7.2 Procedures for Development of a QAPP

The information in this section is a compilation of information found in several QAPP and water quality monitoring guidance documents from the EPA. These resources are listed in the reference section of this document.

A Quality Assurance Project Plan (QAPP) is a formal document that presents a plan for obtaining environmental data. Confidence in data is necessary for a monitoring program to be successful. A QAPP, therefore, describes how quality assurance and quality control measures are applied to a monitoring program to assure that the results are of the needed type and quality for a particular use or decision.

A QAPP should be developed through a systematic planning process. Quality assurance ensures that data will meet required quality standards with a sufficient level of confidence. While the planning process of a monitoring program may be time consuming, the penalty for a lack of planning may be worse and can include unusable or insufficient data, greater cost, and/or lost time. Different QAPPs are needed for different monitoring programs because data quality objectives differ along with intended uses. For example, the data quality objectives for a volunteer monitoring program with a main focus on the education of those involved will probably not have data quality objectives that are as strict as those for a monitoring program from which data will be used for regulatory compliance enforcement.

The management system of a water monitoring project, including the organization, planning, data collection, quality control, documentation, evaluation, and reporting activities, are all forms of quality assurance. Quality control measures are technical activities that are used to reduce the amount of error in sampling results. Internal quality control refers to the measures used by a project's own samplers and within its own laboratory. External quality control refers to laboratories and individuals outside of monitoring project. The EPA recommends that at least 10% of the samples collected for a water quality monitoring program are quality control samples. Quality assurance/quality control (QA/QC) procedures help a monitoring program achieve precision, accuracy, representativeness, completeness, comparability.

Accuracy in water quality monitoring refers to how closely water quality measurements agree with the actual values. Since accuracy is largely affected by equipment and procedures, following appropriate calibration schedules and using quality assurance and quality control techniques are some methods of achieving accuracy in a monitoring program. Accuracy can be tested using standard solutions of known concentrations. These spiked samples can be referred to as blind or double-blind samples. These techniques are covered in more detail in the *Standard Operating Procedures for Water Quality Monitoring in the Red River Watershed.* The accuracy of a set of measurements on a spiked sample or standard solution is equal to the difference between the average value measured and the actual, "True" value. In biological monitoring, the collection of voucher specimens (a preserved archive of organisms that were collected and identified) can be used to determine accuracy.

Precision refers to how well results can consistently be reproduced on the same sample or multiple samples taken from the same place at the same time. Analyzing duplicate (sampling precision) and split/lab replicate (laboratory precision) samples is one way to measure the precision of sampling techniques. This method is described in detail in the *Standard Operating Procedures for Water Quality Monitoring in the Red River Watershed.* The precision of the results can be measured by calculating the standard deviation, relative standard deviation, or the relative percent difference among samples.

Representativeness refers to the degree to which data collected from a stream resembles the actual condition of the stream being monitored. Sampling site location can have an effect on representativeness. Also, sampling techniques can have an effect on representativeness. Sampling techniques designed to maximize representativeness, such as entering the stream downstream of the sampling site and sampling upstream of any areas disturbed by wading, are listed and described in the *Standard Operating Procedures for Water Quality Monitoring in the Red River Watershed.*

Completeness can be measured by comparing the amount of valid, usable data actually obtained to the amount of data expected too be obtained. Incomplete data can be a result of human error (forgetfulness), equipment failures/damage, weather, and any other factors that would hinder or prevent the collection of data. When creating a QAPP, determine the number of samples that need to be collected in order for the data to be useful. Plan to collect more samples than you need in case the results are not 100% complete.

Comparability of results among sites, sampling dates, and projects is also important. Creating a set of standard operating procedures and using the same methods for each monitoring site are ways to ensure comparability.

The guides available from the EPA are very helpful in setting up a QAPP. They provide recommendations for QAPP development. The general steps to developing a QAPP are as follows:

1) Establish a QAPP team.

    ⇒ Make sure all participating groups are represented and establish contact with agencies and experts that may be of assistance or have approval power.

2) Determine the goals and objectives of your project.

    ⇒ Specific goals can help make the QAPP creation process easier. During the goal creation process, consider how the data will be used who will be using it.

3) Collect background information.

   ⇒ More knowledge about the area to be monitored will lead to the creation of a more effective monitoring plan. Contact groups and agencies that are already monitoring in the area to coordinate site selection, types of data collected, and monitoring methods. Obtain any existing data. Conduct a watershed survey (methods for watershed surveys are found in the EPA document: *Volunteer Stream Monitoring: A Methods Manual*).

4) Refine the project.

   ⇒ A review of background information may reveal the need to revise the project goals and objectives.

5) Design the project's sampling, analytical, and data requirements.

   ⇒ Prioritize the parameters and other characteristics that will be monitored.

   ⇒ Determine the necessary level of data quality.

   ⇒ Describe how sampling sites will be chosen and identified.

   ⇒ Determine what methods will be used for sampling and analysis.

   ⇒ Determine when the monitoring will be conducted.

   ⇒ Determine how data will be managed.

   ⇒ Develop a budget for the project. This amount of money available will affect the amount of monitoring and sampling that can be accomplished.

6) Develop an implementation plan.

   ⇒ Decide who will be implementing the individual aspects of the program.

   ⇒ Create a project schedule that shows when tasks such as recruitment, hiring, training, sampling, lab work, and report writing will occur.

7) Draft your standard operating procedures (SOP) and the QAPP.

   ⇒ The *Standard Operating Procedures for Water Quality Monitoring in the Red River Watershed* and other SOP documents are available for any group use. See Section 6.1 for more information.

   ⇒ Standard operating procedures to the finished QAPP.

8) Solicit feedback on the draft SOP and QAPP.

   ⇒ A draft QAPP can be sent to other water quality professionals from the MPCA, SWCDs, EPA, DNR, universities, research groups such as the Energy and Environmental Research Center (EERC), and other experts for comments.

9) Revise the QAPP and submit it for final approval.

   ⇒ Incorporate any feedback into the QAPP. Submission of a QAPP for approval is only necessary for EPA sponsored monitoring projects.

10) Begin your monitoring project.

   ⇒ Follow the procedures outlined in the QAPP and SOP.

11) Evaluate and refine your project over time.

   ⇒ Opportunities for improvement of sampling techniques, site selection, lab procedures, or other elements of the plan may develop.

   ⇒ If any changes in the plan need to be made, it is better that they are made during the sampling season instead of waiting until the sampling is completed and the changes can't be implemented.

Each recommended element of a QAPP is explained in detail in the EPA manuals. QAPPs generally cover project management, data acquisition, assessment, oversight, data validation, and data usability. Below is a composite summary of the elements described in the three EPA QAPP manuals. Although, not all of these suggested elements may be applicable to a particular program, as many as possible should be included in a water monitoring QAPP.

Project Management - This group of elements ensure that a project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs have been documented.

1) Title and approval page

   ⇒ Include the title and date of the QAPP.

   ⇒ Include the names of the organizations involved.

   ⇒ Include the names, titles, and signatures of the project manager, those approving the document, and others that may be appropriate.

2) Table of contents

   ⇒ List sections, figures, and tables.

   ⇒ Any attached SOPs should be included in the appendices.

3) Distribution list

   ⇒ List all the individuals who will need to receive a copy of the QAPP and subsequent revisions.

   ⇒ Copies may be distributed in electronic format.

4) Project/task organization

   ⇒ Identify key personnel and organizations.

   ⇒ List specific roles and responsibilities.

5) Problem identification/background

   ⇒ Draft a narrative stating the problem that the monitoring program will address.

   ⇒ Include any pertinent background information.

⇒ State what methods are currently being used.

⇒ Identify how the data will be used and who will be using it.

6) Project/task description

⇒ Summarize the work to be performed and the products expected from the project.

⇒ Describe the kinds of samples will be taken, kinds of analysis will be performed, other characteristics will be monitored, and sampling sites.

⇒ Specific sampling sites may be described in detail in a project-specific QAPP, but do not need to be described in a generic QAPP because it is intended to be applicable to sampling done at multiple (and possibly changing) sites over a long period of time (like the RLWD long-term monitoring program).

⇒ Provide any maps and tables that describe the project area.

⇒ Include information on how the monitoring results will be evaluated.

⇒ Include a timeline for the project showing sampling frequency, laboratory schedules, and reporting cycles.

7) Data quality objectives for measurement data

⇒ Data quality objectives refer to concepts used to describe the quality of data needed to meet project objectives, such as precision, accuracy, representativeness, completeness, measurement range, and comparability.

⇒ Set specific goals, if possible. Precision, accuracy, and range information for water quality monitoring equipment is usually available in product literature.

⇒ Identify any potential limitations on the use of the data collected.

8) Special training requirements/certification

⇒ Discuss how and when training will be provided.

⇒ Discuss how the necessary skills will be assured and documented.

9) Documentation and records

⇒ Identify the field and laboratory information records that will be collected form the project, including raw data, QC data reports, field data sheets, laboratory forms, calibration records, and voucher collections.

⇒ Ensure that project personnel will have the most current approved version of the QAPP.

⇒ Discuss how records will be stored, where they will be stored, and how long they will be stored.

Measurement/Data Generation and Acquisition – Implementation of these elements ensures that appropriate methods for sampling, measurement, analysis, data collection, data handling, and QC activities are employed and are properly documented.

10) Sampling process design

⇒ Include information on the types of samples required, sampling frequency, sampling period, site selection methods, and site identification methods.

⇒ Discuss how factors such as weather, seasonal variations, stream flow, and site access might affect sampling activities.

⇒ Include any safety plans.

⇒ The SOP being used for the project may be cited in this section instead of describing methods in detail.

11) Sampling methods

⇒ Describe the parameters to be sampled, sampling methods, equipment, sample preservation methods, equipment decontamination and cleaning, sample volumes, and holding times.

⇒ Use standard methods.

⇒ You may choose to refer to sections of the project's SOP in place of describing methods in detail in this section of the QAPP.

12) Sample handling and custody methods

⇒ Explain how samples will be labeled, preserved, handled, packaged, and transported from the field to the laboratory.

⇒ These efforts should all be aimed at making sure that concentrations of parameters within the sample remain the same from the time it is sampled until analysis is complete.

⇒ Include information on chain of custody forms that will be used to keep track of samples delivered or shipped to a laboratory.

⇒ Refer to sections of the project's SOP in place of describing methods in detail in this section of the QAPP.

13) Analytical methods

⇒ This section should include equipment, field methods, and standard laboratory methods used for analysis of samples.

⇒ Identify, if needed, any sub-sampling, extraction, laboratory decontamination, waste disposal methods and their respective performance requirements.

⇒ Explain any corrective actions that may be necessary if there is a failure in the analytical system.

⇒ You may choose to refer to sections of the project's SOP in place of describing methods in detail in this section of the QAPP.

14) Quality control

⇒ This section should include frequency, number, and type of quality control samples that will be collected for sampling, analytical, and measurement techniques.

⇒ Include the desired level of data quality and list any corrective measures.

⇒ Biological monitoring quality control checks may involve replicate samples, cross-checks, sorting checks, and voucher samples.

15) Instrument/equipment testing, inspection, and maintenance

⇒ List the equipment that will need periodic maintenance, testing, or inspection.

⇒ Include maintenance schedules.

⇒ Describe how maintenance should be documented.

⇒ Describe corrective actions that may be necessary (replacing DO membranes, replacing batteries, repair, cleaning, etc).

16) Instrument calibration, frequency, and record-keeping

⇒ List the equipment that will need to be calibrated

⇒ Describe calibration methods or where they are located in the associated SOP.

17) Inspection/acceptance requirements for supplies

⇒ Describe how to determine if supplies such as sample bottles, de-ionized water, nets, standard solutions, and reagents that will be needed in order to obtain quality data.

⇒ Describe how to determine whether supplies are acceptable or not.

⇒ Identify the people who will be responsible for the supplies.

18) Data acquisition requirements

⇒ This section will refer to the acquisition of data that will be collected from other sources.

⇒ Examples of this data include historical data, aerial photos, USGS flow data, and reports from other monitoring groups.

19) Non-direct measurements

⇒ This section describes any data necessary for the project that may come from sources other than direct measurements such as computer databases, meteorological data, Geographical Information System (GIS) data, scientific studies, historical data, literature files, and computer programs (i.e. modeling software).

⇒ Describe how this data will be used and any limitations that may apply to its use or reliability.

20) Data management

⇒ This section should describe how data is processed, stored, and used.

⇒ Specific actions that may be outlined in this section may include the recording, transcribing, digitizing, downloading, transformation, reduction, transmittal, management, storage, and retrieval of data.

⇒ Include examples of forms or checklist.

⇒ Details addressed in this section may include checking for data entry errors, calculations, minimizing error in calculations, report writing, electronic media, data backup procedures, software to be used, and hardware to be used.

⇒ If data will be submitted to the EPA STORET database, include instructions for doing so or cite the SOP section that describes this process.

Assessment and Oversight – These elements address procedures for evaluating the effectiveness of the project and ensure that the QA plan is correctly implemented. Assessments will increase confidence in the information obtained.

21) Assessment and response actions

⇒ This section describes how performance of the samplers and the laboratory will be evaluated and corrected if necessary. This process may involve scientific and statistical evaluations of data to determine if it is of the right type, quality, and quantity to support the intended uses.

⇒ Provide a schedule for these assessments.

⇒ Describe how assessment results will be reported.

⇒ There are some additional assessment techniques listed by the EPA. These are just examples and may or may not be applicable to a particular monitoring program. The EPA document *Guidance on Technical Audits and Related Assessments (G-7)* (EPA, 2000d) describes the different types of assessments.

i) Performance evaluations of laboratories (blind or double-blind samples)

ii) Determining if personnel, equipment, procedures, and facilities are ready for the collection of data (readiness reviews)

iii) Documenting the degree to which specified procedures are being implemented by field, laboratory, and management personnel (technical systems audits)

iv) Continuous assessment of implementation activities (surveillance)

v) Documenting the capabilities of a project's data management system (audits of data quality).

22) Reports

⇒ Identify the frequency, content, and distribution of reports.

⇒ Explain which details of the project are going to be included in the report.

⇒ Including an expected report outline in this section.

⇒ Indicate who is responsible for writing the reports.

Data Validation and Usability – These elements are applied after the completion of the data collection phase of the project and ensure that the data conform to the specified criteria and achieve the program's objectives. These elements involve data verification, data validation, and data quality assessment. Data verification is a performance evaluation conducted by those collecting data with the purpose of verifying that data has been collected using specified methods. It is conducted to show that the reported results reflect the actual results. During the verification process, records are reviewed from sample collection, sample receipt, sample preparation, and sample analysis. Data validation involves the identification of project requirements and inspection of verified data and methods by an independent party. Inputs to the data validation process may include project-specific planning documents (QAPPs), program-wide planning documents, SOPs, approved sampling or analytical methods, calibration records, field notebooks, sample collection logs, chain-of-custody forms, and verified data. During the data quality analysis process, data is evaluated to ensure that it can effectively and credibly provide support for environmental decision-making. The level of stringency of these data evaluation techniques will vary from project to project.

23) Data review, validation, and verification requirements

⇒ Briefly address how decisions will be made regarding accepting, rejecting, or qualifying data.

⇒ Data validation refers to a parameter or sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance.

⇒ Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications.

24) Validation and verification methods

⇒ Methods described in this section may include checking computer entries against field data sheets, looking for gaps in data, discovering outliers or out-of-range readings in the data, detecting errors, analyzing quality control data, using tables, interpreting graphs and charts, and writing a statement certifying that the data has been verified.

⇒ This section basically describes methods for verifying that tasks from the data management section of the QAPP are done correctly.

25) Reconciliation with data quality objectives

⇒ This section should describe any data quality analysis that will be performed to decide whether or not the data collected meets the objectives specified in the QAPP.

⇒ Compare the project's actual data quality indicator calculations to those specified in the project QAPP.

⇒ Provide options for actions that can be taken if the data does not meet the specified objectives, such as discarding the data, setting limits on the use of data, or revising the data quality objectives.

7.3 Resources and Training Opportunities

RLWD staff should participate with all water quality monitoring training sessions held within the Red River Valley when deemed necessary and feasible. In some cases they will be conducting the training. There is always room for improvement in a monitoring program. Opportunities to share ideas on improving sampling techniques should not be missed.

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