AquaQAPP

User Guide

Produced by the Massachusetts Bays National Estuary Partnership
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1. Introduction to AquaQAPP

A. Purpose of AquaQAPP

AquaQAPP is a web-based application that generates tailored Quality Assurance Project Plans (QAPP) for marine and freshwater water quality and benthic monitoring efforts in the Commonwealth of Massachusetts and is intended to assist volunteer monitoring programs in collecting quality-assured data. AquaQAPP was created by the Massachusetts Bays National Estuary Partnership (MassBays) in collaboration with Massachusetts Department of Environmental Protection (MassDEP) and the United States Environmental Protection Agency (EPA).

What is a QAPP?

"[A] QAPP is a document that explains how organizations ensure, using quality assurance and quality control activities, that the data they collect can be used for its intended purpose. By writing and applying a QAPP, an organization builds data quality procedures into the project from the beginning and will be more confident that the data will meet the specific needs of the project. Importantly, the individuals interested in the project, or the agencies that make decisions based on the data and information from the project, will have a better understanding of the quality of the underlying data."

U.S. EPA's *Handbook for Citizen Science Quality Assurance and Documentation*

Use of AquaQAPP is not required. However, by using AquaQAPP to document and plan for collection of quality assured data, a monitoring program's QAPP is considered pre-approved by MassDEP and should be acceptable to EPA, and therefore agency review is not required prior to sampling. This pre-approval is valid so long as samples are collected and analyzed in strict accordance with the QAPP generated by the application which has not been significantly altered from the original output. "Not significantly altered" means that the user has not made or will not make changes to collection protocols, analytical methods, or other substantive content included in the generated QAPP. Changes such as addition of project roles and responsibilities, or additional detail regarding data quality indicators, for example, are not considered significant alterations.

Where new or revised methods, additional parameters, or other substantial changes are included beyond the content generated by AquaQAPP, and a stated objective of the monitoring effort is to submit the resulting data to MassDEP, MassDEP requires QAPP review prior to implementation. The modified QAPP can be submitted to:

Suzanne Flint (Suzanne.Flint@mass.gov)
Bureau of Water Resources, Watershed Planning Program
Massachusetts Department of Environmental Protection
8 New Bond Street, Worcester, MA 01606

A note to EPA and MassDEP grantees

Projects funded by DEP and/or EPA require QAPP review prior to sampling. Monitoring programs funded by EPA or DEP must follow agency requirements for quality assurance, and a QAPP generated with AquaQAPP may or may not meet those requirements. QAPPs for monitoring programs to support or influence discharge permits or TMDLs will also require additional review. Please check with the funding agency for guidance in these cases.

B. How Does AquaQAPP Work?

AquaQAPP functions like a wizard that employs user-provided content to generate a custom QAPP. As users proceed through the AquaQAPP screens, they will see prompts for the following information:

- Details about the citizen science organization and relevant personnel.
- Project information and background.
- Water quality concerns motivating the project.
- Data quality objectives.
- Project schedule.
- Monitoring locations.
- Parameters to be measured and analytical methods used to quantify them.
- Information about record handling procedures.
- Plans for data management.

Once all screens are completed, AquaQAPP will generate a QAPP that is output as a Microsoft Word document, in a format aligned with EPA standards. (See Attachment 4 for a crosswalk between AquaQAPP screens and the sections in the final QAPP.) The QAPP will be nearly complete with the exception of a few tables that require user input outside the application, and required attachments (see Section 4.O, "Record Handling Procedures"). The generated QAPP will also include 1) a cover sheet and checklist of items to edit prior to finalizing the document, with hyperlinks to those sections, and 2) a list of forms required as attachments to your final QAPP.

Users are welcome to further edit the generated QAPP as desired. However, where new or revised methods, additional parameters, or other substantial changes are included beyond the content generated by AquaQAPP, and a stated objective of the monitoring effort is to submit the resulting data to MassDEP, MassDEP requires QAPP review prior to implementation. Notes in this Guide indicate when changes to the generated QAPP could be considered "substantial."

C. Who Should Use AquaQAPP?

AquaQAPP was developed to be used by organizations that plan to share their data with others, whether via a website or government portals, groups that have not received governmental funding, and those that are interested in generating a robust QAPP for their own purposes. Anyone in the organization who has access to all the required information (see Section 2 of this user guide) can use AquaQAPP to generate a QAPP that incorporates all components required by EPA and MassDEP, including recommended sample collection and analysis protocols.

D. What Types of Projects Does AquaQAPP Support?

AquaQAPP is intended for citizen science groups in Massachusetts conducting water quality monitoring projects in freshwater, marine, and estuarine habitats. AquaQAPP provides support for the following:

- Basic water quality monitoring parameters for rivers and streams.
- Basic water quality monitoring parameters for marine and estuarine waters.
- Benthic monitoring and habitat assessment for wadeable rivers and streams.
- Benthic monitoring and characterization in marine or estuarine waters.

Within these media types, AquaQAPP is flexible, to accommodate different types of projects. They can be short- or long-term. They can involve a small group of volunteers who monitor weekly or a large number who conduct sampling only during certain seasons. Monitoring locations can be widely dispersed or constrained to a single waterbody. The questions included in AquaQAPP will capture these conditions and generate a QAPP that reflects your group's monitoring program and objectives for using the data.

Benthic sampling in lakes & ponds

AquaQAPP includes protocols for benthic sampling in wadeable streams and near-shore coastal environments. The application does not include protocols for benthic sampling in lakes, ponds, or reservoirs. Monitoring in those systems is complex and will require site-specific accommodations that cannot be captured in AquaQAPP. For guidelines on designing benthic sampling plans in larger ponds and lakes, see DEP protocol CN 476.0, available on the AquaQAPP webpage (https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project).

While AquaQAPP includes content for parameters commonly measured as part of water quality or benthic monitoring programs, your group may be interested in collecting data associated with additional concerns such as wetlands assessments, invasive species, and toxins (e.g., heavy metals, pesticides, PCBs, and PAHs). Although AquaQAPP does not currently support these types of monitoring projects, you can still use the application to create the majority of the program QAPP. Additional sections can be incorporated into to the generated QAPP and, as described previously, the final QAPP would be submitted to MassDEP for approval before beginning work on the project.

E. Why Write a QAPP?

Community groups have long been concerned about their local environment. In some cases, neighbors have come together to examine a common problem – algae in a pond, unpleasant smells in a river – and take water samples, hoping to identify both the source of the problem and possible solutions.

A robust QAPP meets multiple needs

- Sampling efforts are well-organized and meet their objectives.
- Monitoring protocols and data analysis are consistent over time.
- Decisionmakers and other data users gain confidence in data generated.

Often solutions require action on the part of decisionmakers at the local, state, or federal level. Government action, however, requires not only the results of monitoring, but information about how the monitoring was carried out. Were the sampling locations properly selected? Were volunteers trained in standard protocols? How do we know that measurements were taken with reliable instruments? These types of questions are answered in a QAPP, providing potential data users with a level of confidence in the data collected under the plan.

The process of writing a QAPP prompts the organization to reflect on the purpose and structure of its monitoring program. As you prepare to use AquaQAPP, your team will consider fundamental elements of the monitoring program and identify gaps in knowledge about the water body and its larger ecosystem. As you enter information into the application and work through the questions that lead to a completed QAPP, you will be asked to synthesize and work toward meeting the project's overall objectives, and identify issues that need to be addressed before the plan can be implemented.

Finally, the completed QAPP will serve as an important resource for all individuals involved in the monitoring program. Program staff can track specific roles and responsibilities. Volunteers conducting sampling can reference the sampling protocols to ensure that all details are consistently applied. A QAPP ensures that a long-term monitoring program is conducted in the same way over time, even when staffing changes or volunteers come and go.

Know your goals

Before you embark on preparing a QAPP, consider how you'd like your data to be used, which in turn will inform your *data quality objectives,* or DQOs. If your program is focused on the process of sampling rather than the resulting data – for example, it is an activity designed for educational or community engagement purposes only – MassBays recommends that you take a more qualitative approach to evaluating your results. In fact, you may not want to undertake a full-fledged QAPP at all. We suggest use of AquaQAPP for monitoring efforts designed for scientific investigations or to inform policy action (which require more rigor around data evaluation).

For more discussion of qualitative versus quantitative data assessments, go to page 6 of EPA's Handbook for Citizen Science (available online at: https://www.epa.gov/sites/production/files/2019-03/documents/508_csqapphandbook_3_5_19_mmedits.pdf).

F. Useful Resources

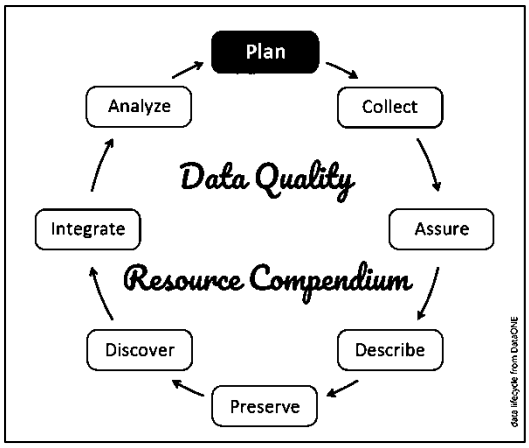
EPA produced a set of guidance manuals in 2019 to guide development of citizen science projects focused on increasing public understanding, conducting scientific studies and research, and advancing legal and policy action:

- *Handbook for Citizen Science Quality Assurance and Documentation:* This handbook includes a detailed introduction to QAPPs and the types of quality assurance that are relevant for citizen science programs. It explains each section of the corresponding template (see below), including guidance on completing each section of a QAPP and topics to consider (https://www.epa.gov/sites/production/files/2019-03/documents/508_csqapphandbook_3_5_19_mmedits.pdf).
- *Examples for Citizen Science Quality Assurance and Documentation:* This document provides completed examples of each section of a QAPP. Each section is modeled on a different concern that could motivate a citizen science program. For example, the example text in one section is based on a program monitoring marine invasive species. Another section offers examples of a water quality monitoring project and a collaborative program monitoring cyanobacteria (https://www.epa.gov/sites/production/files/2019-03/documents/508_csqappexamples3_5_19_mmedits.pdf).
- *Templates for Citizen Science Quality Assurance and Documentation* (PDF version and editable templates): This template is an outline of a QAPP that can be completed by citizen science groups. It includes questions and suggestions to prompt users to provide the appropriate information for each section of the QAPP. (pdf: https://www.epa.gov/sites/production/files/2019-03/documents/508_csqapptemplates3_5_19_mmedits.pdf; Word doc: https://www.epa.gov/sites/production/files/2019-03/templates.docx)

Other helpful EPA resources include:

- *Quality Assurance Project Plan Development Tool.* This is a set of six modules developed to help tribal communities plan surface or groundwater monitoring programs (https://www.epa.gov/quality/quality-assurance-project-plan-development-tool).
- EPA Quality Management Tools for Projects. A webpage (https://www.epa.gov/quality/epa-quality-management-tools-projects) containing a range of supporting documentation for planning, implementing, and reviewing monitoring programs. EPA Region 1 has a similar compendium specific to the New England region (https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-1).

Finally, the Citizen Science Association has compiled a Data Quality Resource Compendium of resources produced to support field-based citizen science efforts. Resources are categorized according to the phase of the data management cycle. https://www.citizenscience.org/get-involved/working-groups/data-and-metadata-working-group/resources/



2. From an Idea to a Completed QAPP

AquaQAPP is designed for users to develop QAPPs over several sessions, beginning with sections that help guide the monitoring project design – both sampling site and parameter selection. Having the following information in hand will help you generate a QAPP more quickly:

Organization-specific information:

- Contact information for the following personnel in the organization conducting the monitoring project: Project Manager, QA Manager, Field Coordinator, and Data Manager.
- Contact information for the individual who will serve as the primary contact for the project.

To design the sampling plan:

- The environmental concern(s) that prompted your project.
- The project objectives, and how you expect the resulting data to be used.
- Background on the water quality issue to be investigated by the monitoring program and previous efforts to address and/or study it.
- The water type at all monitoring stations (freshwater, estuarine/brackish, or marine).
- A list of parameters you plan to measure. (AquaQAPP will suggest parameters as you navigate the application.)

Once a sampling plan is determined:

- Geographical information for each field site (either latitude and longitude or the ability to identify sites on a map).
- Instruments or equipment on hand that will be used to measure *in situ* parameters (e.g., pH, temperature, and salinity).
- Laboratory name(s), and information from the lab(s) regarding analytical methods that will be used for samples sent to the laboratory (e.g., bacteria concentration, sediment grain size, or chlorophyll *a* analysis).

To finalize the QAPP package:

- Generated QAPP.
- Edited field operations manual (an editable version corresponding to the parameters included in AquaQAPP are available on the MassBays webpage at https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project).
- Laboratory SOPs provided by the selected laboratory(ies).
- Sampling forms and labels (If you do not have your own, MassBays has provided editable templates at https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project).
- Project area map with sampling sites indicated (a screen capture from AquaQAPP or other).

3. Quick Start Guide

A. Access AquaQAPP

Access AquaQAPP at the following website: https://aquaqapp.com.

The application is compatible with Google Chrome, Internet Explorer 11 and above, Microsoft Edge, Mozilla Firefox, and Safari. For optimal performance, use the most recent versions of these browsers and avoid using Internet Explorer. AquaQAPP is best viewed using a laptop or desktop computer, or a large tablet. While AquaQAPP can be viewed on a smartphone, you may find it challenging to navigate the app and complete data entry.

B. Create an Account

1. Register for an account

Click on 'Register' at the top right corner of the landing page and complete the registration screen to create an account. An email address will serve as your username. Note that passwords must be at least eight characters in length and contain one numeral, one lower-case letter, and one upper-case letter.

AquaQAPP does not currently support multiple users accessing the same QAPP. If multiple people from a single organization wish to collaborate on a QAPP, they should enter the same email and password.

2. Forgotten Password

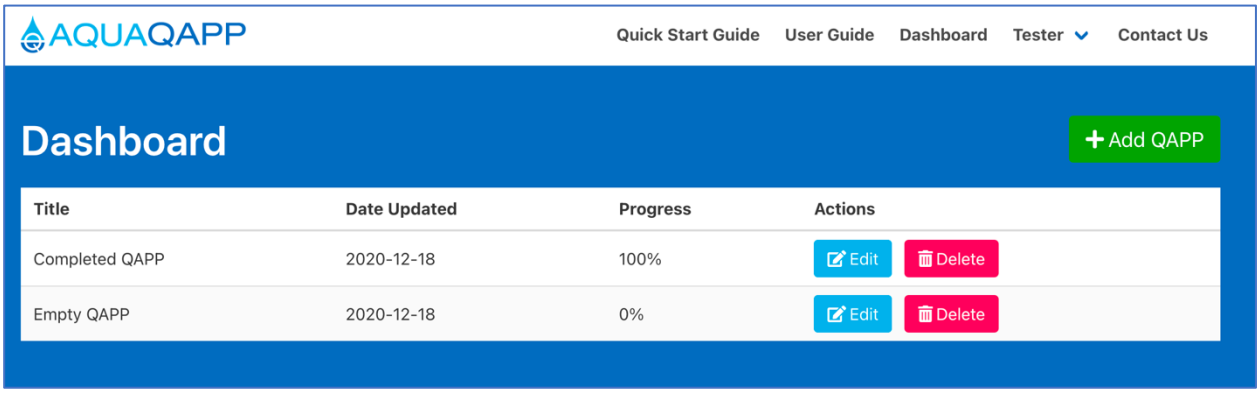
If you have already registered but forgotten your password, click 'Forgot Password?' to access the password recovery page.

C. Navigating AquaQAPP

Use the following features to navigate around AquaQAPP.

1. Dashboard

The Dashboard is where you can create, edit, and see a list of your QAPPs. The Dashboard screen appears immediately after registering or logging in to AquaQAPP and can be revisited at any time by clicking 'Dashboard' in the top navigation bar.



Click the green '+Add QAPP' button to enter the title of a new QAPP. This title will be used to identify your QAPP within the application. The title will not appear in the generated QAPP. Each user can create multiple QAPPs. The Dashboard displays the title, date updated, and progress of each QAPP. Click 'Edit' to start or continue working on a QAPP and 'Delete' to delete a QAPP.

2. Navigation Pane

While in the editing stage of the QAPP, you will see a column on the left-hand side of the screen displaying the title of each section of AquaQAPP. Click on the titles to move between sections. Once you mark a section as complete, a green checkmark will appear next to the section title.

3. Save and Complete Sections

As you add information to each AquaQAPP screen, a blue 'Save" button will be visible in the upper-right corner. Click on this button to save your entries before moving to another screen (the button will now read 'Saved'). Note that partially completed pop-up windows *cannot* be saved before they are fully complete. Pop-up windows require that you respond to all data fields before the information can be saved by clicking the green 'Save' button at the bottom of the pop-up window.

When you are finished entering all data on a given screen, click the toggle button at the top of the screen and to the right of 'Mark as Complete' to indicate that the screen has been completed. If you did not save your work before clicking this bar, AquaQAPP will automatically save the screen when you click 'Mark as Complete.' A green checkmark will then appear next to the name of the screen in the navigation pane.

You may move back and forth among screens as you consider your sampling plan, adding sampling locations, changing parameters, and refining the Project Description even after you have marked a screen as complete, but you will not be able to generate a QAPP until all are marked as complete.

4. Data Entry Formats

AquaQAPP uses different types of data entry formats:

- **Free text entry boxes** (single line): Enter freeform text into the box. This type of field can only support short entries, such as a sentence or phrase.
- **Free text entry boxes** (large): Enter freeform text into the box. This type of field can accommodate longer text entries, including multiple paragraphs of text.
- **Tables and pop-up windows**: Click the corresponding buttons to populate the tables. Complete the pop-up window that appears to fill out one row of the table. Pop-up windows may include free text entry fields, drop-down menus, and/or check boxes. All fields must be completed before information in the pop-up window can be saved.
- **Check boxes**: Click the boxes corresponding to your selection.
- **Map**: Use the 'Add Location' button and click on a map location to identify your sampling site. Complete the pop-up window. See "Monitoring Locations" in Section 4 for more information.

D. Generating a QAPP

After entering all requested information and marking all screens in the navigation pane as complete, you can generate a QAPP for review. Click the green 'Generate QAPP' button at the right of the dark-blue navigation bar. Depending on the extent of your sampling program, it may take a few minutes to generate the QAPP. The generated QAPP will include several cover pages that detail the last hands-on steps to be taken before the plan will be final and ready for signatures.

A peek behind the curtain

While AquaQAPP generates a QAPP that follows the standard EPA format, the sequence in which you'll provide information has been altered to make the process more intuitive. Attachment 4 provides a crosswalk between the EPA QAPP Table of Contents and the AquaQAPP screens. This chart, the Field Operations Manual/Standard Operating Procedures available on MassBays' website (https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project), and this User Guide will provide the background and detail needed to develop and implement your sampling plan and QAPP.

4. AquaQAPP, Screen by Screen

A. Getting Started

This screen provides a summary of Sections 1 through 3 of this User Guide. This screen must be marked as complete before AquaQAPP will generate a QAPP.

B. General Information

Enter the title that will appear on the generated QAPP.

C. Prepared By

Enter the name and organizational affiliation of the individual preparing the QAPP.

D. Project Organization/Personnel

Enter details about the individuals involved with the monitoring project. This may include employees of the organization overseeing the monitoring effort and volunteer citizen scientists conducting the sampling. It should also include the Laboratory Manager(s) if relevant to your project. Click on the green Add button and enter details about each individual in the pop-up window.

The distribution list should include anyone associated with the project. The approval list should include your QA Manager, Project Manager, Data Manager, and Field Coordinator. Only one person can be designated as the primary contact.

An individual may have more than one role. You may write in additional roles in the text box provided, for example “volunteer coordinator” or “outreach coordinator;” be sure to click “Add this as a new role” in the blue band that appears below your entry. If you add new roles, you will be prompted to provide detail about associated responsibilities at the very bottom of the same pop-up window.

There are four designated project roles that must be assigned to individuals. Each role is associated with responsibilities that will appear in the generated QAPP as summarized in Table 1.

Qualities of a Quality Assurance Manager

The Quality Assurance Manager for your project must not participate in the data collection aspects of the project to guard against any bias. If the project team is small, you might consider recruiting a Board member or other person independent of the data collection to serve in this role.

Table 1. Roles and responsibilities assigned by default by AquaQAPP

Role	Responsibilities
Project Manager (PM)	Manager overall project implementation. Obtain appropriate permits for sampling. Obtain and maintain field supplies, delegating as noted. Receive and archive completed sample Chain of Custody forms. Review and accept laboratory reports. Receive notification of required corrective actions by the laboratory. (Or QAM) Generate and/or review all corrective actions required. (With QAM) Approve and ensure implementation of corrective actions. Conduct assessment activities to ensure implementation of the QAPP. Review field records. Receive QA reports from QAM. (Or QAM) Evaluate attainment of data quality objectives, determine limitations to be placed on data use, or whether a revision of the data quality objectives is allowable. Assess and calculate percent completeness of data versus project goals. Prepare final project report for distribution to QAPP distribution list.
Laboratory Manager (LM)	Provide laboratory QAPP and SOPs for attachment to the QAPP. Communicate with QAM regarding laboratory corrective actions. Deliver corrective action files and data reports to the PM.
Quality Assurance Manager (QAM)	Report QAPP implementation problems to PM. Conduct audits of lab data for completeness and proper documentation. (Or PM) Generate and/or review all corrective actions required. (With PM) Approve and ensure implementation of corrective actions. At the close of the project, produce a report detailing how the resulting dataset compares with the program's data quality objectives. (Or PM) Evaluate attainment of data quality objectives, determine limitations to be placed on data use, or whether a revision of the data quality objectives is allowable. Calculate Data Quality Indicators for comparison to Data Quality Objectives (see Attachment 2 to this Guide) Compare results to historical data and check for "reasonableness."
Field Coordinator (FC)	Organize and conduct appropriate training for all volunteers. Maintain and record training data in the project database. Hold copies of all sampling permits. Ensure correct sample handling. Verify alignment of information recorded on sample labels, Survey Log, Field Data Forms, and Chain of Custody Forms. Complete Chain of Custody Forms. Generate proposed corrective actions (including replacing missing samples) for review and approval by PM/QAM. Provide field records, including Chain of Custody Forms, to PM.
Data Manager	Conduct regular review of field data. Review laboratory data. Submit data via EPA's Water Quality eXchange.

E. Water Quality Concerns

If you are developing your project from scratch, AquaQAPP can help develop a sampling plan based on your water quality concerns. On this screen, to select the concern(s) that prompted your monitoring program. When you hover over a box with your cursor, a description will show (also refer to the descriptions below). Click on the check boxes in the corner of each concern box to select as many concerns as applicable. Parameters associated with those concerns will be highlighted on the Parameters screen (Section 4.K).

AquaQAPP assumes that the same parameters and methods will be measured at all locations with the same concern. However, your concerns may vary by monitoring location. The Parameters by Location screen (Section 4.L) allows you to make adjustments according to your sampling plan.

The water quality concerns in AquaQAPP are generally defined as follows:

- **General Environmental Health: Physical/Chemical Water Quality.** You're concerned about the overall condition of your local water body relative to MassDEP standards. Your monitoring program will include routine water quality sampling that quantifies basic characteristics.
- **General Environmental Health: Benthic.** You're wondering about the general conditions in the bottom substrate of your water body. Your monitoring program will include sampling that focuses on properties of the sediment and/or the organisms that live in or on it.
- **Eutrophication (Nutrients) and Harmful Algal Blooms (Algal toxins).** If you are concerned about algae growth (either existing or emerging), your sampling plan should focus on quantifying signs of algal growth (e.g., chlorophyll a), known causes of harmful blooms (i.e., nutrients), and potential effects on those who come in contact with the water (i.e., algal toxins).
- **Point source discharges – illicit connections or Combined Sewer Overflows (CSOs).** Untreated wastewater can enter water bodies through combined sewer-stormwater systems, or when sewer pipes are connected directly to stormwater infrastructure. If you're concerned about this type of pollution, your sampling plan should monitor for wastewater discharges to the waterway.
- **Recreational uses (swimming, boating, and fishing).** Many groups begin monitoring programs to determine whether water quality meets MassDEP standards for recreation – swimming, boating, and fishing. In this case, your sampling program should quantify pollutants that threaten human health via direct contact or ingestion via fish.
- **Nonpoint source discharges – stormwater runoff.** You're concerned that overland flow of stormwater from impervious surfaces or agricultural land, or stormwater discharges from pipes directly into your local water body are impacting water quality. In this case, your sampling plan will focus on assessing the effects of stormwater runoff, especially from impervious surfaces.
- **Other.** Any water quality concern not captured in the above descriptions (see box on next page).

Required selection of co-dependent concerns

If 'General Environmental Health: Benthic' is selected, AquaQAPP will automatically include 'General Environmental Health: Physical/Chemical Water Quality.' MassDEP requires this combination to ensure a comprehensive suite of parameters is included to address concerns regarding the benthos.

"Other" concerns

AquaQAPP was designed to include common water quality concerns and parameters, yet also provides a means to incorporate additional water quality concerns and parameters (e.g., toxins, microplastics, or contaminants of emerging concern). If you select "other" as a concern on the Water Quality Concerns screen, you must address it in the Project Background and other sections of the QAPP as described in Section 5, "Generating and Finalizing Your QAPP." You must also insert "other" parameters and their SOPs into the final generated QAPP (see Section 4.K, "Parameters"). Given that these changes to the generated QAPP are considered substantial, the final QAPP will not be considered pre-approved by MassDEP or suitable by EPA Region 1 (see Section 1.B, "How Does AquaQAPP Work?").

If your project includes habitat assessment other than benthic infauna (e.g., for invasive species or eelgrass), your final QAPP will likely require an additional Section B dedicated to that parameter that includes the components listed in Attachment 4.

F. Problem Definition

Describe the environmental problem or challenge to be explored by the monitoring program. This section of your QAPP should answer the question, "why do we care?" and provide context for the project purpose, the use of the data, and the project objectives. Focus on the question or threat to be addressed by the project; you will have a chance to provide background on subsequent screens.

G. Project Background

Use the free text boxes to describe the history of the project or environmental problem and relevant previous studies. This information will provide background about the monitoring project, so requires a description of the conditions that are believed to have contributed to the present challenge. Examples are provided for each text box; AquaQAPP requires narrative regarding:

- Historical information about the area, especially as it may factor into the observed problem.
- Previous scientific efforts to investigate the problem, including relevant findings.
- Data gaps that will be addressed by the planned project.
- Why your group in particular is undertaking this project.

H. Project Description

Use the text boxes to describe the monitoring program and the type of data that will be collected to investigate the environmental problem. This text will provide a narrative description of the monitoring program in the generated QAPP in the context of the site and environmental problem. Because AquaQAPP will help you evaluate which parameters and methods will help to design your sampling plan, you may decide to come back to this screen after working through the Parameters screen (Section 4.K). This section includes:

- **Objectives**. Do you wish to increase public understanding of a problem, or inform education? Are you conducting a study to inform local action or answer a scientific research question? Do you

expect your results to influence legal or regulatory decisions? What action levels or standards[1] will be used to assess your monitoring results, and what action is expected once the results are compared to those metrics? One way to answer this is using "If/then" statements, such as "If the result for parameter x is above MassDEP's regulatory standard, then we will…"

- **Study area.** What is the extent of the study area or project site? How are the number and distribution of sampling locations related to the water quality concern and project objectives?
- **Time period.** Are your water quality concern or project objectives related to a particular season or time of year? How is your sampling frequency related to the project objectives?
- **Parameters.** How are the selected parameters related to your water quality concern and project objectives? If any parameters will be measured by a laboratory, provide the name and certification number of the testing laboratory(ies). Attachment 3 includes guidance on how to select a laboratory.
- **Data users.** Who will use the data, and for what purpose? What are your plans for sharing your findings with others?

I. Project Schedule

Populate the table on this screen to show the timing of discrete activities associated with the monitoring project over the course of a year. The Master QAPP and Field Operations Manual will help you think through the process of conducting the monitoring program. In the table, include activities that happen before, during, and after sampling, such as:

- Training volunteers, ordering supplies, and identifying sampling sites.
- Conducting monitoring, uploading data, and performing QC.
- Writing reports and summaries for funding agencies and state environmental agencies. In a typical seasonal sampling project, all sampling activities will occur during the same months each

Activity	J	F	M	A	M	J	J	A	S	O	N	D	Actions
Y1: Kick-off meeting	X												Edit Delete
Y1-3: Volunteer training		X	X										Edit Delete
Y1-3: Materials and equipment inventory		X									X		Edit Delete
Y3: Final project report												X	Edit Delete
Y1: Site reconaissance			X	X									Edit Delete

Add Delete All

[1] MassDEP Surface Water Quality Standards are available online. The standards for most coastal waters are designated to govern shellfishing (Class SA); inland fresh water segments are categorized as Class A, B, or C according to their presumed highest use. See 314 CMR 4.0, https://www.mass.gov/doc/314-cmr-400-surface-water-quality-standards/download

year. The Activity column can be labeled to indicate differences by year, as illustrated above. If the project is ongoing or includes multiple years, volunteer training and/or refresher trainings should take place each year.

J. Monitoring Locations

This screen provides two options for users to indicate their monitoring locations. For detailed guidance on selecting and naming monitoring locations, see Attachment 1.

To add a location using the 'Map' tab, click 'Add Location', and then zoom into your location using the '+/-' buttons on the map, or scrolling with your mouse. Move the map by clicking and dragging. When you've identified a location, click once on the map. To add a location using the 'List' tab, click the green 'Add' button below the table.

A pop-up window will appear once a location has been successfully added using the 'Map' or 'List' tab. Future versions of AquaQAPP will support upload of existing monitoring location spreadsheets or directories; for the present the following must be provided for each location:

- **Location ID,** an alphanumeric label for the monitoring location.
- **Location Name** should be descriptive, for example "Center MassAve Bridge."
- **Latitude and longitude** should be provided in decimal units to 6 places (e.g., "38.9072").
- **Water Type** will determine the methods to be used for sample collection and analysis, so indicate whether the sample will be fresh, marine, or estuarine/brackish. AquaQAPP uses the following USGS salinity-based definitions to distinguish among the three water types: fresh water is less than 1,000 ppm, estuarine waters range from 1,000 ppm 30,000 ppm, and marine water contains more than 30,000 ppm dissolved salts.
- An entry for **Water Quality Concerns** will appear if you indicated that your water quality concerns differ among sampling locations. Only the concerns you indicated earlier will be in the drop-down; select one or more for each location.

The following items will facilitate future reporting of your results (see Section 4.O), especially if you choose to upload your data to EPA's Water Quality eXchange (WQX) portal:

- **Location Sample Type** indicates the sample source. Select the best match from the drop-down list.
  - **Horizontal Collection Method** refers to how the sample site was pinpointed on the earth. If you used the map in AquaQAPP, then the horizontal collection method is 'Interpolation-Map.' Other common ways to geolocate sampling sites are with a GPS device ('GPS-Unspecified'), using Google Earth ('Interpolation-Satellite'), referencing a street address in Google Maps or other mapping application ('Address Matching-Digitized'), or using information from a surveyor ('Classical Surveying Techniques'). If the method of determining the sampling coordinates is unknown, indicate that.
  - **Horizontal Coordinate Reference System** documents the reference horizontal datum used to measure the coordinates of a sampling site, usually via GPS. The most recent datums will be North American Datum 1983 (NAD83) and World Goedetic System 1984 (WGS84). If you use a GPS system to measure your sampling coordinates the reference default datum is WSG84.

K. Parameters

At this point in AquaQAPP you will indicate which parameters you will measure. AquaQAPP references sample collection procedures vetted by MassDEP and documented in the AquaQAPP SOPs/Field Operations Manual (found at https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project; see "A peek behind the curtain"). The information included in these documents will help you to plan your equipment purchases and identify training needs. You can also extract sections from those to develop your own project-specific field sampling manual.

"Other parameters"

If you list "Other parameters" on this screen, you must provide all documentation for that parameter – for example, in the Project Description and Sampling Design narratives, as well as analytical methods tables that will be in the final generated QAPP. Given that these changes to the generated QAPP are considered substantial, the final QAPP will not be considered pre-approved by MassDEP or suitable by EPA Region 1 (see Section 1.B, "How Does AquaQAPP Work?"). If one of your project objectives is to share your data with MassDEP and you are including "other" parameters, you should consider requesting MassDEP review of your QAPP prior to conducting monitoring.

1. Selecting Parameters

AquaQAPP lists suggested parameters based on your water quality concerns. The Parameters screen displays parameters and methods that may be selected based on your sampling program.

Parameters appear in the middle of the screen and are separated into marine/estuarine ('Marine' tab) and freshwater ('Fresh' tab) categories. The top box displays suggested parameters based on the combination of water type(s) and concern(s) chosen earlier. The middle box contains all parameters available in AquaQAPP. To select a parameter, click on the checkbox in the same row. This will move the parameter to the 'Selected' box on the right-hand side of the screen which displays all parameters that will be included in the generated QAPP.

The final box, titled 'other parameters,' provides space to enter any parameters not listed. Please note that if an "other" parameter is provided, and a stated objective of the monitoring effort is to submit the resulting data to MassDEP, MassDEP requires QAPP review prior to implementation.

If you are conducting benthic monitoring (i.e., your concerns include "General Environmental Health: Benthic"), MassDEP requires additional companion measurements to provide context for the results of benthic assessments. Currently, AquaQAPP does not automatically populate these companion parameters, instead users are required to manually select the following from the lists on this page:

- **Along with benthic sampling in wadeable streams, select:** temperature, conductivity, and dissolved oxygen of the overlying fresh water.
- **Along with benthic sampling in estuarine or marine waters, select:** sample penetration depth, sediment volume, and sediment texture; temperature, salinity, and dissolved oxygen of the overlying estuarine/marine water.

Adding parameters later?

If you return to this screen to add a parameter, be sure that all parameters you include here are also associated with a location ("Parameters by Location") and sampling frequency ("Sampling Design Details"), or there will be gaps in your final generated QAPP.

2. Selecting Methods

Some parameters are listed multiple times with a different methods listed (as numbers, or as instruments to be used). You should select the parameter name associated with the analytical or assessment method you will use in your project. Tables 2 and 3 list the methods included in AquaQAPP, which are those preferred by EPA and MassDEP. You may select multiple analytical methods for the same parameter if you are varying the methods by sampling location, for example. Note that analytical methods other than those listed below are considered "substantial differences" from AquaQAPP content pre-approved by MassDEP or considered acceptable by EPA (see Section 1.B, "How Does AquaQAPP Work?"). In that case, if one of your project objectives is to share your data with MassDEP, you should consider requesting MassDEP review of your QAPP prior to conducting monitoring.

Table 2. Preferred analytical methods, estuarine/marine samples

Parameter	Method #1	Method #2
Turbidity	EPA 180.1	SM 2130-B
Total suspended solids	EPA 160.2	SM 2540-D
Alkalinity	Greer et al. 2018	SM 2320-B
Chlorophyll a	EPA 445.0	SM 10200-H
Total Kjeldahl Nitrogen	EPA 351.2	
Total Nitrogen	USGS 03-4174	SM 4500-N
Nitrate-Nitrite-N	EPA 353.2	SM 4500-NO3
Ammonium-N	EPA 350.1	SM 4500-NH3
Total Phosphorus	EPA 365.2	SM 4500-P
Orthophosphate	EPA 365.5	
Microcystins	EPA 546, >0.3ppb use EPA 544	Abraxis Strip Test (Field)
Enterococci	EPA 1600	SM 9230

Table 3. Preferred analytical methods, freshwater samples

Parameter	Method #1	Method #2
Turbidity	EPA 180.1	SM 2130-B
Chlorophyll a	EPA 445.0 (modified)	SM 10200-H
Total Nitrogen (TN)	EPA 353.2 (modified)	SM 4500-N USGS I-4650-03
Nitrate-Nitrite-N	EPA 353.1	SM 4500-NO3
Ammonia-N	EPA 350.1	SM 4500-NH3
Total Phosphorus (TP)	EPA 365.2	SM 4500-P USGS-1-4650-03
Orthophosphate	EPA 365.5	SM 4500-P USGS-1-4650-03
Chloride		SM 4500-CL
Total suspended solids	EPA 160.2	SM 2540-D
Microcystins	Abraxis Strip Test (field)	EPA 546; >0.3ppb use EPA 544
E. coli	EPA 1603	SM 9223B

L. Parameters by Location

On this screen, you can customize the list of parameters sampled at each location. Clicking on the "Edit" button for a sampling location brings up a pop-up window pre-populated with parameters corresponding to the water type and water quality concern you selected on the previous screen. De-select parameters as needed to create a list of parameters by location that can be taken into the field. This aspect of AquaQAPP accounts for scenarios in which a parameter is only measured in a subset of locations based on site-specific concerns. Note that you will not see "other" parameters listed in the pop-up window, instead you will be prompted to add this information to your generated QAPP.

M. Sampling Design Summary

This screen is important to setting expectations for the success of your sampling efforts in meeting your project objectives. Your input will describe the relationship between your sampling design and your stated water quality concerns and project objectives.

1. Data Quality Objectives

Provide a one-sentence description of your goal for the data generated by your project. Because you are seeking to be concise and describe the performance criteria for how your data may be used, you should spend time developing your DQOs.[2] See Attachment 2 for more guidance. Here are some examples:

"Sufficient and accurate water quality and macroinvertebrate data are collected to document the locations of high quality and impaired stream segments in Fox Brook."

"Timely and accurate water quality data are collected to assess suitability of Carson Lake for swimming and boating, and inform the public of conditions on a weekly basis."

Data Quality Indicators

AquaQAPP assumes that your project is designed for scientific investigations or to inform policy action (see Section 1.C, "Who Should Use AquaQAPP?"). Your generated QAPP will include **Data Quality Indicators** suitable for these purposes – standards for *accuracy, precision, representativeness, comparability, and completeness.* (Attachment 2 describes these terms and how they are brought to bear in sampling design and implementation.) You must adhere to these standards in your project implementation in order for the resulting data to be considered of suitable quality to meet your objectives.

[2] EPA has developed guidance for thinking about DQOs, available at https://www.epa.gov/quality/guidance-systematic-planning-using-data-quality-objectives-process-epa-qag-4. (U.S. Environmental Protection Agency. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA QA/G-4. EPA/240/B-06/001. Office of Environmental Information. U.S. Environmental Protection Agency. Washington, DC 20460.

2. Sampling Design Overview

Attachment 1 includes guidance for developing this description (as well as the Sampling Rationale, below). In this text box, provide a narrative, or "story" of your monitoring program. It must address each of the items below to support your DQOs:

- What type of samples (water, sediment) will be taken, and how many of each?
- When do you plan to take samples – time of year, stage of tide, time of day?
- Is the layout of your sampling sites targeted to a potential pollutant source, or is it based on statistical representation of the entire water body, stream segment, or embayment?
- Who will be collecting the samples or taking field-based (*in situ*) measurements?
- Who will analyze the samples?

3. Sampling Rationale

What is your rationale for the distribution and number of monitoring locations, the timing and type of samples, and the parameters selected? How do these design elements relate to your project objective? The rationale should be described clearly: a good test of this is to consider whether someone else using the same rationale would end up with similar sampling locations.

N. Sampling Design Details

This screen populates tables in your generated QAPP detailing plans for sample collection organized by sampling location, as well as QA/QC samples to be collected. The latter tables will require editing the generated QAPP (see Section 5.A).

All parameters for each sampling location are listed on this screen using information you provided previously, including the location ID, parameter by sampling method, and water type at the sampling site (indicated on the Monitoring Locations section). For each entry, select the sampling frequency (representing a sampling event) planned for that parameter. The options include:

- daily
- twice per week
- weekly
- every other week
- twice per month
- monthly
- every other month
- weather events
- once per season
- once per year

O. Record Handling Procedures

Information provided via this screen will complete Section A9 of the generated QAPP (See Attachment 4). Consider the discrete steps involved between data collection in the field and official presentation in reports and publications. MassBays has provided templates for all of the forms you may need for your monitoring project; Table 4 lists the forms relevant to all QAPPs; note that AquaQAPP will generate a complete list of necessary forms based on your method and parameter selections.

Table 4. Forms and templates referenced in AquaQAPP

Form Name	Description
Field Data Form	Completed on site at the time of sampling. Includes field measurement (e.g. YSI) and sample collection info, site location and ID, crew names, weather conditions, etc.
Site Assessment Form	Completed as part of site assessment verification visit
Chain-of-Custody Form	These will accompany samples from collection sites to labs.
Sample Label	Attached to all sample containers and will include the site ID, date, time, parameter to be analyzed, and sampler's initials.
Training Log	Compiles information on trainings offered
Training check-in Form	Verifies attendance at trainings
Instrument Calibration and Maintenance Log	This includes documentation of maintenance, calibration and testing carried out on equipment
Sample Log	Used to maintain a list of samples collected in the field.
Secondary Data Table	This documents other data sources employed to design and implement the monitoring program
Corrective Action Reporting Form	This documents actions taken during implementation to assure suitable data quality

To complete this screen, provide the following information:

- **Document control.** Who is responsible for records handling? Who will maintain the project files and ensure that the most current forms, QAPP, and SOPs are in use?
- **Data generation.** List the records that will be produced – field, lab, and/or assessment – and who is responsible for producing those records. Include which will be maintained in the project files.
- **Data quality report.** This is a compilation of all materials used to evaluate whether your DQOs have been met: the final project QAPP, including attachments (sample forms and Laboratory SOPs), a completed Corrective Action Reporting Form, documentation of any substantive changes made to the QAPP generated with AquaQAPP, formatted data, and a data evaluation summary. Indicate who will conduct data valuation and comparison to the DQOs.
- **Data reporting format.** Identify the file type(s) that will be used to deliver data to users (e.g., *.csv, *.xml, *kml).
- **Records storage.** Indicate where completed forms will be stored and the length of time they will be retained.

P. Data Management[3]

In this section of AquaQAPP, you will describe the data management processes used throughout the life of the project. AquaQAPP will generate Section D of the project QAPP (see Attachment 4), which builds on this section to describe how the data will be reviewed and used. Be sure to read through and edit that section carefully to reflect your project plans prior to finalizing your QAPP.

This screen will generate an overview of your project data management practices -- recording and transcribing field notes, logging and retrieval of instrument data, transmittal of automated field and laboratory results, data transformation and reduction procedures, compilation of survey results, and data storage, retrieval and security uses throughout the project. You should also describe how data handling errors will be controlled (e.g., via spot checks for transcription and calculation errors). Example text is provided for each text box within AquaQAPP; the boxes are labelled as follows:

1. Data Management Process and Procedures

Your QAPP should allow tracking of the data's path from planning, through sampling and analysis, to assessment, to final use and storage. Describe data management procedures that will be employed in all phases of your project: project planning, field, lab, assessment, storage and retrieval, project planning, data from other sources, etc. The following are components of an SOP for data management that should be shared with all project personnel:

- How will all data be recorded?
- Will data be transcribed from datasheets to an online database?
- What percent of data will be checked for accuracy and transcription errors?
- Who will check for discrepancies in data entries, How?
- How will lab results be delivered and by whom?
- How will data that did not meet the QC requirements of the lab be qualified?
- Will data be entered into an electronic database? By whom?
- If applicable, will electronic files be backed up daily?
- How will original data be stored and for how long?
- How will you qualify raw data for QA and QC? (See Attachment 2 for guidance)
- How will you ensure access to data by appropriate parties in various stages of processing (e.g., raw, under QA review, final)?

2. Data Handling

You may be handling data generated by hand (in the field), collected from the literature or other sources (i.e., existing data), recorded from equipment or instruments, and/or generated by laboratory analysis. What will be the minimum performance or acceptability requirements for these data sources? Note that this is different from quantitative data quality controls (see Section 5A.4).

3. Data Management Requirements

Do you plan to work with other organizations to make sure you are following their data management requirements? Indicate location of digital data storage. MassBays recommends EPA's Water Quality eXchange (WQX) database or MassDEP's online portal.

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[3] Excerpted from: U.S. Environmental Protection Agency. 2019. Templates for Citizen Science Quality Assurance and Documentation. (March). https://www.epa.gov/sites/production/files/2019-03/documents/508_csqapptemplates3_5_19_mmedits.pdf.

5. Generating and finalizing your QAPP

When you have completed all screens in AquaQAPP, the navigation pane will show green check marks next to all screen names, and the progress bar will show 100%. You are now ready to generate a draft QAPP! Click on the green button in the top right-hand corner of the dashboard. After a few minutes, you will be asked if you want to save or open the generated QAPP. It will be a Microsoft Word, *.docx format file.

As indicated in Attachment 4, several sections will be populated automatically based on the parameters you selected for your monitoring program. ***It is important that you review the entire document to make sure you understand the contents, and confirm it reflects your program's specific plans***. You may note that the section numbers are missing or duplicated. This is because some sections may not be relevant to your project, or are relevant to more than one parameter or location. The generated QAPP will also include 1) a detailed cover sheet and checklist of items to edit prior to finalizing the document, and a list of forms required as attachments to your final QAPP, and 2) at the very end, cover sheets for each set of required attachments. The follow sections provide an overview of these final edits.

A. Final edits

1. Other parameters or methods

If your monitoring program includes any parameters or methods not included in AquaQAPP, the cover sheet will prompt you to complete several tables in Section B of the generated QAPP. You will also need to refer to and attached SOPs relevant to those.

In these same tables you may find that parameters are listed more than once; this is to indicate differing locations and/or sampling frequencies for that parameter.

2. Roles and Responsibilities

Section D of this User Guide lists the assumed responsibilities of each role in the monitoring program. You will need to adjust the text if any of these are not accurate for your project. You will also need to fill in tables in Sections B8, B6 (for Freshwater Water Quality parameters only), and B5 (for Freshwater Benthic parameters only); these list the persons responsible for quality control and/or equipment inspection and testing. All project personnel should be familiar with the final QAPP prior to beginning the project.

3. Map of monitoring locations and surrounding area

The map included in the final QAPP must include a legend, indicators of scale, and compass direction. The water body should be identified, and all sampling locations clearly labelled. Currently AquaQAPP does not include the capability to generate a printed map of sampling locations. You may, however, use a screenshot of the Monitoring Locations screen as a component of your final QAPP. If monitoring will occur over a large area, it may be necessary to take multiple screenshots at different scales.

4. Quality Assurance/Quality Control Summary

To fill in the tables that require information pertaining to precision and accuracy checks, you will need to tally up how many times each parameters will be tested per sampling event, and consider the information included in Attachment 2 regarding data quality indicators and guidance on field duplicates and blanks. You will need to consult with your selected laboratory to fill in this table if lab analysis is required. Attachment 3 provides guidance on selecting a laboratory; note that your final QAPP should include the SOPs from the laboratory.

For each parameter, per sampling event (i.e., matching sampling frequency), indicate the number of:

- **Field Duplicates**, samples to be collected or measurements to be taken at the same time and location as each other, used to estimate the precision of the sampling and measurement process.
- **Field Blanks**, samples used to detect contamination that may introduced through the process be required for that parameter. To produce a field blank, a sample of distilled water is collected using the same instruments and sample bottles, then carried into the field, stored in the coolers, and delivered to the lab for analysis or measured with a meter alongside the field samples.
- **Lab Duplicates, Lab Blanks, and Lab Spikes**. Your selected laboratory will provide instructions for these samples, to be entered here.

What is a suitable number of Field Quality Control samples?

Plan for 20% Field Quality Control Samples per parameter, per sampling event (10% duplicates and 10% blanks). For example, if you are measuring or sampling a given parameter at 20 sites during a given outing, you would have 2 field duplicates and 2 field blanks for that parameter.

Spread the Field QC around

While it may be tempting to designate a single sampling location as "the QC site," you should rotate responsibility for collecting field duplicates and carrying field blanks across sites. Especially if your volunteers are assigned the same site(s) for each sampling event, it is important to gain insight into data quality by assessing QC at all locations over the course of a sampling season.

B. Forms

The cover sheet to the generated QAPP includes a list of all forms needed for your program and referenced in the draft QAPP. Template for all forms are available on MassBays' AquaQAPP website (https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project) as an Excel workbook. Each form is a separate spreadsheet in the workbook, easily edited to reflect your own monitoring program. Attach your project-specific forms to the final QAPP. Only the Secondary Data form needs to be completed prior to project implementation.

Don't underestimate this step!

MassBays has compiled all of the forms you will need for your program, from training logs to templates for uploading your data to EPA's Water Quality eXchange database. They are generic, however, to meet the needs of many types of programs. Be sure to set aside time to customize the forms for your own use.

Attachment 1 – Sampling Location Selection Guidance

A. Sampling location selection methods

Sampling locations can be selected for a variety of reasons, including safe access, convenience, value to specific users (e.g. regulators), knowledge of "hot spot" areas or just for general inquiry. Whatever the reasoning, a well-thought-out sampling design addresses the Data Quality Indicator representativeness. Two common methods for selecting sampling locations for water quality and benthic parameters are ***random or probabilistic sampling***, and ***judgmental sampling***. In random sampling, locations are chosen without regard to any specific conditions other than to obtain a set of samples that are representative of the system. This approach is most useful when your concern is General Environmental Health (water quality or benthic) and/or there are no known "hot spots." Random sampling can be more finely tuned to target desired segments of the study area by incorporating stratification. For example, the location selection process for a benthic survey could first stratify the water body based on available depth or sediment information, and then randomly select locations within those strata. On the other hand, judgmental sampling involves the manual selection of sampling locations based on known conditions under investigation, for example, when evaluating the impact of a point source discharge on water quality or the benthic community. If your concern is related to harmful algal blooms or recreational use, you might want a combination of the above approaches.

B. Selection criteria

Site selection rationale should be described clearly in the Sampling Design Summary screen of AquaQAPP (see Section 4.M), so that if another person were to use the same rationale, they would choose similar locations. If a reference site is used, the conditions there should represent the best range of minimally impaired conditions that can be achieved by similar water bodies within a particular ecological region. A great first step in the selection process is to look for locations with existing or historic data. Reach out to local partners for their input, and check for State and Federal monitoring locations on EPA's Water Quality Portal (WQP).

To select sampling locations, the following information about the water body may be needed:

- A bathymetric map.
- A watershed map with marked inflows and outflows.
- A historical summary of water quality including the location of previous sampling sites and documentation of any problems.
- Information about current activities in the watershed or water body itself that may affect sampling results (point source discharges, construction areas, dredging, water level drawdowns, and/or chemical applications to treat invasive weeds or mosquitoes).

Sampling locations for community-based monitoring programs should take into account safe access for trained volunteers. Lacking regular boat access, marine and estuarine sampling locations are usually at docks or piers. River samples can be collected from bridges, docks, or riverbanks; and lake and pond samples from docks, banks or small boats. All locations should support sample processing without interference from non-participants. Additional considerations depend on the type of sample to be

collected, as described below. You should also refer to the Field Operations Manual/Standard Operating Procedures for all methods included in AquaQAPP, available on the MassBays website (https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project).

1. Freshwater (river/stream) water quality

If targeting a specific point source or inflow, judgmental sampling should include locations upstream and downstream of the mixing zone. Where a mixing zone has been defined in a discharge permit, sampling should be conducted with reference to that zone. If the mixing zone has not been defined, it may be possible to determine the dilution area through visual observation of algal growth or die-off patterns, or using temperature or specific conductance readings. Samples should be collected at one site upstream of the source, one or two in the plume, and at least two farther downstream. If the purpose of the program is monitoring General Environmental Health, any variability in the physical and environmental conditions in the water body should be represented in the sampling locations.

2. Freshwater (lake/pond) water quality

A lake (or pond) and its water quality are not uniform from shore to shore or from surface to bottom. Random sampling will likely only reveal that variability, so depending on the program's purpose, either stratified random sampling or judgmental sampling may provide better representativeness. Lake and pond sampling locations are generally at the downstream ends and/or key segmentation points of major tributaries, and at or near locations for which there are existing data. A site over the deepest section of the lake best represents average conditions. In natural, circular water bodies, the deepest section is usually near the middle. Many lakes, however, possess significant arms or bays. In this instance, it is often useful to sample the deepest section in each individual arm or bay.

3. Freshwater (wadable streams) benthic and physical habitat assessment sites

For benthic and physical habitat assessments, sampling should provide a representative picture of the ecological community. Unless *physical* habitat being sampled is reasonably similar at all stations, it will be difficult to separate the impacts of physical and water quality variabilities in communities observed across sites. Preliminary site evaluation will be critical to selecting sites, including an evaluation of surrounding land uses, structures that may influence conditions (bridges, bank armoring), and in-stream attributes (riffles, pools, fallen trees).

4. Marine water quality

Like lake, pond, and river sampling sites, marine sampling locations for community-based monitoring programs should take into account safe access for trained volunteers. Lacking regular boat access, sampling sites are usually at docks or piers and suitable for dock-side sample processing without interference from non-participants. If sampling near a public beach, there may be overlap with existing or historic government monitoring locations (e.g. Massachusetts Department of Public Health).

5. Marine benthic sites

AquaQAPP supports grab sampling of soft sediments using a Van Veen sampler. Ideally, location selection should be stratified to target fine-grained silts and mud (<0.06 mm), which host more organisms than do sandy sediments.

C. Preliminary sampling location evaluation

In-person reconnaissance at sampling locations selected based on a map is critical. In general, you should assess the following:

- Safe access from the shore to the location.
- Adjacent land use, point sources, or other conditions that will impact water quality at the sampling site (thus impacting representativeness).
- Suitability for benthic assessment, for example the substrate characteristics.
- Especially for locations for longer-term monitoring, adjacent property ownership and rights-of-way.

You'll find templates for documenting findings from a preliminary site visit in the Templates and Forms Excel workbook on MassBays' AquaQAPP website (https://mass.gov/how-to/use-aquaqapp-to-plan-your-monitoring-project).

D. Naming conventions

Consistent use of a standardized naming convention facilitates database management and long-term tracking of trends and conditions. A common method for location names is to use a geographic prefix followed by an alphanumeric designator. For example, CR-B013 would refer to a **B**enthic sample at the **13**th sampling location on the **C**harles **R**iver. Note that the numeric placeholder accommodates up to 999 locations. All volunteers and project participants should be trained in the use of the location naming convention and the designations for their assigned sampling location(s).

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Attachment 2 - Data Quality Objectives and Indicators

A. Overview

Data Quality Objectives (DQOs) describe the criteria your data need to meet to support what you want to do with those data, that is, making sure the data produced during the project allow you to make technically defensible statements with regard to the project objectives.

AquaQAPP (Sampling Design Summary screen; see Section 4.M) prompts the user to describe the DQOs, and Data Quality Indicators (DQIs)for the monitoring program. The required DQIs are:

Accuracy: The extent of agreement between a measured value and the true value of interest.

Precision: The extent of mutual agreement among independent, similar, or related measurements.

Representativeness: The extent to which measurements represent true systems.

Comparability: The extent to which data from one study can be compared directly to similar studies.

Completeness: The measure of the amount of data acquired versus the amount of data required to fulfill the statistical criteria for the intended use of the data.

Table 2-1 documents how each can be measured and evaluated; more detail and considerations for each are provided in the sections below.

Table 2-1. DQIs, QC Actions, and Measures

Data Quality Indicator	Quality Control Actions and Checks	Typical DQI measures
Accuracy	Calibration standards, blanks	No blanks contaminated and all calibrations within acceptable limits
Precision	Field and laboratory duplicates	20% RPD (relative percent deviation)
Representativeness	Evaluate whether the data accurately represent the system population, places, time and/or situation of interest	Data collected represent the system characterized or exposure experienced and are not biased.
Comparability	Compare to existing data or datasets	Data collected are sufficiently similar in methodology to permit a meaningful analysis
Completeness	Compare to intended sampling goals to meet project purpose	Could be stated as total number of samples or % of samples collected (e.g. 90%) or an identification of the critical samples needed for the project purposes.

B. Accuracy

1. Laboratory accuracy

Determined by following the policy and procedures provided in the laboratory's QAPP. These generally employ estimates of percent recoveries for known internal standards, spikes, blanks, and other QC samples. Depending on the analyte, specific accuracy objectives can be concentration-based (e.g., +/- 0.010 mg/L at < .05 mg/L and +/- 20% at > .05 mg/L), or can be defined in terms of recovery percentages (e.g., 80–120% recovery of matrix spike/lab QC sample).

2. Multi-probe accuracy

Measurements via a multi-probe should be tested before field monitoring using standards that bracket the anticipated measurement range. Following field monitoring, the instrument should be checked against standards[4] to determine whether the probes remained in calibration throughout the measurement period (and thus are within QC acceptance limits).

Data that fail to meet accuracy criteria may necessitate sample reprocessing, analysis of archival material, sample recollection, or flagging of the data, depending on the magnitude of the nonconformance, logistical constraints, schedule, and cost.

C. Precision

1. Laboratory precision

Determined by following the policy and procedures provided in the laboratory's QAPP. This varies depending on the analyte, but typically involves analysis of same-sample lab duplicates and matrix spike duplicates.

2. Multi-probe precision

Determined by taking duplicate readings (via a second placement of the unit) at the same station location. Multi-probe precision objectives generally range from 5 to 10% RPD depending on the parameter.

3. Field sampling precision

Estimated through sampling and analysis of duplicate samples. For water quality measurements, EPA and DEP recommend that duplicates for 10% of samples should be taken on every sampling event (i.e., 2 samples per 20 collected for a specific parameter). Overall precision objectives using RPD of field duplicate samples vary depending on the parameter and typically range from 10% to 25% RPD.

Calculating Relative Percent Deviation

RPD between duplicates is defined by the following equation:

$$RPD = |X_1 - X_2| / [(X_1 + X_2)/2] \cdot 100$$

Where:
RPD = Relative Percent Difference (as %)
$|X_1 - X_2|$ = Absolute value (always positive) of X1 – X2
X_1 = Original sample concentration
X_2 = Duplicate sample concentration

[4] A National Institute of Standards and Technology-certified thermometer should be used to periodically check thermometer accuracy; lower limit accuracy for dissolved oxygen (DO) should be checked using a zero DO standard when low DO concentrations are expected.

D. Representativeness

1. Field sampling representativeness

Assessed by verifying that the sampling program was implemented as proposed (see Attachment 1, Sampling Location Selection Guidance) and that proper sampling techniques were used. Factors such as seasonality and weather conditions should be recorded, and considered when evaluating whether the resulting data are representative of desired testing conditions (e.g., wet-weather water quality).

2. Laboratory representativeness

Assessed by verifying that proper analytical procedures and appropriate methods were used.

Comparability

Comparability refers to the extent to which data from one study can be compared directly to similar studies. Standardized sampling and analytical methods, units of reporting, and site selection procedures are used to ensure comparability of data with others using those same methods. Sample time and date of collection, sample storage and transfer, as well as laboratories and identification specialists used are documented so that future surveys can produce comparable data by following similar procedures.

Completeness

Completeness is expressed as a percentage of the number of valid measurements that should have been collected. Field monitoring projects are generally considered fully successful if at least 80% of the anticipated number of samples are collected, analyzed, and determined to meet data quality objectives. At the close of the project, the Project Manager will produce a report detailing the number of samples collected, number of valid results, and percent completion (number of valid samples/number of samples) for each parameter.

Calculating Percent Completeness

Use the following equation:

$$\%C = N/T \cdot 100$$

Where:
%C = Completeness (as %)
N = Number of usable results
T = Targeted number of samples planned to be collected.

If the completeness goal is not met, gaps in the data sets will require evaluation to determine the effect on the intended use of the data. Sample re-analysis, analysis of archived material, and/or re-collection of the sample may be appropriate depending on criticalness of the missing data, logistical constraints, cost, and schedule.

References

U.S. Environmental Protection Agency. 2000. *Guidance for Data Quality Assessment*. EPA/600/R-96/084. https://www.epa.gov/sites/production/files/2015-06/documents/g9-final.pdf

U.S. Environmental Protection Agency. No date. *Quality Assurance Project Plan Development Tool, Module 1.* https://www.epa.gov/quality/quality-assurance-project-plan-development-tool

Godfrey, Paul J., Jerome Schoen, Geoff Dates. 2001. *The Massachusetts Volunteer Monitor's Guidebook to Quality Assurance Project Plans.* Boston: Massachusetts Department of Environmental Protection. http://www.umass.edu/mwwp/pdf/QAPPguidebook.pdf

Attachment 3 - Laboratory Selection Guidance

Selecting a qualified environmental laboratory to assist with sample analysis is an important component of a successful monitoring program, and critical to meeting your project's data quality needs. This attachment covers the multiple considerations to be taken into account during that process,[5] including technical and logistical qualifications (certifications, capacity, and cost), quality system documentation (QAPPs, SOPs, and data archiving), and other factors (reports and subcontracts).

A. Technical and Logistical Qualifications

1. Sample media/matrices, analyses, and detection levels

Does the laboratory have experience analyzing the types of samples (e.g., marine or fresh water, storm water, sediment, etc.) that you want analyzed? Does the laboratory perform the specific analyses that you require? Are the detection and reporting limits sufficient for your project?

Some laboratories may be niche organizations specializing in analyses based on either a particular matrix (e.g., drinking water, fish tissue, etc.) or a particular type of analysis (e.g., pesticides, dioxin, etc.). Others are full-service organizations that can handle many types of matrices, media, and analyses. Most laboratories will perform routine surface or ground water analyses.

Usually laboratories have a business manager, client services manager, sales representative, or other staff who will work with you to determine whether they can provide the particular analyses required for your project at the required detection and reporting limits.

2. State certification and/or National Environmental Laboratory Accreditation Program (NELAP) accreditation

Does the laboratory have Massachusetts state certification or NELAP certification? Does the certification include the types of sample media, matrices, and analyses of interest for your project?
Laboratories are certified for specific media and analyses depending on their interest to pursue specific certification categories, as well as their ability to demonstrate compliance with the associated qualifications. Laboratories will often list their certifications on their websites.
State certification by itself does not guarantee that good quality work will be produced, but it may provide a good starting point to help you evaluate a laboratory's ability to support your project needs. Two options for finding certified laboratories are:

- Massachusetts Department of Environmental Protection maintains a database of certified laboratories for water samples, searchable by potable/non-potable water and by analyte, method, or laboratory name (https://eeaonline.eea.state.ma.us/DEP/Labcert/Labcert.aspx).
- The NELAP Management System maintains a database of certified laboratories for potable and non-potable water, solids and chemical (including sediments), and tissue samples (https://lams.nelac-institute.org/Search).

[5] Setting up an in-house environmental laboratory is beyond the scope of this guidance.

3. Laboratory capacity

Does the laboratory have the capacity to handle your samples (and all related sample preparation and analyses) on the schedule you need? Do they have sufficient instruments (and back-up instruments in case of instrument failure) and personnel to handle the anticipated sample load?
If you are not generating a large number of samples (typically less than 40), most laboratories can handle this sample load without problem. However, if your project will generate a large number of samples at one time and/or you have samples to be analyzed for a variety of analytical parameters, you need to ensure that the laboratory can handle the work load in all of its departments.

Either you can schedule your sampling collection around the laboratory's capacity (making sure you discuss sample capacity loads, sampling holding times, and data deliverables with the laboratory representative), or – if you cannot be flexible in your sample collection and shipping schedule – contract with a laboratory that will handle your samples when they need to be analyzed. If it is a continuing project, you should consult with your laboratory at the beginning of each sampling season.

4. Laboratory location and support services

Is the laboratory location convenient? What support services does the laboratory provide, and what is its sample receipt policy?
A local laboratory may be advantageous to your project as it may more easily facilitate transferring your samples directly to the laboratory the same day as collected, either hand-delivered by a project team member or picked up by a laboratory courier service. This may be especially critical if your project's analytical methods require that your samples be analyzed within a short time frame (after collection) to ensure sample integrity. Overnight courier services can make up for further-afield lab services, however shipping costs should be factored into the project budget.

Laboratories vary in how they typically support sampling, and when they can receive samples for analysis. They may provide coolers for shipping, chain-of-custody forms, free pre-cleaned/certified sample bottles and preservatives, courier service, etc. Some laboratories have staff available to receive samples after hours or on Saturdays.

5. Experience with community-based projects

Does the laboratory have experience working with volunteer monitoring programs, and does it have an established reputation for providing "ngo-friendly" services?
You may wish to check with other groups to find out their experience and recommendations regarding various laboratories. Although EPA and DEP must be impartial and cannot recommend any laboratory, agency staff know which laboratories other groups have used, the types of analyses performed, and an organizational contact you can call for recommendations and advice. MassBays (www.massbays.org) and Mass Rivers (www.massriversalliance.org) can also help connect you to fellow monitoring coordinators in Massachusetts.

6. Cost

Are the laboratory's prices reasonable?
Your selected laboratory should meet your needs and offer a competitive price. Sometimes economies of scale can be realized by making a longer-term commitment (e.g., for all four quarterly monitoring

events in a year) or in sending all samples to one laboratory facility (i.e., rather than splitting up samples submitted for various analyses to individual laboratories).

B. Quality System Documentation

1. Laboratory Quality Assurance Plan (or Manual)

Does the laboratory have a written QAPP, and is it adequate to meet your project's data quality needs?
You will need to include the laboratory's QA Plan as an appendix to your own project QAPP. Most laboratories will already have some form of QA plan, but these documents vary considerably in terms of their content, and some are designed only to provide general information as a form of marketing tool. A plan suitable for inclusion in your own QAPP should include:

- The laboratory's capabilities and state certifications or accreditations
- Methods (by method number) for each analyte
- Types and frequency of laboratory QC samples
- Detection/reporting limits

2. Standard operating procedures

Does the laboratory have written standard operating procedures (SOPs) for all of its operations?
Most full-service laboratories are divided up into departments or sections that include sample receipt, organic sample preparation, inorganic sample preparation, metals analysis, general chemistry analyses, gas chromatography/mass spectrometry (GC/MS) analyses, and gas chromatography (GC) analyses. Some laboratories also offer microbiological analyses or toxicity testing; others may provide analysis of benthic or algal samples.

A "Published Method" is not an SOP

In general, published methods such as EPA methods or those in *Standard Methods* vary considerably in their method description and may need to be modified to meet a project objective. For example, QC requirements, calibration criteria, reporting limits, and method detection limits, are generally specific to a given lab and not included in published methods.

Each laboratory department or section should document its procedures in written SOPs for each analytical method. The SOP should include detailed step-by-step procedures associated with that method, as well as specific QC requirements, frequency, acceptance criteria, and corrective actions to be taken if these criteria are exceeded.

3. Personnel resumes

Are the resumes of key personnel available for review?
This information may be included in the laboratory's QAPP, but sometimes resumes are kept confidential unless requested. State certification agencies typically have minimum experience and/or educational requirements for management and supervisory positions, and they may review the laboratory's general qualifications as part of the certification process. However, you may want to review specific resumes if there are concerns related to a critical analysis area, especially for the more complex analyses.

4. Cost of QC

What QC samples are analyzed and typically reported by the laboratory on a routine basis, and what QC samples may will require an additional cost to the tribe?
Unless requested otherwise, most laboratories will perform their QC analyses on a batch basis. A batch is a set number of samples (frequently, 20) of a similar matrix/medium. The batch may be comprised of samples from a single client or include small groups of samples from multiple clients. The intent of batching samples is for the laboratory to avoid performing an overall disproportionate number of QC sample analyses. For example, one client may submit 5 samples and another client may submit 10 samples for the same type of analysis. But, as the laboratory typically performs analysis of the associated QC check samples (that may include a laboratory blank, a matrix spike, laboratory duplicate and possibly a laboratory control sample) at a rate of one for every 20 samples, the laboratory may combine the client's samples into one batch and report the same batch QC results to both clients. This is logical from a laboratory perspective, as the laboratory typically absorbs the cost of these QC samples. But, this batching could result in generating results of matrix spike and lab duplicate samples that may not be representative of the client's samples. Thus, they provide information about the laboratory's performance, but not necessarily about the client's sample matrix/medium. In most cases, batch QC is sufficient.

Determine which QC samples the laboratory runs routinely for each analysis (as they may differ from method to method), the frequency of those QC sample analyses, as well as which are performed at client versus laboratory expense. Samples sent blind to the laboratory, such as field duplicates and field blanks, will always be at client expense.

5. Chain of custody

If there are legal considerations to the data, does the laboratory have a well-documented, internal chain-of-custody system?
The system may be fully electronic, or be a combination of electronic and logbook documentation.

6. Archiving data

Does the laboratory have a system in place to track, store, and archive raw data and old data reports?
Most laboratories have retention policies, and you should know and understand what they are.

C. Other Factors

1. Data review procedures

Does the laboratory have defined procedures in place covering administrative tasks such as sample receipt and check in, as well as for the reporting and processing of data?
Most laboratories will have SOPs in place covering these tasks. Specific aspects to consider include:

- Does the QA Officer (or some individual independent of performing the actual activity) review all data or a fraction of the data in real time (prior to providing the data to the client)?
- Is there an automated data review system in place? Does the data review SOP describe the review system satisfactorily?
- Are data flagged for the client to review? How are data flagged? Is the system clear?
- Will all data reports contain a narrative explaining any problems?

2. Laboratory report contents

What are the contents of a typical laboratory report?
Request a copy of a typical data report prior to selecting your laboratory, and specify the laboratory QC data you will need as part of the reporting. Review this information to be sure that the laboratory will provide what you need to perform a minimum QC check on your project data.

3. Sample retention and disposal

What are the laboratory's policies with respect to retention and disposal of samples?
The laboratory should be able to assure that your group will not be subject to future liability associated with providing samples to the laboratory (for example, if waste is improperly disposed of).

4. Laboratory subcontracts

What are the laboratory's policies with respect to subcontracts, and what samples might be subcontracted for your project?
Prior to contracting with a laboratory, and especially if they regularly subcontract with other labs, determine whether they have a system in place to evaluate subcontractors' quality assurance/quality control systems. The contracted laboratory should review subcontractor data as if it were its own, since it will be reported as such. A subcontractor introduces another variable into the quality system which you may not be able to evaluate directly. Work with the contracted laboratory representative until you are comfortable with whatever samples might be sent out. If considered critical to a project's success, you may need to request documentation (such as an SOP) from the subcontract laboratory, so that it too can be evaluated.

References

U.S. Environmental Protection Agency. No date. *Quality Assurance Project Plan Development Tool*, *Module 6.* https://www.epa.gov/quality/quality-assurance-project-plan-development-tool

Attachment 4 – Standard QAPP Table of Contents

and corresponding AquaQAPP screens

QAPP Section	QAPP Group/Contents	AquaQAPP Screen
Group A: Project management		
A1	Title and Preparer Page	General Information Prepared By
A2	Contents	*Generated automatically*
A3	Distribution List	Project Organization/Personnel
A4	Project Organization & Responsibilities	Project Organization/Personnel
A5	Problem Definition, Background, & Objectives	Project Definition Project Background Project Description Sampling Design Summary
A6/A8	Project Description, Timeline, & Training	Project Description Sampling Design Summary Project Schedule
A9	Record Handling Procedures	Record Handling Procedures
Group B: Measurement Quality Objectives		
B1	Sampling Design & Sampling Locations	Monitoring Locations
B2	Sampling Methods	Parameters *(this screen also informs the sections following)*
B3	Sample Handling & Custody Requirements	*Generated automatically* *Attached SOPs*
B4	Analytical Methods	Parameters
B5	Quality Control Requirements	Sampling Design Details
B6/B7/B8	Equipment Maintenance & Calibration, Inspection of Supplies, & Corrective Actions	*Generated automatically*
B9	Non-direct/Secondary Data	*Generated automatically*
B10	Data Management & Documentation	Data Management
Group C: Assessment/Oversight		
C1	Field Assessments and Corrective Actions	*Generated automatically*
C2	Project Reporting	*Generated automatically*
Group D: Data Evaluation		
D1/D2	Field Data Review, Verification, & Evaluation	*Generated automatically*
D1/D2	Laboratory Data Review, Verification, & Evaluation	*Generated automatically*
D3	Data Usability, Project Evaluation	*Generated automatically*