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1.0 PURPOSE AND SCOPE

This procedure provides guidance for implementing the Data Quality Objective (DQO) process as outlined in the United States (U.S.) Environmental Protection Agency (EPA), EPA QA/G-4, “Guidance on Systematic Planning Using the Data Quality Objectives Process,” 2006. The objective of the DQO Process is to define the appropriate type and quantity of data to be collected for the intended use based on an acceptable consequence level of a wrong decision made based on the collected data. The process uses the knowledge and synergy of a team consisting of data users, subject matter experts, and stakeholders in a structure approach to achieve concurrence on sampling and analysis objectives. A report is generated after completion of the DQO process to document the DQO outputs. This procedure also identifies the steps necessary to create DQO documents in a consistent manner.

Since the mid 1990’s, Tank Farms has implemented the DQO as a systematic planning process for data collection in a response to direction from the U.S. Department of Energy (DOE) in the memorandum entitled, “Institutionalizing the Data Quality Objective (DQO) Process for the Office of Environmental Management’s (EM) Environmental Data Collection Activities” (Wagner 1995). The memorandum states, “The attached memorandum… implements as policy in EM (DOE Office of Environmental Management) the use of the DQO process as the preliminary step in the development of all our sampling and analysis activities. Central to the DQO process is communication between customers and suppliers to establish data requirements and acceptable levels of errors in decision making before major financial resources are expended.”

Sampling and analysis projects at Tank Farms typically incur significant cost and/or radiation exposure to the workers. The DQO process minimizes cost and worker exposure by avoiding or minimizing taking unnecessary samples, performing unnecessary sample analysis, re-taking samples, or re-performing analysis. A DQO process shall be conducted before major financial resources are expended for data collection, as directed in the DOE memorandum. For smaller data collection activities, a DQO process shall be conducted in a graded approach before starting each activity to minimize cost and radiation exposure to workers. For minor sampling activities where cost and exposure risk are insignificant and data objectives are simple and clear, a DQO may not be necessary.

In addition to the general guidelines above, a DQO is sometimes a required element of the planning for data collection. For examples,

- One, section 6.5 of the Action Plan in the Hanford Federal Facility Agreement and Consent Order, DOE/RL-89-10, states that “data quality objectives shall be specified in RCRA closure plans, the RCRA Permit, and any other relevant plans that may be used to describe sampling and analysis at RCRA TSD units.”

- Two, DOE/RL-96-68, Rev 3, “Hanford Analytical Services QA Requirements Documents (HASQARD),” Volume 1, Section 1.3.1, “Overview of the Data Quality Objective Process,” states that “The client must use the DQO planning process as the preliminary step in the development of all sampling and analysis activities, which may lead to significant environmental decisions.”
Three, the Hanford Facility Dangerous Waste Permit, WA7 89008967, Revision 8C specifies that all waste analysis plans (WAPs) and sampling and analysis plans (SAPs) required by the permit will include a Quality Assurance (QA)/Quality Control (QC) plan or equivalent. It also states that the level of QA/QC may be based upon Ecology approved DQOs.

Anyone conducting sampling and analysis activities governed by such a document should review the document for applicable DQO requirements.

As mentioned above, the primary objective of the DQO process is to define the appropriate type and quantity of data. Project-specific quality requirements should be included in the DQO document or documented in a quality assurance project plan. Applicable commonly practiced quality requirements (e.g., items such as use of qualified personnel, chain of custody, and clean sample bottles) may be incorporated into the DQO or the DQO may incorporate these standard requirements by reference. The sampling design and quality requirements in the DQO and quality assurance project plan, if used, typically are reflected in a sampling and analysis plan for implementation purposes. This guidance is intended for developing DQOs only. Guidance and requirements for developing sampling and analysis plan and quality assurance project plans are outside the scope of this procedure.

2.0 IMPLEMENTATION

This procedure is effective on the date shown in the header. DQO documents that have been prepared or are in process may continue according to the previous revision. Refer to TFC-ENG-DESIGN-C-25 for other implementation considerations such as document numbers, reviews, approvals, and document release.

3.0 RESPONSIBILITIES

3.1 Specific Program or Project

Each program or project requiring sampling and analytical data is responsible for establishing and maintaining the necessary DQO. The program or project provides subject matter experts in the DQO process.

3.2 Tank Waste Inventory and Characterization

Conducts or assists in facilitation of the DQO process and preparation of the DQO document.

3.3 Environmental Protection

Provides guidance as requested for involvement of regulatory agencies in approval process for DQO.

4.0 PROCEDURE

Figure 1 outlines the procedure steps. Some steps may be performed in parallel or out-of-sequence, as appropriate.
4.1 General

4.1.1 DQO Process

The DQO Process is a series of logical steps that guide managers and or staff to a plan for the resource-effective acquisition of data. It is both flexible and iterative, and applies to both decision-making (e.g., compliance/non-compliance with a standard) and estimation (e.g., ascertaining the mean concentration level of a contaminant). The DQO Process is used to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study. Use of the DQO Process leads to efficient and effective expenditure of resources; consensus on the type, quality, and quantity of data needed to meet the project goal; and the full documentation of actions taken during the development of the project.

The DQO Process is described in more detail in EPA QA/G-4. EPA QA/G-4 also contains useful example DQOs that help explain the DQO Process steps. The seven steps of the DQO Process are summarized as follows.

- Step 1. State the Problem: Assemble an effective planning team, concisely describe the problem, and examine resources for investigating the problem. In this step, the planning team should determine the type of intended use for the data (e.g., decision-making or estimation).

- Step 2. Identify the Goal of the Study: Identify the principal study question, identify potential alternative actions with implications, and combine these to make statements on the problem.

- Step 3. Identify Information Inputs: Identify the types and sources of information needed to formulate and investigate the problem. Determine whether appropriate sampling and analytical methods are available.

- Step 4. Define the Boundaries of the Study: Define the target population, the spatial and temporal boundaries associated with the population. Examine any practical constraints to collecting data and factors that affect selection of the unit that defines the scales of sampling, and the scale of decision making or estimation.

- Step 5. Develop the Analytic Approach: Specify the analytic approach to draw conclusions from the study results. For decision problems, construct a theoretical “If…then…else…” decision rule that defines how the decision maker would choose among alternative actions if the true state of nature could be known with certainty. For estimation problems, provide a clear specification of the estimator.

- Step 6. Specify Performance or Acceptance Criteria: For decision problems, specify the decision rule as a statistical hypothesis test, examine consequences of making incorrect decisions from the test, and place acceptable limits on the likelihood of making decision errors. For estimation problems, specify acceptable limits on estimation uncertainty.

- Step 7. Develop the Detailed Plan for Obtaining Data: Compile the information and outputs generated in Steps 1 through 6 to identify alternative sampling and analysis designs. Select and document a design that will yield data that will best achieve the established performance or acceptance criteria.
A checklist has been developed to assist in development of DQOs to ensure important considerations are evaluated in the DQO Process (Attachment A). The checklist identifies important activities in each DQO Process step and the major outputs of each step.

### 4.1.2 DQO Process Flexibility

As stated in EPA QA/G-4, the DQO process is a flexible planning tool that can be used more or less intensively as the situation requires. If a problem is simple and the consequences are low, the DQO process can be completed in a simplified manner in a short period of time (e.g., conducting one DQO process meeting that covers the seven DQO steps and documenting the results in an attachment to the implementing sampling and analysis plan). If a problem is complex and the consequences of a wrong decision are high, deliberate, careful planning is required and may take an extended period of time documented with a released stand-alone document.

The DQO process is an iterative process and can be used repeatedly throughout a project. Early decisions in a project may be preliminary in nature and only require limited planning and evaluation. As a study continues, and making a decision error becomes more critical, the DQO process may require greater effort. The DQO process also may be repeated to optimize the DQO outputs as more information becoming available. Figure 2, taken from EPA QA/G-4, illustrates the iterative nature of the DQO process.

Not every step or all parts of every step in the DQO process applies to all data collection activities. For examples, if a statistical hypothesis is not linked to a clear decision in which the decision maker can identify potential consequences of making a decision error, some activities may not apply, as indicated in Figure 2. In addition, the use of the DQO process will not always result in statistical/probabilistic sampling methods for data collection.

### 4.1.3 DQO Process Variations

Operational constraints can impact the DQO process and should be considered and documented throughout the DQO process. Identifying the constraints in the DQO document identifies limitations on data collection activities and statistical evaluations. Practical constraints or hindrances that interfere with full implementation of the data collection design may be the main obstacle in data collection, and should be carefully defined and addressed during the DQO process. Examples of specific obstacles include the potentially stratified (physical and chemical properties) nature of the tank waste associated with limitations on the number and location of sample locations (riser availability), sampler bias and recovery, and the cost of obtaining and analyzing high-activity radioactive samples.

In general, the DQO process addresses an issue or problem rather than a specific sampling event. Therefore, a specific sampling event may have sampling and analysis requirements from more than one DQO document. In these instances, the specific requirements for sampling and analysis are described in associated documents using the most stringent requirements from each of the applicable DQO documents (e.g., the tank sampling and analysis plans, test plans, or work packages). Each sampling and analysis plan will vary, depending on the constraints of that particular event (e.g., availability of the waste, availability of risers, etc.).
4.1.4 DQO Document Format

The document format outlined in this section is an effort to obtain uniform DQO documents. This general outline should be followed regardless of the length of the document.

- **1.0 Introduction** - The introduction section of the DQO document is optional and should be used only if the author feels a background discussion over and above the information provided in the problem statement is necessary. If an introduction is prepared, it could contain such information as an overview of the program, describe the expectations of the participants and stakeholders, and help the readers understand the scope and any plans for future iterations of the DQO document.

*NOTE:* Sections 2.0 through 8.0 of the DQO document (see below) follow the DQO process steps and describe the results of performing each step of the process.

- **2.0 DQO Step 1** - State the Problem
- **3.0 DQO Step 2** - Identify the Goal of the Study
- **4.0 DQO Step 3** - Identify Information Inputs
- **5.0 DQO Step 4** - Define the Boundaries of the Study
- **6.0 DQO Step 5** - Develop Analytic Approach
- **7.0 DQO Step 6** - Specify Performance or Acceptance Criteria
- **8.0 DQO Step 7** - Develop the Plan for Obtaining Data
- **9.0 References** - Cite all references included in the document.

4.2 Conduct the DQO Process

**Responsible Manager or Designee**

1. Determine the need and scope of the sampling and analysis.

2. Determine the need for DOE, stakeholder, and regulatory agency involvement (depending on the subject and scope).

3. Identify the DQO facilitator and document author.

**Responsible Manager or Designee, Document Author, DQO Facilitator, and Subject Matter Experts (as needed)**

4. Develop the content of the initial DQO process steps as conceived by the project (at a minimum suggested problem statement and suggested decision statements) to be presented at the first DQO process meeting.
NOTE 1: Agreement is reached among the decision makers (commonly the project and, if involved, DOE, stakeholders, and regulatory agencies).

NOTE 2: The meetings are attended by the responsible manager or designee, document author, subject matter experts (e.g., laboratory personnel, statisticians, environmental compliance personnel, sampling personnel, etc.) as needed, and DOE, stakeholders, and regulatory agencies (if involved).

DQO Facilitator 5. Conduct DQO process meetings and reach agreement on the outputs of the DQO process steps (as identified in EPA QA/G-4).

NOTE: The DQO document may range from a comprehensive report for a major sampling activity to an abbreviated report for a limited sampling activity.

Document Author, DQO Facilitator, and Subject Matter Experts (as needed) 6. Prepare the DQO document. Use the attached checklist to assist in the preparation of the document as needed.

NOTE: An internal review would include the responsible manager or designee, DQO facilitator, DOE (if involved), the QA organization, Environmental, and subject matter experts (as needed).

Document Author 7. Provide the document for internal review in accordance with TFC-ENG-DESIGN-C-25.

8. Incorporate comments.

9. Provide document to the stakeholders and regulatory agencies (if involved) for review. This may require transmittal through DOE.

DQO Facilitator 10. Conduct comment resolution meetings, if needed.

Document Author 11. Incorporate comments.

NOTE: If there is a concurrence signature by DOE or a regulatory agency in the document, any document revision must be agreed to by the organizations signing the concurrence page.

12. Obtain required signatures (at a minimum, the document author, responsible manager, and, if applicable, concurrence signatures from Environmental, DOE, and the regulatory agencies) and release the DQO document in accordance with TFC-ENG-DESIGN-C-25.

5.0 DEFINITIONS

Data Quality Objective (DQO) document. The document used to report the outputs of the DQO process.
Data Quality Objective (DQO) process. The seven step planning process for sampling and analysis developed by EPA and presented in EPA QA/G-4, “Guidance on Systematic Planning Using the Data Quality Objectives Process.”

6.0 RECORDS

The following record is generated during the performance of this procedure:

- DQO document.

The following non-record is generated during the performance of this procedure:

- DQO Checklist.

The record custodian identified in the Company Level Records Inventory and Disposition Schedules (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.

7.0 SOURCES

7.1 Requirements

No documents external to this procedure are required for performance.

7.2 References

1. DOE/RL-89-10, “Hanford Facility Agreement and Consent Order (Tri-Party Agreement).”

2. DOE/RL-96-68, “Hanford Analytical Services Quality Assurance Requirements Documents (HASQARD).”


5. TFC-BSM-IRM_DC-C-02, “Records Management.”


7. WA7 89000 8967, “Hanford Facility Dangerous Waste Permit.”

Figure 1. DQO Process Flowchart.

Sampling and analysis needed

Determine need for a DQO

Is a DQO required?

No → Stop

Yes

Determine need for DOE, stakeholder, and/or regulator involvement

Identify author and facilitator

Conduct data quality objective process meetings and prepare meeting minutes

Prepare DQO document

Provide DQO document for internal review (include DOE, if involved) and incorporate comments

Provide DQO document for regulator review (if involved)

Conduct comment resolution meeting (if needed) and incorporate comments

Obtain signatures (including concurrence signatures from DOE and regulators, if required) and release document

Key:

DOE: Department of Energy
DQO: Data Quality Objective
Figure 2. Repeated Application of the Data Quality Objective Process Throughout a Single Project.
# ATTACHMENT A – DATA QUALITY OBJECTIVE CHECKLIST

<table>
<thead>
<tr>
<th>DQO Step</th>
<th>Major DQO Activities in DQO Step</th>
<th>DQO Outputs</th>
<th>Activity and Output Completed? (Yes/No/N/A)</th>
<th>Rationale for Not Completing DQO Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. State the Problem</td>
<td>• Describe the problem;</td>
<td>• A concise description of the problem;</td>
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</tr>
<tr>
<td></td>
<td>• Develop a conceptual model of the environmental hazard to be investigated;</td>
<td>• A conceptual model of the environmental problem to be investigated with a preliminary determination of the type and data needed and how it will be used;</td>
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<tr>
<td></td>
<td>• Identify the general type of data needed;</td>
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<tr>
<td></td>
<td>• Discuss alternative approaches to investigation and solving the problems as applicable.</td>
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<tr>
<td></td>
<td>• Establish the planning team and identify the team’s decision makers;</td>
<td>• A list of the planning team members and identification of decision makers or principal data users within the planning team;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Identify available resources, constraints, and deadlines associated with planning, data collection, and data assessment as applicable.</td>
<td>Note: This list or table may be included in an appendix to the DQO document.</td>
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<tr>
<td></td>
<td></td>
<td>Note: At Tank Farms, resources and schedules are generally addressed in a separate process. Therefore, this item may be marked as “N/A.”</td>
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</tbody>
</table>
### ATTACHMENT A – DATA QUALITY OBJECTIVE CHECKLIST (cont.)

<table>
<thead>
<tr>
<th>DQO Step</th>
<th>Major DQO Activities in DQO Step</th>
<th>DQO Outputs</th>
<th>Activity and Output Completed? (Yes/No/N/A)</th>
<th>Rationale for Not Completing DQO Item</th>
</tr>
</thead>
</table>
| 2. Identify Goal of Study | • Identify the principal study question and define alternative actions that may be taken based upon the range of possible outcomes that result from answering the principal study question;  
• Organize multiple decisions into an order of sequence or priority, and organize multiple estimation problems according to their influence on each other and their contribution to the overall study goals. | • A well-defined principal study question;  
• A listing of alternative outcomes or actions as a result of addressing the principal study questions;  
• For decision problems, a list of decision statements that address the study questions;  
• For estimation problems, a list of estimation statements that address the study question. | | |
| 3. Identify Inputs | • Identify types and sources of information needed to resolve decisions or produce estimates;  
• Identify the basis of information that will guide or support choices to be made in later steps of the DQO process;  
• Select appropriate sampling and analysis methods for generating the information. | • List of environmental characteristics that will resolve the decision or estimate and potential sources for the desired information inputs;  
• Information on the number of variables that will need to be collected;  
• The type of information needed to meet performance or acceptance criteria;  
• Information on the performance of appropriate sampling and analysis methods. | | |
## ATTACHMENT A – DATA QUALITY OBJECTIVE CHECKLIST (cont.)

<table>
<thead>
<tr>
<th>DQO Step</th>
<th>Major DQO Activities in DQO Step</th>
<th>DQO Outputs</th>
<th>Activity and Output Completed? (Yes/No/N/A)</th>
<th>Rationale for Not Completing DQO Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Define Boundaries</td>
<td>• Define the target population of interest and its relevant spatial boundaries;</td>
<td>• Definition of the target population with detailed descriptions of geographic limits (spatial boundaries);</td>
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<td></td>
<td>• Define what constitutes a sampling unit;</td>
<td>• Detailed descriptions of what constitutes a sampling unit;</td>
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<tr>
<td></td>
<td>• Specify temporal boundaries and other practical constraints associated with sample/data collection;</td>
<td>• Time frame appropriate for collecting data and making the decision or estimate, together with those practical constraints that may interfere with data collection;</td>
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<tr>
<td></td>
<td>• Specify the smallest unit on which decisions or estimates will be made.</td>
<td>• The appropriate scale for decision making or estimation.</td>
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</tr>
<tr>
<td>5. Develop Analytic Approach</td>
<td>• Specify the population parameter (e.g., mean, median, or percentile) considered to be important to make inferences about the target population;</td>
<td>• Identification of the population parameters most relevant for making inferences and conclusions on the target population;</td>
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<tr>
<td></td>
<td>• For decision problem, choose an Action Level (using information identified in Step 3) that sets the boundary between one outcome of the decision process and an alternative, and verify that there exist sampling and analysis methods that have detection limits below the Action Level;</td>
<td>• For decision problems, the “if…, then…else…” theoretical decision rule based upon a chosen Action Level;</td>
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<tr>
<td></td>
<td>• For decision problems, construct the theoretical “If…then…else…” decision rule by combining the true value of the selected population parameter; the Action Level; the scale of decision making (Step 4); and the alternative actions (Step 2);</td>
<td></td>
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<tr>
<td>DQO Step</td>
<td>Major DQO Activities in DQO Step</td>
<td>DQO Outputs</td>
<td>Activity and Output Completed? (Yes/No/N/A)</td>
<td>Rationale for Not Completing DQO Item</td>
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<td>For estimation problems, develop the specification of the estimator by combining the true value</td>
<td>For estimation problems, the specification of the estimator to be used.</td>
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<td></td>
<td>of the selected population parameter with the scale of estimation and other boundaries (Step 4).</td>
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<tr>
<td>6. Specify Performance</td>
<td>For decision problems, specify the decision rule as a statistical hypothesis test, examine</td>
<td>Specification of the range of possible true values of the parameter of</td>
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<tr>
<td>or Acceptance Criteria</td>
<td>consequences of making incorrect decisions from the test, and place acceptable limits on the</td>
<td>interest that correspond to the baseline condition;</td>
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<td></td>
<td>likelihood of making decision errors;</td>
<td>Specification of the gray region containing possible true values of the</td>
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<tr>
<td></td>
<td>For estimation problems, specify acceptable limits on estimation uncertainty.</td>
<td>parameter of interest that fall within the alternative condition and for</td>
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<td></td>
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<td>which you can tolerate high probabilities of making false acceptance</td>
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<td></td>
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<td>decision errors;</td>
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<td>The set of tolerable decision error limits at selected true values of the</td>
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<td>parameter of interest (i.e., the boundaries of the gray region);</td>
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<td>The confidence level that specifies the likelihood that the confidence</td>
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<td>interval will contain the true value of the parameter;</td>
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</tbody>
</table>

- An acceptable width associated with the interval, expressed in either absolute or relative terms.
<table>
<thead>
<tr>
<th>DQO Step</th>
<th>Major DQO Activities in DQO Step</th>
<th>DQO Outputs</th>
<th>Activity and Output Completed? (Yes/No/N/A)</th>
<th>Rationale for Not Completing DQO Item</th>
</tr>
</thead>
</table>
| 7. Develop Plan for Obtaining Data | • Gathering information that you will need in developing an acceptable and efficient sampling and analysis design;  
• Identifying constraints that will impact the sampling and analysis design;  
• Providing details on the sampling and analysis methods you will use to generate the data;  
• Identifying one or more candidate designs from which to select;  
• Determining an “optimal” amount of information to collect for the potential design using statistical and cost considerations;  
• Preparing a resource-effective information collection plan that will meet your needs and requirements. | • Full documentation of the final sampling and analysis design, along with a discussion of the key assumptions underlying this design;  
• Details on how the design should be implemented together with contingency plans for unexpected events;  
• The Quality Assurance and Quality Control procedures that would be performed to detect and correct problems and so ensure defensible results.  
Elements of the design include, as applicable:  
• Number of samples;  
• Sample type (e.g., composite vs. individual samples);  
• General collection techniques (e.g., split spoon vs. core drill);  
• Physical sample (i.e., the amount of material to be collected for each sample);  
• Sample support (i.e., the area, or quantity that each individual sample represents);  
• Sample locations (surface coordinates and depth) and how they were selected;  
• Timing issues for sample collection, handling, and analysis;  
• Analytical methods (or performance-based measurement standards);  
• Statistical sampling scheme. | | |