COMPREHENSIVE QUALITY ASSURANCE PLAN 2009

Quality-Assurance Plan for Water-Quality Activities in the U.S. Geological Survey Arkansas Water Science Center

- Compiled by *Evans, D.A., De Lanois J, Schrader T.P.,Petersen J.C., others*

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ABSTRACT

In accordance with guidelines set forth by the Office of Water Quality in the Water Resources Discipline of the U.S. Geological Survey, a quality-assurance plan has been created for use by the U.S. Geological Survey Arkansas Water Science Center in conducting water-quality activities. This quality-assurance plan documents the standards, policies, and procedures used by the Arkansas Water Science Center for activities related to the collection, processing, storage, analysis, and publication of water-quality data. The policies and procedures that are documented in this quality-assurance plan for water-quality activities are meant to complement the Arkansas Water Science Center quality-assurance plans for water-quality monitors and the microbiology laboratory, for surface-water and ground-water activities, and to supplement the Arkansas Water Science Center OWSC quality-assurance plan.

1.0 INTRODUCTION

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to perform the systematic and scientific "classification of the public lands, and examination of the geologic structure, mineral resources, and products of the national domain." The Water Resources Discipline (WRD) of the USGS is the Nation's principal water-resources information agency. The objectives of the WRD's Basic Hydrologic Data Program are to collect and provide unbiased, scientifically based information that describes the quantity and quality of waters in the Nation's streams, lakes, reservoirs, and aquifers. Water-quality activities in the Arkansas Water Science Center (AWSC) **are** part of the WRD's overall mission of appraising the Nation's water resources.

To address quality-control issues that are related to water-quality activities, the WRD has implemented policies and procedures designed to ensure that all scientific work conducted by or for the WRD is consistent and of documented quality. The Office of Water Quality (OWQ) is responsible for providing a quality-assurance (QA) plan that documents the policies and procedures that apply to the water-quality activities in each Water Science Center (WSC) in the WRD.

A QA plan is a formal document that describes the management policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation procedures for ensuring quality. Quality assurance, quality control, and quality assessment are all components of a QA plan. The terms are defined as follows:

Quality assurance (QA)—The systematic management of data-collection systems by using prescribed guidelines and criteria for implementing technically approved methods and policies. Quality assurance incorporates a comprehensive plan that outlines the overall process for providing a product or service that will satisfy the given requirements for quality.

Quality control (QC)—The specific operational techniques and activities used to obtain the required quality of data. Quality control consists of the application of technical procedures to achieve prescribed standards of performance and to document the quality of collected data. Quality-control data that do not meet required standards are used to evaluate and implement corrective actions necessary to improve performance to acceptable levels.

Quality assessment—The overall process of assessing the quality of environmental data by reviewing (1) the appropriate implementation of QA policies and procedures and (2) analyzing the QC data. Quality assessment encompasses both the measurable and unmeasurable factors that affect the quality of environmental data. Assessment of these factors may indicate limitations that require modifications to protocols or standard operating procedures for sample collection and analysis, or that affect the desired interpretation and use of the environmental data.

Quality-assurance, quality-control, and quality-assessment systems complement each other to provide a comprehensive QA program that ensures that quality objectives are identified and integrated into all levels of water-quality activities. By integrating these components into a discipline-wide QA guidance document, the OWQ hopes to enhance water-quality data collected by the USGS by providing for the following:

- **Consistency** in data quality across all levels of the WRD;
- **Accountability** to clients, the scientific community, regulatory agencies, and the general public;
- **Comparability** of results among samples, sites, and laboratories;
- **Traceability** from the end product back to its origins, and to all supplementary information, through written records;
- **Application** of appropriate and documented techniques that lead to similar results time and again;
- **Representativeness** of the data in describing the actual chemical composition of the biological or physical conditions at a sampling site for a given point or period in time; and
- **Adequacy** of the amount of data obtained to meet data objectives.

1.1 Purpose and Scope

The purpose of this QA plan for water-quality activities is to document the standards, policies, and procedures used by the AWSC for activities related to the collection, processing, storage, analysis, and publication of water-quality data. This plan identifies responsibilities for ensuring that stated policies and procedures are carried out. The plan also serves as a guide for all AWSC personnel who are involved in water-quality activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

The scope of this QA plan includes discussions of the policies and procedures followed by the AWSC for the collection, processing, analysis, storage, and publication of water-quality data. Although procedures and products of interpretive investigations are subject to the criteria discussed in this plan, some interpretive investigations may be required to have separate and complete QA plans. The policies and procedures documented in this QA plan for water-quality activities are intended to complement QA plans for water-quality monitors and for surface-water and ground-water activities.

2.0 ORGANIZATION AND RESPONSIBILITIES

Quality assurance is an active process of achieving and maintaining high-quality standards for water-quality data. Consistent quality requires specific actions that are carried out systematically in accordance with established policies and procedures. Errors and deficiencies can result when individuals fail to carry out their responsibilities. Clear and specific statements of responsibilities promote an understanding of each person's duties in the overall process of ensuring the quality of water-quality data.

2.1 Organizational Chart

The AWSC's organizational structure is shown in the organizational chart (fig. 2.1). Discipline specialists (ground water, surface water, and water quality), the National Water Quality Assessement Program (NAWQA), special support (library and building services), and the Supervisor for Administrative Services report directly to the Center Director. There are four investigation units, each with a Investigation Supervisor reporting to the Center Director and team members—Ecological Investigations, Geohydrological Investigations, Hydrologic and Hydraulic Investigations, and Hydrologic Networks and Data Investigations (Little Rock and Fayetteville offices).

Insert Figure 2.1 near here.

Figure **2.1.** Arkansas Water Science Center organizational chart (June, 2007).

2.2 Responsibilities

The final responsibility for the preparation and implementation of and adherence to the QA policies that are described in this QA plan lies with the AWSC Director (Schroder and Shampine, 1992, p. 7). The following is a list of responsibilities for selected AWSC personnel who are involved in the oversight, collection, processing, storage, analysis, and publication of water-quality data.

The Center Director and designated management personnel are responsible for ensuring the technical quality of all AWSC programs and products. Specific duties include:

1. Managing and directing the AWSC program, including designation of personnel responsible for managing all water-quality activities;
2. Ensuring that water-quality activities in the WSC meet the needs of the Federal government, the AWSC, cooperating State and local agencies, and the general public;
3. Ensuring that all aspects of this QA plan are understood and followed by AWSC personnel. This is accomplished by direct involvement of the AWSC Director or through clearly stated delegation of this responsibility to other personnel in the AWSC;
4. Providing final resolution, in consultation with the Water-Quality Specialist, of any conflicts or disputes related to water-quality activities within the AWSC;
5. Ensuring the completion of technical reviews of all water-quality programs on a 10-, 40-, and 70- percent project-completion basis;
6. Ensuring that all publications and other technical communications released by AWSC personnel are accurate and comply with USGS policy.

The AWSC Water-Quality Specialist is responsible for creating QA/QC polices and providing oversight and assistance on project QA/QC activities. Specific duties include:

1. Providing consultation, reviews, and assistance on water-quality issues to project leaders, when needed;
2. Ensuring that all aspects of this QA plan are understood by AWSC personnel involved in water-quality studies;
3. Keeping AWSC personnel briefed on procedural and technical communications from regional and Headquarters offices including OWQ, Branch of Quality Assurance (BQS), and NWQL;
4. Preparing and implementing the AWSC water-quality QA plan and ensuring that it is reviewed and revised every 3-5 years to document current responsibilities, methodologies, and ongoing procedural improvements;
5. Assisting the AWSC Director, project chiefs, and team leaders to ensure that water-quality activities in the AWSC meet the needs of the Federal government, the AWSC, cooperating State and local agencies, and the general public;
6. Participating in technical reviews of all AWSC water-quality programs on a 10-, 40-, and 70-percent project completion basis;
7. Assisting the AWSC Director to ensure that all publications and other technical communications released by the AWSC that relate to and include water-quality information are accurate and comply with USGS policy;
8. Oversees, organizes, and conducts water-quality reviews by Headquarters and the Region.
9. Assisting project personnel in the approval of analytical laboratories (except the NWQL) used for AWSC projects and in reviewing bi-annual Standard Reference Sample program samples operated by BQS.
10. Assisting project personnel to ensure the quality and accuracy of all project water-quality data.
11. Oversees the AWSC staff participation in the National Field Quality Assurance (NFQA) program.
12. Provide training on water-quality issues, as needed.
13. Maintaining copies of the references included in the QA Plan, updating the references, as needed, and providing them to AWSC managers and staff as requested.

The Water-Quality Database Manager(s) provides support to the AWSC Water-Quality Specialist in maintaining the water-quality database. Specific duties include:

1. Oversight and maintenance of the AWSC water-quality database, including data entry and printing of weekly watlists (see Appendix A for the routine QW management process), and entry of batch files from the QW data transfer system (QWDX, see http:qwdx.cr.usgs.gov);
2. Keeping AWSC personnel updated on procedural and technical communications on database issues and providing training, as needed;
3. Maintaining updated parameter code lists and other data base lists for use by project personnel;
4. Assisting project personnel and the AWSC Water-Quality Specialist to ensure quality and acuracy of all data in the database.

The Field Service Unit Coordinator provides suport to the AWSC Water-Quality Specialist in maintaining supplies and equipment. Specific duties include:

1. Maintaining a supply of reagents, bottles, and other supplies needed for routine water-quality sampling, and ensuring that such supplies are in compliance with USGS protocols;
2. Assisting the AWSC Water-Quality Specialist in implementation of the NFQA program.
3. Assisting project personnel in the purchase of water-quality equipment, as needed.

The Project Chief is responsible for ensuring that QA/QC procedures are implemented by the project team. Specific duties include:

1. Managing and directing the project's field and laboratory water-quality activities;
2. Ensuring that the project's field and laboratory water-quality activities meet the needs of the Federal government, the AWSC, cooperating State and local agencies, and the general public;
3. Ensuring that all aspects of this QA plan that pertain to the project's field and laboratory water-quality activities are understood and followed by project personnel;
4. Obtaining guidance, as appropriate, for project quality-assurance/quality-control (QA/ QC) activities from the AWSC Water-Quality Specialist;
5. Ensuring that QA/QC activities are properly carried out by the project staff;
6. Ensuring the quality and accuracy of all project water-quality data.

2.3 References Used for the Organization and Responsibilities Section

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report. Copies of these references are available by contacting the AWSC Water-Quality Specialist.

Table 2.3. Summary of references for organization and responsibilities related to quality assurance

Reference	Subject
Schroder and Shampine, 1992	Guidelines for preparing a quality-assurance plan.
Shampine and others, 1992	Integrating quality assurance into project workplans.

3.0 PROGRAM AND PROJECT PLANNING

The AWSC Director has primary responsibility for overall AWSC program planning and is responsible for ensuring that AWSC projects are supportive of AWSC and national priorities. The AWSC Director receives aid and advice from the Regional office, the AWSC Water-Quality Specislist (and other AWSC technical specialists, as needed), and Project Chiefs about the technical accuracy of water-quality data collection and analyses and conformance with AWSC, Regional, and national policies. All water-quality projects require review and approval prior to the commencement of work. Quality-assurance requirements should be integrated into the project proposal. Whether or not a separate QA plan will be required for a water-quality project will depend on the complexity of the work, the needs of the AWSC or cooperator, or other criteria as described in Shampine and others (1992).

3.1 Project Proposals

Project proposals are developed at the local level in response to requests by cooperating agencies, needs recognized by the WRD in working closely with other agencies, or national programs. AWSC proposals conform to standard USGS format as described in Northeast Region Policy Memoranda 2006-01 and 2004-01 (accessed June 2007 at http://water.usgs.gov/usgs/orh/nrwww/prog-dev/proposals.html), both entitled, "Requirements for Submittal and Approval of Project Proposals."

Each proposal must (l) state the problem or need for the study, (2) define objectives—what will be done to help solve the problem, (3) descibe the relevance and benefits—why should USGS conduct the study and how will the work support the goals of WRD; and (4) define the approach—how work will be done to accomplish the objectives. For revelance and benefits, refer to USGS goals as expressed in the USGS Strategic Plan (accessed June, 2007, at http://www.usgs.gov/stratplan/stratplan.pdf), USGS Federal-State Cooperative Program Priorities (accessed June, 2007 at http://water.usgs.gov/admin/memo/policy/wrdpolicy99.30.html), or WRD Policy on avoiding competition within the private sector (accessed June, 2007 at http://water.usgs.gov/admin/memo/policy/wrdpolicy04.01.html). The approach consists of a detailed outline of the data-collection activities to be carried out (if new data are needed), the QA plan, the QC information needed, and the analytical techniques to be used. Project report plans, cost estimates, time schedules, and personnel requirements also are addressed. Consultation with regional and discipline specialists is encouraged in the preparation of proposals and in the execution of projects.

The number and types of QC samples are established during the proposal proposal phase in consultation with the AWSC Water-Quality Specialist. Careful examination of the following questions will help evaluate QC sample needs:

1. Why are the data being collected and how will the data be used?
2. What level of potential contamination from sampling and analytical procedures will be assessed by use of blanks?
3. How will the data on replicate samples be used to establish acceptable limits of variability?
4. How will the data from standard reference samples and spike samples be used to assess acceptable levels of bias for each analyte?
5. How will the types of QC samples be distributed during phases of the project?
6. What other variables in the project (such as flow, season, etc.) will affec the distribution of QC samples?

Review of project proposals is given high priority. In particular, the design of the data-collection approach is reviewed to ensure that it is neither over-designed nor under-designed, and that it is adequate to fulfill the objectives of the project. Project proposals are reviewed by the appropriate AWSC personnel (discipline specialists, supervisor, technical experts) and, at the discretion of the AWSC Chief, may be sent to other AWSCs for review. The Central Regional office provides final review and approval of all project proposals.

3.2 Project QA/QC Plans and Workplans

Project workplans are developed from approved project proposals. The OWSC requirements for the content, review, and revision of workplans are outlined below.

For small or routine projects, the Project Chief prepares, at the minimum, a project QA/QC plan. The project QA/QC plan contains the project description, objectives, purpose and scope, approach, reports, technical review dates, data collected, a listing of QC objectives and number of samples, and corrective action procedures (see Appendix B for an example of a project QA/QC plans).

For large or complicated projects, the Project Chief prepares a workplan that identifies all project work elements and the related technical methods and approaches that are necessary to satisfy project objectives. The workplan links project personnel, tasks, and functions with associated funds and indicates the projected dates for on-time completion of project elements and, ultimately, the project. Workplans for water-quality programs and projects, including programs and projects with water-quality components, should clearly state how the AWSC's "Quality-Assurance Plan for Water-Quality Activities" will be implemented.

Descriptions of the methods and approaches to be used to complete the technical elements of the project are required in the workplan. References for standard field and analytical procedures are provided. Any new or unapproved field and laboratory methods that will be used must be described in detail. The plan should provide the following details about the study:

- Sampling locations and frequency
- Description of the sample types and their expected uses
- Names of laboratories, approval status, and desccriptions of laboratory tests
- Types and frequency of QC data collection, including sampling and analysis of blanks, spikes, and reference samples to estimate bias and replicates to estimate variability and establish data quality objectives (Mueller and others, 1997).
- Responsibilities for QC data collection and maintenance of the database, and description of how the project uses QC data.
- Procedures to verify field-analysis data, such as pH, temperature, and dissolved oxygen (i.e. participation in NFQA, bench-test meters against standards and ASTM meters, etc.).
- Anticipated methods for data analysis and presentation, including report plans.
- The project timeline listing major project elements and planned completion dates.

3.3 Project Review

Project and field reviews are conducted periodically by AWSC management, technical advisors, or discipline specialists to ensure compliance with the QA/QC plan or project workplan. Project reviews are also used to ensure that data collection, analysis, and reporting are being done in accordance with broader OWSC policies and requirements. Quality-assurance activities with respect to project reviews are outlined in the next section.

3.3.1 Review Schedules

Regularly planned reviews ensure that water-quality programs or projects are conducted efficiently to produce quality products on time. Informal reviews are part of ongoing quality assurance, whereby problems and related issues are addressed as they arise. Quarterly project reviews are held by the AWSC; however, these reviews address budget and cooperator issues and only briefly address technical aspects of the project.

Technical reviews are needed for most projects. The type and frequency of technical reviews depend on the size and duration of the project and project objectives. For most water-quality projects, the AWSC implements a review schedule for evaluating the technical development and progress of project activities at 10-, 40-, 70-percent (10/40/70) project-completion milestones. For small or routine projects or projects of short duration, 10/40/70 technical reviews may be impractical or unnecessary; instead, reviews are done as requested by the Project Chief or required by the Investigation Supervisor. For projects in which the cooperator is heavily involved in project activities, quarterly conference calls or meetings with the cooperator may serve as a technical review.

Field reviews are done by the AWSC Water-Quality Specialist, a designated experienced technician, or the Regional Water-Quality Specialist to ensure sample collection and processing protocols and field documentation procedures are complete and accurate. For long term projects (3 or more years), field reviews are generally done every three years. For short term projects, field reviews are done at least once during the data collection period. Field reviews are documented with a memorandum to the appropriate Project Chief and the AWSC Supervisor.

3.3.2 Review Documentation

The following information should be included in technical project review documentation:

- Date of review
- Type of review (10/40/70, discipline)
- Names of reviewers and(or) attendees
- Responses to recommended action items from the last review
- Status, plans, and problems with data collection, data analysis, and report writing
- Major findings
- QA/QC activities and results
- Cooperator/customer contacts
- Recommended follow-up or action items
- Date for next review

Documentation from the review is maintained in the project files. The Project Chief is responsible for documenting comments and action items from the review, a copy of which is provided to the Investigation Supervisor and each reviewer. Documentation must include all actions or recommendations for fixing deficiencies, or documentation explaining why a fix cannot be made.

3.4 References Used in the Program and Project Planning Section

The following table lists reports and(or) memoranda referred to in this section. For complete citations of reports and memoranda, refer to Sections 13.0 and 13.1 of the report, respectively. Copies of these references are available by contacting the AWSC Water-Quality Specialist.

- 3.4. Summary of references for program and project planning

Reference	Subject
NER Guidance Memorandum 2006-01 and 2004-01	Requirements for submittal and approval of project proposals
USGS Strategic Plan for 2000-2005	Help with writing relevance and benefits section of proposal
WRD Policy Memorandum 99.3	Priority issues for the Federal-State Cooperative Program
WRD Policy Memorandum 04.01	Avoiding competition with the private sector
Mueller and others, 1997	Example of QC sample design used by NAWQA for surface-water sampling.
Shampine and others, 1992	Integrating quality-assurance into project workplans.

4.0 WATER-QUALITY LABORATORIES

The comparability and consistency of water-quality data depends to a large extent on the reliability of the analytical work done in the laboratory. Because of the inherent variability among laboratories, one of the best ways to provide comparability and consistency is to use a single laboratory as much as is practical. A large proportion of the analytical water-quality work for the AWSC is done by the USGS National Water Quality Laboratory (NWQL), laboratories approved by the NWQL.

4.1 Selection and Use of an Analytical Laboratory

The National Water Quality Laboratory (NWQL) was established as the laboratory to meet the needs of the WRD, and it is the required laboratory for use in all WRD national water-quality programs (WRD Memorandum 92.036). However, there are conditions for selecting a laboratory other than the NWQL.

4.1.1 Selection

Contract or cooperator laboratories can be used when the cooperative agreement designates a laboratory other than the NWQL or when analytical services are required that cannot be provided by the NWQL. Laboratories can be used for developing analytical techniques or to provide data for research purposes, and these laboratories are generally exempt from approval requirements that other laboratories must meet (OWQ Technical Memorandum 07.01, accessed June, 2007 at http://water.usgs.gov/admin/memo/QW/index.html). Contract or cooperator laboratories can also be used when analyses must be done within a few hours of sample collection and cannot be done conveniently in the field.

4.1.2 Requirements for Use

All laboratories that provide analytical services to WRD must meet the requirements described in OWQ Memorandum 07.01, before any analytical data can be stored in the WRD National Water Information System (NWIS) data base (discussed in Section 10) or published by the WRD. Laboratories affected by this policy include those that provide chemical, biological, radiochemical, stable isotope, or sediment analytical services. The Project Chief is responsible for assuring that all laboratories providing analytical services to the AWSC have met the requirements for approval. The laboratory approval process is project based, and assistance will be provided by the BQS when requested. The project staff is responsible for obtaining the following data and information from a laboratory and entering it into the BQS database:

1. Document the project data quality requirements and laboratory information.
2. Obtain QC data that provide an initial demonostratin of capability for the laboratory.
3. Evaluate the lab capabilities in relation to project objectives.
4. Prepare a Laboratory Selection Package and submit it for review and approval.
5. Obtain QC data to assess the laboratory performance during the life of the project.
6. Review the laboratory performance at least biannually.

For laboratories analyzing samples for inorganic constituents, the laboratory must participate in the BQS Standard Reference Sample (SRS) program (http://bqs.usgs.gov/srs/), a bi-annual program to evaluate the performance of USGS cooperator and contract laboratories.

4.2 Laboratories Used by the AWSC

In addition to the NWQL and those approved by the NWQL, the laboratories used for analytical services by AWSC projects are listed and described below.

4.3 Documentation for Laboratories Used by the AWSC

4.3.1 National Water Quality Laboratory

1. Methods used—The NWQL uses approved methods for determination of organic, inorganic, and radioactive substances in water, sediments, and biological tissues. The methods used include methods approved by the USGS, USEPA, the American Public Health Association, the American Water Works Association, the Water Environmental Federation, and the ASTM. The references for analytical methods currently used at the NWQL can be found in the LIMS catalog at http://nwql.cr.usgs.gov/usgs/catalog/index.cfm.
    a. Other analytical methods from the USEPA that are currently used at the NWQL can be found on at http://www.epa.gov./epahome/publications.htm. Analytical methods from the ASTM that are currently used at the NWQL can be found at http://www.astm.org.
2. Laboratory QA plan—The NWQL quality-assurance plan is contained in Pritt and Raese (1995). A copy of this report can be obtained by sending an Email request to nwqlqc@usgs.gov .
3. QC program—Quality control at the NWQL is monitored by three programs: (1) the internal blind sample program, (2) the external blind sample program, and (3) bench level QC samples. Information about the internal blind sample program and bench level QC samples can be obtained by sending an Email request to nwqlqc@usgs.gov . Information about the external blind sample program can be found at the following World Wide Web location: http://btdqs.usgs.gov/bsp/Fact.Sheet.html
4. Performance evaluation studies and certification programs—The NWQL participates in performance evaluation studies and laboratory certification programs. A list of the current programs and a description of each can be found by sending an Email request to nwqlqc@usgs.gov .
5. Laboratory reviews—External agencies and customer organizations audit the NWQL to assess analytical methods and QA/QC programs. A table of audits that shows the year reviewed, reviewing agency, and purpose of the review can be obtained by sending an Email request to nwqlqc@usgs.gov .

6. Miscellaneous services—Information about and access to other services offered by the NWQL can be found by USGS employees on the World Wide Web in-house home page at http://wwwnwql.cr.usgs.gov/USGS/profile.html. The services offered include but are not limited to the following:

    Biological unit
    Chain-of-custody procedures
    Contract services
    External performance evaluations
    Laboratory services catalogue
    Methods Research and Development Program
    Organic spike kits
    Publications
    Quality assurance of selected field supplies
    SPiN (schedules, parameters, and network record)
    Technical memoranda

4.4 References Used for the Water-Quality Laboratories Section

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of this report.

1. 4.4. Summary of references for selecting and using water-quality laboratories

Reference	Subject
WRD Memorandum 92.036 (USGS)	Policy of the WRD on the use of laboratories by national water-quality programs.
OWQ Technical Memorandum 07.01	Policy for the evaluation and approval of analytical methods
Pritt and Raese, 1995	Quality assurance/quality control manualNWQL.

5.0 FIELD SERVICE UNITS AND LABORATORIES, MOBILE LABS, AND FIELD VEHICLES

The AWSC maintains laboratory facilities, such as the Field Service Unit, mobile labs, and field vehicles for use in preparing equipment for field activities, processing samples, performing sample analysis, and preparing samples for shipment to analytical laboratories. This section documents the AWSC's criteria for maintaining and operating these facilities. Facilities are maintained in accordance with standards set forth in the AWSC chemical-hygiene plan, written and maintained by the Chemical Hygiene Officer (last updated January, 2007), as required by Branch of Operations Technical Memorandum 91.01. As per the CHP, the Environmental Compliance Coordinator oversees the AWSC waste-disposal practices to ensure that procedures are in compliance with State and Federal regulations.

5.1 AWSC warehouse

The AWSC warehouse serves as a general-purpose area for all personnel and projects. Functioning as a Field Service Unit for preparing for field trips, it is supplied with buffers and standards needed for instrument calibrations; supplies and space for cleaning of instruments, samplers, and other items; and supplies, forms, containers, and coolers for shipping samples. The unit also maintains a limited amount of expendable supplies, such as sample bottles and acid cartridges for titrations. The Field Service Unit Coordinator is responsible for maintaining this inventory of supplies; all users are responsible for general upkeep, organization, safety and cleanliness of the warehouse. Except for those items provided by the Field Service Unit, project personnel are also responsible for ordering supplies and equipment needed for project water-quality operations.

Equipment and appliances in the AWSC warehouse is available for use by all personnel and projects. These include three autoclaves for sterilizing sampling equipment and supplies, two refrigerators for storing samples and supplies, and a system that provides deionized water. The equipment and appliances in the AWSC warehouse are maintained and checked by AWML personnel as described in the AWML QA/QC Manual.

The AWML (main laboratory) is equipped with a fume hood, additional benchtop areas, and chemical storage cabinets for preparing for water-quality field work. The fume hood is used to prepare dilute acid solutions and handle other hazardous materials used for water-quality work. The equipment in the AWML (main laboratory) are maintained and checked by AWML personnel as described in the AWML QA/QC Manual.

5.2 Mobile Labs and Water-Quality Field Vehicles

Mobile labs and field vehicles refer to all vehicles that are designed, designated, and outfitted for use during water-quality sample-collection and processing activities at or near sample-collection sites. The AWSC maintains vehicles designated for water-quality sample collection and processing. If a non-designated vehicle must be used for water-quality work, portable processing and preservation chambers are used for sample processing, and extra QC samples are collected to document that the data have not been compromised.

A field vehicle is designated as a water-quality field vehicle when it meets criteria to maintain a non-contaminating environment for the constituents being sampled. The work area must be maintained to eliminate sources of sample contamination. Specifications for vehicles used when sampling for water-quality constituents are discussed by Horowitz and others (1994) and in the National Field Manual (Wilde and others, eds., 2003, TWRI book 9, chap. A2.3) and include the following:

- Materials used for cabinets, storage, and work surfaces must be easy to maintain, made of or covered with non-contaminating materials, and such that they can be cleaned with water or solvents as appropriate. Cargo must be restricted to equipment and supplies related to water-quality sample collection unless stored in a separate compartment. No potentially contaminating equipment or supplies, such as sounding weights, solvents, fuel, etc., may be transported in the interior compartment of the vehicle.
- If project objectives require a dust barrier, it should be installed between the cab and work area of the vehicle.

The users of the vehicle are responsible for vehicle maintenance, for maintaining the suitability of the vehicle for water-quality sample collection, and for keeping the vehicle supplied.

5.3 References Used for the Field Service Units and Laboratories, Mobile Labs, and Field Vehicles Section

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

- 5.3. Summary of references for Field Service Units and laboratories, mobile labs, and field vehicles

Reference	Subject
Branch of Operations Technical (OP) Memorandum 91.01 (USGS)	SafetyChemical-Hygiene Plan.
Horowitz and others, 1994	Protocol for collecting and processing samples for inorganic analysis.
Wilde and others, eds., 2003 (National Field Manual, TWRI book 9, chap. A2.3)	Guidelines for field vehicles.

6.0 WATER-QUALITY INSTRUMENTS

The AWSC complies with the WRD policy of providing personnel with high-quality field instruments and equipment that are safe, precise, accurate, durable, reliable, and capable of performing required tasks (WRD Memorandum 95.35). Accordingly, appropriate instruments for use in water-quality projects in the AWSC should be selected based upon the specifications described in the USGS "National Field Manual for the Collection of Water-Quality Data (NFM)" (TWRI book 9, chaps. A1-A9) and the requirements of the project. The Hydrologic Instrumentation Facility (HIF), which provides analyses of precision and bias for water-quality instruments, also should be consulted for recommendations when appropriate. Consultation with the Field Service Unit Coordinator should be done if project personnel need assistance with the selection or use of equipment.

All instruments used by AWSC personnel for water-quality measurements are to be properly operated, maintained, and calibrated. Details of methods for field measurements are provided in NFM (TWRI book 9, chaps. A6). All personnel should read the pertinent sections of this chapter prior to making their first field measurements, and use the manual as a reference therafter. Also, for correct operation of any field or laboratory equipment, the manufacturer’s operating guidelines should be carefully followed. Most instruments will be calibrated in the field prior to making the sample measurements.

Maintenance of instruments and QC activities (meter calibrations and equipment maintenance) are the responsibility of individual field and project personnel. Prior to leaving on a field trip, water-quality instruments are cleaned, adjusted if necessary, and checked for serviceability. Instruments that are malfunctioning or in poor condition are reported to the Project Chief and (or) Field Services Unit Coordinator. Batteries are changed on a regular schedule. A spare pH probe and dissolved-oxygen membrane should be carried in the field.

Single or multiparameter water-quality continuous monitors are maintained, calibrated, and operated based on requirements described in Wagner and others (2006).

6.1 Calibration of Water-Quality Instruments

Table 6.1. provides summary information regarding the calibration methods, acceptance criteria, calibration frequency and location, responsible persons, and references for instructions for the calibration and use of water-quality instruments to measure routine parameters in the AWSC. For non-routine measurements, the Project Chief is responsible for establishing calibration methods and acceptance criteria. Consult Wilde (2005−present, NFM, chap. A6.5) for reduction-oxidation potential or the manufacturer's instructions for other non-routine measurements, such as field screenings for chemical constituents.

Table 6.1. Summary of calibration information for water-quality instruments used to measure selected parameters in the OWSC
[NIST, National Institute of Standards and Technology; RP, responsible party; NFM, National Field Manual; FSU, Field Service Unit]

Parameter	Calibration method	Acceptance criteria and response if unacceptable	Calibration frequency and location	Respon-sible person	Reference for calibration and use
Temperature	3-point check with NIST-certified thermometer	± 0.5°C for liquid filled or ± 0.2°C for thermistor; replacement	Semi-Annual, FSU	Field personnel or Project Chief	Wilde, 2006 (NFM, chap. A6.1; manufacturer's instructions
Dissolved oxygen	One-point calibration in water or air	± 0.2 mg/L; change membrane or replace probe	Calibration at each site	Field personnel or Project Chief	Wilde, 2006 (NFM, chap. A6.2; manufacturer's instructions
Specific electrical conductance	At least two standards, bracketing expected values	± 3 percent; change membrane or replace probe	Calibration at each site	Field personnel or Project Chief	Wilde, 2005 (NFM, chap. A6.3; manufacturer's instructions
pH	Two-point calibration, bracketing expected values	± 0.1 unit; clean or replace probe	Daily in field or FSU, prior to taking measure-ments.	Field personnel or Project Chief	Wilde, 2006 (NFM, chap. A6.4; manufacturer's instructions

Parameter	Calibration method	Acceptance criteria and response if unacceptable	Calibration frequency and location	Respon-sible person	Reference for calibration and use
Turbidity (using a ratiometric, white light turbimeter , such as the Hach Model 2100P)	Reference turbidity calibration with formazin	Within manufacturer's range; repair or replace	Annually	Field personnel or Project Chief	Wilde, 2005 (NFM, chap. A6.7; manufacturer's instructions
	Calibrations with secondary standards (0-10, 0-100, and 0-1000)	Within 5 percent of the reference turbidity values; recalibrate with reference turbidity	Daily in field or FSU, prior to taking measure-ments		
Barometric pressure	Check against NIST certified barometer	± 5 millimeters Hg; replacement	Daily calibration	Field personnel or Project Chief	Wilde, 2006 (NFM, chap. A6.2; manufacturer's instructions

Thorough documentation of all calibration activities associated with water-quality data collection is a critical element of the AWSC QA program. A record of the calibration is maintained in an equipment log book and this information is copied onto the site field sheet or entered into the Personal Computer Field Form (PCFF). Project personnel are to keep calibration and maintenance records in bound equipment log books, written in ink, and stored with the instrument; documentation includes the manufacturer, make, model, and serial or property number. Completed notebooks are kept by the Field Services Unit Coordinator. Similar records for AWML laboratory equipment are to be kept in laboratory drawers near the equipment. Information that is required to be included with the calibration and maintenance records includes the date, initials and last name of the individual performing the activity, results of calibration or equipment check, and any actions taken. Calibration and maintenance records are checked for completeness and accuracy annually by the AWSC Water-Quality Specialist.

6.2 References Used for the Water-Quality Instruments Section

Table 6.2 provides a list of reports and(or) memoranda referred to in this section on water-quality instruments. For a complete citation, refer to Section 13.0 of the report.

• 6.2. Summary of references for water-quality instruments

Reference	Subject
U.S. Geological Survey, 1997-present (TWRI Book 9, chaps. A1-A9	National Field Manual for the Collection of Water-Quality Data
Wilde, ed., 2005-present (TWRI book 9, chap. A6)	Field measurements.
WRD Memorandum 95.35 (USGS)	Instrumentation plan for the WRD and the hydrologic field instrumentation and equipment policy and guidelines.
Wagner and others, 2006	Guidelines and standard procedures for continuous water-quality monitors

7.0 SITE SELECTION AND DOCUMENTATION

Deciding where to sample is an important initial step toward achieving project objectives and meeting AWSC QA/QC requirements. Once a site is selected, thorough documentation, usually in the form of a station description, is required.

7.1 Site Selection

Site selection for sampling is important to the validity of water-quality data. Selection of a suitable site can be made only after considering a number of factors, including the study objectives and types of data needed, the suitability of a site for sampling, the physical characteristics of the area, and its accessibility and safety. Specific guidelines for site selection are contained in Wilde (2005, chap. A1). The project chief is responsible for the selection of sampling sites, after consultation with the Water-Quality Specialist and the Surface-Water or Ground-Water Specialist, as appropriate.

7.1.1 Surface Water

If possible, flowing-water sites are located at or near streamflow-gaging stations. If this is not possible, the water-quality station should be located where the stream discharge can be measured and water samples can be collected at all stages of flow to be monitored. If the water-quality station is located too close downstream from either the confluence of two or more streams or a point source of pollution, the collection of a representative sample may be difficult because of incomplete mixing. Under such conditions, the criteria for the minimum number of vertical transects sampled may need to be increased, and lateral mixing should be documented with cross-sectional surveys at various stages of flow. Other considerations for surface-water site selection are described in Averett and Schroder (1994).

The selection of still-water sampling sites depends on whether project objectives can be satisfied by random and (or) stratified sampling strategies. Detailed information on selection of lake monitoring sites is available in Nevers and Whitman (2005) and Averett and Schrdoer (1994). Special considerations should be taken in establishing beach-monitoring sites. Collect samples in the area used for swimming at 0.7 to 1-m water depth. At some beaches, multiple samples may be needed to adequately represent overall water-quality conditions (Myers and others, 2007).

7.1.2 Ground Water

The selection of wells for ground-water sampling is dependent on many variables, including location, depth and accessibility of the well, type of well completion, availability of geologic and water-use information, and sampling purpose(s). If suitable existing wells cannot be found, new wells will need to be installed. The minimum well-selection criteria for any ground-water project done in the OWSC includes sufficient documentation to (1) determine the hydrogeologic zone from which the ground water is being withdrawn and (2) ensure that materials and techniques used to construct the well are suitable for sampling the constituents of concern. Guidelines for ground-water site selection are presented in Lapham and others (1997).

7.2 Site Documentation

All site data, whether for surface-water or ground-water sites, are entered into the USGS Ground-Water Site Inventory (GWSI). The procedures for establishing the station identification number (station ID) and site name and for entering data into GWSI are described below. The Project Chief is responsible for establishing the site, with assistance from the GWSI Administrator.

1. Establish an 8-digit or 15-digit station ID and a site name. Eight-digit numbers are used for establishing the downstream order of surface-water and lake sites that are to be streamflow measuring stations (Martin and Cohen, 1994); they are assigned by the GWSI administrator. Fifteen-digit numbers are used for all other sites and are composed of the latitude, longitude, and a 2-digit sequence number.
   - Determine the latitude and longitude using a topographic map, as described in Martin and Cohen (1994), or by use of a Global Positioning System (GPS).
   - To ensure that sites are not duplicated, retrieve a list of existing sites from GWSI that are within a mile radius of the proposed new site. This does not have to be done for sites that are newly-constructed wells.
   - Follow correct site naming procedures, described more fully in Martin and Cohen (1994). For stream-water sites, use the stream name; at, near, or below, as applicable; the closest town or city; and OH for Ohio. For ground-water sites, use the the land net location. The station name will include the township, range, section, quarter, quarter-quarter, quarter-quarter-quarter, and a two-digit sequence number. All numbers for the township, range, and section are to be written as two digits, (i.e. section one is written as 01). The directional abbreviations for the township and range of north, south, east, and west are to be abbreviated with the capital letters N, S, E, and W, respectively(AWSC 'A Quality-Assurance Plan for Ground-Water Level Activities of the U.S. Geological Survey, 2007).

1. Fill out a GWSI paper form and enter data enetronically nto GWSI. Have another Project Team member check the entry.
2. Transfer the information to the GWSI Administrator who will check, edit, and enter the site into the GWSI database.

After the site is establisihed, the Project Chief constructs a site file containing descriptive information on location, conditions, purpose, and ancillary information for all new water-quality data-collection sites (Schroder and Shampine, 1995). Descriptive site information, including latitude, longitude, hydrolgic units, and other site information is stored electronically in GWSI. The project chief is responsible for assuring that the site file is maintained for each data-collection site. Archiving of this information is discussed in Section 10.4.

In order to standardize and facilitate the processing of water-quality data in the AWSC and to assure that water-quality data are entered into the proper database in a timely manner, the following procedures will be used:

Site-header records will be established for each new site at which water-quality samples will be collected or have been collected. Header record must exist in the NWIS site file before the return of analytical data from the NWQL. New site-header data must be checked by Project or Field Office personnel. These verified records, as well as the resulting water-quality data, will be stored in the NWIS water-quality database for the AWSC. The responsibility for entry of the site-header records and maintenance of the site-header records file currently rests with Project Chief, with help from the AWSC Water-Quality Specialist and Data-base Manager. The pertinent information that comprises the header must be entered into the system prior to but no later than 10 days after sample collection.

- For each sample that will be sent to the NWQL for analysis, an Analytical Services Request (ASR) form will be completed by the Project Team with a copy retained in a project file as part of the sample tracking system. For USGS employees, ASR forms can be downloaded from the NWQL (http://wwwnwql.cr.usgs.gov/USGS/USGS_srv.html)and filled out.
- An alternative to manually completing an ASR form is to enter sample and field data into a Personal Computer Field Form (PCFF). PCFF allows users to enter field-derived sample-collection data into electronic USGS field forms automatically, thereby eliminating any transcription errors in the transferring of data. PCFF software can be downloaded at http://water.usgs.gov/usgs/owq/pcff.html
- The Project Chief is responsible for tracking all pending samples submitted for analysis. Sample status at the NWQL can be tracked from login to completion of analysis (see section 9.0).

7.2.1 Surface Water

A station description is prepared for each water-quality station that is sampled on a regular or periodic basis. Sites established at existing surface-water gaging stations commonly will need only supplemental information to complete the description. Other surface-water sites, such as lakes, estuaries, and coastal waters, may require varying amounts of supplemental information to complete the station descriptions. The minimum information required for establishing electronic files in NWIS for surface water is listed in table 1-1 in Wilde (2005, chap. A1). For continuous water-quality monitoring sites, station-description requirements are presented by Wagner and others (2006).

Information about the station, including the station description and safety information, are kept in a site field folder. A site field-folder checklist for surface-water quality sites is shown in figure 1-2 in Wilde (2005, chap. A1).

7.2.2 Ground Water

A well file (analogous to a surface-water station description) is prepared for each well that is sampled on a regular or periodic basis. The minimum information required for establishing electronic files in NWIS for ground water is listed in table 1-4 in Wilde (2005, chap. A1). Wells selected as potential sampling sites may need to be visited before completion of the GWSI site file to verify that information obtained from driller's log or other sources is correct. Copies of well logs obtained from the Ohio Department of Natural Resources are filed with the original GWSI form and in site field folder. For continuous water-quality monitoring sites, station-description requirements are presented by Wagner and others (2006).

Information about the well, including the station description and safety information and water-level records are kept in a site field folder. Before sampling, obtain permission to sample the well and arrange for site access; keep these documents in the site field folder. It is also recommended that photographs of the well site be taken to document well characteristics and local land-use practices near the well. A site field-folder checklist for ground-water quality sites is shown in figure 1-4 in Wilde (2005, chap. A1).

7.3 References Used for the Site-Selection and Documentation Section

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

- **7.3.** Summary of references for site selection and documentation for water-quality programs

Reference	Subject
Schroder and Shampine, 1995	Guidelines for documenting new water-quality data-collection sites.
Wagner and others, 2006	Guidelines and standard procedures for continuous water-quality monitors
Averett and Schroder, 1994	Guide to the design of surface-water quality studies
Lapham and others, 1997	Guidelines and standard procedures for studies of ground-water quality
Myers and others, 2007	NFM, Fecal indicator bacteria, Surface water sample collection
Martin and Cohen, 1994	Documentation procedures
Nevers and Whitman, 2005	Lake Monitoring Field Manual
Wilde 2005 (TWRI book 9, chap. A1)	Preparations for water sampling

8.0 SAMPLE COLLECTION AND PROCESSING

Water-quality data collected by the USGS are used by agencies throughout the Federal, State, and local levels to guide their decisions concerning the appropriate and efficient management of water resources for the Nation. Water-quality data are collected as part of such Federal programs as the National Stream-Quality Accounting Network (NASQAN) and the National Water-Quality Assessment (NAWQA) Program, as well as cooperative projects jointly funded by local or State agencies, and are a vital component of water-resources activities performed by the USGS and the AWSC.

The primary objective in collecting a water-quality sample is to obtain environmental data that are representative of the system that is being studied. Sampling and processing techniques for specific constituents may vary according to the general class of compound, such as inorganic or organic chemicals. If incorrect sampling procedures produce a nonrepresentative sample, or if the sample is contaminated or degraded before analysis can be completed, the value of the sample is limited and the data are questionable. It is the responsibility of each employee involved in water-quality sampling to avoid sample contamination and degradation during all phases of sample collection and processing. Compliance with documented and technically approved sample-collection and processing protocols, in particular NFM Chapters A4 and A5 (Wilde, 2006 and 2004a), is critical to ensuring the quality of water-quality data.

It is the policy of this AWSC that all personnel involved in collecting and processing water-quality data will be adequately informed and trained regarding water-quality data-collection and processing procedures established by the WRD. Because of rapid changes in technology, however, new and improved methods for sample collection and processing are continually being developed. All OWSC personnel who are involved in water-quality sampling must be aware of changing requirements and recommendations. The AWSC Water-Quality Specialist is responsible for providing current information to field personnel on the correct protocols to follow in collecting and processing water- quality samples. It is AWSC policy to provide water-quality personnel with ample opportunities to attend training courses, including those at the USGS National Training Center. Project personnel are responsible for informing AWSC Managers and the Water-Quality Specialst of sampling plans and any need for current information and (or) training.

The Project Chief is responsible for seeing that field personnel take the following steps to ensure the quality and integrity of the AWSC's water-quality data:

Instantaneous Water-Quality Data

- Samples must be collected and processed according to prescribed WRD protocols, as described and referenced below. For projects that are using non-WRD protocols, samples must be collected and processed as outlined in the project workplan.
- All samples must be shipped to the laboratory from the field in an expedient manner, within the required holding times for each analysis.
- All samples should be logged into NWIS (usually within 7 days of sample collection) prior to the completion of analysis and transmittal of the results back to the AWSC.
- All analytical data must be reviewed in a timely manner and within the required holding times for each analysis (to allow time for re-analysis), and fully documented in the station analysis file.

Continuous Water-Quality Data

- The site should be vertically and horizontally well-mixed in the cross section.
- Location of the sensors must be fully documented.
- All pertinent information regarding the site, cross-sectional variability, equipment maintenance, and data shifts must be fully documented and included in the station analysis file.
- Monitors must be inspected and calibrated as frequently as required to obtain as complete a record as possible.
- Sites should be operated as described by Wagner and others (2006).

8.1 Physical Measurements and Chemical Constituents in Water

Most studies that are designed to evaluate the water quality of an aquatic system are based upon analyses of physical and chemical parameters associated with the water. Physical parameters generally are measured in the field, whereas most chemical and microbiological parameters require laboratory analysis. This section of the QA plan includes an overview of relevant AWSC and WRD policies, as well as references for specific procedures pertaining to the measurement of field parameters and the collection and processing of samples for water-quality analysis. Information in this section is drawn primarily from the National Field Manual—a TWRI that describes in greater detail the recommended and required policies and procedures for collecting and processing water-quality samples in the WRD. Additional sources of information include manuals published by the NAWQA Program (Shelton, 1994; Koterba and others, 1995; Shelton, 1997) with updates on the NAWQA intranet site at http://water.usgs.gov/nawqa-only/ftsup/. The project proposal and workplan also should be consulted for specific guidelines for field personnel regarding details of sample collection and processing.

8.1.1 Field Measurements

Routine field measurements include temperature, dissolved-oxygen (DO) concentration, specific electrical conductance (conductivity), pH, and alkalinity. Other types of measurements that also may be necessary for specific projects include alkalinity and acid neutralizing capacity, reduction-oxidation potential (E_h), and turbidity. AWSC procedures for collecting field measurements in surface- and ground-water systems are provided in chapter A6 of the National Field Manual (Wilde, 2005–present). Field measurements should represent, as closely as possible, the natural conditions of the system at the time of sampling. To ensure quality of the measurements, calibration within the range of field conditions at each site is required for most instruments.

Field-measurement data must be recorded while in the field, including methods, equipment, and calibration information. Field-measurement data can be stored on paper field forms, which may be national forms available at http://water.usgs.gov/usgs/owq/Forms.html or customized for a particular project. Field-measurement data can also be stored directly on a Personal Computer Field Form (PCFF), available at http://water.usgs.gov/usgs/owq/pcff.html. For alkalinity, personnel are encouraged to use alkalinity calculators available at http://or.water.usgs.gov/alk/.

To avoid the loss of data because of possible instrument malfunction, backup instruments and sensors in good working condition should be taken on field trips. To avoid random recording and calculation errors, all measurements should be double-checked. Project Personnel are responsible for accuracy and completeness of field data, with final oversight and review by the the Project Chief.

To document the quality of field measurements, all AWSC personnel involved in the collection of water-quality data are required to participate in the National Field Quality Assurance (NFQA) Program (Stanley and others, 1998). All personnel who use instruments to measure pH, specific conductance, and (or) alkalinity receive Standard Reference Samples (SRS) bi-annually from the NFQA Coordinator at the Branch of Quality Systems in Lakewood, CO (see http://nfqa.cr.usgs.gov/). Each participant receives two samples for each parameter, and performs the measurements with the same techniques and instruments that are routinely used in the field or laboratory. Personnel who expect to perform these measurements or who are are expected to maintain proficiency are also encouraged to participate. The NFQA program is implemented in the AWSC by the Field Service Unit Coordinator with oversight by the AWSC Water-Quality Specialist.

Results of the NFQA Program are reviewed by the Regional Hydrologist, the Field Service Unit Coordinator, and AWSC Water-Quality Specialist; results are also sent to the Director of the AWSC. Staff receiving an unsatisfactory rating will analyze a second set of samples. The AWSC Water-Quality Specialist, Field service Unit Coordinator, or an experienced technician will work with the employee to identify the cause of the unsatisfactory result. If it is caused by a malfunctioning meter, the meter will be repaired or replaced.

8.1.2 Cleaning of Sampling and Processing Equipment

Considerable care must be taken to avoid contamination during sampling and processing. The two biggest sources of aqueous sample contamination are improperly cleaned equipment and atmostpheric inputs, such as dirt and dust (Horowitz and others, 1994).

Procedures for cleaning equipment used for water-quality sampling and processing are described in chapter A3 of the National Field Manual (Wilde, 2004b) and by Koterba and others (1995). All new equipment acquired for water-quality sampling, as well as equipment that has been in long-term storage, must be cleaned in the office before being used in the field. Similarly, equipment must be cleaned as soon as possible after sample collection and before being used again to avoid cross-contamination between sampling sites. The field rinsing of equipment only with site water just prior to sample collection is not a substitute for proper cleaning. Cleaning procedures vary with the intended use of the equipment; that is, whether samples are collected for organic compounds, major constiuents, trace metals, or nutrients. For example, detergent and hydrochloric or nitric acid are used to remove trace inorganics during the cleaning procedure for non-metal equipment; for organics, a methanol rinse is used instead of acid. Methanol is not used, however, to clean equipment used in sampling for dissolved and suspended organic carbon (Wilde, 2004b).

Implementation and continued compliance with the "parts-per-billiion" protocol, originally described by Horowitz and others (1994) requires careful attention to equipment cleaning protocols (Wilde, 2004b).

Equipment blanks are a particular type of blank sample that is used to verify that cleaning procedures used by the field personnel are adequate for removing contamination. These blanks ensure that individual pieces of sampling equipment are not sources of detectable concentrations of constituents to be analyzed in environmental samples. An annual equipment blank, collected in the office laboratory, is required for each set of equipment used to collect water-quality samples (Horowitz and others, 1994; Wilde 2004b, chap. A3). Annual equipment blanks that indicate detectable levels of constituents require submission of blanks for individual components of the equipment to isolate the source of contamination. When the source of contamination has been determined, the necessary maintenance must be performed to eliminate contamination, or the equipment must be replaced. The Project Chief monitors the results of annual equipment blanks and ensures compliance with AWSC standards.

8.1.3 Surface-Water Sampling

Surface-water samples are collected to determine the concentrations of inorganic (trace elements, nutrients, and major ions), organic, and radiochemical constituents. Processes that control concentrations of surface-water constituents are discussed in Hem (1989).

Collecting surface-water samples that accurately represent the physical and chemical characteristics of the aquatic system requires the appropriate use of sampling equipment and methods in order to describe environmental variability and to prevent contamination or bias in the sampling process. All AWSC personnel who are involved in water-quality studies must be well informed of the various factors that must be considered to ensure the collection of representative samples. The choice of sampling equipment and method of sample collection are based on established protocols and guidelines, depending upon the characteristics of the target constituents, study objectives, hydrologic conditions, and sampling logistics.

8.1.3.1 Equipment Selection

Guidelines for selecting equipment for sampling surface water are provided in Horowitz and others (1994) and in chapter A2 of the National Field Manual (Wilde and others, eds., 2003). Review of equipment selection by AWSC technical specialists occurs during proposal and workplan review and during periodic project and field reviews.

8.1.3.2 Sample Collection

Guidelines for the collection of surface-water samples are provided in chapter A4 of the National Field Manual (Wilde, 2006. Field personnel are responsible for examining the sampling site carefully and choosing the most appropriate sampling method to generate the best sample possible under the conditions at the time of sampling. In a comparison of grab samples and cross sectionally integrated sampling methods, investigators found that concentrations of dissolved constituents were not consistently different (Martin and others, 1992). However, concentrations of of some sediment-associated constituents were significantly lower in the grab samples than in the cross sectionally integrated samples.

At flowing-water sites, collection of an isokinetic, depth-integrated, discharge-weighted sample is standard procedure. In this manner, the sample is collected through the entire depth of the water column at multiple vertical transects by either the equal-discharge (EDI) or equal-width increment (EWI) method. The EDI method requires some knowledge of the distribution of streamflow in the cross section; samples are obtained from the centroids of segments having equal discharge increments. The transit rate at each centroid need not be constant, but equal samples volumes are collected at each vertical. The EWI method requires that samples be taken at verticals equally spaced across the stream. The volume collected is proportional to stream discharge and is not the same at each vertical; however, the transit rate at all verticals must be equal. The sampler also needs to be filled isokinetically; that is, water approaching the sampler must not change in velocity or direction as it enters the intake (Ward and Harr, 1990). To collect an isokinetic sample, it is important that the correct sampler be used for the conditions at the sampling site and that the sampler be used correctly. Refer to Wilde (2006) or Edwards and Glysson (1988) for details on how to collect an isokinetic sample. These procedures generate a representative cross-sectional sample that is both flow-weighted and depth- and width-integrated (Edwards and Glysson, 1999; Ward and Harr, 1990).

Occasionally, the use of non-integrated or non-flow-weighted methods may be appropriate at flowing-water sites because of hydrologic, climatic, or safety conditions, or specific project objectives. For example, a single-vertical at the centroid-of-flow (VCF), dip sample, or pump sample are acceptable when high velocities, shallow channel depths, or excessive debris in the stream preclude the use of EDI or EWI methods. Study objectives may also dictate the use of nonisokinetic sampling methods (Wilde, 2006). In the VCF, the sampler is lowered and raised through the water column at a uniform transit rate at one location. In the dip-sampling method, a sample is collected below the surface of the water to minimize collection of surface film and avoid contact with the streambed.

Still-water samples are generally collected at multiple locations in the water body and at multiple depths. The probability that a single sample of a lake or reservoir is representative of the whole body of water is slight; therefore, a still-water sampling program must be carefully designed (Ward and Harr, 1990). Thief-type samplers usualy are used to collect still-water samples; however, pumping samplers also can be used. Refer to Wilde (2006), Ward and Harr (1990), and Nevers and Whitman (2005) for complete discussions of still-water sampling.

Specific procedures employing two-person sampling teams (clean hands/dirty hands) with specific, designated roles in sample collection and handling are required when sampling for trace inorganic constituents with ambient concentrations at or near 1 microgram per liter (µg/L), or when aluminum, iron, and manganese ambient concentrations are up to about 200 µg/ L. These procedures are described by Wilde (2006), with specific instructions in table 4-3.

Thorough documentation of sampling equipment and methods that are used is required in field records associated with water-quality samples. The Project Chief is responsible for timely review of field records.

8.1.4 Ground-Water Sampling

AWSC ground-water sampling procedures are designed to ensure that the samples collected are representative of water in the aquifer and are not contaminated by well construction material or sampling equipment, and that the composition of the samples is not altered by physical or chemical processes during sampling. It is critical that field personnel be aware of all factors that can compromise the integrity of ground-water samples and implement consistent strategies to protect sample integrity.

8.1.4.1 Equipment Selection

Guidelines for selecting appropriate equipment for ground-water sampling are provided in the National Field Manual (Wilde and others, eds., 2003, chap. A2). All project personnel involved in ground-water sampling for water-quality studies must understand the advantages and disadvantages of available equipment with respect to study objectives. Because of the wide range of factors involved, the ideal equipment for sample collection under some circumstances may not exist. When compromise decisions are required, the field team must thoroughly document with field notes the compromises that are made. Review of equipment selection occurs during proposal and workplan review and during periodic project reviews by AWSC technical specialists.

8.1.4.2 Sample Collection

Guidelines, which prevent or minimize loss of sample integrity, for collecting representative water-quality samples from ground water are provided in chapter A4 of the National Field Manual (Wilde, 2006). The standard procedure for ground-water sampling is to purge the well to remove at least three well volumes of standing water while monitoring field measurements for stabilization. Routine field measurements include pH, tempearture, specific electrical conductance, dissolved oxygen, and turbidity. This procedure may be modified, depending on project objectives, site characteristics, or factors such as depth of pump and water availability. Optimum well-purging procedures remove all stagnant water while minimizing turbulence and reaeration of ground water in the well, tubing, and pump.

Two-person sampling teams are required to implement coordinated clean-handling techniques when collecting samples for trace elements with ambient concentrations at or near 1 µg/L or when aluminum, iron, or manganese ambient concentrations are up to about 200 µg/L (Wilde, 2006).

Thorough documentation of sampling equipment and methods that are used is required in field records associated with water-quality samples. The Project Chief is responsible for timely review of field records.

8.1.5 Precipitation Sampling

Specific procedures in the AWSC for collecting precipitation samples are based primarily on the study objectives. Bulk collectors are constructed to accept dryfall in addition to wetfall, whereas wet-only collectors are designed to open up only during periods of precipitation. Bulk sampling is appropriate if the project goal is determination of total atmospheric input of constituents. Wet-only sampling is appropriate if the goal is to determine concentrations of dissolved constituents in the precipitation itself. Major factors that must be considered in sampling for precipitation quality include the location of the sampling station relative to human influences, the choice of sampling equipment, and special sample-handling procedures that may be necessary.

Guidelines regarding the collection and analysis of precipitation samples are provided in Dossett and Bowersox (1999) and in a case study (Willoughby, 2000). The U.S. EPA's recommended QA/QC procedures and requirements for precipitation samples are given in Peden and others (1986).

The project proposal and workplan should be consulted for specific guidelines regarding the factors that must be considered in choosing the sample location, the sampling equipment and frequency, and the special sample handling procedures that may be necessary based upon the study objectives.

8.1.5.1 Site selection and installation

For sites of regional or background precipitation quality, locate sites so that they are reasonably distant from traffic and other human activitiy that would disturb land or water surfaces. Avoid overhead obstructions; a general guidelines is that the line-of-sight angle from the top of the collector to the nearest overhead obstruction should be 30° or less.

For bulk and wet-only samplers, ensure that sample containers, funnels, liners, and tubing consist of inert, nonabsorbing materials that will not affect the typically low concentrations of ions in solution. Polyethyelen or Teflon are suitable materials for subsequent determinations of major ions. Glass is acceptable if mercury is to be determined, but Teflon is recommended if other trace elements are of interest (Willoughby, 2000).

8.1.5.2 Sample collection

Weekly, daily, event, and within-event frequencies are all comment, depending on project objectives. Periods of greater than 2 weeks between retrievals of wet-deposition samples are not recommended because of the possiblity of evaporation and sample degradation. For dry-deposition samples, monthly retrievals are recommended. Remove wet-deposition samples carefully and cap them until they are split and field measurements are made. Do not touch collection surfaces when removing or installing the collection vessel. Remove dry-deposition material from the collector by sequential rinsing with deionized water from a wash bottle of known volume and alternate scrubbing with a spatula of inert plastic.

8.1.6 Automatic Samplers

Automatic water-quality sampling stations are an important part of some water-quality projects. The types of supporting equipment will depend on the objectives of the project and the target analytes. Typical supporting equipment used in the AWSC include the following:

- A data logger to serve as station controller and trigger sample collection
- A modem and telephone for external communications
- Relays for triggering the automatic sampler to collect a sample
- A refrigerator or non-refrigerated automatic water-quality sampler.
- Sample bottles for the automatic sampler
    - 1 liter plastic or glass sample collection bottles
    - 300 mL glass
    - 2 liter glass jars
- Peristaltic pump
- Pump tubing
- Flow through chambers or valuves are sometime used to facilite flushing of the sample line with native water before sample collection.

8.1.6.1 Site selection and installation

Automatic water-quality sampling stations can be located at flowing-water or non-flowing water sites, although they are typically installed on streams and rivers. At flowing-water sites, the automatic sampler is usually co-located with a streamflow gaging station. If this is not possible, the automatic water-quality sampling station should be located where the stream discharge can be measured. The sample intake must be located in an area where there is adequate mixing to assure that the resulting point samples closely represent water from the stream cross section. At non-flowing-water sites, the sample intake should be located as close as possible to the area of interest.

8.1.6.2 Sample collection

Samples are collected based on time, water level, flow, or rainfall and are triggered by the station datalogger. When a sample is triggered, the sample line is first purged, rinsed with native water, and then deposited in the sample bottle(s). Alternatively, the sampler can be equipped with a valve system to flush the line rather than purge and rinse. After the sampling event, samples are retrieved from the sampler and transported to the office of laboratory for processing. Possible sample processing procedures include compositing separate bottlets into one sample, splitting the composited sample, filtration, and sample preservation.

8.1.7 Sample Processing

All samples collected for water-quality analysis must be processed according to procedures in the National Field Manual (Wilde, 2004a, chap. A5) as soon as possible following collection. The constituents of interest and study objectives determine the specific processing procedures that are necessary, which must be described in the project workplan. As a rule, field personnel are required to follow a prescribed order of sample processing, described in the National Field Manual (Wilde, 2004a, Section 5.0.2 and table 5.1) to help ensure the quality of the data collected.

All AWSC water-quality studies that include the analysis of trace elements in concentrations less than 10 ppb must use the protocols for sample processing as described in Wilde, section 5.6 (2004a). These techniques require the use of processing and preservation chambers to reduce the potential for contamination from the surrounding environment during sample splitting, filtration, and preservation.

8.1.7.1 Sample Compositing and Splitting

Guidelines for using sample compositors and splitters are in the National Field Manual (Wilde and others, 2003, chap. A2). Two types of sample splitters presently in use in the WRD are the churn splitter, which also serves as a compositing device, and the cone splitter, which requires a separate compositing vessel. Each splitter has specific advantages and disadvantages (OWQ Technical Memorandum 97.06 and Horowitz and others, 2001). Either splitting method can be applied to inorganic and organic constituents within the technical design limits of the device and as long as the equipment is constructed of appropriate materials. Technical design limits are based on suspended sediment concentrations and the construction material of the splitter.

8.1.7.2 Sample Filtration

Filtration is required for many water-quality samples in order to separate particulates from the water and constituents in solution. Selection of the appropriate filter unit and filter characteristics to be used depends on the constituent class of interest and is based on guidance provided in the National Field Manual (Wilde and others, 2003, chap. A2). Guidelines for filtration procedures for specific constituent groups are provided in the National Field Manual (Wilde, 2004a, chap. A5). The choice of filter type and filtration equipment are to be documented on field forms and in field notes.

For surface water, the most common filtration system consists of a reversible, variable-speed battery-operated peristaltic pump and 0.45-micron pore size disposable capsule filter. For ground water, the sample is generally pumped directly from the well through a 0.45- micron pore size disposable capsule filter. Filtration of samples for analysis of trace elements in concentrations less than 10 ppb must be done in a processing chamber that encloses the filtering unit and sample bottles in a protected environment (Wilde, 2004a, chap. A5). Filtration of water samples for determination of organic compounds involves the use of a glass-fiber plate filter with a stainless steel or aluminum assembly for most organics or a nylon capsule filter for organonitrogen herbicides (Wilde, 2004a, chap. A5, section 5.2.2; Sandstrom, 1995). Filtering of samples for carbon requires the use of a 25-mm glass-microfiber filter; the procedure used is based on the type of carbon analyte (Wilde, 2004a, chap. A5, section 5.2.2.C).

8.1.7.3 Sample Preservation

Sample preservation techniques are required for some constituent groups to prevent reduction or loss of target analytes and to stabilize analyte concentrations for a limited time. Guidelines for sample preservation are provided in the National Field Manual (Wilde, 2004a, chap. A5), and the NWQL Services Catalog at http://nwql.cr.usgs.gov/usgs/catalog/index.cfm. Since some samples have a very limited holding time even when preserved, field personnel must ensure that all water-quality samples are shipped to the laboratory as quickly as possible and that time-sensitive samples are received in good condition within the appropriate holding time. For details on sample shipping requirements, refer to the next section of this QA plan.

8.2 Biological sampling

Many water-quality studies in the WRD are beginning to employ a multidisciplinary approach that relies on data from a range of sampling media. A variety of different types of biological samples may be incorporated into a water-quality project to provide multiple lines of evidence with which to evaluate a particular aquatic system. Different collection and processing methods for biological assessments have been developed to fit a variety of sampling locations and objectives.

8.2.1 Aquatic biota and habitat

Design of studies of aquatic biota and habitat requires careful thought and planning because the sampling error often exceed the natural variability in populations. A variety of biological sample types may be collected including samples of algae, aquatic invertebrates, fish, and habitat assessments. For a discussion of environmental and biological considerations in the sampling of aquatic oganisms refer to Averett (1973).

8.2.1.1 Algae

Algae are present in a variety of stream and lake habitats and microhabitats. Algae grow in waters as periphyton (attached to a substrate) or as phytoplankton (suspended in water). The choice of the type of habitat to sample in streams (riffles, pools, runs) and lakes (littoral, or nearshore; limnetic, or open water; epilimnetic, or upper, warm, lighted, layer of open water; and hypolimnetic, or lower, cool, dark layer of open water) is related to project objectives. The purpose, scope, and objectives of a study will also determine whether samples are collected from natural and (or) artificial substrates, and whether the sampling methods used are to yield quantiative or qualitative results.

Algal samples are collected to determine algal biomass and (or) for taxonomic identification. Guidelines for identifying sampling sites and collecting samples for algal biomass are described in the National Field Manual (Hambrook Berkman and Canova, in press, chap. A7.4). Protocols for collecting samples and identifying the algal community for the NAWQA Program (biomass and taxonomic identification) are described in Moulton and others (2002). Personnel on projects that include algal sampling are advised to consult with the AWSC algal expert for assistance with the latest protocols and other pertinent information.

Measurement of algal biomass is done in many river and lake studies and may be especially important in studies that address nutrient enrichment or toxicity. Algal biomass in a water body can be estimated in three ways: (1) by quantifying chlorophyll a (CHL a), (2) by measuring carbon biomass as ash-free dry mass (AFDM), or (3) by measuring particulate organic carbon (POC) (Hambrook Berkman and Canova, in press). Algal biovolume (a surrogate for biomass) can be calculated from taxonomic samples. Quantitative phytoplankton samples are typically collected in the same manner as water-chemistry samples. The sampling procedures for periphyton vary by the substrate to be sampled. For example, to characterize biomass from a macroalgae such as *Cladophora*, sampling from a large area is recommended. Algae biomass samples are very susceptible to degradation and cannot be held for more than 24 hours before significant changes begin to occur. Sample filtration and freezing is the best protection from degradation. Algal biomass samples are analyzed by the USGS NWQL.

Samples for taxonomic analysis are generally preserved with buffered formaldehyde. Algal taxonomy samples are analyzed as part of a cooperative agreement between a contract laboratory and the USGS (Charles, D.F., and others, eds., 2002).

8.2.1.2 Macroinvertbrates

Macroinvertebrates are organisms such as insect larvae, adult insects, and various classes of worms, mussels, clams, and snails that inhabit surface water for all or part of their life cycle. Collecting and processing samples containing these organisms for subsequent identification and enumeration can be time consuming and complex. Like other aquatic organisms, macroinvertebrate species prefer specific habitats and are associated with those habitats when sampled. In lakes, these habitats include limnetic, profundal (bottom), and littoral areas. In streams, these habitats include riffles, pools, runs, stream banks, island or bar edges, tree roots, and other woody debris. Macroinvertebrates that are benthic (live in or on bed materials) are generally insect larvae and freshwater clams and mussels. Zooplantkton, such as microcrustaceans, represent the larges biomass of invertebrates in lakes. Consider what component of the invertebrate community is most important for meeting project objectives. Scientific collection permits are required from the Arkansas Game and Fish Commission (permits also may be required from the National Park Service and the U.S. Fish and Wildlife Service).

Sampling and identification methods must be closely matched to project objectives to obtain adquate assessment of macroinvertebrate communities. Protocols for collecting samples and identifying the invertebrate community for the NAWQA Program are described in Moulton and others (2002). The advantages and disadvantages of collecting samples of benthic invertebrates by use of of artificial substrates are described in Rosenberg and Resh (1992). Methods for designing sampling plans and collecting mullusks and aquatic insects for subsequent tissue analysis for chemical contaminants are described in Crawford and Luoma (1993). Personnel on projects that include macroinvertebrate sampling are advised to consult with the AWSC macroinvertebrate expert for assistance with the latest protocols and other pertinent information.

Qualitative and Note—you must have spell check turned off somehow—I couldn't find an override. quantitative methods to process benthic macroinvertebrate samples have been development and tested by the USGS NWQL (Moulton and others, 2000). These samples are processed and cleaned before sending to the laboratory and preserverd with 10 percent formalin before shipping to the laboratory (Moulton and others, 2002).

8.2.1.3 Fish

Fish are the most common vertebrates found in streams, rivers, and lakes. Sampling programs must be designed to collected fish in the specific habitats they prefer. These habitats include open water and littoral areas of lakes; stream riffles, pools, runs, stream bans, an disland or bar edges; and tree roots and other wood debris (Meador and others, 1993a). Sampling fish is a labor-intensive endeavor, and most identification and other measurements must be carried out in the field rather than the laboratory. It is essential that an ichthyologist be part of the sampling team. Before fish sampling is conducted, careful consideration must be given to collecting permits; protecting endangered, threatened, and special-concern species; and coordinating sampling efforts with other fish ecologists (Meador and others, 1993a).

Protocols for collecting a representative sample of fish community for the NAWQA Program are described in Meador and others (1993a) which is superceded by Moulton and others (2002). Two complementary methods commonly are used for collecting fish: electrofishing and seining. For electrofishing, a high-voltage potential is applied between two or more electrodes that are placed in the water to capture fish. Seines are sampling devices that trap fish by enclosing or encircling them. After processing and data collection, most fish are relased live back to the water body. Fish speciments that are not positively identified in the field are preserved, labeled, and returned to the laboratory for later identification.

Methods for designing sampling plans and collecting fish for subsequent tissue analysis for chemical contaminants are described in Crawford and Luoma (1993). When collecting samples for tissue analysis, proper precautions must be taken to protect samples from extraneous contaminants in the environment. Tissue samples are processed, carefully packaged, and preserved on dry ice by field crews; they must be analyzed by the USGS NWQL for chemical contaminants within 6 months of the time a sample was collected.

8.2.1.4 Habitat

Evaluation of aquatic habitat in streams and lakes is an important component of biological-water quality investigations. Habitat is assessed in streams based on a spatially hierarchical framework that incorporates habitat data at basin, segment, and reach levels and in microhabitats within the channel and flood plain. At basin and segment levels, most habitat assessments are done from maps or digital coverages. At the reach, channel, and flood-plain levels, most habitat assessments are done on site.

Protocols for characterizing stream habitat for the NAWQA Program are described in Meador and others (1993b), which is superceded by Fitzpatrick and others (1998). The goal of stream habitat characterization in NAWQA is to relate habitat to other physical, chemical, and biological factors that describe water-quality conditions. Procedures for collecting habitat data at basin and segment scales include the use of geographic information system data bases, topographic maps, and aerial photographs. Data collected at the reach scale include measurements and observations of channel, bank, and riparian characteristics.

8.2.2 Microorganisms

Many water-quality studies in the WRD, and especially in the AWSC, involve the collection and analysis of samples for microorganisms of public-health significance. There are three major groups of microoganisms that affect water quality in the United States—bacteria, viruses, and protozoa. Different collection and processing methods for microbiological assessments have been developed to fit a variety of sampling locations and project objectives. All collection, processing, and analysis of microbiological samples must be done by use of sterile techniques.

8.2.2.1 Fecal-indicator and pathogenic bacteria

Samples for bacteria collected in the AWSC include those for fecal-indicator bacteria and for pathogenic (disease-causing) bacteria.

Samples for fecal-indicator bacteria are generally collected in streams, lakes, and ground water to assess the public health acceptability of water. Fecal-indicator bacateria are used to monitor ambient water quality for recreational, industrial, agricultural, and water supply purposes. They do not necessarily cause disease but are associated with the presence of intestinal pathogens in water; some fecal bacteria are found in the environment.

Protocols for collecting and processing samples for fecal-indicator bacteria are described in the National Field Manual (Myers, and others, 2007). Collection methods vary depending on whether samples are obtained from lakes, stream, or wells. AWSC processing protocols are described at the OWML web site at http://oh.water.usgs.gov/micro_index.htm; the type of processing protocol used depends on the water source, target organism, and project objectives. Most processing methods are standard methods established by U.S. EPA. The OWSC routinely tests waters for identification and enumeration of four types of fecal-indicator bacteria: *Escherichia coli* (*E. coli*). Bacteria in the AWSC are generally processed in the field or in a local laboratory within 6 hours of collection using membrane-filtration methods.

8.4 Quality-Control Samples

Quality-control samples must be collected as integral components of all AWSC water-quality studies to determine the acceptability of performance in the data-collection process and provide a basis for evaluating the adequacy of procedures that were used to obtain data. Guidelines for the collection of specific types of QC samples and the use of QC data are provided in the National Field Manual (Wilde and others, eds., 1999a, chap. A4). Issues of QC sample design are addressed in section 3.2 of this plan. Specific guidelines for the collection and processing of QC samples must be included in the project workplan. The project chief is responsible for reviewing QC data in a timely manner and implementing necessary modifications, when appropriate, to sampling and processing techniques. The AWSC Water-Quality Specialist has the responsibility for advising AWSC personnel regarding the collection and interpretation of QC samples.

8.5 Safety Issues

Because the collection of water-quality data in the field can be hazardous at times, the safety of field personnel is a primary concern. Field teams often work in areas of high traffic, remote locations, and under extreme environmental conditions. Field work involves the transportation and use of equipment and chemicals and commonly requires working with heavy equipment, such as boats, samplers and truck-booms or 3-wheel bases. Additionally, field personnel may come in contact with waterborne or airborne chemicals and pathogens while sampling. Beyond the obvious concerns regarding unsafe conditions for field personnel, such as accidents and personal injuries, the quality of the data also may be compromised when sampling teams are exposed to dangerous conditions. Standard procedures require that at least one properly trained and certified boat operator is present on each boat sampling excursion and that at least one properly trained and certified person in electro fishing is present for electro fishing trips.

So that personnel are aware of and follow established procedures and protocols that promote all aspects of safety, the AWSC communicates information and directives related to safety to all personnel. Safety policy information is discussed at “all-hands” meetings, memos are distributed through email and posted on the safety bulletin board.

JHA’s are required to prevent unnecessary exposure to job-related hazards and are conducted prior to performing any high hazard activities. When work is performed by others, such as contractors, the Contracting Officer will determine that the person in charge of the work develops appropriate JHA’s for the work to be performed. This information will be provided to the Contracting Officer or Contracting Officer Representative as part of the accident prevention plan and will be approved/accepted by the Contracting Officer/Contracting Officer Representative prior to permitting the contractor to proceed with the work.

The internal home page includes a link to our internal safety page with the regional safety page. Both of these include archived policy memos and accident/incident reporting procedures. A Safety Training Matrix is being developed to post on the internal safety page so that employees and their supervisors can track and anticipate their safety training needs. Safety training is conducted through in-house and external training classes along with on-line training.

An individual has been designated as Safety Program Coordinator by AWSC. The duties of the Safety Program Coordinator include:

(1) Assist organizational managers and supervisors in the implementation of the JHA program.

(2) Provide technical assistance to line managers/supervisors in the conduct and development of local JHA's.

(3) Maintain a local file of JHA's for all activities and provide copies to the respective Regional Safety Officer or Manager, as applicable.

(4) Provide managers and supervisors with assistance in administering the field organization safety health and environmental program, reporting to their respective management.

(5) Coordinate program implementation and compliance with regard to OSHA, adopted national consensus standards, and Departmental and USGS safety and health standards and advise and support field organizational managers and supervisors in implementation and compliance with program responsibilities described in paragraph 2.9DD(1-15) of this chapter, as applicable.

(6) Participate, upon request, as a member on the Region-wide Safety and Environmental Committee and working groups, as applicable, arising from subject activities to provide field expertise to region-wide programs, problems, or issues.

(7) Ensure that self-conducted program assessments and facility inspections are completed annually and corrective actions are documented. Local units are exempt from this requirement if a formal assessment or inspection was conducted by higher headquarter staff during the same fiscal year.

(8) Track organization corrective actions for program assessments and facility inspections through final abatement action.

(9) Review of field organization accident/incident information to determine accuracy and completeness and appropriate action is taken to correct deficiencies.

(10) Recommend program policies, directives, alternate or supplemental standards, and guidelines to the Regional Safety Officer or Regional Safety Manager.

(11) Coordinate field level contract establishment as needed for areas such as industrial hygiene, safety, occupational health, environmental services, information resources management, and fire protection engineering staff support.

(12) Coordinate and assist managers and supervisors in the identification of field training resources and development and implementation of general/specialized safety and health training to meet field needs, as applicable.

(13) Coordinate the development and maintenance of field organization safety promotional programs, inclusive of making available/recommending safety training materials, journals, reference documents, posters, signs, Safety Day, etc.

(14) Advising supervisors of training needs of employees, advising Senior Staff of program requirements which need to be incorporated into everyday operations, organizing in-house training sessions and notifying employees and their supervisors of online and external training opportunities, and serving as a resource clearinghouse for safety issues.

Coordination of safety programs for the Central Region is the responsibility of the Regional Safety Officer. The Regional Safety Officers serves the REX and Centers to oversee the identification and development of Bureau-wide safety and environmental training and professional development programs that include general safety and environmental program orientation for new employees, supervisor responsibilities, Collateral Duty Safety and Environmental Program Coordinator instruction, defensive driving, watercraft, firearms, diving, aviation, radiation, and emergency response. Duties for the Regional Safety Officer include:

(1) administer the regional safety, health, and environmental program for their respective science areas and field locations, reporting to their respective Regional Executive.

(2) Advise and support regional science and field management in implementation and compliance with program responsibilities.

(3) Participate as a member on the region-wide Safety and Environmental Committee and working groups, as applicable, to provide field/science expertise to regional science programs, problems, or issues.

(4) Coordinate documentation of regional science program field self-conducted program evaluations annually.

(5) Conduct formal inspections of major regional science facilities (district, team, and center) based on high frequency, high hazard, or programmatic or performance deficiencies, as necessary, recommending appropriate actions to correct deficiencies.

(6) Coordinate formal program assessment and facility inspection scheduling with the Regional Safety Manager.

(7) Track regional science field location corrective actions through final abatement action.

(8) Complete self program assessment in annually.

(9) Evaluate regional science field location safety and environmental staffing for managerial effort and effectiveness in establishing and implementing the safety and environmental programs.

(10) Submit requests for alternatives to OSHA regulations, changes to USGS safety and health standards and variances from applicable safety and health standards to the Regional Safety Manager for appropriate action.

(11) Ensure allegations of reprisal, reports of unsafe and unhealthful conditions, and accidents/incidents related to field organizations under their authority are investigated and review reports of allegation-of-reprisal investigations not resolved at the field level, providing recommendations to the field level management for resolution. Forward reports not resolved at the regional field level to the Regional Safety Manager for resolution.

(12) Coordinate use of SMIS to support field and science program needs for collecting, assimilating, and analyzing accidents (employee, contractor or public) involving injuries, illnesses, and property damage related to science and field operations and/or facilities. Review respective regional field organization accident/incident information recorded in SMIS to verify accuracy and completeness and ensure that appropriate action is taken to correct deficiencies and prevent recurrence.

(13) Develop and provide annual field organizational accident statistical reports and analysis and prevention recommendations to regional science and field management.

(14) Recommend program policies, directives, alternate or supplemental standards, and guidelines to the Regional Safety Manager through the Regional Safety, Health, and Environmental Committee for adoption at the Bureau-level.

(15) Coordinate respective science safety program implementation and compliance with regard to OSHA, adopted national consensus standards, and Departmental and USGS safety and health standards.

(16) Coordinate respective science area field level contract establishment as needed for industrial hygiene, safety, occupational health, environmental services, information resources management, and fire protection engineering staff support.

(17) Coordinate and assist Collateral Duty Safety and Environmental Program Coordinators in the identification of field training resources and the development and conduct of general and specialized safety, health, and environmental training to meet field-level science needs, as applicable.

(18) Coordinate the development and maintenance of safety promotional programs aimed at providing information to specific science and field target audiences, inclusive of making available safety training materials, journals, reference documents, posters, signs, etc., and participate in region-wide awareness and promotional programs in coordination with the Regional Safety Manager.

(19) Assist the Regional Safety Manager and other Regional Safety Officers in meeting overall regional safety and environmental program needs.

(20) Provide, as the science program technical safety, environment, and health advisor, assistance to field-level management and Collateral Duty Safety and Environmental Program Coordinators in implementation and compliance with the Program elements

Personnel who have questions or concerns pertaining to safety, or who have suggestions for improving some aspects of safety, should direct those questions, concerns, and/or suggestions to their supervisors and the Safety Program Coordinator.

Guidelines pertaining to safety in field activities are provided in the National Field Manual (Lane and Fay, 1998, chap. A9). USGS Safety Manual 445-2-H (December 2001). Department of the Interior, Safety Manual DM 485 (1999)

8.6 References Used for the Sample Collection and Processing Section

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

8.6.1 Summary of references used for physical measurements and chemical constituents in water

Reference	Subject
Edwards and Glysson, 1999	Representative sampling techniques for surface water.
Hemm, 1989	Processes that control chemical characteristics of water
Horowitz and others, 1994	Protocol for collecting and processing inorganic constituents at ppb concentrations.
Horowitz and others, 2001	Evaluation of a 14-L Teflon churn splitter
Koterba and others, 1995	Collecting and processing ground-water samples (NAWQA).
Lane and Fay, 1998 (TWRI book 9, chap. A9)	Safety in field activities.
Martin and others, 1992	Compare grab sampling with cross sectionally integrated sampling
Nevers and Whitman, 2005	Lake monitoring and sampling manual
OWQ Memorandum 97.06 (USGS)	Comparison of splitting capabilities of the churn and cone splitters.
Peden and others, 1986	QA/QC for precipitation samples
Sandstrom, 1995	Filtration of water-sediment samples for organic compounds
Shelton, 1994	Collecting and processing stream-water samples (NAWQA).
Shelton, 1997	Collecting samples for volatile organic compounds (NAWQA).
Stanley and others, 1998	National field quality-assurance program.
Wagner, 2006	Continuous water-quality monitors
Ward and Harr, 1990	Representative sampling techniques for surface water.
Wilde, ed., 2004a (TWRI book 9, chap. A5)	Processing of water samples
Wilde, ed., 2004b (TWRI book 9, chap. A3)	Cleaning equipment used to collect water-quality samples.
Wilde, 2005-present (TWRI book 9, chap. A6)	Field measurements.
Wilde, 2006 (TWRI book 9, chap. A4)	Collection of water samples.
Wilde and others, 2003 (TWRI book 9, chap. A2)	Selection of equipment used to collect and process water-quality sam ples.
Willoughby, 1995	Case study discussing methods of precipitation sampling and analysis.

8.6.2. Summary of references for collecting and processing biological samples

Reference	Sample type
Averett, 1973	Considerations for biological sampling
Bushon, 2003	Fecal indicator viruses
Bushon and Francy, 2003	Protozoan pathogens
Charles and others, eds., 2002	Protocols for analysis of algal taxonomic samples
Crawford and Luoma, 1993	Contaminants in tissues
Fitzpatrick and others, 1998	Protocols for habitate assessment
Francy and others, 2004	Sampling methods for enteric viruses
Hambrook Berkman and Canova, in press	Algal biomass indicators
Havelaar and others, 1993	Coliphage and viruses
Meador and others, 1993a	Fish
Meador and others, 1993b	Habitat
Moulton and others, 2002	Protocols for sampling algal, invertebrate, and fish communities as part of the NAWQA Program
Myers and others, 2007	Fecal indicator bacteria
Rosenberg and Resh, 1993	The use of artificial substrates for benthic macroinvertebrates

8.6.3. Summary of references for collecting suspended-sediment and bottom material samples

Reference	Subject
Missouri MWSC sediment laboratory QA plan	Laboratory procedures used in processing and analyzing sediment samples.
Edwards and Glysson, 1999	Field methods for measurement of fluvial sediment.
Guy, 1969 (TWRI book 5, chap. C1)	Laboratory theory and methods for sediment analysis.
Knott and others, 1992	Quality-assurance plan for collecting and processing sediment data.
OSW Memorandum 93.01 (USGS)	Instrumentation and field methods for collecting suspended-sediment data.
Radtke, 1998 (TWRI book 9, chap. A8)	Collecting and processing bottom-sediment samples.
Shelton and Capel, 1994	Collecting and processing streambed-sediment samples.
Wilde and others, eds., 1998b (TWRI book 9, chap. A3)	Cleaning equipment for sampling suspended-sediment chemistry.
Wilde and others, eds., 1998a (TWRI book 9, chap. A2)	Selection of equipment for sampling suspended-sediment chemistry.

9.0 WATER-QUALITY SAMPLE HANDLING AND TRACKING

All water-quality samples must be uniquely identified, documented, handled, shipped, and tracked appropriately. Following proper protocols for sample handling, shipping, and tracking ensures that samples are processed correctly and expeditiously to preserve sample integrity between the time of collection and the time of analysis. This section describes the procedures used by the AWSC for handling, shipping, and tracking samples from collection through transfer of the samples to an analytical facility. Receipt of analytical data from laboratories is covered in Section 10.0 (Water-Quality Data Management).

9.1 Preparation for Sampling

Ensuring that field personnel have the correct equipment and supplies on hand to perform the necessary sampling activities saves time and labor costs associated with repeated sampling trips that result from inadequate planning. Therefore, before commencing field activities, the field chief is responsible for ensuring that the following preparations have been completed:

These steps include the following:

Review the sampling instructions for each site and the list of sample types required.

- Ensure that the station site file is current.
- Prepare bottle labels for samples.
- Obtain field sheets or notebooks and analytical services request forms (ASR's).
- Ensure that necessary supplies are available, such as bottles, standards, filters, preservatives, meter batteries, waterproof markers, shipping containers, etc. (see section 5.1.3 (Equipment and Supplies).
- Ensure that all sampling equipment is thoroughly cleaned and prepared.
- Check meters and sensors for proper performance.]

9.2 Onsite Sample Handling and Documentation (Revision 1, June 2002)

During a sampling trip, it is imperative that accurate notes be taken and that sample bottles be labeled and handled appropriately for the intended analysis. Otherwise, bottle mix-ups or other errors may occur, and the samples may be wasted. The crew chief is responsible for ensuring that all of the following sampling requirements are implemented:

- Follow all protocols in Wilde and others, eds. (1999-2002), chap. A5, sec. 5.5.

9.3 Sample Shipment and Documentation (Revision 1, June 2002)

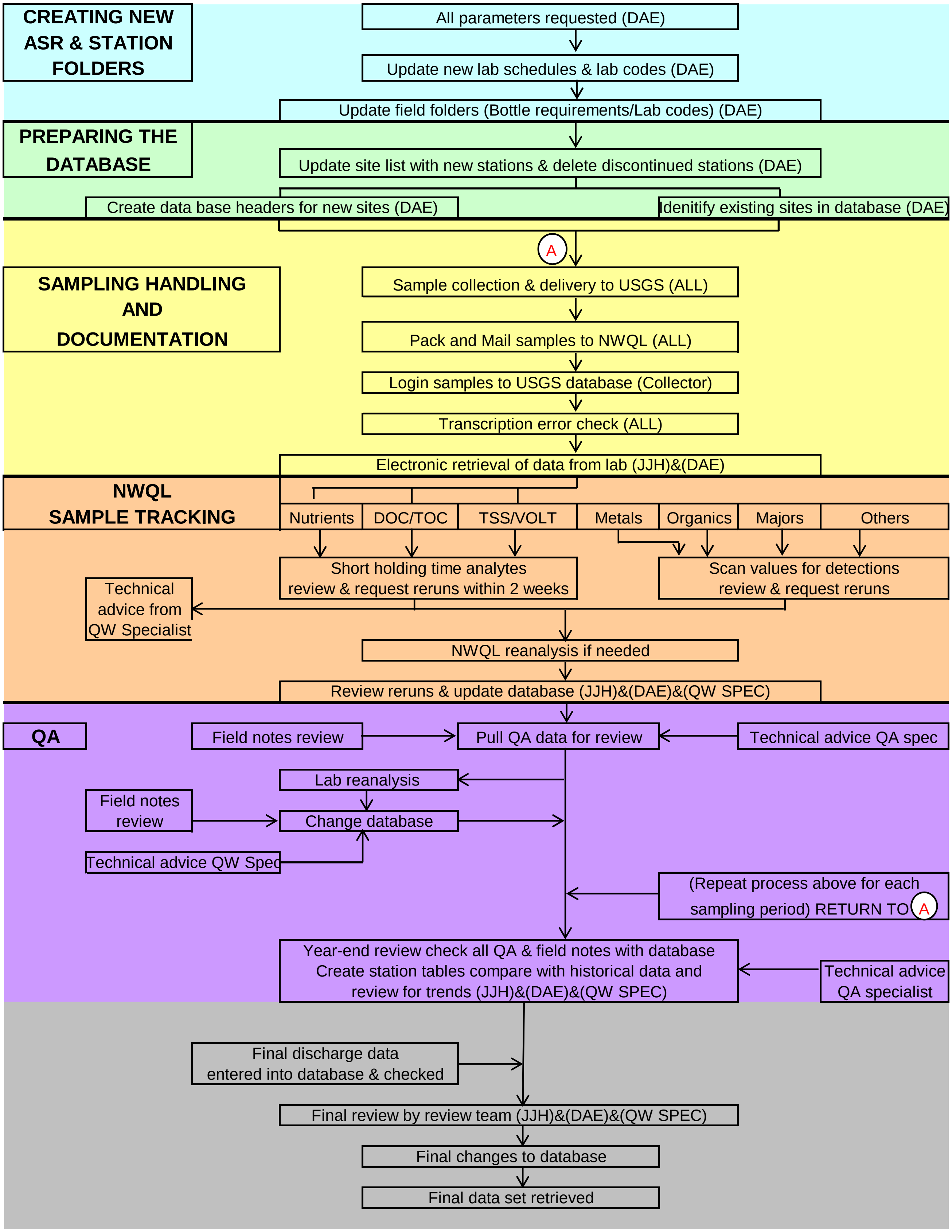
Upon completion of a sampling trip, samples should be packaged and shipped to the laboratory for analysis as soon as possible. Generally, the shorter the time between sample collection and processing and sample analysis, the more reliable the analytical results will be. Before shipping samples to the laboratory, the crew chief should complete the following:

1. Check that sample sets are complete and that sample bottles are labeled correctly, with all required information (see Section 9.2).
2. Complete the ASR's for all samples being sent to the NWQL. If samples are being sent to a different, approved laboratory, information similar to that required on the ASR's should be provided to the laboratory.
3. Pack samples carefully in shipping containers to avoid bottle breakage, shipping container leakage, and sample degradation. Check that bottle caps are securely sealed. Follow the packing and shipping protocols established by the USGS and the receiving laboratory

Ship samples after sample collection and the same day whenever possible. *(reference NWQL Technical Memorandum 95.04 and the National Field Manual for additional information; USGS employees can also access NWQL Rapi-Notes 01-013, 01-023, 01-033, and 01-034).*

9.4 Sample Tracking Procedures

The AWSC or projects maintain(s) a record of all samples collected and shipped to a laboratory for analysis to ensure the complete and timely receipt of analytical results. Fieled personal has responsibility for recording the required information. AWSC water-Quality Specialist and Project Chiefs has responsibility for reviewing the tracking log to determine if analyses are missing and for taking corrective action(s) if necessary. Described below is the AWSC sample tracking system.


CREATING NEW ASR & STATION FOLDERS
All parameters requested (DAE)
Update new lab schedules & lab codes (DAE)
Update field folders (Bottle requirements/Lab codes) (DAE)
PREPARING THE DATABASE
Update site list with new stations & delete discontinued stations (DAE)
Create data base headers for new sites (DAE)
Idenitify existing sites in database (DAE)
A
SAMPLING HANDLING AND DOCUMENTATION
Sample collection & delivery to USGS (ALL)
Pack and Mail samples to NWQL (ALL)
Login samples to USGS database (Collector)
Transcription error check (ALL)
Electronic retrieval of data from lab (JJH)&(DAE)
NWQL SAMPLE TRACKING
Nutrients
DOC/TOC
TSS/VOLT
Metals
Organics
Majors
Others
Short holding time analytes review & request reruns within 2 weeks
Scan values for detections review & request reruns
Technical advice from QW Specialist
NWQL reanalysis if needed
Review reruns & update database (JJH)&(DAE)&(QW SPEC)
QA
Field notes review
Pull QA data for review
Technical advice QA spec
Lab reanalysis
Field notes review
Change database
Technical advice QW Spec
(Repeat process above for each sampling period) RETURN TO A
Year-end review check all QA & field notes with database Create station tables compare with historical data and review for trends (JJH)&(DAE)&(QW SPEC)
Technical advice QA specialist
Final discharge data entered into database & checked
Final review by review team (JJH)&(DAE)&(QW SPEC)
Final changes to database
Final data set retrieved

9.5 Chain-of-Custody Procedures for Samples

When chain-of-custody procedures are appropriate or required (for example, when data may be used in legal proceedings), the project chief or manager should establish, maintain, and document a chain-of-custody system for field samples that is commensurate with the intended use of the data. A sample is in custody if it is in actual physical possession or in a secured area that is restricted to authorized personnel. Every exchange of a sample between people or places that involves a transfer of custody should be recorded on appropriate forms that document the release and acceptance of the sample. Each person involved in the release or acceptance of a sample must sign, date, and keep a copy of the transfer paperwork. The project chief, or designee, is responsible for ensuring that custody transfers of samples are performed and documented according to the requirements listed below.

Chain of custody form must contain:

1. The site identification number, used in NWIS, for every sample that is being shipped.
2. The date and time for each sample or sample suite.
3. The address of origin (office address) and the contact person and telephone number.
4. The matrix and preservative(s) for each sample
5. Identification of any possible hazardous material(s).
6. A unique chain of custody number and the number of pages in the chain of custody.

Upon arrival at the lab or final destination, the complete chain of custody record/form must be returned to the project chief or manager from the lab or final destination, where the complete chain of custody record/form will be filed in the chain-of-custody system for the project. These files must be archived upon completion of the project.

9.6 References Used for the Sample Handling and Tracking Section
(Revision 1, June 2002)

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

- 9.6. Summary of references for handling and tracking water-quality samples

Reference	Subject
NWQL Memorandum 95.04	Shipping samples to the NWQL, and instructions for filling out Analytical Services Request (ASR) forms.
NWQL Rapi-Note 01-013, 01-023, 01-033, 01-034	USGS employees can access Rapi-Notes through the NWQL in-house Web site.
Wilde and others, eds., 1999-2002 (TWRI book 9, chap. A5)	Processing water samples.

10.0 WATER-QUALITY DATA MANAGEMENT (REVISION 1, JUNE 2002)

Water-quality data that are collected for hydrologic investigations are recorded on paper and electronically. Data that are recorded on paper include chemical, physical, biological, and ancillary data measured in the field. This information is documented on standard USGS field forms (fig. 8.1.1) and stored in site files. Data that are recorded electronically include analytical results and continuous monitoring data transmitted over the computer network or stored by electronic data logger. Data that are recorded on paper and electronically typically are stored either in the NWIS QWDATA data base (Maddy and others, 1997, and Hoopes, B.C., written commun.) or in NWIS-ADAPS data base (Bartholoma, 1997). The NWIS is the storage medium for water-quality, streamflow, well, and water-use information collected by the USGS. Data that cannot be stored in these national data bases may be stored in other data bases, such as project data bases.

10.1 Processing Data

Sampling information, field determinations, and ancillary information are recorded on a set of water-quality field notes that are considered original record. These data are combined with analytical data from the laboratory in computer data files and paper files.

10.1.1 Continuous Monitoring Data (Revision 1, June 2002)

Continuous monitoring data are water-quality records collected onsite by electronic sensors and data loggers. Two methods for electronically recording data are by (1) transmitting data from a remote location by land line or radio telemetry to a central location where they are recorded on mediums, such as magnetic tape, disk, or solid-state memory device, and (2) recording data at a remote location on solid-state memory device. Initial data processing in the office is for the purpose of obtaining a copy of the original data for archiving (see Section 10.4). Data are not manipulated by the field instrument or a computer except to convert recorded signals into data in commonly used units or to display data in a convenient format. The transfer of data from the electronic storage medium to NWIS requires thorough checking to ensure that the data have transferred successfully or that as much data as possible have been recovered and errors identified (WRD Memorandum 87.085). All data are stored electroniclly. Continuous water-quality data are processed as described in Wagner and others (2000).

10.1.2 Analytical Data (Revision 1, June 2002)

Analytical data are results of field and laboratory chemical, physical, or biological determinations. Most water-quality samples are analyzed either in the field or at the NWQL. In some cases, samples may be analyzed by research laboratories or by laboratories outside of the USGS (see Section 4.1).

To enter analytical data into the NWIS data base, a site identification number must first be assigned and entered into the AWSC site file (see Section 7.2). Field measurements are entered into the NWIS data base by crew chief as soon as possible after returning from the sampling field trip. A record number is assigned by the system and is recorded on the field sheet. (fig. 10.1.2). (see Section 9.4 for sample tracking.) Sample logging is required for data from the NWQL or AWQRL to successfully transfer the data into the data base. Environmental sample data are entered into the AWSC NWIS QWDATA 1; QA data are entered into the AWSC NWIS QWDATA 2**.**

Station number	Date/ time	Schedules requested	NWIS record number	Lab ID number	Station number	Date/ time	Sched ules requested	NWIS record number	Lab ID number
0208500	Sept. 21, 1993/	1043	993000025						
"	"	542	"						
0209754	Oct. 4, 1993/								

Figure **10.1.2.** Example page from a OWSC sample-collection log book.

All data from the NWQL are electronically transferred to the appropriate AWSC data base by the AWSC Data Base Administrator at least once per week. Hard copies of the analytical reports (WATLIST's) are printed for storage in project files. The NWIS QWDATA data base receives daily incremental backup and weekly full backup.

Data analyzed by laboratories other than the NWQL or AWQRL must be entered into NWIS, if possible (Hubbard, 1992), and identified according to the analyzing laboratory. Data entry is the responsibility of the project chief Data are entered and stored according to procedures already described for processing NWIS analytical data. Appropriate codes are used to identify the data as originating from non- USGS sources.

10.1.3 Non-National Water Information System Data Bases

Sometimes data collected by project personnel cannot be entered into the AWSC NWIS QWDATA data base because the data are proprietary (such as data collected for some military projects) or because NWIS cannot accept the type of data that are generated by the project (for example, taxonomic data). In these cases, project data bases may be established to accommodate the data storage requirements and formats. Project data bases that are the sole repository for project data should have a written procedure for data entry, storage, and long-term backup and archival. Database Administrator has the responsibility for developing and implementing management of project data bases.

10.2 Validation (Records Review)

Data validation is the process whereby water-quality and associated data are checked for completeness and accuracy. After validation, data records are finalized in the AWSC data base.

10.2.1 Continuous Monitoring Data

Following the entry of continuous monitoring data into NWIS, raw data and(or) graphs of raw data are reviewed by assigned personal for anomalous values, dates, and times, and preliminary updating is done**.** Once the data are edited, the record is submitted to the Field Service Unit Coordinator for final review and approval.

10.2.2 Analytical Data (Revision 1, June 2002)

All field notes and field measurements are reviewed for completeness and accuracy within 7 days or as soon as possible after returning from the field trip by crew chief. All chemical analyses are reviewed for completeness, and questionable values are noted. Prompt review is necessary to allow analytical re-analysis to be performed before sample holding times have been exceeded for accuracy and precision. Every data analysis entered into NWIS QWDATA results in output (WATLIST) that includes a copy of the analysis and a report of general validation checks (Maddy and others, 1997, and Hoopes, B.C., written commun.), including but not limited to the following:

- Comparison of determined and calculated values for dissolved solids,
- Comparison of dissolved constituents and total constituents,
- Comparison of specific conductance with dissolved solids,
- Comparison of constituents with relevant Federal drinking-water standards, and
- Comparison of sum of cations with sum of anions (ion balance).

Field and laboratory analyses, such as pH, specific conductance, and alkalinity, are compared to confirm agreement of independent measurements. If data from more than one sample are available for a site, the analysis also is compared with previous analyses within a hydrologic context to identify obvious errors, such as decimal errors, and possible sample mix-ups or anomalies warranting analytical re-analysis. These reports and comparisons are reviewed and noted on the analytical report (WATLIST). If necessary, corrections or re-analysis may be requested by Field Services Unit Coordinator.

Requests to the NWQL for re-analysis are made by USGS employees through the NWQL inhouse Web page (http://wwwnwql.er.usgs.gov/USGS/AWSC_rerun_request.html) and in writing to other laboratories as stipulated in the laboratory contract. Re-analysis requests are logged and tracked by the Water-quality Specialist or Field Services Unit Coordinator. Corrections to NWIS resulting from reruns by the NWQL must be made to the laboratory data base as well as to the AWSC data base and are made by Field Services Unit Coordinator and WQ Specialist.

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Project QA data, such as blanks, replicates, blind standards, and matrix spikes, periodically are tabulated or graphed by Water-Quality Specialist or Field Services Unit Coordinator to facilitate identification of inaccuracies or systematic bias that may not be discernible when reviewing an individual analysis. All personnel responsible for sample collection and field analysis participate in the NFQA Program and process an equipment blank once per year. AWSC QA data, including NFQA sample results and annual equipment blanks, are reviewed by Water-Quality Specialist or Field Services Unit Coordinator.

10.3 Data Storage (Revision 1, June 2002)

In accordance with WRD policy, all water data collected as part of routine data collection by the WRD are stored in the NWIS computer data base. Data collected by others, such as cooperators, universities, or consultants, which are used to support published USGS documents and are not published or archived elsewhere, also should be entered into NWIS; however, these data must be flagged with the appropriate Data Quality Indicator (DQI) code, and identified according to analytical laboratory and collection organization. Other outside data may be entered into the data base at the discretion of the Water-Quality Specialist if data-collection methods and quality have been reviewed and found acceptable. Electronically stored data that cannot be entered into NWIS are stored in project data bases online or offline. The Datebase Administrator (DBA) has responsibility for maintaining backups of data stored electronically in NWIS or online. Data stored electronically offline are maintained by the DBA.

In addition to electronically stored data, other project data and information, including field notes, ASR's, WATLIST's, and Job Hazard Analysis (JHA) are retained in station folders and maintained by Field Services Unit Coordinator in project office while the project is active. (JHA) are also available on the web.

10.4 Records Archival

According to WRD policy, all original data that are published or support published scientific analyses shall be placed in archives (WRD Memorandum 92.059; Hubbard, 1992). Original data—from automated data-collection sites, laboratories, outside sources, and non-automated field observations—are unmodified data as collected or received and in conventional units (engineering units, generally with a decimal). Original data should be preserved in this form, no matter how they may be modified later (Hubbard, 1992). Original data on paper include field notes, field measurements, ASR's, WATLIST's, continuous water-quality monitoring records, and calibration notes. These data are archived when the project is completed or terminated, or if data are more than 5 years old. It is the responsibility of Project Chief to ensure that project files entered into the AWSC archive are organized and complete. The AWSC archive is located Texas and is maintained by National Archives and Records Administration (NARA). Data from the AWSC archives may be transferred to NARA as needed.

10.5 References Used for the Water-Quality Data Management Section (Revision 1, June 2002)

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

Figure 10.5. Summary of references for managing water-quality data and records

Reference	Subject
Bartholoma, S.D., 1997	NWIS ADAPS user's guide, Open-File Report 97-635.
Hubbard, 1992	Policy recommendations for managing and storing hydrologic data.
Maddy and others, 1997 (an update by Hoopes, B.C., ed., is scheduled to be available by the end of 2002)	NWIS QWDATA user's guide.
WRD Memorandum 87.085 (USGS)	Policy for collecting and archiving electronically recorded data.
WRD Memorandum 92.059 (USGS)	Policy for the management and retention of hydrologic data.
Wagner and others, 2000	Guidelines and standard procedures for continuous water-quality monitors

11.0 PUBLICATION OF WATER-QUALITY DATA

Water-quality data are published in Automated data reports or interpretive reports. The selection of the appropriate publication outlet for water-quality data will be the responsibility of the Science Center Water-Quality Specialist in cousltation with the project chief. A summary of USGS and WRD policies pertaining to the publication of data and interpretive reports is contained in the WRD Publications Guides (Alt and Iseri, 1986, p. 382-385; U.S. Geological Survey, 1995). Other references that should be consulted when writing reports include "Suggestions to Authors ..." (Hansen, 1991) and the U.S. Government Printing Office Style Manual (U.S. Government Printing Office, 2000).

11.1 Automated Data Reports

All non-proprietary water-quality data collected during the water year are stored in the WRD automated data report Water Resources Data. Make water-quality data available to users, but without interpretations or conclusions. Approval of hydrologic data reports is in accordance with applicable WRD, Region, and AWSC policy (Alt and Iseri, 1986. These reports are reviewed using a team review approach. Revisions are completed by the authors. The report is approved by the AWSC Director.

11.2 Interpretive Reports

Interpretive reports include such USGS outlets as Circulars, Professional Papers, Fact Sheets, Scientific Investigations Reports, and Open-File Reports, as well as non-USGS outlets, such as scientific journals, books, and proceedings of technical conferences. The AWSC Water-Quality Specialist, project supervisor, and outside technical specialists will provide guidance in ensuring that each water-quality report meets the highest technical standards. Approval of interpretive reports is in accordance with applicable WRD, Region, and AWSC policy (WRD Memorandum 95.18) and is more technically rigorous than the required approval for non-interpretive data reports.

In the AWSC reports are reviewed by the author's supervisor, appropriate AWSC discipline specialist, AWSC report specialist, two colleague reviewers (at least one is from outside the center), and Publication Service Center editors and illustrators. The final draft manuscript is transmitted from the Center Director to the Regional Bureau Approving Official-Water for approval.

11.3 Other Data Outlets (Revision 1, June 2002)

Article 500.14.1 of the Department of the Interior Geological Survey Manual (U.S. Department of the Interior, 1992) states that data and information are released through publications; however publication is not limited to paper media (WRD Memorandum 90.030; U.S. Department of the Interior, 1993). Electronic outlets include the internet (NWISWeb at http://waterdata.usgs.gov/nwis/) and computer storage media, such as CDROM.

The term "data" refers to uninterpreted observations or measurements, usually quantitative measurements resulting from field observations and laboratory analyses of water, sediment, or biota. Data can be released to the public after preliminary review for accuracy by appropriate WRD personnel (WRD Memorandum 90.030). Constituents in water samples collected by or for the USGS that exceed USEPA drinking water maximum contaminant levels (MCL's), as specified in the National Primary Drinking Water Regulations, are promptly reported by the project chief to appropriate agencies that have a need to know (WRD Memorandum 90.038).

The term "information" refers to interpretations of data or conclusions of investigations. Interpretive results or conclusions require colleague review and Director's approval for publication. Release of preliminary interpretations prior to final approval is prohibited to avoid disseminating incomplete and(or) incorrect conclusions, which are subject to change as a result of subsequent technical and policy reviews.

11.4 References Used for the Publication Section (Revision 1, June 2002)

The following table lists reports and(or) memoranda referred to in this section. For a complete citation, refer to Section 13.0 of the report.

Figure 11.4. Summary of references for publishing data

Reference	Subject
Alt and Iseri, 1986	Guide for publishing WRD reports.
Hansen, 1991	Suggestions to authors of USGS reports.
U.S. Department of the Interior, 1992	Safeguard and release of USGS information.
U.S. Department of the Interior, 1993	Policy for release of computer data bases and computer programs.
U.S. Geological Survey, 1995	Guidelines on writing hydrologic reports.
U.S. Government Printing Office, 2000	Style manual for printed government documents.
WRD Memorandum 90.030 (USGS)	Policy for release of digital data.
WRD Memorandum 90.038 (USGS)	Policy for reporting maximum contaminant level exceedances.
WRD Memorandum 92.005 (USGS)	Extended delegation of authority to approve reports of certain categories for open file release.
WRD Memorandum 95.18 (USGS)	Redelegation of Director's report approval authority to Regional Hydrologists.
WRD Memorandum 97.002 (USGS)	Modification to the reports processing system
http://waterdata.usgs.gov/nwis/	NWISWeb

12.0 WATER-QUALITY TRAINING AND REVIEWS

Periodic reviews of data-collection procedures are used to evaluate the effectiveness of training programs and to determine if technical work is being conducted correctly and efficiently. Such reviews also are used to identify and resolve problems before they become widespread and potentially compromise the quality of the data.

12.1 Training (Revision 1, June 2002)

Employee training is an integral part of water-quality activities allowing current employees to maintain and enhance their technical knowledge and new employees to gain the specific skills needed to adequately perform their job. A well-documented training program not only ensures that samples are collected correctly by technically competent personnel, but also lends legal credibility to data and interpretations. Training is accomplished according to the following policies and protocols.

Individual training plans are developed by the supervisor and employee at least annually as part of the performance review process. The OWSC Training Officer is responsible for informing AWSC staff about the availability of training—in-house, USGS, U.S. Government, and other sources of training. The Water-Quality Specialist provides recommendations and advice to supervisors and their staff as needed. The supervisor has authority and responsibility for approving training opportunities. In addition, staff are responsible for taking full advantage of the training provided.

Primary sources of water-quality training are USGS courses, usually taught at the National Training Center at the Denver Federal Center; regional training; Cyberseminars, and AWSC seminars or in-house training courses. The Water- Quality Specialist and Field severces Unit Coordinator plays an important role in providing in-AWSC and in-house training. Training documents are maintained by the Training Officer in AWSC personnel files and by the Personnel Office in Central Region.

12.2 Reviews (Revision 1, June 2002)

Reviews of water-quality data-collection activities are conducted annually for each individual in the AWSC who is actively involved in water-quality data collection. Reviews are conducted in the field or laboratory by Water- Quality Specialist and Field Services Unit Coordinator.

Reviews are completed in a timely manner, and comments are documented by the reviewer in a memorandum or to the immediate supervisor. Reviews address sample collection and processing techniques, compliance with WRD, OWQ, and AWSC policies, the condition of the work environment (for example, the field vehicle), and any other activities pertaining to the collection of high-quality data. When deficiencies are noted, the reviewer, in consultation with the Water-Quality Specialist, is responsible for identifying corrective actions. The immediate supervisor is responsible for ensuring that, once identified, corrective actions are implemented and completed in a timely manner.

13.0 REFERENCES (REVISION 1, JUNE 2002)

Alt, D.F., and Iseri, K.T., eds., 1986, WRD publications guide, v. 1. Publications policy and text preparation: U.S. Geological Survey, 429 p.

Averett, R.C., 1973, Biological sampling and statistics, in Slack and others, eds., Methods for collection and analysis of aquatic biological samples: U.S. Geological Survey Techniques for Water Resources Investigations, Book F, Chapter A4, p. 6-26.

Averett, R.C., and Schroder, L.J., 1994, A guide to the design of surface-water-quality studies, U.S. Geological Survey Open-File Report 93-105, 39 p.

Arvin, D.V., 1995, A workbook for preparing surface-water quality-assurance plans for OWSCs of the U.S. Geological Survey, Water Resources Division: U.S. Geological Survey Open-File Report 94-382, 40 p.

Bartholoma, S.D., comp., 1997, National Water Information System user's manual, chap. 3, automated data processing system: U.S. Geological Survey Open-File Report 97-635, 219 p.

Brunett, J.O., Barber, N.L., Burns, A.W., Fogelman, R.P., Gillies, D.C., Lidwin, R.A., and Mack, T.J., 1997, A quality-assurance plan for OWSC ground-water activities of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 97-11, 21 p.

Bushon, R.N., 2007 Fecal indicator viruses, *in* National field manual for the collection of water-quality data─biological indicators: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7.2, 24 p.

Bushon, R.N. and Francy, D.S., 2007 Protozoan pathogens, *in* National field manual for the collection of water-quality data─biological indicators: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7.3, 24 p.

Charles, D.F., Knowles, C., and Davis. R.S., eds., 2002, Protocols for the analysis of algal samples collected as part of the U.S. Geological Survey National Water-Quality Assessment Program: The Academy of Natural Sciences, Philadelphia, PA, 124 p.

Crawford, J.K., and Luoma, S.N., 1994, Guidelines for studies of contaminants in biological tissues for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 92-494, 69 p.

Cuffney, T.F., Gurtz, M.E., and Meador, M.R., 1993, Methods for collecting benthic invertebrate samples as part of the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 93-406, 66 p.

Delzer, G.C., and McKenzie, S.W., 1999, Five-day biochemical oxygen demand, *in* National Field Manual for the Collection of Water-Quality Data--Biological Indicators: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9 chap. A7, sec. 7.2, 30 p.

Dossett, S.R., and Bowersox, V.C., 1999, National trends network site operation manual: Champaign, Ill., National Atmospheric Deposition Program Office at the Illinois State Water Survey, NADP Manual 1999-01, variously paged, accessed August 2007 at http://nadp.sws.uiuc.edu/lib/manuals/opman.pdf

Edwards, T.K., and Glysson, G.D., 1999, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C2, 89 p.

Fitzpatrick, F.A., Waite, I.R., D'Arconte, P.J., Meador, M.R., Maupin, M.A., and Gurtz, M.E., 1998, Revised methods for characterizing stream habitate in the National water-Quality Assessment Program: U.S. Geological Survey Water-Resources Investigations Report 98-4052, 77 p., accessed August 2007 at http://water.usgs.gov/nawqa/protocols/WRI98-4052/index.html

Francy, D.S., Jones, A.L., Myers, D.N., Rowe, G.L., Eberle, C.M., and Sarver, K.M., 1998, Quality-assurance/quality-control manual for collection and analysis of water- quality data in the Ohio OWSC, U.S. Geological Survey: U.S. Geological Survey Water-Resources Investigations Report 98-4057.

Francy, D.S., Bushon, R.N., Stopar, Julie, Luzano, E.J., and Fout, G.S., 2004, Environmental factors and chemical and microbiological water-quality constituents related to the presence of enteric viruses in ground water from small public water supplies in southeastern Michigan: U.S. Geological Survey Scientific Investigations Report 2004-5219, 60 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, 58 p.

Hambrook Berkman, J., and Canova, M.G., in press, Algal biomass indicators, *in* National field manual for the collection of water- quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7.4.

Hansen W.R., ed., 1991, Suggestions to authors of the reports of the United States Geological Survey (7th ed.): Washington, D.C., U.S. Government Printing Office, 289 p.

Havelaar, A.H., van Olphen, M., and Drost, Y.C., 1993, F-specific bacteriophages are adequate model organisms for enteric viruses in fresh water: Applied and Environmental Microbiology, v. 59, n. 9, p. 2956-2962.

Hemm, J.D., 1989, Study and interpretation of the chemical characteristics of natural water: U.S. Geological Survey water Supply Paper 2254, 263 p.

Horowitz, A.J., Demas, C.R., Fitzgerald, K.K., Miller, T.L, and Rickert, D.A., 1994, U.S. Geological Survey protocol for the collection and processing of surface-water samples for the subsequent determination of inorganic constituents in filtered water: U.S. Geological Survey Open-File Report 94-539, 57 p.

Horowitz, A.J., Smith, J.J., and Elrick, K.A., 2001, Selected laboratory evaluations of the whole-water sample-splitting capabilities of a prototype fourteen-liter Teflon® churn splitter: U.S. Geological Survey, Open-File Report 01-386, 12 p.

Hubbard, E.F., 1992, Policy recommendations for management and retention of hydrologic data of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-56, 32 p.

Knott, J.M., Glysson, G.D., Malo, B.A., and Schroder, L.J., 1993, Quality-assurance plan for the collection and processing of sediment data by the U.S. Geological Survey, Water Resources Division: U.S. Geological Survey Open-File Report 92-499, 18 p.

Koterba, M.T., Wilde, F.D., and Lapham, W.W,. 1995, Ground-water data-collection protocols and procedures for the National Water-Quality Assessment Program: Collection and documentation of water-quality samples and related data: U.S. Geological Survey Open-File Report 95-399, 113 p.

Lane, S.L., and Fay, R.G., 1998, Safety in field activities, *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A9, 71 p.

Lapham, W.W., Wilde, F.D., and Koterba, M.T., 1997, Guidelines and standard procedures for studies of ground-water quality—Selection and installation of wells, and supporting documention; U.S. Geological Survey, Water-Resources Investigations Report 96-4233, 100 p.

Maddy, D.V., Lopp, L.E., Jackson, D.L., Coupe, R.H., Schertz, T.L., and Garcia, K.T., 1997, National Water Information System users's manual, v. 2, chap. 2, water-quality system: U.S. Geological Survey, version 1.2, Sept. 11, 1997 [variously paged]. [An open-file update to this report (by Hoopes, B.C., ed.,) is scheduled to be available by the end of 2002.]

Martin, G.R., Smoot, J.L., and White, K.D., 1992, A comparison of surface-grab and cross sectionally integrated stream-water-quality sampling methods: Water Environment Research, v. 64, no. 7, p. 866-876.

Martin, J.D., and Cohen, D.A., 1994, Policy and procedures for the management and archival storage of data collected for hydrolgic investigations of the U.S. Geological Survey, Indiana District: U.S. Geological Survey, Open File Report 94-61, 36 p.

Meador, M.R., Cuffney, T.F., and Gurtz, M.E., 1993a, Methods for sampling fish communities as part of the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 93-104, 40 p.

Meador, M.R., Hupp, C.R., Cuffney, T.F., and Gurtz, M.E., 1993, Methods for characterizing stream habitat as part of the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 93-408, 48 p.

Moulton, S.R., Kennen, J.G., Goldstein, R.M., and hambrook, J.A., 2002, Revised protocols for sampling algal, invertebrate, and fish communities as part of the National water-Quality Assessment Program: U.S. Geological Survey, Open-File Report 02-150, 75 p.

Mueller, D.K., Martin, J.D., and Lopes, T.J., 1997, Quality-control design for surface-water sampling in the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 97-223, 17 p.

Myers, D.N., Stoeckel, D.M., Bushon, R.N., Francy, D.S., and Brady, A.M.G., 2007, Fecal indicator bacteria, *in* National field manual for the collection of water-quality data─biological indicators: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7.1, [variously paged].

Nevers, M.B., and Whitman, R.L., 2005, Lake Monitoring Field Manual, U.S. Geological Survey report, accessed July 2007 at http://www.glsc.usgs.gov/_files/research/InlandLakesManual.pdf

Peden, M., Bachman, C., Brennan, C., Demir, B., and James, K., 1986, Development of standard methods for the collection and analysis of precipitation: U.S. Environmental Protection Agency, Washington, D.C., EPA/600/4-86/024.

Porter, S.D., Cuffney, T.F., Gurtz, M.E., and Meador, M.R., 1993, Methods for collecting algal samples as part of the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 93-409, 39 p.

Pritt, J.W., and Raese, J.W., eds., 1995, Quality assurance/quality control manual — National Water-Quality Laboratory: U.S. Geological Survey Open-File Report 95-443, 35 p.

Radtke, D.B., 1998, Bottom-material samples, *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A8, 59 p.

Rosenberg, D.M., and Resh, V.H., 1993, Freshwater biomonitoring and benthic macroinvertebrates: New York, Chapman and Hall, Chapter 6, p. 175-233.

Sandstrom, M.W., 1995, Filtration of water-sediment samples for the determination of organic compounds: U.S. Geological Survey, water-Resources Investigations Report 95-4105, 13 p.

Schroder, L.J., and Shampine, W.J., 1992, Guidelines for preparing a quality-assurance plan for district offices of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-136, 14 p.

———1995, Guidelines for preparing a quality-assurance plan for district water-quality activities of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 95-108, 12 p.

Shampine, W.J., Pope, L.M., and Koterba, M.T., 1992, Integrating quality assurance in project work plans of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-162, 12 p.

Shelton, L.R., 1994, Field guide for collecting and processing stream-water samples for the National Water-Quality Assessment Program: U. S. Geological Survey Open File Report 94-455, 42 p.

Shelton, L.R., 1997, Field guide for collecting samples for analysis of volatile organic compounds in stream water for the National Water-Quality Assessment Program: U.S. Geological Survey Open File Report 97-401, 14 p.

Shelton, L.R., and Capel, P.D., 1994, Guidelines for collecting and processing samples of streambed sediment for analysis of trace elements and organic contaminants for the National Water-Quality Assessment Program: U.S. Geological Survey Open-File Report 94-458, 20 p.

Stanley, D.L., Boozer, T.M., and Schroder, L.J., 1998, Summary of the U.S. Geological Survey National Field Quality-Assurance Program from 1979 through 1997: U.S. Geological Survey Open-File Report 98-392-163, 15 p.

U.S. Department of the Interior, 1992, Safeguard and release of U.S. Geological Survey data and information, *in* U.S. Geological Survey manual 500.14.1: U.S. Department of the Interior, Geological Survey, May 15, 1992, 3 p.

______1993, Policy for release of computer data bases and computer programs, *in* U.S. Geological Survey manual 500.24.1: U.S. Department of the Interior, Geological Survey, April 9, 1993, 4 p.

U.S. Geological Survey, 1995, Guidelines for writing hydrologic reports: U.S. Geological Survey Fact Sheet FS-217-95, 4 p.

U.S. Geological Survey, 1997–present, National field manual for the collection of water- quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, variously paged. [Chapters were published from 1997–2007; updates and revisions are ongoing and can be viewed at http://water.usgs.gov/owq/Fieldprocedures.html]

U.S. Government Printing Office, 2000, Style manual: Washington, D.C., U.S. Government Printing Office, 479 p.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for cotinuous water-quality monitors—station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1-D3, 51 p. + 8 attachments; accessed June, 2007 at http://pubs.water.usgs.gov/tm1d3.

Ward, J.R., and Harr, C.A., 1990, Methods for collection and processing of surface-water and bed-material samples for physical and chemical analyses: U.S. Geological Survey Open-File report 90-140, 71 p.

Wilde, F.D., ed., 2004a, Processing of water samples (Version 2.2), *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A5, [variously paged].

Wilde, F.D., ed., 2004b, Cleaning of equipment for water sampling, *in* National field manual for the collection of water- quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A3, 83 p.

Wilde, F.D., ed., 2005−present, Field measurements, *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A6, variously paged. [Updates and revisions are ongoing and can be viewed at http://water.usgs.gov/owq/FieldManual/Chapter6/Ch6_contents.html]

Wilde, F.D., ed., 2005, Preparations for water sampling, *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A1, [variously paged].

Wilde, F.D., ed., 2006, Collection of water samples, *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A4, [variously paged].

Wilde, F.D., Radtke, D.B., Gibs, Jacob, and Iwatsubo, R.T., eds., 2003, Selection of equipment for water sampling, *in* National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A2, 123 p.

Willoughby, T.C., 2000, Quality of wet deposition in the Grand Calumet River watershed, northwestern Indiana, October 17, 1995 to November 12, 1996: U.S. Geological Survey Water-Resources Investigations Report 99-4253, 54 p.

13.1 USGS Memoranda (Revision 1, June 2002)

The following USGS memoranda are available electronically on the Internet at the following site address, unless stated otherwise: http://water.usgs.gov/admin/memo/

Branch of Operations Technical Memorandum 91.01, February 5, 1991, Safety—Chemical-hygiene plan, accessed June 2007 at http://water.usgs.gov/admin/memo/information/op91.01.html

National Water Quality Laboratory Memorandum 92.01, March 25, 1992, Availability of equipment blank water for inorganic and organic analysis.

National Water Quality Laboratory Memorandum 95.04, December 2, 1994, Shipping samples to the National Water-Quality Laboratory.

Northeast Region Policy Memoranda 2004-01, January 13, 2004, Program and Plans—Requirements for submittal and approval of project proposals, accessed June 2007 at http://water.usgs.gov/usgs/orh/nrwww/prog-dev/proposals.html

Northeast Region Policy Memoranda 2006-01, November 18, 2005, Program and Plans—Requirements for submittal and approval of project proposals, accessed June 2007 at http://water.usgs.gov/usgs/orh/nrwww/prog-dev/proposals.html

Office of Surface Water Technical Memorandum 93.01, October 8, 1992, Summary of documentation that describes instrumentation and field methods for collecting sediment data.

Office of Water Quality Technical Memorandum 92.01, December 20, 1991, Distilled/deionized water for OWSC operations.

Office of Water Quality Technical Memorandum 92.06, March 20, 1992, Report of committee on sample shipping integrity and cost.

Office of Water Quality Technical Memorandum 97.06, May 5, 1997 (corrected May 14, 1997), Comparison of the suspended-sediment splitting capabilities of the churn and cone splitters.

Office of Water Quality Technical Memorandum 98.05, September 14, 1998, Policy for the approval of U.S. Geological Survey (USGS) water-quality analytical methods.

Office of Water Quality Technical Memorandum 02.14, April 18, 2002, Availability of universal blank water for inorganic and organic analyses.

Office of Water Quality Technical Memorandum 07.01, November 14, 2006, Policy for the evaluation and approval of analytical laboratories.

Water Resources Division Memorandum 87.085, September 18, 1987, Programs and Plans—Policy for the collection and archiving of electronically recorded data.

Water Resources Division Memorandum 90.030 (revised), March 5, 1990, Programs and Plans—Policy for release of digital data.
Water Resources Division Memorandum 92.005, December 16, 1991, Publications--Extented delegation of authority to approve reports of certain categories for release to the open file.
Water Resources Division Memorandum 92.036, April 16, 1992, Policy of the Water Resources Division on the use of laboratories by national water-quality programs.
Water Resources Division Memorandum 92.059, October 20, 1992, Policy for management and retention of hydrologic data of the U.S. Geological Survey.
Water Resources Division Memorandum 95.18, March 14, 1995, Publications—Redelegation of Director's report approval authority to Regional Hydrologists.
Water Resources Division Memorandum 95.35, May 15, 1995, Programs and Plans—Transmittal of an instrumentation plan for the Water Resources Division and the hydrologic field instrumentation and equipment policy and guidelines.
Water Resources Division Memorandum 97.002, November 15, 1996, Modification to the reports processing system.
Water Resource Division Memorandum 99.30, July 14, 1999, Priority Issues for the Federal-State Cooperative Program, Fiscal year 2000.
Water Resource Division Memorandum 04.01, January 7, 2004, Avoiding competition with the private sector.