Chapter 10: Quality Assurance of Environmental Surveillance Programs

CHAPTER 10

Quality assurance (QA) consists of planned and systematic activities that give confidence in effluent monitoring and environmental surveillance program results (NCRP 2012). Environmental surveillance programs should provide data of known quality for the assessments and decisions being made. Quality assurance and quality control programs were maintained by INL contractors and laboratories performing environmental analyses.

The subcontracted laboratories (e.g., ALS-Fort Collins, GEL-Charleston, SwRI) were rigorously assessed and audited by the U.S. Department of Energy (DOE) Consolidated Audit Program-Accreditation Program, an approved third-party accrediting body. Each laboratory maintained their accreditation for 2021. The accreditation qualifies the laboratories to receive, analyze, and report data to a DOE program. Idaho State University-Environmental Assessment Laboratory was audited in 2021 by the Idaho National Laboratory (INL) quality team and is listed in the Battelle Energy Alliance Qualified Suppliers List.

In addition to the quality assurance processes implemented by the INL contractors, the laboratories also utilize trained personnel, procedures, and quality assurance processes to ensure quality data. Data quality reviews were performed by the laboratory and any unusual conditions were addressed and identified in the case narrative prior to reporting to INL.

Field sampling elements, laboratory measurements (see Section 10.2), and performance evaluation samples were reviewed and evaluated for each INL contractor laboratory. Results are summarized in Section 10.4. Together this information was used to assess the quality of data provided to INL contractors, and to follow-up and/or conduct a corrective action to improve processes when necessary. This multi-faceted approach to quality assurance and quality control added value to each INL Site contractor's monitoring program by providing confidence that all laboratory data reported in this report are reliable and of acceptable quality.

10. QUALITY ASSURANCE OF ENVIRONMENTAL SURVEILLANCE PROGRAMS

This chapter describes specific measures taken to ensure adequate data quality and summarizes performance.

10.1 Quality Assurance Policy and Requirements

The primary policy, requirements, and responsibilities for ensuring QA in U.S. Department of Energy (DOE) activities are provided in:

- DOE O 414.1D, "Quality Assurance"
- 10 Code of Federal Regulations (CFR) 830, Subpart A, "Quality Assurance Requirements"
- U.S. Environmental Protection Agency (EPA) QA/G-4, Guidance on Systematic Planning Using the Data Quality Objective Process

Required Criteria of a Quality Program

- Quality assurance program
- Personnel training and qualification
- Quality improvement process
- Documents and records
- Established work processes
- Established standards for design and verification
- Established procurement requirements
- Inspection and acceptance testing
- Management assessment
- Independent assessment

- EPA Intergovernmental Data Quality Task Force, Uniform Federal Policy for Implementing Quality Systems, (Evaluating, Assessing, and Documenting Environmental Data Collection/Use and Technology Programs) (EPA 2005)
- American Society of Mechanical Engineers NQA-1-2012, "Quality Assurance Requirement for Nuclear Facility Applications."

These regulations specify 10 criteria of a quality program, presented in the gray text box on page 10-1. Additional quality assurance program requirements in 40 CFR 61, Appendix B, Method 114, must be met for all new point sources of radiological air emissions as required by 40 CFR 61, Subpart H.

Each Idaho National Laboratory (INL) Site contractor incorporates appropriate QA requirements to ensure that environmental samples are representative and complete, and that data are reliable and defensible.

10.2 Program Elements and Supporting QA Process

According to the National Council on Radiation Protection and Measurements (NCRP 2012), QA is an integral part of every aspect of an environmental surveillance program, from the reliability of sample collection through sample transport, storage, processing, and measurement, to calculating results and formulating the report. Uncertainties in the environmental surveillance process can lead to misinterpretation of data and/or errors in decisions based on these data. Every step in radiological effluent monitoring and environmental surveillance should be evaluated for integrity, and actions should be taken to evaluate and manage data uncertainty.

Meeting requirements of state regulations and DOE orders is an important part of developing a successful and defensible environmental surveillance program. Gathering of quantitative and qualitative environmental surveillance data is unique to each surveillance program. All data from planning, sample collection and handling, sample analysis, data review and evaluation, and reporting must be of known defensible accuracy, precision, completeness, and representativeness. Approved, detailed procedures are maintained, adequate training given, and documents controlled to ensure that data are of known and acceptable precision and accuracy.

The main elements of environmental surveillance programs implemented at the INL Site, as well as the QA processes/activities that support them, are shown in Figure 10-1 and discussed below.

10.2.1 Planning

Environmental surveillance activities are conducted by a variety of organizations including:

- Idaho National Laboratory contractor
- Idaho Cleanup Project Core contractor
- Environmental Surveillance, Education, and Research Program
- U.S. Geological Survey
- National Oceanic and Atmospheric Administration.

Each INL Site contractor determines sampling requirements using the U.S. Environmental Protection Agency (EPA) data quality objective (DQO) process (EPA 2006) or its equivalent. During this process, the project manager determines the type, amount, and quality of data needed to meet regulatory requirements, support decision making, and address stakeholder concerns.

Sitewide Monitoring Plans. The *Idaho National Laboratory Site Environmental Monitoring Plan* (DOE-ID 2021) and *Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update* (DOE-ID 2021) summarize the various monitoring programs at the INL Site, including compliance monitoring of airborne and liquid effluents; environmental surveillance of air, water (surface, drinking, and ground), soil, biota, agricultural products, and external radiation; and ecological and meteorological monitoring on and near the INL Site. The plans include the rationale for monitoring, the types of media monitored, where the monitoring is conducted, and information regarding access to analytical results.

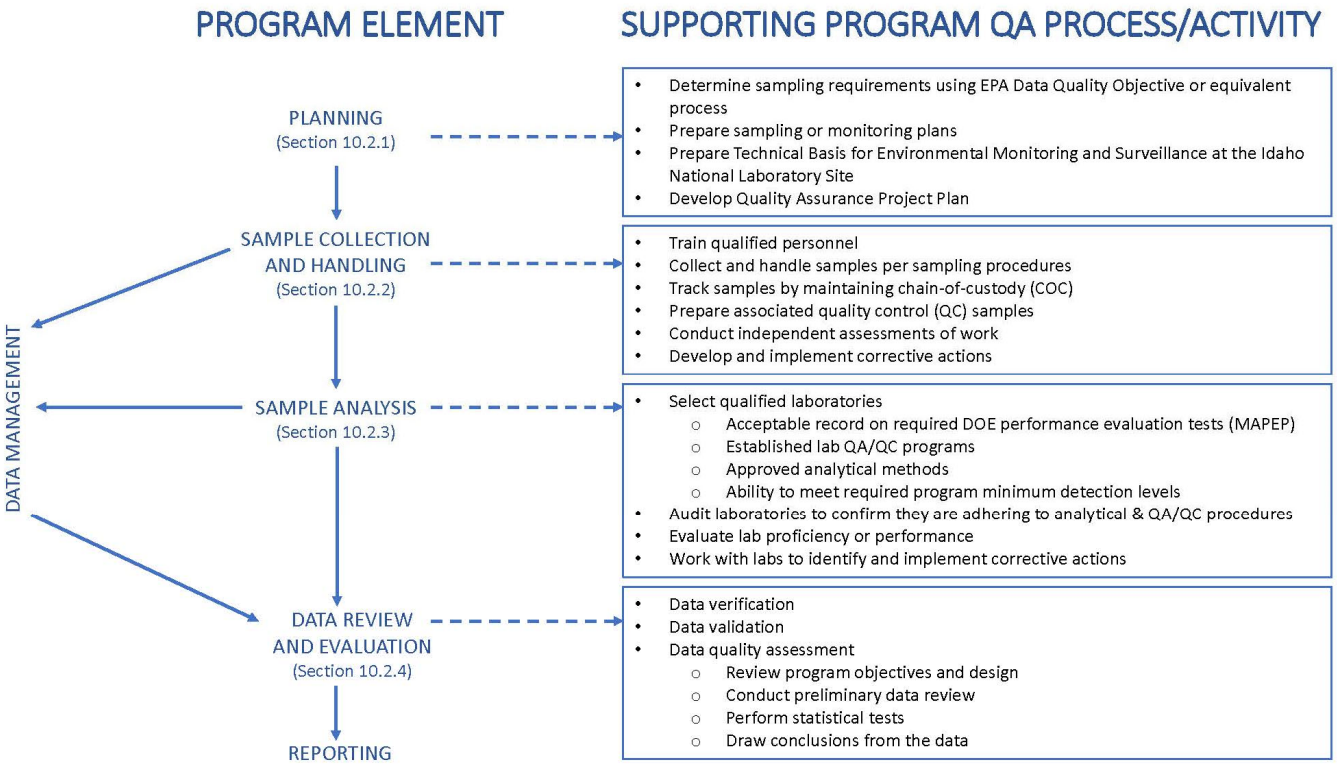

Figure 10-1. Flow of environmental surveillance program elements and associated QA processes and activities.

Quality Assurance Project Plan. Implementation of QA elements for sample collection and data assessment activities are documented by each INL Site contractor using the approach recommended by the EPA. The EPA policy on QA plans is based on the national consensus standard ANSI/ASQC E4-1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs." DQOs are project-dependent and are determined based on the needs of the data users' and the purpose for which that data are generated. DQOs, sampling and analysis plans, and *Technical Basis for Environmental Monitoring and Surveillance at the INL Site* (DOE/ID-11485) are integrated into the INL contractors QA Project Plans. Quality elements applicable to environmental surveillance and decision-making are specifically addressed in *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5) (EPA 2001).

What is the difference between Quality Assurance and Quality Control in an environmental program?

- Quality assurance (QA) is an integrated system of management activities designed to ensure quality in the processes used to produce environmental data. The goal of QA is to improve processes so that results are within acceptable ranges.
- Quality control (QC) is a set of activities that provide program oversight (i.e., a means to review and control the performance of various aspects of the QA program). QC provides assurance that the results are what is expected.

These elements are categorized as follows:

- Project management
- Data generation and acquisition
- Assessment and oversight
- Data verification/validation and usability.

A QA Project Plan documents the planning, implementation, and assessment procedures for a particular project, as well as any specific QA and QC activities. It integrates all technical and quality aspects of the project to provide a 'blueprint'

for obtaining the type and quality of environmental data and information needed for a specific decision or use. Each environmental surveillance program at the INL Site prepares a QA Project Plan.

10.2.2 Sample Collection and Handling

Defensible laboratory data is a critical component of any environmental program. Field sample collection and handling, coupled with a chain-of-custody showing unique sample identification, weight, volume, holding time, approved procedures, and request of laboratory analysis, are important steps of good defensible quality data. The QC elements used to obtain defensible quality data are described below.

Strict adherence to program procedures is an implicit foundation of QA. In 2021, samples were collected and handled according to documented program procedures. Samples were collected by trained personnel. Sample integrity was maintained through a system of sample custody records. Work execution assessments were routinely conducted by personnel independent of the work activity. Deficiencies were addressed by corrective actions, which are tracked in contractor-maintained corrective action tracking systems.

Field quality control sample elements, as shown in Figure 10-2, were also collected or prepared to check the quality of sampling processes. These included the collection of trip blanks, field blanks, equipment blanks, split samples, sample duplicates, and performance evaluation (PE) samples that are defined as follows:

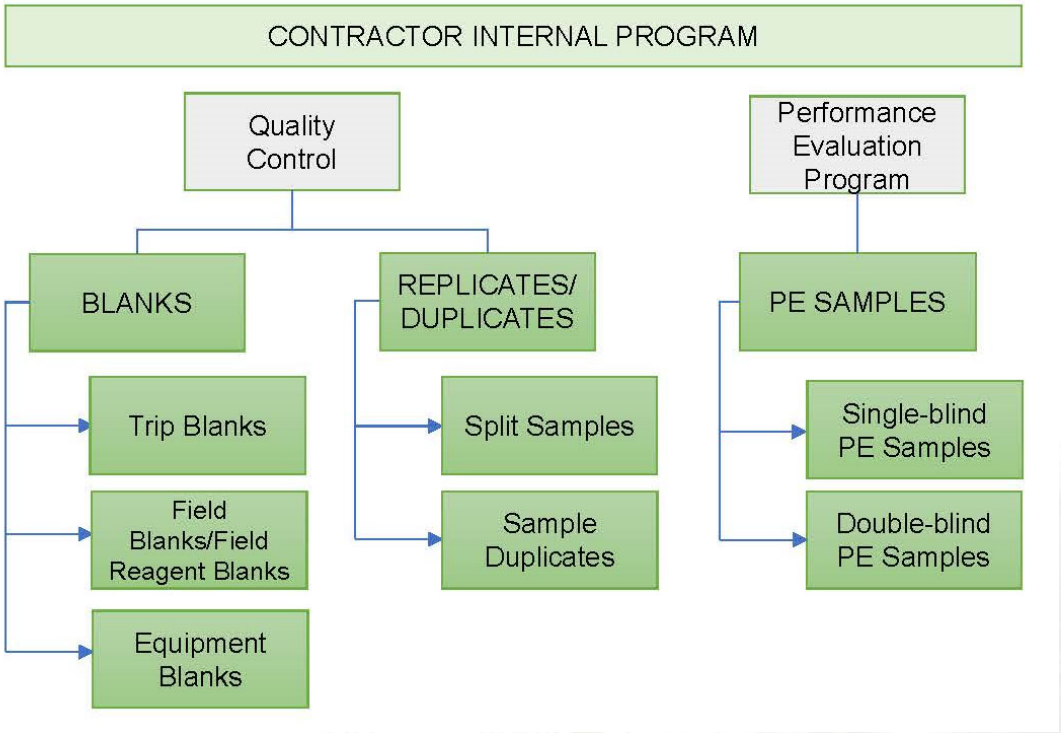

Figure 10-2. Field quality control sampling elements.

Blanks. The primary purpose of blanks (a sample of analyte-free media) is to trace sources of artificially introduced contamination. The INL contactors may utilize various types of blanks based on the samples being collected for a program or project.

- ***Trip Blank.*** The blank sample results can be used to identify and isolate the source of contamination introduced in the field or the laboratory. A trip blank is a clean sample of matrix taken from the sample preparation area to the sampling site and returned to the analytical laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures.

- ***Field Blank (also called Field Reagent Blank).*** A field blank is collected to assess the potential introduction of contaminants and the adequacy of field and laboratory protocols during sampling and laboratory analysis. In air sampling, a field blank is a clean, analyte-free filter that is carried to the sampling site, exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample. In water sampling, field blanks are prepared at the field site where environmental water samples are collected. A sample of analyte-free water is poured into the container in the field where environmental water samples are collected, preserved, and shipped to the laboratory with field samples. Results include relevant ambient conditions during sampling and laboratory sources of contamination.
- ***Equipment Blank.*** An equipment blank is a volume of laboratory-grade water that is used to rinse sampling equipment. The rinse water is collected and tested to verify that the sampling equipment is not contaminated. Equipment blank samples verify the effectiveness of the decontamination (cleaning) procedures on sampling equipment.

Replicate/Duplicate Samples. Field duplicate samples are used to assess precision. Duplicates also provide information on analytical variability caused by sample heterogeneity, collection methods, and laboratory procedures:

- ***Split Samples.*** A sample collected and later divided from the same container into two portions that are analyzed separately. Split samples are used to assess analytical precision.
- ***Sample Duplicate or Field Replicates (collocated samples).*** Two samples collected from a single location at the same time, stored in separate containers, and analyzed independently. In the case of air sampling, two air samplers are placed side by side and each filter is analyzed separately. Duplicates are useful in estimating the precision resulting from the sampling process.

PE Samples. PE samples are prepared samples that contain known values of analyte(s) of interest to the specific project, INL Site contractor program, or laboratory. PE samples are used to assess analytical method specific laboratory performance and to check that the laboratory can be within criteria set by the specific project or program for known value sample recovery. The samples are matched as closely as possible to the specific media, analytes of interest, and expected concentration or activity levels appropriate for the specific project, program, or use in decision-making. In some cases, the PE sample matrix may differ from the field samples (i.e., using deionized water with a known amount of analyte to simulate an atmospheric moisture sample). The PE samples are generally submitted with batches of field samples so they are processed simultaneously in the laboratory. Types of PE samples are described below:

- ***Single-blind PE Samples.*** The value of a single-blind PE sample is known to the INL contractor sending the sample but unknown to the laboratory receiving the sample.
- ***Double-blind PE Samples.*** The value of a double-blind PE sample is unknown to both the laboratory receiving the sample and the INL contractor. While the program specifies PE sample matrix and boundaries of the value's range (i.e., the known value must fall between a pre-determined minimum and maximum value that corresponds to the specific project or program), the actual value is unknown to both the INL Site contractor and the laboratory.

10.2.3 Sample Analysis

Laboratories used for routine analyses of radionuclides in environmental media were selected by INL contractors based on each laboratory's capabilities to meet program objectives, such as the ability to meet required detection levels, and past results in PT programs. Programs exist to help contract holders conduct and assess a laboratory's ongoing performance. Requirements for participation in specific programs are at the discretion of the contract holder. One program, the U.S. Department of Energy Consolidated Audit Program-Accreditation Program (DOECAP-AP), accredits laboratories in meeting requirements outlined in the Quality System Manual (QSM) (QSM 2021). No major findings were identified by the DOECAP-AP, an approved third-party auditors, that would influence the defensibility or quality of laboratory data in 2021. For more information on DOECAP-AP, visit the DOE Analytical Services Program webpage at www.energy.gov/ehss/analytical-services-program.

Laboratory data quality is continually verified by QC samples, as observed in Figure 10-3, and include: calibration verifications, blanks, replicates/duplicates, and intra-laboratory PE samples.

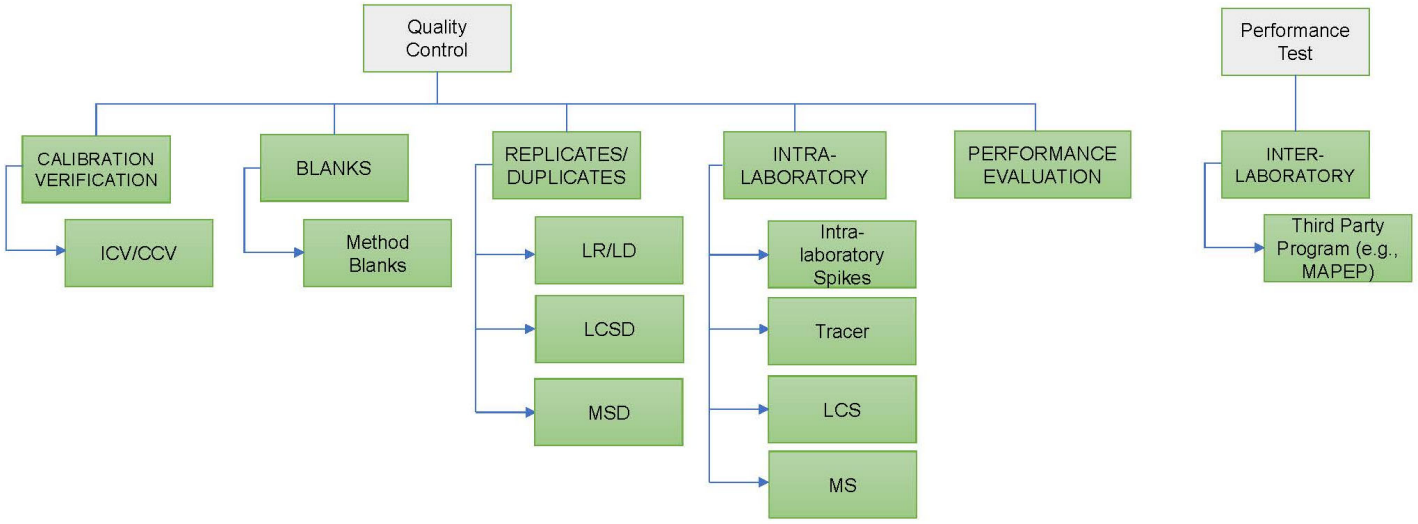

Figure 10-3. Laboratory measurement elements.

The types of QC samples used to assess the quality of laboratory analytical processes and their results are described below.

Calibration Verification. The calibration verification is used to check that the instrument is still within the original calibration of the instrumentation being used for analyses of the samples sent to the laboratory for the requested method and analytes requested on the chain-of-custody.

- ***Initial Calibration Verification (ICV) and Continuing Calibration Verification (CCV).*** The primary purpose of the ICV/CCV is to check the original calibration of the instrumentation being used to analyze samples for that method and targeted analytes. The ICV/CCV is from an external source different than that used in calibration.

Blanks. The primary purpose of blanks (e.g., a sample of analyte-free media) is to trace sources of artificially introduced contamination. Laboratory blanks assess the potential of contamination being introduced during the analytical laboratory process whereas field blanks are used to identify potential contamination that occurred during sample collection.

- ***Method Blank.*** A method blank is an analyte-free matrix such as distilled water for liquids or cleaned sand for solids and/or soils that is processed in the same way as the INL Site contractor program samples. The main function of the method blank is to document contamination resulting from the analytical laboratory process.

Replicate/Duplicate. Replicate/duplicate samples are used to assess precision. Replicates/duplicates also provide information on analytical variability caused by sample heterogeneity, collection methods, and laboratory procedures.

- ***Laboratory Replicate/Duplicate.*** Two aliquots from the same field sample are prepared by the laboratory and analyzed separately using identical procedures to assess the precision of a method in a given sample matrix.
- ***Laboratory Control Sample Duplicate (LCSD) analysis (accuracy and precision).*** The LCSD is used to determine the accuracy and precision, as well as bias of a method in each sample matrix.
- ***Matrix Spike Duplicate (MSD) analysis (accuracy and precision).*** The MSD is used to determine the accuracy and precision, as well as the bias of a method in each sample matrix.

Intra-laboratory samples. Intra-laboratory known value samples can be used to verify competency of the laboratory analysis method and analyst performing the sample preparation and analysis.

- ***Intra-laboratory PE.*** This is an internal laboratory quality program using their own known value sample program to test their laboratory for method performance.

- ***Tracer.*** Tracers are added to samples to determine the overall chemical yield for the analytical preparation steps. Tracers are the same element with a different isotope that are chemically similar. An example would be using ^{242}Pu as a tracer when analyzing for ^{238}Pu and ^{239}Pu.
- ***Laboratory Control Sample (LCS).*** The primary purpose of the LCS (accuracy) is to demonstrate that the laboratory can perform the overall analytical approach in a matrix free of interferences (e.g., reagent water, clean sand, or another suitable reference matrix) and its analytical system is in control but does not reflect analytical performance on analyzing real world samples.
- ***Laboratory Matrix Spike (MS).*** The purpose of the MS (accuracy) sample is to determine if the method is applicable to the sample matrix in question.

Performance Evaluation. This is either a single-blind or double-blind PE sample ideally using a similar matrix as the field samples being submitted by the INL contractor (see Section 10.2.2).

Inter-laboratory PT samples. This is an external PT and inter-laboratory comparison program accredited under the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC 17043:2010[E]). *The Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (QSM 2021) requires that laboratories receiving and analyzing samples for DOE contracts successfully participate in a PT program for one year before becoming an accredited laboratory to receive samples for analyses for all analytes, matrices, and methods included in the laboratory's scope of work. The inter-laboratory program requires that participating laboratories must analyze at least two sets of samples during a calendar year.

The analytical laboratory may use several of the laboratory QC measurement elements identified above. Results of the laboratory QC are presented to the INL contractors as a data package and provide assurance that the data reported is useable and defensible.

10.2.4 Data Review and Evaluation

Data generated from INL Site contractors are routinely evaluated in order to understand and sustain the quality of data. This allows the program to determine if the DQO's established in the planning phase were achieved and whether the laboratory is performing within its QA/QC requirements.

An essential component of data evaluation is the availability of reliable, accurate, and defensible records for all phases of the program, including sampling, analysis, and data management.

Environmental data are subject to data verification, data validation, and data quality assessment. These terms are discussed below:

Data Verification. The act of reviewing, inspecting, testing, checking, auditing, or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements. The data verification process involves checking for common errors associated with analytical data. A review is first conducted to ensure all data and sample documentation are present and complete. In addition, the following also may be reviewed—sample preservation and temperature, defensible chain-of-custody documentation and sample integrity, analytical hold-time compliance, correct test method application, adequate analytical recovery, correct minimum detection limit, possible cross-contamination, and matrix interference (i.e., analyses affected by dissolved inorganic/organic materials in the matrix).

Data Validation. Confirmation by examination and provision of objective evidence that the requirements for a specified intended use are fulfilled. Validation involves a more extensive process than data verification according to the *DOE Handbook–Environmental Radiological Monitoring and Environmental Surveillance* (DOE 2015).

Validation confirms that the required number of samples and types of data were collected in accordance with the INL Site contractor's environmental monitoring plans; confirms the usability of the data for the intended end use via validation of analyses performed and data reduction and reporting; and ensures that requirements were met, such as detection limits, QC measurements, impacts of qualifiers, etc.

Data Quality Assessment. Data quality assessment includes reviewing data for accuracy, representativeness, and, if available, consistency with historical measurements to ensure that the data support their intended uses. A preliminary data assessment is also performed to determine the structure of the data (i.e., distribution of data [normal, lognormal, exponential, or nonparametric]); identify relationships/associations, trends, or patterns between sample points/variables or over time; identify anomalies; and select the appropriate statistical tests for decision making.

The programs include results of individual program QC data, as well as the Mixed Analyte Performance Evaluation Program (MAPEP) PT. Individual QC programs include the use of several elements, as shown in Figure 10-2 and Figure 10-3, respectively, to evaluate the performance of a laboratory. These elements were previously discussed in Sections 10.2.2 and 10.2.3. Not all QC measurement elements are required unless specifically called out in each INL Site contractor program's contract with the laboratory, or as required by the specific analytical method.

Figure 10-4 shows a visual decision tree of the process used for reviewing PE sample results along with sample data. When QC sample results fall within the acceptable range for the INL contractors, review of the remaining data continues. If no issues are identified, the data package is approved. If a non-agreement (not acceptable) is encountered, the INL Site contractor reviews all available QC data to determine the course of action needed. Some of the items that may be reviewed include the following:

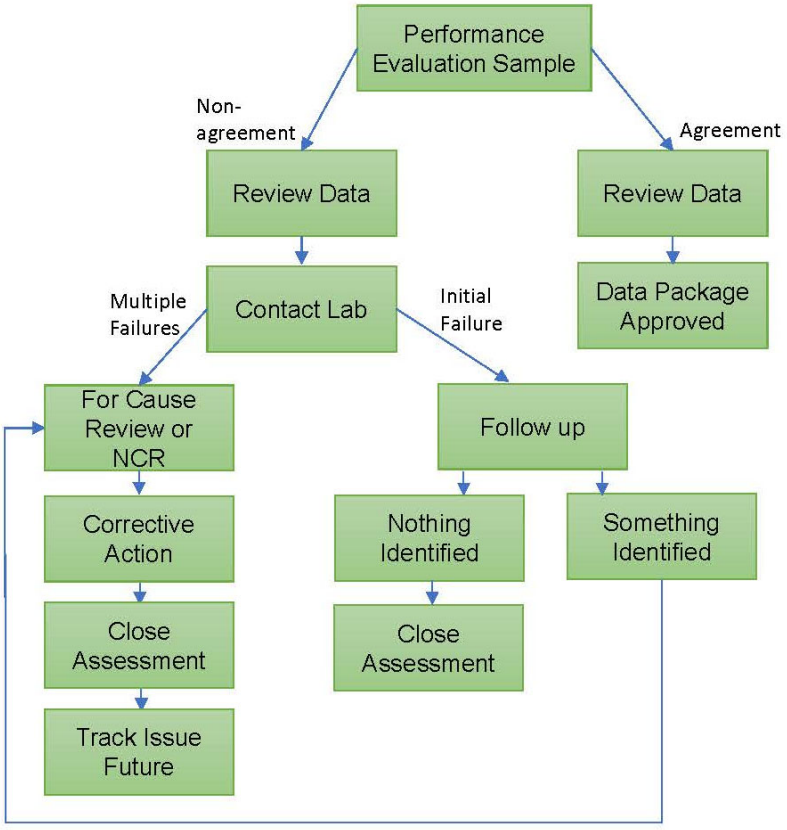

Figure 10-4. Environmental surveillance field sampling data QA review process.

- Did the PE sample provider prepare the sample (single-blind or double-blind) within the range specified by their customer? If yes, begin looking into the other QC data reported by the laboratory. If no, the PE sample may not be an accurate representation of the project-specific field conditions or field results. If the equipment is calibrated for the field concentration range, and the PE sample is not within that range, then the accuracy and representativeness of the PE sample may be called into question.

- Did the laboratory perform all required program- and method-specific QC analyses? Are these QC results within acceptable parameters or not?
- What does a review of the long-term project results indicate? Are all project-specific and analytic-method-specific QC results within specification? If not, does the laboratory have a history of out-of-specification QC results for a specific analyte, or is the new result a one-time anomaly?
- What does a review of long-term PE blind sample results indicate? Is the current 'not acceptable' result a one-time anomaly, or does the long-term data indicate a reoccurring or ongoing concern with accurate PE measurements of a specific analyte?
- What does a review of the long-term MAPEP PT results indicate?
- Do past DOECAP-AP third-party audits, provide insight into any ongoing analytical or QC concerns for this laboratory?
- What information is available from other laboratory accreditation bodies to provide insight into the laboratory's capabilities? Has the laboratory maintained its accreditations? Does the laboratory remain in good standing with these governing scientific bodies (i.e., Is there any reason to believe, based on the opinions/accreditation of the scientific professionals at these bodies, that the laboratory is not capable of accurately measuring the specific analytes in question)?
- Was there a complete dissolution of the sample?
- Was there an issue with the Laboratory Information Management System, or equivalent system, data reduction, or calculation issue?
- Was there incomplete purification of a sample from an interfering analyte? An example would be too much calcium present in a sample for ^{90}Sr analysis.

Upon review of the entire body of QC evidence described above, using both objective and subjective professional judgement, the INL Site contractor will determine if the 'not acceptable' result is a one-time anomaly or if the laboratory needs to implement any follow-up or corrective actions.

A 'For-Cause-Review' or 'Non-Conformance Report' is requested when either multiple blind PE sample issues occur consecutively, or as a result of a follow-up action. The For-Cause-Review would review laboratory data to investigate anything that may have been misreported (e.g., sample units, weights, calculations); whereas a Non-Conformance Report would generate a more rigorous laboratory review. Both the For-Cause-Review and Non-Conformance Report will result in a Corrective Action (CA) being issued which will resolve the problem and prevent future issues from occurring. Upon acceptance of the CA, the assessment would be closed and the issues discussed in the CA will be monitored in future data packages.

A follow-up action occurs after a single failure and may result in the laboratory not identifying any issues leading to the 'not acceptable' result. At this point the data package is good defensible data if the laboratory passed all of their qualifying criteria for the data package and that the following are within the laboratory quality criteria, as applicable: initial calibration verification, continuing calibration verification, method blank, LCS, MS, laboratory replicate, radioactive tracer recovery, and field blank(s). If a laboratory qualifying criteria is not met, the laboratory will re-prepare and re-analyze the samples; however, if enough of a sample is not available, the laboratory may flag their data if their radioactive tracer, LCS, laboratory replicate, or MS are not within their criteria. When the follow-up action identifies issue(s), either a For-Cause-Review or Non-Conformance Report may be requested.

If a laboratory were to have two consecutive sets of PE samples that were not within the acceptable criteria, the specific environmental laboratory project manager would be asked to demonstrate whether the issue in question was investigated, corrective measures were implemented, and additional PE samples were analyzed with results within the acceptable criteria. If the laboratory cannot identify any issues, the INL Site contractor will work with the laboratory to assist in the investigative process. For example, whether additional PE samples may be provided to the analytical laboratory

determine if any problems arise from sample preparation, data calculations, data entry into a database, etc. As a result, the laboratory will provide an acceptable CA to the INL Site contractor. The issue will be monitored for future PE samples. Depending on the severity, the contractor may hold onto samples until the issue is resolved and send a letter-of-concern to the laboratory. Based on the outcome of the investigation, the INL Site contractors may terminate the contract and seek another laboratory.

The PE samples that received a 'not acceptable' performance evaluation were reviewed as per the process discussed in Section 10.2.4. The 'not acceptable' findings are discussed in Sections 10.4.3.1, 10.4.3.2, and 10.4.4.3.

10.3 Inter-laboratory Program Performance Testing Evaluations

The MAPEP is an inter-laboratory program that uses PT evaluations to test the ability of the laboratories to correctly analyze for radiological, non-radiological, stable organic, and stable inorganic constituents' representative of those at DOE sites.

In 2021, all laboratories used by the INL Site contractors participated in two separate MAPEP PT program series. The matrices along with the radioanalytes of interest that received a MAPEP 'not acceptable' evaluation are discussed below. A 'not acceptable evaluation' is assigned to MAPEP results that are > +/-30% of the reference value. The analytical laboratory is responsible for reviewing their individual MAPEP results and to correct potential quality concerns identified by MAPEP. Additional information on MAPEP is available at: https://www.id.energy.gov/resl/mapep/mapep.html.

10.3.1 ALS-Fort Collins

For 2021, there were no analytes or sample matrices of interest that were outside the reference value criteria stated above.

10.3.2 GEL Laboratories

GEL Laboratories received "not acceptable" evaluations for ^{90}Sr in vegetation, ^{226}Ra in water and gross alpha in an air filter. Results for ^{90}Sr were not acceptable for vegetation in the first MAPEP series of 2021. A review of historical MAPEP results indicates this was a single event. Strontium-90 in vegetation will be monitored for future MAPEP results to identify consecutive "not acceptable" evaluations.

The 'not acceptable' evaluation for ^{226}Ra in water occurred in the second MAPEP series of 2021. Results for ^{226}Ra were acceptable in the first MAPEP series of 2021. Review of historical MAPEP results indicate the ^{226}Ra 'not acceptable' in 2021 was a single event and not a consecutive or ongoing non-agreement for MAPEP water media. Future ^{226}Ra MAPEP results will continue to be monitored for trends, and to determine if consecutive 'not acceptable' evaluations occur that require corrective actions by the laboratory.

GEL Laboratories received a 'not acceptable' evaluation for gross alpha in the second MAPEP series of 2021. The result for gross alpha was 'acceptable' in the first MAPEP series of 2021. Gross alpha in air filters is not a regular analyte and matrix of interest to the ICP Core contractor at this laboratory, although there was a single, non-routine sampling event in 2021 that analyzed for gross alpha in a stationary engine air filter. Although the MAPEP result for this analyte and matrix were not discussed with the laboratory, the data package contained other QC measures and underwent third-party validation. The gross alpha air filter 'not acceptable' was a single event for the 2021 MAPEP and will be followed for trending.

10.3.3 ISU-EAL

ISU-EAL received 'not acceptable' evaluations for several matrices and radioanalytes of interest. The matrices and respective radioanalytes include:

- air filter: gross alpha/gross beta
- water: gross alpha/gross beta, ^{57}Co, ^{60}Co
- vegetation: ^{57}Co, ^{60}Co, ^{134}Cs, ^{137}Cs, and ^{65}Zn.

The laboratory director identified issues with sample preparation and data management that is unique to MAPEP. A corrective action plan was developed by the analytical laboratory to prevent any future problems. The ISU-EAL performance will be monitored for future MAPEP PT program samples to identify consecutive 'not acceptable' evaluations.

10.3.4 SwRI

The SwRI was used for special sample analysis by the ICP Core contractor and was not used for routine environmental sampling and reporting.

10.4 Intra-laboratory Performance Evaluation Results

The INL Site contractors submitted blank and duplicate/replicate samples to identify potential contamination and estimate the variability of an analysis. Section 10.2.2 has a more in-depth description of blanks and duplicate/replicate samples. The results for blank and duplicate/replicate samples submitted by each contractor are discussed in Sections 10.4.1 and 10.4.2.

10.4.1 Blanks

The INL contractors submitted blank samples along with the field samples to test for the introduction of contamination during the process of field collection, laboratory preparation, and laboratory analysis. Section 10.2.2 provides a discussion on the various types of blank samples.

10.4.1.1 ESER Contractor Blank Results

In 2021, the ESER contractor submitted blank samples for air, milk, atmospheric moisture, and precipitation. ISU-EAL and GEL reported 616 separate analytes. The criteria were met by 601 out of 616 blank analytes. This meets the criteria in the quality assurance plan.

10.4.1.2 INL Contractor Blank Results

In 2021, the INL contractor submitted blank samples for air and atmospheric moisture. ALS-FC reported 294 separate analytes. The criteria were met by 284 out of 294 blank analytes. This meets the criteria in the quality assurance plan.

10.4.1.3 ICP Core Contractor Blank Results

In 2021, the ICP submitted 146 separate radioanalytes in field blank samples for water with GEL and ALS-Fort Collins, of which 138 did not report detectable activity in the sample. Field blanks were discontinued in 2018 for air filters.

10.4.1.4 USGS Blank Results

In 2021, the USGS INL Project office submitted five blank QA samples for routine groundwater monitoring. A request was made for six separate analytes for analysis by the PE sample provider. Of the requested analytes, none of the blank samples had detections above 3σ (Bartholomay and others, 2021; Rattray, 2014). This meets the criteria in the quality assurance plan.

10.4.2 Duplicate/Replicate Samples

The criteria for acceptable precision may vary by specific project or program based on the characteristics of the media being sampled and the decision-making purpose of the results. Section 10.2.2 provides a discussion on the various types of duplicate/replicate samples.

10.4.2.1 ESER Duplicate/Replicate Results

In 2021, the ESER contractor requested 258 field duplicate analyte pairs for air, milk, agricultural products, and water (drinking water and surface water). The QC criteria for acceptability specifies the relative percent difference determined from field duplicates should be +/- 20% for 98% of the analyses and the QC criteria were met by 253 out of 258 separate analytes and meets the criteria in the quality assurance plan.

10.4.2.2 INL Contractor Duplicate/Replicate Results

Air

In 2021, the INL contractor requested analysis of 563 field duplicate pairs. The air QC criteria for laboratories supporting the program is that at least 90% of the samples submitted annually, must be successfully analyzed and reported according to specified procedures. The results for 547 of 563 (97%) passed the precision criteria for field duplicate samples.

Water

In 2021, the INL contractor water programs requested the analysis of 107 field duplicate analyte pairs. The water QC criteria for acceptability specifies the relative percent difference determined from the field duplicates should be 35% or less for 90% of the analyses. The results for 105 of the 107 (98.1%) duplicate pairs were less than 35% for 2021.

10.4.2.3 ICP Core Contractor Duplicate/Replicate Results

Air

In 2021, the ICP Core contractor requested the analysis of 153 field duplicate pairs for the environmental surveillance air program, of which 143 were determined to be 'acceptable.' Accordingly, total precision for air samples across all projects was 93.5%, which does not indicate an issue with the ICP Core contractor samples.

Water

In 2021, the ICP Core Contractor requested 110 field duplicate pairs for radiological analysis of various environmental monitoring water projects across the site, of which 103 were determined to be 'acceptable.' Accordingly, the total precision for water samples across all projects was 93.6%, which does not indicate an issue with ICP Core contractor samples.

10.4.2.4 USGS Duplicate/Replicate Results

In 2021, the USGS INL Project Office collected sample-replicate pairs from 15 groundwater monitoring wells. A request was made for a total of 41 field sample-replicate analyte pairs by the PE sample provider. The sample-replicate pair variability was determined by calculating normalized absolute difference for the radionuclide results. Evaluation of the 41 sample-replicate pairs, where eight of these pairs had a detection above 3σ, show 100% of the results had a calculated normalized absolute difference < 1.96. These results are in concordance with our stated QA requirements for sample-replicate pairs (Bartholomay and others, 2021; Rattray 2014).

10.4.3 PE Samples

All laboratories used by the INL Site contractors were provided single- or double-blind PE samples throughout the 2021. The sample matrices sent to the laboratories included: air filter, water (e.g., drinking water, atmospheric moisture, surface water, groundwater, effluent, precipitation), milk, soil, and agricultural products. The methods of analysis included: gamma spectroscopy, alpha spectroscopy, beta spectroscopy, and liquid scintillation. In 2021, INL Site contractor monitoring programs issued 253 individual performance tests; 226 were within acceptable criteria. Upon evaluation of all QC evidence available, it was determined that performance tests that did not meet acceptance criteria did not affect the defensibility or usability of the INL Site contractor's results. Additional information regarding the 2021 performance tests that did not meet acceptance criteria is presented in Sections 10.4.3.1, 10.4.3.2, and 10.4.3.3.

10.4.3.1 ESER Blind PEs

A total of 53 analytes were analyzed by GEL Laboratories and ISU-EAL in 2021. GEL Laboratories received a non-agreement for americium-241 (^{241}Am), ^{238}Pu, ^{239}Pu, and ^{90}Sr for two sets of quarterly air filter composites for 2021. GEL Laboratories received a non-agreement for ^{90}Sr in one of two milk samples in 2021. ISU-EAL had an 'acceptable' agreement for all blind PE samples analyzed in 2021.

The GEL project manager was contacted after each non-agreement PE recovery analysis was received. GEL researched the first set of quarterly air filter composite results and did not find anything that would contribute to the low recovery results. GEL was contacted again by the ESER program regarding the second non-agreement PE recovery analysis.

GEL created an NCR to conduct a more rigorous assessment of the issue. A PE set of two quarterly composite samples with known values were sent to GEL to assist with their evaluation of preparing and analyzing the quarterly composites sent to them for alpha spectroscopy (e.g., ^{241}Am, ^{238}Pu, ^{239}Pu) and ^{90}Sr analysis. GEL Laboratories is compiling the analysis results for their internal assessment and will report the results when available. Quarterly air filter composite samples will not be shipped to GEL for analyses until this issue is resolved. The non-agreement for one of the ^{90}Sr in milk, was just outside the reference value. The second milk sample was within the known reference value; no trend was identified for 2021.

10.4.3.2 INL Contractor Blind PEs

A total of 106 analytes were analyzed by ALS and GEL Laboratories for air, milk, and water in 2021. ALS received a 'not acceptable' evaluation for ^{241}Am, ^{238}Pu, and $^{239/240}$Pu for quarterly air filter composites and GEL received a 'not acceptable' evaluation for ^{241}Am and ^{226}Ra in water.

A total of four PE quarterly composite samples were submitted to ALS during 2021. At least one non-agreement was received for ^{241}Am, ^{238}Pu, $^{239/240}$Pu, and ^{90}Sr. The INL contractor contacted ALS regarding the non-agreement results and is awaiting a response from ALS.

Seventy PE water results were analyzed by GEL in 2021, seven received a non-agreement including three gamma spectroscopy results for ^{241}Am and four gamma spectroscopy results for radium-226 (^{226}Ra). Americium-241 and ^{226}Ra emit gamma and alpha radiation. Gamma spectroscopy results for ^{241}Am and ^{226}Ra are used as a screening tool for these project-specific systems in which these analytes are not expected. Additional analysis of field samples for ^{241}Am and ^{226}Ra, using analyte-specific methods, can be performed if the program determines the gamma spectroscopy screening results exceed certain thresholds. The thresholds were not exceeded in the field samples. Review of the ^{226}Ra PE results indicate the PE sample provider prepared all four PE non-agreement samples at levels less than the contractual detection limits of the laboratory. Two of the four ^{226}Ra non-agreement results were correctly noted by the laboratory and that the results were below the contractual minimum detection limit. The PE provider's non-agreement conclusion (not being within 30% of the known values) is considered correct because the PE samples were prepared at levels below the required detection limits. The other two ^{226}Ra PE results were reported as suspected false-positives by the laboratory, meaning the laboratory detected 'something' but the results were less than 3-times the uncertainty and below the minimum required detection level. The 2021 PE provider's non-agreement results were submitted to GEL Laboratory for evaluation. No findings or gamma spectroscopy QC deficiencies requiring CA were reported by GEL. The INL contractor will continue to evaluate future PE sample results for trends and concerns that may require CAs by the laboratory.

10.4.3.3 ICP Core Blind PEs

A total of 99 analytes were analyzed in 2021 for both GEL Laboratories and ALS-Fort Collins. GEL Laboratories received a non-agreement for tritium, ^{90}Sr, and technetium-99 for water samples in 2021. At ICP Core, when a laboratory has a non-agreement assigned, the Sample and Analysis Management office informs the project managers and participating laboratories of the results and requests the laboratory to investigate. For the discrepancies in agreement for 2021, GEL investigated the results and reported back that there were no specific findings that required CAs. GEL reported there was an error in the initial aliquot of the ^{90}Sr sample. A new aliquot was prepared and re-analyzed and the results met the acceptance criteria. Based on the review of all of the quality data presented, there is no indication that there is an issue with the accuracy or defensibility of the field data results.

10.5 Conclusions

The quality elements presented in Figure 10-1 were implemented in 2021. Field sampling elements, as provided in Figure 10-2, laboratory measurements, as outlined in Figure 10-3, and PE samples were reviewed and evaluated for each INL Site contractor laboratory and are summarized in Section 10.4. INL Site contractors scrutinized all recognized performance matters to understand potential impacts on the quality and value of results provided and reconciled issues of concern. It has been determined that all laboratory data presented in this report are reliable and of applicable quality.

10.6 References

10 CFR 830, 2022, Subpart A, "Quality Assurance Requirements," *Code of Federal Regulations*, Office of the Federal Register. Available electronically at https://www.ecfr.gov/cgi-bin/text-idx?SID=074233709c29153b42bc0e7e25e68307&mc=true&node=sp40.10.61.a&rgn=div6.

40 CFR 61, 2022, Appendix B, "Test Methods, Method 114, Test Methods for Measuring Radionuclide Emissions from Stationary Sources," *Code of Federal Regulations*, Office of the Federal Register. Available electronically at https://www.ecfr.gov/cgi-bin/text-idx?SID=11c3269295aab799456dcba14addb85a&mc=true&node=pt40.10.61&rgn=div5#ap40.10.61_1359.c.

40 CFR 61, 2022, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," *Code of Federal Regulations*, Office of the Federal Register. Available electronically at https://www.ecfr.gov/cgi-bin/text-idx?SID=11c3269295aab799456dcba14addb85a&mc=true&node=pt40.10.61&rgn=div5#ap40.10.61_1359.c.

ANSI/ASQC E4-1994, 1994, "Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs," *American National Standards Institute/American Society for Quality Control*.

American Society of Mechanical Engineers NQA-1, 2012, "Quality Assurance Requirements for Nuclear Facility Applications," *American Society of Mechanical Engineers*.

Bartholomay, R. C., N. V. Maimer, A. J. Wehnke, and S. L. Helmuth, 2021, *Field methods, quality-assurance, and data management plan for water-quality activities and water-level measurements, Idaho National Laboratory, Idaho: U.S. Geological Survey Open-File Report 2021-1004*, 76 p. Available electronically at https://doi.org/10.3133/ofr20211004.

DOE, 2015, DOE Handbook – Environmental Radiological Effluent Monitoring and Environmental Surveillance, DOE-HDBK-1216-2015, U.S. Department of Energy.

DOE O 414.1D, 2011, "Quality Assurance," U.S. Department of Energy.

DOE-ID, 2021, *Idaho National Laboratory Site Environmental Monitoring Plan*, DOE/ID-11088, Rev. 5, U.S. Department of Energy–Idaho Operations Office, October 2021.

DOE-ID, 2021, *Idaho National Laboratory Groundwater Monitoring and Contingency Plan Update*, DOE/ID-11034, Rev. 4, U.S. Department of Energy–Idaho Operations Office, July 2021.

EPA, 2001, *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5), EPA/240/B-01/003, U.S. Environmental Protection Agency.

EPA, 2005, Intergovernmental Data Quality Task Force, *Uniform Federal Policy for Implementing Environmental Data Quality Systems*, EPA-505-F-03-001, U.S. Environmental Protection Agency, March 2005.

EPA, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process (EPA QA/G-4)*, EPA/240/B-06/001, U.S. Environmental Protection Agency, February 2006.

ISO/IEC 17043:2010E, 2010, *Conformity assessment – General requirements for proficiency testing,* International Organization for Standardization/International Electrotechnical Commission.

NCRP, 2012, *Design of Effective Radiological Effluent Monitoring and Environmental Surveillance Program*, NCRP Report No. 169, National Council on Radiation Protection and Measurements.

QSM, 2021, *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories.* Based on ISO/IEC 17025:2017(E) and The NELAC Institute (TNI) Standards, Volume 1, (September 2009). DoD Quality Systems Manual Version 5.4 (2021).

Rattray, G. W., 2014, *Evaluation of quality-control data collected by the U.S. Geological Survey for routine water-quality activities at the Idaho National Laboratory and vicinity, southeastern Idaho, 2002-08: U.S. Geological Survey Scientific Investigations Report 2014-5027* (DOE/ID--22228), 66 p. Available electronically at https://doi.org/10.3133/sir20145027.