QUALITY ASSURANCE PROJECT PLAN
for
Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands

Prepared By:

Maine Department of Environmental Protection
Bureau of Land & Water
Division of Environmental Assessment
Biological Monitoring Program
State House Station #17
Augusta, ME 04333
BioME@maine.gov

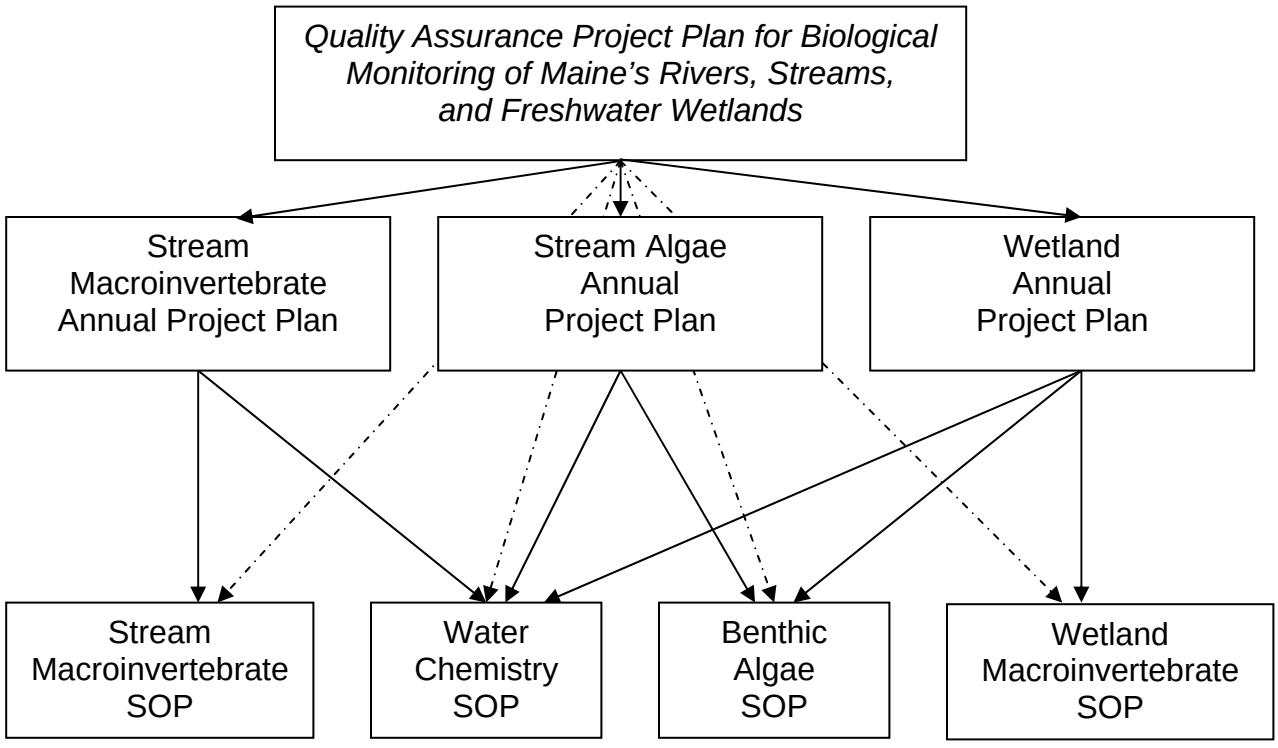
Date: February 1, 2008

DEPLW0638

Preamble

Relationship Between *Quality Assurance Project Plan for Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands* and Project Plans and Standard Operating Procedures

The following diagram provides the general relationships of the generic ***Quality Assurance Project Plan (QAPP) for Biological Monitoring of Maine's Rivers, Streams, and Freshwater Wetlands*** with Annual Project Plans (APPs; for sample see App. E) and associated Standard Operating Procedures (SOPs). This diagram is not intended to display all potential APPs or SOPs. The APPs describe individual sampling efforts and reference method SOPs. The SOPs describe in detail the methods used to sample streams, rivers, and freshwater wetlands, such as how to collect water grab samples and use equipment to measure water conductivity. As shown below, several APPs may reference a single SOP. However, APPs may also reference SOPs that are not referenced by other Project Plans.



A1 – Title and Approval Sheet[1]

Biomonitoring of Rivers, Streams and Freshwater Wetlands in Maine
Quality Assurance Project Plan

Jennie Bridge DATE
Environmental Protection Agency, Region 1
1 Congress Street, Suite 1100, Boston, Massachusetts 02114-2023
Phone: 617/918-1685 Fax: 617/918-1505
EPA PROJECT MANAGER

Dick Siscanaw DATE
Environmental Protection Agency, Region 1
11 Technology Drive, North Chelmsford, Massachusetts 01863-2431
Phone: 617/918-8327 Fax: 617/918-8397
EPA QUALITY ASSURRANCE CHEMIST

Susan Davies DATE
Maine Department. of Environmental Protection (MDEP)
Bureau of Land & Water, Division Of Environmental Assessment
State House Station #17
Augusta, Maine 04333
Phone: 207/287-7778 Fax: 207/287-7191
MDEP PROJECT MANAGER

Malcolm Burson DATE
Maine Department of Environmental Protection (MDEP)
Office of the Commissioner
State House Station #17
Augusta, Maine 04333
Phone: 207/287-7755 Fax: 207/287-2814
MDEP QUALITY ASSURANCE OFFICER

---

[1] Section A1 shows signature page from original QAPP approval, March 4, 2004.

A2 – Table of Contents

ELEMENT/SECTION

Group A: Project Management Elements
A1 Title and Approval Sheet……. 1
A2 Table of Contents…….…. 2
A3 Distribution List……..…… 5
A4 Project/Task Organization…… 5
A5 Problem Identification/Background……...……... 6
A6 Project/Task Description……...…..... 8
A7 Data Quality Objectives for Measurement Data ……..…….…… 11
A8 Training Requirements/Certification…….…….… 12
A9 Documentation and Records…….…….…. 13

Group B: Measurement/Data Acquisition Elements
B1 Sampling Process Design (Experimental Design)…….…… 13
B2 Sampling Methods Requirements……..…. 17
B3 Sample Handling and Custody Requirements…….….... 18
B4 Analytical Methods Requirements……..… 18
B5 Quality Control Requirements……..... 18
B6 Instrument/Equipment Testing, Inspection, and Maintenance Requirements……. 19
B7 Instrument Calibration and Frequency……... 19
B8 Inspection/Acceptance Requirements for Supplies and Consumables…….…….. 19
B9 Data Acquisition Requirements (Non-direct Measurements)…… 19
B10 Data Management…….. 20

Group C: Assessment/Oversight Elements
C1 Assessments and Response Actions…….….. 20
C2 Reports to Management…….. 21

Group D: Data Validation and Usability
D1 Data Review, Validation, and Verification Requirements……..… 21
D2 Validation and Verification Methods……..…...…. 21
D3 Reconciliation with Data Quality Objectives ...……..…. 22

References…….……... 23

TABLES

Table 1 Maine Water Quality Criteria for Classification of Fresh Surface Waters (38 MRSA §465)
Table 2 Data Quality Objectives and Indicators, and Measurement Quality Objectives for Water Quality Monitoring
Table 3 Details for Sampling Biota and Water Quality Parameters
Table 4 Inspection, Maintenance, and Testing Requirements as well as Calibration Method and Frequency for Field Instruments/Equipment

FIGURES

Figure 1 Rotating Basin Schedule

APPENDICES

Appendix A List of Acronyms

Appendix B Field Data Sheets
i. River and Stream Macroinvertebrate Field Data Sheet
a) Maine DEP Biological Monitoring Macroinvertebrate Field Data Sheet
ii. Algae Sampling Field Data Sheets
a) Maine DEP Stream Algae Field Data Sheet
b) Maine DEP Viewing Bucket Survey Data Sheet
c) Maine DEP Canopy Cover Sheet
d) Maine DEP Epiphytic Algae Data Sheet
iii. Wetland Field Sheets
a) Maine DEP Wetland Bioassessment Field Data Form
b) Human Disturbance Ranking Form for Biological Assessment of Wetlands
c) Maine DEP Epiphytic Algae Data Sheet

Appendix C Chemistry Tracking
i. Water Chemistry Chain-of-Custody Form

Appendix D Standard Methods and Standard Operating Procedures (SOPs) Used in this Study
Maine Department of Environmental Protection
i. Methods for Biological Sampling and Analysis of Maine's Rivers and Streams
ii. Protocols for Using the Hanna Dissolved Oxygen and Specific Conductance/pH Meters in Rivers, Streams, and Freshwater Wetlands
iii. Protocols for Using the Global Flow Meter in Wadeable Rivers and Streams

iv. Protocols for Collecting Water Grab Samples in Rivers, Streams, and Freshwater Wetlands
v. Procedure for Measuring Continuous Water Temperature Using an Onset Data Logger
vi. Protocols for Sampling Algae in Wadeable Rivers, Streams, and Freshwater Wetlands
vii. Protocols for Sampling Aquatic Macroinvertebrates in Freshwater Wetlands
viii. Protocols for Managing Biomonitoring Data
ix. Protocols for Decontaminating Biomonitoring Sampling Equipment

<u>State of Maine Health and Environmental Testing Laboratory (HETL)</u>

x. Analysis of Total Kjeldahl Nitrogen in Waters
xi. Analysis of Nitrate+Nitrite in Drinking Water, Groundwater, Surface Water, and Wastewater
xii. Analysis of Ammonia in Water
xiii. Analysis of Total Phosphorus
xiv. Analysis of Total Dissolved Solids
xv. Chlorophyll (Note: this is not a HETL SOP but they use this method for the analysis of Chlorophyll *a*)
xvi. Analysis of Ortho Phosphorus (Note: this method is used for the analysis of Ortho Phosphorus and Soluble Reactive Phosphorus)
xvii. Analysis of Total Suspended Solids
xviii. Determination of Total and Dissolved Organic Carbon in Water
xix. Analysis of Chloride in Water
xx. Analysis of Total Alkalinity
xxi. Analysis of Color in Waters
xxii. Analysis of Sulfate
xxiii. Dissolved Silica Preparation Step
xxiv. Analysis of Trace Metals in Drinking Water
xxv. The Analysis of pH in Drinking Water, Wastewater, Groundwater, and Surface Water
xxvi. Analysis of Conductivity

(**Note**: App. D i, x - xi, xiii, xv – xix, and xxiv are not attached to this QAPP but were submitted to EPA on June 6, 2003 as part of the "Urban Streams NPS TMDLs in Maine" QAPP.)

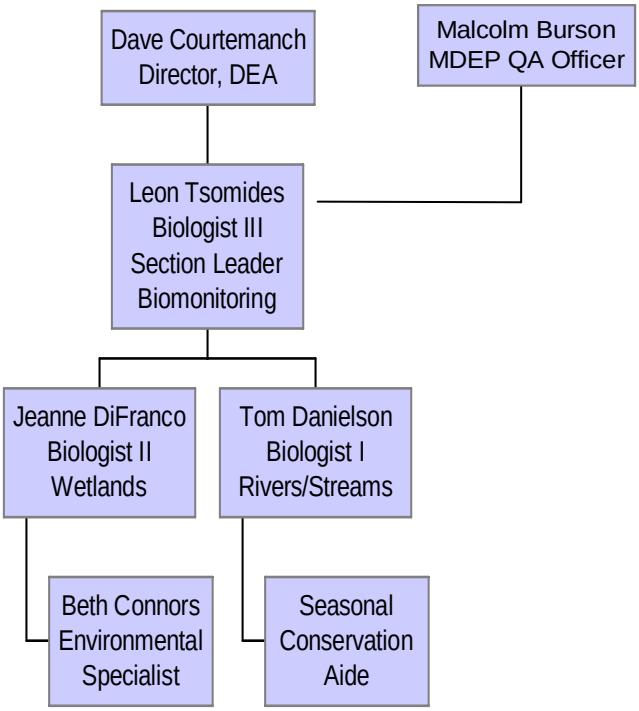
Appendix E Annual Project Plan (sample)

A3 – Distribution List

Name	Organization
Jennie Bridge	U. S. Environmental Protection Agency, Region 1
Dick Siscanaw	U. S. Environmental Protection Agency, Region 1
Leon Tsomides	Maine Department of Environmental Protection
Malcolm Burson	Maine Department of Environmental Protection

Other staff from Maine Department of Environmental Protection as appropriate.

A4 - Project/Task Organization



- Leon Tsomides is responsible for the overall quality assurance of the Biological Monitoring Program as well as the stream macroinvertebrate APP.
- Jeanne DiFranco is the Wetland Subsection Leader and is responsible for APPs and SOPs related to wetlands.
- Tom Danielson is responsible for stream SOPs and for the stream algae APP.

A5 - Problem Identification/Background

In 1986, the Maine State Legislature created the Water Classification Program (WCP) (Title 38 MRSA Art. 4-A) to improve the management of the State's waters. The Legislature declared that it is the State's objective to restore and maintain the chemical, physical, and biological integrity of the State's waters and to preserve certain pristine State waters. The Legislature also recognized that it was unrealistic to assign the same environmental goals to all of the State's fresh surface waters. As a result, the Legislature established four classes (AA, A, B, and C) with different levels of environmental protection, and assigned classes to all rivers and streams in the State. For each class, the Legislature defined the desired environmental goals (designated uses) and established narrative and numeric criteria that must be met to attain the desired environmental goals (Table 1).

Table 1. Maine Water Quality Criteria for Classification of Fresh Surface Waters (Title 38 MRSA §465)

	Dissolved Oxygen Numeric Criteria	**Bacteria (*E. coli*) Numeric Criteria**	**Habitat Narrative Criteria**	**Aquatic Life (Biological) Narrative Criteria**
Class AA	As naturally occurs	As naturally occurs	Free flowing and natural	No direct discharge of pollutants; ***As naturally occurs***
Class A	7 ppm; 75% saturation	As naturally occurs	Natural	***As naturally occurs***
Class B	7 ppm; 75% saturation	64/100 ml (g.m.*) or 236/100 ml (inst.*) of human and domestic animal origin	Unimpaired	Discharges ***shall not cause adverse impact*** to aquatic life in that the receiving waters shall be of sufficient quality to ***support all aquatic species indigenous to the receiving water without detrimental changes to the resident biological community***.
Class C	5 ppm; 60% saturation	126/100 ml (g.m.*) or 236/100 ml (inst.*) of human and domestic animal origin	Habitat for fish and other aquatic life	Discharges ***may cause some changes*** to aquatic life, provided that the receiving waters shall be of sufficient quality to ***support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community***.

* g.m., geometric mean; inst., instantaneous level

The purpose of the Maine Department of Environmental Protection (MDEP) Biomonitoring Program is to evaluate the condition of fresh surface waters, excluding lakes, to determine if they are attaining their aquatic life use criteria. In 1983, the Biomonitoring Program started collecting benthic macroinvertebrates from streams and rivers (Davies *et al.* 1999). Macroinvertebrates are animals without backbones that can be seen with the naked eye, such as mayflies, stoneflies, caddisflies, snails, leeches and crayfish. The Biomonitoring Program uses a statistical model, which combines a database with a series of linear discriminant models, to

predict the likelihood of streams and rivers attaining their aquatic life use criteria (App. D i). In 2003, the MDEP completed the process of adopting its numeric biocriteria, based on this model, into state regulation. Only three other states have accomplished this task (USEPA 2002). The MDEP uses the data to determine the impacts of toxic contamination, reporting in Section 305(b) reports, listing waters on the Section 303(d) list of impaired waters, informing permitting, licensing, and compliance decisions, and measuring the performance of restoration and conservation activities (Davies *et al.* 1999).

In 1999, the MDEP started to collect benthic algae samples from streams with the hopes of adding a second taxonomic assemblage. Maine's narrative aquatic life standard is broad enough to encompass any plants or animals which live in fresh water for at least part of their life cycle, including fish, amphibians, mussels, crustaceans, insects, and algae. Thirty-nine other states collect data on two or more taxonomic assemblages as part of their stream biomonitoring programs (USEPA 2002). Although their programs are in different degrees of program development, thirty-eight states collect stream fish data and twenty states collect stream algae data (USEPA 2002). States have found that adding a second taxonomic assemblage increases confidence in management decisions based on bioassessment data. The MDEP chose to sample benthic algae instead of fish because the MDEP thought that there were too few species of stream fish in Maine to develop rigorous bioassessment methods. In contrast, the MDEP has collected over 1,000 algal taxa to date in the following groups: blue-green algae (Cyanobacteria), diatoms (Bacillariophyceae), dinoflagellates (Pyrrhophyta), euglenoids (Euglenophyta), green algae (Chlorophyta), and red algae (Rhodophyta) (Wehr and Sheath 2003).

In 1998, the MDEP began development of a biological monitoring and assessment program for freshwater wetlands. Under the Clean Water Act, states are required to adopt water quality standards and assessment programs for all waters of the U.S., including wetlands, and must report on attainment status in relation to standards every two years. As part of this effort, MDEP staff actively participate in EPA's New England Biological Assessment of Wetlands Work Group (NEBAWWG), and the National Wetland Monitoring and Assessment Work Group. These groups help states implement wetland monitoring and assessment programs through technical support and policy guidance to ensure that wetlands are integrated into state and tribal monitoring strategies along with other waters. The wetland biomonitoring initiative has been incorporated into the MDEP's existing water quality assessment division as part of the State's Biological Monitoring Program. As of 2002, annual wetland monitoring is coordinated with river and stream biomonitoring using a 5-year rotating basin schedule (see Figure 1).

Major wetland program functions include conducting monitoring and assessment to evaluate ecological integrity of wetlands, investigating causes and sources of wetland degradation, developing wetland water quality standards (including biological criteria), and providing technical support to other State programs. The MDEP currently samples aquatic macroinvertebrates as the primary taxonomic indicator for assessing wetland condition. Macroinvertebrates are an essential component of wetland food webs. They play an integral role in nutrient cycling and energy transfer within wetland ecosystems, and between wetlands and other habitats. The MDEP also collects wetland algae samples with the goal of developing algal

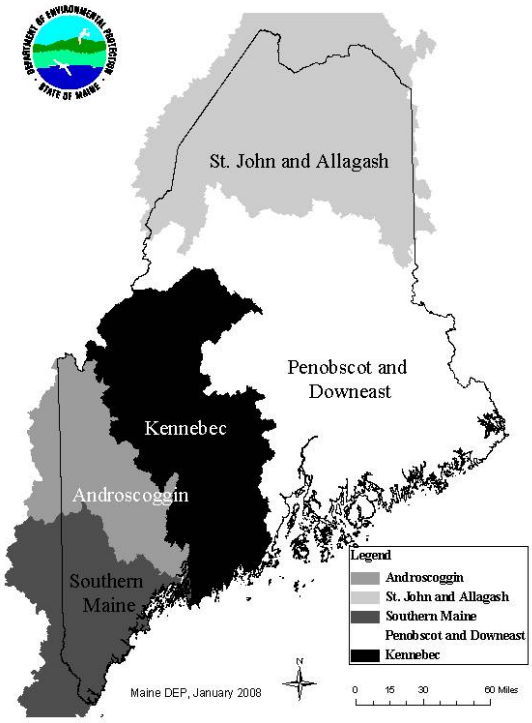
indicators of wetland biological integrity. Algae are expected to be particularly useful for development of wetland nutrient criteria.

To implement a comprehensive biological monitoring program for wetlands, the MDEP needs to build the capacity to assess multiple biological assemblages. This is necessary because various groups of organisms differ in their sensitivity as indicators, depending on the type of wetland and the environmental stressors involved. There is a particular need to incorporate vegetative assessments into the biological monitoring program for wetlands in the future. This will greatly improve the State's ability to monitor a variety of wetland types, including less frequently inundated wetlands, and to evaluate impacts from a wide range of human activities. As funding and staff resources allow, the MDEP plans to incorporate standardized plant community assessments into its biological monitoring program, and to develop vegetative indicators of wetland condition.

A6 – Project/Task Description

The MDEP follows a rotating basin approach for sampling streams, rivers, and wetlands (Figure 1). Each basin is the focus of sampling efforts every five years. The MDEP has found it helpful to coordinate stream and wetland sampling in the same basin and year. Streams, rivers, and wetlands to be sampled in a given year will be chosen on the basis of the rotating basin approach and requests from various programs (*e.g.*, Division of Watershed Management, Surface Water and Ambient Toxics). While basins are emphasized, sampling in a given year is not limited to that year's basin. Special projects and management questions will require the MDEP to diverge from the basin approach in some cases. However, the majority of samples in a given year will come from the assigned basin. The final decision about which locations will be sampled in a given year rests with each task manager (see below).

Figure 1. Rotating Basin Schedule



The MDEP conducts three major types of sampling, including: (1) stream macroinvertebrate sampling; (2) stream algae sampling; and (3) wetland sampling. These three focus areas are defined as tasks in this QAPP. Outlines of the three major tasks included in this QAPP are presented below, while the details are presented in Section B1 - Sampling Process Design (Experimental Design).

Task 1. Stream Macroinvertebrate Sampling.

The macroinvertebrate community at each sampling station is sampled once using substrate samplers (rock bags, rock baskets, cones) during a 4-week period during the summer

low-flow period using the protocol detailed in App. D i. In addition to macroinvertebrate data, information is also collected on physical habitat parameters (land use, upstream terrain, canopy cover, and stream substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; see App. D ii), flow velocity (see App. D iii), stream width and depth, and geographic location (longitude and latitude). Furthermore, water chemistry samples (*e.g.*, for nutrient analysis) may be collected where deemed necessary (see App. D iv, x –xxvi). Finally, at most stations, continuous temperature will be recorded while samplers are deployed (see App. D v). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP						x						
Recon sample locations					x	x						
Train staff (*e.g.*, sample methods, CPR)					x	x						
Collect samples							x	x	x			
Process samples	x	x	x	x				x	x	x	x	x
Send biological samples to taxonomists	x	x	x	x				x	x	x	x	x
Review data sheets for completeness and accuracy							x	x	x	x		
Enter Data	x	x	x	x	x					x	x	x
Analyze Data	x	x	x	x	x					x	x	x
Write Reports	x	x	x	x	x	x					x	x

Task 2. Stream Algae Sampling.

The MDEP collects several kinds of algal samples, including: (1) viewing bucket surveys; (2) Chlorophyll *a* (Chl *a*) samples from natural and/or artificial substrates; and (3) species composition samples from natural and/or artificial substrates. Guidance on where, when, and how to collect algal samples are described in App D vi. In addition to algal data, information is collected on physical habitat parameters (land use, upstream terrain, canopy cover, and stream substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; App. D ii), flow velocity (App. D iii), stream width and depth, and geographic location (longitude and latitude). Furthermore, water chemistry samples (*e.g.*, for nutrient analysis) may be collected where deemed necessary (see App. D iv, x –xvi). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP					x							
Recon sample locations					x	x						
Train staff (*e.g.*, sample methods, CPR)					x	x						
Collect samples						x	x					
Process samples								x	x			
Send biological samples to taxonomists									x	x		
Review data sheets for completeness and accuracy						x	x		x	x		
Enter Data										x	x	x
Analyze Data	x	x	x	x	x					x	x	x
Write Reports	x	x	x	x							x	x

Task 3. Wetland Sampling.

The MDEP collects several kinds of biological samples in wetlands, including: (1) macroinvertebrate samples (D-frame net 1-meter sweep); (2) epiphytic algae from natural substrates (plant stems); and (3) phytoplankton. Guidance on where, when, and how to collect samples are described in relevant SOPs (App. D vi and vii). The MDEP also collects wetland water samples as described in App. D iv. In addition, information is collected on physical habitat parameters (land use, terrain, dominant plant species, and substrate composition), water quality parameters (*e.g.*, instantaneous dissolved oxygen and temperature; see App. D ii), and geographic location (longitude and latitude). The final decision about specific methods to be used and parameters to be sampled in a given year rests with the task manager.

MAJOR TASKS	J	F	M	A	M	J	J	A	S	O	N	D
Select sample locations			x	x	x	x						
Develop APP					x							
Recon sample locations					x	x			x	x		
Train staff (*e.g.*, sample methods, CPR)					x	x						
Collect samples						x	x					
Process samples	x	x	x	x				x	x	x	x	x
Send biological samples to taxonomists	x	x	x	x				x	x	x	x	x
Review data sheets for completeness and accuracy							x	x	x	x		
Enter Data	x	x	x	x	x					x	x	x
Analyze Data	x	x	x	x	x					x	x	x
Write Reports	x	x	x								x	x

A7 – Data Quality Objectives for Measurement Data

a, b) Data quality objectives and indicators.

Collecting high quality data is of prime importance for the Biomonitoring Program. The specific data quality objectives of this program as discussed below include precision and accuracy, representativeness, comparability, and completeness.

Precision and Accuracy

The precision and accuracy levels desired for all data collected are shown in Table 2. All data collected will be compared with the criteria in Table 2 and will be handled according to procedures outlined in sections D1 (Data Review, Validation, and Verification Requirements; p. 21) and D2 (Validation and Verification Methods; p. 21) of this document.

Representativeness

The Biomonitoring Program does not attempt to collect data that are representative of the conditions year-round. Rather, data collection will occur mostly during the summer months (generally June through September, see schedules in section A6). For stream macroinvertebrates, sampling is conducted July through September when macroinvertebrate communities are at their most active and diverse, and when environmental conditions are at their most stressful, *i.e.*, when low flow and high temperatures combine to stress aquatic life resources. Stream algae samples, collected in June and July, target peak algal growth and minimize confounding effects of spring runoff. Wetland sampling for both macroinvertebrates and algae is conducted during June and July. During this index period, wetland invertebrates are mature enough for identification, and wetland hydrology is generally appropriate for sampling. Later in the summer, site selection may be limited because many wetlands have dried out. To minimize effects of habitat heterogeneity, each task has provisions for sample replication as specified in the respective SOPs (see App. D i, vi and vii). Each SOP also contains protocols for targeting specific habitats to ensure that samples represent standardized conditions. Due to the way stations are chosen, they are not necessarily representative of typical conditions along an entire stream or wetland complex.

Completeness

The Biomonitoring Program uses a 5-year rotating basin sampling approach to strive for complete coverage across the State. The rotating basin schedule is described in Section A6 (see Figure 1). There is no fraction of the planned data that must be collected in order to fulfill certain statistical criteria.

Comparability

To ensure comparability among the data, the Biomonitoring Program will employ standardized sampling procedures. References for the methods employed can be found in section B1, and in Tables 2 and 3. Additional methods not included in the program's SOPs may be used, provided they are approved in advance by Biomonitoring Program staff. In such cases, full documentation of the methods used (*i.e.*, a relevant SOP) must be provided to the Biomonitoring Program; this documentation will be included in the program's Methods binder located in the biomonitoring office area.

c) Measurement performance criteria.

Measurement quality objectives (*i.e.*, measurement ranges, method detection limits, and reporting units) desired for the Biomonitoring Program are shown in Table 2. The goal of these objectives is to allow a better assessment of the quality of each parameter or sample that is analyzed in either the field or the laboratory.

A8 –Training Requirements/Certification

Qualifications of new hires

New permanent or acting capacity staff to be hired by the MDEP Biomonitoring Program shall meet all minimum State qualifications appropriate for the classification (Biologist I, Environmental Specialist II, Conservation Aide, etc.). In addition, candidates must posses specialized education and experience necessary for the particular position.

Qualifications of field personnel

All field sampling for Tasks 1-3 will be performed under the supervision of a trained Aquatic Biologist who has the qualifications specified in App. D i. It is preferred that temporary (summer) field staff have a background in biology or environmental studies. At the beginning of each field season, all field staff are required to attend CPR/First Aid training as well as a training session on equipment handling and laboratory safety. The training status of permanent and field personnel will be tracked in electronic format in a dedicated file located in the Biomonitoring Program's "SOP-QAPP" folder.

Qualifications of laboratory personnel

Sample handling in the laboratory must be performed by qualified personnel working under the supervision of a professional aquatic biologist. At the start of employment, laboratory personnel is required to attend a training session on laboratory safety.

Qualifications of taxonomists

Sample taxonomy for macroinvertebrates must be performed by a professional freshwater macroinvertebrate taxonomist who has the qualifications specified in App. D i. Sample taxonomy for algae must be performed by a professional freshwater algal taxonomist or with a closely related advanced degree with specialized training or experience in the taxonomy of freshwater algae. Each contracted taxonomist, working for the MDEP or working for anyone submitting data to the MDEP, will be required to submit a reference collection (physical or digital) of taxa identified, as well as a list of the taxonomic references used in the identifications. Organism identifications will be checked against the MDEP's collection by a MDEP biologist.

Qualifications of non-state agencies submitting data to the biomonitoring program

All samples of aquatic life that are collected for the purposes of classification attainment evaluation by non-state agencies must be collected and identified by qualified personnel (see above).

A9 – Documentation and Records

The QAPP for this project was written by MDEP staff and will be sent to the appropriate EPA New England QAPP contact for review. The QAPP also will be reviewed by competent MDEP staff appointed by the MDEP QAPP manager. The most up-to-date version of this QAPP will be available through the Biomonitoring Program section leader.

The APP for a task will be written by the respective task manager in the spring (see section A6), and copies will be filed in a dedicated binder stored in the biomonitoring office area. All data collected for the Biomonitoring Program will be handled according to the data management SOP (App. D viii). The laboratory analyzing water chemistry samples (State of Maine Health and Environmental Testing Laboratory, HETL) will retain for a minimum of ten years the raw data for all sample runs and related raw data obtained in the course of quality assurance/quality control (QA/QC) procedures (*e.g.*, results from lab duplicates, blank or spiked samples). HETL will send laboratory reports and QA/QC results to the respective task managers as soon as they are available. Macroinvertebrate and algae samples will be returned to the MDEP after identification and retained at the MDEP indefinitely. Chl *a* and other water and sediment samples usually are destroyed during analysis. Taxonomists will send identification records to the MDEP as soon as they are available; they will retain raw taxonomic data for a minimum of five years. Each task manager will keep originals of all field data sheets, laboratory taxonomic, quality control records, and miscellaneous correspondence and notes related to the respective tasks in the appropriate dedicated storage locations. Electronic copies of these documents, if available, as well as databases developed specifically for the respective tasks will be stored on MDEP computers and backed-up on the MDEP network at the end of each day.

B1 – Sampling Process Design (Experimental Design)

Each APP includes a list of proposed sampling areas or sites for macroinvertebrates, algae, or wetlands which are chosen based on the rotating basin approach (see section A6 for details), and on requests from different programs(App. E). Sampling requests can be based on a variety of factors, for example the desire to extend the state-wide coverage of monitored sites, an effort to determine a potential impairment of a waterbody from point or non-point sources of pollution, or the need to ascertain the effectiveness of remedial actions. If a new area on a river or stream or in a wetland is to be investigated, a specific sampling location (“station”) may not yet have been established when an APP is submitted. In this case, a station is chosen either during a separate reconnaissance trip, if time permits, or on the (first) day of sampling (site selection criteria are discussed below). While the majority of sites to be studied each year are located in the basin designated for investigation during that year, sites located in a different basin can also be sampled if those data are required for a particular purpose.

Task 1. Macroinvertebrate sampling.

The protocol employed in collecting and analyzing macroinvertebrate data is detailed in App. D i. Following is a brief description of these methods.

Selection of a specific station location on a given river or stream involves the following criteria:

a) the area should be representative of the habitat of the stream reach as a whole;
b) where available, a riffle/run section is the habitat of choice;
c) the chosen location should have a high degree of certainty that the samplers will remain fully submerged even if the water level drops significantly;
d) precautions should be taken to avoid atypical influences (bridges, entering culverts, channelized areas such as road crossings, culverts, or obstructions to flow), bank effects, or slackwater areas and eddies.

Sampling of the macroinvertebrate community occurs once at each station proposed in an APP during a 4-week period between July 1 and September 30. At each site, three replicate rock-filled bags/baskets/cones are deployed in the stream or river for 28 ± 4 days in riffle/run habitats. However, extended periods may be necessary to allow for adequate colonization in the case of assessments of low velocity or impounded habitats. If such conditions exist, a 56 ± 4 days exposure period may be used. At the end of the colonization period, the samplers are retrieved and the contents washed into a sieve bucket. Bucket contents are transferred into labeled mason jars and preserved with 95% ethyl alcohol, to yield an approximately 70% solution of alcohol after dilution with sample water. Macroinvertebrate samples are sorted at the MDEP laboratory and identified by freshwater macroinvertebrate taxonomists. Taxonomic data are analyzed using a statistical model which assigns each sample to one of the State of Maine water quality classes, or to a Non-Attainment category (see section A5, Table 1).

In addition to sampling the macroinvertebrate community at each station, staff also collects the following information:

- land use, surrounding terrain, canopy cover, and the physical characteristics of the stream substrate are assessed once during sampler deployment;
- instantaneous dissolved oxygen (DO), specific conductance (SPC or conductivity), temperature, pH, and stream flow velocity are measured twice, during deployment and retrieval of samplers, using field meters owned by the MDEP (detailed information on the meters and their use can be found in App. D ii and iii);
- stream width (bankfull and wetted) and stream depth is measured twice, during deployment and retrieval of samplers, using meter sticks, meter tapes, or range finders.
- to obtain a visual record of sampling sites, digital photographs of the waterbody upstream and downstream of the sampler locations are taken twice, during deployment and retrieval of samplers.
- furthermore, for integration into a GIS (Geographic Information System) database, longitude and latitude of each sampling site are recorded using a GPS (global positioning system) unit.

All information gathered, including the running numbers of the digital photographs and the GPS site code, are recorded in the field on the Maine DEP Biological Monitoring Unit Stream Macroinvertebrate Field Data Sheet (App. B i).

The following water chemistry parameters may be sampled once per station, during sampler retrieval, if deemed appropriate: total Kjeldahl nitrogen (TKN), nitrate-nitrite (NO_2-NO_3-N), ammonia-nitrogen (NH_3-N), total phosphorus (TP), orthophosphate (SRP), dissolved organic carbon (DOC), total suspended solids (TSS) and total dissolved solids (TDS). Detailed information on the sampling and analysis protocols can be found in App. D iv, and x - xiv. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Biological Monitoring Unit Stream Macroinvertebrate Field Data Sheet (App. B i). The chain-of-custody form required by the analytical laboratory is shown in App. C i; this form will be completed upon sample delivery to the laboratory.

At most stations, water temperature is monitored continuously while samplers are deployed using temperature loggers. Detailed information on the loggers and their use can be found in App. D v. If a particular location was sampled for stream algae (see Task 2) before macroinvertebrate samplers were deployed, a temperature logger may already be in place; in this case, the logger is retrieved together with the macroinvertebrate samplers.

Task 2. Stream Algae Sampling.

The MDEP collects several kinds of algal samples, including: (1) viewing bucket surveys; (2) Chl *a* samples from natural and/or artificial substrates; and (3) species composition samples from natural and/or artificial substrates. The algal data are considered primary data. Guidance on where, when, and how to collect algal samples are described in App. D vi. This SOP also describes steps taken to minimize sources of variation, such as decision rules on locating sample stations. The Biologist responsible for Task 2 will decide which algal samples to collect based on in-stream conditions, associated management questions, and resource constraints. The viewing bucket survey provides qualitative assessment of algal biomass, which is time consuming in the field but is inexpensive and does not require lab analysis. The Chl *a* samples provide a quantitative estimate of algal biomass, are relatively inexpensive and require limited lab analysis (App. D vi and xv). The species composition samples provide quantitative biomass estimates, taxa densities, and taxa biovolumes. While this type of sample provides the most information, it also requires the most money and lab analysis. The Chl *a* samples are sent to a qualified lab (*e.g.*, HETL) and the MDEP typically receives data within 1-3 months. The species composition samples are sent to a contracted taxonomist and data are typically returned within 6-9 months.

In addition to sampling the algal community at each station, staff also collects the following secondary data:

- land use, upstream terrain, canopy cover, and the physical characteristics of the stream substrate;
- instantaneous DO, SPC, temperature, pH, and flow velocity are measured at each site visit using field meters owned by the MDEP (detailed information on the meters and their use can be found in App. D ii and iii);

- stream width (bankfull and wetted) and depth are measured at each site visit using meter sticks, meter tapes, or range finders.
- to obtain a visual record of sampling sites, digital photographs of the waterbody upstream and downstream of the sampler locations are taken at least once.
- furthermore, for integration into a GIS database, longitude and latitude of each sampling site are recorded using a GPS unit.

All information gathered, including the running numbers of the digital photos and the GPS site code, are recorded in the field on the Maine DEP Stream Algae Field Data Sheet (App. B ii a) and the Maine DEP Viewing Bucket Survey Data Sheet (App. B ii b).

The following water chemistry parameters may be sampled once per station, if deemed appropriate: TKN, NO_2-NO_3-N, NH_3-N, TP, SRP, DOC, TSS and TDS . Detailed information on the sampling and analysis protocols can be found in App. D iv, x, xi, xiii, xvi, and xx. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Stream Algae Data Sheet (App. B ii a). The chain-of-custody form required by the analytical laboratory is shown in App. C i; this form will be completed upon sample delivery to the laboratory.

Task 3. Wetland Sampling.

The protocol employed in collecting and analyzing macroinvertebrate data is detailed in App. D vii. Following is a brief description of these methods.

Selection of a specific station location within a given wetland involves the following criteria:

a) aquatic macroinvertebrates should be collected in areas having emergent vegetation, or in shallow aquatic macrophyte beds consisting of floating and/or submerged plants. This may include appropriate sampling locations within or adjacent to other habitat types.
b) water depth in all locations sampled should be less than 1 meter.
c) locations selected for all three replicate samples collected at a site should be as similar to each other as possible with regard to water depth, vegetative community structure, and substrate type.

Sampling of the macroinvertebrate community occurs once at each station proposed in an APP during June or July. At each site, three replicate samples are collected using a standard D-frame net by performing a 1-meter sweep. The contents of the net are placed into a sieve bucket, and bucket contents are transferred into labeled mason jars and preserved with 95% ethyl alcohol. Macroinvertebrate samples are sorted at the MDEP laboratory and identified by freshwater taxonomists. Biological metrics are calculated from the taxonomic data for statistical analysis.

Sampling of wetland algal communities occurs at the same time and sampling locations as macroinvertebrates. The MDEP routinely collects two kinds of algae samples for wetlands, namely: (1) epiphytic algae samples from natural substrates (plant stems); and (2) phytoplankton

in water samples. Procedures for collecting wetland algae samples are described in App. D vi). This SOP also describes steps taken to minimize sources of variation, such as decision rules on locating sample locations.

In addition to sampling the macroinvertebrate and algal communities at each station, staff also collect the following information during the site visit:

- land use, human disturbance in the wetland and watershed, terrain, dominant vegetation, and the physical characteristics of the wetland habitat and substrate;
- instantaneous DO, SPC, temperature, and pH using field meters owned by the MDEP (detailed information on the meters and their use can be found in App. D ii);
- water depth using a meter stick.
- to obtain a visual record of sampling sites, digital photographs of the wetland are taken.
- furthermore, for integration into a GIS database, longitude and latitude of each sampling site are recorded using a GPS unit.

All information gathered, including the running numbers of the digital photos and the GPS site code, are recorded in the field on the Maine DEP Wetland Bioassessment Field Data Form and the Human Disturbance Ranking Form for Biological Assessment of Wetlands (App. B iii a and b).

Water samples collected during the site visit may include all or a subset of the following, as deemed appropriate: TKN, NO_2-NO_3-N, TP, Chl *a*, SRP, DOC, chloride, alkalinity (as $CaCO_3$), true color, silica, pH and SPC. Detailed information on the sampling and analysis protocols can be found in App. D iv, x – xiii, and xv - xxvi. All field sampling information regarding the water chemistry parameters will be recorded on the Maine DEP Wetland Bioassessment Field Data Form (App. B iii a). The chain-of-custody form required by the analytical laboratory is shown in App. C i; this form will be completed upon sample delivery to the laboratory.

B2 – Sampling Methods Requirements

The sampling method requirements for tasks 1-3 of this project are shown in Table 3. This table presents information on the parameters, sampling techniques, sample area or volume, sampling preservation and maximum holding time, analysis location, and reference to the respective SOP detailing sampling and analysis procedures. Samplers and other equipment required for sampling biota (*e.g.*, rockbags, sieve buckets, glass vials and jars for macroinvertebrates; periphytometers for periphyton) are provided and maintained by the MDEP biomonitoring section as appropriate. For water quality sampling, labeled containers will be provided by HETL. Where required, all materials used will be prepared as specified in the respective SOPs (App. D). Chemicals required for sample preservation will be provided by the MDEP or HETL.

Cleaning or decontamination procedures for standard sampling equipment or instruments are detailed in the respective SOPs (App. D) and in the Protocols for Decontaminating Biomonitoring Sampling Equipment (App. D ix.). Information on data quality objectives for measurement data is presented in section A7, a and b, above and in Table 2.

B3 – Sample Handling and Custody Requirements

Each task coordinator will be responsible for ensuring correct sample handling by

- ensuring availability of all required sampling supplies in the field (for required supplies see respective SOP in App. D);
- properly labeling all sample containers for biological samples in the field (for labeling details see respective SOP in App. D);
- recording all relevant sampling information on the respective field sheets and chain-of-custody forms (App. B and App. C); and
- handling the transfer of all samples from the field to laboratories for analysis (for sample transfer details see respective SOP in App. D).

B4 – Analytical Methods Requirements

Analytical information, and relevant SOPs for tasks 1-3 are listed in Tables 3 and 4.

B5 – Quality Control Requirements

Acceptable relative percent difference values and accuracy levels for quality control procedures for field and laboratory techniques required for tasks 1-3 are shown in Table 2. The analysis of field duplicates measures precision for the both field sampling and lab analysis, while lab duplicates measure only the precision for the actual analysis. The frequency of lab and field duplicates is shown in Table 3. Field duplicates for parameters measured in the field with meters (*i.e.*, DO, SPC, pH and temperature) will be collected randomly, and recorded on the appropriate field sheet (App. B).

Corrective actions for quality problems attributable to malfunctioning of lab equipment are specified in the respective HETL SOP (App. D x – xxvi). If problems with field duplicates for parameters analyzed in the lab are detected before the end of the field season, every effort will be made to resample that parameter. If quality problems are detected for field duplicates of parameters measured with field meters, the meter concerned will be recalibrated as specified in the respective SOP.

B6 – Instrument/Equipment Testing, Inspection, and Maintenance Requirements
B7 – Instrument Calibration and Frequency

Detailed information on testing, inspection, and maintenance requirements, and on calibration procedures and frequency of all meters, instruments and other equipment used in this study can be found in the respective SOPs (App. D ii, iii, v, and x - xxvi) as referenced in Table 3. An overview of these activities for field instruments is shown in Table 4.

B8 – Inspection/Acceptance Requirements for Supplies and Consumables

Supplies and consumables used in tasks 1-3 will be obtained from the MDEP biomonitoring section, State of Maine facilities (HETL, new containers and washed vials/flasks for collecting water samples), or other respected sources (*e.g.*, VWR Scientific Products, 95% ethyl alcohol for preserving macroinvertebrate samples). Rock bags, periphytometers, and ancillary equipment used for macroinvertebrate and algal sampling is part of the standard equipment used by the biomonitoring section, which ensure that everything is in working order at the beginning of the sampling season. Equipment used repeatedly (*e.g.*, nets, sieve buckets) is checked frequently throughout the sampling season to ascertain its functionality. Each task coordinator will obtain all sampling equipment and supplies used for each sampling event, ensure their quality and suitability for this project, and ensure that high quality equipment and supplies are indeed used to collect data. On each field day, multiples or spares of materials will be brought to minimize the risk of problems.

B9 – Data Acquisition Requirements (Non-direct Measurements)

GIS data required to generate maps will be generated by the Biomonitoring Program or obtained by the MDEP GIS program. Combining multiple layers of land features (hydrography, topography, roads, etc.) with station identification will allow the production of accurate and informational maps of the monitored waterbodies and their watersheds. These maps will not only be used to gather additional information but will also facilitate interpretation of sampling results and help task managers put the data into a broader context. The quality of the map data will be assessed based on the metadata accompanying coverages.

Task managers may obtain physical, biological, or chemical data that have been collected by other parts of MDEP (*e.g.*, Division of Watershed Management) or outside organizations (*e.g.*, Acadia National Park). The task managers are responsible for determining if these data are of sufficient quality and confidence to be used in making management decisions. When making these decisions, task managers should consider the following factors:

- Were the data collected following standard operating procedures?
- Were the data collected and managed following an approved quality assurance project plan?
- Are the data in the right units of measurement? If not, then they must be converted.
- Do the data appear to be reasonable? Are there values that appear to be out of range?

- Are there limitations in the quality of the data based on sampling methods (*e.g.*, measuring pH with high quality meter vs. measuring pH with litmus paper, trained taxonomist identifying organisms vs. amateur taxonomist)?

B10 – Data Management

All data collected for the Biomonitoring Program will be handled according to the data management SOP (App. D viii).

C1 – Assessments and Response Actions

The task managers for tasks 1-3 are responsible for ensuring that all QA/QC procedures described above are adhered to in their respective task. The presence of a task manager or other experienced field staff at all sampling events ensures procedural consistency throughout the field season. Methods used to assess the correct working order of electronic meters used in the field are given in the SOPs for individual instruments as referenced in Table 3. Similarly, methods used to asses the correct working order of lab equipment are given in the HETL SOPs for individual analyses (App. D x – xxvi). Actions taken to ensure data quality are described in section B10, Data Management, above. Each task manager is required to record any problems encountered during data collection, sample processing, or data analysis, and to take remedial action where required. Such action may include resampling a parameter, replacing/repairing equipment, qualifying data, or eliminating data from further consideration.

As mentioned in section A5, the MDEP Biomonitoring Program has developed a statistical model that determines whether a station sampled under Task 1 (Stream Macroinvertebrate Sampling) attains its assigned water quality class. The model used for analyzing macroinvertebrate data indicates the association of a sample to each of three water quality classes (Class A, Class B, Class C), or to a Non-attainment (NA) category. A sample is initially deemed to have achieved the class or category that has an association value of >0.6 as calculated by the model. Model results are reviewed by a Department biologist trained and experienced in the interpretation of macroinvertebrate data to ensure that the model results adequately classify the sampled community. Where there is documented evidence of conditions that could result in uncharacteristic findings, allowances may be made to account for those situations by adjusting classification attainment decision through use of professional judgement. The department may make adjustments to the classification decision based on analytical, biological, and habitat information, or may require additional monitoring of affected waters be conducted prior to issuing a classification decision. Guidelines for the application of Professional Judgement are detailed in App. D i, and in “Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams” (06-096 CMR 579).

Tasks 2 and 3, Stream Algae Sampling and Wetland Sampling, are still in the early stages of developing numeric biocriteria and statistical models to analyze and interpret their respective data. As a result, data analysis and interpretation, as well as decisions regarding response

actions, are largely based on best professional judgment by biologists experienced in these systems. Currently, results from algae or wetland samples are not used for management decisions, although the MDEP's goal is to develop these tasks to such an extent that they could be used in a regulatory context in conjunction with Task 1.

C2 – Reports to Management

Biomonitoring Program staff discuss quality assurance issues at regularly scheduled section meetings, or as the need arises, and at meetings and conference calls as needed with laboratory personnel, taxonomic contractors and data management and computer support staff. Problems identified are promptly reported to task managers, who are responsible for determining appropriate corrective actions. Quality assurance procedures and results are also addressed in reports required for various federal grants (Sections 106 and 104(b)(3)), special State initiatives such as the Maine Surface Water Ambient Toxics Monitoring Program (annual report required) and the biannual Maine Water Quality Assessment Report.

D1 – Data Review, Validation, and Verification Requirements

It will be the primary responsibility of each task manager to review and, as far as possible, validate and verify all data collected by the Biomonitoring Program upon collection or upon receipt from a contractor or taxonomist to determine if the data meet QAPP objectives (Table 2). The decision whether to accept, reject, or qualify data will rest primarily with each task manager.

D2 –Validation and Verification Methods

Each appropriate task manager will be responsible for data validation and verification for Tasks 1–3. Data recorded in the field will initially be validated by the person in charge as detailed in the Data Management SOP (App. D viii). Data will be further validated during entry into the biomonitoring streams, algae and wetlands database as noted in the Data Management SOP (App. D viii). This task requires a reconciliation of data recorded on field sheets with those entered into the database, a critical review of spreadsheet print-outs, graphs and tables produced from the database, and the identification of any potential data gaps. A subset (~10 %) of the data entered will be reviewed by MDEP staff to further ensure data quality. Each task manager will perform an analysis of the quality control data collected for their task; which will include a review of the chain-of-custody information and all information available from equipment log books as well as a comparison of the results from quality control samples with those from regular samples. Any errors detected will be rectified by either editing incorrect entries, resampling (where possible), or excluding questionable data.

Data collected by an outside source (consultants, corporations, businesses, organizations or individuals) must be consistent with the MDEP's standard sampling and identification methods and personnel must fulfill the qualifications outlined in section A8 above.

D3 – Reconciliation with Data Quality Objectives

Each appropriate task manager will be responsible for the reconciliation of all data collected for their task with original data quality objectives as detailed in section A7, above. All data collected by the Biomonitoring Program will be reviewed on an ongoing basis for precision, accuracy, and completeness, and corrective action will be implemented if needed. If data quality indicators do not meet the specifications, data may be discarded and resampling may occur as specified in sections B5 and C1.

References

American Public Health Association (APHA), American Water Works Association, Water Environment Federation. 1995. *Standard Methods for the Examination of Water and Wastewater*. 19th edition. Eds. Eaton, A.D., L.S. Clesceri, and A.E. Greenberg. APHA, Washington, D.C.

Davies, S.P., L. Tsomides, J.L. DiFranco, and D.L. Courtemanch. 1999. *Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams.* Maine Department of Environmental Protection, Augusta, ME; DEP LW1999-26. 190 pp.

Maine Department of Environmental Protection. 2003. *Chapter579: Classification Attainment Evaluation Using Biological Criteria for Rivers and Streams.*. Maine Department of Environmental Protection, Augusta, ME; 06-096 CMR 579.

United States Environmental Protection Agency. 1983. *Methods for chemical analysis of water and wastes.* Office of Research and Development, Washington, D.C.; EPA/600/4-79/020.

United States Environmental Protection Agency. 2002. *Summary of Biological Assessment Programs and Biocriteria Development for States, Tribes, Territories, and Interstate Commissions: Streams and Wadeable Rivers.* Office of Environmental Information & Office of Water, Washington, D.C.; EPA-822-R-02-048.

Wehr, J.D. and R.G. Sheath. 2003. Freshwater Algae of North America: Ecology and Classification. Academic Press, Boston, MA, 918pp.

Addendum - List of edits to existing QAPP

QAPP section	Old text	New text
Edited in January 2008		
A4 – Project/Task Organization	Susan Davies is responsible for the overall quality assurance of the Biological Monitoring Program. Leon Tsomides is the River & Stream Subsection Leader and is responsible for the stream macroinvertebrate APP.	Leon Tsomides is responsible for the overall quality assurance of the Biological Monitoring Program as well as the stream macroinvertebrate Annual Project Plan.(APP).
A5 – Problem Identification/ Background, Table 1 Class B and C Bacteria (*E. coli*) Numeric Criteria	64/100 ml (g.m.*) or 427/100 ml (inst.*) and 142/100 ml (g.m.*) or 949/100 ml (inst.*)	64/100 ml (g.m.*) or 236/100 ml (inst.*) of human and domestic animal origin and 126/100 ml (g.m.*) or 236/100 ml (inst.*) of human and domestic animal origin
A5 – Problem Identification/ Background	The Biomonitoring Program uses the BioME model, …	The Biomonitoring Program uses a statistical model, … **Note that all subsequent reference to BioME have been removed from the QAPP.**
B1 – Sampling Process Design (Experimental Design), Task 1. Macroinvertebrate sampling	instantaneous dissolved oxygen (DO), specific conductance (SPC or conductivity), total dissolved solids (TDS), temperature, pH, and stream flow velocity are measured twice, …	instantaneous dissolved oxygen (DO), specific conductance (SPC or conductivity), temperature, pH, and stream flow velocity are measured twice, … **Note that all subsequent reference to (measurement of) TDS have been removed from the QAPP.**
B1 – Sampling Process Design (Experimental Design), Task 1. Macroinvertebrate sampling	At most stations, water temperature is monitored continuously while samplers are deployed using Optic Stowaway temperature loggers.	At most stations, water temperature is monitored continuously while samplers are deployed using temperature loggers.

List of Acronyms

APP	Annual Project Plan
Chl *a*	Chlorophyll *a*
CPR	Cardiopulmonary Resuscitation
DEA	Division of Environmental Protection
DO	Dissolved Oxygen
DOC	Dissolved Organic Carbon
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
GPS	Global Positioning System
HETL	State of Maine Health and Environmental Testing Laboratory
MDEP	Maine Department of Environmental Protection
NEBAWWG	New England Biological Assessment of Wetlands Work Group
NH_3	Ammonia
NO_2-NO_3-N	Nitrate-Nitrite
Ortho-P	Ortho-Phosphorus
SOP	Standard Operating Procedures
SPC	Specific Conductance
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
USGS	United States Geologic Survey
USEPA	United States Environmental Protection Agency
WCP	Water Classification Program
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control