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Standard Guide for Quality Planning and Field Implementation of a Water Quality Measurement Program[1]

This standard is issued under the fixed designation D 5612; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers planning and implementation of the sampling aspects of environmental data generation activities. Environmental data generation efforts are comprised of four parts: (*1*) establishment of data quality objectives (DQOs); (*2*) design of field sampling and measurement strategies and specification of laboratory analyses and data acceptance criteria; (*3*) implementation of sampling and analysis strategies; and (*4*) data quality assessment.

1.2 This guide defines the criteria that must be considered to ensure the quality of the field aspects of environmental data and sample generation activities.

1.3 DQOs should be adopted prior to the application of this guide. The data generated in accordance with this guide are subject to a final assessment to determine whether the DQOs were met. For example, many screening activities do not require all of the quality assurance (QA) and quality control (QC) steps found in this guide to generate data adequate to meet the project needs. The extent to which all of the requirements must be met remains a matter of technical judgement as it relates to the established DQOs.

1.4 This guide presents extensive management requirements designed to ensure high-quality samples and data. The words "must,"" shall," "may," and "should" have been selected carefully to reflect the importance placed on many of the statements made in this guide.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 596 Practice for Reporting Results of Analysis of Water[2]

D 1129 Terminology Relating to Water[2]

D 2777 Practice for Determination of Precision and Bias of Applicable Methods of Committee D-19 on Water[2]

D 3370 Practices for Sampling Water from Closed Conduits[2]

D 3856 Guide for Good Laboratory Practices in Laboratories Engaged in Sampling and Analysis of Water[2]

D 4210 Practice for Interlaboratory Quality Control Procedures and a Discussion on Reporting Low-Level Data[2]

D 4447 Guide for the Disposal of Laboratory Chemicals and Samples[3]

D 4448 Guide for Sampling Groundwater Monitoring Wells[3]

D 4840 Guide for Sampling Chain-of-Custody Procedures[2]

D 4841 Practice for Estimation of Holding Time for Water Samples Containing Organic and Inorganic Constituents[2]

D 5172 Guide for Documenting the Standard Operating Procedures Used in a Specific Laboratory[2]

D5283 Practice for Generation of Environmental Data Related to Waste Management Activities: Quality Assurance and Quality Control Planning and Implementation[3]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

E 178 Practice for Dealing with Outlying Observations[4]

E 1187 Terminology Relating to Laboratory Accredita-tion[4]

2.2 *U.S. Environmental Protection Agency Documents:*[5]

QAMS-005/80 (NTIS No. PB83170514/LL), Interm Guidelines and Specifications for Preparing Quality Assurance Project Plans, Office of Monitoring Systems and Quality Assurance, Dec. 29, 1980

QAMS-500/80. Development of Data Quality Objectives, Description of Stages I and II, July 16, 1986

QAMS-004/80 (NTIS No. PB83219667/LL), Guidelines and Specifications for Preparing Quality Assurance Program Plans, Office of Monitoring Systems and Quality Assurance, Sept. 20, 1980

3. Terminology

3.1 *Definitions*—The terms that are most applicable to this guide have been defined in Terminologies D 1129 and E 1187.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *background sample*—a sample taken from a location on or proximate to the site of interest. This sample is taken to

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.04.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn. NPODS.

document baseline or historical information.

3.2.2 *collocated samples*—independent samples collected as close as possible to the same point in space and time and intended to be identical.

3.2.3 *data quality objectives (DQOs)*— statements on the level of uncertainty that a decision maker is willing to accept in the results derived from environmental data (see QAMS-500/80).

3.2.4 *material blank*—a sample composed of construction materials such as those used in well installation. Well development, pump and flow testing, and slurry wall construction. Examples of these materials are bentonite, sand, drilling fluids, and source and purge water. This blank documents the contamination resulting from usage of the construction materials.

3.2.5 *quality assurance program plan (QAPP)*—an orderly assemblage of management policies, objectives, principles, and general procedures by which an organization involved in environmental data generation activities outlines how it intends to produce data of known quality.

3.2.6 *quality assurance project plan (QAPjP)*—an orderly assemblage of detailed procedures designed to produce data of sufficient quality to meet the DQOs for a specific data collection activity.

4. Summary of Guide

4.1 This guide describes the criteria and activities for organizations involved in obtaining water samples and generating field data in terms of human and physical resources and QC procedures and documentation requirements depending on the DQOs or agreed upon project plan.

5. Significance and Use

5.1 Environmental data are often required for making regulatory and programmatic decisions. These data must be of known quality commensurate with their intended use.

5.2 Certain minimal criteria must be met by the field organizations in order to meet the objectives of the water monitoring activities.

5.3 This guide defines the criteria for organizations taking water samples and generating environmental data and identifies other activities that may be required based on the DQOs.

5.4 This guide emphasizes the importance of communication among those involved in establishing the DQOs, planning, and implementing the sampling and analysis aspects of environmental data generation activities, and assessing data quality.

6. Project Specification

6.1 *Overall Project Objectives*—The overall objectives of the project must be defined prior to the start of any field and laboratory activities.

6.2 *Data Quality Objectives*—DQOs for the data generation activity should be defined prior to the initiation of field and laboratory work, and they must be compatible with project objectives. It is desirable that the field and laboratory organizations be aware of the DQOs so that the personnel conducting the work are able to make informed decisions during the course of the project.

6.3 *Project Plan*— The project plan should be designed to meet the project objectives and DQOs. The project plan should define the following:

6.3.1 *Specific Project Objectives*—The objectives of the field and laboratory work must be defined clearly, define specific objectives for the sampling location, and describe the intended uses for the data. The project objective may need to be reviewed as information is gathered. Any changes in the project objective affecting field and laboratory activities should be communicated to the field and laboratory personnel.

6.3.2 *Background Information*—Any background information that could affect meeting the project objective or DQOs should be provided. For example, the identification of any regulatory programs governing data collection and analysis and the reason for conducting the sample collection work should be included in the background information.

6.3.3 Project management shall have individuals designated as having responsibility and authority for the following: (*1*) developing project documents that implement the DQOs; (*2*) selecting field and laboratory organizations to conduct the work; (*3*) coordinating communication among the field and laboratory organizations and government agencies, as required; and (*4*) reviewing and assessing the final data.

6.3.4 Sampling requirements shall be specified, including sampling locations, equipment and procedures, and sample preservation and handling.

6.3.5 Analytical requirements shall be specified, including the analytical procedures, analyte list, required detection limits, and required precision and bias values. Regulatory requirements and DQOs shall be considered when developing the specifications.

NOTE 1—The above does not imply that the specified analytical requirements can be met.

6.3.6 The QA and QC requirements shall address both field and laboratory activities. The means for controlling false positives and false negatives shall be specified.

6.3.6.1 The types and frequency of field QC samples to be collected, including field blanks, duplicates, and spikes, trip blanks, equipment rinsates, background samples, reference materials, material blanks, and split samples, should be specified. Control parameters for field activities shall be described (see 7.6.3).

6.3.6.2 The types and frequency of laboratory QC samples, such as laboratory control samples, laboratory blanks, matrix spikes, matrix duplicates, and matrix spike duplicates, shall be specified. Any specific performance criteria shall be specified. Data validation criteria shall be defined.

6.4 *Project Documentation*—All documents required for planning, implementing, and evaluating the data collection effort shall be specified. These may include, although are not limited to, a statement of work, technical and cost proposals, work plan, sampling and analysis plan, QAPjP, health and safety plan, community relations plan, documents required by regulatory agencies, requirements for raw field and analytical records, technical reports assessing the environmental data, and records retention policy. Planning documents shall specify the required level of document control and identify the personnel having access. Document formats that may be required to ensure that all data needs are satisfied shall be specified. In addition, a project schedule that identifies critical milestones and completion dates should be available.

7. Standard Guide for Environmental Field Operations

7.1 *Purposes*—the field organization must conduct its operations in such a manner as to provide reliable information that meets the DQOs. To achieve this goal, certain minimum policies and procedures must be implemented in order to meet the DQOs.

7.2 *Organization*— The field organization shall be structured such that each member of the organization has a clear understanding of his or her duties and responsibilities and the relationship of those responsibilities to the total effort. The organizational structure, functional responsibilities, levels of authority, job descriptions, and lines of communication for activities shall be established and documented. One person may cover more than one organizational function.

7.2.1 *Management*—The management personnel of the field organization is responsible for establishing organizational, operational, health and safety, and QA policies. Management shall ensure that the following requirements are met: (*1*) the appropriate methodologies are followed, as documented in the standard operating procedures (SOPs); (*2*) personnel understand clearly their duties and responsibilities; (*3*) each staff member has access to appropriate project documents; (*4*) any deviations from the project plan are communicated to project management; and (*5*) communication occurs between the field, laboratory, and project managements, as specified in the project plan. Management shall foster an attitude within the organization that emphasizes the importance of quality and supports implementation of the QAPjP.

7.2.2 *Quality Assurance Function*—The organization shall appoint an individual(s) to be responsible for monitoring field operations in order to ensure that the site facilities, equipment, personnel, procedures, practices, and documentation are in conformance with the organization's QAPP and any applicable QAPjP. The QA monitoring function should be entirely separate from and independent of personnel engaged in the work being monitored. The QA function shall be responsible for the QA review in accordance with 7.7.

7.2.3 *Personnel*—It is the responsibility of the organization to establish personnel qualifications and training requirements for all positions. Each member of the organization shall possess the education, training, technical knowledge, and experience, or a combination thereof, to enable that individual to perform his or her assigned functions. Personnel qualifications shall be documented in terms of education, experience, and training. Training shall be provided for all staff members, as necessary, so that they can perform their functions properly.

7.2.4 *Subcontractors*— The use of subcontractors shall not jeopardize data quality. The field organization is therefore responsible for ensuring that its subcontractors are in compliance with the requirements of this section as is appropriate to the specific task(s) they are performing.

7.3 *Field Logistics*:

7.3.1 *General*—Sampling site facilities shall be examined prior to the start of work in order to ensure that all required items are available. The actual sampling area shall be examined to ensure that trucks, drilling equipment, and personnel have access to the site. Security, health and safety, and protection of the environment shall be controlled at the site support areas and sampling site.

7.3.2 *Field Measurements*—Project planning documents shall both address the type of field measurements to be performed and plan for the appropriate area to perform the work. Planning documents shall address ventilation, protection from extreme weather and temperatures, access to stable power, and provisions for water and gases of required purity. Plans shall be made to identify and supply applicable safety equipment, as specified in the project health and safety plan.

7.3.3 *Sample Handling, Shipping, and Storage Area*—The determination of whether sample shipping is necessary shall be made during project planning. This need is established by evaluating the analyses required, holding times (see Practice D 4841), and location of the site and laboratory. Shipping or transporting of the samples to a laboratory shall be completed in a timely manner, ensuring that the laboratory is allowed sufficient time to perform its analysis within any required holding times.

7.3.3.1 Samples shall be packaged, labeled, and documented in an area that minimizes sample contamination and provides for safe storage. The level of custody and whether sample storage is required shall be outlined in the planning documents.

7.3.4 *Chemical Storage*— Safe storage areas for solvents, reagents, standards, and reference materials shall be adequate to preserve their identity, concentration, purity, and stability prior to use.

7.3.5 *Decontamination*— Decontamination of sampling equipment may be performed at the location at which sampling occurs, prior to transfer to the sampling site, or in designated areas near the sampling site. Project documentation shall specify where this work will be performed and how it will be accomplished. Water and solvents of appropriate purity shall be available if decontamination is to be conducted at the site. This method of accomplishing decontamination of materials, solvents, and water purity shall be specified in the planning documents or SOPs.

7.3.6 *Waste Storage Area*—Waste materials may be generated during both the sampling process and on site or in situ analysis. Planning documents and SOPs shall outline the method for storage and disposal of these waste materials. Adequate facilities shall be provided for the collection and storage of all wastes. These facilities shall be operated so as to minimize environmental contamination. Waste storage and disposal facilities shall comply with applicable federal, state, and local regulations.

7.4 *Equipment and Instrumentation*:

7.4.1 *Equipment and Instrumentation*—The equipment, instrumentation, and supplies required at the sampling site shall be appropriate to accomplish the activities planned. The equipment and instrumentation shall meet the requirements of pertinent specifications, methods, and SOPs. Before the field staff arrives at the site, a list of required items shall be prepared and checked to ensure availability at the site.

7.4.2 *Maintenance and Calibration of Equipment and Instrumentation*—An SOP or operation and maintenance manual shall set forth the methods, materials, and schedules to

be used in the routine inspection, cleaning, maintenance testing, and calibration of the equipment and instrumentation used in performing geophysical, analytical, or in situ measurements. Procedures or manuals may outline typical problems for common malfunctions. Procedures shall designate a person(s) or organizations responsible for maintenance and calibration. Records of all inspections, maintenance, repairs, testing, and calibration shall be maintained.

7.5 *Standard Operating Procedures*—The organization shall have written SOPs for all procedures performed routinely that affect data quality. Guide D 5172 contains information for documenting standard operating procedures. SOPs shall be available for the following areas and shall contain the information described:

7.5.1 *Sample Management*—The SOPs describe the numbering and labeling systems, chain-of-custody procedures, and tracking of samples from collection to shipment or relinquishment to the laboratory. Sample management includes the specification of holding times, volume of sample required by the laboratory, preservatives, and shipping requirements.

7.5.2 *Reagent and Standard Preparation*—These SOPs describe the procedures used to prepare standards and reagents. Information should include the specific grades of materials used in reagent and standard preparation, appropriate glassware and containers for preparation and storage, labeling and record keeping for stocks and dilutions, and safety precautions to be taken.

7.5.3 *Decontamination*— These SOPs describe the procedures used to clean field equipment before and during the sample collection process. The SOPs should include the cleaning materials used, order of washing and rinsing with the cleaning materials, requirements for protecting or covering cleaned equipment, procedures for disposing of cleaning materials, and safety considerations.

7.5.4 *Sample Collection Procedures*—SOPs for sample collection procedures shall describe how the procedures are actually performed in the field and shall not be a simple reference to a standard sampling method, unless the procedure is performed exactly as described in the published sampling method. If possible, industry-recognized sample collection methods from source documents published by the U.S. Environmental Protection Agency, ASTM, U.S. Department of the Interior, National Water Well Association, American Petroleum Institute, or other recognized organizations should be used. The SOP for sample collection procedures should include the following information:

7.5.4.1 Applicability of the procedure.

7.5.4.2 Equipment and reagents required.

7.5.4.3 Detailed description of the procedures to be followed when collecting the samples (see Guide D 4448 and Practices D 3370 for sampling guidance and common practices).

7.5.4.4 Common problems encountered.

7.5.4.5 Precautions to be taken.

7.5.4.6 Health and safety considerations.

7.5.5 *Equipment Calibration and Maintenance*—These SOPs describe the procedures used to ensure that field equipment and instrumentation are in working order. The SOPs describe calibration and maintenance procedures and schedules, maintenance logs, service contracts or service arrangements for equipment, and spare parts available in-house. The calibration and maintenance of field equipment and instrumentation should be in accordance with the manufacturer's specifications and shall be documented.

7.5.6 *Field Measurements*—These SOPs describe all methods used in the field to determine a chemical or physical parameter.

7.5.7 *Corrective Action*—These SOPs describe procedures used to identify and correct deficiencies in the sample collection process. These should include specific steps to take when correcting deficiencies such as performing additional decontamination of equipment, resampling, or additional training or field personnel in methods procedures. The SOP shall specify that each corrective action must be documented with a description of the deficiency, corrective action taken, and person(s) responsible for implementing the corrective action.

7.5.8 *Data Reduction and Validation*—These SOPs describe procedures used to compute the results from field measurements and to review and validate these data. They should include all formulas used to calculate the results and procedures used to verify independently that the field measurement results are correct.

7.5.9 *Reporting*—These SOPs describe the process for reporting the results of field activities (see Practices E 29 and D 4210 for additional information).

7.5.10 *Records Management*—These SOPs describe the procedures for generating, controlling, and archiving field records. The SOPs should describe the responsibilities for record generation and control and the policies for record retention, including type, time, security, and retrieval and disposal authorities. Records should include project-specific and field operations records.

7.5.10.1 Project-specific records relate to field work performed for a group of samples. Project records may include correspondence, chain-of-custody, field notes, all reports issued as a result of the work, project planning documents, and procedural SOPs used.

7.5.10.2 Field operations records document overall field operations. These records may include equipment performance and maintenance logs, personnel files, general field SOPs, and corrective action reports.

7.5.11 *Waste Disposal*— These SOPs describe policies and procedures for the disposal of waste materials resulting from field operations (see Guide D 4447). The disposal of all wastes must conform to federal, state, and local regulations, including those associated with the Resource Conservation and Recovery Act, Superfund Act Reauthorization and Amendments, Department of Transportation, and Occupational Safety and Health Administration.

7.5.12 *Health and Safety*—These SOPs describe policies and procedures designed both to provide a safe and healthy working environment for field personnel and to comply with federal and sate regulations.

7.6 *Field Quality Assurance and Quality Control Requirements*:

7.6.1 *Quality Assurance Program Plan*—The field organization shall have a written QAPP that describes the organization's QA policy. The plan shall specify the responsibilities of the field management and field staff and the QA function in the areas of QA and QC, and it shall also describe the QC procedures followed by the organization (see QAMS-004/80 for an example).

7.6.2 *Quality Assurance Project Plan*—Some projects, particularly those that are large or complex, require a QAPjP. The QAPjP details the QA and QC goals and protocol for a specific data collection activity to ensure that the data generated by sampling and analysis activities are of quality commensurate with their intended use. The QAPjP elements should include a discussion of the quality objectives of the project, identification of those involved in the data collection and their responsibilities and authorities, enumeration of the QC procedures to be followed, and reference to the specific SOPs that will be followed for all aspects of the project. Elements may be added or removed, as required, by the project or the end-user of the data (see QAMS-005/80 for an example).

7.6.3 *Control Samples*— Control samples are QC samples that are introduced into a process to monitor the performance of the system. Control samples, which may include blanks, duplicates, spikes, analytical standards, and reference materials, can be used in different phases of the overall process, beginning with sampling and continuing through transportation, storage, and analysis. The types of control samples used, and the frequency of usage, are dependent on the DQOs of the data collection effort and must be specified for each project.

7.6.4 *Procedures for Establishing Acceptance Criteria*—Procedures shall be in place for establishing acceptance criteria for field activities, as required, in the project planning documents. Acceptance criteria may be qualitative or quantitative. Field events or data that fall outside of the established acceptance criteria may indicate a problem with the sampling process that must be investigated.

7.6.5 *Deviations*—Any activity not performed in accordance with the SOPs or project planning documents is considered a deviation from the plan. Deviations from the plan may or may not effect data quality. All deviations from the plan shall be documented as to the extent of or the reason for the deviation, or both.

7.6.6 *Corrective Action*—Errors, deficiencies, deviations, or field events or data that fall outside the established acceptance criteria require investigation. Corrective action may be necessary to resolve the problem and restore proper functioning to the system in some instances. Investigation of the problem and any subsequent corrective action taken shall be documented.

7.6.7 *Data Handling Procedures*:

7.6.7.1 *Data Reduction*— All field measurement data are reduced in accordance with protocol described in the appropriate SOP. Computer programs used for data reduction shall be validated before use and verified on a regular basis. All information used in the calculations shall be recorded to enable reconstruction of the final result at a later date.

7.6.7.2 *Data Review*— All data are reviewed in accordance with SOPs to ensure that the calculations are correct and to detect transcription errors. Spot checks are performed on computer calculations to verify program validity.

7.6.7.3 *Data Reporting*— Data are reported in accordance with the requirements of the end-user.

7.7 *Quality Assurance Review*:

7.7.1 *General*—The QA review consists of internal and external assessments to ensure that both QA and QC procedures are in use and field staff conform to these procedures. Planning documents shall specify the requirements for internal, external, and on-site assessment. These documents shall specify the frequency and documentation of these assessments.

7.7.1.1 *Internal Assessment*—Personnel responsible for performing field activities are responsible for continually monitoring individual compliance with the QA and QC programs and planning documents. A QA officer or an appropriate management designee shall review the field results and findings for compliance to the QA and QC programs and planning documents. The results of this internal assessment should be reported to management with requirements for a plan to correct the observed deficiencies.

7.7.1.2 *External Assessment*—The field staff may be reviewed by personnel external to the organization. The results of the external assessment should be submitted to management with requirements for a plan to correct the observed deficiencies.

7.7.1.3 *On-Site Evaluation*—On-site evaluations may be conducted as part of both internal and external assessments. On-site evaluations may include, but are not limited to, a complete review of the facilities, staff, training, instrumentation, SOPs, methods, field analysis, sample collection, QA and QC policies, and procedures related to the generation of environmental data. Records of each evaluation shall be maintained in accordance with regulation or the organization's policy. These records should include the date of the evaluation, area or site, areas reviewed, individual performing the evaluation, findings and problems, actions recommended and taken to resolve the problems, and scheduled date for re-inspection. Any problems identified that are likely to affect data integrity shall be brought to the attention of management immediately.

7.7.2 *Evaluation of Field Records*—The review of field records shall be conducted by one or more individuals knowledgeable in the field activities, evaluating the following subjects at a minimum:

7.7.2.1 *Completeness of Field Records*—This review ensures that all requirements for field activities in the planning documents have been fulfilled, that complete records exist for each field activity, and that the procedures specified in the planning documents have been implemented. Emphasis on documentation will help ensure sample integrity and that sufficient technical information is available to recreate each field event. The results of this completeness check shall be documented, and environmental data affected by incomplete records shall be identified.

7.7.2.2 *Identification of Valid Samples*—This review involves interpretation and evaluation of the field records to detect problems affecting the representativeness of environmental samples. Examples of items that could indicate invalid samples include improper well development, improperly screened wells, instability of pH or conductivity, and collection

of volatiles near combustion engines. The field records shall be evaluated against planning documents and SOPs. The reviewer shall document the sample validity and identify the environmental data associated with poor or incorrect field work.

7.7.2.3 *Correlation of Field Test Data*—The results of field measurements obtained by more than one method shall be compared. For example, surface geophysics may be surveyed using both ground-penetrating radar and a resistivity survey.

7.7.2.4 *Identification of Anomalous Field Test Data*—Anomalous field test data should be identified. For example, a water temperature for one well that is 5° higher than any other well temperature in the same aquifer should be noted. The impact of anomalous field measurement results on the associated environmental data shall be evaluated.

7.7.2.5 *Validation of Field Analysis*—All data from field analysis that are generated in situ or from mobile laboratory shall be validated by one or more individuals knowledgeable in the analysis. The results of the validation shall be reported. The report shall discuss whether the QC checks meet the acceptance criteria and whether corrective actions were taken for any analysis performed when the acceptance criteria were not met.

7.7.3 *Quality Assurance Reports to Management*—The QA program shall provide for the periodic reporting of pertinent QA and QC information to management to allow assessment of the overall effectiveness of the QA program.

7.7.3.1 *Report on Measurement Quality Indications*—This report shall include the assessment of QC data (such as that generated in accordance with 7.6.3) gathered over the period, frequency of repeating work due to unacceptable performance, and corrective action taken.

7.7.3.2 *Report on Quality Assurance Assessments*—This report shall be submitted immediately following any internal or external on-site evaluations or upon receipt of the results of any performance evaluation studies. The report shall include the results of the assessment and the plan for correcting identified deficiencies.

7.7.3.3 *Report on Key Quality Assurance Activities During the Period*—A report shall be delivered to management summarizing key QA activities during the period. The report shall stress measures that are being taken to improve data quality and shall include a summary of the significant quality problems observed and corrective actions taken. The report shall also include a summary of involvements in resolution of quality issues with clients or agencies, QA organizational changes, and notice of the distribution of any revised documents controlled by the QA function.

7.8 *Field Records*:

7.8.1 Records provide direct evidence and support for the necessary technical interpretations, judgements, and discussions concerning project activities. These records, particularly those that are anticipated for use as evidential data, must support current or ongoing technical studies and activities directly and must provide the historical evidence necessary for later reviews and analyses. Records shall be legible, identifiable, and retrievable and protected from damage, deterioration, or loss. Field records generally consist of bound field notebooks with prenumbered pages, sample collection forms, personnel qualifications and training forms, sample location maps, equipment maintenance and calibration forms, chain-of-custody forms, sample analysis request forms, and field change request forms. All records shall be completed with black, waterproof ink.

7.8.2 Procedures for reviewing, approving, and revising field records must be defined clearly, with the lines of authority included. At a minimum, all documentation errors shall be corrected by drawing a single line through the error and initialing by the responsible individual, along with the date of change. The correction is written adjacent to the error. Deviations from field SOPs shall be documented.

7.8.3 *Personnel Training and Qualification Records*—It is the responsibility of the organization to establish personnel qualifications and training requirements. Each staff member shall have the education, training, technical knowledge, and experience, or a combination thereof, to enable that individual to perform his or her assigned functions. Personnel qualifications shall be documented in terms of education, experience, and training. Training shall be provided for all staff members so that they can perform their functions properly.

7.8.4 SOPs shall be available to those performing the task outlined, and revisions to field SOPs shall be written and distributed to all affected individuals to ensure the implementation of changes. The areas covered by SOPs are given in 7.5.

7.8.5 *Quality Assurance Plans*—The QAPP and all applicable QAPjPs shall be on file.

7.8.6 *Equipment Maintenance*—Maintenance procedures shall be defined clearly and written for each measurement system and required support equipment. When maintenance is necessary, it shall be documented in either standard forms or in logbooks. A history of the maintenance record of each system serves as an indication of the adequacy of maintenance schedules and parts inventory.

7.8.7 *Calibration and Traceability of Standards and Reagents*—Calibration is a reproducible reference base to which all sample measurements can be correlated. A sound calibration program shall include provisions for documentation of the frequency, conditions, standards, and records reflecting the calibration history of a measurement system. The accuracy of calibration standards is an important point to consider because all data will be in reference to the standards used. A program for verifying and documenting the accuracy of all working standards against primary grade standards shall be followed routinely.

7.8.8 *Sample Collection and Tracking Records*—To ensure maximum utility of the sampling effort and resulting data, documentation of the sampling protocol, as performed in the field, is essential. Sample collection records shall contain the persons conducting the activity, sample number, sample location, equipment used, climatic conditions, documentation of adherence to protocol, and unusual observations as a minimum. The actual sample collection record is usually one of the following: a bound field notebook with prenumbered pages, a preprinted form, or digitized information on a computer tape or disc.

7.8.8.1 Sample tracking records (chain of custody) involving the possession of samples from the time at which they are obtained until they are relinquished shall be documented with

the following minimum information: (*1*) project name; (*2*) signatures of the samplers; (*3*) sample number, date and time of collection, and grab or composite sample designation; (*4*) signatures of the individuals involved in sample transfer; and (*5*) the air bill or other shipping number, if applicable. Additional chain of custody information may be found in Practice D 4840.

7.8.9 *Maps and Drawings*—Project planning documents and reports often contain maps. The maps are used to document the location of sample collection points and monitoring wells, and as a means of presenting environmental data. Information used to prepare maps and drawings is normally obtained through field surveys, property surveys, surveys of monitoring wells, serial photography, or photogrammetric mapping. The final, approved maps shall have a revision number and date and shall be subject to the same controls as other project records.

7.8.10 *Results from Control Samples*—Documentation for the collection of QC samples, such as field, trip, and equipment rinsate blanks, duplicate samples, spikes, and reference materials, shall be maintained.

7.8.11 *Correspondence*— Project correspondence can provide evidence supporting technical interpretations. Correspondence pertinent to the project shall be kept and placed in the project files.

7.8.12 *Deviations*—Field changes and deviations from the planning documents shall be reviewed and approved by either the authorized personnel who performed the original technical review or their designees. All deviations from the procedural and planning documents shall be recorded in the site log.

7.8.13 *Final Report*— The final report shall summarize the field activities, data, results of deviations from the planning documents, and interpretation of the data. The planning documents shall outline the items to be included in the report, which may include any special formats required, QC reporting requirements, conclusions, and recommendations.

8. Data Quality Assessment

8.1 The assessment of environmental data occurs in two phases. Field records and analytical data are reviewed during the first phase to identify whether the data are accurate and defensible. The data are interpreted in the second phase with respect to meeting DQOs or the project plan.

8.2 Technical reports of environmental data collection efforts should summarize the information contained in the field records and the results of the laboratory data review, in accordance with 7.7.2. This information should be used to identify clearly the data that are not representative of environmental conditions or that have been generated using poor field or laboratory practices.

8.3 The combined field and laboratory data are then subject to a final assessment to determine whether the DQOs or project plan have been met. Practices D 2777, E 29, and E 178 will be of help in the final assessment process.

9. Standard Practice for Analytical Operations

9.1 Analytical operations are an integral part of the water sampling and field analysis process. It is not the intent of this guide to cover all aspects of analytical operations. The following documents will help both the field and analytical personnel to determine that which is needed to meet the DQOs: Practices D 596 and D 5283 (section titled Standard Practices for Environmental Laboratory Operations) and Guides D 3856 and D 5172.

10. Documentation Storage

10.1 *Documentation Archive*—Procedures shall be established to ensure that the documents required to recreate the sampling, analysis, and reporting of information are stored. These documents may include, but are not limited to, planning documents, SOPs, logbooks, field data records, sample tags and labels, chain-of-custody records, photographs, and any other information noted in 7.8.

10.2 *Storage Time*— The length of storage time for field records shall comply with regulatory requirements, organizational policy, or project requirements, whichever is or are more stringent.

10.3 *Filing System*— The control of records is essential for providing evidence of technical adequacy and quality for all project activities. These records shall be identified, retrievable, and organized to prevent loss.

10.4 *Personnel Authorized to Enter Archive*—Access to project files shall be controlled to restrict unauthorized personnel from having free and open access. An authorized access list shall be prepared for the project files and shall name the personnel who have unrestricted access to the files.

11. Keywords

11.1 field; quality assurance; quality control; sampling