United States Environmental Protection Agency
Office of Water
Washington, D.C.
EPA 843-R-15-008

National Wetland Condition Assessment 2016

Quality Assurance Project Plan

Version 1.0, February 2016

QUALITY ASSURANCE PROJECT PLAN

REVIEW & DISTRIBUTION ACKNOWLEDGMENT AND COMMITMENT TO IMPLEMENT

FOR

NATIONAL WETLAND CONDITION ASSESSMENT 2016

I/We have read the Quality Assurance Project Plan (QAPP) and the methods manuals for the National Wetland Condition Assessment listed below. Our agency/organization agrees to abide by its requirements for work performed under the National Wetland Condition Assessment. Please check the boxes for the appropriate documents.

Quality Assurance Project Plan □
Field Operations Manual □
Site Evaluation Guidelines □
Laboratory Operations Manual □

Field Crew leads: *I also certify that I attended an NWCA 2016 training and that all members of my crew have received training in NWCA protocols* □

Print Name

Title
(Cooperator's Principal Investigator)

Organization

Signature Date

Field Crews: Please return the signed original to the Logistics Contractor. The Logistics Contractor will ensure all parties have signed the QA forms, compile them and submit to the EPA Project QA Coordinator. Send your forms to: Chris Turner, cturner@glec.com. Great Lakes Environmental Center, Inc.; 739 Hastings Street; Traverse City, MI 49686.

Labs and others: Please return the signed original to Kendra Forde who will ensure all parties have signed the QA forms, compile them, and submit them to the EPA QA Coordinator. Send your forms to: Kendra Forde, forde.kendra@epa.gov. US EPA; 1200 Pennsylvania Ave, NW (4503T); Washington, DC 20460.

Retain a copy for your files.

NOTICE

The objective of the National Wetland Condition Assessment 2016 (NWCA 2016) project is to describe the ecological condition of the nation's wetlands and stressors commonly associated with poor condition. The complete documentation of overall project management, design, methods, and standards is contained in companion documents, including:

National Wetland Condition Assessment 2016: Field Operations Manual (EPA 843-R-15-007)
National Wetland Condition Assessment 2016: Laboratory Operations Manual (EPA 843-R-15-009)
National Wetland Condition Assessment 2016: Site Evaluation Guidelines (EPA 843-R-15-010)

This document (Quality Assurance Project Plan) contains elements of the overall project management, data quality objectives, measurement and data acquisition, and information management for NWCA 2016. Methods described in this document are to be used specifically in work relating to NWCA. All Project Cooperators should follow these guidelines. Mention of trade names or commercial products in this document does not constitute endorsement or recommendation for use. More details on specific methods for site evaluation, field sampling, and laboratory processing can be found in the appropriate companion document(s).

The suggested citation for this document is:

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VERSION HISTORY

QAPP Version	Date Approved	Changes Made
1.0	2/19/2016	

DISTRIBUTION LIST

This Quality Assurance Project Plan (QAPP) and associated manuals or guidelines will be distributed to the following: EPA, States, Tribes, universities, and contractors participating in NWCA 2016. EPA Regional Coordinators are responsible for distributing the QAPP to State and Tribal Water Quality Agency staff or other cooperators who will perform the field sampling and laboratory operations. The Quality Assurance (QA) Officers will distribute the QAPP and associated documents to participating project staff at their respective facilities and to the project contacts at participating laboratories, as they are determined.

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1 PROJECT PLANNING AND MANAGEMENT

1.1 Introduction

Several recent reports have identified the need for improved water quality monitoring and analysis at multiple scales. In 2000, the General Accounting Office (USGAO, 2000) reported that the U.S. Environmental Protection Agency (EPA), states, and tribes collectively cannot make statistically valid inferences about water quality (via 305[b] reporting) and lack data to support key management decisions. In 2001, the National Research Council (NRC, 2000) recommended EPA, states, and tribes promote a uniform, consistent approach to ambient monitoring and data collection to support core water quality programs. In 2002, the H. John Heinz III Center for Science, Economics, and the Environment (Heinz Center, 2002) found there are inadequate data for national reporting on fresh water, coastal and ocean water quality indicators. The National Association of Public Administrators (NAPA, 2002) stated that improved water quality monitoring is necessary to help states and tribes make more effective use of limited resources. EPA's Report on the Environment 2003 (USEPA 2003) says that there is insufficient information to provide a national answer, with confidence and scientific credibility, to the question, "What is the condition of U.S. waters and watersheds?"

The most commonly cited and scientifically valid sources of national-scale wetland information are the U.S. Fish and Wildlife Service (FWS) *Wetlands Status and Trends Reports* (S&T Report), which have documented trends in wetland acreage since the 1950's. The most recent report, published in 2011, documented a decline of 62,300 wetland acres from 2004-2009. While the report noted gains for some wetland types, such as freshwater ponds, it found continued declines in area of forested wetlands and salt marshes (Dahl 2011). Companion reports focused specifically on wetlands in coastal watersheds (Dahl and Stedman 2013) and the prairie pothole region (Dahl 2014) also found wetland area is decreasing in these areas. It is vitally important for wetland managers to understand the causes and sources of this loss to inform implementation of appropriate management measures. While the S&T Report is an invaluable source of information on trends in wetland acreage and class, it does not provide data on wetland condition.

In response to these needs, EPA Office of Water (OW), in concert with EPA's Office of Research and Development (ORD), the 10 EPA Regions, states and tribes has begun a program to assess the condition of the nation's waters via a statistically valid approach. The current assessment, the National Wetland Condition Assessment 2016 (referred to as NWCA 2016 throughout this document), builds upon the National Wetland Condition Assessment 2011, as well as other National Aquatic Resource Surveys (NARS) such as the National Coastal Condition Assessment (NCCA), the National Lakes Assessment (NLA), and the National Rivers and Streams Assessment (NRSA). The NWCA 2016 effort will provide important information to states and the public about the condition of the nation's wetland resources and key stressors on a national and regional scale.

EPA developed this Quality Assurance Project Plan (QAPP) to support project participants and to ensure that the final assessment is based on high quality data and information. The QAPP contains elements of the overall project management, data quality objectives, measurement and data acquisition, and information management for NWCA. EPA recognizes that states and tribes may add elements to the Survey, such as supplemental indicators, that are not covered in the scope of this integrated QAPP. EPA requires that any supplemental elements are addressed by the states, tribes, or their designees, in a separate approved QAPP. This document covers all core NWCA 2016 QA activities. The NWCA 2016 participants have agreed to follow this QAPP and the protocols and design laid out in this document, and its associated documents – the NWCA 2016 Field Operations Manual (FOM), Laboratory Operations Manual (LOM), and Site Evaluation Guidelines (SEG).

This cooperative effort between states, tribes, and federal agencies makes it possible to produce a broad-scale assessment of the condition of the Nation's wetlands with both a known confidence and scientific credibility. Through this survey, states and tribes have the opportunity to collect data that can be used to supplement their existing monitoring programs or to begin development of new programs.

The NWCA 2016 has three main objectives:

1. Produce a report that describes the ecological condition of the Nation's wetlands, ranks the predominant stressors associated with poor wetland condition, and evaluates change between 2011 and 2016.

2. Assist states and tribes in the implementation of wetland monitoring and assessment programs that will guide policy development and aid project decision-making.

3. Advance the science of wetlands monitoring and assessment to support management needs.

Through the framework of its goals and objectives, the NWCA addresses the long-term goals outlined in the Agency's current strategic plan (USEPA, 2014) to improve the Nation's water quality and to protect, sustain, and restore the health of critical natural habitats and ecosystems, including wetlands (Figure 1-1).

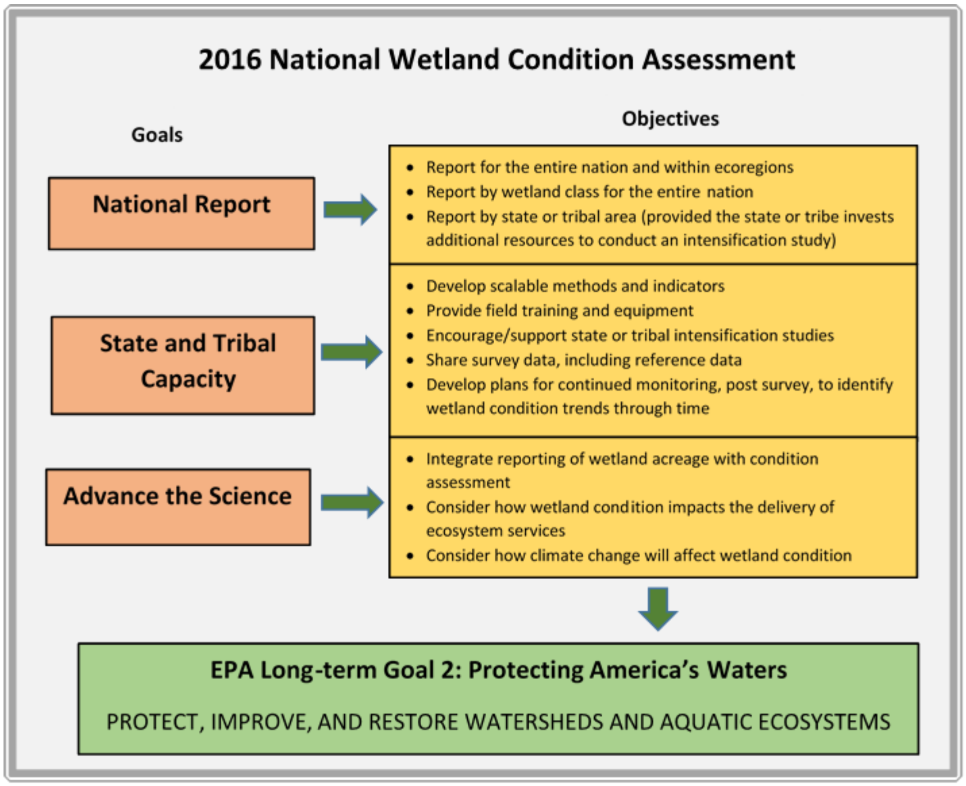

Figure 1-1. Relationship between the goals and objectives of the National Wetland Condition Assessment and the long-term goals of EPA's current strategic plan (USEPA, 2014)

1.2 Project Organization

The responsibilities and accountability of the various principals and cooperators are described here and illustrated in Figure 1-2. The overall coordination of the project will be provided by EPA's Office of Water (OW) in Washington, DC, with support from EPA's Office of Research and Development (ORD). Each EPA Regional Office has identified Regional EPA Coordinators to provide the critical link with state and tribal partners. State and Tribal Cooperators will work with their Regional EPA Coordinator to address any technical issues. A comprehensive quality assurance (QA) program has been established to ensure data integrity and provide support for the reliable interpretation of the findings from this project. Technical Experts Workgroups will be convened to provide EPA with support for determining the most appropriate approaches for key technical issues, such as: (1) the selection and establishment of reference conditions based on least-disturbed sites and expert consensus for characterizing benchmarks for assessment of ecological condition; (2) selection and calibration of ecological endpoints and attributes of the biota and relationship to stressor indicators; (3) a data analysis plan for interpreting the data and addressing the objectives in a nationwide assessment; and (4) a framework for the reporting of the condition assessment and conveying the information on the ecological status of the nation's wetlands.

Contractor support is provided for all aspects of this project. Contractors will provide support ranging from implementing the survey, sampling and laboratory processing, data management, data analysis, and report writing. Cooperators will interact with their Regional EPA Coordinator and the EPA Project Leader regarding contractual services.

The primary responsibilities of the principals and cooperators are as follows:

Project Manager – Gregg Serenbetz, OW

- Provides overall coordination of the project and makes decisions regarding the proper functioning of all aspects of the project.
- Makes assignments and delegates authority, as needed to other parts of the project organization.
- Leads the NWCA Steering Committee and established needed technical workgroups.
- Interacts with EPA Project Team on technical logistical, and organizational issues on a regular basis.

Alternate Project Manager – Chris Faulkner, OW

- Assists EPA Project Manager with coordination and assumes responsibility for certain aspects of the project, as agreed upon with the EPA Project Manager.
- Serves as primary point-of-contact for project coordination in the absence or unavailability of Project Manager.
- Serves on the Technical Experts Workgroup and interacts with Project Manager on technical, logistical, and organizational issues on a regular basis.

EPA Field Logistics Coordinator – Colleen Mason, OW

- EPA employee who functions to support implementation of the project based on technical guidance established by the EPA Project Manager and serves as point-of-contact for questions from field crews and cooperators for all activities.
- Tracks progress of field sampling activities.
- Coordinates all field and laboratory quality assistance visits.

EPA Project QA Lead – Sarah Lehman, OW

- Provides leadership, development and oversight of project-level quality assurance for NARS.
- Assembles and provides leadership for NWCA 2016 QA Team.
- Maintains official, approved QAPP.
- Maintains all training materials and documentation.
- Maintains all laboratory accreditation files.

EPA Technical Advisor – Mary Kentula, ORD Western Ecology Division (Teresa Magee, alternate)

- Advises the Project Manager on the relevant experiences and technology developed within ORD that are to be used in this project.
- Facilitates consultations between NWCA personnel and ORD scientists.

EPA Laboratory Review Coordinator – Kendra Forde, OW

- Ensures participating laboratories have the appropriate technical competencies to process samples.
- Ensures participating laboratories complete sample analysis following Laboratory Operations Manual.
- Ensures participating laboratories follow QA activities.

- Ensures laboratory data is submitted within specified timelines.
- Coordinates activities of individual lab Task Order Project Officers to ensure methods are followed and QA activities take place.

Information Management Coordinator – Marlys Cappaert, SRA International Inc.

- A contractor who functions to support implementation of the project based on technical guidance established by the EPA Project Manager and Alternate EPA Project Manager.
- Oversees all sample shipments and receives data forms from the Cooperators.
- Oversees all aspects of data entry and data management for the project.

EPA QA Officer – Margarete Heber, OW

- Functions as an independent officer overseeing all QA and quality control (QC) activities.
- Responsible for ensuring that the QA program is implemented thoroughly and adequately to document the performance of all activities.

Wetlands Division QA Coordinator – Rebecca Dils, OW

- Functions as an independent officer overseeing all QA and quality control (QC) activities.

Regional EPA Coordinators

- Assist Project Manager with regional coordination activities.
- Serve on the NWMAWG and interact with Project Manager on technical, logistical, and organizational issues on a regular basis.
- Serve as primary points-of-contact for the Cooperators.

Study Design Manager – Tony Olsen, ORD

- Coordinates w/ Project Manager and Field Implementation Coordinator to develop and manage the Sampling Frame, select sampling locations, and track field evaluation and site reconnaissance.

Steering Committee (Technical Experts Workgroup) – States, EPA, academics, other federal agencies

- Provides expert consultation on key technical issues as identified by the EPA Project Management team and works with Project Lead to resolve approaches and strategies to enable data analysis and interpretation to be scientifically valid.

Cooperator(s) – States, Tribes, academics, other federal agencies, contractors

- Under the scope of their assistance agreements, plan and execute their individual studies as part of the cross jurisdictional NWCA, and adhere to all QA requirements and standard operating procedures (SOPs).
- Interact with the Regional EPA Coordinators, Field Implementation Coordinator and EPA Project Manager regarding technical, logistical, organizational issues.

Field Sampling Crew Leaders

- Functions as the senior member of each Cooperator’s field sampling crew and the point of contact for the Field Logistics Coordinator.

- Responsible for overseeing all activities of the field sampling crew and ensuring that the Project field method protocols are followed during all sampling activities.

National Laboratory Task Order Managers

- Responsible for managing activities of the national contract laboratories.
- Provide direction to national and state laboratories on methods, timelines and QA activities to ensure all actions are followed.
- Provide updates to EPA Laboratory Review Coordinator on the sample processing status of the laboratory and any questions or concerns raised by participating laboratories regarding timelines and deliverables.

Field Logistics Coordinator – Chris Turner, Great Lakes Environmental Center (GLEC)

- A contractor who functions to support implementation of the project based on technical guidance established by the EPA Project Manager and Alternate EPA Project Manager serves as point-of-contact for questions from field crews and cooperators for all activities.
- Tracks progress of field sampling activities.
- Tracks progress of lab activities.

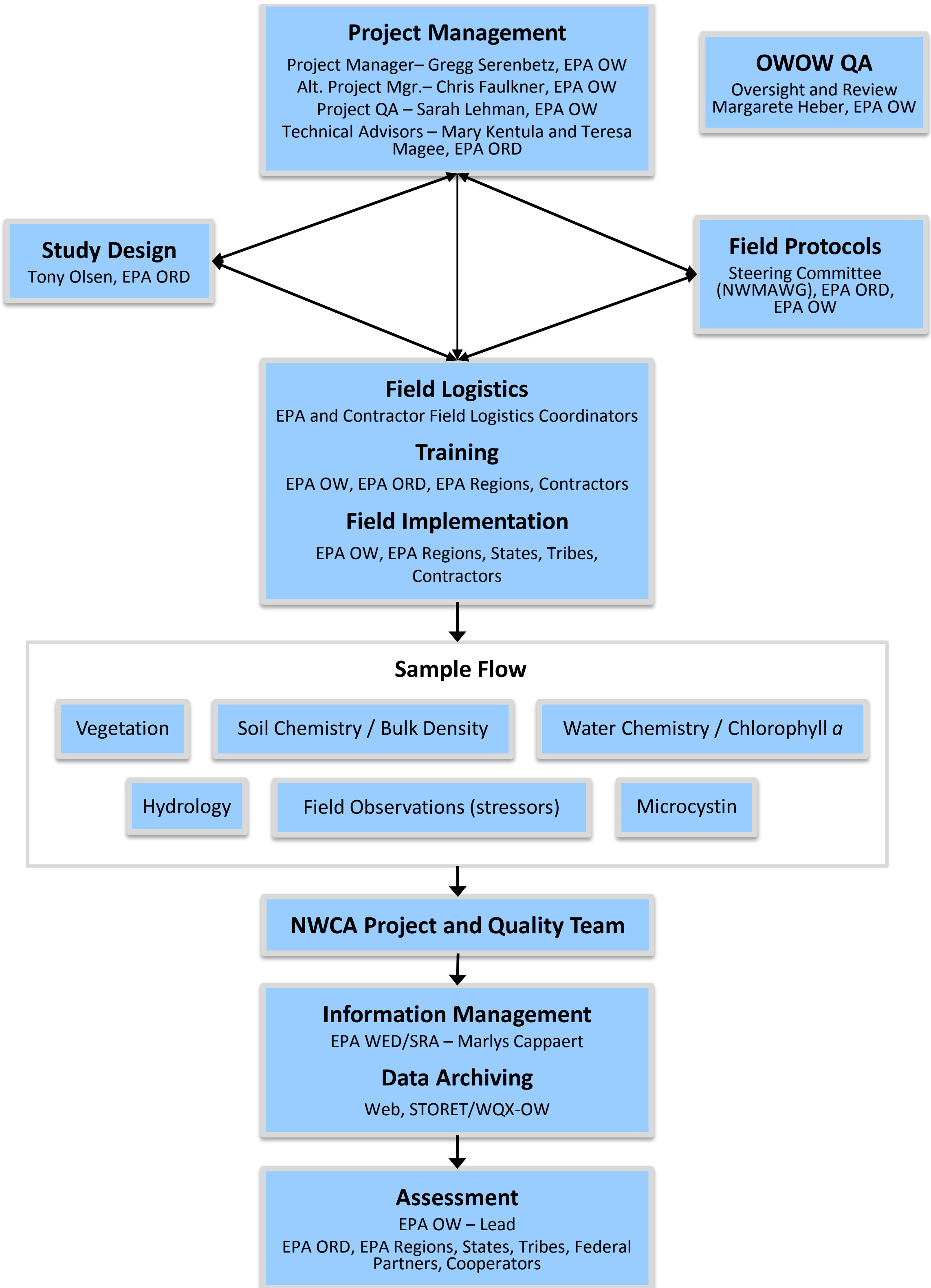

Figure 1-2. NWCA Project Organization

1.2.1 Project Schedule

Training and field sampling will be conducted in spring/summer of 2016. Sample processing and data analysis will be completed by December 2017 to support a published report in 2018. Figure 1-3 gives an overview of the major tasks leading up to the final report.

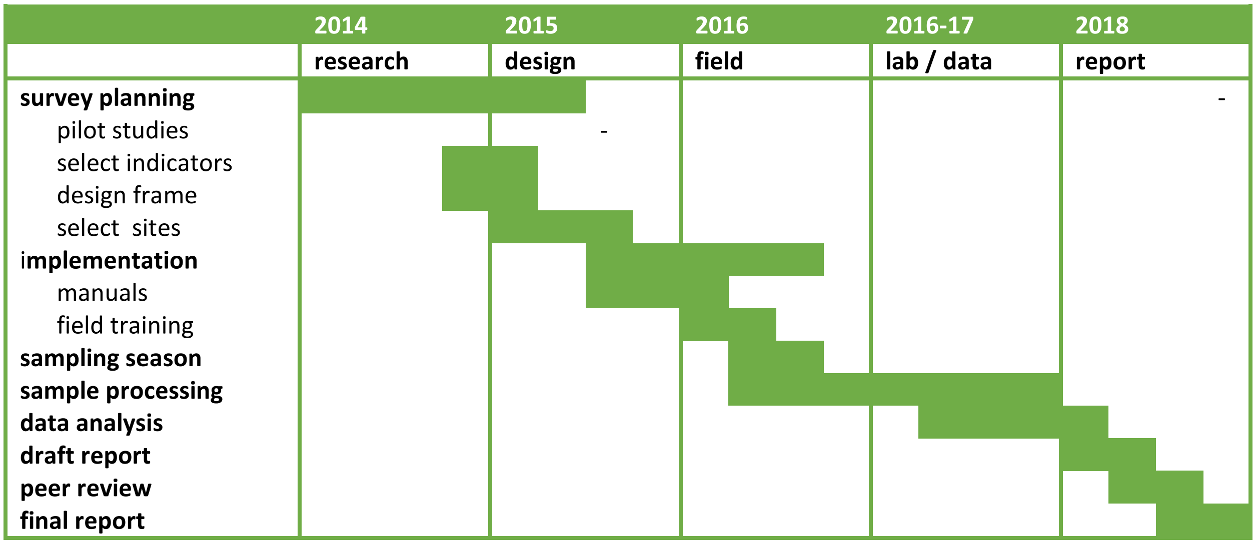

Figure 1-3. Timeline of NWCA Activities

1.3 Scope of Quality Assurance Project Plan

This QAPP addresses the data acquisition efforts of the NWCA, which focuses on the 2016 sampling of wetland sites in the conterminous United States. Analysis of data from approximately 1000 sites (selected with a probability design) will provide a comprehensive assessment of the nation's wetlands. Companion documents to this QAPP that are relevant to the overall project include:

- National Wetland Condition Assessment 2016: Site Evaluation Guidelines (EPA 843-R-15-010)
- National Wetland Condition Assessment 2016: Field Operations Manual (EPA 843-R-15-007)
- National Wetland Condition Assessment 2016: Laboratory Methods Manual (EPA 843-R-15-009)

1.3.1 Overview of Field Operations

Field measurements and samples are collected by trained teams. Typically, each Field Crew is comprised of 4 members, divided into the Vegetation (Veg) Team and the Assessment Area and Buffer (AB) Team. The number and size of crews depends on the duration of the sampling window, geographic distribution of sampling locations, number and complexity of samples and field measurements, and other factors. The two teams will work closely with each other, and coordinate sampling activities.

1.3.1.1 Field Crew Duties and Qualifications

The NWCA **Veg Team** is composed of a **Botanist/Ecologist** and a **Botanist Assistant**. Primary responsibilities for the Veg Team include:

1. Laying out the Assessment Area (AA) and vegetative plots;

2. Collecting high quality plant ecological data (including species identities, presence and cover of individual species, presence and cover of vertical vegetation strata, and counts of larger trees);
3. Collecting other information related to vegetation condition; and
4. Collecting and processing plant specimens.

The Veg Team carefully follows protocols to make onsite decisions regarding layout and set-up of the vegetation plots within the assessment area and to collect ecological data. Accurate plant species identification is critical to data quality. Careful descriptions of diagnostic characteristics, habitat, and plant associations will be documented. Plant specimens must be collected for all unknown taxa and quality assurance taxa, which will be later identified by expert taxonomists. Careful attention to providing tracking information for all specimens is essential.

In addition, NWCA will provide Veg Team members with training on study goals, vegetation sampling methods, field protocols, and plant collection requirements. Training will prepare the Team to accurately complete data and specimen collection tasks.

In addition to the skills developed in the training, the Botanist/Ecologist will have the following minimum qualifications:

- Understanding of basic wetland plant ecology.
- Familiarity with regional flora and proficiency in identifying common wetland plant species:
  - capable of sight recognition of often dominant species to the level of genus and species, provided plants are at the proper phenological stage; or
  - capable of sight recognition of dominant species to the family, and proficiency in keying in the field.
- Proficiency in keying many unknown plants (e.g., forbs, shrubs, trees) to species using regionally appropriate floras and diagnostic keys.
- Ability to distinguish difficult graminoid taxa as Poaceae (grasses), Juncaceae (rushes), and Cyperaceae (sedges, bulrushes, spikerushes), and to distinguish unknown species within these families or genera from one another.
- College course-work in plant taxonomy or systematics that included field identification of plant species; and/or excellent references regarding proficiency in botanical identification.
- Previous experience conducting botanical or ecological field work, including the collection and preservation of plant specimens.

All Botanist/Ecologist applicants will send their Curriculum vitae and references to the Regional EPA Coordinators and Project Manager, who will review and verify the qualifications of all applicants prior to the applicants joining a Field Crew. If a State is unable to identify a Botanist/Ecologist, EPA will work with the State to identify a Botanist/Ecologist.

The NWCA **AB Team** is composed of two crew members, one of whom will ideally have background and experience sampling wetland soils. Primary responsibilities for the **AB Team** include:

1. Collecting high-quality soils, hydrology, water chemistry, biological (e.g.,% vegetative cover), and stressor data following the FOM protocols,
2. Collecting and processing soil, water chemistry, chlorophyll-*a*, and microcystin specimens.

The AB team carefully follows protocols in the FOM to make onsite decisions regarding the collection of ecological data. All samples (soil, water chemistry, chlorophyll-*a*, and microcystin) must be carefully collected, preserved, packed and catalogued for tracking.

AB Team members should have the following skills/abilities:

- Previous experience conducting ecological field work
- Ability to recognize evidence of human (or natural) landscape disturbance from the present or recent past
- Ability to use common field equipment (compass, GPS, laser rangefinder, etc.)
- Experience measuring or describing basic physical characteristics of soil
- Knowledge of regional hydric soil indicators
- Knowledge of hydrogeomorphic classification

In addition, NWCA will provide AB Team members with additional training on study goals, biological and physical sampling methods, field protocols, and soil collection requirements. Training will prepare the Team to accurately complete data and tracking tasks.

1.3.1.2 Field Crew Training

Each Field Crew Leader and field personnel who will lead the Veg Team (Botanist/Ecologist) and AB Team, if not the overall Field Crew Leader, must be trained at an EPA-sponsored training session prior to the start of the field season, along with as many crew members as possible. The training program stresses hands-on practice of methods, comparability among crews, collection of high quality data and samples, and safety. Training will be provided in nine central locations for cooperators and contractors. Project organizations responsible for training oversight are identified in Figure 1-2. Training documentation will be maintained by the Project QA Officer.

1.3.1.3 Field Operations Timeline

Field data acquisition activities are implemented for the NWCA (Table 1-1), based on guidance developed for earlier Environmental Monitoring and Assessment Program (EMAP) studies (Baker and Merritt 1990).

Table 1-1. Critical logistics elements (from Baker and Merritt, 1990)

Logistics Plan Component	Required Elements
Project Management	Overview of Logistic Activities Staffing and Personnel Requirements Communications
Access and Scheduling	Sampling Schedule and Site Access Reconnaissance
Safety	Safety Plan Waste Disposal Plan
Procurement and Inventory Control	Equipment, Supplies, and Services Requirements Procurement Methods and Scheduling
Training and Data Collection	Training Program Field Operations Scenario Laboratory Operations Scenarios Quality Assurance Information Management
Assessment of Operations	Field Crew Debriefings Logistics Review and Recommendations

1.3.1.4 Pre-Field Visit Activities

Survey preparation is initiated with selection of the sampling locations by EPA's Office of Research and Development (WED in Corvallis). The list of sampling locations is distributed to the EPA Regional Wetland Monitoring Coordinators and cooperators. With the sampling location list, State and Tribal cooperators can decide to what level they wish to participate (vs. requesting in-kind or Associated Program Support assistance). Participating State and Tribal Field Crews can then begin site reconnaissance on both the primary sites and alternate/replacement sites (known as *base* and *oversample* locations, respectively) and begin work on obtaining access permission to each site[1].

Field Crews need to acquire permission to access sites on private property, as well as permits to access and sample federally protected or managed land. The Field Crew Leader should begin contacting private property owners (and the appropriate federal agency in the case of federally protected land) as early as 2015. As a general rule, and because the design requires repeat visits to selected sites, it is important for the Field Crews to do everything possible to maintain good relationships with landowners. This includes prior contacts, respect of special requests, closing gates, minimal site disturbance, and removal of all materials including flagging and trash. More details on the timing and acquisition of property access permissions and permits are found in the NWCA 2016 Site Evaluation Guidelines (USEPA 2016c).

In addition to the initial list of base and oversample sampling locations, Cooperators conducting field operations (i.e., States and Tribes that decide to conduct field operations themselves, and contractors performing in-kind support) will develop Site Packets for the base locations. Each Site Packet should contain the following applicable information:

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[1] Specific procedures for evaluating each sampling location and for replacing target sites are documented in the *NWCA 2016: Site Evaluation Guidelines* (USEPA, 2016).

- Applicable site maps, aerial photos, and other Imagery
- USDA-NRCS Soil Survey information
- Land ownership status, requirements and permissions for access
- Permits
- Information for accessing the site
- Site evaluation notes
- Driving and hiking routes to the site
- Preliminary plan for Assessment Area (AA) and Buffer Plot establishment
- Any other site specific information useful to the Field Crew

EPA will provide site maps for states if requested.

1.3.1.4.1 Equipment Use during NWCA Field Activities

The timely receipt, proper use (including inspection and calibration), and maintenance of equipment are important contributors to acquiring quality data.

The Field Crews will use standard field equipment and supplies provided by EPA and contractors, as well as equipment and supplies provided by the crews themselves (e.g., Global Positioning Devices, soil augers, regional flora field guides). The Field Logistics Coordinator will work with Regional EPA Coordinators, Cooperators, States, Tribes and Contractors to make certain the Field Crews have the required equipment and supplies provided by EPA in a timely fashion. Detailed lists of equipment and supplies required for each field protocol are provided in the NWCA 2016 Field Operations Manual (USEPA 2016a).

Also, some sampling locations require teams to hike to them, transporting all equipment in backpacks. For this reason, ruggedness and weight are important considerations in the selection of equipment and instrumentation. In addition, Field Crews may need to camp out at the sampling location, and if this is the case then they must be equipped with the necessary camping equipment.

The Field Crews will be responsible for the inspection, maintenance, and calibration of the equipment they use. Detailed information (including guidance) on equipment inspection, maintenance, and calibration, are contained in the NWCA 2016 Field Operations Manual (USEPA 2016a).

1.3.1.5 Field Visit Activities

The site verification process is shown in Figure 1-4. Upon arrival at a site, the POINT location is verified by a Global Positioning System (GPS) receiver. Samples and measurements for various indicators are collected according to step-by-step procedures described in the NWCA 2016 Field Operations Manual (USEPA 2016a). The manual also contains detailed instructions for completing documentation, labeling samples, any field processing requirements, and sample storage and shipping. Any revision of methods must be approved in advance by the EPA Project Leader. Field communications will be available through Field Coordinators, regularly scheduled conference calls, a Communications Center, or an electronic distribution.

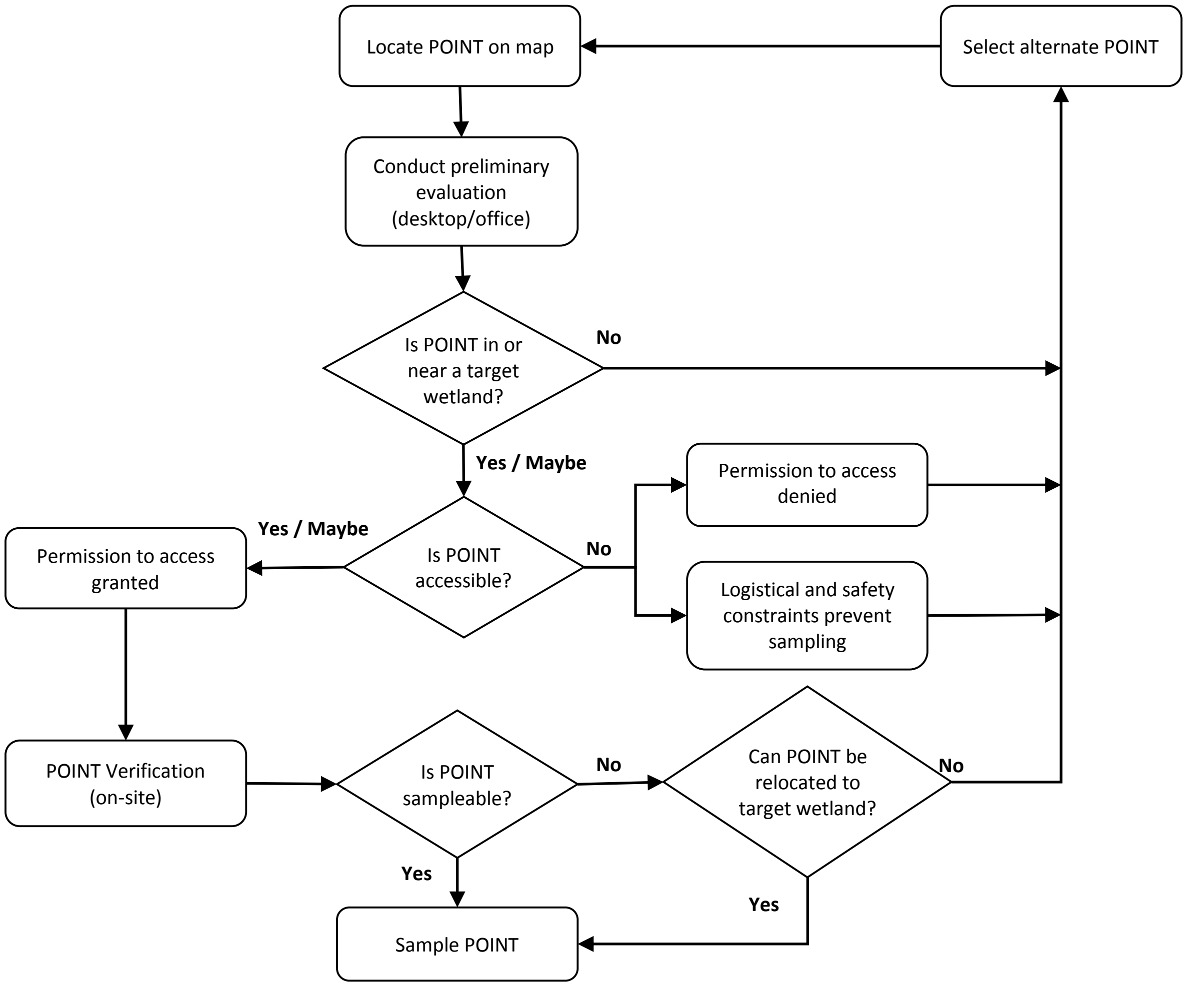

Figure 1-4. Site verification activities for wetland field surveys

Standardized field data forms are provided to the Field Crews as the primary means of data recording. On completion, the data forms are reviewed by a Field Crew member other than the person who initially entered the information. Prior to departure from the field site, the Field Crew Leader reviews all forms and labels for completeness and legibility and ensures that all samples are properly labeled and packed. Each site has a unique identifier provided by the design. All samples from a site must be labeled with this unique identifier.

Post-Field Visit Activities

Upon return from a field sampling site (either to the Field Crew's home office or to a motel), completed data forms are sent to the Information Management Staff at WED for entry into a computerized data base. At WED, electronic data files are reviewed independently to verify that values are consistent with those recorded on the field data form or original field data file (refer to section 4.4 of this document for more information).

Samples are stored or packaged for shipment in accordance with instructions contained in the Field Operations Manual. Samples which must be shipped are delivered to a commercial carrier. The recipient is notified to expect delivery; thus, tracing procedures can be initiated quickly in the event samples are not received. Bills of lading and chain-of-custody forms are completed for all transfers of samples maintained by the labs, with copies also maintained by the field team. The Logistics Coordinator maintains a centralized tracking system of all shipments.

The field operations phase is completed with collection of all samples or expiration of the sampling window. Following completion of all sampling, a debriefing session will be scheduled (see Table 1-1). These debriefings cover all aspects of the field program and solicit suggestions for improvements.

1.3.2 Overview of Laboratory Operations

Holding times for samples vary with the sample types and analytes. Field crews begin some analytical measurements during sampling (e.g., *in situ* soil profiles) while others are not initiated until sampling has been completed (e.g., water chemistry, microcystin, soil chemistry). Analytical methods are summarized in the NWCA 2016 Laboratory Operations Manual (LOM). When available, standard methods are used and are referenced in the LOM. Where experimental methods are used or standard methods are modified by the laboratory, these methods are documented in the laboratory methods manual by EPA or in internal documentation by the appropriate laboratory. The Laboratory Review Coordinator will work with appropriate experts to describe them in Standard Operating Procedures (SOPs) developed by the analytical laboratories.

Contractor and/or cooperator laboratories will perform chemical, physical, or biological analyses. National contract laboratories will process most samples. Where those laboratories are currently in place, EPA has identified them here. A national contract laboratory, PG Environmental, will analyze water chemistry and chlorophyll-a samples. A national contract laboratory, Enviroscience, will analyze unknown and QA plant specimens. The USDA NRCS Kellogg Soil Survey Laboratory will analyze soil chemistry and bulk density samples. The USGS Kansas Water Laboratory will analyze water samples for microcystin. Additionally, EPA anticipates that pre-approved state laboratories may opt to analyze samples for the water chemistry, chlorophyll *a*, microcystin, and vegetation indicators.

Laboratories providing analytical support must have the appropriate facilities to properly store and prepare samples and appropriate instrumentation and staff to perform analyses and produce data of the required quality within the time period dictated by the project. Laboratories are expected to conduct operations using good laboratory practices. General guidelines for analytical support laboratories:

- A program of scheduled maintenance of analytical balances, water purification systems, microscopes, laboratory equipment, and instrumentation.
- Verification of the calibration of analytical balances using class "S" weights which are certified by the National Institute of Standards and Technology (NIST).
- Verification of the calibration of top-loading balances using NIST-certified class "P" weights.
- Checking and recording the composition of fresh calibration standards against the previous lot. Acceptable comparisons are 2 percent of the theoretical value. (This acceptance is stricter than the method calibration criterion.)

- Recording all analytical data in bound logbooks in ink, or on standardized recording forms.
- Verification of the calibration of uniquely identified daily use thermometers using NIST-certified thermometers.
- Monitoring and recording (in a logbook or on a recording form) temperatures and performance of cold storage areas and freezer units (where samples, reagents, and standards may be stored). During periods of sample collection operations, monitoring must be done on a daily basis.
- An overall program of laboratory health and safety including periodic inspection and verification of presence and adequacy of first aid and spill kits; verification of presence and performance of safety showers, eyewash stations, and fume hoods; sufficiently exhausted reagent storage units, where applicable; available chemical and hazardous materials inventory; and accessible material safety data sheets for all required materials.
- An overall program of hazardous waste management and minimization, and evidence of proper waste handling and disposal procedures (90-day storage, manifested waste streams, etc.).
- If needed, having a source of reagent water meeting American Society of Testing and Materials (ASTM) Type I specifications for conductivity (< 1 µS/cm at 25 °C; ASTM 1984) available in sufficient quantity to support analytical operations.
- Appropriate microscopes or other magnification for biological sample sorting and organism identification.
- Approved biological identification and taxonomic keys/guides for use in biological identification (plants) as appropriate.
- Labeling all containers used in the laboratory with date prepared, contents, and initials of the individual who prepared the contents.
- Dating and storing all chemicals safely upon receipt. Chemicals are disposed of properly upon expiration.
- Using a laboratory information management system to track the location and status of any sample received for analysis.
- Reporting results using standard formats and units compatible with the information management system.

All laboratories providing analytical support to the NWCA 2016 must adhere to the provisions of this integrated QAPP and LOM. Laboratories will provide information documenting their ability to conduct the analyses with the required level of data quality before analyses begin. EPA provides different requirements based on the type of analysis being completed by the laboratory (i.e., chemistry vs. biological analyses).

Laboratories will send the documentation to the EPA Project QA Coordinator and the Laboratory Review Coordinator at EPA Headquarters (or other such designated parties). Such information may include the following, depending on the evaluation by the Project QA Officer.

- Signed Quality Assurance Project Plan by the laboratory performing analysis;
- Signed Laboratory Form;
- Valid Accreditation or Certification;
- Laboratory's Quality Manual and/or Data Management Plan;
- Method Detection Limits (MDL);
- Demonstration of Capability;
- Results from inter-laboratory comparison studies;
- Analysis of performance evaluation samples; and

- Control charts and results of internal QC sample or internal reference sample analyses to Document achieved precision, bias, accuracy.

Other requirements may include:

- Participation in calls regarding laboratory procedures and processes with participating laboratories;
- Participation in a laboratory technical assessment or audit;
- Participation in performance evaluation studies; and
- Participation in inter-laboratory sample exchange.

See Section 6 of this QAPP and the LOM for additional information related to laboratory certification. All qualified laboratories shall work with the NARS IM Center to track samples as specified by the NARS Information Management Lead.

1.3.2.1 Chemistry Lab Quality Evaluation

Participating laboratories will send requested documentation to the NWCA 2016 QA Team for evaluation of qualifications. The NWCA 2016 QA Team will maintain these records in the project QA file.

1.3.2.2 Biological Laboratory Quality Evaluation

The NWCA 2016 QA Team will review the past performance of biological laboratories. The biological laboratories shall adhere to the quality assurance objectives and requirements as specified for the pertinent indicators in the LOM.

1.3.3 Data Analysis and Reporting

A technical data analysis and reporting workgroup convened by the EPA Project Leader is responsible for developing a data analysis plan that includes a verification and validation strategy. These processes are summarized in the indicator-specific sections of this QAPP.

Data from laboratories is transferred to the appropriate member of the NWCA 2016 QA Team, including Task Order managers, for review. The QA Team transfers validated data to the central National Aquatic Resource Surveys (NARS) surface waters information management system at WED-Corvallis and managed by Information Management Staff. Information management activities in support of this effort are discussed further in Section 4. Data in the database are available to Cooperators for their own use upon completion of the final verification and validation. All validated measurement and indicator data from the NWCA will eventually be transferred to EPA’s Water Quality Exchange (WQX) and then the National STORET warehouse.

1.3.4 Peer Review

The NWCA 2016 report will undergo a thorough peer review process, where the scientific community and the public will be given the opportunity to provide comments. Cooperators have been actively involved in the development of the overall project management, design, methods, and standards including the drafting of four key project documents:

- National Wetland Condition Assessment 2016: Quality Assurance Project Plan (EPA 843-R-15-008)
- National Wetland Condition Assessment 2016: Site Evaluation Guidelines (EPA 843-R-15-010)
- National Wetland Condition Assessment 2016: Field Operations Manual (EPA 843-R-15-007)
- National Wetland Condition Assessment 2016: Laboratory Methods Manual (EPA 843-R-15-009)

Outside scientific experts from universities, research centers, and other federal agencies have been instrumental in indicator development and will continue to play an important role in data analysis.

The EPA will utilize a three-tiered approach for peer review of the Survey: (1) internal and external review by EPA, states, other cooperators and partners, (2) external scientific peer review (when applicable), and (3) public review (when applicable).

Once data analysis is complete, cooperators will examine the results at regional meetings. Comments and feedback from the cooperators will be incorporated into the draft report. The NWCA 2016 Project Team will follow Agency and OMB requirements for public and peer review. External scientific peer review and public review will be initiated for new analyses or approaches. Additionally, following applicable guidance, other aspects of NWCA may undergo public and scientific peer review.

Below are the proposed measures EPA will implement for engaging in the peer review process:

1. Develop and maintain a public website with links to standard operating procedures, quality assurance documents, fact sheets, cooperator feedback, and final report
2. Conduct technical workgroup meetings composed of scientific experts, cooperators, and EPA to evaluate and recommend data analysis options and indicators
3. Hold national meeting where cooperators will provide input and guidance on data presentation and an approach for data analysis
4. Complete data validation on all chemical, physical and biological data
5. Conduct final data analysis with workgroup to generate assessment results
6. Engage peer review contractor to identify external peer review panel
7. Develop draft report presenting assessment results
8. Conduct regional meetings with cooperators to examine and comment on results
9. Develop final draft report incorporating input from cooperators and results from data analysis group to be distributed for peer and public review (when applicable)
10. Issue Federal Register (FR) Notice announcing document availability and hold scientific/peer review and 30-45 day public comment periods (when applicable)
11. Consider scientific and public comments and produce a final report (when applicable)

The proposed peer review schedule is provided below in Table 1-2 and is contingent upon timeliness of data validation, schedule availability for regional meetings and experts for data analysis workshop as well as final decisions on what reviews are required.

Table 1-2. Peer review schedule

Proposed Schedule	Activity
May 2016 - December 2017	Data validation
March 2018	Data analysis workshop
May - August 2018	Internal peer review meetings with states, cooperators, participants
October, 2018	Draft released for external peer review
December, 2018	Draft released for public review

2 DATA QUALITY OBJECTIVES

It is a policy of the U.S. EPA that Data Quality Objectives (DQOs) be developed for all environmental data collection activities following the prescribed DQO Process. DQOs are qualitative and quantitative statements that clarify study objectives, define the appropriate types of data, and specify the tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA 2006a). Data quality objectives thus provide the criteria to design a sampling program within cost and resource constraints or technology limitations imposed upon a project or study. DQOs are typically expressed in terms of acceptable uncertainty (e.g., width of an uncertainty band or interval) associated with a point estimate at a desired level of statistical confidence (USEPA 2006a). The DQO Process is used to establish performance or acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of a study (USEPA 2006a). As a general rule, performance criteria represent the full set of specifications that are needed to design a data or information collection effort such that, when implemented, generate newly-collected data that are of sufficient quality and quantity to address the project's goals (USEPA 2006a). Acceptance criteria are specifications intended to evaluate the adequacy of one or more existing sources of information or data as being acceptable to support the project's intended use (USEPA 2006a).

2.1 Data Quality Objectives for the National Wetland Condition Survey

Target DQOs established for the NWCA relate to the goal of describing the current status in the condition of selected indicators of the condition of wetlands in the conterminous U.S. and ecoregions of interest.

The formal statement of the DQO for national estimates is as follows:

- Estimate the proportion of wetlands (± 5%) in the conterminous U.S. that fall below the designated threshold for good conditions for selected measures with 95% confidence.

For the ecoregions of interest the DQO is:

- Estimate the proportion of wetlands (± 15%) in a specific ecoregion that fall below the designated threshold for good conditions for selected measures with 95% confidence.

For estimates of change nationally, the DQOs are:

- Estimate the proportion of the nation's wetlands (± 7%) that have changed condition classes for selected measures with 95% confidence.

2.2 Measurement Quality Objectives

For each parameter, performance objectives (associated primarily with measurement error) are established for several different data quality indicators (following EPA Guidance for Quality Assurance Plans, USEPA 2002a). Specific measurement quality objectives (MQOs) for each parameter are presented in the indicator section of this QAPP and in the LOM. The following sections define the data quality indicators and present approaches for evaluating them against acceptance criteria established for the program.

2.2.1 Laboratory Reporting Level (Sensitivity)

For chemical measurements, requirements for the method detection limit (MDL) are typically established. The MDL is defined as the lowest level of analyte that can be distinguished from zero with 99 percent confidence based on a single measurement (Glaser et al., 1981). USGS NWQL has developed a variant of the MDL called the long-term MDL (LT-MDL) to capture greater method variability (Oblinger Childress et al. 1999). Unlike MDL, it is designed to incorporate more of the measurement variability that is typical for routine analyses in a production laboratory, such as multiple instruments, operators, calibrations, and sample preparation events (Oblinger Childress et al. 1999). Because the LT-MDL addresses more potential sources of variability than the MDL, the NWCA uses the LT-MDL.

The LT-MDL determination ideally employs at least 24 blanks and spiked samples prepared and analyzed by multiple analysts on multiple instruments over a 6- to 12-month period at a frequency of about two samples per month (USEPA 2004). The LT-MDL uses "F-pseudosigma" (F_σ) in place of s, the sample standard deviation, used in the EPA MDL calculation. F-pseudosigma is a non-parametric measure of variability that is based on the interquartile range of the data (USEPA 2004). The LT-MDL is calculated using either the mean or median of a set of long-term blanks, and from long-term spiked sample results (depending on the analyte and specific analytical method). The LT-MDL for an individual analyte is calculated as:

Equation 1a

$$LT-MDL = M + \left(t_{0.99,n-1} \times F_\sigma\right)$$

where:

M = the mean or median of blank results
n = the number of spiked sample results
F_σ = F-pseudosigma, a nonparametric estimate of variability calculated as:

Equation 1b

$$F_\sigma = \frac{Q_3 - Q_1}{1.349}$$

where:

Q_3 = the 75th percentile of spiked sample results
Q_1 = the 25th percentile of spiked sample results

LT-MDL is designed to be used in conjunction with a laboratory reporting level (LRL; Oblinger Childress et al. 1999). The LRL is designed to achieve a risk of ≤1% for both false negatives and false positives (Oblinger Childress et al. 1999). The LRL is set as a multiple of the LT-MDL, and is calculated as follows:

LRL = (2 x LT–MDL)/fractional spike recovery

Where fractional spike recovery is the mean or median recovered spike concentration divided by the expected spike concentration. For example, at 50% recovery, LRL is 4 times the LT-MDL.

Therefore, multiple measurements of a sample having a true concentration at the LRL should result in the concentration being detected and reported 99 percent of the time (Oblinger Childress et al. 1999).

All laboratories will develop calibration curves for each batch of samples that include a calibration standard with an analyte concentration equal to the LRL. Estimates of LRLs (and how they are determined) are required to be submitted with analytical results. Analytical results associated with LRLs that exceed the objectives are flagged as being associated with unacceptable LRLs. Analytical data that are below the estimated LRLs are reported, but are flagged as being below the LRLs.

2.2.2 Sampling Precision and Bias

Precision and bias are estimates of random and systematic error in a measurement process (Kirchmer, 1983; Hunt and Wilson, 1986, USEPA 2002a). Collectively, precision and bias provide an estimate of the total error or uncertainty associated with an individual measurement or set of measurements. Precision and bias MQOs are developed for lab measurements. Precision, bias, and accuracy of field measurements will not be monitored during the NWCA[2].

2.2.2.1 Laboratory Measurements

Systematic errors are minimized by using validated methods and standardized procedures across all laboratories. Precision is estimated from repeated measurements of samples. Net bias is determined from repeated measurements of solutions of known composition, or from the analysis of samples that have been fortified by the addition of a known quantity of analyte. For analytes with large ranges of expected concentrations, MQOs for precision and bias are established in both absolute and relative terms, following the approach outlined in Hunt and Wilson (1986). At lower concentrations, MQOs are specified in absolute terms. At higher concentrations, MQOs are stated in relative terms. The point of transition between an absolute and relative MQO is calculated as the quotient of the absolute objective divided by the relative objective (expressed as a proportion, e.g., 0.10 rather than as a percentage, e.g., 10%).

Precision based on duplicate measurements (e.g., from revisited POINTs) is estimated based on the range of measured values (which equals the difference for two measurements). The relative percent difference (RPD) is calculated as:

Equation 2

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

Where:

A = the first measured value
B = the second measured value.

Bias in relative terms (B*[%]*) is calculated as:

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[2] Bias, for example, cannot be determined directly, since the “true” values at any particular site are not known.

Equation 3

$$B[\%] = \frac{\bar{x} - T}{T} \times 100$$

Where:

x = the mean value for the set of measurements
T = the theoretical or target value of a performance evaluation sample.

Precision and bias within each laboratory are monitored for every sample batch by the analysis of internal QC samples. Samples associated with unacceptable QC sample results are reviewed and re-analyzed if necessary. Precision and bias across all laboratories will be evaluated after analyses are completed by using the results of performance evaluation (PE) samples sent to all laboratories (3 sets of 3 PE samples, with each set consisting of a low, moderate, and high concentration sample of all analytes).

2.2.2.2 Field Measurements

Since precision, bias, and accuracy of field measurements will not be monitored during the NWCA 2016, a revisit site approach will be taken to ensure the quality of data. The survey design incorporates a plan for repeated sampling of a subset of sites. Data from these repeat visits provide estimates of important components of variance to evaluate the performance of ecological indicators. These variance components are presented in Table 2-1. If estimates of these components are available from other studies, they are used in conjunction with the project requirements to evaluate alternative design scenarios (Larsen et al. 1995, 2001, 2004). Status estimates are influenced most by the interaction (if multiple years are required to complete sampling) and residual variance components. Residual variance is composed of temporal variance within a sampling period confounded with measurement error of various types. If the magnitude of residual variance is sufficiently large to impact status estimates (see above), then relative magnitudes of the interaction variance and various components of residual variance are examined to determine if any reduction can be achieved in the future. Interaction variance can only be reduced by increasing the sample size. Index variance can be reduced by either increasing the number of sites, increasing the number of times a site is visited within a year, reducing the length of the index period, or by reducing measurement error. Trend detection is evaluated using the equation to determine the variance in the slope of the trend (Table 2-1). In this model, residual variance also includes the interaction component. For multi-site networks such as the national aquatic resource assessments, trend detection is most sensitive to coherent year variance, which can only be reduced by extending the time period for monitoring (Larsen et al. 1995, 2001, 2004). If residual variance is large relative to the coherent year variance, then trend detection within a fixed time period can be improved by increasing the number of sites sampled each year, increasing the number of times each site is sampled within a year, or by reducing measurement error.

Table 2-1. Important variance components for aquatic resource assessments

Model for status estimation

$$\sigma^2_{total} = \sigma^2_{sites} + \left(\sigma^2_{year} + \sigma^2_{site\times year} + \sigma^2_{residual}\right)$$

and

$$\sigma^2_{residual} = \sigma^2_{within-year} + \sigma^2_{error}$$

Model for trend detection

$$\mathrm{var}(slope) = \frac{\frac{\sigma^2_{sites}}{N_{sites}} + \left(\sigma^2_{year} + \frac{s^2_{residual}}{N_{sites}}\right)}{\sum_{i=1}^{years}\left(y_i - \bar{Y}\right)^2}$$

and

$$s^2_{residual} = \sigma^2_{site\times year} + \frac{\sigma^2_{residual}}{N_{visit}}$$

Components in parentheses represent "extraneous" variance

Variance Component	Description
σ^2_{sites}	Observed variance among all sites sampled over multiple-year sampling cycle. If sites are revisited across years, this effect can be eliminated
σ^2_{year}	Coherent variance across years that affects all sites equally, due to regional-scale factors such as climate or hydrology Principal effect on trend detection, reduced only by increasing number of years
$\sigma^2_{site\times year}$	"Interaction" variance occurring at each site across years that affects each site independently. Principal effect on status, reduce by increasing number of sites
$\sigma^2_{residual}$	"Residual" variance: Includes temporal variance at each site within a single index period ($\sigma^2_{within-year}$) confounded with measurement error (σ^2_{error}) due to acquiring the data from the site (e.g., sample collection and analysis) Principal effect on status, If σ^2_{index} >> σ^2_{error} reduce by increasing number of sites or altering index period If σ^2_{error} is large relative to σ^2_{index}, then modify sampling and analysis procedures

For the NWCA, approximately ten percent of all sample sites will receive repeat visits to determine if differences exist in field data collection on different days. Revisit sites will be sampled at least 2 weeks apart to ensure that we are assessing temporal variability. Control measures to minimize measurement error among crews and sites will be employed. These control measures include the use of standardized field protocols provided in the Field Operations Manual (FOM), consistent training of all crews, field assistance visits to all crews, and availability of experienced technical personnel during the field season to respond to site-specific questions from field crews as they arise.

Each Field Crew Leader and Botanist/Ecologist must be trained at an EPA-sponsored training session prior to the start of the field season, along with as many crew members as possible. The training program stresses hands-on practice of methods, comparability among crews, collection of high quality data and samples, and safety. A 3.5 day training course will be provided in nine central locations for cooperators and contractors. Project organizations responsible for training oversight are identified in Figure 1-2. Training documentation will be maintained by the Project QA Officer.

Evaluation and assistance visits will be conducted with each Field Team early in the sampling and data collection process, and that corrective actions will be conducted in real time. These visits provide a basis for the uniform evaluation of the data collection techniques, and an opportunity to conduct procedural reviews to minimize data loss due to improper technique or interpretation of program guidance. The field visits evaluations will be based on the uniform training, plans, and checklists. For more information on field assistance visits, see section 6 of this document.

2.2.3 Taxonomic Precision and Accuracy

Taxonomic precision can be evaluated by comparing whole-sample identifications completed by independent taxonomists or laboratories. For the NWCA, five known plant specimens (QA plant vouchers) from each assessed sampling site will be randomly-selected for re-identification by a second botanist (“verifying botanist”), independent of the field botanist who initially identified the plant specimens. In addition, all unknown plant specimens sent to a State or National Plant Laboratory for initial identification will also be subject to quality assurance. Of these unknown specimens, 10% will be randomly selected for re-identification by a second verifying botanist, independent of the botanist who initially identified the unknown specimens. Comparison of the results of whole-sample re-identifications allows Percent Taxonomic Disagreement (PTD) to be calculated using the following equation:

Equation 4

$$PTD = \left[1 - \left(\frac{comp_{pos}}{N}\right)\right] \times 100$$

Where:

$comp_{pos}$ = the number of agreements
N = the total number of individuals in the larger of the two counts.

The lower the PTD, the more similar taxonomic results are and the overall taxonomic precision is better. A specific MQO will not be established for taxonomic precision for NWCA 2016. The NWCA QA Team will monitor differences in the taxonomic identification of plant specimens between the botanists providing the initial identification (in the field or lab in the case of unknown specimens) and the verifying botanists providing the independent re-identifications. Substantial disagreements between the two will be investigated and reasons for the discrepancies examined and corrected.

Taxonomic accuracy is evaluated by having individual specimens representative of selected taxa identified by recognized experts. Samples will be identified using the most appropriate technical literature that is accepted by the taxonomic discipline and reflects the accepted nomenclature. The USDA-NRCS PLANTS Database (http://plants.usda.gov/) will be used to verify nomenclatural validity and spelling.

2.2.4 Completeness

Completeness requirements are established and evaluated from two perspectives. First, valid data for individual parameters must be acquired from a minimum number of sampling locations in order to make subpopulation estimates with a specified level of confidence or sampling precision. The objective of this study is to acquire valid data at 95% or more of the sampled sites. Percent completeness is calculated as:

Equation 5

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

Where:

V = the number of measurements/samples judged valid
T = the total number of planned measurements/samples.

Within each indicator, completeness objectives are also established for individual samples or individual measurement variables or analytes. These objectives are estimated as the percentage of valid data obtained versus the amount of data expected based on the number of samples collected or number of measurements conducted. Where necessary, supplementary objectives for completeness are presented in the indicator-specific sections of this QAPP.

The completeness objectives are established for each measurement per site type (e.g., probability sites, revisit sites, etc.). Failure to achieve the minimum requirements for a particular site type results in regional population estimates having wider confidence intervals. Failure to achieve requirements for revisit samples (10% of sites visited) reduces the precision of estimates of index period and annual variance components, and may impact the representativeness of these estimates because of possible bias in the set of measurements obtained.

2.2.5 Comparability

Comparability is defined as the confidence with which one data set can be compared to another (USEPA 2002a). A performance-based methods approach is being utilized for water chemistry analyses that define a set of laboratory method performance requirements for data quality. Following this approach, participating laboratories may choose which analytical methods they will use for each target analyte as long as they are able to achieve performance requirement criteria established by EPA as described in the Laboratory Operations Manual. For all parameters, comparability is addressed by the use of standardized sampling procedures and analytical methods by all sampling crews and laboratories. Comparability of data within and among parameters is also facilitated by the implementation of standardized quality assurance and quality control techniques and standardized performance and acceptance criteria. For all measurements, reporting units and format are specified, incorporated into standardized data recording forms, and documented in the information management system. Comparability is also addressed by providing results of QA sample data, such as estimates of precision and bias, conducting methods comparison studies when requested by the grantees and conducting interlaboratory performance evaluation studies among state, university, and NWCA contract laboratories.

2.2.6 Representativeness

Representativeness is defined as "the degree to which the data accurately and precisely represent a characteristic of a population parameter, variation of a property, a process characteristic, or an operational condition" (USEPA 2002a). At one level, representativeness is affected by problems in any or all of the other data quality indicators.

At another level, representativeness is affected by the selection of the target wetlands, the location of sampling sites within that wetland, the time period when samples are collected, and the time period when samples are analyzed. The probability-based sampling design should estimate the condition of wetland resource populations that are representative of the region. The individual sampling programs defined for each indicator attempt to address representativeness within the constraints of the response design, (which includes when, where, and how to collect a sample at each site). Holding-time requirements for analyses ensure analytical results are representative of conditions at the time of sampling.

3 SAMPLING DESIGN AND SITE SELECTION

The overall sampling program for the National Wetland Condition Assessment project requires a randomized, probability-based approach for selecting wetlands where sampling activities are to be conducted. Details regarding the specific application of the probability design to surface waters resources are described in Paulsen et al. (1991) and Stevens (1994). The specific details for the collection of samples associated with different indicators are described in the indicator-specific sections of this QAPP.

3.1 Probability-Based Sampling Design and Site Selection

3.1.1 Target Population

The target population for NWCA 2016 is tidal and nontidal wetlands of the conterminous U.S., including certain farmed wetlands not currently in crop production. The wetlands have rooted vegetation and, when present, open water less than 1 meter deep. A wetland's jurisdictional status[3] under state or federal regulatory programs does not affect a site's status as target.

3.1.2 Sample Frame

The sample frame from which sites were selected for the NWCA included two components: 1) the most current National Wetland Status and Trends (S&T) assessment sample frame, obtained from the USFWS (Dahl and Bergeson 2009, Dahl 2011) and 2) USFWS National Wetland Inventory (NWI) digitized maps of wetland types and locations (http://www.fws.gov/wetlands). The S&T sample frame consists of all polygons mapped based on remote sensing information for over 5,048 four square-mile plots across the 48 states. The S&T plots were used as the base data layer for the NWCA sample frame because they are the most consistent and current source of mapped wetlands on a national scale. The digitized NWI maps were used to increase the number of wetlands in the NWCA sample frame. Several other attributes incorporated into the sample frame were the boundaries for states, the boundaries for the five aggregated Omernik Level III ecoregions used in reporting the assessment results (NWCA Ecoregions), and designations of sites to one of twelve NWCA Survey Design Groups which are combinations of NWCA Ecoregions and NWCA Target Wetland Types. Table 3-1 below provides descriptions of the NWCA Target Wetland Types.

[3] Impacts to wetlands and other aquatic resources are regulated under the Clean Water Act when an aquatic resource is determined to be a "Water of the United States". Jurisdictional Determinations are made on a case-by-case basis according to the definition found in 40 CFR 230.3(s). For more information please visit the website: http://www.epa.gov/owow/wetlands/guidance/CWAwaters.html.

Table 3-1. NWCA Target Wetland Types and cross-walk with US Fish & Wildlife Service (USFWS) Status & Trends (S&T) wetland categories and USFWS National Wetland Inventory (NWI) wetland classes.

NWCA Target Wetland Type Code	NWCA Target Wetland Type	S&T Wetland Categories*[1,]	Included *NWI Classes*: Systems/Subsystems[2]
EH	Estuarine Emergent	*E2EM* -Estuarine Intertidal Emergent	*Emergent and Aquatic Bed Classes in* Estuarine/Intertidal Subsystems
EW	Estuarine Shrub/Forest	*E2SS* - Estuarine Intertidal Forest or Shrub	*Forested and Scrub-Shrub Classes in* Estuarine/Intertidal Subsystems
PRL-EM	Palustrine, Riverine, and Lacustrine - Emergent	*PEM* - Palustrine Emergent	*Emergent Classes* in Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems
PRL-UBAB	Palustrine, Riverine, and Lacustrine - Unconsolidated Bottom/Aquatic Bed	*PUB* - Palustrine Unconsolidated Bottom *PAB* - Palustrine Aquatic Bed	*Unconsolidated Bottom, Aquatic Bed Unconsolidated Shore, Rock Bottom, and Rocky Shore Classes in* Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems
PRL-f	Palustrine, Riverine, and Lacustrine - Farmed	*Pf* - Palustrine farmed	*Farmed Modifier in* Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems
PRL-SS	Palustrine, Riverine, and Lacustrine -Shrub/Scrub	*PSS* - Palustrine Shrub	*Scrub-Shrub Classes in* Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems
PRL-FO	Palustrine, Riverine, and Lacustrine - Forested	*PFO* - Palustrine Forested,	*Forested Classes in* Palustrine Systems; Shallow Riverine/Tidal, Lower Perennial, Upper Perennial, or Intermittent Subsystems; and Shallow Lacustrine/Littoral Subsystems

IMPORTANT NOTE: Status and Trends (S&T) category names DO NOT precisely equate to National Wetland Inventory (NWI) Codes for wetland type. S&T categories often aggregate multiple NWI types.

[1]Dahl TE and Bergeson MT (2009) Technical procedures for conducting status and trends of the Nation's wetlands. U.S. Fish and Wildlife Services, Division of Habitat and Resource Conservation, Washington, D.C., p 74.

[2]US Fish and Wildlife Service, National Wetlands Inventory, Wetland Classification Codes. http://www.fws.gov/wetlands/Data/Wetland Codes.html. Accessed December 2014.

3.1.3 Selection of Sampling Locations

Sites were randomly selected from the NWCA sample frame using a spatially balanced Generalized Random Tessellation Stratified (GRTS) survey design for an area resource, with each point having a known probability of being sampled (Stevens and Olsen 2004). The GRTS design ensures the sample is representative of wetland resources at national and regional scales. Using this approach, EPA selected 904 wetland assessment locations from across the conterminous US, consisting of 239 resampled sites from 2011 and 665 new sites and with 96 of the 904 sites to be sampled twice to quantify variability in sampling. In addition, a pool of oversample sites are included for use as replacements if any of the 904 assessment locations are not sampleable. The selected sites are distributed across seven target wetland types defined for the NWCA (Table 3-1) and five NWCA Ecoregions. In addition, some states invested additional resources to supplement the NWCA survey design to add sites to allow state-scale reporting of wetland quality.

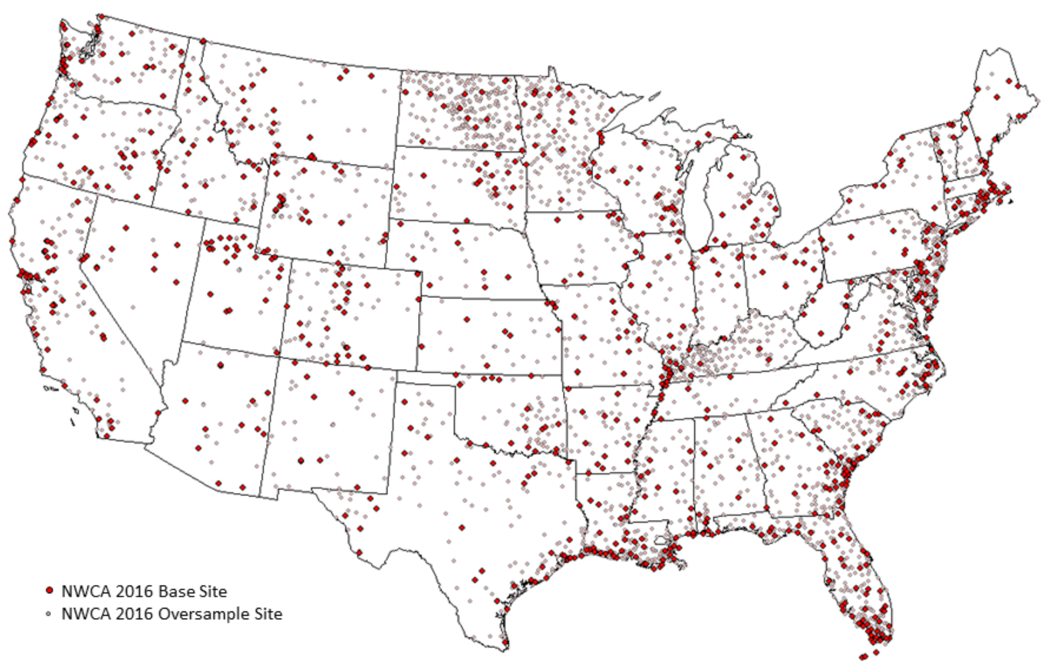

Figure 3-1. NWCA 2016 survey design summary map

3.1.4 Revisit and Resample Sites

Of the sites visited in the field and found to be target sites, approximately 10% will be revisited and sampled again during the NWCA 2016 sampling season. Two revisit sites are designated by EPA for each state. The primary purpose of this revisit set of sites is to allow variance estimates on the extent to which the population estimates may vary if sampled at a different time.

In addition, 239 NWCA 2011 sites will be resampled during the 2016 sampling season to assist in the evaluation of change.

3.2 Handpicked Candidate Reference Site Selection

EPA selected a set of potential reference sites to sample in NWCA 2016. This handpicked set of candidate sites comes from various sources. First, the EPA NWCA team applied a screening process to identify reference lakes from NLA and reference rivers and streams from WSA and NRSA. These reference sites were then mapped and compared to National Wetland Inventory maps to determine if wetlands were co-located with these sites. Second, EPA solicited recommendations from States and other partners for potential reference sites based on their own wetland monitoring and assessment programs. EPA assembled a panel to examine aerial maps and select sites with the least amount of disturbance based on land cover, road networks, and hydrologic features observed on the maps.

Although crews will sample these potential reference sites during the field season, the final set of reference wetlands (i.e., those that EPA will use in the assessment), will be determined after the complete set of data is returned. At this point, EPA will run a set of screening criteria similar to that used in NWCA 2011. This screening approach can be found in the NWCA 2011 Technical Report (http://www.epa.gov/national-aquatic-resource-surveys/national-wetland-condition-assessment-2011-draft-technical-report).

4 INFORMATION MANAGEMENT

Environmental monitoring efforts that amass large quantities of information from various sources present unique and challenging data management opportunities. To meet these challenges, the NWCA 2016 employs a variety of well-tested information management (IM) strategies to aid in the functional organization and ensured integrity of stored electronic data. IM is integral to all aspects of the NWCA 2016 from initial selection of sampling sites through the dissemination and reporting of final, validated data. And, by extension, all participants in the NWCA 2016 have certain responsibilities and obligations which also make them a part of the IM system. This "inclusive" approach to managing information helps to:

- Strengthen relationships among NWCA 2016 cooperators;
- Increase the quality and relevance of accumulated data; and
- Ensure the flexibility and sustainability of the NWCA 2016 IM structure.

This IM strategy provides a congruent and scientifically meaningful approach for maintaining environmental monitoring data that will satisfy both the scientific and technological requirements of the NWCA 2016.

4.1 Roles and Responsibilities

At each point where data and information are generated, compiled, or stored, the NWCA 2016 IM team must manage the information. Thus, the IM system includes all of the data-generating activities, all of the means of recording and storing information, and all of the processes that use data. The IM system also includes both hardcopy and electronic means of generating, storing, organizing and archiving data, and the effort to achieve a functional IM process is all encompassing. ***To that end, all participants in the NWCA 2016 play an integral part within the IM system.*** Table 4-1 provides a summary of the IM responsibilities identified by NWCA 2016 group. Specific information on the field crew responsibilities for tracking and sending information is found in the FOM.

Table 4-1 Summary of IM responsibilities.

NWCA 2016 Group	Contact	Primary Role	Responsibility
Field Crews	State/tribal partners and contractor or other field crews (regional EPA, etc.)	Acquire in-situ measurements and prescribed list of biotic/abiotic samples at each site targeted for the survey	Complete and review field data forms and sample tracking forms for accuracy, completeness, and legibility. Ship/fax field and sample tracking forms to NARS IM Center so information can be integrated into the central database. Work with the NARS IM Center staff to develop acceptable file structures and electronic data transfer protocols should there be a need to transfer and integrate data into the central database. Provide all data as specified in FOM, SEG or as negotiated with the NWCA Project Manager. Maintain open communications with NARS IM Center regarding any data issues.

NWCA 2016 Group	Contact	Primary Role	Responsibility
Analytical Laboratories	State/tribal partners and contractors	Analyze samples received from field crews in the manner appropriate to acquire biotic/abiotic indicators/measurements requested.	Review all electronic data transmittal files for completeness and accuracy (as identified in the QAPP). Work with the NARS IM Center staff to develop file structures and electronic data transfer protocols for electronically-based data. Submit completed sample tracking forms to NWCA 2016 IM Center so information can be updated in the central database. Provide all data and metadata as specified in the laboratory transmittal guidance section of the LOM, with specific templates for each indicator or as negotiated with the NWCA Project Manager. Maintain open communications with NWCA 2016 IM Center regarding any data issues.
IM Center staff	USEPA ORD NHEERL Western Ecology Division-Corvallis, Contractors	Provides support and guidance for all IM operations related to maintaining a central data management system for NWCA 2016	Develop/update field data forms. Plan and implement electronic data flow and management processes. Manage the centralized database and implement related administration duties. Receive, scan, and conduct error checking of field data forms. Monitor and track samples from field collection, through shipment to appropriate laboratory. Receive data submission packages (analytical results and metadata) from each laboratory. Run automated error checking, e.g., formatting differences, field edits, range checks, logic checks, etc. Receive verified, validated, and final indicator data files (including record changes and reason for change) from QA reviewers. Maintain history of all changes to data records from inception through delivery to WQX. Organize data in preparation for data verification and validation analysis and public dissemination. Implement backup and recovery support for central database. Implement data version control as appropriate.
Project Quality Assurance Manager	USEPA Office Of Water	Lead QA Team to review and evaluate the relevancy and quality of information/data collected and generated through the NWCA 2016 surveys.	Monitor quality control information. Evaluate results stemming from field and laboratory audits. Investigate and take corrective action, as necessary, to mitigate any data quality issues. Issue guidance to NWCA 2016 Project Manager and IM Center staff for qualifying data when quality standards are not met or when protocols deviate from plan.
Steering Committee	NWCA Project Manager and other team members, EPA Regional and ORD staff, States, tribes, other federal agencies	Provide technical recommendations related to data analysis, reporting and overall implementation	Provide feedback and recommendations related to QA, data management, analysis, reporting and data distribution issues. Review and comment on QA and information management documentation (QAPP, data templates, etc.).

NWCA 2016 Group	Contact	Primary Role	Responsibility
Data Analysis and Reporting Team	USEPA Office of Water, ORD WED, Partners	Provide the data analysis and technical support for NWCA 2016 reporting requirements	Provide data integration, aggregation and transformation support as needed for data analysis. Provide supporting information necessary to create metadata. Investigate and follow-up on data anomalies using identified data analysis activities. Produce estimates of extent and ecological condition of the target population of the resource. Provide written background information and data analysis interpretation for report(s). Document in-depth data analysis procedures used. Provide mapping/graphical support. Document formatting and version control. Develops QA report for management.
Data Finalization Team	TBD	Provides data librarian support	Prepare NWCA 2016 data for transfer to USEPA public web-server(s). Generate data inventory catalog record (Science Inventory Record). Ensure all metadata is consistent, complete, and compliant with USEPA standards.

4.1.1 State/Tribe-Based Data Management

Some state and tribal partners will be managing activities for both field sampling and laboratory analyses. While the NARS program encourages states and tribes to use these in-house capabilities, it is imperative that NWCA 2016 partners understand their particular role and responsibilities for executing these functions within the context of the national program. If a state or tribe chooses to conduct these activities, the state or tribe must perform all of the functions associated with the following roles:

- Field Crew—including shipping/faxing of field data forms to the IM Coordinator (NWCA 2016 paper or electronic field forms must be used and the original field forms must be sent to the NARS IM Center as outlined in the NWCA 2016 FOM).
- Laboratory Quality Assurance including responding to the NWCA 2016 QA Team questions after submitting data.
- Submission of data from the state or tribe to the Laboratory Review Coordinator or other designated member of the QA Team and then to the NARS IM Center. Typically, the state or tribe will provide a single point of contact for all activities related to NWCA 2016 data. However, it may be advantageous for the Laboratory Review Coordinator to have direct communication with the state or tribe participating laboratories to facilitate the transfer of data, a point that may be negotiated between the primary state or tribal contact, the EPA Regional Coordinator and the NWCA Laboratory Review Coordinator.
- Data transfers to the NARS IM Center must be timely. States and tribes must submit all initial laboratory results (i.e., those that have been verified by the laboratory and have passed all internal laboratory QA/QC criteria) in the appropriate format to NARS IM Center by May 2017, in order to meet NWCA 2016 product deadlines.
- Data transfers must be complete. For example, laboratory analysis results submitted by a state or tribe must be accompanied by related quality control and quality assurance data, qualifiers code definitions, contaminant/parameter code cross-references/descriptions, test methods, instrumentation information and any other relevant laboratory-based assessments or documentation related to specific analytical batch runs.

- The state or tribe will ensure that data meet minimum quality standards and that data transfer files meet negotiated content and file structure standards.

The Laboratory Review Coordinator communicates the necessary guidance for data management and submission requirements (i.e. data templates).

4.2 Overview of System Structure

In its entirety, the NARS IM system includes site selection and logistics information, sample labels and field data forms, tracking records, mapping and analytical data, data validation and analysis processes, reports, and archives. NARS IM staff provides support and guidance to all program operations in addition to maintaining a central database management system for the NWCA data.

The central repository for data and associated information collected for use by NWCA 2016 is a secure, access-controlled server located at WED-Corvallis. This database is known as the NARS IM. Data are stored and managed on this system using the Structured Query Language (SQL). Data review (e.g., verification and validation) and data analysis (e.g., estimates of status and extent) are accomplished primarily using programs developed in either Statistical Analysis System (SAS) or 'R' language software packages.

4.2.1 Data Flow

The NWCA 2016 will accumulate large quantities of observational and laboratory analysis data. To manage this information appropriately, it is essential to have a well-defined data flow model and documented approach for acquiring, storing, and summarizing the data. This conceptual model (Figure 4-1) helps focus efforts on maintaining organizational and custodial integrity, ensuring that data available for analyses are of the highest possible quality.

4.2.2 Simplified Description of Data Flow

There are several components associated with the flow of information, these are:

- Communication between the NARS IM Center, the NWCA 2016 QA Team and the various data contributors (e.g., field crews, laboratories and the data analysis and reporting team) is vital for maintaining an organized, timely, and successful flow of information and data.
- Data are captured or acquired from four basic sources: field data transcription, laboratory analysis reporting, automated data capture, and submission of external data files (e.g., Geographic Information Systems (GIS) data) encompassing an array of data types (site characterization, biotic assessment, sediment and tissue contaminants, and water quality analysis). Data capture generally relies on the transference of electronic data, e.g., optical character readers and email, to a central data repository. However, some data must be transcribed by hand in order to complete a record.
- Data repository or storage provides the computing platform where raw data are archived, partially processed data are staged, and the "final" data, assimilated into a final, user-ready data file structure, are stored. The raw data archive is maintained in a manner consistent with providing an audit trail of all incoming records. The staging area provides the IM Center staff with a platform for running the data through all of its QA/QC paces as well as providing data analysts a first look at the incoming data. This area of the data system evolves as new data are gathered and user-requirements are updated. The final data format becomes the primary source for all statistical analysis and data distribution.

- Metadata—a descriptive document that contains information compliant with the Content Standards for Digital Geospatial Metadata (CSDGM) developed by the Federal Geographic Data Committee (FGDC).

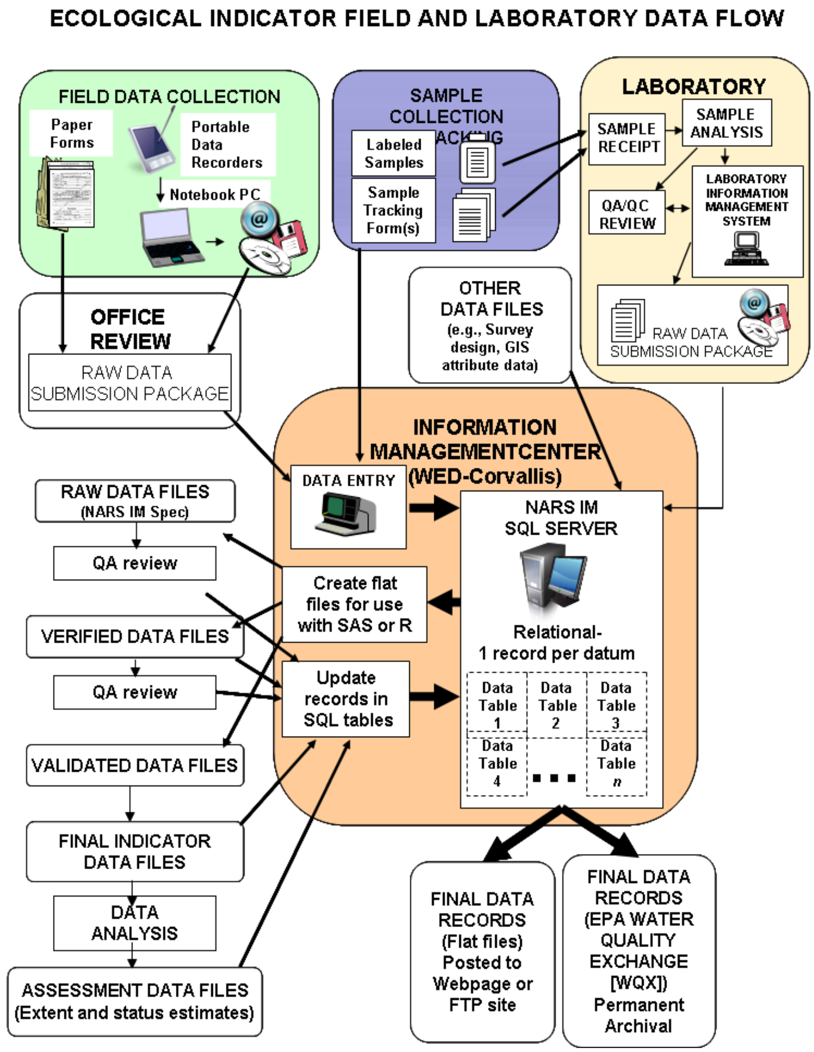

Figure 4-1. Conceptual model of data flow into and out of the master SQL

The following sections describe core information management standards, data transfer protocols, and data quality and results validation. Additionally, Section 4.4 describes the major data inputs to the central database and the associated QA/QC processes used to record, enter, and validate measurement and analytical data collected.

4.2.3 Core Information Management Standards

The development and organization of the NARS IM system is compliant with current EPA guidelines and standards. Areas addressed by these policies and guidelines include, but are not limited to, the following:

- Taxonomic nomenclature and coding;
- Locational data;

- Sampling unit identification and reference;
- Hardware and software; and
- Data catalog documentation.

NWCA 2016 is committed to compliance with all applicable regulations and guidance concerning hardware and software procurement, maintenance, configuration control, and QA/QC. To that end, the NWCA 2016 team has adopted several IM standards that help maximize the ability to exchange data within the study and with other aquatic resource surveys or similar large-scale monitoring and assessment studies (e.g. NARS, past EMAP and R-EMAP studies). Specific information follows.

4.2.4 Data Formats

4.2.4.1 Attribute Data

- SQL Tables;
- SAS Data Sets;
- R Data Sets[4]; and
- American Standard Code for Information Interchange (ASCII) Files: Comma-Separated values, or space-delimited, or fixed column.

4.2.4.2 GIS Data

- ARC/INFO native and export files; compressed .tar file of ARC/INFO workspace; and
- Spatial Data Transfer Standard (SDTS; FGDC 1999) (format available upon request).

4.2.4.3 Standard Coding Systems

- Sampling Site: (EPA Locational Data Policy; USEPA 1991);
- Coordinates: Latitude and Longitude in decimal degrees (±0.002);
- Datum: NAD83;
- Chemical Compounds: Chemical Abstracts Service (CAS 1999) (http://www.cas.org/) ;
- Species Codes: Integrated Taxonomic Information System when possible; and
- Land cover/land use codes: Multi-Resolution Land Characteristics; National Hydrography Dataset Plus Version 1.0 (NHDPlus 2005).

4.2.5 Public Accessibility

While any data created using public funds are subject to the Freedom of Information Act (FOIA), some basic rules apply for general public accessibility and use. Briefly, those rules are:

- Program must comply with Data Quality Act before making any data available to the public and person generating data must fill out and have a signed Information Quality Guidelines package before any posting to the Web or distribution of any kind.
- Data and metadata files are made available to the contributor or participating group for review or other project-related use from NARS IM or in flat files before moving to an EPA-approved public website.

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[4] **R** is a freely available software programming language and a software environment for statistical computing and graphics. The R language is widely used among statisticians and data miners for developing statistical software and data analysis.

- Data to be placed on a public website will undergo QA/QC review according to the approved QAPP.
- Only "final" data (those used to prepare the final project report) are readily available through an EPA-approved public website.

As new guidance and requirements are issued, the NARS IM staff will assess the impact upon the IM system and develop plans for ensuring timely compliance.

4.3 Data Transfer Protocols

Field crews are expected to send in hard copies of field forms or use the provided electronic field forms containing *in situ* measurement and event information to the NARS IM Center defined in the FOM for submission. Laboratories will submit electronic data files to either the EPA Task Order Manager (contractors) or the Laboratory Review Coordinator (states and tribes) or as otherwise agreed to by the EPA Project Manager and the laboratory. Field crews and laboratories must submit all sample tracking and analytical results data in electronic form using a standard software package to export and format data. Data submission templates for laboratories are included in the LOM. Examples of software and the associated formats are given in Table 4-2:

Table 4-2 Summary of software

Software	Export Options (file extensions)
Microsoft Excel®	xls, xlsx, csv, formatted txt delimited
Microsoft Access®	mdb, csv, formatted txt delimited
SAS®	csv, formatted txt delimited
R	csv, formatted txt delimited

All electronic files must be accompanied by appropriate documentation (e.g., metadata, laboratory reports, QA/QC data and review results). This documentation must contain sufficient information to identify field contents, field formats, qualifier codes, etc. It is very important to keep EPA informed of the completeness of the analyses. Labs may send files periodically, before all samples are analyzed, but EPA must be informed that more data are pending if a partial file is submitted. All data files sent by the labs must be accompanied by text documentation describing the status of the analyses, any QA/QC problems encountered during processing, and any other information pertaining to the quality of the data. Following is a list of general transmittal requirements each laboratory, state, or tribal based IM group should consider when packaging data for electronic transfer to the IM Center:

- Provide data in row/column data file/table structure – see Appendix C in LOM for templates. All cooperators and contractors should further consider the following:
  a. Include NWCA site and sample ID provided on the sample container label in a field for each record (row) to ensure that each data file/table record can be related to a site visit.
  b. Use a consistent set of column labels.
  c. Use file structures consistently.
  d. Use a consistent set of data qualifiers.
  e. Use a consistent set of units.
  f. Include method detection limit (MDL) as part of each result record.
  g. Include reporting limit (RL) as part of each result record for water chemistry.
  h. Provide a description of each result/QC/QA qualifier.
  i. Provide results/measurements/MDL/RL in numeric form.

j. Maintain result qualifiers (e.g., <, Not Detected (ND)) in a separate column.
k. Use a separate column to identify record-type. For example, if QA or QC data are included in a data file, there should be a column that allows the IM staff to readily identify the different result types.
l. Include laboratory sample identifier.
m. Include batch numbers/information so results can be paired with appropriate QA/QC information.
n. Include "true value" concentrations, if appropriate, in QA/QC records.
o. Include a short description of preparation and analytical methods used to analyze samples (where appropriate) either as part of the record or as a separate description for the test(s) performed on the sample. For example, EPAxxxx.x, ASTMxxx.x, etc. Provide a broader description (e.g., citation) if a non-standard method is used.
p. Include a short description of instrumentation used to acquire the test result (where appropriate). This may be reported either as part of the record or as a separate description for each test performed on the sample. For example, GC/MS-ECD, ICP-MS, etc.
q. Ensure that data ready for transfer to NARS IM are verified and validated, and results are qualified to the extent possible (final verification and validation are conducted by EPA).
r. Data results must meet the specified requirements for each indicator found in the LOM as specified by contract or agreement.
s. Identify and qualify missing data (why are the data missing?).
t. Submit any other associated quality assurance assessments and relevant data related to laboratory results (i.e., chemistry, nutrients). Examples include summaries of QC sample analyses (blanks, duplicates, check standards, matrix spikes) standard or certified reference materials, etc.), results for external performance evaluation or proficiency testing samples, and any internal consistency checks conducted by the laboratory. For requirements, please see specific indicator sections of this QAPP and LOM.

The Laboratory Review Coordinator will work with the NARS IM Coordinator to establish a data load process into NARS IM.

4.4 Data Quality and Results Validation

Data quality is integrated throughout the life cycle of the data. This includes development of appropriate forms, labels etc. for capturing data as well as verifying data entry, results, and other assessments. Indicator workgroup experts, the data analysis and reporting team submit any recommended changes to the Project QA Coordinator who recommends and submits any changes (deletions, additions, corrections) to the NARS IM data center for inclusion in the validated data repository. All explanation for data changes is included in the record history.

4.4.1 Design and Site Status Data Files

The site selection process described in Section 3 produces a list of candidate sampling locations, inclusion probabilities, and associated site classification data (e.g., target status, ecoregion, etc.). The Design Team provides this file to the NWCA 2016 Project Manager, who in turn distributes to the IM staff, and field coordinators. Field coordinators determine ownership and contacts for acquiring permission to access each site, and conduct site evaluation and reconnaissance activities. Field Crews document information from site evaluation and reconnaissance activities following the SEG and the FOM. The site evaluation spreadsheets are submitted to the Logistics Field Coordinator by the field crews. The Logistics Field Coordinator and NARS IM Center compile all information such as ownership, site evaluation, and reconnaissance information for each site into a "site status" data file. Any missing information from the site status data file is identified and a request is made by the Field Logistics Coordinator to the field crew (or site evaluator) to complete the record. Revised information is then submitted to the NARS IM Center.

4.4.2 Sample Collection and Field Data

Field crews record sampling event observational data in a standard and consistent manner using field data collection forms (Appendix B of the NWCA 2016 FOM). Prior to initiation of field activities, the NARS IM staff works with the indicator leads and analytical support laboratories to develop standardized field data forms and sample labels. Adhesive labels, completed by the field crews, have a standard recording format and are affixed to each sample container. Field protocols include precautions to ensure that label information remains legible and the label remains attached to the sample.

NWCA 2016 provides two options for completing field forms: electronic data entry using pre-developed e-forms or "traditional" paper. Paper forms are printed for field crews on water resistant paper. Copies of the field data forms and instructions for completing each form are documented in the NWCA 2016 FOM. Recorded data whether through e-forms or paper are reviewed upon completion of data collection and recording activities by the Field Crew Leader. Field crews check completed data forms and sample labels before leaving a sampling site to ensure information and data were recorded legibly and completely. Errors are corrected by field crews if possible, and data considered as suspect are qualified using a flag variable. The field sampling crew enters explanations for all flagged data in a comments section. Field crews transmit e-forms to the NARS IM Staff by selecting the "submit" button as described in the FOM. Alternately, field crews, ship completed paper field data forms to the NARS IM staff for entry into the central database management system.

All samples are tracked from the point of collection. Tracking of samples refers to the documentation of the specified location of each sample in the centralized NARS IM Center database. This is done by requiring that field crews ensure that copies of the shipping and custody record accompany all sample transfers; other copies are transmitted to the IM Center. Each sample has a custody record that laboratory manager is required to enter into NARS IM Center upon receipt of sample. The IM Center tracks samples to ensure that they are delivered to the appropriate laboratory, that lost shipments can be quickly identified and traced, and that any problems with samples observed when received at the laboratory are reported promptly so that corrective action can be taken, if necessary. Detailed procedures on shipping and sample tracking can be found in the FOMs.

Procedures for completion of sample labels and field data forms and use of personal computers (PCs) are covered extensively in training sessions. General QC checks and procedures associated with sample collection and transfer, field measurements, and field data form completion for most indicators are listed in Table 4-3. Additional QA/QC checks or procedures specific to individual indicators are described in the LOM.

Table 4-3 Summary sample and field data quality control activities: sample tracking

Quality Control Activity	Description and/or Requirements
Contamination Prevention	All containers for individual site sealed in plastic bags until use; specific contamination avoidance measures covered in training
Sample Identification	Pre-printed labels with unique ID number on each sample
Data Recording	Data recorded on pre-printed forms of water-resistant paper; field sampling crew reviews data forms for accuracy, completeness, and legibility
Data Qualifiers	Defined qualifier codes used on data form; qualifiers explained in comments section on data form
Sample Custody Records	Unique sample ID and tracking form information entered in LIMS; sample shipment and receipt confirmed
Sample Tracking	Sample condition inspected upon receipt and noted on tracking form with copies sent to NWCA Field Logistics Coordinator and/or IM
Data Entry	Data entered using customized entry screens that resemble the data forms; entries reviewed manually or by automated comparison of double entry
Data Submission	Standard format defined for each measurement including units, significant figures, and decimal places, accepted code values, and required field width
Data Archival	All data records, including raw data, archived in an organized manner. For example, following verification/validation of the last submission into the NARS database, it is copied to a terabit external hard drive and sent to the Project Leader for inclusion in their project file, scheduled as 501, permanent records. Processed samples and reference collections of taxonomic specimens submitted for cataloging and curing at an appropriate museum facility

4.4.3 Laboratory Analyses and Data Recording

Upon receipt of a sample shipment, analytical laboratory receiving personnel check the condition and identification of each sample against the sample tracking record. Each sample is identified by information written on the sample label. The laboratory reports any discrepancies, damaged samples, or missing samples to the NARS IM staff and NWCA 2016 Project Manager electronically.

Most of the laboratory analyses for the NWCA 2016 indicators, particularly chemical and physical analyses, follow or are based on standard methods. Standard methods generally include requirements for QC checks and procedures. General laboratory QA/QC procedures applicable to most NWCA 2016 indicators are described in Section 5. Additional QA/QC procedures specific to individual indicator and parameter analyses are described in the LOM and the FOM. Biological sample analyses are generally based on current acceptable practices within the particular biological discipline. Table 4-4 provides a summary of the lab data QC activities for NWCA 2016.

Table 4-4 Summary laboratory data quality control activities

Quality Control Activity	Description and/or Requirements
Instrument Maintenance	Follow manufacturer's recommendations and specific guidelines in methods; maintain logbook of maintenance/repair activities
Calibration	Calibrate instruments according to manufacturer's recommendations for each specific indicator; recalibrate or replace before analyzing any samples
QC Data	Maintain control charts, determine LT-MDLs and achieved data attributes; include QC data summary (narrative and compatible electronic format) in submission package
Data Recording	Use software compatible with NARS IM system. Check all data entered against the original bench sheet to identify and correct entry errors. Review other QA data (e.g., condition upon receipt, etc.) for possible problems with sample or specimen.
Data Qualifiers	Use defined qualifier codes; explain all qualifiers
Data Entry	Automated comparison of double entry or 100% manual check against original data form
Submission Package	Includes: ▪ Letter by laboratory manager ▪ Data ▪ Data qualifiers and explanations ▪ Electronic format compatible with NARS IM ▪ Documentation of file and database structures ▪ Metadata: variable descriptions and formats ▪ Summary report of any problems and corrective actions implemented

A laboratory's IM system may consist of only hardcopy records such as bench sheets and logbooks, an electronic laboratory information management system (LIMS), or some combination of hardcopy and electronic records. Laboratory data records are reviewed at the end of each analysis day by the designated laboratory onsite QA coordinator or by supervisory personnel. Errors are corrected by laboratory personnel if possible, and data considered as suspect by laboratory analysts are qualified with a flag variable. All flagged data are explained in a comments section. Private contract laboratories generally have a laboratory Quality Assurance Protection Plan and established procedures for recording, reviewing, and validating analysis data.

Once analytical data have passed all of the laboratory's internal review procedures, the lab prepares and transfers a submission package using the prescribed templates in the LOM. The contents of the submission package are largely dictated by the type of analysis (e.g., physical, chemical, or biological).

Remaining sample material and voucher specimens may be transferred to EPA's designated laboratory or facilities as directed by the NWCA 2016 Project Lead. All samples and raw data files (including logbooks, bench sheets, and instrument tracings) are to be retained by the laboratory for 3 years or until authorized for disposal, in writing, by the EPA Project Leader. Deliverables from contractors and cooperators, including raw data, are permanent as per EPA Record Schedule 258 (http://www.epa.gov/records/policy/schedule/sched/258.htm). EPA's project records are scheduled 501 (http://www.epa.gov/records/policy/schedule/sched/501.htm) and are also permanent.

4.4.4 Data Review, Verification, and Validation Activities

Raw data files are created from entry of field and analytical data, including data for QA/QC samples and any data qualifiers noted on the field forms or analytical data package.

4.4.4.1 Paper Forms

The NARS IM Center either optically scans or transcribes information from field collection forms into an electronic format (sometimes using a combination of both processes). During the scanning process, incoming data are subjected to a number of automated error checking routines (e.g., entry and character reading errors). Obvious errors are corrected immediately at the time of scanning. Suspected errors that cannot be confirmed at the time of scanning are qualified for later review by someone with the appropriate background and experience (e.g., a chemist or aquatic ecologist). The process continues until the transcribed data are 100% verified or no corrections are required.

4.4.4.2 Electronic Forms

The NARS IM Center directly uploads information from the electronic field collection forms into their database. During the upload process, incoming data are subjected to a number of automated error checking routines. Omissions and errors are automatically noted in an email message to the field crew lead.

4.4.4.3 Additional Review

Additional validation is accomplished by the NARS IM Center staff using a specific set of guidelines and executing a series of programs (computer code) to check for: correct file structure and variable naming and formats, outliers, missing data, typographical errors and illogical or inconsistent data based on expected relationships to other variables. Data that fail any check routine are identified in an “exception report” that is reviewed by an appropriate scientist for resolution.

The NARS IM Center brings any remaining questionable data to the attention of the EPA Project QA Officer and individuals responsible for collecting the data for resolution. The EPA Project QA Officer evaluates all data to determine completeness and validity. Additionally, the data are run through a rigorous inspection using SQL queries or other computer programs such as SAS or R to check for anomalous data values that are especially large or small, or are noteworthy in other ways. Focus is on rare, extreme values since outliers may affect statistical quantities such as averages and standard deviations.

The EPA Project QA Officer examines all laboratory quality assurance (QA) information to determine if the laboratory met the predefined data quality objectives - available through the QAPP. Some of the typical checks made in the processes of verification and validation are described in Table 4-5.

Automated review procedures may be used. The primary purpose of the initial checks is to confirm that each data value present in an electronic data file is accurate with respect to the value that was initially recorded on a data form or obtained from an analytical instrument. In general, these activities focus on individual variables in the raw data file and may include range checks for numeric variables, frequency tabulations of coded or alphanumeric variables to identify erroneous codes or misspelled entries, and summations of variables reported in terms of percent or percentiles. In addition, associated QA information (e.g., sample holding time) and QC sample data are reviewed to determine if they meet acceptance criteria. Suspect values are assigned a data qualifier. They will either be corrected, replaced with a new acceptable value from sample reanalysis, or confirmed suspect after sample reanalysis. For biological samples, species identifications are corrected for entry errors associated with incorrect or misspelled codes. Errors associated with misidentification of specimens are corrected after voucher specimens have been confirmed and the results are available. Files corrected for entry errors are considered to be raw data files. Copies of all raw data files are maintained in the centralized NARS IM System**.** Any suspect data will be flagged for data qualification.

The NARS IM staff, with the support of the NWCA 2016 QA Team, correct and qualify all questionable data. Copies of the raw data files are maintained in NARS IM, generally in active files until completion of reporting and then in archive files. Redundant copies of all data files are maintained and all files are periodically backed up to the EPA HQ shared G drive system.

Table 4-5 Data review, verification, and validation quality control activities

Quality Control Activity	Description and/or Requirements
Review any qualifiers associated with variable	Determine if value is suspect or invalid; assign validation qualifiers as appropriate
Determine if Measurement Quality Objective (MQOs) and project DQOs have been achieved	Determine potential impact on achieving research and/or program objectives
Exploratory data analyses (univariate, bivariate, multivariate) utilizing all data	Identify outlier values and determine if analytical error or site-specific phenomenon is responsible
Confirm assumptions regarding specific types of statistical techniques being utilized in development of metrics and indicators	Determine potential impact on achieving research and/or program objectives

In the final stage of data verification and validation, exploratory data analysis techniques may be used to identify extreme data points or statistical outliers in the data set. Examples of univariate analysis techniques include the generation and examination of box-and-whisker plots and subsequent statistical tests of any outlying data points. Bivariate techniques include calculation of Spearman correlation coefficients for all pairs of variables in the data set with subsequent examination of bivariate plots of variables having high correlation coefficients. Multivariate techniques have also been used in detecting extreme or outlying values in environmental data sets (Meglen, 1985; Garner et al., 1991; Stapanian et al., 1993).

The QA Team reviews suspect data to determine the source of error, if possible. If the error is correctable, the data set is edited to incorporate the correct data. If the source of the error cannot be determined, the QA Team qualifies the data as questionable or invalid. Data qualified as questionable may be acceptable for certain types of data analyses and interpretation activities. The decision to use questionable data must be made by the individual data users. Data qualified as invalid are considered to be unacceptable for use in any analysis or interpretation activities and will generally be removed from the data file and replaced with a missing value code and explanatory comment or flag code. After completion of verification and validation activities, a final data file is created, with copies transmitted for archival and for uploading to the centralized IM system.

Once verified and validated, data files are made available for use in various types of interpretation activities; each activity may require additional restructuring of the data files. These restructuring activities are collectively referred to as "data enhancement." In order to develop indicator metrics from one or more variables, data files may be restructured so as to provide a single record per site.

4.5 Data Transfer

Field crews may transmit data electronically; hardcopies of completed data and sample tracking forms are sent via express courier service. Copies of raw, verified, and validated data files are transferred from the QA lead to the IM staff for inclusion in the central IM system. All transfers of data are conducted using a means of transfer, file structure, and file format that has been approved by the EPA IM Project lead. Data files that do not meet the required specifications will not be incorporated into the centralized data access and management system.

4.5.1 Database Changes

The NARS IM Center staff complete data corrections at the lowest level to ensure that any subsequent updates will contain only the most correct data. The NARS IM Center sends back laboratory results found to be in error to the originator (e.g., analysis laboratory) for correction. After the originator makes any corrections, the entire batch or file is resubmitted to the NARS IM Center. The NARS IM Center uses these resubmissions to replace any previous versions of the same data.

The NARS IM Center uses a version control methodology when receiving files. This methodology is explained in the following discussion. Incoming data are not always immediately transportable into a format compatible with the desired file structures. When this situation occurs, the IM staff creates a copy of the original data file, which then becomes the working file in which any formatting changes will take place. The original raw data will remain unchanged. This practice further ensures the integrity of the data and provides an additional data recovery avenue, should the need arise.

All significant changes are documented by the NARS IM Center staff. The NARS IM Center includes this information in the final summary documentation for the database (metadata).

After corrections have been applied to the data, the NARS IM Center will rerun the validation programs to re-inspect the data.

If requested by the NARS Project QA Officer, the NARS IM Center will implement database auditing features to track changes.

4.6 Metadata

All metadata will be kept according to the Federal Geographic Data Committee, Content standard for digital geospatial metadata, version 2.0. FGDC-STD-001-1998 (FGDC 1998).

4.6.1 Parameter Formats

The following parameter formats will be used:

- Sampling Site (EPA Locational Data Policy (USEPA 1991)
- Latitude and Longitude in decimal degrees (+/- 7.4), Negative longitude values (west of the prime meridian),
- Datum: NAD83;
- Date: YYYYMMDD (year, month, day)
- Hour: HHMMSS (hour, minute, second), Greenwich mean time, Local time
- Data loaded to STORET will take on the STORET formats upon loading.

4.6.2 Standard Coding Systems

The following standard coding systems will be used:

- Chemical Compounds: Chemical Abstracts Service (CAS 1999)
- Species Names: USDA-NRCS PLANTS Database (USDA-NRCS 2016)
- Land cover/land use codes: Multi-Resolution Land Characteristics (MRLC 1999)

4.7 Information Management Operations

4.7.1 Computing Infrastructure

Electronic data are collected and maintained within a central server housed at WED using a Windows Server 2003 R2 (current configuration) or higher computing platform in SQL native tables for the primary data repository and SAS® native data sets or R datasets for data analysis. Official IM functions are conducted in a centralized environment.

4.7.2 Data Security and Accessibility

The NARS IM Center ensures that all data files in NARS IM are protected from corruption by computer viruses, unauthorized access, and hardware and software failures. Guidance and policy documents of EPA and management policies established by the IM Technical Coordination Group for data access and data confidentiality are followed. Raw and verified data files are accessible only to the NWCA 2016 collaborators. Validated data files are accessible only to users specifically authorized by the NWCA 2016 Project Leader. Data files in the central repository used for access and dissemination are marked as read-only to prevent corruption by inadvertent editing, additions, or deletions.

Data generated, processed, and incorporated into the IM system are routinely stored as well as archived on redundant systems by the NARS IM Center. This ensures that if one system is destroyed or incapacitated, IM staff can reconstruct the databases. Procedures developed to archive the data, monitor the process, and recover the data are described in IM documentation.

Data security and accessibility standards implemented for NWCA 2016 IM meet EPA's standard security authentication (i.e., username, password) process in accordance to EPA's *Information Management Security Manual* (1999; EPA Directive 2195 A1) and EPA Order 2195.1 A4 (2001). Any data sharing requiring file transfer protocol (FTP) or internet protocol is provided through an authenticated site.

4.7.3 Life Cycle

Data may be retrieved electronically by the NWCA 2016 team, partners and others throughout the records retention and disposition lifecycle or as practicable (Section 4.4).

4.7.4 Data Recovery and Emergency Backup Procedures

The NARS IM Center maintains several backup copies of all data files and of the programs used for processing the data. Backups of the entire system are maintained off-site by the NARS IM Center. The IM process used by the NARS IM Center for NWCA 2016 uses system backup procedures. The NARS IM Center backs up and archives the central database according to procedures already established for EPA Western Ecology Division and NARS IM. All laboratories generating data and developing data files are expected to establish procedures for backing up and archiving computerized data.

4.7.5 Long-Term Data Accessibility and Archive

All data are transferred by OW's Water Quality Exchange (WQX) team working with the NARS IM Team to EPA's agency-wide WQX data management system for archival purposes. WQX is a repository for water quality, biological, and physical data and is used by state environmental agencies, EPA and other federal agencies, universities, and private citizens. Data from the NWCA 2016 project will be run through an Interface Module in an Excel format and uploaded to WQX by the WQX team. Once uploaded, states and tribes and the public will be able to download data (using Oracle software) from their region. Data will also be provided in flat files on the NARS website.

4.8 Records Management

Removable storage media (i.e., CDs, USB Drives) and paper records are maintained in a centrally located area at the NARS IM Center. Paper records will be returned to OW once the assessment is complete. The IM Team identifies and maintains files using standard divisional procedures as established by EPA Western Ecology Division. Records retention and disposition comply with U.S. EPA directive 2160 Records Management Manual (July, 1984) in accordance with the Federal Records Act of 1950.

5 INDICATORS

This section of the QAPP provides summary information on laboratory and field performance and quality control measures for the NWCA 2016 indicators. Additional details are described in the NWCA 2016 Field Operations Manual and Laboratory Operations Manual. A description of the NWCA 2016 indicators is found in Table 5-1.

Table 5-1. Description of indicators and collection locations

Indicator	Description	Location of Sample Collection
Vegetation	Measurements of composition and abundance of plant species used to evaluate biological integrity.	Five 100-m^2 Vegetation Plots systematically placed across the Assessment Area.
Soil	Measurements of physical and chemical properties to evaluate the health and condition of soil.	Collected in a 3- meter diameter Soil Plot co-located with one of the Vegetation Plots.
Hydrology	Measurements include an assessment of hydrologic sources and connectivity, observation of hydrologic indicators, and documentation of hydrologic alterations or stressors.	Collected from Assessment Area.
Water Chemistry	Measurements used to determine general surface water conditions, various chemical analytes, and evidence of disturbance.	Collected from location with standing water in Assessment Area.
Chlorophyll *a*	Measurement used to determine algal biomass in the water.	Collected from location with standing water in Assessment Area.
Microcystin	Measurement used to determine the harmful algal bloom biomass in the water.	Collected from location with standing water in Assessment Area.
Buffer Characterization	Measurements used to physically characterize the area surrounding the Assessment Area.	Thirteen 100-m^2 Buffer Plots systematically placed on cardinal transects (3 in each direction and one at the center of the AA).

5.1 Vegetation

5.1.1 Introduction

Wetland plant species 1) represent diverse adaptations, ecological tolerances, and life history strategies, and 2) effectively integrate environmental conditions, species interactions, and human-caused disturbance. Data describing plant species composition and abundance and vegetation structure are powerful, robust, and relatively easy to gather. They can be used to derive myriad metrics or indicators that are useful descriptors of ecological integrity or stress (e.g., Lopez and Fennessy 2002, USEPA 2002b, Pino et al. 2005, Bourdaghs et al. 2006, Quétier et al. 2007, Magee et al. 2008, Magee et al. 2010, Mack and Kentula 2010). NWCA collects data on plant species composition and abundance, on vegetation structural attributes, and on ground surface attributes within in vegetation plots at each sample site. This vegetation data collected by field crews is later used during analysis to calculate numerous metrics in a variety of categories that inform the development of Vegetation Multimetric Indices that serve as indicators of wetland vegetation condition. Thus, the vegetation data collected in the field by the Vegetation Team is central to the key descriptors of ecological condition for the NWCA. The field data and metrics can also be used to characterize wetland vegetation across the NWCA target population or subpopulations.

5.1.2 Sampling Design and Methods

Detailed sample collection and handling procedures are described in the NWCA 2016 Field Operations Manual.

5.1.3 Quality Assurance Objectives

As mentioned above in section 2.2.2 (Precision, Bias, and Accuracy), precision of field measurements will not be monitored during the NWCA. Previous plant identification experience or class work will be valuable for Veg Team members, but mandatory NWCA training will prepare the crew to accurately complete vegetation data collection tasks according to the standardized field protocols.

MQOs are given in Table 5-2. General requirements for comparability and representativeness are addressed in Section 2. The MQOs given in Table 5-2 represent the maximum allowable criteria for statistical control purposes. Precision is determined from results of revisits (field measurements) taken on a different day at least two weeks apart.

Table 5-2. Measurement data quality objectives for vegetation indicator

Variable or Measurement	Precision	Taxonomic Disagreement	Completeness
Field Measurements and Observations	±10%	≤ 15%	90%

5.1.4 Quality Control Procedures: Field Operations

Control measures to minimize measurement error among crews and sites include the use of standardized field protocols, consistent training of all crews, field assistance visits to all crews, and availability of experienced technical personnel during the field season to respond to site-specific questions from field crews as they arise. In addition, quality assurance audits will be conducted at least once during the field season for each Field Crew to ensure that the protocols are being implemented consistent with training.

Upon completion of sampling, the Botanist/Ecologist reviews all vegetation forms for completeness, legibility, and for any errors (e.g. spelling) in species names. The Botanist/Ecologist checks the voucher collection record on the Vascular Plant Species Presence and Cover Form (FOM Vegetation Chapter) for all taxa with pseudonyms to ensure that specimens have been collected for all unknown species. Additionally, the Botanist/Ecologist and Botanist Assistant collect five known plant species (randomly selected from species identified from the 100-m^2 vegetation plots) as QA plant voucher specimens. These QA voucher specimens are sent to a QA taxonomist ("verifying botanist") for re-identification. The NWCA QA Team will monitor differences in the taxonomic identification of plant specimens between the Botanist/Ecologist ("identifying botanist") and the verifying botanist. Substantial disagreements between the two will be investigated and logged for indication of error patterns or trends, but all values will generally be considered acceptable for further analysis, unless the investigation reveals significant problems.

Other controls include audits and revisits. Quality assurance audits are conducted of each Field Crew at least once during the field season, to ensure the protocols followed are consistent with training. Ten percent of all sites will receive repeat sampling visits to be sampled by a Field Crew to determine the extent to which the population estimates might vary if they were sampled at a different time (revisit sites must be sampled at least two weeks apart).

5.1.5 Quality Control Procedures: Laboratory Operations

A subset of plant samples collected as unknown specimens and later identified by a State or National Plant Laboratory botanist ("identifying botanist") will be verified by a QA taxonomist ("verifying botanist") for additional quality assurance. The lab will randomly select 10% of the identified unknown samples for re-identification by another experienced taxonomist who did not participate in the original identifications. The NWCA QA Team will evaluate differences in the taxonomic identification of plant specimens between the identifying and verifying botanists. Substantial disagreements between the two will be investigated and logged for indication of error patterns or trends, but all values will generally be considered acceptable for further analysis, unless the investigation reveals significant problems.

Quality control procedures associated with sample handling and processing at laboratories handling NWCA QA and unknown plant vouchers are summarized in Table 5-3.

Table 5-3. Laboratory quality control activities for vegetation indicator.

Quality Control Activity	Frequency	Acceptance Criteria	Corrective Action
Demonstrate competency for identifying samples to meet the performance measures	Once	Demonstration of past experience relevant to identifying plants collected from wetlands	EPA will not approve any laboratory for NWCA voucher identifications if the laboratory cannot demonstrate competency. In other words, EPA will select another laboratory that can demonstrate competency.

Quality Control Activity	Frequency	Acceptance Criteria	Corrective Action
Verify that plant voucher has arrived in acceptable condition	All vouchers	The condition must allow for positive identification	Lab will consult immediately with EPA TOCOR if voucher does not arrive in acceptable condition.
Sample Log-in	All vouchers	Plant vouchers logged into NARS IM system within 24 clock hours of receipt.	Discrepancies, damaged or missing samples are reported to EPA Project Manager and Laboratory Review Coordinator.
Store sample appropriately	All vouchers	Vouchers must be treated to kill potential contaminants and properly stored dry in a condition that prevents contamination by detritivores, molds, and pests (typically in herbarium cabinets or sealable plastic containers).	EPA expects that the laboratory will exercise every effort to maintain vouchers in proper storage conditions.
Use widely / commonly accepted taxonomic references and reconcile to USDA-NRCS PLANTS taxonomic nomenclature	All identifications	Full citations for floras and field guides used in plant identification must be provided and; identifications must be reconciled to the taxonomic nomenclature of the USDA-NRCS PLANTS database	Lab will provide explanation and discuss deviances with EPA TOCOR.
Identification by laboratory	When field plant ID specialist cannot identify specimen	Identification by lab plant ID specialist (who must be a different individual than the field plant ID specialist)	Replace field crew's "unknown" identification with determination by lab
Unknowns QC	Approximately 10% of all unknown vouchers independently identified in the lab	PTD ≤ 15%	If PTD > 15%, review data for possible explanations; otherwise, insert data qualifier for laboratory identifications
Conduct assistance visit	EPA may choose to visit any laboratory	Visit conducted using checklist	Performance and any recommended improvements described in debrief with laboratory staff

5.1.6 Data Management, Review, and Validation

The Botanist and Field Crew Leader are responsible for the validity of all field-generated data (i.e. measurement and observation data) up to the point it is sent to EPA. The Botanist and Field Crew Leader are likewise responsible for the proper labeling, storage, and delivery for shipping of all voucher samples, and for informing ORD/Corvallis when samples have been shipped. Laboratory SOPs (see Section 1 for details) will be followed to ensure that data generated and delivered to EPA are valid. Once data have been delivered to EPA, data quality procedures will be followed to ensure the validity of data in storage, analysis, reporting and archiving. All raw data (including all standardized forms and logbooks) are retained permanently in an organized fashion in accordance with EPA records management policies.

Other checks made of the data in the process of review and verification are summarized in Table 5-4.

Table 5-4. Data validation quality control for vegetation indicator.

Activity or Procedure	Requirements and Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Corrective reporting errors or qualify as suspect or invalid
Review data from QA plant vouchers	Determine impact and possible limitations on overall usability of data

5.2 Soils

5.2.1 Introduction

Soils data will be collected in a 3 m diameter Soil Plot and will include a soil profile description and collection of soil samples for laboratory analysis of physical and chemical properties. Soils cycle nutrients, mediate groundwater movement and storage, and serve as a growth medium or habitat for plants, microbes, and macroinvertebrates. Soil physical and chemical characteristics can be indicative of hydrology, past and present land uses, and the health and condition of the soil (which impacts its ability to perform important ecosystem services).

5.2.2 Sampling Design and Methods

There are two components to collecting soil information: The first component involves field measurement and description of soil morphological properties (e.g., texture, color). The second component involves collecting soil samples for laboratory analysis of various physical characteristics and chemical constituents. Detailed sample collection and handling procedures are described in the NWCA 2016 Field Operations Manual and Lab Operations Manual. A summary of the field measurements and laboratory analyses are given in Table 5-5.

Table 5-5. Soil indicator field and laboratory measurements and analyses.

Analysis Method	Analyte(s) Measured
Field Measurements	
Soil Profile Description	Soil Morphological Properties: description/identification of horizon boundaries and designations, soil texture, rock fragment volume, root volume, matrix color, redoximorphic features, masked sand grains, organic features, and mottles
Hydric Soil Field Indicator	Identification of Hydric Soil Field Indicators (if present)
Depth to Water Table	Depth to water table
Laboratory Analyses	
Particle Size Distribution Analysis (PSDA), < 2mm, air dry	Clay, Silt, Sand
Calcium Carbonate Equivalent, < 2mm	$CaCO_3$
Calcium Carbonate Equivalent, < 20 mm	$CaCO_3$
Total Carbon, Nitrogen, and Sulfur	C, N, S
pH	1:1 H_2O, 1:2 0.01 M $CaCl_2$
Cation Exchange Capacity and Base Cations	CEC, Ca^{2+}, K^+, Mg^{2+}, Na^+
Ammonium Oxalate Extraction	Al, Fe, Mn, P, Si
Electrical Conductivity	EC
Dithionite-Citrate Extraction	Al, Fe, Mn
Olsen Phosphorus	P
Mehlich Phosphorus	P
Trace Elements	Ag, As, Ba, Be, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, P, Pb, Sb, Se, Sn, Sr, V, W, Zn
Bulk Density	Db_f

5.2.3 Quality Assurance Objectives

As mentioned above in section 2.2.2, precision of field measurements will not be monitored during the NWCA. Previous soils experience or class work will be valuable for AB team members, but mandatory NWCA training will provide an understanding of basic soil processes, soil description methods, and sampling techniques. This training will prepare the crew to accurately complete soil data collection tasks according to the standardized field protocols.

MQOs are given in Table 5-6. General requirements for comparability and representativeness are addressed in section 2. The MQOs given in Table 5-6 represent the maximum allowable criteria for statistical control purposes. Precision is determined by the comparison of field measurements from two visits to the same site; the revisit is at least two weeks after the first visit. Due to the high level of disturbance caused by the soil sampling methods, it is not appropriate for the soil protocols to be completed in the same location twice. During the second sampling event the AB team will locate the Soil Plot as close as possible, but not overlapping the original Soil Plot to avoid the area disturbed during the first sampling event. This will ensure that the soil data collected are as similar to the original data as possible.

Table 5-6. Measurement quality objectives for soil indicator

Variable or Measurement	Precision	Accuracy	Completeness
Field Measurements and Observations	±10%	NA	90%
NA = not applicable in most cases. This would apply if the field auditor did a separate assessment and compared the results to the crews.			

5.2.4 Quality Control Procedures: Field Operations

Control measures to minimize measurement error among crews and sites include the use of standardized field protocols, consistent training of all crews, and availability of experienced technical personnel during the field season to respond to site-specific questions from field crews. Additionally, field crews will apply a consistent labeling convention across all samples (see the NWCA 2016 FOM, Soils Chapter for details on info to include on labels).

Other controls include audits and revisits. Quality assurance audits are conducted of each Field Crew at least once during the field season, to ensure the protocols followed are consistent with training. At approximately ten percent of sites, Field Crews will be accompanied by an NRCS Soil Scientist. The NRCS Soil Scientist will assist the Field Crew with the soil profile description and collection of soil samples, review the morphological description, and assign horizon designations. Ten percent of all sites will be sampled by a Field Crew during a repeat sampling visit to determine the extent to which the population estimates might vary if they were sampled at a different time.

In addition, field Crew Leaders are responsible for reviewing all forms for completeness and legibility, and ensuring that all samples are properly collected and shipped. Field forms are then sent to participating NRCS State Soil Scientists to review morphological descriptions, review determination of any hydric soil field indicators, and assign horizon designations (using soil profile photographs and morphological descriptions). Specific quality control measures are listed in Table 5-7 for field measurements and observations.

Table 5-7. Field quality control for soil indicator

Quality Control Activity	Frequency	Acceptance criteria	Corrective Action
Quality Control			
Check completeness of soil descriptive data	Each soil horizon	Values for each soil horizon	Repeat observations
Check for completeness of soil sample collection for chemical analyses and bulk density	Each site	Data sheets complete where appropriate	Repeat observations
Sample Storage	Each site	All samples kept in a cool dry place until shipped	Qualify sample as suspect for all analyses
Data Validation			
Estimate precision of measurement based on repeat visits	2 visits	Measurements should be within 10 percent	Review data for reasonableness; Determine if acceptance criteria need to be modified

5.2.5 Quality Control Procedures: Laboratory Operations

Standardized lab protocols, consistent training of all lab technicians, lab assistance visits to all labs, and availability of experienced technical personnel to respond to site-specific questions as they arise are important to ensuring the quality of lab data. Additionally, control measures to minimize measurement error among lab technicians and laboratories include the use of a Control Sample, a Blank Sample, Data Review, and Data Validation.

A **Control Sample** represents a sample of known concentration for a particular attribute. A Control Sample is collected in bulk for an attribute and repetitively analyzed to determine statistical control limits (i.e., range of expected values) for the particular method. A Control Sample is analyzed in conjunction with every batch of samples to ensure the method was run correctly. If the value of the Control Sample falls outside the expected range of values then the process has failed and the batch is triggered for reanalysis.

A **Blank Sample** is used to ensure equipment is thoroughly cleaned before each use. A Blank Sample is especially important when measuring soil chemistry (i.e., trace metals) because concentrations may be quite small. A Blank Sample is analyzed in conjunction with every batch of samples to ensure that proper equipment cleaning protocols are followed. If the value of the Blank Sample does not equal zero or fall below the MDL, then the equipment is not clean and the batch is triggered for reanalysis.

The process of **Data Validation** is described here. Laboratory data undergo four **Data Reviews**, first by the Bench Analysts, second by the Lead Analyst, third by the Project Coordinator Soil Scientist, and fourth by a Soil Scientist Liaison with expertise in soils from the region where the samples are from. The Bench Analysts verifies that blank and control samples return results that fall within established control limits. The Lead Analyst examines the data for inconsistencies and apparent anomalies; inconsistencies usually take the form of unexpected high or low values for a particular analyte or values that do not fit with the expected trend of a soil profile. The Project Coordinator will use professional judgment to determine whether the project data are self-consistent and congruent with the site data collected in the field; incongruities within the data that can be explained either by site data or the results of other analytes are recorded. A final review is given by a Soil Scientist Liaison to the area of sample origin, before the data are released.

Table 5-8. Lab analysis quality control for soil indicator

Activity or Procedure	Requirements and Corrective Action
Sample Log-in	Upon receipt of a sample shipment, record receipt of samples in the NARS IM system (within 24 clock hours) and the laboratory's Information Management System (LIM). Discrepancies, damaged or missing samples are reported to EPA Project Manager and Laboratory Review Coordinator.
Range check of Control Sample	If value is outside expected range, batch is triggered for reanalysis
Value check of Blank Sample	If value is >0 or the MDL, batch sample is triggered for reanalysis
Data Review	Corrective reporting for explicable incongruities within the data
Data Validation	Corrective reporting for explicable incongruities within the data

5.2.6 Data Management, Review, and Validation

Checks made of the data in the process of review, verification, and validation are summarized in Table 5-9. The Field Crew Leader is responsible for the validity of all field-generated data (i.e. measurement and observation data) up to the point it is sent to EPA (NARS IM). The Field Crew Leader is responsible for the proper labeling, storage, and delivery for shipping of all samples. The Field Crew Leader is responsible for notifying both the laboratory and NARS IM when samples have been shipped. Laboratory SOPs (see section 1 for details) will be followed to ensure that data generated and delivered to EPA are valid. Once NARS IM receives the data, DQ procedures (as detailed in section 4) will be followed to ensure the validity of data in storage, analysis, reporting and archiving. Raw data (including standardized forms and logbooks) are retained permanently in an organized fashion in accordance with EPA records management policies.

Table 5-9. Data validation quality control for soil indicator

Activity or Procedure	Requirements and Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Corrective reporting errors or qualify as suspect or invalid
Review data from QA samples (e.g., laboratory control samples, blank samples, or other standards or replicates)	Determine impact and possible limitations on overall usability of data

5.3 Hydrology

5.3.1 Introduction

Hydrology data will include an assessment of hydrologic sources and connectivity, indirect evidence of hydroperiod, estimates of hydrologic fluctuations, and documentation of hydrology alterations or stressors. Wetland hydrology is the primary driver of wetland formation and persistence. Hydrology impacts soil geochemical dynamics, plant productivity, nutrient cycling, and accretion and erosion of organic and inorganic materials in wetlands (Mitch and Gosselink 2007, Tiner 1999).

5.3.2 Sampling Design and Methods

The collection of hydrologic data for the NWCA will be entirely in the field - no hydrology samples will be collected for laboratory analysis. Field measurements, observations, and associated methodology are summarized in Table 5-10. Detailed data collection procedures are described in the NWCA 2016 Field Operations Manual.

Table 5-10. Field measurement methods for hydrology indicator.

Variable or Measurement	Units	Summary of Method
Water Sources		Count of seasonal and perennial sources, including inlets, streams, springs, the ocean, ditches, and pipes
Hydrologic alterations		Count of damming features (e.g., dikes/berms, roads), length and depth of ditches/drains, evidence of tilling and fresh sediment influx
Drift lines		Evidence of leaf packs and other plant detritus, anthropogenic trash, and the percent of the AA with standing water.
Water Depth	cm	Determine the maximum depth of surface water and the percent of the AA covered. (Form WQ-1)
Depth to Groundwater	cm	Recorded on S-1 Form

5.3.3 Quality Assurance Objectives

As mentioned above in section 2.2.2, precision of field measurements will not be monitored during the NWCA. Previous hydrology experience or class work will be valuable for AB team members, but mandatory NWCA training will provide an understanding of basic hydrology. This training will prepare the crew to accurately complete hydrology data collection tasks according to the standardized field protocols.

MQOs are given in Table 5-11. General requirements for comparability and representativeness are addressed in Section 2. The MQOs given in Table 5-11 represent the maximum allowable criteria for statistical control purposes. Precision is determined from results of the revisits (field measurements) taken on a different day (at least two weeks apart).

Table 5-11. Measurement quality objectives for hydrology indicator.

Variable or Measurement	Precision	Accuracy	Completeness
Field Measurements and Observations	±10%	NA	90%
NA = not applicable in most cases. This would apply if the field auditor did a separate assessment and compared the results to the crews.			

5.3.4 Quality Control Procedures

Control measures to minimize measurement error among crews and sites include the use of standardized field protocols, consistent training of all crews, and availability of experienced technical personnel during the field season to respond to site-specific questions from field crews. In addition, quality assurance audits are conducted, at least once during the field season of every field crew to ensure that the protocols are being implemented consistent with training.

5.3.5 Data Management, Review, and Validation

Checks made of the data in the process of review, verification, and validation are summarized in Table 5-12. The Field Crew Leader is responsible for the validity of all field-generated data (i.e. measurement and observation data) up to the point they are sent to EPA (NARS IM). EPA QA SOPs (see section 2 for details) will be followed to ensure that data generated and delivered to EPA are valid. Once data have been delivered to EPA, DQ procedures (as detailed in section 2) will be followed to ensure the validity of data in storage, analysis, reporting and archiving. All raw data (including all standardized forms and logbooks) are retained permanently in an organized fashion in accordance with EPA records management policies.

Table 5-12. Data quality control for hydrology indicator.

Quality Control Activity	Frequency	Acceptance criteria	Corrective Action
Quality Control			
Check completeness of hydrology data	Across AA and Buffer	Values where appropriate	Repeat observations

5.4 Water Chemistry (including chlorophyll-*a*)

5.4.1 Introduction

Surface water conditions will be noted and water chemistry samples collected to assess general surface water conditions, various chemical analytes, and evidence of disturbance. Total nitrogen and phosphorus reflect the trophic state of the wetland, providing crucial information on possible eutrophication (Keddy 1983). Anthropogenic disturbances such as hydrologic modifications and land use changes are known to alter water chemistry variables (Lane and Brown, 2007; Reiss and Brown, 2005). Chlorophyll-a samples describe blue-green algal biomass, which gives an estimate of algal productivity which reflects nutrient concentrations of water. Nutrient status can reflect normal or stressed conditions, and are dependent on wetland type.

5.4.2 Sampling Design and Methods

Detailed sample collection and handling procedures are described in the NWCA 2016 Field Operations Manual. Detailed laboratory methods are described in the NWCA 2016 Laboratory Operations Manual.

5.4.3 Quality Assurance Objectives

A central national laboratory and some State laboratories will analyze the water chemistry and chlorophyll-*a* samples. Specific quality control procedures used by each laboratory are implemented to ensure that:

- Objectives for various data quality indicators are met
- Results are consistent and comparable among all participating laboratories

The central laboratory has demonstrated in previous studies that it meets performance-based criteria established by EPA. State laboratories analyzing samples are required to demonstrate equivalent performance-based criteria prior to processing NWCA samples. All laboratories must follow QA/QC procedures outlined in this QAPP and the NWCA 2016 Laboratory Operations Manual.

5.4.4 Quality Control Procedures: Field Operations

Control measures to minimize measurement error among crews and sites include the use of standardized field protocols, consistent training of all crews, and availability of experienced technical personnel during the field season to respond to site-specific questions from field crews. Field crews will verify that all sample containers are uncontaminated and intact, and that all sample labels are legible and intact. Before leaving the field site, crews will:

- Check the label to ensure that all written information is complete and legible.
- Place a strip of clear packing tape over the label, covering the label completely.
- Record the sample ID number assigned to the water chemistry and chlorophyll-*a* samples on the Sample Collection Form.
- Enter a flag code and provide comments on the Sample Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity.
- Store the samples on wet ice in a cooler.

- Recheck all forms and labels for completeness and legibility.

Other controls include audits and revisits. Quality assurance audits are conducted of each Field Crew at least once during the field season, to ensure the protocols followed are consistent with training. Ten percent of all sites will be sampled by a Field Crew during a repeat sampling visit to determine the extent to which the population estimates might vary if they were sampled at a different time.

5.4.5 *Quality Control Procedures: Laboratory Operations*

Quality control procedures associated with sample handling and processing at laboratories handling NWCA samples are described in Table 5-11. Figure 5-13 illustrates the general scheme for analysis of a batch of water chemistry samples, including associated QC samples.

Table 5-13. Required quality control activities for water chemistry and chlorophyll-a samples.

QC Sample Type and Description	Indicators	Description	Frequency	Acceptance Criteria	Corrective Action
Demonstrate competency for analyzing water samples to meet the performance measures	All	Demonstration of past experience with water samples in achieving the method detection limits	Once	See LOM	EPA will not approve any laboratory for NWCA sample processing if the laboratory cannot demonstrate competency. In other words, EPA will select another laboratory that can demonstrate competency for its NWCA samples.
Sample Log-in	All	Upon receipt of a sample shipment, record receipt of samples in the NARS IM system (within 24 clock hours) and the laboratory's Information Management System (LIMS).	Once		Discrepancies, damaged, or missing samples are reported to the EPA HQs Laboratory QA Coordinator
Check condition of sample when it arrives.	All	Sample issues such as cracked container; missing label; temperature; adherence to holding time requirements; sufficient volume for test.	Once	No sample issues or determination that sample can still be analyzed	Lab determines if the sample can be analyzed or has been too severely compromised (e.g., contamination).

QC Sample Type and Description	Indicators	Description	Frequency	Acceptance Criteria	Corrective Action
Store sample appropriately.	All	Check the temperature of the refrigerator per laboratory's standard operating procedures.	Record temperature of sample upon arrival at the laboratory. Check temperature of the refrigerator/freezer where samples are stored at least daily if using a continuous temperature logger and twice daily (once at beginning of the day and once at the end) not using a continuous logger.	While stored at the laboratory, the sample must be kept at a maximum temperature of 4° C (for aliquots except chlorophyll *a*) and -20° C for the chlorophyll *a* sample.	If at any time samples are warmer than required, note temperature and duration (either from the continuous temperature log or from the last manual reading) in comment field. Lab will still perform test. EPA expects that the laboratory will exercise every effort to maintain samples at the correct temperature.
Analyze sample within holding time	All	-	NA	The test must be completed within the holding time specified in the analytical method.	Perform test in all cases, but note reason for performing test outside holding time. EPA expects that the laboratory will exercise every effort to perform tests before the holding time expires.
Analyze Laboratory/ Reagent Blank	All	-	Once per day prior to sample analysis	Control limits ≤ MDL	Prepare and analyze new blank. Determine and correct problem (e.g., reagent contamination, instrument calibration, or contamination introduced during filtration) before proceeding with any sample analyses. Reestablish statistical control by analyzing three blank samples.
Analyze Filtration Blank	All dissolved analytes	ASTM Type II reagent water processed through filtration unit	Prepare once per week and archive Prepare filter blank for each box of 100 filters, and examine the results before any other filters are used from that box.	Measured concentrations <MDL	Measure archived samples if review of other laboratory blank information suggest source of contamination is sample processing.

QC Sample Type and Description	Indicators	Description	Frequency	Acceptance Criteria	Corrective Action
Determine LT-MDL Limit for Quality Control Check Sample (QCCS)	All	Prepared so concentration is four to six times the LT-MDL objective	Once per day	Target LT-MDL value (which is calculated as a 99% confidence interval)	Confirm achieved LRL by repeated analysis of LT-MDL QCCS. Evaluate affected samples for possible re-analysis.
Analyze Calibration QCCS	All	-	Before and after sample analyses	±10% or method criteria	Repeat QCCS analysis. Recalibrate and analyze QCCS. Reanalyze all routine samples (including PE and field replicate samples) analyzed since the last acceptable QCCS measurement.
Analyze Laboratory Duplicate Sample	All	-	One per batch	Control limits < precision objective	If results are below LRL: Prepare and analyze split from different sample (volume permitting). Review precision of QCCS measurements for batch. Check preparation of split sample. Qualify all samples in batch for possible reanalysis.
Analyze Standard Reference Material (SRM)	When available for a particular indicator	-	One analysis in a minimum of five separate batches	Manufacturers certified range	Analyze standard in next batch to confirm suspected inaccuracy. Evaluate calibration and QCCS solutions and standards for contamination and preparation error. Correct before any further analyses of routine samples are conducted. Reestablish control by three successive reference standard measurements that are acceptable. Qualify all sample batches analyzed since the last acceptable reference standard measurement for possible reanalysis.

QC Sample Type and Description	Indicators	Description	Frequency	Acceptance Criteria	Corrective Action
Analyze Matrix Spike Samples	Only prepared when samples with potential for matrix interferences are encountered	-	One per batch	Control limits for recovery cannot exceed 100±20%	Select two additional samples and prepare fortified subsamples. Reanalyze all suspected samples in batch by the method of standard additions. Prepare three subsamples (unfortified, fortified with solution approximately equal to the endogenous concentration, and fortified with solution approximately twice the endogenous concentration).
Use consistent units for QC samples and field samples	All	Verify that all units are provided consistently within each indicator.	Data reporting	For each indicator, all field and QC samples are reported with the same measurement units	If it is not possible to provide the results in consistent units, then assign a QC code and describe the reason for different units in the comments field of the database.
Maintain completeness	All	Determine completeness	Data reporting	Completeness objective is 95% for all indicators (useable with or without flags).	Contact EPA HQ NWCA Laboratory Review Coordinator* immediately if issues affect laboratory's ability to meet completeness objective.

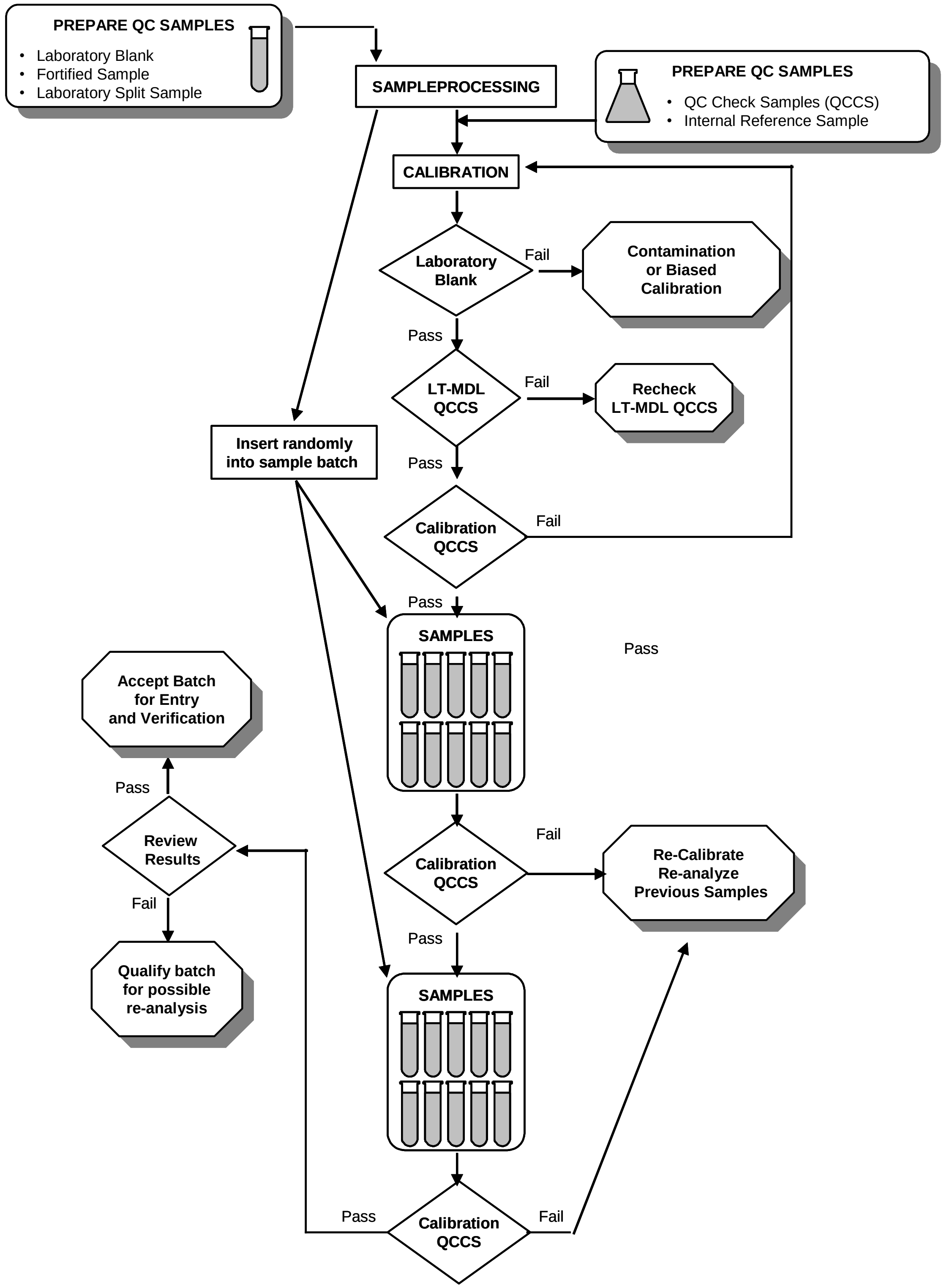

Figure 5-1. Analysis Activities for Water Chemistry Samples

5.4.6 Data Reporting, Review, and Management

Checks made of the data in the process of review and verification is summarized in Table 5-14. Data reporting units and significant figures are given in Table 5-15. The Project Lead is ultimately responsible for ensuring the validity of the data, although performance of the specific checks may be delegated to other staff members.

Table 5-14. Data validation quality control for water chemistry indicator.

Activity or Procedure	Requirements and Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Correct reporting errors or qualify as suspect or invalid.
Review holding times	Qualify value for additional review
Review data from QA samples (laboratory PE samples, and interlaboratory comparison samples)	Determine impact and possible limitations on overall usability of data

Table 5-15. Data reporting criteria for water chemistry indicator.

Measurement	Units	No. Significant Figures	Maximum No. Decimal Places
Temperature	°C	2	1
pH	pH units	3	2
Conductivity	µS/cm at 25 °C	3	1
Ammonia	mg/L	3	2
Dissolved organic carbon (DOC)	mg/L	3	2
Nitrate-Nitrite	mg/L	3	2
Total nitrogen	mg/L	3	2
Total phosphorus	µg/L	3	0
Turbidity	NTU	3	0
Chlorophyll-*a*	µg/L	3	2
Chloride	mg/L	3	2
Sulfate	mg/L	3	2

5.5 Microcystin

5.5.1 Introduction

Microcystins are a class of toxins produced by bluegreen algae that can have harmful health effects to humans and animals if concentrations are high as a result of high abundance of certain bluegreen algae. If water is present, crews will collect a sample to measure concentrations of microcystin.

5.5.2 Sampling Design and Methods

Detailed sample collection and handling procedures are described in the NWCA 2016 Field Operations Manual. Detailed laboratory methods are described in the NWCA 2016 Laboratory Operations Manual.

5.5.3 Quality Assurance Objectives

A central national laboratory and some State laboratories will analyze the water chemistry and chlorophyll-a samples. Specific quality control procedures used by each laboratory are implemented to ensure that:

- Objectives for various data quality indicators are met
- Results are consistent and comparable among all participating laboratories

All laboratories must follow QA/QC procedures outlined in this QAPP and the NWCA 2016 Laboratory Operations Manual. Laboratory performance requirements are listed in Table 5-16.

Table 5-16. Measurement quality objectives for microcystin.

Parameter	Units	Method Detection Limit Objective	Reporting Limit Objective
Microcystins, undiluted samples with salinities <3.5 part per thousand (ppt)	µg/L	0.1	0.15
Microcystins, undiluted samples with salinity greater than or equal to 3.5 ppt	µg/L	0.175	0.263
Microcystins, diluted samples with salinities <3.5 ppt	µg/L	0.1 times the dilution factor	Will vary
Microcystins, diluted samples with salinity greater than or equal to 3.5 ppt	µg/L	1.75 times the dilution factor	Will vary

5.5.4 Quality Control Procedures: Field Operations

Field data quality is addressed, in part, by application and consistent performance of valid procedures documented in the standard operating procedures detailed in the NWCA 2016 Field Operations Manual. That quality is enhanced by the training and experience of project staff and documentation of sampling activities. Crews will collect a single water sample for microcystins analyses. Field crews will verify that all sample containers are uncontaminated and intact, and that all sample labels are legible and intact. While in the field, the crew will store samples in a cooler on ice and will then freeze the sample upon returning to the base site (e.g., hotel, lab, office)(Table 5-17). Before leaving the field, the crews will:

- Check the label to ensure that all written information is complete and legible.
- Place a strip of clear packing tape over the label, covering the label completely.

- Record the sample ID number assigned to the microcystins sample on the Sample Collection Form.
- Enter a flag code and provide comments on the Sample Collection Form if there are any problems in collecting the sample or if conditions occur that may affect sample integrity.
- Store the sample on ice in field.
- Recheck all forms and labels for completeness and legibility.

Table 5-17. Field quality control for microcystin.

Quality Control Activity	Description and Requirements	Corrective Action
Holding time	Hold sample on wet ice and freeze immediately upon return to the base site (hotel, lab, office) and keep frozen until shipping	Qualify samples
Sample Storage	Store samples in darkness and frozen (-20 °C) Monitor temperature daily	Qualify sample as suspect

5.5.5 *Quality Control Procedures: Laboratory Operations*

Quality control procedures associated with sample handling and processing at laboratories handling NWCA samples are described in Table 5-18 and Table 5-19.

Table 5-18. Required quality control activities for microcystin samples.

Quality Control Activity	Description and Requirements	Corrective Action
Kit – Shelf Life	Is within its expiration date listed on kit box.	If kit has expired, then discard or clearly label as expired and set aside for training activities.
Kit - Contents	All required contents must be present and in acceptable condition. This is important because Abraxis has calibrated the standards and reagents separately for each kit.	If any bottles are missing or damaged, discard the kit.
Calibration	All of the following must be met: Standard curve must have a correlation coefficient of ≥0.99; Average absorbance value, $\bar{A}_0$, for S0 must be ≥0.80; and Standards S0-S5 must have decreasing average absorbance values. That is, if $\bar{A}_i$ is the average of the absorbance values for S_i, then the absorbance average values must be: $\bar{A}_0 > \bar{A}_1 > \bar{A}_2 > \bar{A}_3 > \bar{A}_4 > \bar{A}_5$	If any requirement fails: Results from the analytical run are not reported. All samples in the analytical run are reanalyzed until calibration provides acceptable results.
Kit Control	The average concentration value of the duplicates (or triplicate) must be within the range of 0.75 +/- 0.185 µg/L. That is, the average must be between 0.565 µg/L and 0.935 µg/L.	If either requirement fails: Results from the analytical run are not reported The lab evaluates its processes, and if appropriate, modifies its processes to

Quality Control Activity	Description and Requirements	Corrective Action
Negative Control	The values for the negative control replicates must meet the following requirements: All concentration values must be < 0.15 µg/L (i.e., the reporting limit; and one or more concentration results must be nondetectable (i.e., <0.10 µg/L)	Correct possible contamination or other problems. The lab reanalyzes all samples in the analytical run until the controls meet the requirements. At its discretion, the lab may consult with EPA for guidance on persistent difficulties with calibration.
Sample Evaluations	All samples are run in duplicate. Each duplicate pair must have %CV ≤15% between its absorbance values.	If %CV of the absorbances for the sample >15%, then: Record the results for both duplicates using different start dates and/or start times to distinguish between the runs. Report the data for both duplicate results using the Quality Control Failure flag "QCF"; and re-analyze the sample in a new analytical run. No samples are to be run more than twice. If the second run passes, then the data analyst will exclude the data from the first run (which will have been flagged with "QCF"). If both runs fail, the data analyst will determine if either value should be used in the analysis (e.g., it might be acceptable to use data if the CV is just slightly over 15%).
Results Within Calibration Range	All samples are run in duplicate. If both of the values are less than the upper calibration range (i.e., ≤ 5.0 µg/L for undiluted samples with salinity <3.5 ppt; ≤ 8.75 µg/L for undiluted samples with salinity ≥3.5 ppt), then the requirement is met.	If a result registers as 'HIGH', then record the result with a data flag of "HI." If one or both duplicates register as 'HIGH,' then the sample must be diluted and re-run until both results are within the calibration range. No samples are to be run more than twice. The lab reports both the original and diluted sample results.
External Quality Control Sample	External QC Coordinator, supported by QC contractor, provides 1-2 sets of identical samples to all laboratories and compares results.	Based upon the evaluation, the External QC Coordinator may request additional information from one or more laboratories about any deviations from the Method or unique laboratory practices that might account for differences between the laboratory and others. With this additional information, the External QC Coordinator will determine an appropriate course of action, including no action, flagging the data, or excluding some or all of the laboratory's data.

Table 5-19. Sample receipt and processing quality control for microcystin.

Quality Control Activity	Description and Requirements	Corrective Action
Sample Log-in	Upon receipt of a sample shipment, record receipt of samples in the NARS IM system (within 24 clock hours) and the laboratory's Information Management System (LIMS).	Discrepancies, damaged, or missing samples are reported to the EPA HQs Laboratory QA Coordinator
Sample condition upon receipt	Sample issues such as cracked container; missing label; temperature (frozen); adherence to holding time requirements; sufficient volume for test.	Qualify samples
Sample Storage	Store sample frozen	Qualify samples
Holding time	Frozen samples can be stored for several months.	Qualify samples

5.5.6 Data Management, Review, and Validation

Checks made of the data in the process of review and verification are summarized in Table 5-20. Data reporting units and significant figures are given in Table 5-21. The Project Lead is ultimately responsible for ensuring the validity of the data, although performance of the specific checks may be delegated to other staff members.

Table 5-20. Data validation quality control microcystin.

Activity or Procedure	Requirements and Corrective Action
Range checks, summary statistics, and/or exploratory data analysis (e.g., box and whisker plots)	Correct reporting errors or qualify as suspect or invalid.
Review holding times	Qualify value for additional review
Review data from QA samples (laboratory PE samples, and interlaboratory comparison samples)	Determine impact and possible limitations on overall usability of data

Table 5-21. Data reporting criteria for microcystin.

Measurement	Units	No. Significant Figures	Maximum No. Decimal Places
Microcystin	ug/L	3	3

5.6 Buffer Characterization

5.6.1 Introduction

Buffer data will be collected in thirteen 100-m^2 Buffer Plots systematically placed on cardinal transects (three in each direction and one at the center of the AA) to physically characterize the area surrounding the AA. Buffer is often defined as an area of natural vegetation surrounding the perimeter of a wetland that is not directly affected by human activities and thus can provided some level of protection to the wetland from stressors and neighboring land uses. Human caused stressors affect wetland hydrology by draining the site, impounding water compacting soils, and filling or eroding the wetland. Alteration of vegetation through replacement and removal can also affect hydrology. Buffer data has proven useful for describing anthropogenic stress in developing indicators of ecological integrity or condition (USEPA 2006b, USEPA 2013, Kaufmann et al 2014).

5.6.2 Sampling Design and Methods

This indicator is based on field measurements and observations, so there is no sample collection associated with it. At NWCA sites, twelve 100-m^2 plots are systematically arrayed along the four cardinal transects at equal intervals extending outwards from the core assessment area boundary. An additional 100-m^2 plot is located at the center of the AA. This sampling design is used to minimize bias in the selection of the measurement sites. Descriptions of the field measurements and procedures for completing the protocols are described in the NWCA 2016 Field Operations Manual.

5.6.3 Quality Assurance Objectives

Measurement data quality objectives (measurement DQOs or MQOs) are given in Table 5-22. General requirements for comparability and representativeness are addressed in Section 2. The MQOs represent the maximum allowable criteria for statistical control purposes. Precision is determined from results of revisits (field measurements) taken on a different day at least two weeks apart.

Table 5-22. Measurement data quality objectives for buffer characterization.

Variable or Measurement	Precision	Accuracy	Completeness
Field Measurements and Observations	±10%	NA	90%
NA = not applicable in most cases. This would apply if the field auditor did a separate assessment and compared the results to the crews.			

5.6.4 Quality Control Procedures: Field Operations

Control measures to minimize measurement error among crews and sites include the use of standardized field protocols, consistent training of all crews, field assistance visits to all crews, and availability of experienced technical personnel during the field season to respond to site-specific questions from field crews as they arise.

5.6.5 Data Management, Review, and Validation

The Field Crew Leader is responsible for the validity of all field-generated data (i.e. measurement and observation data) up to the point it is sent to EPA (ORD/Corvallis. Once data have been delivered to EPA, DQ procedures (as detailed in section 1) will be followed to ensure the validity of data in storage, analysis, reporting and archiving. All raw data (including all standardized forms and logbooks) are retained permanently in an organized fashion in accordance with EPA records management policies.

6 FIELD AND LABORATORY QUALITY EVALUATION AND ASSISTANCE VISITS

6.1 National Wetland Condition Assessment Field Quality Evaluation and Assistance Visit Plan

EPA, contractor and other qualified staff will conduct evaluation and assistance visits with each field crew early in the sampling and data collection process, if possible, and corrective actions will be conducted in real time. These visits provide both a quality check for the uniform evaluation of the data collection methods and an opportunity to conduct procedural reviews, as required, minimizing data loss due to improper technique or interpretation of field procedures and guidance. Through uniform training of field crews and review cycles conducted early in the data collection process, sampling variability associated with specific implementation or interpretation of the protocols will be significantly reduced. The visit also provides the field crews with an opportunity to clarify procedures and offer suggestions for future improvements based on their sampling experience preceding the visit. The field evaluations, while performed by a number of different supporting collaborator agencies and participants, will be based on the uniform training, plans, and checklists. The field evaluations will be based on the evaluation plan and field evaluation checklist. EPA has scheduled this review and assistance task for each unique field crew collecting and contributing data under this program. If unforeseen events prevent the EPA from evaluating every crew, the NWCA Quality Assurance Coordinator (QAC) will rely on the data review and validation process to identify unacceptable data that will not be included in the final database. If inconsistencies cannot be resolved, the QAC may contact the Field Crew Leader for clarification.

One or more designated EPA, contractor or other staff who are qualified (i.e. have completed training) in the procedures of the NWCA 2016 field sampling operations will visit trained state, contractor, federal agency and EPA field sampling crews during sampling operations on site. If membership of a field crew changes, and at least two of the members have not been evaluated previously, the field crew must be evaluated again during sampling operations as soon as possible to ensure that all members of the field crew understand and can perform the procedures. If a deviation is needed from the process described here, the staff member conducting the assistance visit (AV) must contact the Assistance Visit Coordinator who will contact the NWCA Project Manager and the NWCA Project QA Coordinator to determine an acceptable course of action.

The purpose of this on-site visit will be to identify and correct deficiencies during field sampling operations. The process will involve preparation activities, field day activities and post field day activities as described in the following sections. Additionally, conference calls with crews may be held approximately every two weeks to discuss issues as they come up throughout the sampling season.

6.1.1 Preparation Activities

- Each Field Crew Evaluator will schedule an assistance visit with their designated crews in consultation with the Contractor Field Logistics Coordinator, Regional NWCA Coordinator, and respective Field Sampling Crew Leader. Ideally, each Field Crew will be evaluated within the first two weeks of beginning sampling operations, so that procedures can be corrected or additional training provided, if needed.

- Each Evaluator is responsible for providing their own field gear sufficient to accompany the Field Sampling Crews during a complete sampling cycle. Schedule of the Field visits will be made by the Evaluator in consultation with the respective Field Crew Leader. **Evaluators should be prepared to spend additional time in the field if needed (see below).**
- Each Field Crew Evaluator will ensure that field crews are aware of their visit plans and all capacity and safety equipment will be provided for the Field Crew Evaluator.
- Each Field Crew Evaluator will need to bring the items listed in Table 6-1.

Table 6-1. Equipment and Supplies – Field Evaluation and Assistance Visits

Type	Item	Quantity
Assistance Visit Checklist	Assistance Visit Manual	1
Documentation	NWCA 2016 Field Operations Manuals NWCA 2016 Quality Assurance Project Plan Clipboard Pencils (#2, for data forms)/Pen (or computer for electronic versions) Field notebook (optional)	1 1 1 1 1
Gear	Field gear (e.g., protective clothing, sunscreen, insect repellent, hat, water, food, backpack, cell phone)	As needed

6.1.2 Field Day Activities

- The Field Crew Evaluator will review the Field Evaluation & Assistance Visit Checklist with each crew during the field sampling day and establish and plan and schedule for their evaluation activities for the day.
- The Field Crew Evaluator will view the performance of a field crew through one complete set of sampling activities as detailed on the checklist.
- Scheduling might necessitate starting the evaluation midway on the list of tasks at a site, instead of at the beginning. In that case, the Field Crew Evaluator will follow the crew to the next site to complete the evaluation of the first activities on the list.
- If the field crew misses or incorrectly performs a procedure, the Field Crew Evaluator will note this on the checklist and *immediately point this out so the mistake can be corrected on the spot*. The role of the Field Crew Evaluator is to provide additional training and guidance so that the procedures are being performed consistent with the FOM, all data are recorded correctly, and paperwork is properly completed at the site.
- When the sampling operation has been completed, the Field Crew Evaluator will review the results of the evaluation with the field crew before leaving the site (if practicable), noting positive practices and problems (i.e., weaknesses [might affect data quality]; deficiencies [would adversely affect data quality]). The Field Crew Evaluator will ensure that the field crew understands the findings and will be able to perform the procedures properly in the future.
- The Field Crew Evaluator will review the list and record responses or concerns from the field crew, if any; on the checklist (this may happen throughout the field day).
- The Field Crew Leader will sign the checklist after this review.

6.1.3 Post Field Day Activities

- The Field Crew Evaluator will review the checklist that evening and provide a summary of findings, including lessons learned and concerns.
- If the Field Crew Evaluator finds major deficiencies in the field crew operations (e.g., less than two members, equipment, or performance problems) the Field Crew Evaluator must contact the EPA NWCA Project QA Coordinator. The EPA NWCA Project QA Coordinator will work with the EPA NWCA Program Manager to determine the appropriate course of action. Data records from sampling sites previously visited by this Field Crew will be checked to determine whether any sampling sites must be redone.
- The Field Crew Evaluator will retain a copy of the checklist and submit to the EPA Logistics Coordinator either via Fed-Ex or electronically.
- The EPA Logistics Coordinator and the NWCA Project QA Coordinator or authorized designee (member of the NWCA 2016 quality team) will review the returned Field Evaluation and Assistance Visit Checklist, note any issues, and check off the completion of the evaluation for each field crew.

6.1.4 Summary

Table 6-2 summarizes the plan, checklist, and corrective action procedures.

Table 6-2. Summary of Field Evaluation and Assistance Visit Information

Field Evaluation Plan	The Field Crew Evaluator: • Arranges the field evaluation visit in consultation with the Project QA Coordinator, Regional NWCA Coordinator, and respective Field Sampling Crew Leader, ideally within the first two weeks of sampling • Observes the performance of a crew through one complete set of sampling activities • Takes note of errors the field crew makes on the checklist and immediately point these out to correct the mistake • Reviews the results of the evaluation with the field crew before leaving the site, noting positive practices, lessons learned, and concern
Field Evaluation Checklist	The Field Crew Evaluator: • Observes all pre-sampling activities and verifies that equipment is properly calibrated and in good working order, and protocols are followed • Checks the sample containers to verify that they are the correct type and size, and checks the labels to be sure they are correctly and completely filled out • Confirms that the field crew has followed NWCA protocols for locating the POINT • Observes the Assessment Area and buffer characterization sampling, confirming that all protocols are followed • Records responses or concerns, if any, on the Field Evaluation and Assistance Checklist
Corrective Action Procedures	• If the Field Crew Evaluator's findings indicate that the Field Crew is not performing the procedures correctly, safely, or thoroughly, the Evaluator must continue working with this Field Crew until certain of the crew's ability to conduct the sampling properly so that data quality is not adversely affected. • If the Field Crew Evaluator finds major deficiencies in the Field Crew operations the Evaluator must contact the EPA NWCA Project QA Coordinator.

6.2 National Wetland Condition Assessment Laboratory Quality Evaluation and Assistance Visit Plan

As part of the NWCA 2016, field samples will be collected at each assessment site. These samples will be sent to laboratories cooperating in the assessment. To ensure quality, each Project Cooperator laboratory analyzing samples from the NWCA 2016 will receive an evaluation from an NWCA Lab Evaluator. All Project Cooperator laboratories will follow these guidelines.

No national program of accreditation for laboratory processing for many of our indicators currently exists. For this reason, a rigorous program of laboratory evaluation has been developed to support the NWCA 2016.

Given the large number of laboratories participating in the NWCA 2016, it is not feasible to perform an assistance visit[5] (AV) on each of these laboratories. An AV would include an on-site visit to the laboratory lasting at least a day. As a result, the EPA Headquarters Project Management Team will conduct remote review of laboratory certifications and accreditations of all laboratories. If issues arise from the remote review or inter-laboratory comparison that cannot be resolved remotely, the EPA QA Team and/or contractors will perform an on-site visit to the laboratory. This process is in keeping with EPA's *Policy to Assure Competency of Laboratories, Field Sampling, and Other Organizations Generating Environmental Measurement Data under Agency-Funded Acquisitions.*

6.2.1 Remote Evaluation/Technical Assessment

A remote evaluation procedure has been developed for performing assessment of all laboratories participating in the NWCA 2016.

The Laboratory Review Coordinator, the NWCA Project QA Coordinator and other members of the NWCA QA Team will conduct laboratory evaluation prior to data analysis to ensure that the laboratories are qualified and that techniques are implemented consistently across the multiple laboratories generating data for the program. The EPA National Aquatic Resource Surveys team has developed laboratory evaluation plans to ensure uniform interpretation and guidance in the procedural reviews.

The NWCA QA Team is using a procedure that requests the laboratory to provide documentation of its policies and procedures. For the NWCA 2016 project, the QA Team is requesting that each participating laboratory provide the following documentation:

- The laboratory's Quality Manual, Quality Management Plan or similar document.
- Standard Operating Procedures (SOPs) for each analysis to be performed.
- Long term Method Detection Limits (MDLs) for each instrument used and Demonstration of Capability for each analysis to be performed.
- A list of the laboratory's accreditations and certifications, if any.
- Results from Proficiency Tests for each analyte to be analyzed under the NWCA 2016 project.

[5] The evaluation of the labs is being considered an Assistance Visit rather than an audit because the evaluation is designed to provide guidance to the labs rather than as "inspection" as in a traditional audit.

If a laboratory has clearly documented procedures for sample receiving, storage, preservation, preparation, analysis, and data reporting; has successfully analyzed Proficiency Test samples (if required by EPA, EPA will provide the PT samples); has a Quality Manual that thoroughly addresses laboratory quality including standard and sample preparation, record keeping and QA non-conformance; participates in a nationally recognized or state certification program; and has demonstrated ability to perform the testing for which program/project the audit is intended, then the length of an on-site visit will be minimum, if not waived entirely. The QA Team will make a final decision on the need for an actual on-site visit after the review and evaluation of the documentation requested.

If a laboratory meets or exceeds all of the major requirements and is deficient in an area that can be corrected remotely by the lab, suggestions will be offered and the laboratory will be given an opportunity to correct the issue. The QA Team will then verify the correction of the deficiency remotely. The on-site visit by EPA and/or a contractor should only be necessary if the laboratory fails to meet the major requirements and is in need of help or fails to produce the requested documentation.

In addition, all laboratories must sign a Laboratory Signature Form (see NWCA 2016 LOM) indicating that they will abide by the following:

- Utilize procedures identified in the NWCA 2016 Laboratory Operations Manual (or equivalent). If using equivalent procedures, please provide procedures manual to demonstrate ability to meet the required MQOs.
- Read and abide by the NWCA 2016 Quality Assurance Project Plan (QAPP) and related Standard Operating Procedures (SOPs).
- Have an organized IT system in place for recording sample tracking and analysis data.
- Provide data using the template provided in the Laboratory Operations Manual.
- Provide data results in a timely manner. This will vary with the type of analysis and the number of samples to be processed. Sample data must be received no later than May 1, 2016 or as otherwise negotiated with EPA.
- Participate in a lab technical assessment or audit if requested by EPA NWCA QA Team staff (this may be a conference call or on-site audit).

If a laboratory is participating in biology analyses, they must, in addition, abide by the following:

- Use taxonomic standards outlined in the NWCA 2016 Laboratory Manual.

Note: All laboratories must also sign the approved NWCA 2016 QAPP.

6.2.2 Water Chemistry Laboratories

The water chemistry laboratory approval process which is outlined on in the previous paragraphs of this section is deemed appropriate because many laboratories participate in one or more national laboratory accreditation programs such as the National Environmental Laboratory Accreditation Program (NELAP), International Organization for Standardization (ISO-17025) as well as various state certification programs which include strict requirements around documentation and procedures as well as site visits by the accrediting authority. It is built off of the processes used by the NLA 2012, NRSA 2013/14, and NCCA 2015. The laboratories participating in NWCA 2016 meet these qualifications and as such have demonstrated their ability to function independently. This process is one that has been utilized in Region 3 for many years and is designed around the national accrediting programs listed above.

6.2.3 Assistance Visits

Assistance Visits will be used to:

- Confirm the NWCA 2016 Laboratory Operations Manual (LOM) methods are being properly implemented by cooperator laboratories.
- Assist with questions from laboratory personnel.
- Suggest corrections if any errors are made in implementing the lab methods.

Evaluation of the laboratories will take the form of administration of checklists which have been developed from the LOM to ensure that laboratories are following the methods and protocols outlined therein. The checklist will be administered on-site by a qualified EPA scientist or contractor.

See sections 6.2.4 and 6.2.5 and the Laboratory Operations Manual for copies of the Document Request form used for the biological laboratories and chemical laboratories.

6.2.4 NWCA 2016 Document Request Form - Chemistry Laboratories

EPA and its state and tribal partners will conduct a survey of the nation's wetlands. This National Wetland Condition Assessment (NWCA), is designed to provide statistically valid regional and national estimates of the condition of wetlands. Consistent sampling and analytical procedures ensure that the results can be compared across the country. As part of the NWCA 2016, the Quality Assurance Team will conduct a technical assessment to verify quality control practices in your laboratory and its ability to perform chemistry analyses under this project. Our review will assess your laboratory's ability to receive, store, prepare, analyze, and report sample data generated under EPA's NWCA 2016.

The first step of this assessment process will involve the review of your laboratory's certification and/or documentation. Subsequent actions may include (if needed) reconciliation exercises and/or a site visit. All laboratories will need to complete the following forms:

If your lab has been previously approved within the last 5 years for the specific parameters:

- A signature on the attached Laboratory Signature Form indicates that your laboratory will follow the quality assurance protocols required for chemistry laboratories conducting analyses for the NWCA 2016. A signature on the QAPP and the LOM Signature Form indicates that you will follow both the QAPP and the LOM.

If you have not been approved within the last 5 years for the specific parameters in order for us to determine your ability to participate as a laboratory in the NWCA, we are requesting that you submit the following documents (if available) for review:

- Documentation of a successful quality assurance audit from a prior National Aquatic Resource Survey (NARS) that occurred within the last 5 years (if you need assistance with this please contact the individual listed below).

- Documentation showing participation in a previous NARS for Water Chemistry for the same parameters/methods.

Additionally, we request that all laboratories provide the following information in support of your capabilities, (these materials are required if neither of the two items above are provided):

- A copy of your Laboratory's accreditations and certifications if applicable (i.e. NELAC, ISO, state certifications, North American Benthological Society (NABS), etc.).
- An updated copy of your Laboratory's QAPP.
- Standard Operating Procedures (SOPs) for your laboratory for each analysis to be performed (if not covered in NWCA 2016 LOM).
- Documentation attesting to experience running all analytes for the NWCA 2016, including chlorophyll *a*.

This documentation may be submitted electronically via e-mail to forde.kendra@epa.gov. Questions concerning this request can be submitted forde.kendra@epa.gov (202-566-0417) or Serenbetz.gregg@epa.gov (202-566-1253).

6.2.5 NWCA 2016 Vegetation Laboratory Quality Assurance Evaluation Form

The National Wetland Condition Assessment (NWCA) is designed to provide statistically valid regional and national estimates of the condition of wetlands in the 48 conterminous states of the U.S. Plant samples collected in the field are sent to a designated laboratory/herbarium for identification using standard laboratory protocols outlined in the NWCA 2016 Laboratory Operations Manual (LOM).

As specified in the NWCA Quality Assurance Project Plan (QAPP), an NWCA Evaluator will evaluate each laboratory/herbarium to ensure the NWCA data quality objectives are satisfied. **Each laboratory/herbarium must participate in an evaluation and sign the laboratory signature form and acknowledgement and commitment to implement page of the QAPP to satisfy the terms of the NWCA QAPP.**

It is essential that each laboratory/herbarium accurately implement standardized protocols for vegetation identification and storage to ensure comparability of data among NWCA sites and minimize data loss that could result from damaged or degraded specimens, errors in data recording, sample processing, data storage, plant identification, or misinterpretation of guidance for laboratory operations. These quality assurance evaluations are designed to:

1. Confirm the 2016 NWCA Laboratory Operations Manual (LOM) protocols are implemented as intended.
2. Assist with questions the laboratory/herbarium may have.
3. Suggest corrections if any errors have been made by a laboratory/herbarium in implementing methods described in the LOM.

This evaluation will include a discussion of the attached checklist between the NWCA Evaluator and the laboratory/herbarium over the phone rather than an actual laboratory visit. The checklist includes descriptions of sample handling and other requirements to which each laboratory/herbarium must comply. The discussions will be scheduled with Chris Faulkner (EPA HQ NWCA Project Manager-Alternate, Faulkner.Chris@epa.gov).

Background: For all NWCA field work, whenever the identity of a species cannot be confirmed in the field, a sample is collected for later identification in the office by the field botanist/ecologist or by another botanist at a designated laboratory/herbarium. All unknown species located in one of five Vegetation Plots arrayed across a site's Assessment Area that are mature and have key structures needed for identification are collected (unknown species voucher). Unknown species that are immature or senescent comprising more than 5% cover are also collected. The field botanist/ecologist will ship unknown samples they cannot identify to the botanist (also called plant ID specialist or taxonomist in NWCA) at the laboratory/herbarium for initial identification.

In addition to all unknown specimens, field crews collect five known plant voucher samples (randomly selected from species identified by the Vegetation Team) for quality assurance (NWCA 2016 QAPP). These QA vouchers are sent to a QA "verifying botanist" for re-identification/verification. Collecting voucher specimens of known species both provides a quality assurance check on species identity data, and a permanent record of the occurrence of a particular species at a given location.
The QA verifying botanist is responsible for re-identification/verification of the QA vouchers as well as a random selection of 10% of the unknown specimens that were initially determined by the "identifying botanist" at the laboratory/herbarium.

If the unknown species specimens and QA voucher samples are planned to be sent to the same institution, it is important that all quality assurance activities be completed by a taxonomist that did not participate in the identification of unknown specimens. .
All laboratory methods and quality assurance requirements are fully described in the NWCA 2016 LOM and QAPP.

For the purposes of the Vegetation Laboratory Quality Assurance Evaluations, the Vegetation Checklist will focus on the lab's competence to receive and properly store specimens and to track and manage the vegetation data.

Definitions:

Voucher Sample - A pressed and dried plant sample, ideally comprised of leaves, stems, flowers, fruits and roots. An integral component of each voucher sample is written data describing the location, date of collection, habitat, plant habit, characteristic features and other information. Vouchers provide physical evidence that confirms the presence of plant species at specific locations.

Identifying Botanist - The person identifying and processing unknown samples. This could be a field botanist/ecologist; university, state, national or regional herbarium botanist; or an EPA contractor that has qualifying credentials in plant taxonomy. The identifying botanist is responsible for ensuring all plant identification and processing tasks outlined in the LOM are completed. In some cases this may require the identifying botanist to identify partners to assist with the work.

QA Verifying Botanist – The person re-identifying and verifying QA voucher identifications and a 10% subset of unknown species identifications by the laboratory/herbarium. This could be a botanist, ecologist, taxonomist, and/or plant ID specialist that is an expert in the identification of wetland plants.

The verifying botanist agrees to use the NWCA prescribed methods, as described in chapter 4 of the LOM, to ensure that all QA vouchers are correctly verified.

7 DATA ANALYSIS PLAN

The Data Analysis Plan describes the general process used to analyze the data for the survey. It outlines the steps taken to assess the condition of the nation's wetlands and identify the relative impact of stressors on this condition. Results from the analysis will be included in the final report and used in future analysis. The 2016 survey is only the second iteration of the NWCA, so the data analysis plan will likely be refined and clarified as the data are analyzed by EPA and states.

7.1 Data Interpretation Background

The basic intent of data interpretation is to evaluate the occurrence and distribution of parameters throughout the population of wetlands in the United States within the context of regionally relevant expectations for least disturbed reference conditions. This is presented using a cumulative distribution function or similar graphic. For most indicators the analysis will also categorize the condition of the wetland as good, fair, or poor. Because of the large-scale and multijurisdictional nature of this effort, the key issues for data interpretation are unique and include: the scale of assessment, selecting the best indicators, defining the least impacted reference conditions, and determining thresholds for judging condition.

7.1.1 Scale of assessment

This will be the second national report on the ecological condition of the nation's wetlands using comparable methods. EPA selected the sampling locations for the survey using a probability based design, and developed rules for selection to meet certain distribution criteria, while ensuring that the design yielded a set of wetlands that would provide for statistically valid conclusions about the condition of the population of wetlands across the nation. A challenge that this mosaic of sites poses is developing a data analysis plan that allows EPA and other partners to interpret data and present results at a large, aggregate scale.

7.1.2 Selecting the best indicators

Indicators for the 2016 survey will remain basically the same as those used in the first assessment in 2011. Most of the 2011 indicators were found to be applicable across all reporting units, and were able to differentiate a range of conditions. The notable exception was the algae species indicator, which has been dropped for 2016.

7.1.3 Defining least impacted reference condition

Reference condition data are necessary to describe expectations for biological conditions under least disturbed setting. The NWCA 2016 project team will use an approach similar to that used in NWCA 2011, which is described in detail in the NWCA 2011 Technical Report (http://www.epa.gov/national-aquatic-resource-surveys/national-wetland-condition-assessment-2011-draft-technical-report).

7.1.4 Determining thresholds for judging condition

This reference site approach is used to set expectations and benchmarks for interpreting the data on wetland condition. The range of conditions found in the reference sites for an ecoregion describes a distribution of those biological or stressor values expected for least disturbed condition. The benchmarks used to define distinct condition classes or stressor classes (e.g., good, fair, poor / low, moderate, high) are drawn from this reference distribution. EPA's approach is to examine the range of values for biological condition or a stressor indicator in all of the reference sites in a region, and to use the 5th percentile of the reference distribution for that indicator to separate the most disturbed of all sites from moderately disturbed sites. Using the 5th percentile means that wetlands in the most disturbed category are worse than 95% of the best sites used to define reference condition. Similarly, the 25th percentile of the reference distribution can be used to distinguish between moderately disturbed sites and those in least disturbed condition. This means that wetlands reported as least disturbed are as good as 75% of the sites used to define reference condition.

7.2 Geospatial Data

Geospatial data is an integral part of the data analysis for the NWCA 2016, as it has been for all other surveys. Anticipated activities utilizing geospatial data include review of coordinate data on sampling locations, compilation of attribute data (e.g., watershed information, protected area status) based on the location of sites, and computing landscape metrics (e.g., land cover, climate, pollutant loads).

7.3 Datasets Utilized for the Report

The datasets available for use in the report will be developed based on the data collected during NWCA 2016 and NWCA 2011. NWCA 2011 data will be used for change analysis, reference condition development, and other analytical purposes as needed. Other data (e.g. taxonomic trait information, geospatial information) may be added when appropriate.

The survey will use indicators to assess ecological integrity and the extent of stressors impacting integrity.

7.3.1 Ecological integrity

Ecological integrity describes the ecological condition of a wetland based on different assemblages of the vegetative community, soil characteristics, presence of appropriate hydrology and their physical habitat. The indicators include vegetation, soils, hydrology, and water chemistry.

7.3.2 Stressor Status / Extent

Stressor indicators describe the extent of key parameters impacting the condition of wetlands as well as the relative risk and attributable risk associated with stressors. The indicators include vegetation, soils, hydrology, water chemistry, and buffer characterization.

7.4 Vegetation Data Analysis

Vegetation data will be analyzed using multimetric indices (MMI). The MMI approach summarizes various assemblage attributes, such as composition, tolerance to disturbance, trophic and habitat preferences, as individual metrics or measures of the biological community. Candidate metrics are evaluated for aspects of performance and a subset of the best performing metrics are combined into an index known as a Vegetation MMI. This index is then used to rank the condition of the resource.

7.5 Soils, Hydrology, Water Chemistry, and Buffer Data Analysis

A wide array of soil, water, and hydrologic/habitat disturbance parameters will be measured, including a mix of field and lab-derived values. Results from an analysis of soil morphological properties, soil chemistry, water chemistry (including chlorophyll-*a* and microcystin concentrations), and hydrologic alteration will feed into an assessment framework to estimate the extent of key stressors and the relative risks that stressors pose to wetland condition.

EPA will develop a set of regional stressor profiles which are qualitative characterizations of the general types of human-caused stressors that affect wetlands within a broadly defined landscape. The analytical process of grouping stressors into a profile takes into account the dominant land use and climatic conditions surrounding the surveyed population of wetlands.

7.6 Relative Extent, Relative Risk, and Attributable Risk Evaluation

Each targeted reference site and survey site will be classified as being in either “Good”, “Fair”, or “Poor” condition, separately for each stressor variable and for each MMI (response variable). From this data, an estimate will be made of the *relative extent* (prevalence) of wetlands in “Poor” condition for a specified stressor and the MMI.

The *relative risk* (*RR*) of each stressor for a biological response will also be estimated. *RR* measures the severity of a stressor’s effect on that response in an individual wetland assessment area, when that stressor is in Poor condition (Van Sickle, et al. 2006).

Finally, the population *attributable risk* (*AR*) of each stressor for a biological response will be estimated. *AR* combines *RR* and relative extent into a single measure of the overall impact of a stressor on a biological response, over the entire wetland resource (Van Sickle and Paulsen 2008).

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