12.0 Quality Assurance

WS Thompson

Quality assurance (QA) and quality control (QC) practices encompass all aspects of Hanford Site environmental monitoring and surveillance activities. Hanford Site contractors, subcontractors, and multiple DOE organizations are involved in and conduct environmental monitoring and surveillance activities independently, each driven by different missions and regulatory requirements but with the same goal in mind. This section describes the Environmental Surveillance program, part of the Public Safety and Resource Protection Program (PSRP) managed by MSA. The Environmental Surveillance program includes environmental surveillance and monitoring across multiple media types both on and off the Hanford Site. The program conducts multi-media environmental monitoring to assess Hanford Site and off-site human health exposures to radionuclides and chemicals and evaluate the potential impact of site operations on the environment. This section provides information on specific measures taken in 2015 to ensure quality and defensibility in project management, sample collection, and analytical results.

Note: Because of the complexity of the groundwater program, QA/QC specifications for groundwater sampling and program management are reported independently in the *Hanford Site Groundwater Monitoring Report for 2015* (DOE/RL-2016-09) and are not discussed in this section.

Quality assurances and controls of the Hanford Site and offsite surveillance programs are documented through QA program plans and describe applicable QA elements (e.g., MSC-23333, *Environmental Quality Assurance Program Plan*). Sample analyses across all media types are performed by contracted laboratories, which are also required to meet these plan specifications. To ensure the highest quality data are obtained, accredited off-site laboratories used were audited for equipment and services before the contract awards were made.

12.1 Program Management

Per federal requirements, environmental surveillance activities are subject to an overall QA program that satisfies requirements for collecting and assessing environmental data in compliance with the following:

- 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements"
- DOE O 414.1D, *Quality Assurance*
- Analytical Services - Hanford Site, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- *EPA Requirements for Quality Assurance Project Plans* (EPA 2001b)
- Richland Requirements Document 008, Quality Assurance Program Requirements
- Project-specific QA plans and documentation are found in MSC-23333 and describe the QA/QC elements associated with the Environmental Surveillance program.

DOE O 414.1D
QA Program Requirements

Management/QA Program
Personnel Training/Qualification
Quality Improvement
Documents and Records
Work Processes
Design
Procurement
Inspection and Acceptance Testing
Management Assessment
Independent Assessment

Personnel Training and Qualifications

Hanford Site personnel are provided with the knowledge and skills necessary to perform specific jobs safely, effectively, and efficiently with minimal supervision. This capacity is accomplished by establishing and enforcing site-wide policies, procedures, and guidance through training programs that provide general and specialized training classes and housing hands-on training facilities dedicated to ensuring personnel are qualified and confident to perform the task safely. The following principles and practices are included in the training program and are documented in MSC-23333:

- Develop training standards and procedures that meet valid requirements and regulations and are consistent with industry-proven best management practices
- Recognize management's responsibility to lead and coach their employees to ensure employees are trained and remain proficient to perform assigned tasks
- Conduct evaluations of employee training to ensure regulatory compliance, compliance with standards and instructions, and improve the training process
- Employ instructional staff and subject matter experts who are qualified and maintain their instructional and subject area skills and knowledge
- Use a graded approach to develop training programs to ensure value and effectiveness.

12.2 Quality Control Samples

Several types of QC samples are collected during monitoring and sampling events. The QC samples are in place to help reduce data uncertainty and collect the highest quality data possible. The tasks vary by monitoring and sampling event, and QC procedures are followed in the field and laboratory to ensure that reliable data are obtained.

Field environmental QC samples are collected to evaluate the potential for cross-contamination and provide information pertinent to field variability. Field QC samples require the collection of field duplicates, trip or field blanks, and equipment blanks. Laboratory QC samples estimate the precision and accuracy of the analytical data and include method blanks, laboratory replicates, matrix spikes, and matrix spike duplicates. Table 12.1 summarizes the different types, characteristics, and frequency of QC samples. A QC sample frequency goal of 5% (1 in 20 samples) where feasible is set for environmental surveillance activities on the Hanford Site for the number of QC samples needed for environmental data collection and surveillance activities.

Table 12.1. Field and Laboratory Quality Control Sample Types, Characteristics, and Frequency

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC Samples		
Field trip blank (FTB)	Volatile organic compound cross-contamination from other sources during transportation	1 per field trip
Equipment blank (EB)	Cross-contamination from non-dedicated equipment	1 per sampling method type per year for selected analytes
Duplicate	Reproducibility	1 per 20 samples, where feasible
Laboratory QC Samples		
Method blank	Laboratory contamination	As defined in the laboratory contract or QA plan, and/or analysis procedures.
Laboratory replicate	Laboratory reproducibility	
Matrix spike	Matrix effect and laboratory accuracy	
Matrix spike duplicate	Laboratory reproducibility/accuracy	

Blanks. A sample of the carrying agent (gas, liquid, or solid) normally used to measure selectively a material of interest subjected to the usual analytical process and associated procedures to establish a baseline or background value. This value is then used to adjust or correct the routine analytical results.

Field Duplicate Samples. Two samples produced from material collected in the same location at roughly the same time. The parent sample and its duplicate are each uniquely labeled and used to provide information on the homogeneity of the matrix and ensure consistency in sample collection procedures.

Laboratory Replicate Sample. A single sample aliquoted alternately into two sets of sample containers for duplicate analysis by the primary laboratory. Replicates are a measure of variation of aliquots analyzed from the same sample.

Spiked Sample. A normal sample of material (gas, liquid, or solid) to which a known amount of some substance of interest is added. Spiked samples check the accuracy of a routine analysis or the recovery efficiency of an analytical method. Spiked samples are exclusively used by the laboratory.

12.3 Sample Collection Quality Assurance and Quality Control

Trained personnel collected environmental samples for air, surface water, biota (wildlife and food/farm products), soil and vegetation, and sediment in accordance with approved desk instructions or procedures. Established sampling locations were accurately identified with visible postings or plotted GPS readings and documented to ensure data continuity. In 2015, collected environmental samples were submitted to General Engineering Laboratories, LLC (GEL) or TestAmerica Richland Laboratories (TARL; Table 12.2).

Table 12.2. Laboratories and Types of Environmental Surveillance Samples Analyzed

	Environmental Monitoring and Surveillance Samples			
Analytical Laboratory	**Air**	**Water**	**Biota**	**Other**
TARL (TestAmerica Richland Laboratory)	X			X
GEL (General Engineering Laboratories, LLC)	X	X	X	X

Personnel are trained to conduct sampling in accordance with approved schedules, instructions, and procedures. Field assessments are routinely performed by media task leads and documented. Field duplicate samples are used to assess sampling and measurement precision. In 2015, duplicate samples were collected and analyzed for air, soil, Columbia River water, natural vegetation, milk, wine, mulberries, wildlife, irrigation water, sediment, and seep samples (Table 12.3).

Table 12.3. Field Duplicate Samples and Locations

Media	Location	Number of Samples
Air	Various	39
Columbia River Water	Richland Pumphouse – Hanford River Mile (HRM) 46.4	1
Columbia River Water	Priest Rapids Dam	2
Columbia River Water Transects	Various	4
Irrigation Water	Horn Rapids Area	1
Milk	East Wahluke Area	1
Mulberries	100-N Area	3
Natural Vegetation	Various	5
Sediment	West Lake	1
Sediment	Columbia River	1
Seep	300 Area	1
Seep	100-K Area	1
Soil	Various	8
Wine	Columbia Basin	2
Wildlife	Various	9

Analytical results for on- and off-site parent and duplicate samples were reviewed against the criterion that the result must be greater than the minimum detectable activity value or method detection limit to be evaluated (commonly known as a detect). To be considered an acceptable result (within the control limits), the relative percent difference (RPD) of the detected routine sample and its duplicate must be less than 30%. Duplicate results for 2015 are shown in Table 12.4.

Relative Percent Difference (RPD)

A measure of precision of the measurement of a sample (S) and its duplicate (D). The formula is as follows:

$$RPD = \left(\frac{|S - D|}{\frac{(S + D)}{2}} \right) \times 100$$

Table 12.4. Field Duplicate Sample Results

Media	Detected Analytes	Number of Results Within Control Limits*	Percent of Results within Control Limits
Radionuclides			
Air	Alpha (gross)	31 of 39	79
	Beta (gross)	31 of 39	79
	Americium-241	4 of 4	100
	Antimony-125	4 of 4	100
	Colbalt-60	4 of 4	100
	Cesium-134	4 of 4	100
	Cesium-137	4 of 4	100
	Europium-152	4 of 4	100
	Europium-154	4 of 4	100
	Europium-155	4 of 4	100
	Hydrogen-3 (tritium)	14 of 14	100
	Plutonium-238	4 of 4	100
	Plutonium-239/-240	4 of 4	100
	Potassium-40	4 of 4	100
	Ruthenium-106	4 of 4	100
	Strontium-90	4 of 4	100
	Uranium-234	4 of 4	100
	Uranium-235	4 of 4	100
	Uranium-238	4 of 4	100
Soil	Antimony-125	8 of 8	100
	Cesium-134	7 of 8	87
	Cesium-137	7 of 8	87
	Cobalt-60	8 of 8	100
	Europium-152	8 of 8	100
	Europium-154	8 of 8	100
	Europium-155	8 of 8	100
	Plutonium-238	8 of 8	100
	Plutonium-239/-240	8 of 8	100
	Potassium-40	8 of 8	100
	Ruthenium-106	8 of 8	100
	Strontium-90	8 of 8	100
	Uranium-234	8 of 8	100
	Uranium-235	8 of 8	100
	Uranium-238	8 of 8	100
Natural Vegetation	Antimony-125	5 of 5	100
	Cesium-134	5 of 5	100
	Cesium-137	5 of 5	100
	Cobalt-60	5 of 5	100

Table 12.4. Field Duplicate Sample Results

Media	Detected Analytes	Number of Results Within Control Limits*	Percent of Results within Control Limits
	Europium-152	5 of 5	100
	Europium-154	5 of 5	100
	Europium-155	5 of 5	100
	Plutonium-238	5 of 5	100
	Plutonium-239/-240	5 of 5	100
	Potassium-40	5 of 5	100
	Ruthenium-106	5 of 5	100
	Strontium-90	5 of 5	100
	Uranium-234	5 of 5	100
	Uranium-235	5 of 5	100
	Uranium-238	5 of 5	100
Mulberries			
Bark	Strontium-90	1 of 1	100
	Uranium-234	0 of 1	0
	Uranium-238	1 of 1	100
Fruit	Potassium-40	1 of 1	100
	Uranium-235	0 of 1	0
	Uranium-238	0 of 1	0
Leaves	Beryllium-7	0 of 1	0
	Potassium-40	1 of 1	100
	Strontium-90	0 of 1	0
	Tritium	1 of 1	100
	Uranium-234	1 of 1	100
	Uranium-235	1 of 1	100
	Uranium-238	1 of 1	100
Farm Products			
Milk	Hydrogen-3 (tritium)	1 of 1	100
	Potassium-40	1 of 1	100
Wine	Hydrogen-3 (tritium)	1 of 2	50
	Potassium-40	2 of 2	100
Surface Water			
Columbia River	Hydrogen-3 (tritium)	1 of 2	50
	Uranium-234	2 of 2	100
	Uranium-238	2 of 2	100
Seep	Alpha (gross)	1 of 1	100
	Beta (gross)	1 of 1	100
	Hydrogen-3 (tritium)	1 of 1	100
	Uranium-234	1 of 1	100
	Uranium-235	1 of 1	100
	Uranium-238	1 of 1	100
Columbia River Transects	Hydrogen-3 (tritium)	4 of 4	100
	Uranium-234	3 of 4	75
	Uranium-235	1 of 2	50
	Uranium-238	3 of 4	75
Off-site Irrigation	Hydrogen-3 (tritium)	1 of 1	100

Table 12.4. Field Duplicate Sample Results

Media	Detected Analytes	Number of Results Within Control Limits*	Percent of Results within Control Limits
Sediment			
West Lake Sediment	Cesium-137	1 of 1	100
	Alpha (gross)	1 of 1	100
	Beta (gross)	1 of 1	100
	Potassium-40	1 of 1	100
	Uranium-234	1 of 1	100
	Uranium-235	1 of 1	100
	Uranium-238	1 of 1	100
Columbia River Sediment	Cesium-137	1 of 1	100
	Plutonium-239/-240	1 of 1	100
	Potassium-40	1 of 1	100
	Uranium-234	1 of 1	100
	Uranium-235	1 of 1	100
	Uranium-238	1 of 1	100
Wildlife	Cesium-137	1 of 1	100
	Potassium-40	5 of 5	100
	Uranium-234	1 of 1	100
	Uranium-238	1 of 1	100
Anions			
Surface Water Transects	Chloride	4 of 4	100
	Fluoride	4 of 4	100
	Nitrate	4 of 4	100
	Sulfate	4 of 4	100
Seep	Bromide		
	Chloride	1 of 1	100
	Fluoride	1 of 1	100
	Nitrate	1 of 1	100
	Sulfate	1 of 1	100
Columbia River Sediment	Chloride	1 of 1	100
	Sulfate	1 of 1	100
Metals			
Surface Water Transects	Aluminum	3 of 3	100
	Barium (filtered)	4 of 4	100
	Barium (non-filtered)	4 of 4	100
	Boron (filtered)	3 of 4	75
	Boron (non-filtered)	4 of 4	100
	Calcium (filtered)	4 of 4	100
	Calcium (non-filtered)	4 of 4	100
	Cobalt (filtered)	0 of 3	0
	Copper (filtered)	3 of 4	75
	Copper (non-filtered)	4 of 4	100
	Iron (non-filtered)	1 of 1	100
	Magnesium (filtered)	4 of 4	100
	Magnesium (non-filtered)	4 of 4	100
	Manganese (filtered)	2 of 3	67
	Manganese (non-filtered)	4 of 4	100
	Molybdenum (filtered)	4 of 4	100
	Molybdenum (non-filtered)	4 of 4	100
	Potassium (filtered)	4 of 4	100
	Potassium (non-filtered)	4 of 4	100

Table 12.4. Field Duplicate Sample Results

Media	Detected Analytes	Number of Results Within Control Limits*	Percent of Results within Control Limits
	Sodium (filtered)	4 of 4	100
	Sodium (non-filtered)	4 of 4	100
	Strontium (filtered)	4 of 4	100
	Strontium (non-filtered)	4 of 4	100
	Uranium (filtered)	4 of 4	100
	Uranium (non-filtered)	4 of 4	100
	Vanadium (filtered)	1 of 1	100
	Vanadium (non-filtered)	2 of 2	100
	Zinc (filtered)	1 of 1	100
	Zinc (non-filtered)	1 of 1	100
Wildlife	Copper	1 of 3	33
	Mercury	2 of 2	100
	Selenium	1 of 1	100
	Thorium	1 of 1	100
	Zinc	2 of 3	67
Columbia River Sediment	Antimony	0 of 1	0
	Arsenic	1 of 1	100
	Cadmium	1 of 1	100
	Chromium	1 of 1	100
	Copper	1 of 1	100
	Hexavalent chromium	0 of 1	0
	Lead	1 of 1	100
	Mercury	0 of 1	0
	Nickel	1 of 1	100
	Zinc	1 of 1	100
Volatile Organics			
Seep	Trichlorethene	1 of 1	100
Other			
Columbia River Sediment	Total Organic Carbon	0 of 1	0

*Number of reported results within control limits are those with the RPD value less than 30%, and the result is greater than the minimum detectable activity or method detection limit.

12.4 Media Audits and Comparisons

Selected sediment, surface water, food and farm products, wildlife, soil, and vegetation samples are provided to the WDOH for comparative analysis as part of the Public Safety and Resource Protection QA program (DOE/RL-91-50). The Hanford Environmental Radiation Oversight Program of the WDOH independently verifies the quality of DOE monitoring programs at the Hanford Site. Since 1985, WDOH and DOE have collaboratively participated in the collection of environmental samples located on or in the surrounding areas of the Hanford Site (DOH 320-111, *Hanford Environmental Radiation Oversight Program: 2014 Data Summary Report*). This includes but is not limited to conducting split, collocated, and independent sampling at locations that have the potential to release radionuclides to the environment or that could be impacted by such releases. This program is not intended to characterize completely the environmental radiation on the Hanford Site but provides oversight to Hanford Site contractors in determining the impact of Hanford releases on the environment and the public. More information can be found on the WDOH Environmental Sciences website at http://www.doh.wa.gov/CommunityandEnvironment/Radiation/EnvironmentalSciences.aspx.

Media types analyzed by the WDOH in 2015 included the following:

- Air Filters from 12 locations
- Sediment from 5 locations
- Cherries from 2 locations
- Pheasant from 1 location
- Bass from 1 location
- Carp from 2 locations
- Backtail deer from 1 background location
- Columbia River surface water from 1 locations
- Off-site irrigation water from 2 locations
- Columbia River shoreline springs (seeps) from 6 locations.

No comparison data for 2015 were available at the time this report was written; however, links to past data summary reports and other environmental science publications for the Hanford Environmental Radiation Oversight program are available at http://www.doh.wa.gov/communityandenvironment/radiation/publications/environmentalsciences.aspx.

12.5 Laboratory Quality Assurance Programs

Contracted analytical laboratories are required to maintain internal QC programs and participate in independent QC programs used to determine analytical precision and accuracy. These laboratories house chemical technologists who are qualified to perform these analyses through formal classroom education and on-the-job training. Internal QC programs for contracted laboratories involve routine calibrations of counting instruments, yield determinations of radiochemical procedures, frequent radiation-check sources and background counts, replicate and spiked sample analyses, use of matrix and reagent blanks, and maintenance of control charts to indicate analytical deficiencies. Examples of independent QC programs are the Mixed Analyte Performance Evaluation Program (MAPEP) and the DOE Consolidated Audit Program (DOECAP) described in the following sections.

12.5.1 Analytical Quality Assurance and Quality Control

Hanford Site environmental samples were sent to two laboratories in 2015 (Tables 12.5 and 12.6) and included routine chemical and radiological analyses of air, water, soil, vegetation, sediment and biota. In 2015, General Engineering Laboratories, LLC (GEL) and TestAmerica Richland Laboratory (TARL) participated in independent QA and QC programs including MAPEP and DOECAP. These managed programs use standardized audit methods, processes, and procedures to ensure the validity, reliability, and defensibility of data annually from the contract laboratories.

Table 12.5. DOE Mixed Analyte Performance Evaluation Program Results for General Engineering Laboratories, LLC

Environmental Sample Media and Analytes		MAPEP 32 Series March 2015*	MAPEP 33 Series August 2015*
Radionuclides			
Air Filters	Alpha (gross), beta (gross), americium-241, cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239/-240, strontium-90, uranium-234/233, uranium-235, uranium-238	100% Acceptable	100% Acceptable
Water	Alpha (gross), beta (gross), americium-241, cesium-134, cesium-137, cobalt-60, iodine-129 plutonium-238, plutonium-239/-240, potassium-40, strontium-90, technetium-99, tritium, uranium-234/233, uranium-238	100% Acceptable	100% Acceptable
Vegetation	Americium-241, cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239/-240, strontium-90, uranium-234/233, uranium-238	100% Acceptable	100% Acceptable
Soil	Americium-241, cesium-134, cesium-137, colbalt-60, potassium-40, plutonium-238, plutonium-239/-240, strontium-90, technetium-99	100% Acceptable	100% Acceptable
Inorganic Compounds			
Water	Antimony, arsenic, barium, beryllium, cadmium, chromium, copper, copper, lead, mercury, nickel, selenium, thallium, vanadium, zinc	Zinc†	100% Acceptable

*Performance results 100% acceptable for all analytes unless otherwise noted.
†False negative. No adverse effect on Hanford samples.

Table 12.6. DOE Mixed Analyte Performance Evaluation Program Results for TestAmerica Richland Laboratory

Environmental Sample Media and Analytes		MAPEP 32 Series March 2015*	MAPEP 33 Series August 2015*
Radionuclides			
Air Filters	Alpha (gross), beta (gross), americium-241, cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239/-240, strontium-90, uranium-234/233, uranium-238	Gross alpha† Americium-241†	100% Acceptable
Water	Alpha (gross), beta (gross), americium-241, cesium-134, cesium-137, cobalt-60, iodine-129 plutonium-238, plutonium-239/-240, potassium-40, strontium-90, technetium-99, tritium, uranium-234/-233, uranium-238	100% Acceptable	Uranium-234/-233† Uranium-238†
Vegetation	Americium-241, cesium-134, cesium-137, cobalt-60, plutonium-238, plutonium-239/-240, strontium-90, uranium-234/-233, uranium-238	100% Acceptable	100% Acceptable
Soil	Americium-241, cesium-134, cesium-137, colbalt-60, potassium-40, plutonium-238, plutonium-239/-240, strontium-90, technetium-99	100% Acceptable	100% Acceptable

*Performance results 100% acceptable for all analytes unless otherwise noted.
†Result not acceptable; bias >30%.

In 2015, GEL and TARL were audited by DOECAP, whose objective is to ensure the application of consistent standards between the analytical laboratories supporting the DOE complex and its compliance programs. Audit objectives included assessing the ability of the laboratory to produce data of acceptable and documented quality through analytical operations that follow approved and technically sound methods, and the handling of DOE samples and associated waste in a manner that protected human health and the environment. GEL and TARL also participated in MAPEP Studies 32 and 33 and a number of Environmental Resource Associate's proficiency studies for water, soil, air filter, and vegetation matrices.

12.5.2 Laboratory Performance Evaluation and Proficiency Testing

Participation of Hanford Site analytical laboratories in DOE and EPA laboratory performance evaluation programs serves to ensure data quality. Hanford Site environmental monitoring contract laboratories participate in MAPEP-sanctioned proficiency testing provided by an independent laboratory (e.g., Environmental Resource Associates).

DOE's MAPEP provides critical QA testing for environmental analytical services. Radiological and non-radiological (organic and inorganic) constituents are evaluated by performing semiannual proficiency testing of the Hanford Site DOE laboratories, and other federal, state, commercial, and international laboratories. MAPEP proficiency tests help to ensure the accuracy of analytical results reported to DOE and other stakeholders, while also providing an efficient means for laboratories to demonstrate analytical proficiency. Results to past MAPEP studies can be found on the DOE's Mixed Analyte Performance Evaluation Program webpage at http://www.id.energy.gov/resl/mapep/mapepreports.html.

GEL's MAPEP program radiological results were 100% acceptable for Studies 32 and 33 in 2015 for air, water, soil, and vegetation. Results for inorganic compounds in water were 100% acceptable with the exception of the Study 32 result for zinc which reported a false negative associated with a sensitivity analysis. Results of MAPEP Studies 32 and 33 for GEL are provided in Table 12.5 or at http://www.id.energy.gov/resl/mapep/mapepreports.html.

TARL's MAPEP program radiological results were 100% acceptable for Studies 32 and 33 in 2015 for air, water, soil, and vegetation with the exception of the gross alpha and americium-241 results in Study 32 and the uranium-233/234 and uranium-238 results in Study 33. These results were not acceptable due to bias greater exceeding 30%. Results of MAPEP Studies 32 and 33 for TARL are provided in Table 12.6 or at http://www.id.energy.gov/resl/mapep/mapepreports.html.

12.6 Data Recording and Data Management

Record keeping is a vital part of all environmental programs on the Hanford Site. Maintenance of environmental data is essential for QA, regulatory compliance, trend analysis, and optimization purposes. The Environmental Surveillance program is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements governing data management procedures. Project documentation includes environmental sample logbooks and processing forms, and as applicable, monthly, quarterly, and annual occurrence reports. Several electronic data repositories are used to house the environmental data, all of which have their own internal QA and QC policies and procedures.