWS AS NEEDED						

MDL = ***Method Detection Limit*** (lab)
RDL = ***Reporting Detection Limit*** (lab)

8. Training Requirements

Training in the following general areas, as specified in the General QAPP, shall be conducted as part of the _____ (*program/project name)*:

- ❑ Field safety
- ❑ Lab safety
- ❑ Water sample collection
- ❑ Filling out field sheets
- ❑ Biomonitoring of wetlands and habitat
  (*Specify parameters)*_____
- ❑ Invasive species monitoring
- ❑ Data entry and database management
- ❑ Recordkeeping and documentation
- ❑ Report writing
- ❑ Other: (*specify)*_____

Project training shall take place as specified in Table 8.1

All training activities shall be documented by *(check all that apply)*:

- ❑ Training forms signed by the trainees
- ❑ Documented in a final report
- ❑ Other *(specify)*: _____

Table 8.1. Project-Specific Training

Specific Training Type & Description	Trainer(s)	Training Date(s)	Trainees	Location of Training Records
EXAMPLE: Aquatic plant mapping and identification	Monitoring Coordinator.	At beginning of project and whenever new volunteers join.	Volunteers *to be named*	Watershed Organization computer (electronic copy), office filing cabinet #1 (paper copy)
ADD MORE ROWS AS NEEDED				

9. Documentation and Records

To ensure that an adequate and acceptable level of records is kept, the following general documentation procedures, as specified in the General QAPP, shall be followed *(check all that apply)*:

- ❑ Document survey and sample information using Field Sheets
- ❑ Document survey and sample information using personal Field Notebooks
- ❑ Document sample custody at all times using Chain-of-Custody Forms
- ❑ Track sample identification using sample labels
- ❑ Document lab data/metadata using lab notebooks
- ❑ Document lab results using lab reports
- ❑ Collection and management of voucher specimens
- ❑ Photography used for species verification
- ❑ Other: (*specify)*_____

The specific forms to be used for the _____ project are listed and described in Table 9.1.

Table 9.1. Project-Specific Datasheets, Labels, Laboratory and Voucher Forms

Documentation Type	Form Name	How Used?	Example in Appendix?
Sample Collection Records			
Field Analysis Records			
Laboratory Records			
Data Assessment Records			
Training Records			
ADD MORE ROWS AS NEEDED			

10. Sampling Process

To comply with the General QAPP, the following sampling safety and design principles shall be followed for the _____ project *(check all that apply)*:

Sampling Safety.

- ❑ Personal safety shall be a primary consideration in selection of sampling sites and dates.
- ❑ No sampling shall occur when personal safety is thought to be compromised.
- ❑ The Monitoring Coordinator and Field Coordinator shall confer before each sampling event to decide whether conditions pose a threat to safety of field volunteers, and will cancel/postpone sampling when necessary.
- ❑ Sampling shall take place in teams of two or more.
- ❑ Samplers shall wear life vests when sampling from boats or wading in waters under difficult conditions.
- ❑ Samplers shall wear proper clothing to protect against the elements as applicable, especially footwear and raingear.
- ❑ When sampling in rivers by wading in, samplers shall estimate flow and avoid sampling when river depth (in feet) times velocity (feet per second) appear to equal 5 or greater.
- ❑ Other safety measures: _____

Sampling Design

- ❑ Map(s) of the area and pertinent water bodies with sampling sites are included here (or in Element 6)
- ❑ Photographs of sampling sites are included here, in Element 6 or in an appendix.
- ❑ Descriptions of sampling sites are included here, in Element 6 or in an appendix.

Table 10.1. Sample Site Description and Location

Site #	Site Name	Description & Access	GPS coordinates
ADD MORE ROWS AS NEEDED			

Table 10.2. Sampling Design

Survey type	Indicators	Number of sample locations	Site location rationale	Frequency, duration, special conditions	Field survey QC
	ADD MORE ROWS AS NEEDED				

11. Sampling Method Requirements

To comply with the requirements of the General QAPP, all sample collections for the _____ project shall follow detailed methods on how samples will be collected and preserved and/or follow the Standard Operating Procedures (SOPs) contained in Appendix A.

- ❑ Detailed, project-specific sampling method descriptions are in Appendix A of this Adoption Form.
- ❑ Copies of standard operating procedures (SOPs) are in Appendix A of this Adoption Form. Pre-coordination will occur with project lab(s) to ensure that sample collection procedures meet lab needs.
  List labs:
  _____
  _____

Table 11.1. Sample Collection Methods

Survey type	Sample Type	Parameter(s)	Container Type(s) and Preparation	Minimum Sample Quantity	Sample Preservation
	ADD MORE ROWS AS NEEDED				

12. Sample Handling and Custody Requirements

As specified in the General QAPP, all sample handling and custody procedures shall be in compliance with project Standard Operating Procedures for each indicator. The following procedures shall be followed for the _____project. *(Check all that apply).*

- ❑ This program consists solely of field measurements. No samples are collected.

OR

- ❑ Sample container labels shall be attached to dry bottles, with the following information:
  - ❑ Site ID# □ Sample type
  - ❑ Date and time □ Preservation
  - ❑ Name of sampler
  - ❑ Name of organization conducting sample.

- ❑ Macroinvertebrate □ Macrophyte samples
  - ❑ Shall be labeled in pencil on paper placed in sample container …

OR

- ❑ Macroinvertebrate □ Macrophyte samples
  - ❑ Shall be placed in plastic bags; outside of bags shall be labeled with permanent ink markers. Said earlier it's ok to put pencil-written labels in bag with specimen.

Separate checkbox for Invasives?

- ❑ Examples of labels are provided in the appendices.
- ❑ Chain of custody forms shall be prepared and completed in all cases.
- ❑ The whereabouts of all samples shall be known at all times.

The following steps shall be taken to avoid sample mis-labeling.

13. Analytical Methods Requirements

To comply with the requirements of the General QAPP, all analytical methods used in the _____project, including methods used by laboratories performing analyses for the project, shall be based on standardized laboratory methods.

Check which statement applies:

- ❑ This program consists solely of field measurements. No laboratory analysis is required
- ❑ All analytical methods used for this project are referenced below and provided as Standard Operating Procedures in Attachment B.

Table 13.1. Analytical Methods. The following methods will be used in this project.

Parameter	Method #	Source of Method	MDL (mg/l or as stated)	Special Considerations
EXAMPLE: Total Phosphorus (TP)	SM 4500-P-E	Standard Methods, 21st	0.01	Field preservation with 9N H2SO4
ADD MORE ROWS AS NEEDED				

14. Quality Control Procedures

As specified in the General QAPP, the following quality control procedures for the _____ project shall be followed *(Check all that apply)*

Water Quality

- ❑ Field duplicates shall be taken side-by-side and simultaneous
- ❑ Field quality control samples shall be taken for 10% of all water quality samples collected unless otherwise specified in Table 14.1 below
- ❑ Field duplicates shall be taken sequentially
- ❑ Field duplicates shall be split from a large volume sample.
- ❑ Field blanks shall be taken
- ❑ ***Trip blanks*** shall be taken
- ❑ Lab QC protocols shall be discussed with the lab(s) prior to sampling to ensure acceptability
- ❑ Other: _____

Procedures for each Water Quality QC step checked above are described here:

Biological & Habitat Assessment and/or Invasive Species

- ❑ Field measurements by two different samplers
- ❑ Duplicate measurement by same sampler
- ❑ Compare side-by-side assessment/identification made by two or more personnel
- ❑ Compare to a voucher specimen collection
- ❑ Peer-review of voucher identifications
- ❑ Two or more personnel conduct separate mappings of same area, compare results, discuss to resolve differences
- ❑ Discrepancies/unknowns taken to expert for ID confirmation.
- ❑ Verification in the field of an organism identity by an expert or qualified supervisor
- ❑ Taxonomic verification of voucher specimens by scientific advisor(s).
- ❑ Photo documentation
- ❑ Other: _____

Procedures for each Biological QC step checked above are described here:

Table 14.1. Quality Control Procedures for each survey type, instrument/parameter are summarized here.

Sample Type	Instrument/ Parameter	Accuracy Checks	Precision Checks	% Field QC Samples
EXAMPLE: … Water Quality -Grab.	Total Phosphorus	Analysis of spiked samples, QC standards will be performed at each lab session. See lab SOPs for full discussion of lab QC exercises.	Sequential duplicate samples will be taken by sampler, once per sample event	10%
ADD MORE ROWS AS NEEDED				

15. Instrument/Equipment Inspection and Testing

To comply with the requirements of the General QAPP, the following instrument/equipment inspection and testing methods shall be followed for the _____project. *(Check all that apply, fill in Table 15.1 as needed)*

- ❑ Maintenance shall occur as needed.
- ❑ Records of equipment inspection, maintenance, repair and replacement shall be kept in a logbook.
- ❑ Detailed inspection, maintenance and calibration procedures are described in SOPs contained in Appendices A and B.

Table 15.1. Instrument/Equipment Inspection, Testing Procedures – Summary

Equipment Type	Inspection Frequency	Type Inspection	Maintenance, Corrective Action
EXAMPLE: Nutrient sample bottles	Before each use	Visual for integrity, cleanliness.	Acid washed prior to delivery to volunteers. See SOP for bottle preparation.
ADD MORE ROWS AS NEEDED			

16. Instrumentation Calibration and Frequency

To meet the requirements of the General QAPP, the following instrument calibration procedures will be followed for the _____ project:

- Instruments shall be calibrated at the frequency listed in Table 16.1
- Detailed inspection, maintenance and calibration procedures are described in SOPs contained in appendices A and B.
- All calibration activities shall be logged in a project notebook

Table 16.1. Instrumentation Calibration Procedures

Instrument	**Inspection and Calibration Frequency**	**Standard of Calibration Instrument Used**	**Corrective Action**
EXAMPLE: pH Meter	Before each sampling run	pH buffers 4 and 7 or external standards	Adjust instrument, clean electrodes, replace electrodes ,etc. as directed by manufacturer manual
ADD MORE ROWS AS NEEDED			

17. Inspection & Acceptance Requirements for Supplies

To meet the requirements of the General QAPP, the following procedures for procurement, inspection and acceptance of sampling, analytical and ancillary project supplies shall be followed for the _____ project:

Table 17.1. Supplies Inspection, Acceptance Procedures

Supplies	Inspection Frequency	Type of Inspection	Available Parts	Maintenance
EXAMPLE: Reagents, titration cartridges	Before each sampling date	Visual inspection of quantity and expiration date	spare, fresh reagents/cartridges	Storage according to manufacturer's recommendations, annual replacement at beginning of sampling season
ADD MORE ROWS AS NEEDED				

18. Data Acquisition Requirements

To meet the data acquisition requirements of the General QAPP, the following non-project information will be evaluated for the _____ project *(check all that apply):*

- ❑ No data other than that collected by project participants under the auspices of this General QAPP Adoption Form will be used.
- ❑ External data validity shall be documented as described in Table 18.1

Table 18.1. Non-Project Data Validity

Title or descriptive name of data document	**Source of data**	**QAPP written? Y/N**	**Notes on known or unknown quality of data**	**Planned restrictions in use of the data due to questions about data quality**
ADD MORE ROWS AS NEEDED				

19. Data Management

To meet the requirements of the General QAPP, the following data management activities shall be followed for the _____ project *(check all that apply):*

- ❑ Field samplers shall record data on field sheets, review them, sign and turn over to field coordinator.
- ❑ Field Coordinator shall review sheets and confer with samplers on any needed corrective action.
- ❑ Field samplers shall fill out the chain-of-custody form for forwarding the processed samples to the laboratory.
- ❑ Each person who handles or transports samples shall also sign the custody form upon receipt of the samples.
- ❑ Chain of custody forms will follow samples to the lab and back to Monitoring Coordinator by mail or pickup after each analysis run is completed.
- ❑ Once laboratory analyses are complete, the laboratory personnel shall mail lab results to the Monitoring Coordinator or arrange for pickup.
- ❑ The Monitoring Coordinator and/or Data Entry Coordinator will enter raw field and lab data into the project computer system.
- ❑ Computer-entered data shall then be compared with field sheets for accuracy.
- ❑ Original data sheets will be stored at *(specify):* _____
- ❑ Disk back-ups and copies of the data sheets will be made and stored in a separate location designated by the Monitoring Coordinator. *(Provide details):*

  _____

  _____

  _____

- ❑ Documentation of data recording and handling, including all problems and corrective actions, shall be included in all preliminary and final reports.
- ❑ Reports submitted to state and federal agencies shall generally conform to MassDEP guidelines CN 0.74 *Recommended Content of 3rd Party Data*, CN 0.78 *Data Deliverable Guidelines for Grant Projects* and /or other MassDEP guidance (see Appendix 4). MassDEP shall be contacted prior to submission of raw data and final reports.
- ❑ Examples of data forms and checklists are provided in Attachment C.
- ❑ Other _____

Data management systems - spreadsheets, databases, statistical or graphical software packages, location of data records (paper and electronic), are described here:

Table 19.1. Data Management, Review, Validation, Verification Process Summary

Activity	By whom	Corrective action, if needed
EXAMPLE: Check labels just prior to sampling, to ensure correct labeling of container.	Field sampler	Correct label or change container
ADD MORE ROWS AS NEEDED		

20. Assessment and Response Actions

To comply with the requirements of the General QAPP, the Monitoring Coordinator, QA Officer and TAC (as applicable) will use the following process to identify and effectively address any issues that affect data quality, personal safety, and other important project components. Table 20.1 describes possible assessment methods and corrections and who will implement the action to assure program integrity.

The Monitoring Coordinator will periodically check to see the following:

- □ Monitoring is occurring as planned;
- □ Sufficient written commentary and supporting photographs exist;
- □ Sufficient volunteers are available;
- □ Volunteers have been observed as they sample their sites;
- □ Samplers are collecting in accordance with project schedules;
- □ Data sheets and custody control sheets are being properly completed and signed off;
- □ Data are properly interpreted;
- □ Plans for dealing with adverse weather are in place;
- □ Retraining or other corrective action is implemented at the first hint of non compliance with the QAPP or SOPs;
- □ Labs are adhering to the requirements of their QAPP, in terms of work performed, accuracy, acceptable holding times, timely and understandable results and delivery process;
- □ Data management is being handled properly, i.e. data are entered on a timely basis, are properly backed up, are easily accessed, and raw data are properly stored in a safe place;
- □ Procedure for developing and reporting the results exists.
- □ Other _____

Table 20.1. Assessment and Response Action

Activity	By whom	Corrective action, if needed
EXAMPLE: Review precision results for each field sampling team.	Monitoring Coordinator	Retrain/replace volunteers, qualify questionable data
ADD MORE ROWS AS NEEDED		

21. Reports

To comply with the requirements of the General QAPP, the following reporting mechanisms will be used.

☐ The final report will describe the program's goals, methods, quality control, results, data interpretation, and recommendations and include

- □ Raw data,
- □ QC data
- □ Associated metadata
- □ Questionable data flagged
- □ Preliminary or final report label
- □ Other: _____

☐ The final report will be sent to the QAPP and General QAPP Adoption Form distribution lists and submitted to MassDEP, following MassDEP guidelines CN 0.74 *Recommended Content of 3rd Party Data* and CN 0.78 *Data Deliverable Guidelines for Grant Projects*. (see appendix 4)

Table 21.1 describes the reporting mechanism for this project's data, who is responsible for completion and distribution, and to whom each report will be distributed.

Table 21.1. Report Mechanisms, Responsibilities, and Distribution

Reporting Mechanism	By Whom	Distribution
EXAMPLE: Annual monitoring report.	Monitoring Coordinator	Distribution list. Public by being posted on the organization's web site, being shared with the local media, by donating to town library.
ADD MORE ROWS AS NEEDED		

22. Data Review, Validation and Verification Requirements

☐ To comply with the requirements of the General QAPP, all project data, metadata and quality control data shall be critically reviewed by the Monitoring Coordinator and QA Officer to determine if there are any problems that compromise data usability.

Describe the process.

23. Validation and Verification Methods

☐ To comply with the requirements of the General QAPP, all project data and metadata are reviewed and approved as usable data or as un-usable when the data are questionable for any reason.

☐ Data validation and verification will occur as described in Table 19.1, and will include checks on:

- ☐ Completion of all fields on data sheets; missing data sheets
- ☐ Completeness of sampling runs (e.g. number of sites visited/samples taken vs. number proposed, were all parameters sampled/analyzed?)
- ☐ Completeness of QC checks (e.g. number and type of QC checks performed vs. number/type proposed)
- ☐ Accuracy and precision compared to data quality objectives
- ☐ Representativeness of samples and resulting data by examining survey metadata for unusual conditions and occurrences that may have affected the validity of results.
- ☐ Number of samples exceeding QC limits for accuracy and precision and how far limits were exceeded.
- ☐ Other _____

24. Reconciliation with Data Quality Objectives

To comply with the requirements of the General QAPP, at the conclusion of the sampling season (i.e., after all in-season quality control checks, assessment actions, validation and verification checks and corrective actions have been taken), the resulting data set will be compared with the program's data quality objectives (DQOs).

This review will include, for each parameter, calculation of the following:

- ☐ Completeness goals: overall % of samples passing QC tests versus number proposed in Element 7
- ☐ Percent of samples exceeding accuracy and precision limits
- ☐ Average departure from accuracy and precision targets.
- ☐ Other _____
- ☐ After reviewing these calculations, and taking into consideration such factors as clusters of unacceptable data (e.g. whether certain parameters, sites, dates, volunteer teams etc. produced poor results), the Monitoring Coordinator, QA Officer and TAC members (as applicable) will evaluate overall program attainment of DQOs and determine what limitations to place on the use of the data, or if a revision of the DQOs is allowable.
- ☐ Other _____

The following process describes how project data are compared to the program's data quality objectives (DQOs) and the mechanisms used to accomplish it.

Attachments

Attachment A. Sampling methods
Attach all project-specific Standard Operating Procedures and guidance manuals written for your program.

Attachment B. Analytical methods
Attach all Standard Operating Procedures written for your program, including Standard Operating Procedures written by laboratories conducting analyses for your program and for specific parameters being analyzed for your program. Also include individual laboratory Quality Assurance Plans for participating laboratories.

Attachment C. Data forms and checklists
Attach all field data forms and checklists used for your program.

END OF GENERAL QUALITY ASSURANCE PROJECT PLAN ADOPTION FORM

Appendix 2. Selected References to Field Methods and Identification Guides

NOTE: References to trade names, commercial products and manufacturers in this General QAPP do not constitute endorsement. Specified URL links are provided for convenience and are subject to change without notice.

Field Methods for Rivers and Lakes:

- Massachusetts Water Watch Partnership, 2003. *Sampling Protocols For Lakes and Rivers.* http://www.umass.edu/tei/mwwp/protocols.html.
- MassDEP-DWM. SOP for Bottle Basket Sampler; CN 001.4. 627 Main St., 2nd floor, Worcester, MA 01608.
- MassDEP-DWM SOP for Continuous Temperature Monitoring; CN103.0 627 Main St., 2nd floor, Worcester, MA 01608.
- MassDEP-DWM. SOP for Field Sampling, CN 001.21. 627 Main St., 2nd floor, Worcester, MA 01608.
- MassDEP-DWM. SOP for Sample Collection Pole; CN 001.3. 627 Main St., 2nd floor, Worcester, MA 01608.
- MassDEP-DWM. SOP for Secchi Disk Use; CN 055.0. 627 Main St., 2nd floor, Worcester, MA 01608.
- Michaud, J. P. Washington State Department of Ecology,1994. *A Citizen's Guide to Understanding and Monitoring Lakes and Streams.* Olympia, WA.
- Minnesota Pollution Control Agency. *Citizen Stream Monitoring Program.* http://www.pca.state.mn.us/water/csmp.html.
- Minnesota Pollution Control Agency, 2003. *Volunteer Surface Water Monitoring Guide.* http://www.pca.state.mn.us/water/monitoring-guide.html.
- US EPA. Volunteer Lake Monitoring, A Methods Manual. http://www.epa.gov/owow/monitoring/lakevm.html .
- US EPA and Ocean Conservancy. Volunteer Stream Monitoring: A Methods Manual. 1997 http://www.epa.gov/owow/monitoring/volunteer/stream/.
- Vermont Department of Environmental Conservation. Vermont Volunteer Surface Water Monitoring Guide. 2005. Waterbury, VT. http://www.anr.state.vt.us/dec/waterq/lakes/htm/lp_monitoringguide.htm.
- Maine Volunteer Lake Monitoring Program. 24 Maple Hill Road, Auburn, ME 04210 (207)-783-7733 www.MaineVolunteerLakeMonitors.org
- US EPA Office of Wetlands, Oceans, and Watersheds. *Lake and Reservoir Bioassessment and Biocriteria: Technical Guidance Document.* http://www.epa.gov/owow/monitoring/tech/lakes.html
- ISCO, Inc. Surface Water Monitoring Guide. http://www.isco.com/Stormwater/default.asp?url=/stormwater5/Default.asp&lead=9252
- MassDEP SOP for Field Safety. CN 000.2. 627 Main St., 2nd floor, Worcester, MA 01608
- USGS *Publications Warehouse.* http://infotrek.er.usgs.gov/pubs/

Field Methods for Wetlands:

- Great Lakes Marsh Monitoring Program (amphibians, birds) http://www.bsc-eoc.org/mmpmain.html
- Kenney, Leo and Burne, Matthew. Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. *A Field Guide to the Animals of Vernal Pools.* http://www.vernalpool.org/fldgide.htm
- Minnesota Pollution Control Agency, January 2005. *A Citizen's Guide to Biological Health of Wetlands* http://www.pca.state.mn.us/publications/wq-bwm1-01.pdf
- Natural Heritage and Endangered Species Program, Massachusetts Division of Fisheries and Wildlife. *Vernal Pool Certification Guidelines.* http://www.mass.gov/dfwele/dfw/nhesp/vpcert.pdf.
- NEIWPCC, April 2004. *Field Indicators for Identifying Hydric Soils in New England.* http://www.neiwpcc.org/hydricsoils.asp
- NEIWPCC. *Water Quality: Wetlands.* http://www.neiwpcc.org/wetlands/volunteermonitoring.asp
- Rocque, David P. NEIWPCC, April 2004. *Field Indicators for Identifying Hydric Soils in New England – Supplement.* http://www.neiwpcc.org/neiwpcc_docs/V3_Supplement.pdf
- Vernal Pool Association. *Guidelines for evidence of vernal pool habitat.* http://www.vernalpool.org/macert_2.htm
- Wetland Health Evaluation Program. http://www.mnwhep.org/

Beach Sampling Methods:

- Mass DEP-DWM. Guidance for Bacteria Sampling at Beaches, CN 104.0; 627 Main St., 2nd floor, Worcester, MA 01608
- US EPA. Data Quality Objectives and Statistical Design Support for Development of a Monitoring Protocol for Recreational Waters. USEPA Contract 68-D4-0091.Prepared by Research Triangle Institute. September 1999. http://www.epa.gov/microbes/bch_dqo.pdf
- US EPA. National Beach Guidance and Required Performance Criteria for Grants. June 2002. http://www.epa.gov/waterscience/beaches/grants/guidance/index.html
- US EPA. Time Relevant Beach & Recreational Water Quality Monitoring and Reporting, EPA/625/R-02/017. October 2002. http://www.epa.gov/ord/NRMRL/Pubs/625R02017/625r02017.pdf

Field Sampling Methods and Identification Resources for Freshwater Macroinvertebrates:

- Cummins & Merritt, ed. 1995. *Aquatic Insects of North America.* Kendall/Hunt Publishing Company; 3rd Edition. 2460 Kerper Boulevard PO Box 539, Dubuque, IO 52004.
- Hicks, Anna. University of Massachusetts Extension. 2000. *New England Freshwater Wetlands Invertebrate Biomonitoring Protocol.*
- McCafferty, W. Patrick, 1981. *Insects of North America.* Jones and Bartlett, One Exeter Plaza, Boston MA 02116.
- Mid-Atlantic Coastal Streams Workgroup. Field and Laboratory Methods for Macroinvertebrate and Habitat Assessment of Low Gradient, Nontidal Streams. 1997. http://www.epa.gov/maia/pdf/MACS-FieldandLabMethods.pdf
- New York State Department of Conservation. Key to Freshwater Benthic Macroinvertebrates. http://www.dec.ny.gov/animals/7105.html
- River Network. Living Waters: Using Benthic Macroinvertebrates and Habitat to Assess Your River's Health; Portland, Oregon. Dates, Geoff. http://www2.rivernetwork.org/marketplace/index.cfm?fuseaction=product.display&Product_ID=12
- University of Minnesota, Water Resources Center. Guide to Aquatic Invertebrates of the Upper Midwest. 2004. 173 McNeal Hall, 1985 Buford Avenue, St. Paul MN 55108. Bouchard, R.W. Jr. http://www.entomology.umn.edu/midge/GuidePage.htm AND http://www.entomology.umn.edu/midge/VSMIVP.htm
- US EPA. Generic QAPP Guidance for Programs using Community Level Biological Assessment in Wadeable Streams and Rivers. (EPA 841-B-95-004). 1995. http://www.epa.gov/bioindicators/html/qapp.html
- US EPA Office of Water. Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition, 1999. EPA 841-B-99-002. Barbour et al. http://www.epa.gov/owow/monitoring/rbp/
- MassDEP-DWM SOP for Benthic Macroinvertebrate Sampling; CN 039.2. 627 Main St., 2nd floor, Worcester, MA 01608
- Voshell, J. Reese Jr. 2002. *A Guide to Common Freshwater Invertebrates of North America.* McDonald and Woodward Publishing. Blacksburg VA.
- Wetland Health Evaluation Program Macroinvertebrate Sampling. http://www.mnwhep.org/id28.html

Habitat Assessment Methods:

- MA Department of Fish and Game. Riverways Program. Leaders Manual to Coordinating a Volunteer Lake Watershed Study. 2003. http://www.mass.gov/dfwele/river/pdf/lakewatershedleadersmanual.pdf
- MA Department of Fish and Game. Riverways Program. Massachusetts Stream Crossings Handbook. 2005. Singler, A. and Graber, B. (editors). http://www.mass.gov/dfwele/river/pdf/stream_crossings_handbook.pdf
- MA Department of Fish and Game. Riverways Program. Shoreline Survey – A Stream Team Monitoring Project Leader's Manual. 2000. Kimball, Joan. http://www.mass.gov/dfwele/river/pdf/rivintro.pdf
- MassDEP. Massachusetts Volunteers Guide for Surveying a Lake Watershed and Preparing an Action Plan. http://www.mass.gov/dep/public/lwsguide.pdf

Aquatic Plant/Algae Characterization and Identification Guides:

- Sorrie, B. A.; Somers, P. 1999. *The vascular plants of Massachusetts: a county checklist*. Westborough, Massachusetts: Massachusetts Natural Heritage and Endangered Species Program. http://www.mass.gov/dfwele/dfw/nhesp/nhpubs.htm
- Drociak, J. 2006. A Field Guide to Common Riparian Plants of New Hampshire. New Hampshire Department of Environmental Services, Volunteer River Assessment Program. Concord, NH. http://www.des.nh.gov/wmb/vrap/documents/FieldGuideToCommonRiparianPlantsOfNH.pdf
- Magee, D.W. 1981. Freshwater Wetlands-A Guide to Common Indicator Plants of the Northeastern United States. University of Massachusetts Press, Amherst, MA.

Invasive Species Monitoring and Information:

- ANS Task Force. *Habitattidude*. http://www.habitattitude.net/
- Aquatic ***Nuisance Species*** Task Force. http://www.anstaskforce.gov/default.php
- Haber, Erich:, National Botanical Services, Ecological Monitoring and Assessment Network Environment Canada, 1997. *Guide to Monitoring Exotic and Invasive Plants.* http://www.emanrese.ca/eman/ecotools/protocols/terrestrial/exotics/intro.html
- Hellequist and Straub. MA Department of Conservation and Recreation, 2002 . *A Guide to Selected Invasive* ***Non-native*** *Aquatic Species in Massachusetts*. http://www.mass.gov/dcr/waterSupply/lakepond/downloads/aquatic_species.pdf
- MA Department of Conservation and Recreation. *Invasive Aquatic Species.* http://www.mass.gov/dcr/waterSupply/lakepond/invasive_1.htm
- MA Department of Conservation and Recreation. *Standard Operating Procedures: Using Hand Pulling and Benthic Barriers to Control Pioneer Populations of Non-Native Aquatic Species.* http://www.mass.gov/dcr/waterSupply/lakepond/downloads/sop2007.pdf
- Massachusetts Water Watch Partnership, 2005. *Procedure for Monitoring an Aquatic Plant Problem*. (Adapted from McVoy (DEP) manual of the same name). Blaisdell House, University of Massachusetts, Amherst MA 01003.
- MassDEP-DWM. SOP for Macrophyte Survey Mapping. CN 067.2. 627 Main St., 2nd floor, Worcester, MA 01608
- McVoy, Richard, MassDEP-DWM. *Procedure for Monitoring an Aquatic Plant Problem*. 627 Main St., 2nd floor, Worcester, MA 01608.
- National Invasive Species Information Center. http://www.invasivespeciesinfo.gov/
- Ontario Federation of Anglers and Hunters. Invading Species Watch Program: An Instruction Manual for Volunteers. http://www.invadingspecies.com/Programs.cfm?A=Page&PID=19
- Sorrie, Bruce. The BioOne. Volume 107, Issue 931. October 2005. *Alien Vascular Plants in Massachusetts.* http://www.bioone.org/perlserv/?request=get-document&doi=10.3119%2F0035-4902(2005)107%5B0284%3AAVPIM%5D2.0.CO%3B2
- Northeast Aquatic Nuisance Species Panel. http://www.neans.org/
- University of Connecticut. *Invasive Plant Atlas of New England.* http://nbii-nin.ciesin.columbia.edu/ipane/
- Witten, Matthew. NEIWPCC, July 2005. *Image-based Plant Estimate Protocol.* http://www.neiwpcc.org/plantprotocol.asp

Probe Maintenance, Calibration and Operation:

- US EPA Office of Environmental Measurement and Evaluation, 2005. Revision 7. *Standard Operating Procedures for Calibrating and Field Measurement Procedures for the YSI Model 6 Series Sondes and Datalogger*. http://www.epa.gov/earth1r6/6pd/qa/qadevtools/mod5_sops/field_measurements/ecasop-ysi .pdf
- MassDEP-DWM. SOP for Multi-Probe Use: CN 4.21. 627 Main St., 2nd floor, Worcester, MA 01608
- MassDEP-DWM. SOP for Multi-Probe Deployments for Unattended Logging: CN 4.4. 627 Main St., 2nd floor, Worcester, MA 01608
- USGS. Office of Surface Water, 1999.*Technical Memorandum 99.06: Care and Maintenance of Vertical Axis Current Meters.* http://water.usgs.gov/admin/memo/SW/sw99.06.html

Flow Measurements:

- MA Department of Fish and Game, Riverways Program. 2003. RIFLS River Instream Flow Stewards Quality Assurance Project Plan. http://www.rifls.org/
- MassDEP-DWM. SOP for Flow Measurement: CN 68.0. 627 Main St., 2nd floor, Worcester, MA 01608
- USGS-MA/RI: http://ma.water.usgs.gov/

Pollution Source Tracking:

- Center for Watershed Protection. October 2004. *Illicit Discharge Detection and Elimination; A Guidance Manual For Program Development And Technical Assessments*. Pitt, Robert. http://www.cwp.org/idde_verify.htm
- ISCO, Inc. *Surface Water Monitoring Guide*. http://www.isco.com/Stormwater/default.asp?url=/stormwater5/Default.asp&lead=9252
- NEIWPCC. January 2003. *Illicit Discharge Detection and Elimination Manual, A Handbook for Municipalities.* http://www.neiwpcc.org/neiwpcc_docs/iddmanual.pdf
- USEPA Office of Research and Development. June, 2005. *Microbial Source Tracking Guide Document.* http://www.sourcemolecular.com/pdfs/MSTGuide.pdf

Weather- and Location-Related (misc.):

- Weather station information http://www.erh.noaa.gov/box/dailystns.shtml
- Weather station information http://cdo.ncdc.noaa.gov/CDO/cdo
- Weather station information http://cdo.ncdc.noaa.gov/ulcd/ULCD
- Massachusetts Geographic Information System http://www.mass.gov/mgis/massgis.htm
- Pond maps http://www.mass.gov/dfwele/dfw/habitat/maps/ponds/pond_maps.htm
- Lat/Long Finder http://pagesperso-orange.fr/universimmedia/geo/loc.htm
- Lat-Long Converter http://www.fcc.gov/mb/audio/bickel/DDDMMSS-decimal.html
-

Appendix 3. Selected References of Laboratory Methods and Analyses

General Laboratory Methods:

- Eaton, A. D., Clesceri, L. S., Rice, E. W., & Greenberg, A. E. (Eds.). (2005). *Standard Methods for the Examination of Water and Wastewater* (21st ed.). Washington, DC: American Public Health Association, American Water Works Association, Water Environment Federation.
- National Environmental Methods Index. http://www.nemi.gov/
- US EPA *Sources of EPA Test Methods*. http://www.epa.gov/epahome/index/sources.htm
- US EPA. 1983. *Methods for Chemical Analysis of Water and Wastes*. EPA Document No. 600/4-79-020. Cincinnati, OH: Us Environmental Protection Agency, Office of Research and Standards, Environmental Monitoring and Support Laboratory. Available: http://tinyurl.com/yzuyzx
- US EPA *Water Science Analytical Methods.* http://www.epa.gov/waterscience/methods/

Analyses for Bacteria (including human vs. non-human source research):

- Bernhard, A.E. and Field, K.G. 2000. A PCR assay to discriminate human and ruminant feces on the basis of host differences in *Bacteroides-Prevotella* genes encoding 16S rRNA. Appl. Environ. Microbiol. 66(10): 4571-4574.
- MassDEP-DWM. Analytical Quantification of Escherichia coli and Enterococci Bacteria in Ambient Surface waters using an Enzyme Substrate Test (SM 9223B). 627 Main St., 2nd floor, Worcester, MA 01608
- MassDEP-DWM. SOP for Analysis of Bacteria Using Colilert: CN 198.0. 627 Main St., 2nd floor, Worcester, MA 01608
- Scott, T. M., Jenkins, T.M., Lukasik, J., and Rose, J.B. 2005. Potential use of a host associated molecular marker in *Enterococcus faecium* as an index of human fecal pollution. Environ. Sci. Technol. 39(1): 283-287.
- Tang, et al 2005. Validation of a Potential Human Fecal Pollution Marker Based on a Putative Virulence factor (ESP Gene) in Enterococcus faecium and its Application to the Assessment of the Charles River and Boston Harbor Beaches, Massachusetts.
- MassDEP-DWM. SOP for Analysis of Bacteria Using Colilert; CN 198.0. 627 Main St., 2nd floor, Worcester, MA 01608

Analyses for Chlorophyll a:

- MassDEP-DWM. CN 3.4; Chlorophyll *a* Analysis. 627 Main St., 2nd floor, Worcester, MA 01608
- University of Massachusetts Environmental Analysis Lab. Analytical methods: SOP for Chlorophyll *a* Analysis. 2003. Amherst MA 01003.

Total Phosphorus:

- USGS. Evaluation of Alkaline Persulfate Digestion as an Alternative to Kjeldahl Digestion for Determination of Total and Dissolved Nitrogen and Phosphorus in Water, WRIR 03-4174. November 2003. Patton and Kryskalla. http://nwql.usgs.gov/Public/pubs/WRIR03-4174/WRIR03-4174.html

Analyses for Nitrogen:

- Grace Analytical Lab, Standard Operating Procedure for Total Kjeldahl Nitrogen (Lachat Method). Revision 2. 1994. 536 South Clark Street, 10th Floor, Chicago, IL 60605. http://www.epa.gov/grtlakes/lmmb/methods/tknalr2.pdf
- USGS. Evaluation of Alkaline Persulfate Digestion as an Alternative to Kjeldahl Digestion for Determination of Total and Dissolved Nitrogen and Phosphorus in Water, WRIR 03-4174. 2003. http://nwql.usgs.gov/Public/pubs/WRIR03-4174/WRIR03-4174.html
- Wisconsin State Lab of Hygiene, Environmental Sciences Section, Inorganic Chemistry Unit. ESS Method 220.3: Ammonia Nitrogen and Nitrate + Nitrite Nitrogen, Automated Flow Injection Analysis Method. 1991. 465 Henry Mall, Madison, WI 53706. http://www.epa.gov/grtlakes/lmmb/methods/methd220.pdf

Optical Brighteners and Fluorescent Whitening Agents (FWAs):

- Eight Towns and the Bay. Water Sampling, an Optical Brightener Handbook. Sargent and Castonguay. http://www.naturecompass.org/8tb/sampling/index.html
- Hagedorn, C., et al, 2005. Fluorometric Detection of Optical Brighteners as an Indicator of Human Sources of Water. Crop and Soil Environmental News. http://www.ext.vt.edu/news/periodicals/cses/2005-11/part1.html (Part 1) http://www.ext.vt.edu/news/periodicals/cses/2005-11/part2.html (Part 2)
- Poiger, T., Field, J.A., Field, T.M., and Giger, W. 1996. Occurrence of fluorescent whitening agents in sewage and river water determined by solid-phase extraction and high-performance liquid chromatography. Environ. Sci. Technol. 30:2220-2226.
- Rhode Island Department of Environmental Management. Quality Assurance Project Plan. Optical Brightening Study-Green Hill Pond, Ninigret Pond, Factory Brook, Teal Brook. May 2001. http://www.dem.ri.gov/pubs/qapp/optbri.pdf
- MassDEP SOP for Optical Brighteners. CN 058.0. 627 Main St., 2nd floor, Worcester, MA 01608

Pharmaceuticals and Personal Care Products (PPCPs):

- Alvarez, et. Al 2004. Water Quality Monitoring of Pharmaceuticals and Personal Care Products Using Passive Samplers. Symposia Papers Presented Before the Division of Environmental Chemistry American Chemical Society. August 2004. http://www.epa.gov/esd/chemistry/ppcp/images/alvarez.pdf
- Glassmeyer, et al, 2005 Transport of Chemical and Microbial Compounds from Known Wastewater Discharges: Potential for Use as Indicators of Human Fecal Contamination; Environ. Sci. Technol. 39, 5157-5169

Algae and Algal Toxin Monitoring:

- Florida Department of Environmental Protection. *Searchable Biology Section SOPs.* http://www.dep.state.fl.us/labs/cgi-bin/sop/biosop.asp
- Micscape Magazine, 2000. *Pond Life Identification Kit* (on-line guide) http://www.microscopy-uk.org.uk/index.html?http://www.microscopy-uk.org.uk/pond/
- Minnesota Pollution Control Agency. *Toxic Algae* website. http://www.pca.state.mn.us/water/clmp-toxicalgae.html
- Purdue University, Department of Biological Sciences. *A Webserver for Cyanobacterial research.* http://www-cyanosite.bio.purdue.edu/index.html
- Wallace, Rachel. University of Georgia. *Discover Life* Algae Identification guide (online) http://stri.discoverlife.org/mp/20q?guide=Groups_Algae
- Connecticut College key for freshwater algae (on-line) http://silicasecchidisk.conncoll.edu/LucidKeys/Carolina_Key/html/Group_List.html

Appendix 4. Miscellaneous Resources

Agency/government plans, programs, legislation:

- Massachusetts Department of Conservation & Recreation http://www.mass.gov/dcr/
- Massachusetts Department of Conservation & Recreation (Lakes & Ponds) http://www.mass.gov/dcr/waterSupply/lakepond/lakepond.htm
- Massachusetts Department of Fish & Game http://www.mass.gov/dfwele/
- MA Executive Office of Environmental Affairs Watershed Action Plans http://www.mass.gov/envir/water/publications.htm
- Massachusetts Beaches Act http://www.mass.gov/legis/laws/seslaw00/sl000248.htm
- MA Coastal Zone Management Coastal Pollution Remediation Grant Program http://www.mass.gov/czm/cprgp.htm
- MA Coastal Zone Management Wetlands Restoration Program http://www.mass.gov/czm/wrp/
- MA Coastal Zone Management Aquatic Invasive Species Management Plan . December 2002. http://www.mass.gov/czm/invasives/background/plan.htm

Data reporting:

- Mass-DEP-DWM. CN 0.71 Data Submittal Guidelines. 627 Main St., 2nd floor, Worcester, MA 01608
- Mass-DEP-DWM. CN 0.74 Recommended Content of 3rd Party Data. 627 Main St., 2nd floor, Worcester, MA 01608
- Mass-DEP-DWM. CN 0.78 Data Deliverable Guidelines for Grant Projects. 627 Main St., 2nd floor, Worcester, MA 01608
- EPA WQ database: http://www.epa.gov/storet/wqx.html

Data information sources:

- Mass-DEP 305(b) waterbody health assessments http://www.mass.gov/dep/water/resources/wqassess.htm
- Mass-DEP Total Maximum Daily Load reports http://www.mass.gov/dep/water/resources/tmdls.htm
- National Oceanic and Atmospheric Administration. Weather information. http://www.weather.gov/
- US EPA Ecoregional Nutrient Criteria http://www.epa.gov/waterscience/criteria/nutrient/ecoregions/
- USGS Real-Time Data for Massachusetts: Streamflow Information http://waterdata.usgs.gov/ma/nwis/current/?type=flow

Quality Assurance Project Plans, Sampling and Analysis Plans:

- Mass-DEP. The Massachusetts Volunteer Monitor's Guide to Quality Assurance Project Plans. 2001. Godfrey, P. et al. http://www.mass.gov/dep/public/qapp.pdf
- Mass-DEP-DWM. CN 0.76 QAPP Approval & Data Review Process. 627 Main St., 2nd floor, Worcester, MA 01608
- US EPA. Guidance on Choosing a Sampling Design for Environmental Data Collection For Use in Developing a Quality Assurance Project Plan. 2002. http://www.epa.gov/quality/qs-docs/g5s-final.pdf
- US EPA Region 1. Examples of Quality Assurance Project Plans http://www.epa.gov/region01/measure/qapp_examples/index.html
- US EPA Sampling and Analysis Plan (Field Sampling Plan and Quality Assurance Project Plan) with Guidance; Quality Assurance Program United States Environmental Protection Agency Region IX 75 Hawthorne Street San Francisco, CA 94105 March 1997
- US EPA. The Volunteer Monitor's Guide to Quality Assurance Project Plans. 1996. http://www.epa.gov/OWOW/monitoring/volunteer/qappcovr.htm

Volunteer monitoring information :

- US EPA The Volunteer Monitor Newsletter http://www.epa.gov/owow/monitoring/volunteer/vm_index.html
- USDA, CREES, and The Land Grant System: Volunteer Water Quality Monitoring National Facilitation Project http://www.usawaterquality.org/volunteer/
- Massachusetts Water Watch Partnership http://www.umass.edu/tei/mwwp/index.html

Appendix 5. Massachusetts Laboratories [1] Certified [2] in One or More Parameters by the MassDEP, Division of Environmental Analysis, 2008

AMESBURY WTP LAB TOWN HALL 62 FRIEND ST AMESBURY, MA 01913-0000

HANSCOM AFB ENVIRONMENTAL LAB 66 MDOS/SGOAB 90 VANDENBERG DR BLDG 1212 BEDFORD, MA 01731-0000

BROCKTON WATER TREATMENT PLANT #1 SILVER LAKE ROUTE 36 PEMBROKE, MA 02359-0000

GARELICK FARMS 1199 WEST CENTRAL ST FRANKLIN, MA 02038-0000

AQUARION WATER CO OF MASSACHUSETT 900 MAIN ST HINGHAM, MA 02043-0000

MORRELL ASSOCIATES INC PO BOX 268 MARSHFIELD, MA 02050-0000

NORTH ANDOVER WTP LAB 420 GREAT POND RD NORTH ANDOVER, MA 01845-0000

SHREWSBURY HOMEFARM WTP TOWN OF SHREWSBURY WATER & SEWER DEPT 100 MAPLE ST SHREWSBURY, MA 01545-0000

FRONTIER RESEARCH LAB PO BOX 205/1 FRONTIER DR NORTH CHELMSFORD, MA 01863-0000

HOWARD LABORATORIES INC PO BOX 68 HATFIELD, MA 01038-0000

MWRA QUABBIN LABORATORY 100 TAFTS AVE DEER ISLAND TP WINTHROP, MA 02152-0000

CHATHAM WATER QUALITY LABORATORY 549 MAIN ST CHATHAM, MA 02633-0000

WEST GLOUCESTER WTP 50 ESSEX AVE GLOUCESTER, MA 01930-0000

HOLYOKE WATER WORKS LABORATORY 600 WESTFIELD RD HOLYOKE, MA 01040-0000

NANTUCKET ENVIRONMENTAL LABORATO PO BOX 1419 NANTUCKET, MA 02554-0000

WEST PEABODY WATER TREATMENT PLA 38 BUTTERNUT AVE PEABODY, MA 01960-0000

SOMERSET WTP LABORATORY 3249 COUNTY ST PO BOX 35 SOMERSET, MA 02726-0000

SPRINGFIELD WATER AND SEWER COMMIS 1515 GRANVILLE RD WESTFIELD, MA 01085-0000

ATTLEBORO WATER TREATMENT FACILIT 77 PARK ST ATTLEBORO, MA 02703-0000

QUABBIN ANALYTICAL LABORATORY PO BOX 1192 BELCHERTOWN, MA 01007-0000

FAIRHAVEN BOARD OF HEALTH 40 CENTER STREET FAIRHAVEN, MA 02719-0000

HANOVER WTP 40 POND STREET HANOVER, MA 02339-0000

TAUNTON WATER TREATMENT PLANT 91 PRECINCT ST LAKEVILLE, MA 02347-0000

NEWBURYPORT WPT LAB 7 SPRING LN NEWBURYPORT, MA 01950-0000

G AND L LABS INC 246 ARLINGTON ST QUINCY, MA 02170-0000

MWRA CHELSEA LABORATORY 100 TAFTS AVE DEER ISLAND TP WINTHROP, MA 02152-0000

WHITE LODGE LABORATORY C/O DEDHAM WESTWOOD WATER DIST 50 ELM ST DEDHAM, MA 02026-9137

MICROBAC LABORATORIES INC 148 BARTLETT ST MARLBOROUGH, MA 01752-0000

QUITTACAS WTP LAB 1 NEGUS WAY FREETOWN, MA 02717-1320

GEOLABS INC 45 JOHNSON LANE BRAINTREE, MA 02184-0000

ANALYTICAL BALANCE CORP 422 WEST GROVE ST MIDDLEBOROUGH, MA 02346-0000

ANDOVER WATER TREATMENT PLANT LA 397 LOWELL ST ANDOVER, MA 01810-0000

GREENFIELD WATER POLLUTION CONTRO TOWN HALL DPW 14 COURT SQ GREENFIELD, MA 01301

BILLERICA WATER TREATMENT PLANT 270 TREBLE COVE RD BILLERICA, MA 01821-0000

BIOMARINE INC 16 E. MAIN ST GLOUCESTER, MA 01930-0000

NEW BEDFORD HEALTH DEPARTMENT LA 1000 SO RODNEY FRENCH BLVD NEW BEDFORD, MA 02744

SALEM-BEVERLY WATER SUPPLY BOARD 50 ARLINGTON AVE BEVERLY, MA 01915-0000

BARNSTABLE COUNTY HEALTH & ENV DEP SUPERIOR CT HOUSE 3195 MAIN ST, RTE 6A BARNSTABLE, MA 02630-0000

TESTAMERICA WESTFIELD 53 SOUTHAMPTON RD WESTFIELD, MA 01085-5308

DANVERS WATER DIVISION LABORATORY 30 LAKE ST MIDDLETON, MA 01949-0000

BERKSHIRE ENVIRO-LABS INC 266 MAIN ST LEE, MA 01238-1641

EMLAB P&K BILLERICA 148 RANGEWAY RD NO.BILLERICA, MA 01862

FITCHBURG DPW WATER LAB 1200 RINDGE RD FITCHBURG, MA 01420-0000

ENVIROTECH LABORATORIES INC 8 JAN SEBASTIAN DR UNIT 12 SANDWICH, MA 02563-0000

AMERICA SCIENCE TEAM BOSTON INC 8 SCHOOL ST WEYMOUTH, MA 02189-8951

WASTE WATER ENVIRONMENTAL MANAGE 270 LITTLETON RD UNIT 30 WESTFORD, MA 01886

METHUEN WATER TREATMENT PLANT 25 BURNHAM ROAD METHUEN, MA 01844-0000

PROSCIENCE ANALYTICAL SERVICES INC 22 CUMMINGS PARK WOBURN, MA 01801-0000

PRACTICAL APPLICATIONS INC 12 CHANNEL ST SUITE 601 BOSTON, MA 02210-0000

AREVA NP INC ENVIRONMENTAL LABORAT 29 RESEARCH DR WESTBOROUGH, MA 01581-3913

GROUNDWATER ANALYTICAL INC PO BOX 1200 BUZZARDS BAY, MA 02532-0000

MASS DPH ENVIRONMENTAL CHEMISTRY LAB 305 SOUTH ST. JAMAICA PLAIN, MA 02130

THORSTENSEN LABS INC PO BOX 426 WESTFORD, MA 01886-0000

GREATER LAWRENCE SANITARY DISTRIC 240 CHARLES ST NORTH ANDOVER, MA 01845-0000

MT TOM GENERATING CO LLC ANALYTICA 15 AGAWAM AVE WEST SPRINGFIELD, MA 01089

ALPHA ANALYTICAL 8 WALKUP DR WESTBOROUGH, MA 01581-1019

ALPHA ANALYTICAL 320 FORBES BLVD. MANSFIELD, MA 02048

CON-TEST ANALYTICAL LABORATORY 39 SPRUCE STREET EAST LONGMEADOW, MA 01028

WORCESTER WATER FILTRATION PLANT L 71 STONE HOUSE HILL RD HOLDEN, MA 01520-0000

WAMPANOAG ENVIRONMENTAL LABORAT 20 BLACK BROOK RD AQUINNAH, MA 02535-0000

SPECTRUM ANALYTICAL INC. 11 ALMGREN DR AGAWAM, MA 01001-0000

RI ANALYTICAL LABORATORIES INC 131 COOLIDGE ST SUITE 105 HUDSON, MA 01749-0000

WORCESTER HEALTH DEPARTMENT LAB 25 MEADE ST WORCESTER, MA 01610

LAPUCK LABORATORIES INC 70 SHAWMUT PARK CANTON, MA 02021-0000

HAVERHILL WATER DEPT LAB 131 AMESBURY ROAD HAVERHILL, MA 01830-0000

NEW ENGLAND CHROMACHEM INC 6 NICHOLS STREET SALEM, MA 01970-1368

GZA-GEOENVIRONMENTAL INC 106 SOUTH ST HOPKINTON, MA 01748-0000

GROUNDWATER ANALYTICAL INC 1748B WEST TRUCK RD. OTIS AFB, MA 02542

MWRA SOUTHBORO LABORATORY 100 TAFTS AVE DEER ISLAND TP WINTHROP, MA 02152-0000

AGRI-MARK CENTRAL LABORATORY 1000 RIVERDALE ST WEST SPRINGFIELD, MA 01089-0000

VALLID LABS INC 295 SILVER ST AGAWAM, MA 01001-0000

NASHOBA ANALYTICAL LLC 29 KING ST LITTLETON, MA 01460-0000

LYNN WATER TREATMENT PLANT LABOR 390 PARKLAND AVE LYNN, MA 01905

NORTHEAST ENVIRONMENTAL LABORATO 18 RIVERSIDE AVE DANVERS, MA 01923-0000

MARTINAGE ENGINEERING ASSOC INC 131 MAIN STREET THIRD FLOOR READING, MA 01867-3966

ACCUTEST LABORATORIES OF NEW ENGLAND 495 TECHNOLOGY CENTER WEST 50 D'ANGELO DR MARLBOROUGH, MA 01752-0000

CAMBRIDGE WATER DEPARTMENT LABOR 250 FRESH POND PARKWAY CAMBRIDGE, MA 02138

SOUTH ESSEX SEWERAGE DISTRICT PO BOX 989 SALEM, MA 01970-0000

TEWKSBURY WATER TREATMENT PLAN 71 MERRIMACK DR TEWKSBURY, MA 01876-1070

DOBLE MATERIALS LABORATORY 85 WALNUT ST WATERTOWN, MA 02472-0000

SPECTRUM ANALYTICAL INC 11 ALMGREN DR AGAWAM, MA 01001-0000

SPRINGFIELD REGIONAL WW TREATMENT 190 M STREET EXT AGAWAM, MA 01001-0000

CYN OIL CORP 1771 WASHINGTON ST PO BOX 119 STOUGHTON, MA 02072-0000

LOWELL REGIONAL WASTEWATER UTILIT 451 FIRST STREET BLVD RTE 110 LOWELL, MA 01850

LOWELL REGIONAL WATER UTILITY 815 PAWTUCKET BLVD LOWELL, MA 01854-0000

MAXYMILLIAN TECHNOLOGIES INC 86 SOUTH MAIN ST LANESBOROUGH, MA 01237-0000

MWRA CENTRAL LABORATORY DEER ISLAND TREATMENT PLANT 190 TAFTS AVE WINTHROP, MA 02152-0000

ENVIRONMENTAL TESTING AND RESEARC 29 FULLER ST LEOMINSTER, MA 01453-4225

CHICOPEE WATER DEPARTMENT LAB 1334 BURNETT RD. CHICOPEE, MA 01020

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[1] This list shows certified labs in Mass. only. While certification is helpful and recommended whenever possible, it is not required for non-drinking water applications. Non-certified, qualified and experienced labs can also produce acceptable lab data.

[2] A searchable online list of labs certified by MassDEP in one or more analyses can be found on MassDEP website: http://public.dep.state.ma.us/Labcert/Labcert.aspx

Appendix 6. Agency Contacts

Executive Office of Energy & Environmental Affairs (EEA)

100 Cambridge Street, Suite 900, Boston, MA 02114
Telephone: 617.626.1000
Fax: 617.626.1181
Email: env.internet@state.ma.us

Department of Environmental Protection (MassDEP):

MassDEP-DWM contacts (627 Main St., 2nd floor, Worcester, MA 01608):

- Richard Chase. (508) 767-2859. richard.f.chase@state.ma.us
- Arthur Screpetis. (508) 767-2875 arthur.screpetis@state.ma.us

Regional Offices:

- **Northeast Region**: 205-B Lowell St. Wilmington, MA 01887 (978) 694-3200
  - Jenny Birnbaum, DWM-regional source-tracking program, 978-694-3234
  - Katie Zink, DWM-regional source-tracking program, 978-694-3253
- **Southeast Region**: 20 Riverside Dr. Lakeville, MA 02347 (508) 946-2700
  - Jennifer Sheppard, DWM-regional source-tracking program, 508-946-2701
  - Tracie Beasley, DWM-regional source-tracking program, 508-946-2787
- **Western Region**: 436 Dwight Street, Springfield, MA 01103. 413-784-1100
  - Matt Poach, DWM-regional source-tracking program, 413-755-2128
- **Central Region**: 627 Main Street, Worcester, Massachusetts 01608. 508-792-7650
  - Warren Kimball, CERO-SMART monitoring, 508-767-2879
  - Therese Beaudoin, CERO-SMART monitoring, 508-767-2742

Department of Conservation and Recreation (DCR):

251 Causeway Street, Suite 600, Boston MA 02114

- Anne Monnelly, Aquatic Ecologist, Office of Water Resources. 617- 626-1395 anne.monnelly@state.ma.us
- Jim Straub 617-626-1411 jim.straub@state.ma.us
- Michelle Robinson, Aquatic Biologist. 180 Beamon St. West Boylston MA 01583. 508-792-7423 ext.304 michelle.robinson@state.ma.us

Massachusetts Department of Fish & Game, Riverways Program:

251 Causeway St., Suite 400, Boston, MA 02114

- Margaret Kearns. (617) 626-1540. Watershed Ecologist, RIFLS Coordinator. Margaret.Kearns@state.ma.us
- Cindy DelPapa, Stream Ecologist, Urban Rivers Coordinator. 617-626-1545 cindy.delpapa@state.ma.us

Appendix 7. Selected suppliers of sampling equipment and supplies

This list in part courtesy of *Vermont Volunteer Surface Water Monitoring Guide*

NOTE: References to trade names, commercial products and manufacturers in this General QAPP do not constitute endorsement.

Acorn Naturalists Science and environmental education resources, including field kits for schools 155 El Camino Real Tustin, CA 92780 1-800-422-8886 http://www.acornnaturalists.com/	**IDEXX** Colilert coliform analysis products One IDEXX Drive Westbrook Maine 04092 United States Telephone: 1-800-321-0207 Fax: (207) 556-4630 http://www.idexx.com/water/colilert/
Ben Meadows Company Equipment and supplies for a variety of outdoor work, including water sampling P.O. Box 5277 Janesville, WI 53547-5277 1-800-241-6401 www.benmeadows.com	**In-Situ, Inc.** Sampling instruments 221 East Lincoln Ave. Fort Collins, CO 80524 1-800-446-7488 http://www.in-situ.com/
Carolina Biological Supply Curriculum supplements and monitoring equipment for schools 2700 York Court Burlington, NC 27215 1-800-334-5551 www.carolina.com	**LaMotte** Water quality testing equipment 802 Washington Ave. P.O. Box 329 Chestertown, Maryland 21620 1-800-344-3100 www.lamotte.com
Eureka Environmental Engineering Sampling instruments, software 2113 Wells Branch Parkway Suite 4400 Austin, TX 78728 1-512-302-4333 http://www.eurekaenvironmental.com/	**VWR Scientific Products** Sampling equipment, instruments, supplies 1-800-932-5000 http://www.vwrsp.com/
Fisher Scientific Full range of monitoring instruments and supplies 2000 Park Lane Pittsburgh PS 15275 1-800-766-7000 http://www.fisherscientific.com/	**Water Monitoring Equipment and Supply (Lawrence Enterprises of Maine)** Lake, stream, and pond/vernal pool monitoring equipment P.O. Box 344 Seal Harbor, Maine 04675 207-276-5746 www.watermonitoringequip.com
HACH/Hydrolab Company Analyzers, instruments, and chemistries for water analysis P.O. Box 389 Loveland, Colorado 80539 1-800-227-4224 www.hach.com; http://www.hydrolab.com/	**Wildlife Supply Wildco** Aquatic sampling instruments and equipment 301 Cass St. Saginaw, MI 48602-2097 1-800-799-8301 www.wildco.com

Healthy Water Healthy People Manuals, curriculum and field kits available 201 Culbertson Hall PO Box 170575 Montana State University Bozeman, MT 59717-0575 www.HealthyWater.org	**YSI Environmental** Equipment, supplies and instruments for environmental monitoring 1700/1725 Brannum Land Yellow Springs, OH 45387 1-800 897-4151 https://www.ysi.com/ysi

Appendix 8. Glossary

Accuracy: A data quality indicator, accuracy is the extent of agreement between an observed value (sampling result) and the accepted, or true, value of the parameter being measured. High accuracy can be defined as a combination of high precision and low ***bias***. Accuracy checks are typically done in the laboratory. For some indicators, the only available means of checking accuracy is to compare results with another "trusted" lab or with a taxonomic expert.

Analyte: Within a medium, such as water, an analyte is a property or substance to be measured. Examples of analytes would include pH, dissolved oxygen, bacteria, and heavy metals.

Bias: Often used as a data quality indicator, bias is the degree of systematic error or inaccuracy present in the assessment or analysis process. When bias is present, the sampling result value will differ from the accepted, or true, value of the parameter being assessed in one direction.

Blank Plate. For bacteria samples. Rinse water is used instead of field sample, otherwise processed just as a field sample. Result should be "0". Each batch of samples should include at least one blank and one positive check sample.

Blind Sample: A blind sample is a sample submitted to an analyst without their knowledge of its identity or composition. Blind samples are used to test the analyst's or laboratory's expertise in performing the sample analysis.

Calibration Blank: Reagent-grade, purified water (deionized/distilled) used as a zero standard. Used to "zero" lab instruments, evaluate instrument drift and check for sample contamination of field blanks.

Calibration Check Standard: A standard used to check the calibration of an instrument between periodic recalibrations.

Censored Data: Data that has been found to be unacceptable as a result of the data validation process, including review for conformance to the approved QAPP and data quality objectives for the project (e.g., required holding times for analysis, required frequency of field blanks and duplicates/splits, acceptability of precision estimates (***standard deviation***, or relative percent difference (RPD)).

Chain-of-Custody: Used for routine sample control for regulatory and non-regulatory monitoring. The chain-of-custody form contains the following information: sample IDs, collection date/time/samplers, sample matrix, preservation requirements, delivery persons/date/time, etc Used also as a general term to include sample labels, field logging, field sheets, lab receipt and assignment, disposal and all other aspects of sample handling from collection to ultimate analysis.

Comparability: A data quality indicator, comparability is the degree to which different methods, data sets, and/or decisions agree or are similar.

Completeness: A data quality indicator that is generally expressed as a percentage, completeness is the amount of valid data obtained compared to the amount of data planned.

Data Quality Objectives (DQOs): Data quality objectives are quantitative and qualitative statements describing the degree of the data's acceptability or utility to the data user(s). They include indicators such as accuracy, precision, representativeness, comparability, and completeness (PARCC). DQOs specify the quality of the data needed in order to meet monitoring project goals.

Data Users: The group(s) that will be applying the data results for some purpose. Data users can include the principle investigators, as well as government agencies, schools, universities, watershed organizations, and business and community groups.

Detection Limits: Applied to both methods and equipment, detection limits are descriptions of the lowest concentration of a target analyte that a given method or piece of equipment can reliably ascertain as greater than zero. Specific detection limits include: Instrument detection limit, level of quantitation, lower level of detection, method detection limit, practical quantitation limit and reporting detection limit.

Duplicate Sample: Used for quality control purposes, field/lab duplicate samples are two samples taken generally at the same time from, and representative of, the same site/sample that are carried through all assessment and analytical procedures in an identical manner. Field duplicate samples are used to measure natural variability as well as the precision of field sampling and lab analytical methods. Lab duplicates are used as a measure of method precision. Field duplicates can be: side-by-side and simultaneous (generally, two people will take samples or readings simultaneously); sequential (i.e. sample once, then sample again immediately afterwards at the same location); split from a large volume sample (take a sample, then pour a portion of the sample (an aliquot) from the sampling container into another). More than two duplicate samples are referred to as replicate samples.

Environmental Sample: An environmental sample is a specimen of any material collected from an environmental source, such as water or macroinvertebrates collected from a stream, lake, or estuary.

Equipment or Rinsate Blank: Used for quality control purposes, equipment or rinsate blanks are types of field blanks used to check specifically for carryover contamination from reuse of the same sampling equipment (see field blank).

Exotic species: A species that is the result of direct or indirect introduction of the species by humans, and for which introduction permitted the species to cross a natural barrier to dispersal.

Field Blank: A field blank is created by filling a clean sample bottle with deionized or distilled water in the field during sampling activities. The sample is treated the same as other samples taken from the field. Field blanks are submitted to the lab along with all other samples and are used to detect any contaminants that may be introduced during sample collection, fixing, storage, analysis, and transport.

Field Composite Sample: A sample taken by mixing equal volumes of a pre-determined number of grab samples from the same location at different times, i.e. a time-composite. Used to assess average conditions present between the first and last grab samples that are composites. Use time-composite sampling only for those parameters that can be shown to remain unchanged under the specific conditions of composite sample collection. Flow-weighted composite sampling is a variation to time-composite sampling, in which sample volume adjustments are made to each grab based on variations in flow, such as, during stormwater monitoring loading studies.

Field Integrated Sample: A sample taken by simultaneously combining a matrix across vertical or horizontal strata as an evaluation of average composition within the boundaries of the integration (ex. photic zone sampling for chlorophyll a). Sampling tubes can sample continuous, integrated media.

Field Split: A second sample generated from the same sampling location and at the same time by splitting a large volume sample from one sampler deployment into two equal volume samples. Used to measure precision, except that associated with actual sample collection, and excludes natural variability. Also referred to as duplicate subsample.

Field Duplicate (sequential): A second sample generated from the same sampling location as the initial sample, but from a second sampler deployment immediately after the first. Used to measure overall field sampling precision and includes an unknown amount of natural variability (spatial and temporal), if present.

Field Duplicate (simultaneous): A second sample generated from the same sampling location and at the same exact time as the other sample by simultaneous deployment of two identical sampling devices or by the simultaneous filling of two separate sample bottles. Used to measure overall field sampling precision and includes an unknown amount of natural variability (spatial), if present. Also referred to as a co-located duplicate.

Grab Sample: A manually collected sample at a specific location and time. Given practical constraints and budget limitations, assumptions are usually made that the natural variation is small enough over space/time to consider the grab to be representative of conditions over a greater expanse and/or longer period. In some cases, these assumptions may not always be valid.

Instrument Detection Limit (IDL): The concentration that produces a signal greater than five times the signal/noise ratio of the instrument.

Introduced species: A species that has been transported by human activities into a region in which it did not occur in historical time and which is now reproducing in the wild.

Invasive species: A species that displaces native species and has the ability to dominate an ecosystem, or a species that enters an ecosystem beyond its natural range and causes economic or environmental harm.

Known Samples: An internal check that compares your results against another analyst or a "known." The true or expected concentration of the analyte is known prior to performing the analysis.

Lab Fortified Blank: Known concentration of target analyte(s) introduced to clean reference matrix and processed through the entire analytical procedure; used as an indicator of method performance and accuracy. Also known as Spike Blank.

Lab Fortified Matrix: Difference in analyte concentration between a spiked sample and the non-spiked sample should be equivalent to the amount added to the spiked sample. Lab QC sample used to assess sample matrix effects on recovery of target analyte and evaluate accuracy. Also known as Matrix Spike. Duplication of this sample is referred to as matrix spike duplicate or lab-fortified matrix duplicate.

Lab Split: A sample that has been divided into two or more subsamples. Splits are submitted to different analysts or laboratories and are used to measure the precision of the analytical methods. Lab splits are an external QC protocol.

Lab Duplicate: A sample that has been divided into two or more subsamples. It is processed concurrently and identically with the initial sample by the same laboratory. It is used to measure the precision of the analytical methods. Lab duplicates are also referred to as lab splits. At least 10% replication is advised

Level of Quantitation (LOQ): The concentration that produces a signal sufficiently greater than the blank that it can be detected; typically the concentration that produces a signal 10 times above the blank signal (SM, 1998).

Lower Level of Detection (LLD): Measurement level reproducible with 99% certainty; typically twice the IDL.

Matrix: A matrix is a specific type of medium, such as surface water or sediment, in which the analyte of interest may be contained.

Matrix Spike: A sample to which a known concentration of target analyte has been added. When analyzed, the difference in analyte concentration between a spiked sample and the non-spiked sample should be equivalent to the amount added to the spiked sample. Lab QC sample used to assess sample matrix effects on recovery of target analyte and evaluate accuracy. Also known as Lab-fortified matrix. Duplication of this sample is referred to as matrix spike duplicate or lab-fortified matrix duplicate.

Measurement Range: The measurement range is the extent of reliable readings of an instrument or measuring device, as specified by the manufacturer.

Method Blank: An aliquot of clean reference matrix carried through the analytical process to assess the degree of laboratory contamination and indicate accuracy.

Method Detection Limit (MDL): The MDL is the concentration that produces a signal with a 99% probability that it is different from the blank, after going through the entire method. The smallest amount that can be detected above the noise in a procedure and within a stated confidence level. Typically, four times the IDL.

Method Validation: Testing procedure for existing, new and modified methods, in which several evaluation steps are typically employed: determinations of MDL, method precision, method accuracy, and sensitivity to variation in method steps ("method ruggedness", SM, 1998).

Native species: A species that occurs naturally in an area, and has not been introduced by humans.

Non-native species: A species that has been introduced to an area or bioregion.

Nuisance species: A nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested area, or human activities dependent on such resources

Performance Audit: Unscheduled evaluation of field sampling QC or laboratory QC procedures by a third party not directly involved in the taking, transport and analysis of the samples; used to detect deviations from accepted SOPs. Audits can take many forms. Submittal of identical check samples to two different labs is an example of an external, blind performance audit. Lab inter-comparison samples can also be used to test the lab's proficiency in relation to other labs. Results of audits are documented and any necessary corrections recommended.

Performance Evaluation (PE) Samples: A sample of known concentration submitted "blind" (without lab's knowledge) to the analyst. PE samples are provided to evaluate the ability of the analyst or laboratory to produce analytical results within specified limits, and as an indicator of method accuracy. Also called a laboratory control sample.

Positive plate: a sample known to contain bacteria (e.g. waste-water treatment plant influent) is processed along with field samples. Determines if a lab procedural error inhibits bacterial growth.

Results should be "too numerous to count." Each batch of samples should include at least one blank and one positive check sample.

Practical Quantitation Limit (PQL): The level that several labs can achieve using the same method and samples; typically, ten times the IDL, and 3-5 times the MDL.

Precision: A data quality indicator, precision measures the level of agreement or variability among a set of repeated measurements, obtained under similar conditions. Precision is usually expressed as a standard deviation in absolute or relative terms. Precision checks are primarily accomplished through

replicate sampling and analysis in the field and lab.

Proficiency Testing (Unknown Samples): Concentrations are known to an auditor but not to the person performing the analysis.

Protocols: Protocols are detailed, written, standardized procedures for field and/or laboratory operations.

Qualifier: Used to indicate additional information about the data, and generally denoted as capital letters in data reports. Qualifier acronyms or terms are unique to each laboratory.

Quality Assurance (QA): QA is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. QA activities involve planning quality control, quality assessment, reporting, and quality improvement. These activities can be internal (within the main group) or external (involving outside parties).

Quality Assurance Project Plan (QAPP): A QAPP is a formal written document describing the detailed quality control procedures that will be used to achieve a specific project's data quality requirements. A QAPP is a planning tool to ensure that project goals are achieved. Typically, QAPPs are finalized prior to monitoring activities and any deviations from the final QAPP made during the actual monitoring are noted in a subsequent task, such as the data-reporting phase of the project. QAPPs can be of two main types:

-- A "project-specific QAPP" provides a QA blueprint specific to one project or task and is considered the sampling and analysis plan/workplan for the project.

-- A "generic program QAPP" is an overview-type plan that describes program data quality objectives, and documents the comprehensive set of sampling, analysis, QA/QC, data validation and assessment SOPs specific to the program. An example is a macroinvertebrate monitoring program performed throughout many watersheds within a State.

Quality Control (QC): QC is the overall system of technical activities designed to measure quality and limit error in a product or service. A QC program manages quality so that data meets the needs of the user as expressed in a quality assurance project plan. Specific quality control samples include blanks, check samples, matrix spikes and replicates.

Quality Control Sample: An uncontaminated sample matrix spiked with known amounts of analytes from a source independent of the calibration standards. Generally used to establish intra- laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system.

Quality Control Standard: See Quality Control Sample

Random Sample: A sample chosen such that the choice of each event in the sample is left entirely to chance; an unbiased sample generally representative of the population. Randomness is a property of a sample that must exist for almost any statistical test, but may not be appropriate for all sampling designs (ex. Non-random site selection based on targeting specific conditions or based on practical considerations).

Reference collection: An exact duplicate of a voucher collection (a preserved collection of each type (i.e. taxon) of specimen found in a water body). Used regularly as reference when identifying new specimens. Reference collections should be verified by an expert.

Relative Standard Deviation (RSD): A measure of precision calculated by dividing the std. deviation by the mean, expressed as a percentage. Used when sample number exceeds two.

Relative Percent Difference (RPD): A measure of precision used for duplicate sample results. It is calculated by dividing the difference between the two results by the mean of the two results, expressed as a percentage ((|A-B|)/((A+B)/2))*100. Used when sample number equals two.

Reporting Detection Limit (RDL): The lower limit that the lab feels comfortable reporting with a high level of certainty. For practical purposes, the RDL is often equivalent to the MDL.

Representativeness: A data quality indicator, representativeness is the degree to which data accurately and precisely portray the actual or true environmental condition measured.

Sensitivity: Related to detection limits, sensitivity refers to the capability of a method or instrument to discriminate between measurement responses.

Spike Blank: Known concentration of target analyte(s) introduced to clean reference matrix and processed through the entire analytical procedure; used as an indicator of method performance and accuracy. Also known as Lab-fortified blank.

Spiked Samples: Sample is split into 2. A known amount of the indicator (e.g. phosphorous) is added to one. Analysis of samples should show spiked sample with exactly the known amount increase over unspiked.

Standard Reference Materials (SRM): An SRM is a certified material or substance with an established, known and accepted value for the analyte or property of interest. Employed in the determination of bias, SRMs are used as a gauge to correctly calibrate instruments or assess measurement methods. SRMs are produced by the U. S. National Institute of Standards and Technology (NIST) and characterized for absolute content independent of any analytical method.

Standard Deviation(s): Used in the determination of precision, standard deviation is the most common calculation used to measure the range of variation among repeated measurements. The standard deviation of a set of measurements is expressed by the positive square root of the variance of the measurements.

Standard Operating Procedures (SOPs): An SOP is a written, official document detailing the prescribed and established methods used for performing project operations, analyses, or actions.

Trend: Systematic tendency over time in a specific direction in time series data, ideally collected at uniform intervals, collected and analyzed using the same (or comparable) methods and containing no gaps in periodic data.

Trip blanks: A sample container filled in the lab with de-ionized water. It accompanies other samples to field and returned unopened to the lab and is analyzed at the lab as if it were a regular sample. For most analyses, field blanks are preferred over trip blanks.

True Value: In the determination of accuracy, observed measurement values are often compared to true, or standard, values. A true value is one that has been sufficiently well established to be used for the calibration of instruments, evaluation of assessment methods or the assignment of values to materials.

Unknown Samples (Proficiency Testing): Concentrations are known to an auditor but not to the person performing the analysis.

Variance: A statistical term used in the calculation of standard deviation, variance is the sum of the squares of the difference between the individual values of a set and the arithmetic mean of the set, divided by one less than the numbers in the set.

Voucher collection is a preserved collection of each type (i.e. taxon) of specimen found in your water

body. Maintained in archival condition by a trained curator. Voucher reference collections should be verified by an expert.

Wetland: Under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." Definition taken from the EPA Regulations listed at 40 CFR 230.3(t).

Appendix 9. Examples of labels, forms, training records, data sheets

The format and content of forms used to record sample information varies considerably among monitoring groups. Links to some example forms are provided below. Also, some forms can be viewed at individual volunteer group web sites.

- Fieldsheets (WQ, habitat) and lab sheets (courtesy of MassDEP-DWM): http://www.mass.gov/dep/public/volmonit.htm; http://www.mass.gov/dep/water/resources/2005qapp.pdf;
- Lakes & Ponds Fieldsheet (courtesy of MassDEP-DWM & MWWP): http://www.umass.edu/tei/mwwp/acrobat/lakefieldsheet.pdf
- Rivers & Streams Fieldsheet (courtesy of MassDEP-DWM & MWWP): http://www.umass.edu/tei/mwwp/acrobat/riverfieldsheet.pdf
- Surveying a Lake Watershed Data Collection Forms (MassDEP): http://www.mass.gov/dep/public/lwsforms.doc
- Riparian Area Survey (courtesy of MA DFG-Riverways Program): http://www.mass.gov/dfwele/river/pdf/rivriparian.pdf
- Adopt-A-Stream Shoreline Survey Data Sheets (Riverways Program): http://www.mass.gov/dfwele/river/volunteer/2007data_sheets.doc
- River Continuity Data Form (Riverways Program): http://www.mass.gov/dfwele/river/volunteer/culvert_field_data_form.doc
- Stormdrain Datasheet (Riverways Program): http://www.mass.gov/dfwele/river/pdf/rivstormdraindata.pdf

Appendix 10. MassDEP-DWM Data Submittal Guidelines

Monitoring Method Guidance CN 0.71 **(December, 2006)**	**DATA SUBMITTAL GUIDELINES** **Massachusetts Department of Environmental Protection** **Division of Watershed Management- Watershed Planning Program** **627 Main St., Worcester, MA. 01608; 508-792-7470**	

Objective: To provide guidance to external groups regarding the submittal to the MassDEP/Division of Watershed Management (DWM) of quality-assured monitoring data and supporting information. Also, to briefly explain DWM's external data review process.

Background: In addition to using primary (DWM) data, DWM often uses 3rd party data from outside groups to assess waterbody health and develop cleanup plans for impaired waterbodies. In order to be usable by DWM for these purposes, these data must meet certain guidelines (as explained below) AND undergo detailed review to help evaluate the accuracy, precision and representativeness of the data. Outside groups include, but are not limited to, environmental consultants, agencies and volunteer organizations.

Guidelines for Submittal of Data for potential use in DWM's Waterbody Assessments and TMDLs (Clean Water Act, Sections 305(b) and 303(d)):

1. ***Monitoring data are generated through implementation of a DEP-approved Quality Assurance Project Plan (QAPP).***

   The project QAPP shall follow applicable DEP and/or EPA guidance for monitoring QAPPs, which can be found at: http://www.epa.gov/quality/qapps.html; and http://www.mass.gov/dep/public/volmonit.htm. DEP-approved QAPPs shall include appropriate documentation from the analytical laboratory to be used, such as their current Quality Assurance Plan (QAP) and Standard Operating Procedures (SOPs), as well as project protocols for sample collection, quality control sampling and data management. Stated project objectives should be consistent with DWM's use of data for waterbody assessment purposes.

2. ***Analytical data provided by a laboratory certified by the Commonwealth of Massachusetts in the applicable analyses, or a laboratory with a documented and acceptable Quality Assurance Plan (QAP), as well as documented and acceptable Standard Operating Procedures (SOPs).***

   Use of a State-certified laboratory for all sample analyses is highly recommended, but is not always possible. While all submitted external data undergoes detailed review by DWM, data generated through the use of non-certified labs may receive a higher level of scrutiny than that from certified labs. If not already provided in the QAPP, provide certified/non-certified laboratory quality assurance information (lab QAP, lab SOPs, contacts, etc.) in the data report. A list of State-certified labs is available at: http://www.mass.gov/dep/water/drinking/certifie.htm.

3. ***Quality-assured data (and metadata) presented in a citable report in sufficient detail for DWM to evaluate the usability of the data.***

   See CN 0.74 for recommended outline and format of submitted monitoring report. In general, DWM is interested in the raw data and metadata (sampling and analytical information related to the data); graphic and textual data analysis/display is optional.

Recommended Media: If possible and as standard practice, monitoring data can be provided to DWM using the following media. Electronic media are preferred. Raw data tables are also preferred over graph-only displays.

1. Paper for report and example documentation (including those components identified in CN 0.74)
2. CD-ROM (containing report (e.g., MS Word) and spreadsheet (e.g., MS Excel) raw data tables)

3. e-files of report and data tables (e-mailed)
4. Electronic Data Deliverable, EDD (*optional and/or as requested, appropriate and feasible; per standard DWM format)*

MADEP/DWM's External Data Review Process:

Submitted, quality-assured data from outside groups are reviewed by DWM using the following criteria (as appropriate) and best professional judgement, in order to evaluate their potential for use.

1. Clarity, organization, detail, completeness and accuracy of the raw and analyzed data (including QC analyses)
2. Overall precision of field duplicates/replicates compared to project DQOs.
3. Estimated accuracy of lab analyses, using Quality Control/Performance Evaluation (QC/PE) samples, spiked sample matrices, and positive/negative controls (for bacteria samples), as compared to project DQOs.
4. Overall evaluation of QAPP implementation (i.e., documentation of actual QC measures to ensure data quality, such as the frequency of instrument calibration and maintenance, problem identification and response, and personnel training)
5. Evaluation of field audit information.
6. Side-by-side and/or inter-laboratory QC audit information, if available, to assess inter-group and/or inter-lab precision.
7. Personal communication with project lead(s) and/or QC officer(s), if needed, to address questions (such as, Were sample data representative of a waterbody at a specific location?).
8. Appropriateness and accuracy of the data analyses. Volunteer guidance regarding data interpretation and analysis is available at: http://www.umass.edu/tei/mwwp/publicat.html#new1.
9. Method consistency/variability among project participants and over time throughout the duration of the project.

Based on a thorough review, submitted data may be accepted, accepted with caveat/qualification and/or rejected. If accepted with qualification, data will be flagged with one or more data qualifiers, as identified in DWM's SOP for Data Validation (CN 056.2). For any data that are rejected, DWM shall provide justification using data qualifier symbols and a brief explanation. In some cases, it may be necessary for DWM to postpone decisions regarding the usability of external data, pending submittal of additional information, lack of staff resources to adequately review the data, or for other reason(s). In accepting external data from a variety of sources, it is not DWM's intent to become a repository for external data. Data management is the responsibility of the organization that collects it.

DEP Contacts For Submittal of Monitoring Data, QAPP Approval and Laboratory Certification:

For questions regarding DWM's review of external QAPPs and SAPs, monitoring reports or WES' Laboratory Certification Program, please contact the following persons:

Monitoring Data Review:
- Laurie Kennedy, 508-767-2791
- Richard Chase, 508-767-2859
- misc. project coordinators 508-792-7470

QAPP/SAP Approval:
- Richard Chase, 508-767-2859
- Arthur Screpetis, 508-767-2875

Lab Certification:
- Ann Marie Allen 978-682-5237 ext. 333
- Lisa Touet, 978-682-5237 ext. 364
- Oscar Pancorbo, 978-682-5237

Monitoring Method Guidance CN 0.74 **(November, 2006)**	**RECOMMENDED CONTENT OF DATA REPORT SUBMITTALS**	

Massachusetts Department of Environmental Protection
Division of Watershed Management- Watershed Planning Program
627 Main St., Worcester, MA. 01608; 508-792-7470

Objective: To provide guidance to external groups regarding the recommended content of data reports submitted to MassDEP- Division of Watershed Management (DWM).

Background: DWM often uses data from outside groups (including, but not limited to, environmental consultants, agencies and volunteer organizations) to assess waterbody health and develop cleanup plans for impaired waterbodies. These data are typically contained in monitoring reports submitted to DWM. In order for DWM to make decisions on the usability of these data, the reports need to be detailed, complete, accurate, organized and understandable. Recommended information that should be included in these reports is as follows:

Recommended Content (general):

1. Cover letter. Provide a brief cover letter explaining what data is being submitted, project contact persons, and a statement that the approved project QAPP was followed in generating the data.

2. Cover page. Show project name/title, lead organization, author(s) and report date

3. Introduction. Provide background information related to the monitoring, such as funding source(s), water quality-related issues of concern and objectives of the monitoring.

4. Methods Used. List all field and lab methods that were employed during the project. Reference Standard Methods, EPA, etc. as appropriate.

5. Quality assurance, quality control and data validation (in main report or in an appendix):

   - Provide title and DWM-approval date for project QAPP

   - Discuss the extent to which the QAPP was implemented (e.g., Were there any deviations from the approved QAPP? And if so, what were they, and what are the implications of the change, if any?).

   - Consider including the following information in the **QA/QC section** of the report.
     - Current contact information for project personnel, especially the project Quality Control (QC) officer(s) and Database Manager;
     - Type and number of QC samples taken during the project (e.g., field blanks, duplicates);
     - Type of sample preservatives used;
     - Type, extent and dates of actual field equipment calibration and maintenance;
     - Dates and personnel involved for any survey and/or lab audits;
     - Database management system employed;
     - Specific data validation steps actually performed to accept, qualify and censor project data. List data qualifier symbols used, if any (e.g., "J" for 'estimated' by laboratory).
     - Results and discussion of both field and laboratory quality control sample results (including overall precision of field duplicates (as relative percent difference, or RPD);
     - Ambient field blank data,
     - Missing data,
     - Field/lab audits,
     - Any exceedances of analytical holding times,

- Other project information as they may have affected sample data and lab QC data.
- Range and RPD of the log (10) results (for bacteria duplicate data),
- Discussion of how data validation process was implemented and how the results of validation affected the project data (e.g., Were data quality objectives (DQOs) met, as outlined in the QAPP?).
- Data decisions (list all data that were accepted with qualification and/or censored, along with justification for each decision.)
- QC issues affecting single datum versus whole survey/batched analyses.

6. Results: Provide raw field measurement data and raw laboratory data, including that for quality control samples, in a clear and organized format. (Include raw laboratory data reports, completed fieldsheets and completed chain-of-custody forms in appendices.) Also provide important metadata, such as sample collection dates/times, analysis dates/times, exact station location descriptions, sample ID numbers, analytical method used with method detection limits (MDLs) and reporting detection limits (RDLs), weather, field observations and measurement units.

7. Discussion: In general, DWM is interested in the quality-assured RAW data, and not as much with analysis of the data (e.g., graphic presentations). However, discussion of results can provide important information that should be included in the reports. Provide discussion and analysis of data, as needed.

8. Conclusion: Summarize findings and provide recommendations for additional monitoring and/or remedial actions to improve water quality.

9. Appendices. Include complete set or example completed copies of relevant appendices for raw laboratory data and raw field data (including survey dates), completed fieldsheets and completed sample chain-of-custody forms, as well as any other relevant information. Provide detailed sampling station maps/tables showing or describing precise locations where samples were taken.

Recommended Media: If possible and as standard practice, monitoring data can be provided to DWM using the following media. Electronic media are preferred. Raw data tables are also preferred over graph-only displays.

5. Paper for report and example documentation (including those components identified in CN 0.74)
6. CD-ROM (containing report (e.g., MS Word) and spreadsheet (e.g., MS Excel) raw data tables)
7. e-files of report and data tables (e-mailed)
8. Electronic Data Deliverable, EDD (*optional and/or as requested, appropriate and feasible; per standard DWM format)*

DWM Contacts For Submittal of Monitoring Data Reports:

- Arthur Screpetis, 508-767-2875 (grant projects)
- Richard Chase, 508-767-2859
- Laurie Kennedy, 508-767-2791 (WET reports)
- Jane Ryder, 508-767-2743 (WET reports)
- Rick McVoy, 508-767-2877
- Arthur Johnson, 508-767-2873
- DWM monitoring coordinators (various)

Monitoring Method Guidance CN 0.78 **(September, 2004)**	**DATA DELIVERABLE REQUIREMENTS FOR GRANT PROJECTS** **Massachusetts Department of Environmental Protection** **Division of Watershed Management**	

Objective: To provide minimum contractual specifications for data deliverables for DWM-managed, grant-funded water quality monitoring projects.

Background: In coordination with EPA, DWM manages grant-funded water quality monitoring projects for monitoring performed by outside groups. Outside groups include, but are not limited to, environmental consultants and volunteer organizations. The projects are guided by formal contracts and work plans. Although many projects may have specific data delivery requirements, all projects must meet these minimum requirements for submittal of data.

These requirements are minimum standards and are included in all grant projects producing data. Consistent delivery of project data as specified herein will facilitate more effective project management, external data storage and retrieval, and data review by DWM.

Data Deliverable Requirements:

1) Draft and final reports submitted as part of this project shall follow the guidelines specified in CN 0.71, Data Submittal Guidelines, and CN 0.74 Content for External Data Reports.

2) All draft and final data deliverables shall be checked for accuracy, organization, completeness, acceptable format and coherence prior to submittal.

3) The following media types and quantities of each ( ) shall be submitted:

    - Paper reports (3)
    - Labeled CD-ROM (containing report files (e.g., Adobe Acrobat, MS Word), spreadsheet (e.g., MS Excel) data table files, and other files as appropriate (e.g., compressed .jpg photos, Arc View GIS .shp files, etc.) (1)
    - e-files of report and data tables (*via email; optional)*
    - Electronic Data Deliverable, EDD (*optional and/or as requested, appropriate and feasible)*
    - Calibrated and verified files to run Water Quality Model with all supporting documentation (*for modeling projects only)*

Status of Project Data: Until the project is completed, all data and reports generated and delivered as specified above shall be considered DRAFT. Ownership, transmittal and/or use of draft and final project data shall be as specified in the contract.

DEP/DWM Contacts For Submittal of Project Data Deliverables:

- Arthur Screpetis, 508-767-2875
- Gary Gonyea, 617-556-1152
- Richard Chase, 508-767-2859
-