MODULE 1.
GUIDANCE ON PREPARING A QA PROJECT PLAN

This module (Athe Guidance@) is meant to provide you with a starting place for preparing your QA Project Plan. An attempt has been made to minimize QA Ajargon@ while, at the same time, ensuring the Guidance is inclusive of the national EPA requirements described in the EPA=s requirements and companion guidance documents:

$ *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5

$ *EPA Guidance for the Preparation of Quality Assurance Project Plans*, EPA QA/G-5

(NOTE: Both of these national EPA documents are available in Module 4.)

The Guidance is written mainly in a directive (or Ato do@) format and describes the materials you will need to assemble via lists, questions to think about and/or obtain answers to, and comments or perspective on the contents for each required section. The Guidance follows the same organization structure as the Template and the Model QA Project Plan provided in Modules 2 and 3, respectively. The section titles are designed to follow those of EPA QA/R-5, while the section numbering system has been simplified to be entirely numerical (e.g., here we use Section 1.1 instead of Section A1). For clarity, and to support referring back to the national EPA documents, the associated EPA QA/R-5 section number has been included in parentheses following the title of each section.

1.0 PROJECT MANAGEMENT (Sections 1.1 - 1.9): These sections describe how you will organize and run the project activities.

1.1 **<u>Title and Approval Page</u> (EPA QA/R-5 A1)** - [The purpose of this section is to identify the project title and name of organization conducting the project, as well as to document approval of the QAPP.]

Ensure this page includes:

- **$** Title of project and/or of QA Project Plan
- **$** Name of organization conducting the work (e.g., Big River Tribe Environmental Protection Agency) and their associated address
- **$** Signature/date line for all key parties who must approve the QA Project Plan followed by a printed line including their name, organization, and title (Note: Approving officials may include the Tribal Project Manager, Tribal QA Manager, the Tribal Environmental Director, the Tribal Chairperson or Tribal Council Members, consultant staff, contract laboratory director, the EPA Project Officer, the Regional EPA QA Manager or project representative)
- **$** Assistance agreement or contract number(s) funding the activity and knowledge of what program is funding the work (e.g., Clean Water Act 106 program, Brownfields

Program, Drinking Water Program, etc.)

1.2 **Table of Contents (EPA QA/R-5 A2)** - [The purpose of this section is to allow the reader of the QA Project Plan to locate the different information sections.]

Provide a list of the various QA Project Plan sections and subsections, tables, figures, references, appendices, etc. Include the section number, section title, and associated page where the information will be found.

Recommend including a header on each page (typically, in the upper right corner) of the QA Project Plan denoting the project name, revision number and/or date of version, and page number.

1.3 **Distribution List (EPA QA/R-5 A3)** - [The purpose of this section is to present a list of all individuals who should receive a copy of the approved QA Project Plan, as well as any subsequent revisions/updates.]

Provide a list of all key personnel that will receive original and updated copies of the QA Project Plan, along with their respective organization and contact information (i.e., telephone number, email address, and/or mailing address). These individuals may include:

- Project manager for tribe
- Field team leader for tribe
- QA/QC manager for tribe
- QA Project Plan preparer for tribe
- Laboratory manager
- Data reviewers
- Any essential contractor personnel
- Project Officer for EPA
- QA Officer for EPA

1.4 **Project Organization (EPA QA/R-5 A4)** - [The purpose of this section is to identify the roles and responsibilities of those individuals involved in the project and their respective organizations.]

Identify the individuals and organizations participating in the project and discuss their specific roles and responsibilities. Include:

- Program or project supervisor
- Program or project staff conducting the various project activities
- Tribal person responsible for QA/QC (activities may include: ensuring sampling, shipment, and lab analysis incorporate adequate QC components; reviewing QC results; recommending corrective action, when necessary; and evaluating data for

inclusion in reports) – whenever possible, ensure this individual is independent of the staff generating the data

- **$** Point(s) of contact and associated organization for any consultants and/or contractors and their specific project responsibilities
- **$** Contract laboratory, if applicable, as well as associated name(s) of points(s) of contact and QA Officer
- **$** Any other key personnel or organizations involved in project or program activities

Include contact information (i.e., telephone numbers, email addresses, and/or mailing addresses) of all program or project staff, consultants and/or contractors, laboratory contacts and QA Officer, etc. responsible for the project and the QA Project Plan. (Note: If this information was included in Section 1.3, it doesn't need to be repeated here.)

Provide an organization chart showing lines of authority/communication (i.e., who reports to whom) for all referenced people or organizations.

1.5 **Problem Definition/Background (EPA QA/R-5 A5) -** [The purpose of this section is to describe the specific problem to be investigated with the current project, along with any pertinent background information.]

Describe the purpose of the project by identifying the environmental problem and stating what you want to accomplish with the current efforts.

Provide information on why the investigation needs to take place. This might include knowledge about tribal concerns, reasons for conducting baseline monitoring, any background on why a problem exists or may exist, knowledge of any data gaps that need to be filled, or anything else that supports the need for the project or monitoring effort. (NOTE: This information may have been included in your work plan submittal. If so, this information could be reiterated in this section, or the current section could reference where the pertinent information was included in a previous document.)

Identify the principal data users/decision makers, i.e., the individual(s) who will use the data to make decisions.

Provide a brief summary of existing information (including previously collected field and/or laboratory data related to the project or monitoring effort) to provide a historical, scientific, and/or regulatory perspective for the current project. This information may include:

- **$** Qualitative or quantitative data such as chemical monitoring data (e.g., metals, nutrients, organic chemicals, microbiological data, etc.), physical parameter monitoring data (e.g., pH, conductivity, turbidity, dissolved oxygen), observational data (e.g., non-native plant inventories, fish or bird populations, benthic macroinvertebrate populations, etc.),

anecdotal data, wetlands evaluation data (e.g., geomorphology, turnover rates for wetlands, etc.), global information system (GIS) data, or any other environmental data relevant to the project

- **$** Information regarding where and how historical data were obtained
- **$** Source of the data such as state, tribe, US Geological Survey, US Forest Service, county, city, volunteer, permittees, university, or other sources
- **$** Summary of data gaps indicating what information is not known

1.6 **Project/Task Description and Schedule (EPA QA/R-5 A6)** - [The purpose of this section is to provide a management overview or summary of the work to be detailed in the remaining sections of the QA Project Plan.]

Demonstrate an understanding of what the project hopes to accomplish, by providing a summary of:

- **$** Work to be performed - This discussion should be as specific as possible and may include answering questions such as: What locations will be sampled for what parameters? How many samples are being collected? What analyses will take place for each measurement?
- **$** Products to be generated including reports to be written
- **$** Schedule for implementation - This information is often presented as a timeline bracketing the targeted dates for each key project task such as: development & approval of QA Project Plan, sample collection dates, laboratory analysis and reporting, data validation/evaluation, other project milestones, project report development and due date.

Connect what is needed to address the project objectives to how it will be obtained.

1.7 **Quality Objectives and Criteria for Measurement Data (EPA QA/R-5 A7)** - [The purpose of this section is to describe the objectives of the project (i.e., decision or study questions to be answered), identify the targeted action limits/levels, and define the measurement performance or acceptance criteria deemed necessary to meet those objectives.]

Describe Objectives and Project Decisions:

- **$** Provide statements of the general objectives showing knowledge of the overarching purpose of the sampling and analysis effort.
- **$** Demonstrate an understanding of what decisions are to be made using the data. In other words, what will this testing effort enable the tribe to do, or what questions are to be answered with the data? The decisions to be made or questions to be answered may be simple (e.g., to establish a baseline so that changes in the future can be identified) or challenging (e.g., to answer questions about health impacts), but EPA policy is that information needs to be collected for a clearly stated purpose. It is

recommended that decisions be framed in terms of "…if...then…" types of statements, so that the linkage between the data to be collected (or obtained from secondary sources) and the decisions to be made is clearly established.

Identify Action Limits/Levels (for selection of an analytical operation):

- Provide action limits/levels (often called project action limits or PALs) pertinent to the project. These are numerical values that will help the decision makers target a course of action from the project=s data. They may be:
  - Regulatory Standards - such as maximum contaminant levels (MCLs) for drinking water, tribal and/or Federal Water Quality Standards for fresh water bodies, etc.
  - Risk-Based Concentration Levels - such as concentrations triggering fish advisories, etc.
  - Technology Limitations - such as the ability of a state-of-the-art analytical method to measure to some Alow@ level, the capability of an engineering feature to remove a contaminant, etc.
- Identify the laboratory limits associated with the method, analysis, etc. selected to support the PALs.

(NOTE: See Appendix A for a more detailed discussion of PALs and their relationship to laboratory limits.)

Identify Data Quality Needs and Establish Acceptance Criteria (for each field sampling and analytical operation):

- Identify the Data Quality Indicators (DQIs) to be assessed to ensure the quality of your data will support scientific conclusions and/or project decisions. These DQIs include both quantitative and qualitative terms for characterizing data quality. The principal DQIs, whether they are quantitative or qualitative terms, and the types of questions they are designed to support include:
  - Precision (quantitative) - How reproducible do the data need to be?
  - Accuracy/bias (quantitative) - How well do the measurements reflect what is actually in the sample?
  - Representativeness (quantitative and/or qualitative) - How well do the data reflect the environmental conditions?
  - Comparability (qualitative) - How similar do the data need to be to those from other studies or from similar locations of the same study, same sampling locations but at different times of the years, etc.?
  - Completeness (quantitative and/or qualitative) - What amount, typically expressed in percentage, of the data you plan to collect is necessary to meet your project objectives (quantitative)? And, are there any data points that are absolutely critical and therefore may warrant re-sampling and/or re-analysis if not attained (qualitative)?

- **$** Sensitivity (quantitative) - Are the field and/or laboratory methods sensitive enough to Asee" or quantify/qualify your parameters of concern at concentrations at or below the regulatory standards or your PALs? Are the quantitation limits (QLs) low enough to answer the question(s) you are asking?
- **$** Describe how you plan to assess each data quality indicator, for example:
  - **$** For quantitative terms – Identify the field and/or laboratory quality control (QC) samples to be used to assess each DQI.
  - **$** For qualitative terms – Identify processes in place, procedures to be followed, etc. to ensure the necessary data quality.
- **$** Provide the acceptance criteria (often referred to as measurement performance criteria or MPC) for each data quality indicator that will be assessed quantitatively, and include example calculations when pertinent.

(NOTE: Review of the analytical laboratory procedures is often a good place to start when attempting to establish QC samples and project-specific MPC for these methods. Often, the QC samples and criteria provided in these methods are adequate to meet your data quality needs. The laboratory QC criteria, as well as discussions with experienced laboratory and field personnel, may also provide insight into establishing reasonable MPC for field QC samples such as field duplicates and equipment blanks.

Also, see Appendix B for a more detailed description of each DQI, as well as a discussion of establishing associated MPC. This appendix also presents information regarding selecting QC samples to assess that the MPC are met for each DQI. The discussion in Appendix B is most pertinent to chemical analyses. For additional information pertaining to biological studies, see Appendix C.)

1.8 **Special Training Requirements/Certifications (EPA QA/R-5 A8)** - [The purpose of this section is to describe any special or non-routine training or certifications necessary to successfully complete the project.]

Identify any special training or certifications needed by personnel to conduct project activities. (This might be associated with activities such as: collecting samples, performing field measurements, handling of hazardous waste, reviewing data, etc.)

Discuss plans for providing any necessary training, as well as how training records will be documented and where this information will be stored.

1.9 **Documents and Records (EPA QA/R-5 A9)** - [The purpose of this section is to provide information concerning the management of project documents and records, including this QAPP.]

Describe the process for distributing the most current approved QA Project Plan, as well any revisions/updates, to the appropriate project staff.

Summarize the type of information necessary to be included in laboratory data report packages. This may include (but not be limited to, or necessarily inclusive or exclusive of) such items as:

- **$** Field sample results
- **$** QC sample results (e.g., blanks, spikes, duplicates, etc.)
- **$** Instrument Calibration data
- **$** Description of data qualifiers that the laboratory applies to sample results
- **$** Narrative summarizing issues/problems during analysis, as well as their resolutions
- **$** Copies of chain-of-custody records (e.g., chain-of-custody forms, sample receipt records, shipping records, etc.)
- **$** Raw data and copies of any logbook information, including sample preparation logs, etc.
- **$** Electronic data deliverables, if needed

Discuss any other project records to be maintained. Some examples include information generated in the field (e.g., field forms, well development and sampling logs, field logbooks, chain-of-custody forms, etc.), assessment/oversight reports, interim progress/status reports, final reports, etc.

State where all project documents and records will be stored and how long. Include any backup procedures for electronic data.

Describe plans or requirements for reporting data to EPA or other report recipients. Identify what final reports will be generated, what the report will include, and how the data will be stored (e.g., in a database, an Excel spreadsheet, a file cabinet, etc.).

(NOTE: This section provides a discussion of the management of reports and documentation. Procedures and management specific to data are covered in Section 2.10.)

2.0 DATA GENERATION (Sections 2.1 - 2.10): These sections describe how you will collect and report data.

2.1 **Sampling Design (Experimental Design) (EPA QA/R-5 B1)** - [The purpose of this section is to describe the overall design of the project=s data collection activities and the rationale supporting the design.]

Provide the rationale for the sampling design and selection of sampling locations, measurement/analytical parameters, and matrix/media to be sampled. Include any assumptions about the nature of the area being sampled, as well as the individual sampling locations.

Describe the project=s sampling design including:

- **$** Types of media or matrix to be sampled (e.g., surface water, groundwater, soil, sediment, etc.) and numbers of each
- **$** Sampling locations and frequencies at each location
- **$** Parameters to be measured (both field measurements and laboratory analyses) for each sample/media/location
- **$** Type of sample (i.e., grab vs. composite)
- **$** Any design assumptions (Note: If samples are to be collected after a storm event, you may define the storm event based on the number of inches of rain after some number of dry days.)
- **$** Types of field QC samples to be collected and their overall frequency

Include map(s) depicting sampling locations.

2.2 **Sampling Methods (EPA QA/R-5 B2)** - [The purpose of this section is to describe the procedures to be used to collect field samples.]

Include a detailed description of sample collection methods. Each method should include:

- **$** Step-by-step instructions for sample collection and any procedures to homogenize, filter, preserve, and/or composite the samples in the field
- **$** List of field sampling equipment, materials, supplies
- **$** Equipment preparation/decontamination methods along with plans for disposal of decontamination fluids (Note: If dedicated/disposable equipment is to be used, decontamination procedures are not required.)
- **$** Detailed instructions for collection of all field QC samples (for example, equipment blanks, field duplicates, etc.)

Alternatively, if information is included in standard operating procedures (SOPs), provide these as an attachment/appendix. If the SOPs provide options, ensure that the option(s) selected for the current project are identified in the text.

Provide a list or table identifying all sample media and analytical parameters along with their associated sample containers (including number, type, and size), preservation method, and maximum holding times. (Note: This information should be available from the laboratory.)

2.3 **Sample Handling and Custody (EPA QA/R-5 B3)** - [The purpose of this section is to describe the sample handling and custody procedures from sample collection through transfer/transport and laboratory analysis, as well as for ultimate disposal.]

Describe the plans to ensure sample integrity (i.e., to ensure samples don=t get lost, mixed up, or tampered with) and chain-of-custody from sample collection through analysis, and identify the

individuals responsible.

Provide examples of all associated chain-of-custody/tracking forms used to document sample custody transfers, and describe how these sample handling documents will be filed and archived.

Describe the sample numbering/identification system planned to provide each sample with a unique sample identification number.

Provide an example of a sample label. This label may include:

- **$** Sample number/location
- **$** Time and date of collection
- **$** Name of individual who collected the sample
- **$** Preservation requirements

Describe the procedures for packing samples for transfer/shipment and sealing the shipping containers. Provide examples of any chain-of-custody seals.

(NOTE: Any or all of the information needed for this section could be presented as a standard operating procedure or SOP to be referenced in the text and included as an appendix/attachment.)

2.4 **Analytical Methods (EPA QA/R-5 B4)** - [The purpose of this section is to describe the procedures to be used to analyze samples in the laboratory and/or in the field, as well as the associated sample preparation (including extraction, digestion, etc.) methods.]

Identify the analytical methods (including field measurements, field analyses, and laboratory analyses). Include sample preparation and/or extraction methods, waste disposal requirements (if any), and specific performance requirements.

Depending on the nature and extent of the analyses to be performed, you may opt to divide this section into subsections to address various types of measurements/analyses as follows:

- **$** Field Measurements - Include on-site measurements such as dissolved oxygen, turbidity, pH, etc. that provide supporting information for your project.
- **$** Field Analyses
  - **B** Screening - Include on-site analyses to focus future sampling and/or analysis activities but not used to make definitive decisions for the project. This may include analysis of nutrient by various field test kits, PCBs by immunoassay test kit, select metals by XRF, etc.
  - **B** Definitive - Include on-site analyses that may provide data of equivalent quality as off-site laboratory analysis. This may include analysis of volatile organic compounds by

field GC, etc. It could also include analysis of PCBs by immunoassay test kit, select metals by XRF, etc. if supported by confirmatory off-site laboratory analysis.

- **$** Laboratory Analysis - Include off-site analyses conducted at a contracted or Tribe-owned laboratory. (NOTE: See Module 6 for guidance in selecting a laboratory.)

Provide a list or table identifying the measurement/analysis and sample preparation methods for each sample media, identifying the EPA or "Standard Methods" method number when appropriate.

Include copies of methods or standard operating procedures (SOPs) (as an attachment/appendix) that are not likely to be readily available to EPA reviewers or other project personnel. Each method should include:

- **$** Step-by-step instructions
- **$** Associated calibration and QC criteria (including frequency, acceptance criteria, and corrective actions if acceptance criteria are exceeded, as well as how this information will be documented)
- **$** Sources and concentrations of any calibration standards, QC check samples, etc.
- **$** Quantitation/reporting limits to be obtained

Identify the laboratory (or other organization) responsible for each measurement/analysis. Include all pertinent Laboratory QA Manuals (as an attachment/appendix) for off-site analyses. If the analysis is a field method, state this clearly, identify who will be performing the measurement/analysis, and provide copies of any associated field measurement equipment owners manuals (as an attachment/appendix).

Provide proof of laboratory experience in running non-standard methods or unusual matrices (e.g., fish) (i.e., information showing that a non-EPA or "Standard Methods" method has been developed and tested). Include a copy of the most current method detection limit (MDL) studies, when applicable.

2.5 **Quality Control Requirements (EPA QA/R-5 B5)** - [The purpose of this section is to identify the QC checks in place for the sample collection, analysis, and field measurement activities that will be used to help determine the reliability of the data generated.]

Provide a list (either as a narrative or in a table) of all planned field and laboratory QC tests/samples for each measurement/analytical parameter and for each sample medium/matrix. This section may include some similar information as previously discussed in Section 1.7. It's important that Section 1.7 clearly defines the data quality acceptance criteria or MPC for the project, while Section 2.5 provides the necessary supporting documentation further defining just how the goals will be met/accomplished including frequency, acceptance criteria and corrective actions if the acceptance criteria are not met. If any of the information necessary to support Section 1.7 is provided in Section 2.5, this should be clearly stated and referenced within

Section 1.7. There is no need to provide the same information in both sections.

For each QC check (for field sampling, field measurements, field analyses, and laboratory analyses) include:

- **$** Frequency with which the QC measurement will be made
- **$** Acceptance criteria for each QC measurement
- **$** Corrective actions if acceptance criteria are not met

(NOTE: This information may be contained in field or laboratory standard operating procedures, Laboratory QA Manuals, etc. However, it should be summarized in your QA Plan.)

2.6 **Instrument/Equipment Testing, Inspection, and Maintenance (EPA QA/R-5 B6)** - [The purpose of this section is to describe how you will know that the equipment and instruments will work properly when needed.]

Identify tools, gauges, test equipment, instruments, etc. (for both field and laboratory) that need periodic maintenance, testing or inspection. These may include: pumps, flowmeters, dissolved oxygen probes, pH meters, balances/scales, etc.

Provide a description of:

- **$** Inspections and testing of environmental sampling and measurement systems that will be performed before use (to deem acceptable for use)
- **$** Periodic preventive maintenance of each piece of equipment or instrument
- **$** Schedule/frequency of performing these tasks
- **$** Identity of who will perform these tasks
- **$** Method of how testing, inspections, and maintenance will be documented and records maintained, as well as how these records will be traceable to a particular instrument/equipment
- **$** Critical spare parts to ensure the reduction of downtime, and how they will be supplied and/or stocked

(NOTE: This information may be contained in field or laboratory standard operating procedures, equipment manuals, Laboratory QA Manuals, etc. If so, please reference this information in your QA Project Plan and ensure the supporting documentation is included as an attachment/appendix.)

2.7 **Instrument/Equipment Calibration and Frequency (EPA QA/R-5 B7)** - [The purpose of this section is to identify how you will ensure continual quality performance of any equipment and instruments.]

Identify tools, gauges, test equipment, instruments, etc. (for both field and laboratory) that need to be calibrated. These may include: pumps, flowmeters, dissolved oxygen probes, pH meters,

balances/scales, etc.

Provide a detailed discussion of all calibration methods including:

- **$** Step-by-step instructions, with acceptance criteria (or control limits)
- **$** Sources and concentrations of any calibration standards
- **$** Schedule/frequency of calibration
- **$** Identity of who will perform the calibration
- **$** Method of how calibration will be documented and records maintained, as well as how these records will be traceable to a particular instrument/equipment

(NOTE: This information may be contained in field or laboratory standard operating procedures, equipment manuals, Laboratory QA Manuals, etc. If so, please reference this information in your QA Project Plan and ensure the supporting documentation is included as an attachment/appendix.)

2.8 **Inspection/Acceptance Requirements of Supplies and Consumables (EPA QA/R-5 B8)** - [The purpose of this section is to document your system for ensuring you have the right critical field and laboratory supplies and consumables.]

Provide a list of all critical supplies and consumables. "Critical" refers to those that may directly or indirectly affect the quality of the results (for example: sample containers, collection devices, preservation solutions, decontamination fluids).

Describe the specifications or acceptance criteria for supplies and consumables. Identify who is responsible for inspecting and accepting the supplies, how often, and how and where the materials will be handled and stored. (Note: This information may be contained in field or laboratory standard operating procedures, equipment manuals, Laboratory QA Manuals, etc. If so, please reference this information in your QA Project Plan and ensure that supporting documentation is included as an attachment/appendix.)

2.9 **Data Acquisition Requirements (Non-Direct Measurements) (EPA QA/R-5 B9)** - [The purpose of this section is to describe any existing data to be obtained from external sources as well as plans to evaluate any limitations on its intended use for the current project.]

Identify any data that you plan to use that you are getting from someone else, such as:

- **$** Existing sampling and analysis data from a previous project
- **$** Photographs or maps
- **$** Published literature
- **$** Information from public databases
- **$** Weather or GPS (location) data

And, ensure you identify the associated source of the information.

Describe the purpose of the original collection of the data, and indicate its relevance to the current project.

Describe how you intend to use the data, and discuss how you will know if the data are of acceptable quality for your current project and/or if there are any limitations on its use. (For example: Is there any knowledge of the quality of this information? If there are quantitative field or laboratory measurement data, how will you evaluate it for adequacy for the current project? Were the data collected under some other documented plan/QA Project Plan?)

2.10 **Data Management (EPA QA/R-5 B10)** - [The purpose of this section is to provide an overview of the management of data generated throughout the project.]

Describe how data (both hard-copy and electronic) will be managed from generation (in the field and/or lab) to final report and storage. Include any plans to:

- **$** Record, transcribe, digitize, and/or download data
- **$** Check and verify data manually entered into electronic systems and databases
- **$** Transform and/or reduce data using mathematical calculations (including example calculations)
- **$** Transmit data within as well as outside your organization
- **$** Store and retrieve data from storage (including project files and archiving)

Discuss the methods and any equipment to be used to:

- **$** Identify and correct errors found during data management
- **$** Prevent loss of data during data entry, reduction, and reporting
- **$** Check any computer outputs

Describe checks that ensure data quality throughout all data management activities (especially when encoding during data entry).

Identify who is responsible for each data management task.

3.0 ASSESSMENT AND OVERSIGHT (Sections 3.1 - 3.2): These sections describe how you will check that all activities are completed correctly and as planned.

3.1 **Assessments/Oversight and Response Actions (EPA QA/R-5 C1)** - [The purpose of this section is to provide information concerning how a project=s activities will be assessed during the course of the project to ensure the QA Project Plan is being implemented as planned/approved.]

Provide a brief summary of assessment techniques, including roles of different parties involved.

These are the activities to evaluate the various project components (such as field activities, lab analysis, data management, etc.) during the project to assure activities are being conducted as planned (instead of finding out at the end of the project when there=s no chance to refocus efforts). Examples of types of assessments you may consider include:

- **$** Readiness reviews of field team prior to starting field efforts
- **$** Performance evaluation samples submitted to the lab along with the field samples
- **$** A senior staff member reviewing how well a junior staff member or volunteer is following documented field procedures, etc.

(NOTE: Additional suggestions may be found in the *Volunteer Monitor=s Guide to Quality Assurance Project Plans* and *EPA QA/G-5* included in the reference materials. Informal oversight or procedural reviews conducted by tribal staff may serve as assessments if the review is supported by documentation (such as a memo to the files) describing the evaluation, its results or findings, any recommended corrective actions, and implementation of the corrective actions.)

For each type of assessment (audit), include:

- **$** Frequency and purpose
- **$** Criteria for assessment and deeming it acceptable/successful
- **$** Identity of assessment personnel/assessors
- **$** Reporting of assessment results - how, by whom, and to whom
- **$** Authority of assessors, including any related stop work orders
- **$** Response actions to assessment findings; corrective actions, if acceptance criteria are exceeded

Examples of any forms or checklists to be used to document assessment and response/correction action activities may be provided as an appendix/attachment.

3.2 **Reports to Management (EPA QA/R-5 C2)** - [The purpose of this section is to describe how management will be kept informed of project oversight and assessment activities and their findings on an ongoing basis during the course of the project.]

Identify the types of reports to be provided to EPA and tribal officials, their content, frequency, and who is responsible for writing them. These may include periodic telephone calls, progress/status reports (including QA/QC updates), data evaluation reports, draft & final project reports, etc. The final project report should analyze and interpret data, present observations, draw conclusions, identify data gaps, and describe any limitations in the way the data should be used.

4.0 DATA REVIEW AND USABILITY (Sections 4.1 - 4.3): These sections describe how you will review and interpret the data. Data review encompasses the processes of verification and evaluation/validation, as well as reconciling for usability in supporting project objectives and decisions.

4.1 **Data Review, Verification, and Validation Requirements (EPA QA/R-5 D1)** - [The purpose of this section is to identify the criteria for deciding to accept, reject, or qualify project data in an objective and consistent manner.]

Describe the criteria you will use for deciding to accept, reject, or qualify any data. These are the final checks on the data to decide whether they satisfy the quality objectives and measurement criteria listed in Section 2.5.

Include a brief discussion of plans to:

- **$** Provide in-house examination that data have been recorded, transmitted, and processed correctly.
- **$** Ensure there is a complete list of sample information available (sample numbers, matrixes, QC samples, shipping dates, preservation methods, sample containers, holding times, etc.)
- **$** Conduct a completeness check on sample data, as well as all associated field data and logs.

4.2 **Verification and Validation Methods (EPA QA/R-5 D2)** - [The purpose of this section is to describe the methods or procedures for verifying and validating project data.]

Describe the process to be used to verify and validate data (including field information, lab data, etc.), including the chain-of-custody for data throughout the project.

Verification -

- **$** Describe how data will be checked to ensure it is complete and generated according to the methods and procedures specified in the QA Project Plan. Include any associated checklists or forms to document the type of items to be checked/verified (such as sample containers, preservation methods, chain of custody forms, etc.).
- **$** Include a discussion of procedures to be taken to ensure that there are no unacceptable departures from the sampling SOPs.
- **$** Describe steps taken by the lab to qualify sample results. Include data qualifiers that the lab will apply when data do not meet lab QC acceptance limits. (Note: This may be included in a lab QA Manual or SOP that could be referenced.)
- **$** Discuss how issues (such as any inconsistency with the QA Project Plan) will be resolved, documented, and reported and the personnel responsible for these tasks.

Validation -

- **$** Describe the procedures you will use to accept, reject, or qualify data based on the QC criteria (listed in Section 2.5), as well as any associated calibration criteria, holding times/preservation, etc. deemed appropriate. Include any associated checklists or

forms to document the data validation effort.

- **$** Define the data qualifiers to be used (e.g., U = not detected, J = estimated, R = rejected).
- **$** Reference or include any written data validation procedures, if used.
- **$** Identify the individuals who will review data, as well as resolve and document any data quality problems.

4.3 **Reconciliation with User Requirements (EPA QA/R-5 D3)** - [The purpose of this section is to describe how you will evaluate the results of the study to see if they meet the requirements defined (in Sections 1.7 and/or 2.5) by the data users or decision makers. This is the final assessment of the data quality and the culmination of the entire QA process for the project.]

Describe how the sample results (which have already been verified and validated) will be analyzed and evaluated to determine whether the objectives and data quality needs of the project were met, as well as how the results of this evaluation will be reported.

Include any mathematical and/or statistical formula to be used to calculate precision, accuracy/bias, completeness, etc. of the project data. If these calculations are presented in another section (such as Section 1.7), reference where these may be found in the current section.

Discuss how you will handle any limitations on the use of the data and how you will report the impact of any data-use limitations to data users and decision makers.

5.0 REFERENCES: This section provides supporting documentation to the QA Project Plan text.

References - Include a list of all pertinent references.

SUPPLEMENTAL INFORMATION/ATTACHMENTS - FIGURES, TABLES, & APPENDICES: These attachments provide supporting information to the QA Project Plan text.

Maps and Figures - Include maps and figures that don=t easily fit within the QA Project Plan text as an appendix or attachment.

Tables - Include large tables that don=t easily fit within the QA Project Plan text as an appendix or attachment.

Appendices - Include items such as: field equipment manuals, laboratory contracts and/or QA Manuals, field and laboratory SOPs, example documentation (i.e., field forms, chain-of-custody forms, sample labels), etc.

APPENDIX A.
Project Action Limits (PALs), Detection Limits (DLs), and Quantitation Limits (QLs)

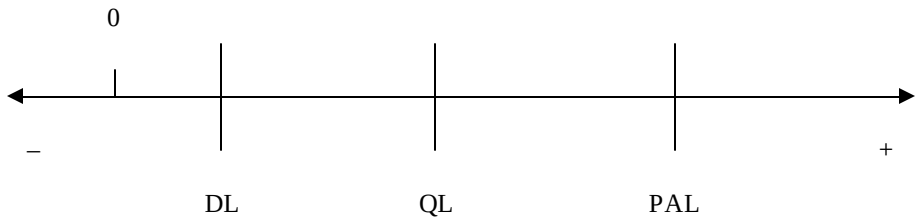
The Project Action Limits (PALs), as introduced and defined in Section 1.7, will help target the selection of the most appropriate method, analysis, laboratory, etc. (the analytical operation) for your project. One important consideration in this selection is the type of decision or action you may wish to make with the data, depending on whether you generate results in concentrations below, equal to, or above the PALs. In order to ensure some level of certainty of the decisions or actions, it is recommended that you consider choosing an analytical operation capable of providing quality data at concentrations less than the PALs.

When choosing an analytical operation, you will come across terms such as Detection Limit (DL) and Quantitation Limit (QL). These terms are frequently expressed by other terminology, but the two key words to look for are "detection" and "quantitation" (sometimes referred to as "quantification"). The following describes the differences between these terms:

- **Detection Limit** or **DL** - This is the minimum concentration that can be detected above background or baseline/signal noise by a specific instrument and laboratory for a given analytical method. It is not recognized as an accurate value for the reporting of project data. If a parameter is detected at a concentration less than the QL (as defined below) but equal to or greater than the DL, it should be qualified as an estimated value.

- **Quantitation Limit** or **QL** - This is the minimum concentration that can be identified and quantified above the DL within some specified limits of precision and accuracy/bias during routine analytical operating conditions. It is matrix and media-specific, that is, the QL for a water sample will be different than for a sediment sample. It is also recommended that the QL is supported by the analysis of a standard of equivalent concentration in the calibration curve (typically, the lowest calibration standard).
  (Note: The actual "real time" sample Reporting Limit or RL is the QL adjusted for any necessary sample dilutions, sample volume deviations, and/or extract/digestate volume deviations from the standard procedures. It is important to anticipate potential deviations to minimize excursions of the RL above the PAL, whenever possible.)

For any analytical operation, the relationship between the PAL, QL, and DL terms can be represented as:

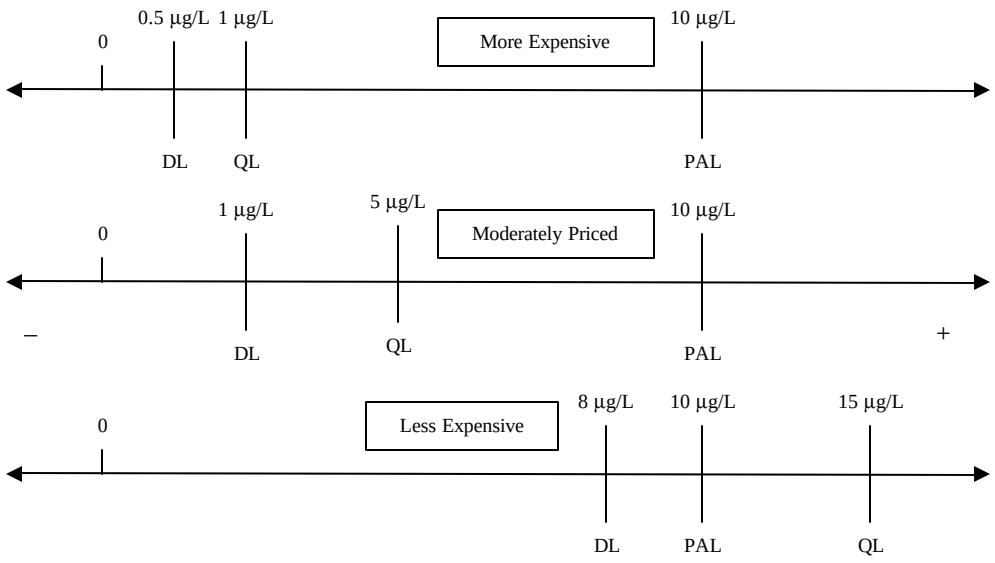


A standard general rule of thumb is to select an analytical operation capable of providing a QL in the range of 3-10 times lower than the PAL and 3-10 times higher than the DL. Some additional considerations for selecting an analytical operation with the most appropriate relationship for your data needs may include the following:

- When critical decisions will be made with project data exceeding the PALs, you may wish to have a greater level of certainty at the PAL concentration level. To accomplish this, you may want to select an analytical operation capable of providing a QL towards the lower end of the range (closer to values 5-10 times lower than the PAL). This would result in a greater distribution of concentrations that could be reported with certainty, both less than and approaching the PAL.

- When you're looking to minimize uncertainty of the project data reported at the QL, you may choose to select an analytical operation where the QL is much greater than the DL (closer to values 5-10 times higher than the DL). This would help to ensure less background noise impacts on the data.

Careful consideration of the PAL/QL/DL relationship should be given when balancing your data quality needs with project resources to get the most appropriate data quality for the least cost. For example, the PAL for one analytical parameter may be 10 µg/l based on the Federal Water Quality Standard, and you have a choice between an expensive state-of-the-art analytical technology providing QL = 1 µg/l and DL = 0.5 µg/l, a moderately-priced standard method with QL = 5 µg/l and DL = 1 µg/l, or an inexpensive field measurement with QL = 15 µg/l and DL = 8 µg/l. These choices may be represented as follows:



If you are attempting to identify whether the analytical parameter exceeds the Federal Standard, the moderately priced method may serve your needs. However, if the parameter is known to be present and you're attempting to further identify the boundaries of those areas minimally impacted by low levels (for example, you're suspecting lower concentrations may pose a risk to some aquatic species of concern in the area), you may opt for the more expensive analysis with the lower QL and DL. In both of these examples, the inexpensive field measurement may not be appropriate to meet your project needs, as the lowest concentration that would be reported (15 µg/l) exceeds the PAL. However, if you are just trying to get a handle on whether some specific locations within your study region grossly exceed the PAL, data generated from the inexpensive field measurement may suit your project needs.

APPENDIX B.
Data Quality Indicators (DQIs) and Measurement Performance Criteria (MPC) for Chemical Data

Identifying Data Quality Indicators (DQIs) and establishing Quality Control (QC) samples and Measurement Performance Criteria (MPC) to assess each DQI, as introduced in Section 1.7, are key components of project planning and development. These components demonstrate an understanding of how "good" the data need to be to support project decisions, and help to ensure there is a well-defined system in place to assess that data quality once data collection/generation activities are complete.

When faced with addressing data quality needs in your QA Project Plan, one of the first terms you may come across is Data Quality Indicators (DQIs). DQIs include both quantitative and qualitative terms. Each DQI is defined to help interpret and assess specific data quality needs for each sample medium/matrix and for each associated analytical operation. The principal DQIs and a brief summary of information related to assessing each DQI is as follows:

- **Precision** -

  Questions answered: How reproducible do the data need to be? How good do I need to be at doing something (such as sample collection, sample prep/analysis, etc.) the same way two or more times?

  Expressed in terms of "*relative percent difference*" for comparison of 2 data points -

  Quantitative vs. Qualitative term: Quantitative.

  QC samples (may include):

  Field duplicates - To duplicate all steps from sample collection through analysis;

  Laboratory duplicates - To duplicate inorganic sample preparation/analysis methodology; and/or

  Matrix spike/matrix spike duplicates - To duplicate organic sample preparation/analysis methodology; to represent the actual sample matrix itself.

  Acceptance criteria or MPC: May be expressed in terms of Relative Percent Difference (RPD) between two data points representing duplicates and defined by the following equation:

$$RPD = \frac{\left|X_1 - X_2\right|}{\left(X_1 + X_2\right)/2} \times 100$$

  where,

  RPD = Relative Percent Difference (as %)

  $\left|X_1 - X_2\right|$ = Absolute value (always positive) of $X_1 - X_2$

  X_1 = Original sample concentration

  X_2 = Duplicate sample concentration

For field duplicate precision, an RPD of =20% might serve as a standard rule of thumb for aqueous samples.

For laboratory QC sample precision, information provided in the analytical methods might be found to be adequate to meet your data quality needs.

Expressed in "*relative standard deviation*" or other statistical means for comparison of 3 or more data points - Follow a similar thought process as described above and include appropriate calculations.

- **Accuracy/Bias** -

Questions answered: How well do the measurements reflect what is actually in the sample? How far away am I from the accepted or "true" value, and am I above this value or below it?

Expressed in terms of *"Recovery"* -

Quantitative vs. Qualitative term: Quantitative.

QC samples (may include):

Matrix spikes - To monitor sample preparation/analysis methodology, as well as, to represent the actual sample matrix itself;

Standard reference materials and/or laboratory control samples - To monitor sample preparation/analysis methodology and often of a similar media (such as water, soil, sediment) as the field samples; and/or

Performance Evaluation (PE) samples – (may be appropriate for complex analyses) To serve as an external check on sample preparation/analysis methodology, as samples of known concentration are prepared external to the laboratory and submitted for analysis as "blind" or unknown samples.

(NOTE: The concentrations of these QC samples are typically near the middle of the calibration range.)

Acceptance criteria or MPC: MPC are typically expressed in terms of % Recovery of a known or accepted/true amount and defined by the following equation:

$$\%R = \frac{X}{K} \times 100$$

where,

$\%R$ = Recovery (as %)

X = Measured value or concentration

K = Known or accepted/true value or concentration

For matrix spikes, the % Recovery calculation typically takes into account correcting the matrix spike concentration for the naturally occurring amounts (as measured in the unspiked sample). The calculation may be represented by the following equation:

$$\%R = \frac{(A-B)}{K} \times 100$$

where,

%R = Recovery (as %)

A = Measured value or concentration in the matrix spike

B = Measured value or concentration in the unspiked sample

K = Known or accepted/true value or concentration in the matrix spike without native amounts present

For laboratory QC sample accuracy/bias, information provided in the analytical methods might be found to be adequate to meet your data quality needs.

For PE sample accuracy/bias, information is available from the PE sample vendor.

Expressed in terms of *"Contamination"* -

Quantitative vs. Qualitative term: Quantitative.

QC samples (may include):

Field blanks - To assess the affect of any potential sample collection contaminant sources on the associated sample data; and

Laboratory blanks - To assess the affect of any potential laboratory preparation/analysis contaminant sources on the associated sample data.

Acceptance criteria or MPC: MPC are typically expressed in reference to the QL (as defined in Appendix A). MPC are often set at <QL for field blanks and <QL or some fraction of the QL (such as <1/2 QL) for laboratory blanks.

- **Representativeness** -

Questions answered: How well do the sample data reflect the environmental conditions? Does my 500mL sample represent all the water in that lake? Is my sample still the same after that hot, bumpy truck ride to the laboratory?

Quantitative vs. Qualitative term: May include both.

As *"Quantitative"* term:

QC samples (may include):

QC samples for other DQIs - To serve as overall checks of representativeness; and/or

Temperature blanks (water samples that travel with samples from transport in the field to the laboratory) - To serve as a QC check for temperature-related sample preservation.

Acceptance criteria or MPC: For temperature blanks, MPC may be expressed in relation to an acceptable temperature range. For example, for field samples requiring preservation at 4°C, the MPC may be 4°C +/- 2°C.

As *"Qualitative"* term:

QC samples (may include): None.

Acceptance criteria or MPC: Assessing this DQI may include plans to verify that documented sample collection and analytical methods (including sample handling &

chain-of-custody procedures, sample preservation, and sample holding times protocols) were followed to ensure the data reflects the environmental conditions. Assessing may also include a review of the sampling design to determine whether samples collected were representative of the environmental conditions and extent of physical boundaries, especially if the sampling design was based on judgmental sampling and not on statistical means.

- **Comparability** –

  Questions answered: How similar do the data need to be to those from other studies or from similar locations of the same study, same sampling locations but at different times of the year, etc.? Are similar field sampling and analytical methods followed to ensure comparability? If variations are noted in field conditions (such as a stream bed being somewhat dry resulting in more turbid water samples), do these observations support poor comparability of associated data?

  Quantitative vs. Qualitative: Qualitative.

  QC samples (may include): None.

  Acceptance criteria or MPC: Assessing this DQI may include plans to compare sample collection and handling methods, analytical procedures, and QA/QC protocols between studies, study locations, sampling time of year, etc. along with the associated data. Additionally, comparison of concentration units, types of equipment used, and weather/seasonal variations may be assessed.

- **Completeness** –

  Questions answered: What amount (typically expressed in percentage) of the data you plan to collect is necessary to meet your project objectives? And, are there any data points that are absolutely critical and therefore may warrant re-sampling and/or re-analysis if not attained? After all the things that went wrong do I still have enough acceptable information and data to make a decision?

  Quantitative vs. Qualitative: May include both.

  As *"Quantitative"* term:

  QC samples (may include): None.

  Acceptance criteria or MPC: MPC are typically expressed in terms % Completeness between the amount of usable data collected versus the amount of data planned to be collected for the study. Completeness is defined by the following equation:

$$\%C = \frac{N}{T} \times 100$$

  where,

  $\%C$ = Completeness (as %)

  N = Number of usable results

  T = Targeted number of samples planned to be collected

Typical MPC may fall somewhere in the range of 75 - 90% completeness, depending on how critical it is to supporting project decisions.

As *"Qualitative"* term:

QC samples (may include): None.

Acceptance criteria or MPC: Assessing this DQI may include ensuring that any data points (locations and/or analyses) that were defined as being absolutely critical to the project have in fact produced usable data and, if not, have set plans in motion to re-sample and/or re-analyze.

- **Sensitivity -**

Questions answered: Are the field and/or laboratory methods sensitive enough to "see" or quantify your parameters of concern at or below the regulatory standards or your PALs? Are the QLs low enough to answer the question(s) you are asking? How low can I measure and still have confidence in the results?

Quantitative vs. Qualitative: Quantitative.

QC samples (may include):

Calibration verification - To assess the ability to accurately quantify data at the low end of the calibration curve; and/or

Laboratory QC samples (such as laboratory control samples, laboratory fortified blanks, etc.) - To ensure accurate quantifying of data at the QL.

(NOTE: The concentrations of these samples are typically at or near the QL which is typically defined by the lowest point on a calibration range.)

Acceptance criteria or MPC: MPC may be expressed in terms of the laboratory's acceptable performance criteria for their QC checks. This is typically expressed as QL +/- some defined acceptable concentration value deviation.

Another way of approaching this material is through a systematic process broken down into several steps (for each sample medium and associated analytical operation:

Step 1 - Identify the most critical Data Quality Indicators (DQIs) for your project. (For example, sensitivity may be more critical than another DQI and would drive your selection of a sampling or analytical method.) DQIs should be associated with each sample medium/matrix and each sampling & measurement/analysis scheme planned. The principal DQIs include: precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity (as described above).

Step 2 - Determine which of the DQIs will be assessed quantitatively (typically, these may include precision, accuracy/bias, and sensitivity) and which are more qualitative in nature (typically, these may include representativeness, comparability, and completeness).

Step 3 - Describe how each DQI will be assessed. Identify pertinent quality control (QC) samples that

will serve as checks on data quality, and discuss how these QC samples will be evaluated.

Step 4 - For the DQIs that can be assessed quantitatively:

- **$** Identify the QC samples selected for assessing each DQI. The QC samples, as discussed previously, may include both field QC samples (such as field duplicates, field/equipment blanks, etc.) and measurement/analysis QC samples (such as laboratory duplicates, method blanks, matrix spikes/matrix spike duplicates, laboratory control samples, etc.).
- **$** Provide the calculation(s) that will be used to define the acceptance criteria or Measurement Performance Criteria (MPC) for each DQI.
  (NOTE: These equations are generally included in Section 1.7 of the QA Project Plan. If they are presented in another section, Section 1.7 should clearly state where they will be found.)

- **$** Identify the Measurement Performance Criteria (MPC) for each DQI and the associated QC samples selected for assessing whether the MPC was met. The MPC for your project may be defined by several options. The two primary options include:
  - **$** Project team defines project-specific criteria; or
  - **$** Project team defaults to QC criteria already defined by a sampling, field measurement, or analytical method once reviewed and deemed acceptable to meet the data needs of the project.

  Types of QC Samples and MPC to consider include:

  Field QC Samples - MPC to be assessed by field QC samples are generally defined by the project team. For example: If analyzing sodium in a surface water sample, you may collect field duplicate samples at a frequency of 1 duplicate for every set of 20 samples or less. These QC samples would be used to assess the precision encompassing both sample collection and analytical methods. In this case, the analytical parameter is sodium, the sample matrix is surface water, the DQI is precision of field plus analytical methods, and the MPC set might be Relative Percent Difference (RPD) < 20% between the results of the field duplicate pair.

  Field Measurement QC – MPC and associated QC samples are generally defined by the project team in conjunction with any information provided in the associated field instrument manuals.

  Analytical QC - For laboratory measurements, the selected laboratory is often helpful in providing information on its internal quality control (QC) measures and criteria that may be "accepted" by (or defaulted to) the project team. It's important that the project team reviews the laboratory information and decides whether the criteria are rigorous enough for its use. To do this, you will need to identify a lab, make contact with it, and ask for its QA Manual and relevant standard operating procedures (SOPs). Within the QA Manual and

SOPs, you will need to look for QC acceptance criteria usually in the form of numerical values. (NOTE: Some lab QA plans lack specific QC acceptance criteria. Instead, these plans may provide marketing information and simply "say" the laboratory is good for the reasons they will list. In this case, the pertinent QC information is probably included in the SOPs.) Alternatively, you may choose to specify the criteria you're expecting the laboratory to meet. If you choose to do this, you will need to have the associated laboratory contract criteria ready to insert into the QA Project Plan.

(NOTE: The MPC and associated field, measurement, and/or analytical QC samples are generally provided in Section 1.7 of the QA Project Plan. If they are presented in another section of the QA Project Plan, Section 1.7 should clearly state where they will be found. This information can very easily be combined with Section 2.5 Quality Control Requirements and summarized in a table similar to Table 2-4 of the QA Project Plan Template included in Module 2. If the project team has reviewed the QC acceptance limits summarized in Table 2-4 and has selected to accept these as the MPC meeting the data quality needs of the project, this needs to be clearly stated within Section 1.7.)

Step 5 - For the DQIs that will be assessed qualitatively, discuss the plans to assess each DQI and support the assurance that the quality of the data generated will be acceptable for making project decisions. Some examples to consider include:

Representativeness - Discuss how you will follow standardized and well-accepted sampling and analytical methods for ensuring the data collected reflects the environmental conditions. Describe the importance of any pertinent chain-of-custody procedures, sample preservation, and/or maximum sample holding times.

Comparability - Discuss if/how similar the project data need to be to those from other studies, similar locations within the same study, same sampling locations at different times of the year, etc. Compare sample collection and handling methods, analytical procedures, and QA/QC protocols as pertinent.

Completeness - Describe the amount, usually expressed in percentage, of data you plan to collect that is essential/necessary to meet your project objectives. Identify any data points (locations and/or measurements/analyses) that are absolutely critical and therefore may warrant re-sampling and/or re-analysis if not attained.

APPENDIX C.
Data Quality Indicators, Measurement Performance Criteria, and Quality Control for Biological Studies

When your project involves obtaining information related to biological analysis or surveys of macroinvertebrates, fish, and/or periphytons populations, addressing traditional Data Quality Indicators (DQIs) can be challenging. Identifying Measurement Performance Criteria (MPC) for DQIs, and determining the most pertinent quality control (QC) checks to assess whether you met your criteria, is equally challenging. Some of the quality control checks and activities that are described in both field and laboratory methodologies address ways to assess MPC for select DQIs individually or in combination. (NOTE: See Section 1.7 and Appendix B for a more complete discussion of DQIs, MPC, and QC samples.)

Below are examples of some of the information you may consider when addressing DQIs for various types of project activities. Bear in mind that this information includes examples and does not cover each DQI for each type of activity.

FIELD ACTIVITIES - For field activities, consult the procedures that the field team will be using. You may wish to consider a variety of types of quality control checks/activities. Depending on your budget, the number of people doing sampling, and other project-specific factors, you will need to adopt the suggestions below to suit your needs. The following include some examples for biological assessment studies:

Freshwater Biological Assessment Studies -

- Precision – The initial field crew may re-sample 10% of the sampling locations to assess potential field method repeatability (to determine whether the same field crew measures the same parameter, % stream shading, etc. the same way each time). If other personnel are available, a different crew may re-sample 10% of the sites to assess potential variations in the way samples are taken. For smaller projects and limited resources, it may be sufficient to cite published field protocols and the types and frequencies of evaluations (such as field duplicates collected for every 1 in 10 field samples, etc.) developed specifically for these methodologies and defined therein.
- Accuracy/Bias & Precision - If biota are to be identified and enumerated in the field, the persons performing this activity must be trained in appropriate taxonomy. The type of qualifications and training proposed for these persons needs to be provided. In the case of any fish, macroinvertebrates, or other biota whose identification is difficult or unclear, a voucher specimen should be preserved so that the identification can be confirmed by a second trained expert.
- Comparability & Representativeness - The use of standard or published field protocols may be cited, and any training necessary to implement those protocols needs to be identified. If there

are multiple field teams, ensure all are following the same protocols.

- Representativeness - Sample identification (site sample #, location, date, sampler, etc.), handling, preservation, and shipping needs to be described. The use of these documented sample handling standard operating procedures (SOPs) or protocols needs to be cited.

Paleolimnological Studies (generally for lakes) -

- Precision - Collecting multiple samples from the same depth in each core is not possible. As a substitute for quantitative analysis of data precision, qualitative methods are often used. These methods focus on recording and anomalies related to the use of a specific sediment sampler or core extruder. This information may be used by the project team and QA Officer to make qualitative judgment about data precision.
- Accuracy/Bias – Fieldwork includes both sample collection and preservation. The most likely source of measurement inaccuracy/bias during these tasks is sample contamination. To prevent contamination, the sample collection equipment (such as polycarbonate barrels, caps, and core extruding apparatus) needs to be cleaned before each use. The cleaning typical involves thoroughly scrubbing all equipment with soap and a large "bottle brush," followed by rinsing with distilled water prior to use. Once cleaned, it is recommended that the caps be attached and not removed until on site at the target habitat. In addition, it is recommended that anyone handling open barrels during sample collection or preservation use disposable gloves.
- Comparability - Comparability has issues related to both internal comparisons and external comparisons to other studies:

  External comparisons - Since few studies are generally available for comparison and standard methodology is still under development, issues related to external comparisons are typically reserved for future research.

  Internal comparisons - The larger more immediate issue is often how to develop a system of rules to guide comparison of the diatom assemblages collected from sediment cores for a current study. Some language used in one recent study included:

  > "Diatom characteristics vary seasonally and among habitat types within a wetland. Diatom distribution may not follow commonly used wetland classification schemes. Species abundance and composition are influenced most strongly by water chemistry, the amount of light and nature of the substrate. In addition, research to date has found that comparing samples from similar target habitats more precisely indicates wetland change that composite samples from multiple habitats. We use substrate composition as the most important habitat characteristic to control to ensure comparability.
  >
  > To address seasonal variability of diatomic assemblages, sediment cores will be collected during a one day period in October."

- Representativeness - The sampling design needs to be developed to ensure collection of data that are as representative as possible in the early phases of the project. While sample locations were systematically chosen to represent the extremes of land development activity in the vicinity, exact coring locations will be determined by substrate composition to ensure sample collection similarity.

Periphyton Algal Assemblage Studies (generally in wadeable streams) –

$ Representativeness - Periphyton algal assemblage collection generally consists of a single sample representing the entire stream reach. All samples, regardless of substrate or habitat type, are combined into a single composite sample.

Planktonic Algal Studies (generally in larger streams) –

$ Representativeness - Planktonic algal samples collection generally consists of a single sample representing the entire stream reach. Planktonic algae are typically collected at the most downstream transect by triplicate, horizontal plankton tows using an 80 micron mesh plankton net (e.g., Wildco 40D10). All three samples are combined into a single composite sample.

LABORATORY ACTIVITIES - For laboratory activities, consult the procedures that your laboratory will be using. You may wish to consider a variety of types of quality control checks/activities. The following include some examples for macroinvertebrates and periphyton studies:

Macroinvertebrate Studies -

- Precision in sorting (that is, sample cleaning to remove the non-invertebrates from the sample) and sub-sampling - The laboratory's standard operating procedure (SOP) for sorting and sub-sampling may be cited. The laboratory's sorting goals (for example, removal of 90% of the invertebrates from the macroinvertebrate population is a common sorting number, with a second technician verifying the original sort) may be cited, along with plans to re-sort/re-sample if the goal is not met.
- Accuracy/Bias in counting - The laboratory's goal for a total number of organisms count (for example, 500 is a typical subsample count) may be described. Identification or taxonomic resolution (such as genus, species, and/or level) required for each type of organism to be encountered and the taxonomic keys to be used to identify the organisms may be stated. Confirmation of questionable identification (against a verified voucher collection and/or by a second taxonomic expert) may be included.
- Accuracy/Bias & Precision in subsampling - Re-identification and re-counting of 10% of the samples may be performed by a second taxonomist
- Comparability & Representativeness - The use of standard or published laboratory procedures may be cited, and any training that is necessary to implement those protocols may be indicated.

Periphyton Studies -

- Accuracy/Bias - Identification or taxonomic resolution (such as genus, species, and/or higher

level) required for each kind of organism to be encountered and the taxonomic keys to be used to identify the organisms may be stated. Confirmation of questionable identification (against a verified voucher collection and/or by a second taxonomic expert) may be included.

- Accuracy/Bias & Precision - Confirmation of the identification of a designated number of samples may be stated. Confirmation is commonly performed on every tenth sample (10% of the total samples) by a second phycologist/analyst. Some additional quality control checks/activities to consider are:
    - The type(s) of common soft-bodied algae identified, as well as the rank assigned to the most abundant soft-bodied algae, should be confirmed by a second analyst.
    - Diatom taxa accounting for >10% abundance should be confirmed by a second analyst. It is important to note that it is acceptable for analysts to use different synonyms for the classification.
    - The percent community similarity index calculated from the two diatom counts should exceed 75%.
- Comparability & Representativeness - The use of standard or published laboratory procedures may be cited, and any training that is necessary to implement those protocols may be indicated.