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Draft A

Sampling and Analysis Plan for the 300 Area Decision Unit Remedial Investigation/Feasibility Study

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

U.S. DEPARTMENT OF ENERGY
Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

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Approval Page

Title: Sampling and Analysis Plan for the 300 Area Decision Unit Remedial Investigation/Feasibility Study

Approval: U.S. Department of Energy, Richland Operations Office

_____ _____
B. L. Charboneau Date

U.S. Environmental Protection Agency

_____ _____
L. E. Gadbois Date

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Terms

ALARA	as low as reasonably achievable
CFR	*Code of Federal Regulations*
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQA	data quality assessment
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
PNNL	Pacific Northwest National Laboratory
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RL	U.S. Department of Energy, Richland Operations Office
SAP	sampling and analysis plan
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*

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1 Introduction

This sampling and analysis plan (SAP) is written in support of the remedial investigation/feasibility study (RI/FS) process for the 300 Area Decision Unit. The 300 Area Decision Unit is located on the Hanford Site in southeastern Washington State and is associated with two source operable units: 300-FF-1 and 300-FF-2. The 300-FF-5 Groundwater Operable Unit underlies the two source operable units. This SAP describes the sampling and analysis to be performed associated with environmental investigation (boreholes) and the groundwater-monitoring wells. Figure 1-1 shows the location of the planned and existing boreholes and groundwater-monitoring well network within the 300 Area scope of this SAP. Figure 1-2 shows the location of the groundwater-monitoring well network within the scope of this SAP including both the 300 Area and 600 Area. Table 1-1 presents a crosswalk between data needs discussed in DOE/RL-2009-30, *300 Area Decision Unit Remedial Investigation/Feasibility Study Work Plan*, and sampling and analysis activities. The site background and environmental setting of the 300 Area Decision Unit are described in Chapter 2 of DOE/RL-2009-30.

1.1 Vadose Zone Characterization

This SAP describes activities planned to characterize the vadose zone within the 300 Area Decision Unit. Groundwater wells drilled as part of the 300 Area Decision Unit remedial investigation also will have vadose zone soil samples collected during drilling. Samples will be collected and analyzed to evaluate the nature and extent of contamination. The following areas will be characterized:

- 316-2, North Process Pond
- 316-1, South Process Pond
- 316-5, 300 Area Process Trenches
- Perimeter Area
- Near River Area
- 618-10 Burial Ground
- 618-11 Burial Ground
- 316-4 Crib.

1.2 Groundwater Characterization

Groundwater samples will be collected and analyzed from new and existing groundwater-monitoring wells to define the extent of contamination and to support evaluation of contaminant transport. Where possible, new well locations and construction have been selected to satisfy multiple project data needs, such as delineating vadose zone and groundwater contamination.

1.3 Target Analytes and Contaminants of Potential Concern

Method-based analysis addresses the suites of analytical methods that will yield results for the target analytes or contaminants of potential concern (COPC) needed. This method of laboratory analysis provides an umbrella effect in that analyses are provided for the target analytes or COPCs, as well as for any related constituents. Method-based analysis will be performed for all chemical soil/aquifer sediment and water samples analyzed for this decision unit.

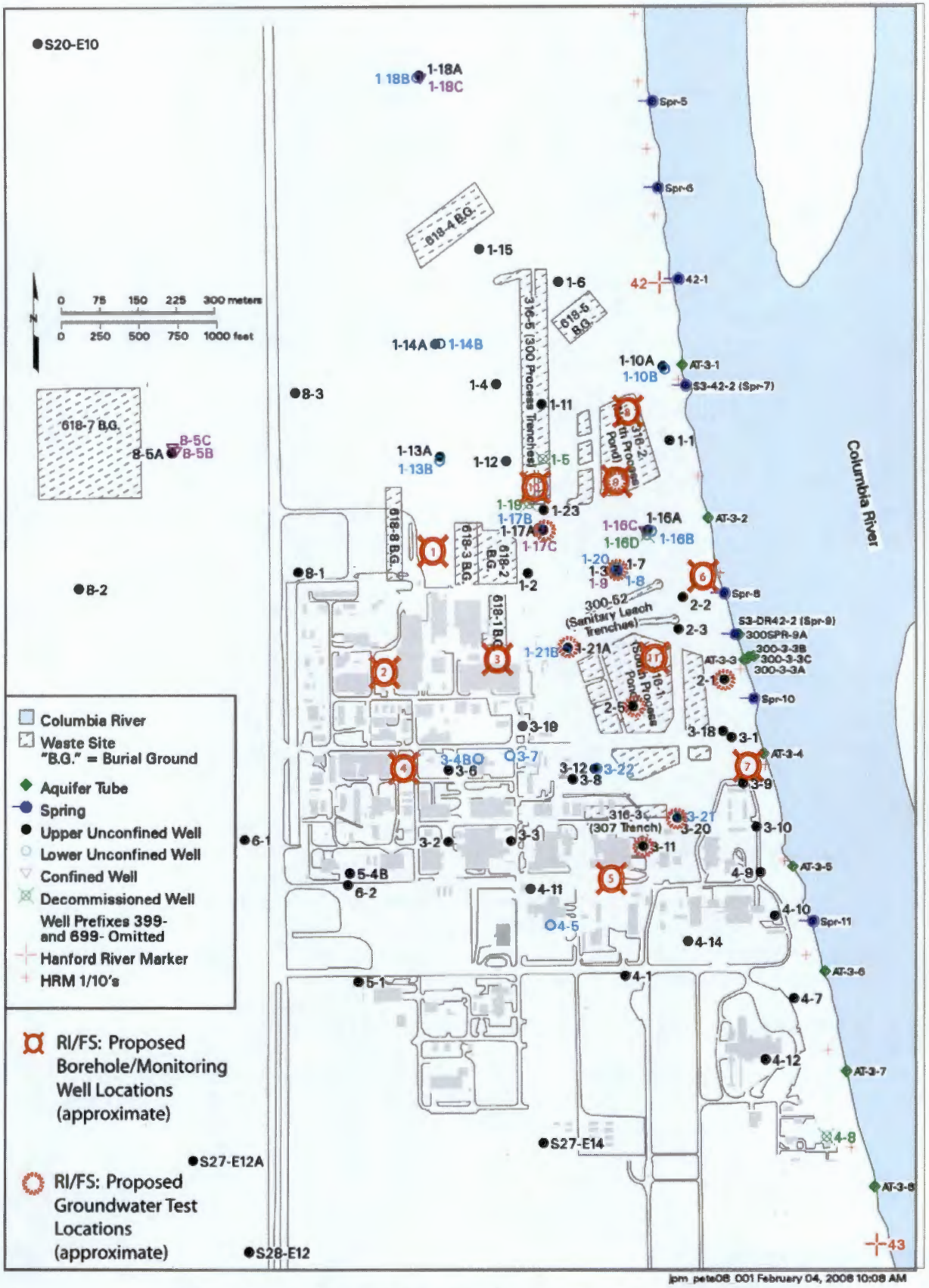


Figure 1-1. 300 Area Planned and Existing Sampling Locations

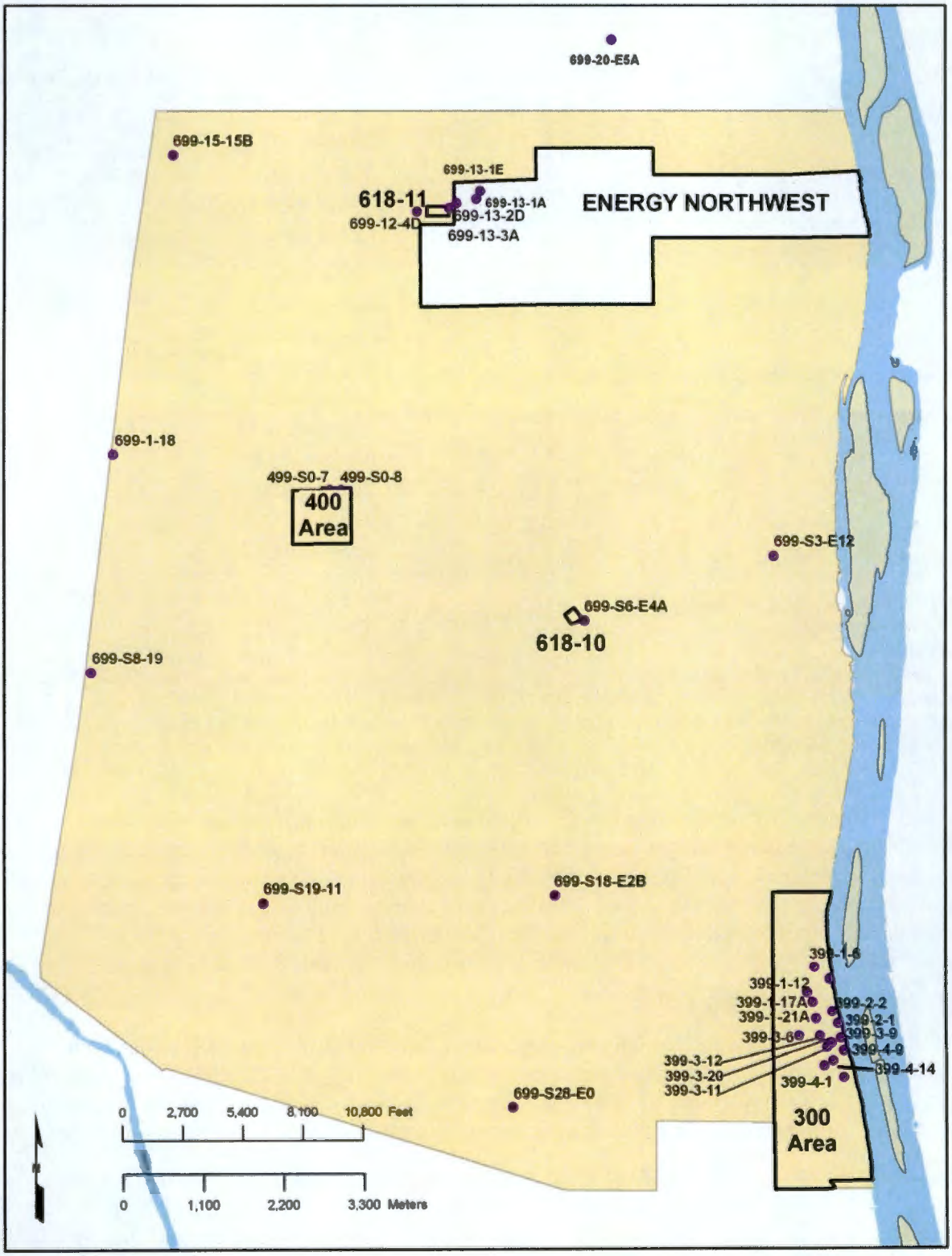


Figure 1-2. 300 Area Decision Unit Spatial/Temporal Uncertainty Monitoring Well Locations

Table 1-1. Plan Activities and Data Needs

Planned Activity	300 Area		Data Needs No.
	Quantity	Location	
New boreholes (vadose zone)*	3	Borehole 300-DU-VZ-1 Borehole 300-DU-VZ-2 Borehole 300-DU-VZ-3	26
New wells to characterize vadose zone, unconfined aquifer, and the Ringold lower member*	11	Well 300-DU-1 Well 300-DU-2 Well 300-DU-3 Well 300-DU-4 Well 300-DU-5 Well 300-DU-6 Well 300-DU-7 Well 300-DU-8 Well 300-DU-9 Well 300-DU-10 Well 300-DU-11	2, 3, 4, 7, 8,11, 13, 14,18
Sample spatial/temporal uncertainty groundwater monitoring wells	33 existing locations		Needed for spatial/temporal uncertainty

*Boreholes and groundwater-monitoring wells will be logged with a neutron moisture tool and the high-resolution, spectral gamma ray logging system. Geologic samples also will be logged. NOTE: This SAP is in addition to field activities described in DOE/RL-2008-27, *Sampling and Analysis Plan for 618-10 and 618-11 Nonintrusive Sampling*, and other planned activities.

Standard laboratory method reporting lists (presented in the appendix) that are used when running Hanford Site samples under current contractual agreements will be input into the Hanford Environmental Information System (HEIS) database. The tables in the appendix have been provided to define the analytes that will be reported when using a method-based analysis approach. In addition, tentatively identified compounds will be reported for SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, Methods 8260 and 8270.

1.3.1 Soil/Aquifer Sediment

The soil/aquifer sediment target analytes are presented in Table 1-2. The 300 Area Decision Unit approach used for development of the target analytes is presented in WCH-332, *300-Area Decision Unit Target Analyte List Development for Soil*. These lists of analytes may increase (or decrease) depending on the results of verification sampling performed following remediation of the waste sites.

Only a subset of 300 Area and 600 Area target analytes will be identified for analysis during SAP implementation, based on relevant location- and process-specific data and information. This SAP does not include samples to be collected in the 400 Area, although part of the 300 Area Decision Unit. The subset of 300 Area and 600 Area location-specific target analytes to be analyzed are presented in Section 2.1.4.

Table 1-2. Master 300 Area Decision Unit Soil/Aquifer Sediment Target Analytes

Radionuclides	Nonradionuclides	
Americium-241	1,1,1-Trichlorethane	
Carbon-14	Antimony	
Carbon-14	Aroclor-1016 (PCB)	
Cesium-137	Aroclor-1221 (PCB)	
Cobalt-60	Aroclor-1232 (PCB)	
Europium-152	Aroclor-1242 (PCB)	
Europium-154	Aroclor-1248 (PCB)	
Europium-155	Aroclor-1254 (PCB)	
Iodine-129	Aroclor-1260 (PCB)	
Nickel-63	Arsenic	
Plutonium-238	Asbestos	
Plutonium-239/240	Barium	
Plutonium-241	Benzene	
Strontium-90	Benzo(a)pyrene	
Technetium-99	Beryllium	
Tritium	Bis(2-ethylhexyl)phthalate	
Uranium-233/234	Bismuth	
Uranium-235	Butylbenzylphthalate	
Uranium-238	Cadmium	
	Carbon tetrachloride	
	Chloride	
	Chloroform	
	Chromium (hexavalent)	
	Chromium (total)	
	Chrysene	
	Cobalt	
	Copper	
	Cyanide	
	Dichloroethene 1, 2- (total)	
	Dichloroethylene; 1,2-cis-	
	Ethyl acetate	
	Ethylene glycol	
	Fluoride	
	Hexachlorobutadiene	
	Hexachloroethane	
	Lead	
	Lithium	
	Manganese	
	Mercury	
	Methyl ethyl ketone	
	Methyl isobutyl ketone (hexone)	
	Nickel	
	Nitrate	
	Nitrite	
	Normal paraffin hydrocarbon (kerosene)	
	Phenanthrene	

Table 1-2. Master 300 Area Decision Unit Soil/Aquifer Sediment Target Analytes

Radionuclides	Nonradionuclides	
	Selenium Silver Sodium (metal) Strontium Sulfate Tetrachloroethene Thallium Tin Toluene Total petroleum hydrocarbons Tributyl phosphate Trichloroethene Uranium (total) Vanadium Vinyl chloride Xylene Zinc	

PCB = polychlorinated biphenyl

The samples collected from this decision unit will also have supplemental, non-target analyte analysis as presented in Section 2.1.4 to fulfill specific data needs as identified in the work plan.

1.3.2 Groundwater

The groundwater COPCs are presented in Table 1-3 for the 300 Area and Table 1-4 for the 600 Area. The approach used for development of the COPCs is presented in Chapter 4 of DOE/RL-2009-30.

Table 1-3. 300 Area Groundwater COPCs

Radionuclides	Nonradionuclides	
Strontium-90	1,2-Dichloroethene (total)	Mercury
Tritium	Antimony	Nickel
	Arsenic	Nitrate (as N)
	Cadmium	Nitrite (as N)
	Carbon tetrachloride	Selenium
	Chloroform	Silver
	Chromium	Sulfate
	cis-1,2-dichloroethene	Tetrachloroethene
	Cobalt	Thallium
	Copper	Trichloroethene
	Cyanide	Uranium

Table 1-3. 300 Area Groundwater COPCs

Radionuclides	Nonradionuclides	
	Fluoride	Vinyl Chloride
	Lead	Zinc
	Manganese	

Table 1-4. 600 Area Groundwater COPCs

Radionuclides	Nonradionuclides	
Iodine-129	Antimony	Nitrate (as N)
Strontium-90	Arsenic	Nitrite (as N)
Tritium	Cadmium	Sulfate
	Carbon tetrachloride	Tetrachloroethene
	Chromium	Tributyl phosphate
	Copper	Trichloroethene
	Fluoride	Uranium
	Lead	Vinyl Chloride
	Manganese	Zinc
	Nickel	

1.4 Data Needs

A systematic planning process, described in Chapter 1 of DOE/RL-2009-30, was used to identify 300 Area Decision Unit data gaps. The problem statement definition was covered in the systematic planning process. The data needs outcomes from the systematic planning process for the 300 Area Decision Unit, as well as the systematic planning process and its outcome, are covered in DOE/RL-2009-30.

1.5 Sampling Design

The type of sampling design is judgmental (e.g., based on prior knowledge and professional judgment/expertise). The locations of waste sites, boreholes, and groundwater wells were defined to address the uncertainties and data needs identified during systematic planning. Figures 1-1 and 1-2 show the locations of environmental investigation borings (boreholes) and groundwater-monitoring wells described in this SAP. Tables 2-2 through 2-18 in Chapter 2 present the selected analytical methods to meet the required detection limits and the analytical performance requirements.

1.6 Project Schedule

The 300 Area Decision Unit remedial investigation field efforts will occur between April 2010 and March 2011. The relative borehole and groundwater well schedule for new installations will be prepared by the drilling lead. A spatial and temporal uncertainty sample round, or event, will be collected from each the seasonal "high" water level, a seasonal "low" water level, and a "mid-point" water level, for a total of three samples per well. Each round of monitoring in the network of wells for this decision unit will be completed within the shortest interval of time that logistics permit, to minimize statistical variability in water levels. The results provided by sampling and analysis in this plan will be documented in the remedial investigation report.

2 Quality Assurance Project Plan

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. The work performed under this plan is conducted in accordance with:

- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents*
- DOE O 414.1C, Quality Assurance
- 10 CFR 830, Subpart A, "Quality Assurance Requirements"
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5.

Sections 6.5 and 7.8 of Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order Action Plan*, require that quality assurance (QA)/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal units, as well as past-practice processes. Therefore, this QAPjP follows the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to Part B requirements of ANSI/ASQC E4-2004, *Quality Systems for Environmental Data and Technology Programs – Requirements with Guidance for Use.*

In addition to the requirements cited above, the following reference also was used as a resource for identification of QAPjP elements: EPA-505-B-04-900A, *Intergovernmental Data Quality Task Force, Uniform Federal Policy for Quality Assurance Project Plans, Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs, Part 1: UFP-QAPP Manual.*

The UFP-QAPP manual is not imposed through Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement). However, the manual is a valuable resource and provides a comprehensive treatment of quality elements that should be addressed in any SAP. The manual also was designed to be compatible with EPA/240/B-01/003, which forms the basis for this QAPjP.

The QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to this investigation.

Section 2.1 Project Management – This section addresses project management, including the project history and objectives, roles, and responsibilities of the participants. These elements ensure that the project has a defined goal, that the participants understand the goal and the approach to be used, and that the planning outputs are documented.

Section 2.2 Data Generation and Acquisition – This section addresses aspects of project design and implementation. Implementation of these elements ensures that appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented.

Section 2.3 Assessment and Oversight – This section addresses the activities for assessing the effectiveness of the implementation of the project and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

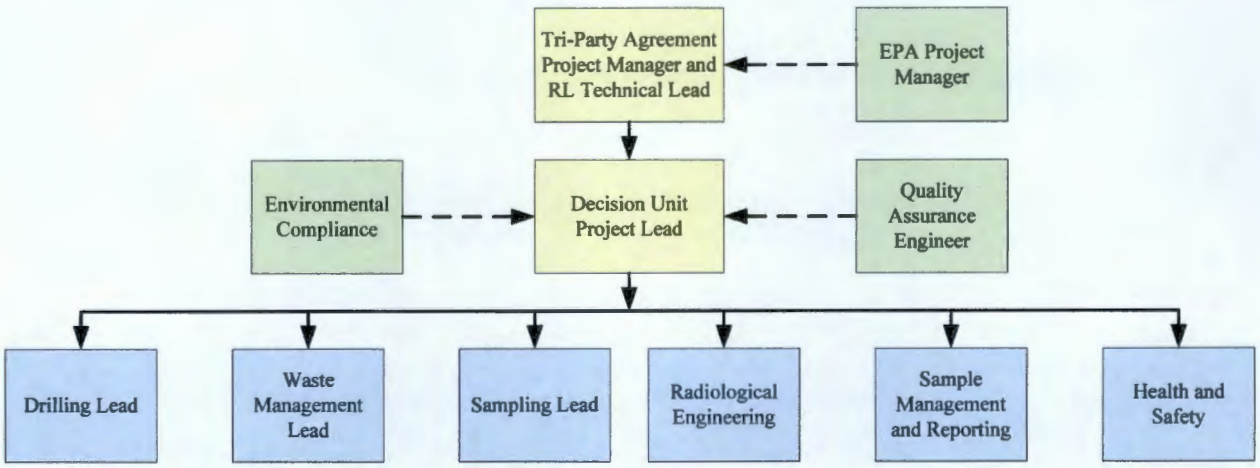
Section 2.4 Data Validation and Usability – This section addresses the QA activities occurring after the data collection or generation phase of the project is completed. Implementation of these elements ensures that data conform to the specified criteria, thus achieving the project objectives.

2.1 Project Management

The following sections address the basic aspects of project management and will ensure that the project has defined goals, the participants understand the goals and the approaches used, and the planned outputs are appropriately documented.

2.1.1 Project/Task Organization

The Plateau Remediation Contractor and River Corridor Contractor, or its approved subcontractor, are responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory. The project organization, in regard to sampling and characterization, is described in the following sections and is shown graphically in Figure 2-1. The project lead maintains a list of individuals or organizations as points of contact for each functional element in the figure. For each functional primary contractor role, a corresponding oversight role exists within the U.S. Department of Energy (DOE).



EPA = U.S. Environmental Protection Agency
RL = U.S. Department of Energy, Richland Operations Office

Figure 2-1. Project Organization

EPA Project Manager. The U.S. Environmental Protection Agency (EPA) has assigned project managers responsible for oversight of the cleanup projects and activities. The EPA has approval authority as the lead regulatory agency for the work being performed under this SAP. The EPA will work with the U.S. Department of Energy, Richland Operations Office (RL) to resolve concerns over the work as described in this SAP in accordance with the Tri-Party Agreement.

Tri-Party Agreement Project Manager and RL Technical Lead. The Tri-Party Agreement Project Manager is responsible for authorizing remedial investigation/feasibility study activities for the 300 Area Decision Unit. The Tri-Party Agreement Project Manager also is responsible for obtaining lead regulator approval of DOE/RL-2009-30 and SAP that authorize the remedial investigation/feasibility study activities under the Tri-Party Agreement. The RL technical lead is responsible for oversight of the contractor in performing the work scope, for working with the contractor and the regulatory agencies to identify and work through issues, and to provide technical input to the Tri-Party Agreement Project Manager.

Environmental Compliance. The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The environmental

compliance officer also reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues affecting operations and develops cost-effective solutions; and responds to environmental/regulatory issues or concerns raised by RL and/or regulatory agency staff. The environmental compliance officer also may oversee project implementation for compliance with applicable internal and external environmental requirements.

Decision Unit Project Lead. The project lead is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks and for ensuring the project file is properly maintained. The project lead ensures that the sampling design requirements are converted into field instructions (e.g., work packages) providing specific direction for field activities. The project lead works closely with QA, Health and Safety, the drilling lead, and the sampling lead to integrate these and the other lead disciplines in planning and implementing the work scope. The project lead maintains a list of individuals or organizations filling each of the functional elements of the project organization (Figure 2-1). In addition, the project lead is responsible for version control of the SAP to ensure that personnel are working to the most current job requirements. The project lead also coordinates with RL and the primary contractor management on sampling activities. The project lead supports RL in coordinating sampling activities with the regulators.

Quality Assurance Engineer. The QA point of contact is matrixed to the project lead and is responsible for QA issues on the project. Responsibilities include oversight of implementation of the project QA requirements; review of project documents, including data needs summary reports, SAPs, and the QAPjP; and participation in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

Drilling Lead. The drilling lead has overall responsibility for the planning, coordination, and execution of drilling activities. Specific responsibilities include coordinating with the geological and drilling contractors. The drilling lead also communicates with the decision unit project lead designee to identify field constraints or emergent conditions affecting sampling design/execution, and directs the procurement and installation of materials and equipment needed to support fieldwork.

Waste Management Lead (Waste Coordinator). Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. In addition, Waste Management is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance, interpreting the characterization data to generate waste designations and profiles, and preparing and maintaining other documents that confirm compliance with waste acceptance criteria.

Sampling Lead. The sampling lead has overall responsibility for the planning, coordination, and execution of sampling activities. Specific responsibilities include converting the sampling design requirements into field task instructions providing specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The sampling lead also communicates with the decision unit project lead designee to identify field constraints or emergent conditions affecting sampling design/execution, directs the procurement and installation of materials and equipment needed to support fieldwork, and prepares data packages based on instructions from the decision unit project lead designee and information contained in this SAP. The shipping lead reports to the sampling lead for shipment authorization. No sample material will be transported on or off the Hanford Site without permission from an authorized shipper (or designee).

Radiological Engineering. The Radiological Engineering lead is responsible for the radiological/health physics support within the project. Specific responsibilities include conducting as-low-as-

reasonably-achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for work planning. In addition, the Radiological Engineering lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The Radiological Engineering lead also interfaces with the project health and safety contact, and plans and directs radiological control technician support for activities.

Sample Management and Reporting. The Sample Management and Reporting organization coordinates laboratory analytical work ensuring the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by DOE, the EPA, and the Washington State Department of Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into HEIS, and arranges for data validation. This organization is responsible for informing the project lead of any issues reported by the analytical laboratory. In addition, Sample Management and Reporting develops and oversees the implementation of the letter of instruction to the analytical laboratories, oversees data validation, and works with the project lead to prepare a characterization report on the sampling and analysis results.

The Sample Management and Reporting organization also is responsible for the performance of the data needs process, or equivalent. Additional related responsibilities include development of the SAP, including documentation of the data needs and the sampling design, preparation of associated presentations, resolution of technical issues, and preparation of any revisions to the SAP. Samples taken in the field and released to the River Corridor Contractor for shipping and analysis, as well as the resulting data, will be managed in accordance with applicable procedures, and work plans. The **laboratories** analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

Health and Safety. The Health and Safety organization is responsible for coordination of industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or by internal primary contractor work requirements. In addition, Health and Safety assists project personnel in complying with applicable health and safety standards and requirements. Health and Safety coordinates with Radiological Engineering to determine personal protective clothing requirements.

2.1.2 Problem Definition/Background

This SAP describes the sampling and analysis to be performed associated with environmental investigation borings (boreholes) and groundwater-monitoring wells. The specific problem(s) to be solved, background information, and general information are provided in DOE/RL-2009-30. Media to be sampled include water, aquifer sediment, and soil. Figures 1-1 and 1-2 show the location of the planned and existing boreholes and groundwater-monitoring wells within the scope of this SAP. Regulatory drivers and reference to agreement documents for the activity are provided in DOE/RL-2009-30.

2.1.3 Project/Task Description

The field sampling plan is presented in Chapter 3. The target analytes and COPCs are presented in Tables 1-2 through 1-4. Section 1.6 provides guidance on the implementation schedule.

2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance providing data of known and appropriate quality. Data quality indicators describe data quality, by evaluation against identified data needs, and by evaluation against the work activities identified in this SAP. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of

the data and the nature of the analytical method. The principal data quality indicators are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These data quality indicators are defined for the purposes of this document in Table 2-1. The data quality indicators will be evaluated during the data quality assessment (DQA) process (Section 2.4.3).

Analytical performance requirements for soil/aquifer sediment samples are presented in Tables 2-2 through 2-14. Analytical performance requirements for water samples are presented in Tables 2-15 through 2-18. Laboratory operations and analytical services will be in compliance with Volume 4 of DOE/RL-96-68 and any specific criteria identified in Tables 2-2 through 2-18. Criteria in Tables 2-2 through 2-18 take precedence over similar criteria in DOE/RL-96-68. In consultation with the laboratory, the project lead, and/or others as appropriate, Sample Management and Reporting can approve changes to analytical methods. Note that only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

2.1.5 Special Training/Certification

A graded approach is used to ensure workers receive a level of training commensurate with responsibilities and complies with applicable DOE orders and government regulations. The sampling lead and drilling lead, in coordination with line management, will ensure that field personnel meet special training requirements.

Typical training requirements or qualifications have been instituted by the primary contractor management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirements documents, American National Standards Institute/American Society of Mechanical Engineers, *Washington Administrative Code*, etc. For example, the environmental, safety and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically will have completed the following training before starting work:

- Occupational Safety and Health Administration 40-hour hazardous waste worker training and supervised 24-hour hazardous waste-site experience
- 8-hour hazardous waste worker refresher training (as required)
- Hanford general employee radiation training
- Hanford general employee training
- Radiological worker training.

Project-specific safety training, geared specifically to the project and the day's activity, will be provided. Project-specific training includes the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling being performed in the field:
  - Soil/aquifer sediment sampling
  - Water sampling.

Qualification requirements for radiological control technicians are established by the Radiation Protection Program; radiological control technicians assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Precision	The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions; calculated either as the range or as the standard deviation. Also may be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).	Use the same analytical instrument to make repeated analyses on the same sample. Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze collocated samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	Field precision: Duplicate samples will be taken at one randomly selected location per 20 samples per media. Laboratory precision: analysis of laboratory duplicate or matrix spike duplicate.	If duplicate data do not meet objective: Evaluate apparent cause (e.g., sample heterogeneity) Request reanalysis or remeasurement Qualify the data before use.
Accuracy	A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of sampling and analytical operations.	Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample); usually expressed either as percent recovery or as a percent bias.	Laboratory accuracy determination based on matrix spikes and matrix spike duplicates.	If recovery does not meet objective: Qualify the data before use Request reanalysis or remeasurement.

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Representativeness	A qualitative term to expresses "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition." (ANSI/ASQC S2-1995)	Evaluate whether measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	Samples will be collected as described in the sampling design. Judgment sampling ensures areas most likely to be contaminated, based on current information, will be evaluated.	If results are not representative of the system sampled: Identify the source of the nonrepresentation Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system the data represent Redefine sampling and measurement requirements and protocols Resample and reanalyze.
Comparability	A qualitative term expressing the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and quality assurance protocols.	Sampling personnel will use the same sampling protocols. Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis by the same methods, thus data results will be comparable.	If data are not comparable to other data sets: Identify appropriate changes to data collection and/or analysis methods Identify quantifiable bias, if applicable Qualify the data as appropriate Resample and/or reanalyze if needed Revise sampling/analysis protocols to ensure future comparability.

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Completeness	A measure of the amount of valid data needed to be obtained from a measurement system.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's data needs.	The percent complete will be determined during data validation.	If data set does not meet completeness objective: Identify appropriate changes to data collection and/or analysis methods Identify quantifiable bias, if applicable Qualify the data as appropriate Resample and/or reanalyze if needed Revise sampling/analysis protocols to ensure future comparability.
Sensitivity	The capability of a method or instrument to discriminate among measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute to be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level that can be routinely quantified and reported by a laboratory.	Ensure that sensitivity, as measured by detection limits, is appropriate for the action levels.	If sensitivity does not meet objective: Request reanalysis or remeasurement Qualify/reject the data before use.

*Field sampling requirements are noted. Laboratories will follow requirements for use and interpretation of laboratory control samples.

ANSI/ASQC S2-1995, *Introduction to Attribute Sampling.*

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-1

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10028-17-8	C	Tritium	10 pCi/g	1,980 pCi/g	5,360 pCi/g	5,360 pCi/g	LSC – tritium	±30%[b]	70-130%[b]
--	C	Uranium-233/ 234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium -alpha energy analysis	±30%[b]	70-130%[b]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	CG	Aluminum	5 mg/kg	3,500,000 mg/kg	35,000 mg/kg	16,000 mg/kg	EPA 6010 or 6020	±30%[d]	70-130%[d]
7440-36-0	G	Antimony	6 mg/kg						
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	CG	Cadmium	0.5 mg/kg	139 mg/kg	0.81 mg/kg	0.81 mg/kg			
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	CG	Chromium (total)	1 mg/kg	>1,000,000 mg/kg	NA	NA			
7440-48-4	G	Cobalt	2 mg/kg						

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-1

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-50-8	G	Copper	1 mg/kg						
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	G	Lead	5 mg/kg						
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[g]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	G	Selenium	10 mg/kg						
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[e]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[e]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via Isotopic	±30%[d]	70-130%[d]
16887-00-6	CG	Chloride	2 mg/kg	NV[e]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[d]	70-130%[d]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-1

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
14797-55-8	CG	Nitrate (as N)[h]	2.5 mg/kg	5,600,000 mg/kg	1,000 mg/kg	2,000 mg/kg			
14797-65-0	C	Nitrite (as N)[h]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[f]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-1

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

c. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

d. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

e. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

f. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

g. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford Site background.

h. Nitrate/nitrite also may be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-2

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium -alpha energy analysis	±30%[b]	70-130%[b]
15117-96-1	C	Uranium-235	0.5 pCi/g[c]	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[d]	70-130%[d]
7440-36-0	G	Antimony	6 mg/kg						
7440-38-2	G	Arsenic	10 mg/kg						
7440-39-3	G	Barium	2 mg/kg						
7440-41-7	CG	Beryllium	0.5 mg/kg	104 mg/kg	1.51 mg/kg	1.51 mg/kg			
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	G	Cadmium	0.5 mg/kg						
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	G	Chromium (total)	1 mg/kg						
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	G	Copper	1 mg/kg						
7439-89-6	G	Iron	5 mg/kg						

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-2

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7439-92-1	CG	Lead	5 mg/kg	1,000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	G	Manganese	5 mg/kg						
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	G	Nickel	4 mg/kg						
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	G	Selenium	10 mg/kg						
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	G	Strontium	1 mg/kg						
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	G	Vanadium	2.5 mg/kg						
7440-66-6	G	Zinc	1 mg/kg						
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[d]	70-130%[d]
141-78-6	C	Ethyl acetate	5 mg/kg	3,150,000 mg/kg	29.8 mg/kg	NV[e]	EPA 8015 (nonhalogenated volatile organic analyte)	±30%[f]	70-130%[f]

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-2

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg	EPA 8260 (volatile organics)	±30%[f]	70-130%[f]
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2,570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
16887-00-6	G	Chloride	2 mg/kg				EPA 300.0 (anions by IC)	±30%[d]	70-130%[d]
16984-48-8	G	Fluoride	5 mg/kg						
14797-55-8	G	Nitrate (as N)[h]	2.5 mg/kg						
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-2

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	G	Alkalinity[g]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

c. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

d. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

e. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

f. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

g. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

h. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis*.

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-2

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-3

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
--	C	Uranium-233/ 234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium - alpha energy analysis	±30%[b]	70-130%[b]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[c]	70-130%[c]
7440-36-0	G	Antimony	6 mg/kg						
7440-38-2	G	Arsenic	10 mg/kg						
7440-39-3	G	Barium	2 mg/kg						
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	G	Cadmium	0.5 mg/kg						
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	G	Chromium (total)	1 mg/kg						
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	G	Copper	1 mg/kg						

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-3

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	G	Lead	5 mg/kg						
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	G	Manganese	5 mg/kg						
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	G	Nickel	4 mg/kg						
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	G	Selenium	10 mg/kg						
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	G	Strontium	1 mg/kg						
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	G	Vanadium	2.5 mg/kg						
7440-66-6	G	Zinc	1 mg/kg						
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[c]	70-130%[c]
16887-00-6	G	Chloride	2 mg/kg				EPA 300.0 (anions by	±30%[c]	70-130%[c]
16984-48-8	G	Fluoride	5 mg/kg						

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-3

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
14797-55-8	G	Nitrate (as N)[d]	2.5 mg/kg				IC)		
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[e]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-3

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

c. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

d. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

e. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

CaCO3 = calcium carbonate

CAS = Chemical Abstracts Service

IC = ion chromatography

ICP/MS = inductively coupled plasma/ mass spectrometry

EQL = estimated quantitation limit

UKPA = total uranium by kenotic phosphorescence analysis

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-4

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10028-17-8	C	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[b]	70-130%[b]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium -alpha energy analysis	±30%[b]	70-130%[b]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[d]	70-130%[d]
7440-36-0	G	Antimony	6 mg/kg						
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	G	Cadmium	0.5 mg/kg						
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	G	Copper	1 mg/kg						

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-4

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	G	Lead	5 mg/kg						
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	G	Nickel	4 mg/kg						
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	CG	Selenium	10 mg/kg[c e]	17,500 mg/kg	5 mg/kg	1.0 mg/kg			
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[f]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[f]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[d]	70-130%[d]

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-4

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
56-23-5	C	Carbon tetrachloride	0.005 mg/kg	1,010 mg/kg	0.0337 mg/kg	0.05 mg/kg	EPA 8260 (volatile organic analyte)	±30%[g]	70-130%[g]
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg			
156-59-2	C	cis-1,2-dichloroethene	0.005 mg/kg	35,000 mg/kg	0.350 mg/kg	NV[f]			
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
16887-00-6	CG	Chloride	2 mg/kg	NV[f]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[d]	70-130%[d]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
14797-55-8	CG	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1,000 mg/kg	2,000 mg/kg			
14797-65-0	C	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-4

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-4

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

c. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

d. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

e. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

f. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-5

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
--	C	Plutonium-239/240	1 pCi/g	245 pCi/g	NV[b]	NV[b]	Isotopic – plutonium	±30%[c]	70-130%[c]
14133-76-7	C	Technetium-99	0.25 pCi/g	410,000 pCi/g	239 pCi/g	239 pCi/g	LSC – Tc-99	±30%[c]	70-130%[c]
10028-17-8	C	Tritium	10 pCi/g	1,980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[c]	70-130%[c]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium -alpha energy analysis	±30%[c]	70-130%[c]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[e]	70-130%[e]
7440-36-0	G	Antimony	6 mg/kg						
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	G	Cadmium	0.5 mg/kg						
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-5

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	CG	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	CG	Lead	5 mg/kg	1,000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	G	Selenium	10 mg/kg						
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	CG	Silver	1 mg/kg[d f]	17,500 mg/kg	8 mg/kg	0.73 mg/kg			
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[b]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[b]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-5

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg	EPA 8260 (volatile organics)	±30%[g]	70-130%[g]
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
108-88-3	C	Toluene	0.005 mg/kg	28,000 mg/kg	64 mg/kg	1360 mg/kg			
71-55-6	C	Trichlorethane; 1,1,1-	0.005 mg/kg	>1,000,000 mg/kg	1.58 mg/kg	3.17 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
16887-00-6	CG	Chloride	2 mg/kg	NV[b]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[e]	70-130%[e]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
14797-55-8	CG	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1,000 mg/kg	2,000 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-5

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

Table 2-6. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-5

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

c. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-6

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10198-40-0	C	Cobalt-60	0.05 pCi/g	5.2 pCi/g	NV[b]	NV[b]	Gamma energy analysis	±30%[c]	70-130%[c]
10045-97-3	C	Cesium-137	0.1 pCi/g	25 pCi/g	NV[b]	NV[b]			
10028-17-8	C	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[c]	70-130%[c]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium - alpha energy analysis	±30%[c]	70-130%[c]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[e]	70-130%[e]
7440-36-0	CG	Antimony	6 mg/kg[d f]	1,400 mg/kg	5 mg/kg	5 mg/kg			
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	G	Cadmium	0.5 mg/kg						
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-6

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-48-4	CG	Cobalt	2 mg/kg	1,050 mg/kg	15.7 mg/kg	NV[b]			
7440-50-8	CG	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22 mg/kg			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	CG	Lead	5 mg/kg	1,000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	G	Selenium	10 mg/kg						
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[b]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[b]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-6

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
12674-11-2	C	Aroclor-1016	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg	EPA 8082 (PCB by GC)	±30%[g]	70-130%[g]
11104-28-2	C	Aroclor-1221	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11141-16-5	C	Aroclor-1232	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
53469-21-9	C	Aroclor-1242	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
12672-29-6	C	Aroclor-1248	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11097-69-1	C	Aroclor-1254	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11096-82-5	C	Aroclor-1260	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
71-43-2	C	Benzene	0.005 mg/kg[d]	4530 mg/kg	0.0795 mg/kg	0.159 mg/kg	EPA 8260 (volatile organics)	±30%[g]	70-130%[g]
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg			
156-59-2	C	cis-1,2-dichloro-ethene	0.005 mg/kg	35,000 mg/kg	0.350 mg/kg	NV[c]			
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
1330-20-7	C	Xylene (total)	0.01 mg/kg	700,000 mg/kg	160 mg/kg	NA			
16887-00-6	CG	Chloride	2 mg/kg	NV[c]	25,000 mg/kg	NA	EPA 300.0 (anions by	±30%[e]	70-130%[e]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-6

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
14797-55-8	CG	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1,000 mg/kg	2,000 mg/kg	IC)		
14797-65-0	C	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-6

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D 2937	NA	NA

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

c. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

Table 2-7. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-6

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
GC = gas chromatograph
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
PCB = polychlorinated biphenyl
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-7

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10045-97-3	C	Cesium-137	0.1 pCi/g	25 pCi/g	NV[b]	NV[b]	Gamma energy analysis	±30%[c]	70-130%[c]
10198-40-0	C	Cobalt-60	0.05 pCi/g	5.2 pCi/g	NV[b]	NV[b]			
14133-76-7	C	Technetium-99	0.25 pCi/g	410,000 pCi/g	239 pCi/g	239 pCi/g	LSC – Tc-99	±30%[c]	70-130%[c]
10028-17-8	C	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[c]	70-130%[c]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium - alpha energy analysis	±30%[c]	70-130%[c]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[e]	70-130%[e]
7440-36-0	CG	Antimony	6 mg/kg[d f]	1,400 mg/kg	5 mg/kg	5 mg/kg			
7440-38-2	G	Arsenic	10 mg/kg						
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	CG	Cadmium	0.5 mg/kg	139 mg/kg	0.81 mg/kg	0.81 mg/kg			
7440-70-2	G	Calcium	100 mg/kg						

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-7

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	CG	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22 mg/kg			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	CG	Lead	5 mg/kg	1000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	G	Selenium	10 mg/kg						
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	CG	Silver	1 mg/kg[d f]	17,500 mg/kg	8 mg/kg	0.73 mg/kg			
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[b]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[b]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-7

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]
50-32-8	C	Benzo(a)pyrene	0.015 mg/kg[d]	18 mg/kg	0.015 mg/kg	0.015 mg/kg	EPA 8310 (poly-aromatic hydrocarbon)	±30%[g]	70-130%[g]
218-01-9	C	Chrysene	0.1 mg/kg[d]	1,800 mg/kg	0.12 mg/kg	0.1 mg/kg			
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg	EPA 8260 (volatile organics)	±30%[g]	70-130%[g]
156-59-2	C	cis-1,2-dichloro-ethene	0.005 mg/kg	35,000 mg/kg	0.350 mg/kg	NV[b]			
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
16887-00-6	CG	Chloride	2 mg/kg	NV[b]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[e]	70-130%[e]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
14797-55-8	CG	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1000 mg/kg	2000 mg/kg			
14797-65-0	C	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-7

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

Table 2-8. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-7

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

c. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-8 and 300-DU-9

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10198-40-0	C	Cobalt-60	0.05 pCi/g	5.2 pCi/g	NV[b]	NV[b]	Gamma energy analysis	±30%[c]	70-130%[c]
10028-17-8	C	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – Tritium	±30%[c]	70-130%[c]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium - alpha energy analysis	±30%[c]	70-130%[c]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[e]	70-130%[e]
7440-36-0	G	Antimony	6 mg/kg						
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	CG	Cadmium	0.5 mg/kg	139 mg/kg	0.81 mg/kg	0.81 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-8 and 300-DU-9

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	CG	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22 mg/kg			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	CG	Lead	5 mg/kg	1,000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	CG	Selenium	10 mg/kg[d f]	17,500 mg/kg	5 mg/kg	1 mg/kg			
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[b]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	CG	Tin	10 mg/kg	2,100,000 mg/kg	960 mg/kg	NV[b]			
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[b]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-8 and 300-DU-9

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]
7439-97-6	C	Mercury	0.2 mg/kg	1,050 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	±30%[e]	70-130%[e]
117-81-7	C	Bis(2-ethylhexyl)-phthalate	0.33 mg/kg	70,000 mg/kg	13.9 mg/kg	8.01 mg/kg	EPA 8270 (semi-volatiles)	±30%[g]	70-130%[g]
56-23-5	C	Carbon tetrachloride	0.005 mg/kg	1,010 mg/kg	0.0337 mg/kg	0.05 mg/kg	EPA 8260 (volatile organics)	±30%[g]	70-130%[g]
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg			
540-59-0	C	1,2-Dichloroethene (total)	0.005 mg/kg	31,500 mg/kg	0.360 mg/kg	0.700 mg/kg			
156-59-2	C	cis-1,2-dichloroethene	0.005 mg/kg	35,000 mg/kg	0.350 mg/kg	NV			
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	10.16 mg/kg			
108-88-3	C	Toluene	0.005 mg/kg	28,000 mg/kg	64 mg/kg	1360 mg/kg			
71-55-6	C	Trichlorethane; 1,1,1-	0.005 mg/kg	>1,000,000 mg/kg	20 mg/kg	40 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
12674-11-2	C	Aroclor-1016	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg	EPA 8082 (PCB by GC)	±30%[g]	70-130%[g]
11104-28-2	C	Aroclor-1221	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-8 and 300-DU-9

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
11141-16-5	C	Aroclor-1232	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
53469-21-9	C	Aroclor-1242	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
12672-29-6	C	Aroclor-1248	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11097-69-1	C	Aroclor-1254	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11096-82-5	C	Aroclor-1260	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
16887-00-6	CG	Chloride	2 mg/kg	NV[b]	25000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[e]	70-130%[e]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
14797-55-8	CG	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1,000 mg/kg	2,000 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-8 and 300-DU-9

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

Table 2-9. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-8 and 300-DU-9

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

c. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Methods 8260 and 8270.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
GC = gas chromatograph
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
PCB = polychlorinated biphenyl
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-10

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10028-17-8	C	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – Tritium	±30%[b]	70-130%[b]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium -alpha energy analysis	±30%[b]	70-130%[b]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[d]	70-130%[d]
7440-36-0	CG	Antimony	6 mg/kg[c e]	1,400 mg/kg	5 mg/kg	5 mg/kg			
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	G	Cadmium	0.5 mg/kg						
7440-70-2	G	Calcium	100 mg/kg						
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-48-4	CG	Cobalt	2 mg/kg	1,050 mg/kg	15.7 mg/kg	NV[f]			
7440-50-8	CG	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22 mg/kg			
7439-89-6	G	Iron	5 mg/kg						

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-10

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7439-92-1	CG	Lead	5 mg/kg	1000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	CG	Selenium	10 mg/kg[c e]	17,500 mg/kg	5 mg/kg	1 mg/kg			
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	G	Silver	1 mg/kg						
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	CG	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[g]			
7440-28-0	G	Thallium	5 mg/kg						
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[g]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[d]	70-130%[d]
7439-97-6	C	Mercury	0.2 mg/kg	1,050 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	±30%[d]	70-130%[d]
71-43-2	C	Benzene	0.005 mg/kg	4530 mg/kg	0.079 mg/kg	0.159 mg/kg	EPA 8260 (volatile	±30%[g]	70-130%[g]

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-10

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
56-23-5	C	Carbon tetrachloride	0.005 mg/kg	1,010 mg/kg	0.0337 mg/kg	0.05 mg/kg	organics)		
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg			
156-59-2	C	cis-1,2-dichloro-ethene	0.005 mg/kg	35,000 mg/kg	0.350 mg/kg	NV[f]			
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
108-88-3	C	Toluene	0.005 mg/kg	28,000 mg/kg	64 mg/kg	1360 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
16887-00-6	CG	Chloride	2 mg/kg	NV[f]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[d]	70-130%[d]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
14797-55-8	CG	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1000 mg/kg	2000 mg/kg			
14797-65-0	C	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-10

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

Table 2-10. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-10

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

c. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

d. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

e. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

f. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis*.

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10198-40-0	C	Cobalt-60	0.05 pCi/g	5.2 pCi/g	NV[b]	NV[b]	Gamma energy analysis	±30%[c]	70-130%[c]
10098-97-2	C	Strontium-90[i]	1 pCi/g	2500 pCi/g	NV[b]	NV[b]	Gas Flow Proportional Counting	±30%[c]	70-130%[c]
10028-17-8	C	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[c]	70-130%[c]
--	C	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium -alpha energy analysis	±30%[c]	70-130%[c]
15117-96-1	C	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	C	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	CL	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	CL	Uranium-235	1 pCi/L						
--	CL	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)									
7429-90-5	G	Aluminum	5 mg/kg				EPA 6010 or 6020	±30%[e]	70-130%[e]
7440-36-0	CG	Antimony	6 mg/kg[d f]	1,400 mg/kg	5 mg/kg	5 mg/kg			
7440-38-2	CG	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	CG	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	G	Beryllium	0.5 mg/kg						
7440-69-9	G	Bismuth	10 mg/kg						
7440-42-8	G	Boron	2 mg/kg						
7440-43-9	CG	Cadmium	0.5 mg/kg	139 mg/kg	0.81 mg/kg	0.81 mg/kg			
7440-70-2	G	Calcium	100 mg/kg						

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-47-3	CG	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-48-4	G	Cobalt	2 mg/kg						
7440-50-8	CG	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-89-6	G	Iron	5 mg/kg						
7439-92-1	CG	Lead	5 mg/kg	1000 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-93-2	G	Lithium	2.5 mg/kg						
7439-95-4	G	Magnesium	75 mg/kg						
7439-96-5	CG	Manganese[j]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	G	Molybdenum	2 mg/kg						
7440-02-0	CG	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7723-14-0	G	Phosphorus	50 mg/kg						
7440-09-7	G	Potassium	400 mg/kg						
7782-49-2	CG	Selenium	10 mg/kg[d f]	17,500 mg/kg	5 mg/kg	1 mg/kg			
7440-21-3	G	Silicon	2 mg/kg						
7440-22-4	CG	Silver	1 mg/kg[d f]	17,500 mg/kg	8 mg/kg	0.73 mg/kg			
7440-23-5	G	Sodium	50 mg/kg						
7440-24-6	G	Strontium	1 mg/kg						
7440-28-0	CG	Thallium	5 mg/kg	245 mg/kg	1.59 mg/kg	4.46 mg/kg			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-31-5	G	Tin	10 mg/kg						
7440-62-2	CG	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[b]			
7440-66-6	CG	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
7440-61-1	CG	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]
71-43-2	C	Benzene	0.005 mg/kg	4530 mg/kg	0.079 mg/kg	0.159 mg/kg	EPA 8260 (volatile organics)	±30%[g]	70-130%[g]
67-66-3	C	Chloroform	0.005 mg/kg	21,500 mg/kg	0.717 mg/kg	1.14 mg/kg			
127-18-4	C	Tetrachloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
79-01-6	C	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
50-32-8	C	Benzo(a)pyrene	0.015 mg/kg	18 mg/kg	0.015 mg/kg	0.015 mg/kg	EPA 8310 (polyaromatic hydrocarbon)	±30%[g]	70-130%[g]
218-01-9	C	Chrysene	0.1 mg/kg[d]	180 mg/kg	0.12 mg/kg	0.1 mg/kg			
12674-11-2	C	Aroclor-1016	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg	EPA 8082 (PCB by GC)	±30%[g]	70-130%[g]
11104-28-2	C	Aroclor-1221	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11141-16-5	C	Aroclor-1232	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
53469-21-9	C	Aroclor-1242	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
12672-29-6	C	Aroclor-1248	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11097-69-1	C	Aroclor-1254	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
11096-82-5	C	Aroclor-1260	0.017 mg/kg[d]	65.6 mg/kg	0.017 mg/kg	0.017 mg/kg			
16887-00-6	CG	Chloride	2 mg/kg	NV[b]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[e]	70-130%[e]
16984-48-8	CG	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
14797-55-8	CG	Nitrate (as N)[k]	2.5 mg/kg	5,600,000 mg/kg	1000 mg/kg	2000 mg/kg			
14797-65-0	C	Nitrite (as N)[k]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
14265-44-2	G	Phosphate	5 mg/kg						
14808-79-8	G	Sulfate	5 mg/kg						
7440-38-2	CL	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	CL	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	CL	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	CL	Copper	1 µg/L	NA	NA	NA			
7439-92-1	CL	Lead	1 µg/L	NA	NA	NA			
7439-98-7	CL	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	CL	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	CL	Silver	1 µg/L	NA	NA	NA			
7440-61-1	CL	Uranium	1 µg/L	NA	NA	NA			

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	G	Total carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Inorganic carbon	200 mg/kg	NA	NA	NA	Carbon dioxide coulometer	NA	NA
--	G	Calcium carbonate equivalent	NA	NA	NA	NA	Calculation	NA	NA
--	G	Alkalinity[h]	10 mg as $CaCO_3$/L	NA	NA	NA	Auto titrator method	±20%	75-125%
--	P	Grain-size (sieve) analysis	NA	NA	NA	NA	Field procedure or ASTM D422-63	NA	NA
--	P	Sediment moisture content	NA	NA	NA	NA	ASTM D2216	NA	NA
--	P	Bulk density	NA	NA	NA	NA	ASTM D2937	NA	NA

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

b. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

c. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

d. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

g. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Method 8260.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

i. Sr-90 will be assessed as total radioactive strontium.

j. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

k. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

Table 2-11. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-11

CAS	Class	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
				Direct Exposure (industrial)	Groundwater Protection	River Protection			

$CaCO_3$ = calcium carbonate
CAS = Chemical Abstracts Service
GC = gas chromatograph
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
PCB = polychlorinated biphenyl
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-1

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements								
	Gross gamma	10 pCi/g	NA	NA	NA	Portable sodium iodide detector	±50	[b]
	Gross alpha	100 dpm/ 100 cm^2	NA	NA	NA	Portable contamina-tion detector	±50	[b]
	Gross beta	5,000 dpm/ 100 cm^2	NA	NA	NA	Portable contamina-tion detector	±50	[b]
	VOC vapors	1 ppm	NA	NA	NA	Photo Ionization detector	±30%	±30%
Performance Requirements for Laboratory Measurements (radiological)								
14762-75-5	Carbon-14	2 pCi/g	82 pCi/g	NV[c]	NV[c]	LSC – C-14	±30%[d]	70-130%[d]
13981-37-8	Nickel-63	30 pCi/g	3,370,000 pCi/g	NV[c]	NV[c]	LSC – Ni-63	±30%[d]	70-130%[d]
14133-76-7	Technetium-99	0.25 pCi/g	410,000 pCi/g	239 pCi/g	239 pCi/g	LSC – Tc-99	±30%[d]	70-130%[d]
10028-17-8	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[d]	70-130%[d]
10045-97-3	Cesium-137	0.1 pCi/g	25 pCi/g	NV[c]	NV[c]	Gamma energy analysis	±30%[d]	70-130%[d]
10198-40-0	Cobalt-60	0.05 pCi/g	5.2 pCi/g	NV[c]	NV[c]			
15046-84-1	Iodine-129	2 pCi/g	4041 pCi/g	2 pCi/g	2 pCi/g	Low energy-gamma energy analysis	±30%[d]	70-130%[d]
13981-16-3	Plutonium-238	1 pCi/g				Isotopic – plutonium	±30%[d]	70-130%[d]

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-1

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
--	Plutonium-239/240	1 pCi/g	245 pCi/g	NA	NA			
13966-29-5	Uranium-234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic -- uranium - alpha energy analysis	±30%[d]	70-130%[d]
15117-96-1	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	Uranium-234	1 pCi/L				Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
15117-96-1	Uranium-235	1 pCi/L						
--	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)								
7429-90-5	Aluminum	5 mg/kg	3,500,000 mg/kg	35,000 mg/kg	16,000 mg/kg	EPA 6010 (ICP Metals	±30%[e]	70-130%[e]
7440-36-0	Antimony	6 mg/kg[f g]	1400 mg/kg	5 mg/kg	5 mg/kg			
7440-38-2	Arsenic	8 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	Barium	10 mg/kg	4900 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	104 mg/kg	1.51 mg/kg	1.51			
7440-47-3	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-50-8	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22 mg/kg			
7439-96-5	Manganese[i]	5 mg/kg	165000 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7782-49-2	Selenium	10 mg/kg[f g]	17,500 mg/kg	5 mg/kg	1 mg/kg			
7440-22-4	Silver	1 mg/kg[f g]	17,500 mg/kg	8 mg/kg	0.73 mg/kg			
7440-24-6	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[c]			

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-1

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
7440-62-2	Vanadium	2.5 mg/kg	24500 mg/kg	85.1 mg/kg	NV[c]			
7440-66-6	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
16887-00-6	Chloride	2 mg/kg	NV[c]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[e]	70-130%[e]
14797-55-8	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1000 mg/kg	2,000 mg/kg			
14797-65-0	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
16984-48-8	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	1050 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	±30%[e]	70-130%[e]
126-73-8	Tributyl phosphate	3.3 mg/kg[f]	24,300 mg/kg	3.3 mg/kg	NV[c]	EPA 8270 (semi-volatiles)	±30%[h]	70-130%[h]
71-55-6	1,1,1-Trichloroethane	0.005 mg/kg				EPA 8260 (volatile organics)	±30%[h]	70-130%[h]
156-59-2	cis-1,2-dichloroethene	0.005 mg/kg						
71-43-2	Benzene	0.005 mg/kg	24,530 mg/kg	0.079 mg/kg	0.159 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg						
67-66-3	Chloroform	0.005 mg/kg	21500 mg/kg	0.717 mg/kg	1.14 mg/kg			
75-01-4	vinyl chloride	0.005 mg/kg						
108-10-1	Methyl isobutyl ketone (hexone)	0.010 mg/kg						

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-1

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
127-18-4	Tetrachloroethene	0.005 mg/kg						
79-01-6	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
7440-61-1	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]
7440-38-2	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	Copper	1 µg/L	NA	NA	NA			
7439-92-1	Lead	1 µg/L	NA	NA	NA			
7439-98-7	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	Silver	1 µg/L	NA	NA	NA			
7440-61-1	Uranium	1 µg/L	NA	NA	NA			

Table 2-12. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-1

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

c. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

d. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

g. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

h. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Methods 8260 and 8270.

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis*.

CAS = Chemical Abstracts Service
dpm = disintegrations per minute
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-2

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements								
	Gross gamma	10 pCi/g	NA	NA	NA	Portable sodium iodide detector	±50	[b]
	Gross alpha	100 dpm/ 100 cm^2	NA	NA	NA	Portable contamina-tion detector	±50	[b]
	Gross beta	5,000 dpm/ 100 cm^2	NA	NA	NA	Portable contamina-tion detector	±50	[b]
	VOC vapors	1 ppm	NA	NA	NA	Photo Ionization detector	±30%	±30%
Performance Requirements for Laboratory Measurements (radiological)								
14762-75-5	Carbon-14	2 pCi/g	82 pCi/g	NV[c]	NV[c]	LSC – C-14	±30%[d]	70-130%[d]
13981-37-8	Nickel-63	30 pCi/g	3,370,000 pCi/g	NV[c]	NV[c]	LSC – Ni-63	±30%[d]	70-130%[d]
14133-76-7	Technetium-99	0.25 pCi/g	410,000 pCi/g	239 pCi/g	239 pCi/g	LSC – Tc-99	±30%[d]	70-130%[d]
10028-17-8	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – Tritium	±30%[d]	70-130%[d]
13981-16-3	Plutonium-238	1 pCi/g				Isotopic – plutonium	±30%[d]	70-130%[d]
--	Plutonium-239/240	1 pCi/g						
13966-29-5	Uranium-234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium - alpha energy analysis	±30%[d]	70-130%[d]
15117-96-1	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			
--	Uranium-238	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g			
13966-29-5	Uranium-234	1 pCi/L				Water	±10%	90-110%

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-2

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
15117-96-1	Uranium-235	1 pCi/L				leachate from sediment ICP/MS, PNNL-AGG-415		
--	Uranium-238	1 pCi/L						
Performance Requirements for Laboratory Measurements (nonradiological)								
7429-90-5	Aluminum	5 mg/kg	3,500,000 mg/kg	35,000 mg/kg	16,000 mg/kg	EPA 6010 (ICP metals)	±30%[e]	70-130%[e]
7440-38-2	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	Barium	2 mg/kg	4,900 mg/kg	200 mg/kg	400 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-50-8	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-96-5	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	70,000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7782-49-2	Selenium	10 mg/kg[f g]	17,500 mg/kg	5 mg/kg	1 mg/kg			
7440-22-4	Silver	1 mg/kg[f g]	17,500 mg/kg	8 mg/kg	0.73 mg/kg			
7440-24-6	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[c]			
7440-62-2	Vanadium	2.5 mg/kg	24,500 mg/kg	85.1 mg/kg	NV[c]			
7440-66-6	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			
16887-00-6	Chloride	2 mg/kg	NV[c]	25,000 mg/kg	NA	EPA 300.0	±30%[e]	70-130%[e]

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-2

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
14797-55-8	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1000 mg/kg	2000 mg/kg	(anions by IC)		
14797-65-0	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
16984-48-8	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	1,050 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	±30%[e]	70-130%[e]
126-73-8	Tributyl phosphate	3.3 mg/kg				EPA 8270 (semi-volatiles)	±30%[h]	70-130%[h]
71-55-6	1,1,1-Trichloroethane	0.005 mg/kg				EPA 8260 (volatile organics)	±30%[h]	70-130%[h]
156-59-2	cis-1,2-dichloroethene	0.005 mg/kg						
71-43-2	Benzene	0.005 mg/kg	4530 mg/kg	0.0795 mg/kg	0.159 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg						
67-66-3	Chloroform	0.005 mg/kg						
75-01-4	vinyl chloride	0.005 mg/kg						
108-10-1	Methyl isobutyl ketone (hexone)	0.010 mg/kg						
127-18-4	Tetrachloroethene	0.005 mg/kg						

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-2

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			
79-01-6	Trichloroethene	0.005 mg/kg						
7440-61-1	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[e]	70-130%[e]
7440-38-2	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-110%
7440-43-9	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	Copper	1 µg/L	NA	NA	NA			
7439-92-1	Lead	1 µg/L	NA	NA	NA			
7439-98-7	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	Selenium	1 µg/L	NA	NA	NA			
7440-22-4	Silver	1 µg/L	NA	NA	NA			
7440-61-1	Uranium	1 µg/L	NA	NA	NA			

Table 2-13. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-2

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Groundwater Protection	River Protection			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

c. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

d. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

e. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

f. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

g. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

h. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Methods 8260 and 8270.

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford Site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis*.

CAS = Chemical Abstracts Service
dpm = disintegrations per minute
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-3

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (unrestricted)	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements								
	Gross gamma	10 pCi/g	NA	NA	NA	Portable sodium iodide detector	±50	[b]
	Gross alpha	100 dpm/ 100 cm^2	NA	NA	NA	Portable contamination detector	±50	[b]
	Gross beta	5,000 dpm/ 100 cm^2	NA	NA	NA	Portable contamination detector	±50	[b]
	VOC vapors	1 ppm	NA	NA	NA	Photo Ionization detector	±30%	±30%
Performance Requirements for Laboratory Measurements (radiological)								
14762-75-5	Carbon-14	2 pCi/g	82 pCi/g	NV[c]	NV[c]	LSC – C-14	±30%[d]	70-130%[d]
13981-37-8	Nickel-63	30 pCi/g	3,370,000 pCi/g	NV[c]	NV[c]	LSC – Ni-63	±30%[d]	70-130%[d]
14133-76-7	Technetium-99	0.25 pCi/g	410,000 pCi/g	239 pCi/g	239 pCi/g	LSC – Tc-99	±30%[d]	70-130%[d]
10028-17-8	Tritium	10 pCi/g	1980 pCi/g	5360 pCi/g	5360 pCi/g	LSC – tritium	±30%[d]	70-130%[d]
10045-97-3	Cesium-137	0.1 pCi/g	25 pCi/g	NV[d]	NV[d]	Gamma energy analysis	±30%[d]	70-130%[d]
10198-40-0	Cobalt-60	0.05 pCi/g	5.2 pCi/g	NV[d]	NV[d]			
15046-84-1	Iodine-129	2 pCi/g	4041 pCi/g	2 pCi/g	2 pCi/g	Low energy-gamma energy analysis	±30%[d]	70-130%[d]
	Uranium-233/234	1 pCi/g	167 pCi/g	127.4 pCi/g	127.4 pCi/g	Isotopic – uranium - Alpha energy	±30%[d]	70-130%[d]
15117-96-1	Uranium-235	0.5 pCi/g	16 pCi/g	13.2 pCi/g	13.2 pCi/g			

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-3

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (unrestricted)	Groundwater Protection	River Protection			
--	Uranium-238	1 pCi/g	13.7 pCi/g	127.4 pCi/g	127.4 pCi/g	analysis		
13966-29-5	Uranium-234	1 pCi/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	□10%	90-110%
15117-96-1	Uranium-235	1 pCi/L	NA	NA	NA			
--	Uranium-238	1 pCi/L	NA	NA	NA			
Performance Requirements for Laboratory Measurements (nonradiological)								
7440-36-0	Antimony	6 mg/kg[e f]	1400 mg/kg	5 mg/kg	5 mg/kg	EPA 6010 (ICP metals)	±30%[g]	70-130%[g]
7440-38-2	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	Barium	2 mg/kg	4900 mg/kg	200 mg/kg	200 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	104 mg/kg	1.51 mg/kg	1.51 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	5,250,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-50-8	Copper	1 mg/kg	130,000 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-96-5	Manganese[i]	5 mg/kg	165,000 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	70000 mg/kg	19.1 mg/kg	27.4 mg/kg			
7782-49-2	Selenium	10 mg/kg[e f]	17,500 mg/kg	5 mg/kg	1 mg/kg			
7440-22-4	Silver	1 mg/kg[e f]	17,500 mg/kg	8 mg/kg	0.73 mg/kg			
7440-24-6	Strontium	1 mg/kg	2,100,000 mg/kg	960 mg/kg	NA[c]			
7440-62-2	Vanadium	2.5 mg/kg	24500 mg/kg	85.1 mg/kg	NV[c]			
7440-66-6	Zinc	1 mg/kg	1,050,000 mg/kg	480 mg/kg	67.8 mg/kg			

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-3

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (unrestricted)	Groundwater Protection	River Protection			
16887-00-6	Chloride	2 mg/kg	NV[c]	25,000 mg/kg	NA	EPA 300.0 (anions by IC)	±30%[g]	70-130%[g]
14797-55-8	Nitrate (as N)[j]	2.5 mg/kg	5,600,000 mg/kg	1000 mg/kg	2000 mg/kg			
14797-65-0	Nitrite (as N)[j]	2.5 mg/kg	350,000 mg/kg	100 mg/kg	200 mg/kg			
16984-48-8	Fluoride	5 mg/kg	210,000 mg/kg	96 mg/kg	400 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	1050 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	±30%[g]	70-130%[g]
126-73-8	Tributyl phosphate	3.3 mg/kg[e]	24,300 mg/kg	3.3 mg/kg	NV[d]	EPA 8270 (semi-volatiles)	±30%[h]	70-130%[h]
98-95-3	Nitrobenzene	0.33 mg/kg	7000 mg/kg	1.6 mg/kg	3.4 mg/kg			
71-43-2	Benzene	0.005 mg/kg	4530 mg/kg	0.0795 mg/kg	0.159 mg/kg	EPA 8260 (volatile organics)	±30%[h]	70-130%[h]
67-66-3	Chloroform	0.005 mg/kg	21500 mg/kg	0.717 mg/kg	1.14 mg/kg			
108-10-1	Methyl isobutyl ketone (hexone)	0.010 mg/kg						
79-01-6	Trichloroethene	0.005 mg/kg	2570 mg/kg	0.0858 mg/kg	0.16 mg/kg			
7440-61-1	Uranium (total)	1 mg/kg	505 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	±30%[g]	70-130%[g]
7440-38-2	Arsenic	1 µg/L	NA	NA	NA	Water leachate from sediment ICP/MS, PNNL-AGG-415	±10%	90-10%
7440-43-9	Cadmium	1 µg/L	NA	NA	NA			
7440-47-3	Chromium	1 µg/L	NA	NA	NA			
7440-50-8	Copper	1 µg/L	NA	NA	NA			
7439-92-1	Lead	1 µg/L L	NA	NA	NA			
7439-98-7	Molybdenum	1 µg/L	NA	NA	NA			
7782-49-2	Selenium	1 µg/L	NA	NA	NA			

Table 2-14. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 300-DU-VZ-3

CAS	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method[a]	Precision Require-ment (%)	Accuracy Require-ment (%)
			Direct Exposure (unrestricted)	Groundwater Protection	River Protection			
7440-22-4	Silver	1 µg/L	NA	NA	NA			
7440-61-1	Uranium	1 µg/L	NA	NA	NA			

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

b. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

c. NV = No value or NA = Not available. The generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years.

d. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

e. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

f. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if EQLs are met.

g. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

h. The accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for Methods 8260 and 8270.

i. The manganese preliminary remediation goal groundwater and river protection values are not risk based. They are predicated on a secondary maximum contaminant level (taste and/or odor) and are based on Hanford Site background.

j. Nitrate/nitrite may also be reported as nitrogen in nitrate/nitrite by Method 353.1/353.2/353.3 with the reporting limits specified in the appendix.

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis*.

CAS = Chemical Abstracts Service
dpm = disintegrations per minute
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
EQL = estimated quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kenotic phosphorescence analysis

Table 2-15. Analytical Performance Requirements for Groundwater Water Samples During Drilling.

CAS	Analyte	Analytical Method[a]	EQL	Precision Requirement (%)[b]	Accuracy Requirement (%)[b]	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
	Oxidation reduction potential	REDOX PROBE	NA	c	c		
	pH measurement	PROBE	0.5 pH unit	c	c		
	Specific conductance	PROBE	1 µS/cm	c	c		
	Temperature	PROBE	--	c	c		
	Dissolved oxygen	PROBE	--	c	c		
	Turbidity	PROBE	0.1 nephelo-metric turbidity unit	c	c		
	Water level in the well at time of sampling	Tape	NA	NA	NA		
Performance Requirements for Laboratory Measurements (nonradiological)							
7440-38-2	Arsenic	EPA 6010 or 6020	4 µg/L	±20%	80-120%		
7440-39-3	Barium	EPA 6010 or 6020	20 µg/L	±20%	80-120%		
7440-41-7	Beryllium	EPA 6010 or 6020	2 µg/L	±20%	80-120%		
7440-43-9	Cadmium	EPA 6010 or 6020	2 µg/L	±20%	80-120%		
7440-47-3	Chromium	EPA 6010 or 6020	10 µg/L	±20%	80-120%		
7440-50-8	Copper	EPA 6010 or 6020	8 µg/L	±20%	80-120%		
7439-89-6	Iron	EPA 6010 or 6020	50 µg/L	±20%	80-120%		
7439-92-1	Lead	EPA 6010 or 6020	2 µg/L	±20%	80-120%		
7439-95-4	Magnesium	EPA 6010 or 6020	750 µg/L	±20%	80-120%		
7439-96-5	Manganese	EPA 6010 or 6020	5 µg/L	±20%	80-120%		
7439-97-6	Mercury	EPA 7470 or 200.8 (Mercury)	0.5 µg/L	±20%	80-120%		

Table 2-15. Analytical Performance Requirements for Groundwater Water Samples During Drilling.

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis
7440-09-7	Potassium	EPA 6010 or 6020	4000 µg/L	±20%	80-120%		
7440-22-4	Silver	EPA 6010 or 6020	10 µg/L	±20%	80-120%		
7440-66-6	Zinc	EPA 6010 or 6020	10 µg/L	±20%	80-120%		
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	±20%	80-120%		
56-23-5	Carbon tetrachloride	EPA 8260 (volatile organics)	1 µg/L	±20%	80-120%		
156-59-2	cis-1,2-dichloroethene	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%		
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%		
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	1 µg/L	±20%	80-120%		
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%		
126-73-8	Tributyl phosphate	EPA 8270 (semivolatile organics)	100 µg/L	±20%	80-120%		
16887-00-6	Chloride	EPA 300.0 (anions by IC)	200 µg/L	±20%	80-120%		
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%		
14797-55-8	Nitrate (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%		
14797-65-0	Nitrite (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%		
14265-44-2	Phosphate	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%		
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%		
	Alkalinity[d]	[d]	[d]	[d]	[d]		

Table 2-15. Analytical Performance Requirements for Groundwater Water Samples During Drilling.

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for Methods 8260 and 8270.

b. Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples also is performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analyses.

c. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

d. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

WAC 173-340-720(4), "Method B Cleanup Levels for Potable Ground Water."

CAS = Chemical Abstracts Service
IC = ion chromatography
NA = not applicable
EQL = estimated quantitation limit
REDOX = Reduction Oxidation (Plant or process)

Table 2-16. Analytical Performance Requirements for Non-Risk Assessment Groundwater Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision Requirement (%)[b]	Accuracy Requirement (%)[b]	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
	Oxidation reduction potential	REDOX PROBE	NA	c	c		
	pH measurement	PROBE	0.5 pH unit	c	c		
	Specific conductance	PROBE	1 µS/cm	c	c		
	Temperature	PROBE	--	c	c		
	Dissolved oxygen	PROBE	--	c	c		
	Turbidity	PROBE	0.1 nephelo-metric turbidity unit	c	c		
	Water level in the well at time of sampling	Tape	NA	NA	NA		
Performance Requirements for Laboratory Measurements (nonradiological)							
7440-38-2	Arsenic	EPA 6010 or 6020	4 µg/L	±20%	80-120%		
7440-39-3	Barium	EPA 6010 or 6020	20 µg/L	±20%	80-120%		
7440-41-7	Beryllium	EPA 6010 or 6020	2 µg/L	±20%	80-120%		
7440-43-9	Cadmium	EPA 6010 or 6020	2 µg/L	±20%	80-120%		
7440-47-3	Chromium	EPA 6010 or 6020	10 µg/L	±20%	80-120%		
7440-50-8	Copper	EPA 6010 or 6020	8 µg/L	±20%	80-120%		
7439-89-6	Iron	EPA 6010 or 6020	50 µg/L	±20%	80-120%		
7439-92-1	Lead	EPA 6010 or 6020	2 µg/L	±20%	80-120%		
7439-95-4	Magnesium	EPA 6010 or 6020	750 µg/L	±20%	80-120%		
7439-96-5	Manganese	EPA 6010 or 6020	5 µg/L	±20%	80-120%		
7439-97-6	Mercury	EPA 7470 or 200.8 (Mercury)	0.5 µg/L	±20%	80-120%		

Table 2-16. Analytical Performance Requirements for Non-Risk Assessment Groundwater Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis
7440-09-7	Potassium	EPA 6010 or 6020	4000 µg/L	±20%	80-120%		
7440-22-4	Silver	EPA 6010 or 6020	10 µg/L	±20%	80-120%		
7440-66-6	Zinc	EPA 6010 or 6020	10 µg/L	±20%	80-120%		
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	±20%	80-120%		
56-23-5	Carbon tetrachloride	EPA 8260 (volatile organics)	1 µg/L	±20%	80-120%		
156-59-2	cis-1,2-dichloroethene	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%		
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%		
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	1 µg/L	±20%	80-120%		
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%		
16887-00-6	Chloride	EPA 300.0 (anions by IC)	200 µg/L	±20%	80-120%		
24959-67-9	Bromide	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%		
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%		
14797-55-8	Nitrate (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%		
14797-65-0	Nitrite (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%		
14265-44-2	Phosphate	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%		
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%		
	Alkalinity	d	d	d	d		

Table 2-16. Analytical Performance Requirements for Non-Risk Assessment Groundwater Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis
	Microbiological activity	e	e	e	e		

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for Method 8260.

b. Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples also is performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analyses.

c. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

d. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

e. The purpose of determining microbial activity will be to identify the microbes in the aquifer responsible for degradation of trichloroethylene or tetrachloroethylene only as far as dichloroethene, and not farther to vinyl chloride and beyond. Details of the tests, including EQL, precision and accuracy, will be discussed with the laboratory personnel before analysis.

CAS = Chemical Abstracts Service
IC = ion chromatography
NA = not applicable
EQL = estimated quantitation limit
REDOX = Reduction Oxidation (Plant or process)

Table 2-17. Analytical Performance Requirements for 300 Area Risk Assessment Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision Requirement (%)[b]	Accuracy Requirement (%)[b]	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
	Oxidation reduction potential	REDOX PROBE	NA	[c]	[c]	NA	NA
	pH measurement	PROBE	0.5 pH unit	[c]	[c]	NA	NA
	Specific conductance	PROBE	1 µS/cm	[c]	[c]	NA	NA
	Temperature	PROBE	--	[c]	[c]	NA	NA
	Dissolved oxygen	PROBE	--	[c]	[c]	NA	NA
	Turbidity	PROBE	0.1 nephelo-metric turbidity unit	[c]	[c]	NA	NA
Performance Requirements for Laboratory Measurements (radiological)							
10098-97-2	Strontium-90	Strontium 89/90 – Sr-90	2 pCi/L	±30%	70-130%	8 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC – Tritium (H-3)	400 pCi/L	±30%	70-130%	20,000 pCi/L	40 CFR 141.66
Performance Requirements for Laboratory Measurements (nonradiological)							
7440-36-0	Antimony	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	±20%	80-120%	5.60 µg/L	Human Health for the Consumption of Water + Organism
7440-38-2	Arsenic	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L[d]	±20%	80-120%	0.018 µg/L	Human Health for the Consumption of Water + Organism
7440-43-9	Cadmium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[d]	±20%	80-120%	0.25 µg/L	Freshwater CCC
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	±20%	80-120%	74 µg/L	Freshwater CCC
7440-48-4	Cobalt	EPA 6010 (ICP metals)	4 µg/L	±20%	80-120%	4.8	WAC 173-340-720(4)
7440-50-8	Copper	Trace – ICP (6010)	8 µg/L	±20%	80-120%	9 µg/L	Freshwater CCC

Table 2-17. Analytical Performance Requirements for 300 Area Risk Assessment Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	±20%	80-120%	2.5 µg/L	Freshwater CCC
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	±20%	80-120%	50 µg/L	40 CFR 143.3
7439-97-6	Mercury	EPA 7470 or 200.8 (Mercury)	0.5 µg/L[d]	±20%	80-120%	0.012 µg/L	WAC 173-201A
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	±20%	80-120%	52 µg/L	Freshwater CCC
7782-49-2	Selenium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	±20%	80-120%	5 µg/L	Freshwater CCC
7440-22-4	Silver	EPA 6010 (ICP metals)	10 µg/L	±20%	80-120%	80 µg/L	WAC 173-340-720(4)
7440-28-0	Thallium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[d]	±20%	80-120%	0.24 µg/L	Human Health for the Consumption of Water + Organism
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	±20%	80-120%	30 µg/L	40 CFR 141.66
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	±20%	80-120%	120 µg/L	Freshwater CCC
540-59-0	1,2-Dichloroethene (total)	EPA 8260 (volatile organics)	10 µg/L	±20%	80-120%	72 µg/L	WAC 173-340-720(4)
56-23-5	Carbon tetrachloride	EPA 8260 (volatile organics)	1 µg/L[d]	±20%	80-120%	0.23 µg/L	Human Health for the Consumption of Water + Organism
67-66-3	Chloroform	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%	5.7 µg/L	Human Health for the Consumption of Water + Organism
156-59-2	cis-1,2-dichloroethene	EPA 8260 (volatile organics)	5 µg/L	±20%	80-120%	70 µg/L	40 CFR 141.66
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L[d]	±20%	80-120%	0.081 µg/L	WAC 173-340-720(4)
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	1 µg/L[d]	±20%	80-120%	0.49 µg/L	WAC 173-340-720(4)

Table 2-17. Analytical Performance Requirements for 300 Area Risk Assessment Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis
75-01-4	Vinyl chloride	EPA 8260 (volatile organics)	5 µg/L[d]	±20%	80-120%	0.029 µg/L	Human Health for the Consumption of Water + Organism
57-12-5	Cyanide	EPA 9010 or 9012 (total cyanide)	5 µg/L	±20%	80-120%	5.2 µg/L	Freshwater CCC
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%	960 µg/L	WAC 173-340-720(4)
14797-55-8	Nitrate (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%	10,000 µg/L	40 CFR 141.66
14797-65-0	Nitrite (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%	1,000 µg/L	40 CFR 141.66
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%	250,000 µg/L	40 CFR 143.3
	Alkalinity	e	e	e	e		

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for Method 8260.

b. Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples also is performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analyses.

c. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

d. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

e. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."

WAC 173-340-720(4), "Method B Cleanup Levels for Potable Ground Water."

CAS = Chemical Abstracts Service
CCC = criterion continuous concentration
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
MCL = maximum contaminant level
NA = not applicable
EQL = estimated quantitation limit
REDOX = Reduction Oxidation (Plant or process)

Table 2-18. Analytical Performance Requirements for 600 Area Risk Assessment Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision Requirement (%)[b]	Accuracy Requirement (%)[b]	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
	Oxidation reduction potential	REDOX PROBE	NA	[c]	[c]	NA	NA
	pH measurement	PROBE	0.5 pH unit	[c]	[c]	NA	NA
	Specific conductance	PROBE	1 µS/cm	[c]	[c]	NA	NA
	Temperature	PROBE	--	[c]	[c]	NA	NA
	Dissolved oxygen	PROBE	--	[c]	[c]	NA	NA
	Turbidity	PROBE	0.1 nephelo-metric turbidity unit	[c]	[c]	NA	NA
Performance Requirements for Laboratory Measurements (radiological)							
15046-84-1	Iodine-129	Iodine-129 – low level	1 pCi/L[e]	±30%	70-130%	1 pCi/L	40 CFR 141.66
10098-97-2	Strontium-90	Strontium 89/90 – Sr-90	2 pCi/L	±30%	70-130%	8 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC – Tritium (H-3)	400 pCi/L	±30%	70-130%	20,000 pCi/L	40 CFR 141.66
Performance Requirements for Laboratory Measurements (nonradiological)							
7440-36-0	Antimony	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	±20%	80-120%	5.60 µg/L	Human Health for the Consumption of Water + Organism
7440-38-2	Arsenic	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	±20%	80-120%	0.018 µg/L	Human Health for the Consumption of Water + Organism
7440-43-9	Cadmium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[e]	±20%	80-120%	0.25 µg/L	Freshwater CCC
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	±20%	80-120%	74 µg/L	Freshwater CCC
7440-50-8	Copper	Trace – ICP (6010)	8 µg/L	±20%	80-120%	9 µg/L	Freshwater CCC

Table 2-18. Analytical Performance Requirements for 600 Area Risk Assessment Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	±20%	80-120%	2.5 µg/L	Freshwater CCC
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	±20%	80-120%	50 µg/L	40 CFR 143.3
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	±20%	80-120%	52 µg/L	Freshwater CCC
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	±20%	80-120%	30 µg/L	40 CFR 141.66
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	±20%	80-120%	120 µg/L	Freshwater CCC
56-23-5	Carbon Tetrachloride	EPA 8260 (volatile organics)	1 µg/L[e]	±20%	80-120%	0.23 µg/L	Human Health for the Consumption of Water + Organism
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L[e]	±20%	80-120%	0.081 µg/L	WAC 173-340-720(4)
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	1 µg/L[e]	±20%	80-120%	0.49 µg/L	WAC 173-340-720(4)
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L[e]	±20%	80-120%	0.029 µg/L	Human Health for the Consumption of Water + Organism
126-73-8	Tributyl Phosphate	EPA 8270 (semivolatile organics)	100 µg/L[e]	±20%	80-120%	16.2 µg/L	WAC 173-340-720(4)
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%	960 µg/L	WAC 173-340-720(4)
14797-55-8	Nitrate (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%	10,000 µg/L	40 CFR 141.66
14797-65-0	Nitrite (as N)	EPA 300.0 (anions by IC)	250 µg/L	±20%	80-120%	1,000 µg/L	40 CFR 141.66
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	±20%	80-120%	250,000 µg/L	40 CFR 143.3
	Alkalinity	[f]	[f]	[f]	[f]		

Table 2-18. Analytical Performance Requirements for 600 Area Risk Assessment Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	EQL	Precision	Accuracy	Action	Action Level Basis

NOTE: Only those constituents specified as a target analyte or COPC have established preliminary cleanup goals stated.

a. Equivalent methods may be substituted. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for Methods 8260 and 8270.

b. Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples also is performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analyses.

c. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

e. Calculated cleanup goals are below established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.

f. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

WAC 173-340-720(4), "Method B Cleanup Levels for Potable Ground Water."

CAS = Chemical Abstracts Service
CCC = criterion continuous concentration
IC = ion chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
MCL = maximum contaminant level
NA = not applicable
EQL = estimated quantitation limit
REDOX = Reduction Oxidation (Plant or process)

In addition, pre-job briefings will be performed to evaluate an activity and its hazards by considering many factors, including the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts.

Training records are maintained for each individual in an electronic training record database. The contractor training organization maintains the training records system. Line management will be used to confirm an individual employee's training is appropriate and up-to-date before performing any field work.

2.1.6 Documents and Records

The project lead is responsible for ensuring the current version of the SAP is being used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Changes to the sampling plan affecting the data needs will be reviewed and approved by DOE and the lead regulatory agency before implementation. Information pertinent to sampling and analysis will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols in accordance with DOE/RL-96-68.

The sampling lead or drilling lead is responsible for ensuring the field instructions are maintained up-to-date and aligned with any revisions or other approved changes to the SAP. The sampling lead or drilling lead will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or on nonconformance report forms) in accordance with internal corrective-action procedures.

The project lead, drilling lead, sampling lead, or designee will be responsible for communicating field corrective-action requirements and for ensuring immediate corrective actions are applied to field activities. Table 2-19 presents the change control for this project.

Logbooks are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for logbooks will be listed. Only authorized persons may make entries in logbooks. Logbooks will be signed by the sampling lead, drilling lead, cognizant scientist/engineer, or other responsible individual. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason.

Entries will be made in indelible ink. Corrections will made by marking the erroneous data through with a single line, entering the correct data, and initialing and dating the changes.

Table 2-19. Change Control for the 300 Area Decision Unit Project

Type of Change	Action	Documentation
By drilling lead or sampling lead: • Increasing sampling frequency based on field-screening results or visual observations	No SAP revision necessary	Field logbooks or operational records
By project management: • Change in target analytes or COPCs • Adding/removing wells • Significant increases or decreases in sampling frequency	Revise SAP plan (can be accomplished with Tri-Party Agreement Change Notice); obtain regulatory approval; distribute plan	Revised plan or approved Tri-Party Agreement Change Notice.

The project lead is responsible for ensuring a project file is properly maintained. The project file will include the following, as appropriate:

- Field logbooks or operational records
- Data forms
- Global Positioning System data
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective-action reports
- Interim progress reports
- Final reports
- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract
- Laboratory data packages
- Remedial investigation report
- Verification and validation report.

The project file will contain the records or references to their storage locations. The laboratory is responsible for maintaining, and having available upon request, the following:

- Analytical logbooks
- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information.

Records may be stored in either electronic or hard-copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure

accuracy and retrievability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements of the Agreement.

2.2 Data Generation and Acquisition

The following sections address data generation and acquisition to ensure the project methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

2.2.1 Sampling Process Design (Experimental Design)

The sampling design is judgmental sampling. In judgmental sampling, the selection of sampling units (e.g., the number and location and/or timing of collecting samples) is based on knowledge of the feature or condition under investigation and on professional judgment. Judgmental sampling is distinguished from probability-based sampling in that inferences are based on professional judgment, not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment; probabilistic statements about parameters are not possible. The types, number, and location of samples are provided in Section 3.5.

2.2.2 Sampling Methods

Sampling methods are described in the Section 3.6. The specific information includes the following:

- Field sampling methods
- Corrective actions for sampling activities (ultimately, the task lead will be responsible for corrective action)
- Decontamination of sampling equipment
- Radiological field data.

2.2.3 Sample Handling and Custody

A sampling and data-tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomalies (e.g., sample appears unusual or sample is sludge) with the samples to prevent batching across similar matrices. If anomalies are found, the samplers should write "DO NOT BATCH" on the chain-of-custody form and inform Sample Management and Reporting.

Laboratory analytical results are entered and maintained in HEIS. Hanford Environmental Information System sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical property sample is identified and labeled with a unique HEIS sample number.

Section 3.7 provides the following specific sample-handling information:

- Container packaging
- Container labeling
- Sample custody requirements
- Sample transportation.

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure sample integrity and identification are maintained

throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by Sample Management and Reporting.

2.2.4 Analytical Methods

Information on analytical methods is provided in Tables 2-2 through 2-18. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor, or vadose zone contractor as applicable, participates in oversight of offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. Deviations from the analytical methods noted in Tables 2-2 through 2-18 must be approved by Sample Management and Reporting in consultation with the project lead. Laboratories providing analytical services in support of this SAP will have in place a corrective-action program addressing analytical system failures and documents on the effectiveness of corrective actions. Issues affecting analytical results are to be resolved by Sample Management and Reporting in coordination with the project lead.

For the analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future performed by Pacific Northwest National Laboratory (PNNL), details of the tests will be discussed with the laboratory personnel before analysis.

The purpose of determining microbial activity to fulfill Data Need 4 will be to identify the microbes in the aquifer responsible for degradation of trichloroethylene or tetrachloroethylene only as far as dichloroethene, and not farther to vinyl chloride and beyond. Details of the tests will be discussed with the laboratory personnel before analysis.

2.2.5 QC

Quality control procedures must be followed in the field and laboratory to ensure reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field transfer blanks, equipment blanks, and field splits. Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table 2-20. Additional QC samples may be collected if conditions arise.

Table 2-20. Project QC Checks

QC Sample Type	Purpose	Frequency
Field QC		
Full trip blank	Assess contamination from containers or transportation.	One per 20 samples per media sampled.
Field transfer blank	Assess contamination from sampling site.	One per day when volatile organics are sampled per media sampled.

Table 2-20. Project QC Checks

QC Sample Type	Purpose	Frequency
Equipment rinsate blank	Verify adequacy of sampling equipment decontamination.	As needed.[a] If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. Otherwise, one per 20 samples per media sampled.
Field duplicates	Estimate precision, including sampling and analytical variability.	One per batch,[b] 20 samples maximum, of each media sampled.
Field split	Estimate precision, including sampling, analytical, and inter-laboratory variability.	At a minimum, one per analytical method, per media for analyses performed where detection limit and precision and accuracy criteria have been defined in the performance requirements tables in Chapter 2.
Laboratory QC[b]		
Method blank	Assess response of an entire laboratory analytical system.	One per batch,[b] 20 samples maximum, or as identified by the method guidance per media sampled.
Matrix spike	Identify analytical (preparation and analysis) bias; possible matrix affect on the analytical method used.	When required by the method guidance, one per batch,[b] 20 samples maximum, or as identified by the method guidance per media sampled.
Matrix duplicate or matrix spike duplicate	Estimate analytical bias and precision.	When required by the method guidance, one per batch,[b] 20 samples maximum, or as identified by the method guidance per media sampled.
Laboratory control samples	Assess method accuracy.	One per batch,[b] 20 samples maximum, or as identified by the method guidance per media sampled.
Surrogates	Estimate recovery/yield.	When required by the method guidance, one as identified by the method guidance.

a. Whenever a new type of nondedicated equipment is used, an equipment blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the nondedicated equipment.

b. Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

Field QC Samples

Full trip blanks are samples prepared by the sampling team before traveling to the sampling site. The preserved bottle set is identical to the set collected in the field, but it is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and transported, unopened, to the field in the same storage container used for samples collected the same day. Full trip blanks are typically analyzed for the same constituents as the samples from the associated sampling event. However, the analytical list for full trip blanks on soil may be limited to volatile organic analytes, semivolatile

organic analytes, and total petroleum hydrocarbon, depending on resolution/determination of the target analyte list.

Field transfer blanks are preserved volatile organic analysis sample containers filled at the sample collection site with reagent water, or silica sand, as appropriate to the primary sample media, transported to the field. The samples are prepared during the sampling to evaluate potential contamination caused by conditions in the field. After collection, field transfer blank bottles are sealed and placed in the same storage container with the samples from the associated sampling event. Field transfer blank samples are analyzed for volatile organic compounds only.

A minimum of one field transfer blank will be collected at each borehole where the samples will undergo volatile organic analysis. The field transfer blank will consist of reagent water or silica sand, as appropriate to the primary sample media, added to clean sample containers at the location where the volatile organic compound sample was collected. The field transfer blank will be batched with samples for which volatile organic analysis is being requested.

Equipment rinsate blanks are collected for sampling devices reused to assess the adequacy of the decontamination process. Equipment blanks will consist of silica sand or reagent water poured over the decontaminated sampling equipment and placed in containers, as identified on the project Sampling Authorization Form. If disposable (e.g., single-use) equipment is used, equipment blanks will not be required.

For the field transfer blanks (e.g., full trip blank, field transfer blank, and equipment rinsate), results above two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit. For radiological data, blank results are flagged if they are greater than two times the total minimum detectable activity.

Field duplicate samples are used to evaluate sample consistency and the precision of field sampling methods. Field duplicates are independent samples that are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently.

A minimum of one soil and one aquifer sediment field duplicate will be collected for each day of sampling. The duplicate should be collected generally from an area expected to have some contamination, so valid comparisons between the samples can be made (e.g., at least some of the constituents will be above the detection limit). When sampling is performed from a split spoon, volatile organic samples and volatile organic duplicate samples are collected directly from the sampler. The remaining soil/aquifer sediment is then composited in a stainless steel mixing bowl. The soil/aquifer sediment sample and duplicate sample are collected from this composited material.

Evaluation of the results can provide an indication of intra-laboratory variability. Large relative percent differences can be an indication of laboratory performance problems and should be investigated. Only those field duplicates with at least one result greater than five times the method detection limit or minimum detectable activities are evaluated.

A **field split** is a representative sample(s) from a sampling event(s) sent to a third-party laboratory (reference laboratory). Evaluation of the results can provide an indication of inter-laboratory variability. Large relative percent differences can be an indication of laboratory performance problems and should be investigated. Only those results greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated. One field split will be collected for every analytical method except for PNNL specific tests, per media sampled.

Laboratory QC Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, and matrix spike) are defined for three-digit EPA methods (EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes* and EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*) and four-digit EPA methods (SW-846), and will be run at the frequency specified in the respective reference.

Quality control checks outside of control limits will be reflected in the data validation process and during the DQA described in Section 2.4.

QC Requirements

If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. If no volatile organic compound samples are collected, then a field transfer blank is not required. Field transfer blanks are not required when simply transferring samples to the field gas chromatograph for analysis.

Field duplicates must agree within 20 percent, as measured by the relative percent difference, to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit are evaluated. Unacceptable field duplicate results also are flagged with a "Q" in the database.

For chemical analyses, the acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples generally are stated in Tables 2-2 through 2-18. Holding time is the elapsed time period between sample collection and analysis. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the analytical method, as specified for three- and four-digit EPA methods (EPA/600/4-79/020; EPA/600/R-94/111; SW-846). Data associated with exceeded holding times are flagged.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The laboratories participate in national studies such as the EPA-sanctioned water pollution and water supply performance evaluation studies. The Soil & Groundwater Remediation Project periodically audits the analytical laboratories to identify and solve quality problems or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater-monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*).

Failure of QC will be determined and evaluated during data validation and the DQA process. Data will be qualified as appropriate.

2.2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing should meet the applicable standards (e.g., American Society for Testing and Materials) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The sampling lead or equivalent will ensure that the data generated from instructions using a software system are backed up and/or downloaded on a regular basis. Software configuration will be acceptance tested before use in the field.

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and

calibrate their equipment. Maintenance requirements (such as documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures (as appropriate). Maintenance of laboratory instruments will be performed in a manner consistent with three- and four-digit EPA methods (EPA/600/4-79/020; EPA/600/R-94/111; SW-846), or with auditable DOE Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

2.2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section 3.4. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

2.2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used in support of sampling and analysis activities will be procured in accordance with internal work requirements and processes described in the contractor acquisition system. Responsibilities and interfaces necessary to ensure are items procured/acquired for the contractor to meet the specific technical and quality requirements must be in place. The procurement system is used to ensure purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users before use.

Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratories' QA plans.

2.2.9 Nondirect Measurements

Nondirect measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Nondirect measurements will not be evaluated as part of this activity.

2.2.10 Data Management

Sample Management and Reporting, in coordination with the project lead, is responsible for ensuring analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order Action Plan*.

Laboratory errors are reported to Sample Management and Reporting on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution with the project lead. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Planning for sample collection and analysis will be in accordance with the programmatic requirements governing fixed-laboratory sample collection activities, as discussed in sampling procedures. In the event specific procedures do not exist for a particular work evolution, or it is determined additional guidance to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of the sampling procedure requirements include activities associated with the following:

- Chain-of-custody/sample analysis requests
- Project and sample identification for sampling services

- Control of certificates of analysis
- Logbooks
- Checklists
- Sample packaging and shipping.

Approved work control packages and procedures will be used to document field activities, including radiological and nonradiological measurements when this SAP is implemented. Field activities will be recorded in the field logbook. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, "Occupational Radiation Protection"
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of primary contractor radiological records
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related records
- The indoctrination of personnel on the development and implementation of sample plans
- The requirements associated with preparing and transporting regulated material
- Daily reports of radiological surveys and measurements collected during conduct of field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

2.3 Assessment and Oversight

The elements in this group address the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

2.3.1 Assessments and Response Actions

Contractor management, quality, and/or health and safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements. The only planned assessment for the activities identified in this SAP is a DQA; this assessment is discussed in Section 2.4. The results of the DQA will be provided to the project lead.

If circumstances should arise in the field dictating the need for additional assessment activities, then they would be performed. Deficiencies identified by these assessments will be reported in accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions/deficiencies in accordance with the contractor QA program, the corrective-action management program, and associated procedures that implement these programs.

Oversight activities in the analytical laboratories, including corrective-action management, are conducted in accordance with the laboratories' QA plans. The contractor conducts oversight of offsite analytical laboratories and qualifies the laboratories for performing Hanford Site analytical work.

2.3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to Sample Management and Reporting, which initiates a sample issue resolution form in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the project lead.

At the end of the project, a DQA report will be prepared to determine if the type, quality, and quantity of collected data met the quality objectives described in this SAP.

2.4 Data Validation and Usability

The elements in this group address the QA activities occurring after the data-collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review, Verification, and Validation

The criteria for verification include, but are not limited to, review for completeness (samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. Data validation will be in accordance with internal procedures. The criteria for data validation are based on a graded approach. The primary contractor has defined five levels of validation, A through E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of data (e.g., calibration data; calculations of representative samples from the dataset). Validation will be performed to contractor Level C, which is a review of the QC data. Level C validation specifically requires verification of deliverables and requested versus reported analyses and qualification of the results based on analytical holding times, method blank results, matrix spike/matrix spike duplicate, surrogate recoveries, duplicates, and analytical method blanks. Level C validation will be performed on at least 5 percent of the data by matrix and analyte group. Analyte group refers to categories, such as radionuclides, volatile chemicals, semivolatiles, polychlorinated biphenyls, metals, and anions. The goal is to cover the various analyte groups and matrices during the validation.

Relative to analytical data in sample media, physical data and/or field-screening results are of lesser importance in making inferences of risk. Field QA/QC will be reviewed to ensure that physical property data and/or field-screening results are usable.

2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines. Data validation may be performed by the Sample Management and Reporting and/or by a party independent of both the data collector and the data user. Data validation qualifiers must be compatible with the HEIS database.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to 5 percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure that data are usable. Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the dataset. Data validation will be documented in data validation reports. An example of questionable data is the positive detections are greater than the practical quantitation limit or reporting limit in soil/aquifer sediment from

a site that should not have exhibited contamination. Similarly, results below background would not be expected and could trigger a validation inquiry. The determination of data usability will be conducted and documented in a DQA report.

Data validation will be documented in data validation reports, which will be included in the project file.

2.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met.

The DQA will be in accordance with EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide* and EPA/240-B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*.

2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data- or measurement-specific. Some pre-identified corrective actions are identified in Table 2-1.

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3 Field Sampling Plan

The following sections provide additional details regarding field-specific collection requirements.

3.1 Site Background and Objectives

Site background information is contained in DOE/RL-2009-30. The target analytes and COPCs are presented in Tables 1-2 through 1-4. Section 1.6 of this SAP provides a schedule for implementation. The objective of the field sampling plan is to clearly identify project sampling and analysis activities. The field sampling plan uses the sampling design identified during the systematic planning process and presents the design to identify sampling locations, the total number of samples to be collected, and analyses to be performed.

3.2 Documentation of Field Activities

Logbooks or data forms are required for field activities. Requirements for the logbook are provided in Section 2.1.6. Data forms may be used to collect field information; however, the data forms must follow the same requirements as those for logbooks presented below and the data forms must be referenced in the logbooks. The following is a summary of information to be recorded in logbooks:

- Purpose of activity
- Day, date, time, weather conditions
- Names, titles, organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (preparation, splits, duplicates, matrix spikes, blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations and surveys and equipment identification numbers as applicable
- Equipment decontaminated, number of decontaminations, and variations to any decontamination procedures
- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls relating to field activities.

3.3 Sampling Design

The sampling design is judgmental sampling as presented in Section 2.2.1.

3.4 Calibration of Field Equipment

The sampling lead is responsible to ensure that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with the manufacturer operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from instrument calibration activities are recorded in logbooks and/or work packages; either hard copy or electronic versions are acceptable.

Calibrations must be performed as follows:

- Before initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria.

Field instrumentation, calibration, and QA checks will be performed in accordance with the following.

- Calibration of radiological field instruments on the Hanford Site is performed by PNNL, as specified in its program documentation.
- Daily calibration checks will be performed and documented for each instrument used to characterize areas under investigation. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.

3.5 Sample Location and Frequency

The purpose of this section is to identify the sampling locations and frequencies and define the sampling and analysis requirements for samples and measurements to be collected. Figures 1-1 and 1-2 show the approximate location of boreholes and groundwater-monitoring wells described in this SAP for the 300 Area, locations 300-DU-1 through 300-DU-11. Figure 1-2 shows the approximate location of groundwater-monitoring wells described in this SAP. There are no planned sampling activities in the 400 Area. The actual locations will be determined based on a field walkdown of current site conditions to avoid Hanford Site National Historic restrictions, roads, and other obstructions.

The locations of boreholes for the 618-10 and 618-11 Burial Grounds, and the 316-4 Crib (locations 300-DU-VZ-1 through 300-DU-VZ-3) will be based on results of the radiological surveys performed during remediation of the waste sites and verification sampling results following remediation. Emphasis for locating the boreholes will be placed on points of high residual contamination at the bottom of the excavations ("hot spots") and locations of deep vadose zone contamination approaching the water table.

Table 3-1 presents estimates for the minimum and maximum thicknesses for saturated Hanford formation sediment during the course of a seasonal cycle at the approximate locations for the 11 proposed wells in the 300 Area.

3.5.1 Vadose Zone Characterization

Samples will be collected from boreholes and planned groundwater-monitoring wells to support characterization of the vadose zone and groundwater as outlined in Table 1-1.

Table 3-1. Estimates for Thickness of Saturated Hanford Formation

Location ID	Site Description	Max Water-Table Elevation, 1992-2009 (m-88)	Max Water-Table Elevation, 1992-2009 (m-88)	Hanford/Ringold Contact Elevation (m-88)	Minimum Saturated Thickness (m)	Maximum Saturated Thickness (m)
300-DU-1	Northwest portion of uranium plume	104.676	107.905	96	8.7	11.9
300-DU-2	West portion of uranium plume	104.676	107.905	95	9.7	12.9
300-DU-3	West-central portion of uranium plume	104.593	107.267	95	9.6	12.3
300-DU-4	Southwest portion of uranium plume	104.544	108.294	97	7.5	11.3
300-DU-5	Southern portion of uranium plume	104.544	107.622	94	10.5	13.6
300-DU-6	Near-river portion of uranium plume, north	104.598	108.295	98	6.6	10.3
300-DU-7	Near-river portion of uranium plume, south	104.344	108.227	102	2.3	6.2
300-DU-8	North Process Pond, north portion	104.399	108.452	99	5.4	9.5
300-DU-9	North Process Pond, south portion	104.399	108.452	100	4.4	8.5
300-DU-10	300 Area Process Trenches, south portion	104.524	108.505	103	1.5	5.5
300-DU-11	South Process Pond, north portion	104.524	107.684	98	6.5	9.7

NOTE: *North American Vertical Datum of 1988* (NAVD88).

Reference PNNL-17034, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington.*

ID = identification

The vadose zone and groundwater will be characterized by performing intrusive investigations in eight areas: the North Process Pond, the South Process Pond, the 300 Area Process Trenches, the Perimeter Area, the Near River Area, 618-10 Burial Ground, 618-11 Burial Ground, and 316-4 Crib. Intrusive investigations consist mainly of collecting and analyzing samples from planned boreholes and wells in areas of known or suspected contamination. Each groundwater well will have vadose zone samples collected for vadose zone characterization. These activities are planned to characterize the nature and extent of contamination in the vadose zone, characterize the physical properties of soil/aquifer sediments, locate potential sources, and support modeling and an assessment of risk. The data from the activities will be used to verify the adequacy of interim remedial actions and refine the preliminary conceptual site model of the 300 Area Decision Unit.

The scope of vadose zone characterization efforts includes collecting and analyzing soil samples from the vadose zone, collecting and analyzing aquifer sediment, performing groundwater sampling and analysis, and performing geophysical logging. The general intent of the borehole sampling design is to begin sample collection at the maximum depth of the historically high-water level or bottom of the waste site. The sampling frequency will be continuous within 3.1 m (10 ft) of the vadose zone-groundwater interface and at select intervals thereafter. Soil/aquifer sediment and water samples will be collected according to the sampling scheme shown in Table 3-2. Additional samples may be collected based on observations made in the field.

In addition to the target analytes, samples for uranium (total and isotopic) and geochemical analyses of sediments (organic carbon, inorganic carbon, calcium carbonate equivalent, trace metals, major cations, and major anions) will be collected at select locations. The purpose for collecting trace metals, major cations, and major anions in the vadose zone and periodically rewetted zone in select locations is to increase understanding with respect to the geochemical environment and uranium transport. Pacific Northwest National Laboratory-specific tests also will include analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future.

At select locations, sediment samples will be analyzed for various physical properties that are used as input parameters for computer models. The physical property samples will be collected from major formation and lithology changes, approximately in the unsaturated Hanford formation, partially saturated water-table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. The physical property samples will be collected in conjunction with split-spoon sample intervals, where possible.

3.5.1.1 Field Screening

Radiological field-screening data, visual observation of lithologies, visual observation of contamination, or site geologist professional judgment may be used to adjust sampling points presented in Table 3-2, assist in determining sample shipping requirements, and support worker health and safety monitoring. Radiological field-screening methods are described in Section 3.6.3.

To determine the presence of volatile organic contaminants, a photo ionization detector will be used for field screening of soil samples in the 600 Area. The direct readings from this instrument will be recorded in the field logbook. The instrument shall be equipped with a 10.6 eV lamp and calibrated in accordance with the manufacturer's recommendations. The soil sample for volatile organic by SW-846 Method 8260 will be packaged first, and the photo ionization detector reading taken on the remaining soil mass. Volatile organic compound screening with a photo ionization detector should be used to report the general presence or absence of a wide variety of volatile compounds, but will not report the specific compound detected.

3.5.1.2 Geophysical Logging

The planned boreholes and groundwater-monitoring wells will be geophysically logged with the high-resolution, spectral gamma-ray logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides. Soil moisture will be determined using a neutron logging tool. The boreholes and groundwater-monitoring wells will be logged before the casing is telescoped and before the borehole is decommissioned. The starting point for logging will be recorded; this is usually at the ground surface or the top of the casing. Boreholes will be decommissioned after geophysical logging and all sampling are completed in accordance with WAC 173-160 unless the Tri-Parties (DOE, EPA, and Washington State Department of Ecology) direct otherwise.

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Well 300-DU-1 – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the Perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at northwest perimeter of uranium plume.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-2 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future Below water table: • Leach tests in accordance with Table 2-2 (Class L).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water-table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-2 (Class P).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-2 (Class G).		
Well 300-DU-2 – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at west perimeter of uranium plume.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. • Above water table: • Laboratory analyses in accordance with Table 2-3 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-3 (Class L).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-3 (Class P).		
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-3 (Class G).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Well 300-DU-3 – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at west perimeter of uranium plume, and downgradient of 618-1 and 618-2 Burial Grounds remedial action sites.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-4 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-4 (Class L).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-4 (Class P).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-4 (Class G).		
Well 300-DU-4 – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at southwest perimeter of uranium plume.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-5 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-5 (Class L).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-5 (Class P).		
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-5 (Class G).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Well 300-DU-5 – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at south perimeter of uranium plume. This location is south of the uranium plume between the western edge and the river.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-6 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-6 (Class L).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-6 (Class P).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-6 (Class G).		
Well 300-DU-6 – Near River To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the Near River Area. Justification. Proposed to evaluate water-table zone and unconfined aquifer in high-concentration portion of uranium plume, within zone of groundwater/river water interaction.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-7 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-7 (Class L).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-7 (Class P).		
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-7 (Class G).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Well 300-DU-7 – Near River To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the Near River Area. Justification. Proposed to evaluate water-table zone and unconfined aquifer in high-concentration portion of uranium plume, within zone of groundwater/river water interaction.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 2 samples from within the saturated Hanford formation by **split spoon** (15 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-8 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-8 (Class L).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-8 (Class P).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-8 (Class G).		
Well 300-DU-8 – North Process Pond To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the northern portion of the North Process Pond. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid-waste-disposal site.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5 (or bottom of saturated Hanford formation), by **split spoon** (22 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-9 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-9 (Class L).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-9 (Class P).		
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-9 (Class G).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Well 300-DU-9 – North Process Pond To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the southern portion of the North Process Pond. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid-waste-disposal site.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5 (or bottom of saturated Hanford formation), by **split spoon** (22 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-9 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-9 (Class L).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-9 (Class P).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-9 (Class G).		
Well 300-DU-10 – 300 Area Process Trenches To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the southern end of the 300 Area Process Trenches. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid waste disposal site.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5 (or bottom of saturated Hanford formation), by **split spoon** (18 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-10 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-10 (Class L).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-10 (Class P).		
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-10 (Class G).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Well 300-DU-11 – South Process Pond To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the northern end of the South Process Pond. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid-waste-disposal site.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-15. Field parameters at the time of sampling in accordance with Table 2-15.
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5 (or bottom of saturated Hanford formation), by **split spoon** (22 samples)	Geologic description of sediments encountered. Above water table: • Laboratory analyses in accordance with Table 2-11 (Class C) • Analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future. Below water table: • Leach tests in accordance with Table 2-11 (Class L).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (5 samples)	Physical properties in accordance with Table 2-11 (Class P).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
		Major formation and lithology changes and 48-50.5, 53-55.5, and 55.5-58 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. (8 samples)	Geochemical analyses of sediments in accordance with Table 2-11 (Class G).		
Borehole 300-DU-VZ-1 – 618-10 To be drilled to the bottom of the aquifer and decommissioned in the 600 Area at the 618-10 Burial Ground. Justification. Proposed to evaluate the 618-10 Burial Ground.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	None	None
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5, 91-93.5, 94-96.5, 97-99.5 (or bottom of saturated Hanford formation), by **split spoon** (25 samples)	Laboratory analyses in accordance with Table 2-12. Field-screening parameters in accordance with Table 2-12.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Borehole 300-DU-VZ-2 – 618-11 To be drilled to the bottom of the aquifer and decommissioned in the 600 Area at the 618-11 Burial Ground. Justification. Proposed to evaluate the 618-11 Burial Ground.	58	During drilling, archive samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	None	None
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5, 91-93.5, 94-96.5, 97-99.5 (or bottom of saturated Hanford formation), by **split spoon** (25 samples)	Laboratory analyses in accordance with Table 2-13. Field-screening parameters in accordance with Table 2-13.		
Borehole 300-DU-VZ-3 – 316-4 To be drilled to the bottom of the aquifer and decommissioned in the 600 Area at the 316-4 Crib. Justification. Proposed to evaluate the 316-4 Crib.	58	During drilling, samples will be **grab** collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	None	None
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5, 91-93.5, 94-96.5, 97-99.5 (or bottom of saturated Hanford formation), by **split spoon** (25 samples)	Laboratory analyses in accordance with Table 2-14. Field-screening parameters in accordance with Table 2-14.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Sample 7 existing and one new monitoring wells in the 300 Area:* • 399-1-17A • 399-1-7 • 399-2-1 • 399-1-21A • 399-2-5 • 399-3-11 • 399-3-20 • Well 300-DU-9. *Equivalent wells may be substituted. Justification. Proposed to support vertical profiling.	58	None	None	Sample at 1 m intervals throughout the screened interval, assumed to be 5 m screens (8 wells × 5 samples per well = 40 samples)	Only analyze for the following in accordance with Table 2-15: • Uranium (total, unfiltered sample) • Method 6010 or 6020 • Method 7470 or 200.8 • Method 300.0 • Alkalinity. Field parameters at the time of sampling in accordance with Table 2-15.

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Sample one existing monitoring well in the 300 Area: • 399-1-16B. Justification. Proposed to support Data Need 4.	58	None	None	Total of 10 samples as pumping proceeds.	For the 1st and 10th samples – only analyze for the following in accordance with Table 2-15: • Uranium (total, unfiltered sample) • Method 6010 or 6020 • Method 7470 or 200.8 • Method 8260 • Method 300.0 • Alkalinity. Field parameters at the time of sampling in accordance with Table 2-15. For the 2nd through 9th samples: Only analyze for the following in accordance with Table 2-15: • Method 8260 • Alkalinity Field parameters at the time of sampling in accordance with Table 2-15.

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Sample one existing and one new monitoring well in the 300 Area: 399-1-8 Well 300-DU-9 Justification. Proposed to support Data Need 4.	58	None	None	One sample at the beginning of the pump test and one a day following completion of the test for each well. (2 samples x 2 wells=4 samples)	Only analyze for the following in accordance with Table 2-15: • Uranium (total, unfiltered sample) • Method 6010 or 6020 • Method 7470 or 200.8 • Method 8260 • Method 300.0 • Alkalinity. Field parameters at the time of sampling in accordance with Table 2-15.
Sample 16 spatial/temporal uncertainty monitoring wells (Table 3-3); multiple rounds in the 300 Area.	58	None	None	Multiple sampling rounds to support remedial investigation. (16 wells × approximately 3 rounds = 48 samples)	Laboratory analyses in accordance with Table 2-16. Field parameters at the time of sampling in accordance with Table 2-16.
Sample 17 spatial/temporal uncertainty monitoring wells (Table 3-3); multiple rounds in the 600 Area.	58	None	None	Multiple sampling rounds to support remedial investigation. (17 wells × approximately 3 rounds = 51 samples)	Laboratory analyses in accordance with Table 2-17. Field parameters at the time of sampling in accordance with Table 2-17.

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft) bgs	Analyte/ Property List	Sample Interval Depth (ft) bgs or Frequency	Analyte/ Property List
Number of samples		Soil/aquifer sediment chemical: 352 (Chemical + geochemical) Physical property: 55 Geologic archive samples: variable		Water samples collected during drilling: 55 Risk assessment samples: 99 (3 rounds total)	
Minimum number of field QC samples		Soil/aquifer sediment chemical: 55 (18 equipment blank, 18 field blank, 18 duplicate, 1 split) Physical property: 0 Geologic archive samples: 0		Water samples collected during drilling: 10 (3 equipment blank, 3 field blank, 3 duplicate, 1 split) Risk assessment samples: 16 (5 equipment blank, 5 field blank, 5 duplicate, 1 split)	
Total number of samples		Soil/aquifer sediment chemical: 407 Physical property: 55 Geologic archive samples: variable		Water samples collected during drilling: 65 Risk assessment samples: 115	

*Archive samples may be omitted at the discretion of the field geologist due to radiological field data.

bgs = below ground surface
GW = groundwater

3.5.2 Groundwater Characterization

3.5.2.1 New Groundwater Wells

Groundwater well activities are summarized in Table 3-2. From each new well screened in the Ringold upper mud unit, slug testing and pump testing will be performed to characterize hydraulic conductivity.

Well Depth and Screen Placement

For the 11 new groundwater wells in the unconfined aquifer in the 300 Area, a 4.6 m (15-ft) screen will be installed and centered such that the middle of the screen is at the water table to monitor the upper portion of the unconfined aquifer. However, screen length at a particular location may be modified to account for local hydrologic conditions. Also, screen slot size will be based on conditions encountered at the site.

For the three remaining boreholes in the 600 Area, each will be decommissioned after drilling.

Well Drilling and Completion Procedures

Well drilling will be performed in accordance with WAC 173-160. The wells will be drilled using 25.4 cm (10-in.-) diameter (or larger) casing to total depth. The drilling method will be determined based on discussions between the drilling lead and drilling contractor.

The wells will be constructed as 15.2 cm (6-in.) wells with Schedule 10, Type 304 or 316, stainless-steel, V-slot continuous wire-wrap screen, atop a 1.5 m (5-ft-) long, stainless-steel sump with end cap. A Schedule 10 stainless-steel riser will be used to extend the permanent well into the vadose zone, with Schedule 10 stainless steel casing through the vadose zone to ground surface. Colorado silica sand will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material; and Type I/II Portland cement will be used for cement grout.

Surface construction consisting of protective casing, protective guard posts, and cement pad must be in place before job completion. The protective casing will be a minimum of 5 cm (2 in.) larger in diameter than the permanent casing. Protective casing will rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing will rise to approximately 0.3 m (W1 ft) below the top of the protective casing. Protective casing will have a lockable well cap extending approximately 38 cm (15 in.) above the top of the protective casing.

Final well design, including screen placement and length, will be determined by concurrence of the field geologist, drilling lead, and OU lead based on field conditions. If the completion differs from the WAC 173-160 requirements, then variances will be obtained from the Washington State Department of Ecology.

3.5.2.2 Groundwater Network to Evaluate Spatial and Temporal Uncertainty

Table 3-2 summarizes groundwater-monitoring activities to address spatial and temporal uncertainties. The spatial/temporal uncertainty monitoring wells to be sampled are presented in Tables 3-3 and 3-4. Multiple rounds of groundwater samples will be collected for analysis to support the remedial investigation in the existing groundwater wells for each contaminant identified in Tables 1-5 and 1-6.

Table 3-3. 300 Area Spatial and Temporal Uncertainty Monitoring Well Network Near-Field Uranium Plume Wells

399-1-10A	399-3-12
399-1-12	399-3-20
399-1-21A	399-3-6
399-1-17A	399-3-9
399-1-6	399-4-1
399-2-1	399-4-9
399-2-2	399-4-12
399-3-11	399-4-14

Table 3-4. 600 Area Spatial and Temporal Uncertainty Monitoring Well Network Far-Field Wells

99-S0-7	699-15-15B
499-S0-8	699-20-E5A
499-S1-8J	699-S18-E2B
699-1-18	699-S19-11
699-12-4D	699-S28-E0
699-13-1A	699-S3-E12
699-13-1E	699-S6-E4A
699-13-2D	699-S8-19
699-13-3A	

To determine spatial and temporal risk uncertainty for potential human and ecological receptors, the remedial investigation process requires that the groundwater be sampled, providing representative data of aquifer conditions. It is required the groundwater be sampled throughout a decision unit without regard to the location of surface facilities or known groundwater plumes. If there are temporal changes in groundwater conditions, samples must be collected to capture these varying stages to properly delineate temporal risk uncertainties to potential receptors. The following discussion explains the method used to develop both the number and location of sampling points along with the sampling frequency for the decision units associated with the River Corridor RI/FS investigations. The resulting well network data will be used to evaluate the groundwater risk information presented in the RCBRA (DOE/RL-2007-21), while observations and conclusions regarding the data collected and the RCBRA evaluation will be documented in the remedial investigation report (e.g., risk uncertainties associated with temporal and spatial representativeness, verifying RCBRA groundwater risk conclusions, ensuring no contaminants were inadvertently overlooked, and establishing a "present condition" dataset that can be used to measure the progress of future cleanup actions).

Sample Number and Location

Sampling well locations within a groundwater decision unit must be identified to spatially represent all of the areas within a decision unit, regardless of facility or known contaminant plume locations. These sampling networks should represent locations where human or ecological receptors could potentially encounter groundwater. The primary pathway for human exposure is through direct contact with groundwater obtained from a residential or community water well. Identification of sampling locations to assess the direct exposure pathways is to assume development of the land for future human habitation. With this scenario as a guide to assessing a viable sampling grid of plausible groundwater pathways, land use regulations were used to develop a reasonable network of supply wells for each decision unit, based on state regulations and site-specific hydrologic properties. This approach resulted in a sampling grid and corresponding network of monitoring wells tailored for each decision unit. As part of this semi-quantitative approach, the locations of community water delivery systems were developed to meet not only the negotiated Tri-Party land use needs but also State of Washington requirements.

Rules and regulations of the Washington State Department of Health regarding public water supplies, WAC 246-290, "Group A Public Water Supplies," are explained in the associated guidance document, DOH 331-123, *Water System Design Manual*. This manual is maintained by the Washington State Department of Health and provides the necessary information on specifications to develop groundwater resources for human use. By applying these specifications to the possible locations of water supply wells that might act as complete exposure pathways, the number and spacing of sampling locations is determined with credibility for each decision unit, providing justified and defensible monitoring networks.

Based on remedial action goals for the interim record of decision, the assumption for future habitation is families will live on the land, grow a garden, and raise livestock to provide approximately 25 percent of the family's food requirements. This land usage places specific state and daily water requirements for each residence. Because the remedial action goals are based on groundwater restored to highest beneficial use (i.e. drinking water), the Washington Growth Management Act requires each residence occupy at least one acre of land. It is also assumed that at least a 5-acre plot per unit is necessary to raise livestock. Thus, each residence in the following scheme assumes a family plot size of 5 acres.

Therefore, residential water usage must be sufficient to supply not only in-house needs but also to irrigate a large garden and to water livestock. For a water well that supplies one residence, Washington State Department of Ecology requires a minimum of 400 gal per day (gal/day). Thus, an extreme lower limit is established for in-house use. However, for a communal system, which the Washington State Department of Health regulates, guidance on the daily water use is found in DOH 331-123. One of the key parameters for estimating potential water use is the lot size of the individual residence.

Another important consideration is location of the well within the state because of climate differences east and west of the Cascade Mountains. Based on utility records in eastern Washington, which has a dominantly arid climate, a residence's maximum day demand is 1,500 gal./day for lot sizes in excess of 2.5 acres. Although values as high as 8,000 gal./day have been recorded, the historical sizing guideline of 1,500 gal./day has generally been adequate. With the information on requirements for residential water supplies, the number of possible supply wells and thus the number of sampling points is calculated based on how much water the local aquifer is expected to produce.

To provide the number of sampling points for the well network, the average groundwater yields, calculated from pump tests conducted at each decision unit, are used to determine the number of residences supported on one supply well. Thus, the grid size specific to each decision unit is determined. Use of a random grid generator provides approximate locations for sampling points based on the final

number of sampling points and the total area of each decision unit. To the degree possible, one well within each grid was chosen to represent the potential exposure pathway; thereby providing a network of sampling points to provide a spatially representative sampling network of groundwater wells.

In addition to determining the maximum number and location of potential exposure pathways, additional wells were added to networks to define potential exposures associated with known contaminant plumes. Current monitoring wells were chosen to provide data on maximum contaminant levels and to define plume extents. For decision units with active remedial activities, extraction/injection and chemical treatment wells were not included in any of the well networks. The pump and treat wells are not configured for routine sampling and the chemical treatment wells are not representative of ambient groundwater conditions.

Sampling Frequency

To capture baseline aquifer conditions fully, it is required that samples represent not only spatial variations but also changes that occur over time. Near the river, these varying conditions are observed as changes in groundwater flow, both direction and rate, causing temporary movement of contaminants through different portions of the unconfined aquifer. For decision units bordering on the Columbia River, the changing aquifer conditions are caused by fluctuating river elevations associated with flood control and hydroelectric production. For representing baseline groundwater conditions, samples are required to represent these varying aquifer conditions associated with high, low, and mid-point or transitional river elevations. The date and frequency of sample collection is based on measurements of the river elevation to optimize collection of samples representing these temporal changes in groundwater conditions.

Effect of River Elevation on Groundwater Conditions

Along the Columbia River, rapid, periodic, or cyclic elevation fluctuations of the river occur in controlled response to flood conditions, hydroelectric production, and salmon spawning programs at a series of dams and reservoirs upriver of the Hanford site. These rapid elevation changes in the river cause periodic influences on flow conditions within the aquifer. For example, there are two times during a calendar year when the river elevation peaks and two times the river elevation is low. The highest river elevation occurs in early June when water is released from reservoirs that have reached capacity from the melting snow pack in the Cascade Mountains. The lowest river elevation is engineered in late September to early October to encourage salmon spawning in low pockets of the river bottom along the Hanford Reach.

When water is released upriver, the river elevation rises above the elevation of the local aquifer causing movement of water from the river into the aquifer. At this time, the flow direction in the aquifer is modified from the ambient condition and varies with local conditions along the river. This flow from the river brings cleaner river water into the groundwater causing a temporary reduction in contaminant levels in monitoring wells near the river.

When the river elevation is artificially lowered to a level below the aquifer by holding water back in the upriver reservoirs, groundwater moves from the aquifer into the river. The river then recharges from the aquifer, causing a change in the flow direction to roughly perpendicular to the river's edge, once again varying with specific locations along the river. These changes in direction may bring contaminated groundwater through observation wells at certain places and into the river. Thus, near the river/groundwater interface, the flow direction and rate change with time. The effect on aquifer conditions is greatest when the river peaks in June and, again, at its lowest level in late September to early October. To capture these temporal effects on contaminant plumes within the aquifer from the low river elevation, groundwater sampling should be conducted prior to late October.

Inland from the river, the rapid river elevation changes form a pressure pulse that appears to be transmitted along the free surface of the unconfined aquifer. This effect causes groundwater elevation changes in wells not affected by actual movement of aquifer water. For some places, the elevation increase may allow the groundwater to interact with contaminated soils located just above the water table. The timing of these periodic or cyclic river elevation changes determines the sampling frequency required to represent the temporal variations in groundwater conditions.

Groundwater Sampling Dates

Because the goal of the temporal uncertainty groundwater sampling is to determine groundwater conditions when the river has the maximum effect on flow rate and direction, sampling is scheduled for late May to mid-June during the highest peak and from late September to late October during the time of the lowest elevation. From the second week in June to mid-September, the river elevation is in transition, decreasing from the maximum elevation to the lowest elevation. Also from March through April, elevations change from low to the high that occur in the first week of June. Consequently, the best opportunity to capture transitional conditions occurs during the months of March and April or July and August.

Based on the previous discussion, three sampling events are recommended to represent the temporal fluctuations in groundwater conditions at each of decision units located along the river corridor. One sampling event captures the effect on the aquifer when the river stage is highest and the greatest increase in aquifer elevation occurs (May to mid-June). The second sampling interval ranges from mid-September to mid-October when the river is at the lowest elevation for the year. This period is when contamination from the aquifer might be affecting the river. The third sampling point represents the mid-point or transitional aquifer conditions occurring from either March through April or July through August. Thus, the groundwater sampling schedules, which support the temporal uncertainty evaluation for the RI/FS at each decision unit along the river, capture the maximum effects of changing river elevations on aquifer conditions as well as the transitional time between the maximum and minimum changing conditions.

3.6 Sampling Methods

Soil/aquifer sediment sampling will be performed in accordance with approved procedures for soil and aquifer sediment sampling using a 10.2 cm (4-in.) split-spoon sampler. The split-spoon samplers will be equipped with separate stainless steel or polycarbonate liners. Site personnel will not overdrive the sampling device. Samples for volatile organic compounds will be packaged first. Next, the remaining soil/aquifer sediment will be transferred to a precleaned, stainless steel mixing bowl or other suitable precleaned container, homogenized, then containerized in accordance with the sampling procedure. If sample volume requirements cannot be met, samples will be collected according to the following priority:

- For 300 Area: Leach tests on sediment with chemical and radiological analysis of pore water samples, analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future, and uranium (chemical and isotopic) and target analytes are high priority. Physical property and geochemical analyses of sediments are lower priority.

- For 600 Area: Leach tests on sediment with chemical and radiological analysis of pore water samples are high priority, followed by chemical and radiological target analyte analysis and field-screening parameters.

Groundwater samples collected during drilling, before development, will be pumped from selected intervals. The pump will be operated for a period of time sufficient to provide stabilized field readings,

but not necessarily three casing volumes. Borehole water samples will be filtered as required during drilling. If the solid content in the water influences the collection of the samples, then filtering will be performed. No absolute turbidity value is given as to filter or not, it is a judgment in the field by the sampling lead.

For the spatial/temporal uncertainty groundwater-monitoring well network, before sample capture, the pump will be operated for a period of time sufficient to provide stabilized field readings, and at least three casing volumes.

3.6.1 Corrective Actions and Deviations for Sampling Activities

The project lead, sampling lead, drilling lead, or designee must document deviations from procedures or other problems pertaining to sample collection, chain-of-custody, target analytes, COPCs, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions, changes in sample locations because of physical obstructions, or additions of sample depth(s).

As appropriate, such deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with internal corrective-action procedures. The project lead, sampling lead, drilling lead, or designee will be responsible for communicating field corrective-action requirements and for ensuring immediate corrective actions are applied to field activities.

More significant changes in sample locations not impacting the data needs will require notification and approval of the project lead. Changes to sample locations resulting in impacts to meeting the data needs will require concurrence with DOE and regulator project leads. Changes to the SAP will be documented as noted in Section 2.1.6.

3.6.2 Decontamination of Sampling Equipment

Sampling equipment will be decontaminated in accordance with the sampling equipment decontamination procedure. To prevent contamination of the samples, care should be taken to use clean equipment for each sampling activity. Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample container by setting the equipment/sample container on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events. Field decontamination (e.g., field washing and reuse) is not appropriate for sampling equipment.

The drill rig derrick, all downhole equipment, and temporary casing will be field decontaminated (e.g., high pressure and temperature), at a minimum, before mobilization and demobilization.

3.6.3 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. As a general rule, cuttings from boreholes, exclusive of slough, will be field screened for evidence of radiological contamination. Screening will be conducted visually and with field instruments. Radiological screening will be performed by the radiological control technician or other qualified personnel. The radiological control technician will record field measurements, noting the depth of the

sample and the instrument reading. Measurements will be relayed to the field geologist for inclusion into the field logbook or operational records daily, as applicable.

The following information will be disseminated to personnel performing work in support of this SAP.

- Instructions will be provided to radiological control technicians on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller, portable alpha meter, dual phosphors beta/gamma, and sodium iodide portable instruments, will include a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance-testing descriptions, and the application/operation of the instrument. These instruments are commonly used on the Hanford Site for obtaining measurements of removable surface contamination measurements and direct measurements of the total surface contamination.
- Information on the characteristics associated with the hand-held probes to be used in the performance of direct radiological measurements will include a physical description of the probe, the radiation and energy response characteristics, calibration/maintenance and performance-testing descriptions, and the application/operation of the instrument. The hand-held probe is an alpha detection instrument commonly used on the Hanford Site for obtaining removable surface contamination measurements and direct measurements of the total surface contamination.

3.7 Sample Handling

3.7.1 Packaging

Level I EPA precleaned sample containers will be used for soil/aquifer sediment and water samples collected for chemical analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. The Radiological Engineering organization will measure the contamination levels and dose rates associated with the sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead, in consultation with Sample Management and Reporting, can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Tables 3-5 and 3-6.

Table 3-5. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
ICP/MS, PNNL-AGG-415	Cool 4 °C	6 months	Lexan liner	4-in.-diameter by 6-in.-long liners
PNNL specific tests	To be determined	To be determined	To be determined	Variable between 1 L poly container and a 5-gal bucket due to variability in grain size (cobble or larger sediment will need the largest sample)
Isotopic – uranium	None	6 month	G/P	5 g
Isotopic – plutonium	None	6 months	G/P	5 g
Liquid scintillation counter	None	6 months	G	33 g

Table 3-5. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
Gamma energy analysis	None	6 months	G/P	750 g
EPA 6010/6020	Cool ~4 °C	6 months	G/P	15 g
EPA 7471	None	28 days	G/P	15 g
EPA 8015	Cool ~4 °C	14 days	G	50 g
EPA 8082	Cool ~4 °C	14/40 days[b]	aG	50 g
EPA 8260	Cool ~4 °C [c]	14 days	G	50 g
EPA 8270	Cool ~4 °C	14/40 days [b]	aG	50 g
EPA 8310	Cool ~4 °C	14/40 days [b]	aG	120 g
UKPA	None	6 months	G/P	10 g
EPA 300.0	Cool ~4 °C	48 hours/ 28 days[d]	G/P	50 g
Total carbon	None	6 months	Lexan liner	4-in.-diameter by 6-in.-long liners
Inorganic carbon	None	6 months	Lexan liner	4-in.-diameter by 6-in.-long liners
Alkalinity	None	None	G	100 mL
ASTM D2216	None	None	Moisture-proof container	200 g
ASTM D2937	None	None	G/P	1,000 g

a. Based on minimum QC requirements.

b. 14/40 days = 14 days to extraction, then 40 days to analysis.

c. Field preservation EPA 5035A also may be used.

d. 48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days.

For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis*.

Lexan is a registered trademark of Sabin Innovative Plastics, Pittsfield, Massachusetts.

aG = amber glass
G = glass
ICP/MS = inductively coupled plasma/mass spectrometry
P = plastic
UKPA = total uranium by kenotic phosphorescence analysis

Table 3-6. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
PNNL specific tests (to include microbial activity)	To be determined	To be determined	To be determined	To be determined
Iodine-129 – low level	None	6 months	G/P	2,000 mL
Strontium 89/90 – Sr-90	HNO_3 to pH <2	6 months	G/P	2,000 mL
Tritium (H-3)	None	6 months	G	60 mL
EPA 6020 or 200.8	HNO_3 to pH <2	6 months	G/P	300 mL
EPA 6010	HNO_3 to pH <2	6 months	G/P	300 mL
Total uranium (chemical)	HNO_3 to pH <2	6 months	G/P	500 mL
EPA 8260	Cool ~4 °C, HCl or H_2SO_4 to pH <2	14 days	aGs	40 mL
EPA 8270	Cool ~4 °C	7/40 days[b]	aG	1,000 mL
EPA 7470 or 200.8	HNO_3 to pH <2	28 days	G	500 mL
EPA 9010 or 9012	NaOH to pH >= 12	14 days	G/P	1,000 mL
Alkalinity	None	None	G	100 mL
EPA 300.0	Cool ~4 °C	48 hours/ 28 days[c]	P	125 mL

a. Based on minimum QC requirements.

b. 14/40 days = 14 days to extraction, then 40 days to analysis.

c. 48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days.

For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*. For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

aG = amber glass
aGs = amber glass septum; no headspace
G = glass
H_2SO_4 = sulfuric acid
HCl = hydrochloric acid
HNO_3 = nitric acid
NaOH = sodium hydroxide
P = plastic

3.7.2 Container Labeling

The sample location, depth, and corresponding HEIS numbers are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering.

Each sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable)
- Sampling authorization form number.

In addition to the above information, sample records must include the following:

- Analysis required
- Source of sample
- Matrix
- Field data (pH, radiological readings).

Except for volatile organic analysis samples, a custody seal will be affixed to the lid of each sample container. The custody seal will be inscribed with the sampler's initials and the date. Custody seals are not applied directly to volatile organic analysis bottles collected because of a potential for affecting analytical results and/or fouling of laboratory equipment. Custody seals and any other required labels/documentation can be fixed to the exterior of a plastic bag holding vials in such a manner to detect potential tampering.

3.7.3 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample Management and Reporting within 48 hours of shipping.

The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto.

3.7.4 Sample Transportation

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste mandated by the U.S. Department of Transportation (49 CFR 171-177, Chapter 1, "Research and Special Programs Administration, Department of Transportation," Part 171, "General Information, Regulations, and Definitions," through Part 177, "Carriage By Public Highway") in association with the International Air Transportation Authority, DOE requirements, and applicable program-specific implementing procedures.

3.8 Management of Waste

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with DOE/RL-2000-56, *Waste Management Plan for the 300-FF-5 Operable Unit*. Pursuant to 40 CFR 300.440, "Procedures for Planning and Implementing Off-Site Response Actions," approval from the CERCLA lead agency Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

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4 Health and Safety

Field operations will be performed in accordance with health and safety requirements and appropriate Soil & Groundwater Remediation Project requirements. Additionally, work control documents will be prepared to further control site operations. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement ALARA practices to minimize the radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835.

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Appendix

Laboratory Standard Compound List

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A1 Laboratory Standard Compound List

Tables A-1 through A-10 provide the laboratory standard compound list.

A2 References

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Table A-1. U.S. Environmental Protection Agency Method 300.0

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
24959-67-9	Bromide	250	2500	±20%/±30%	80-120%/70-130%
16887-00-6	Chloride	200	2000	±20%/±30%	80-120%/70-130%
16984-48-8	Fluoride	500	5000	±20%/±30%	80-120%/70-130%
14797-55-8	Nitrate	250	2500	±20%/±30%	80-120%/70-130%
14797-65-0	Nitrite	250	2500	±20%/±30%	80-120%/70-130%
NO3-N	Nitrogen in nitrate	75	750	±20%/±30%	80-120%/70-130%
NO2-N	Nitrogen in nitrite	75	750	±20%/±30%	80-120%/70-130%
14265-44-2	Phosphate	500	5000	±20%/±30%	80-120%/70-130%
14808-79-8	Sulfate	500	5000	±20%/±30%	80-120%/70-130%

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes.*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-2. U.S. Environmental Protection Agency SW-846 Method 6010

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7439-92-1	Lead	50	5000	±20%/±30%	80-120%/70-130%
7439-93-2	Lithium	25	2500	±20%/±30%	80-120%/70-130%
7439-98-7	Molybdenum	20	2000	±20%/±30%	80-120%/70-130%
7440-28-0	Thallium	50	5000	±20%/±30%	80-120%/70-130%
7440-38-2	Arsenic	100	10000	±20%/±30%	80-120%/70-130%
7440-41-7	Beryllium	2	500	±20%/±30%	80-120%/70-130%
7440-42-8	Boron	20	2000	±20%/±30%	80-120%/70-130%
7782-49-2	Selenium	100	10000	±20%/±30%	80-120%/70-130%
7440-09-7	Potassium	4000	400000	±20%/±30%	80-120%/70-130%
7429-90-5	Aluminum	50	5000	±20%/±30%	80-120%/70-130%
7439-89-6	Iron	50	5000	±20%/±30%	80-120%/70-130%
7439-95-4	Magnesium	750	75000	±20%/±30%	80-120%/70-130%
7439-96-5	Manganese	5	5000	±20%/±30%	80-120%/70-130%

Table A-2. U.S. Environmental Protection Agency SW-846 Method 6010

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7440-02-0	Nickel	40	4000	±20%/±30%	80-120%/70-130%
7440-22-4	Silver	10	1000	±20%/±30%	80-120%/70-130%
7440-23-5	Sodium	500	50000	±20%/±30%	80-120%/70-130%
7440-36-0	Antimony	60	6000	±20%/±30%	80-120%/70-130%
7440-39-3	Barium	20	2000	±20%/±30%	80-120%/70-130%
7440-43-9	Cadmium	2	500	±20%/±30%	80-120%/70-130%
7440-47-3	Chromium	10	1000	±20%/±30%	80-120%/70-130%
7440-48-4	Cobalt	4	2000	±20%/±30%	80-120%/70-130%
7440-50-8	Copper	8	1000	±20%/±30%	80-120%/70-130%
7440-62-2	Vanadium	25	2500	±20%/±30%	80-120%/70-130%
7440-66-6	Zinc	10	1000	±20%/±30%	80-120%/70-130%
7440-70-2	Calcium	1000	100000	±20%/±30%	80-120%/70-130%
7440-31-5	Tin	100	10000	±20%/±30%	80-120%/70-130%
7440-69-9	Bismuth	100	10000	±20%/±30%	80-120%/70-130%
7723-14-0	Phosphorus	100	50000	±20%/±30%	80-120%/70-130%
7440-21-3	Silicon	20	2000	±20%/±30%	80-120%/70-130%
7440-24-6	Strontium (elemental)	10	1000	±20%/±30%	80-120%/70-130%

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-3. U.S. Environmental Protection Agency Method 200.8 or SW-846 Method 6020

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7439-92-1	Lead	2	500	±20%/±30%	80-120%/70-130%
7440-22-4	Silver	2	200	±20%/±30%	80-120%/70-130%
7440-28-0	Thallium	2	500	±20%/±30%	80-120%/70-130%
7440-36-0	Antimony	5	600	±20%/±30%	80-120%/70-130%
7440-38-2	Arsenic	4	1000	±20%/±30%	80-120%/70-130%
7440-39-3	Barium	5	500	±20%/±30%	80-120%/70-130%

Table A-3. U.S. Environmental Protection Agency Method 200.8 or SW-846 Method 6020

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
7440-41-7	Beryllium	2	200	±20%/±30%	80-120%/70-130%
7440-43-9	Cadmium	2	200	±20%/±30%	80-120%/70-130%
7440-47-3	Chromium	2	200	±20%/±30%	80-120%/70-130%
7782-49-2	Selenium	4	1000	±20%/±30%	80-120%/70-130%

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1.*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8081

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
72-54-8	4,4'-DDD	0.1	3.3	±20%/±30%	80-120%/70-130%
72-55-9	4,4'-DDE	0.1	3.3	±20%/±30%	80-120%/70-130%
50-29-3	4,4'-DDT	0.1	3.3	±20%/±30%	80-120%/70-130%
309-00-2	Aldrin	0.05	1.65	±20%/±30%	80-120%/70-130%
319-84-6	Alpha-BHC	0.05	1.65	±20%/±30%	80-120%/70-130%
5103-71-9	alpha-Chlordane	0.5	16.5	±20%/±30%	80-120%/70-130%
319-85-7	Beta-BHC	0.05	1.65	±20%/±30%	80-120%/70-130%
57-74-9	Chlordane	0.5	16.5	±20%/±30%	80-120%/70-130%
319-86-8	Delta-BHC	0.05	1.65	±20%/±30%	80-120%/70-130%
60-57-1	Dieldrin	0.1 (0.05)	3.3	±20%/±30%	80-120%/70-130%
959-98-8	Endosulfan I	0.05	1.65	±20%/±30%	80-120%/70-130%
33213-65-9	Endosulfan II	0.1	3.3	±20%/±30%	80-120%/70-130%
1031-07-8	Endosulfan sulfate	0.1	3.3	±20%/±30%	80-120%/70-130%
72-20-8	Endrin	0.1	3.3	±20%/±30%	80-120%/70-130%
7421-93-4	Endrin aldehyde	0.1	3.3	±20%/±30%	80-120%/70-130%
53494-70-5	Endrin ketone	0.1	3.3	±20%/±30%	80-120%/70-130%
58-89-9	Gamma-BHC (Lindane)	0.05	1.65	±20%/±30%	80-120%/70-130%

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8081

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
5103-74-2	gamma-Chlordane	0.5	16.5	±20%/±30%	80-120%/70-130%
76-44-8	Heptachlor	0.05	1.65	±20%/±30%	80-120%/70-130%
1024-57-3	Heptachlor epoxide	0.05	1.65	±20%/±30%	80-120%/70-130%
72-43-5	Methoxychlor	0.5	16.5	±20%/±30%	80-120%/70-130%
8001-35-2	Toxaphene	5 (2)	165	±20%/±30%	80-120%/70-130%

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*
CAS = Chemical Abstracts Service
EQL = estimated quantitation limit

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8082

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
12674-11-2	Aroclor-1016	0.5	16.5	±20%/±30%	80-120%/70-130%
11104-28-2	Aroclor-1221	0.5	16.5	±20%/±30%	80-120%/70-130%
11141-16-5	Aroclor-1232	0.5	16.5	±20%/±30%	80-120%/70-130%
53469-21-9	Aroclor-1242	0.5	16.5	±20%/±30%	80-120%/70-130%
12672-29-6	Aroclor-1248	0.5	16.5	±20%/±30%	80-120%/70-130%
11097-69-1	Aroclor-1254	0.5	16.5	±20%/±30%	80-120%/70-130%
11096-82-5	Aroclor-1260	0.5	16.5	±20%/±30%	80-120%/70-130%
37324-23-5	Aroclor-1262	0.5	16.5	±20%/±30%	80-120%/70-130%
11100-14-4	Aroclor-1268	0.5	16.5	±20%/±30%	80-120%/70-130%

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*
CAS = Chemical Abstracts Service
EQL = estimated quantitation limit

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8260

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
100-41-4	Ethylbenzene	5	5	±20%/±30%	80-120%/70-130%
100-42-5	Styrene	5	5	±20%/±30%	80-120%/70-130%
10061-01-5	cis-1,3-dichloropropene	5	5	±20%/±30%	80-120%/70-130%
10061-02-6	trans-1,3-dichloropropene	5	5	±20%/±30%	80-120%/70-130%
107-06-2	1,2-dichloroethane	5	5	±20%/±30%	80-120%/70-130%
108-10-1	4-methyl-2-pentanone	10	10	±20%/±30%	80-120%/70-130%
108-88-3	Toluene	5	5	±20%/±30%	80-120%/70-130%
108-90-7	Chlorobenzene	5	5	±20%/±30%	80-120%/70-130%
124-48-1	Dibromochloromethane	5	5	±20%/±30%	80-120%/70-130%
127-18-4	Tetrachloroethene	5	5	±20%/±30%	80-120%/70-130%
1330-20-7	Xylenes (total)	10	10	±20%/±30%	80-120%/70-130%
540-59-0	1,2-dichloroethene(total)	10	5	±20%/±30%	80-120%/70-130%
591-78-6	2-hexanone	20	20	±20%/±30%	80-120%/70-130%
67-64-1	Acetone	20	20	±20%/±30%	80-120%/70-130%
71-43-2	Benzene	1.5	5	±20%/±30%	80-120%/70-130%
71-55-6	1,1,1-trichloroethane	5	5	±20%/±30%	80-120%/70-130%
74-83-9	Bromomethane	10	10	±20%/±30%	80-120%/70-130%
74-87-3	Chloromethane	10	10	±20%/±30%	80-120%/70-130%
75-00-3	Chloroethane	10	10	±20%/±30%	80-120%/70-130%
75-01-4	Vinyl chloride	5	5	±20%/±30%	80-120%/70-130%
75-09-2	Methylene chloride	5	5	±20%/±30%	80-120%/70-130%
75-15-0	Carbon disulfide	5	5	±20%/±30%	80-120%/70-130%
75-25-2	Bromoform	5	5	±20%/±30%	80-120%/70-130%
75-27-4	Bromodichloromethane	5	5	±20%/±30%	80-120%/70-130%
75-34-3	1,1-dichloroethane	2	10	±20%/±30%	80-120%/70-130%
75-35-4	1,1-dichloroethene	10	10	±20%/±30%	80-120%/70-130%
78-87-5	1,2-dichloropropane	5	5	±20%/±30%	80-120%/70-130%
78-93-3	2-butanone	10	10	±20%/±30%	80-120%/70-130%
79-00-5	1,1,2-trichloroethane	2	5	±20%/±30%	80-120%/70-130%
79-34-5	1,1,2,2-tetrachloroethane	5	5	±20%/±30%	80-120%/70-130%

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8260

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
56-23-5	Carbon tetrachloride	1	5	±20%/±30%	80-120%/70-130%
79-01-6	Trichloroethene	1	5	±20%/±30%	80-120%/70-130%
67-66-3	Chloroform	5	5	±20%/±30%	80-120%/70-130%
106-46-7	1,4-Dichlorobenzene	5	5	±20%/±30%	80-120%/70-130%
156-59-2	cis-1,2-Dichloroethylene	5	5	±20%/±30%	80-120%/70-130%

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-7. U.S. Environmental Protection Agency (EPA) SW-846 Method 8270

CAS #	Constituent	Water RDL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
100-01-6	4-Nitroaniline	10	330	±20%/±30%	80-120%/70-130%
100-02-7	4-Nitrophenol	20	660	±20%/±30%	80-120%/70-130%
101-55-3	4-Bromophenylphenyl ether	10	330	±20%/±30%	80-120%/70-130%
105-67-9	2,4-Dimethylphenol	10	330	±20%/±30%	80-120%/70-130%
106-44-5	4-Methylphenol (cresol, p-)*	10	330	±20%/±30%	80-120%/70-130%
106-46-7	1,4-Dichlorobenzene	10 (5)	330	±20%/±30%	80-120%/70-130%
106-47-8	4-Chloroaniline	10	330	±20%/±30%	80-120%/70-130%
108-39-4	3-Methylphenol (cresol, m-)*	20	660	±20%/±30%	80-120%/70-130%
108-60-1	Bis(2-chloro-1-methylethyl)ether	10	330	±20%/±30%	80-120%/70-130%
108-95-2	Phenol	10	330	±20%/±30%	80-120%/70-130%
111-44-4	Bis(2-chloroethyl) ether	10	330	±20%/±30%	80-120%/70-130%
111-91-1	Bis(2-Chloroethoxy)methane	10	330	±20%/±30%	80-120%/70-130%
117-81-7	Bis(2-ethylhexyl) phthalate	10	330	±20%/±30%	80-120%/70-130%
117-84-0	Di-n-octylphthalate	10	330	±20%/±30%	80-120%/70-130%
118-74-1	Hexachlorobenzene	10	330	±20%/±30%	80-120%/70-130%
120-12-7	Anthracene	10	330	±20%/±30%	80-120%/70-130%
120-82-1	1,2,4-Trichlorobenzene	10	330	±20%/±30%	80-120%/70-130%
120-83-2	2,4-Dichlorophenol	10	330	±20%/±30%	80-120%/70-130%

Table A-7. U.S. Environmental Protection Agency (EPA) SW-846 Method 8270

CAS #	Constituent	Water RDL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
121-14-2	2,4-Dinitrotoluene	10	330	±20%/±30%	80-120%/70-130%
129-00-0	Pyrene	10	330	±20%/±30%	80-120%/70-130%
131-11-3	Dimethyl phthalate	10	330	±20%/±30%	80-120%/70-130%
132-64-9	Dibenzofuran	10	330	±20%/±30%	80-120%/70-130%
191-24-2	Benzo(ghi)perylene	10	330	±20%/±30%	80-120%/70-130%
193-39-5	Indeno(1,2,3-cd)pyrene	10	330	±20%/±30%	80-120%/70-130%
205-99-2	Benzo(b)fluoranthene	10	330	±20%/±30%	80-120%/70-130%
206-44-0	Fluoranthene	10	330	±20%/±30%	80-120%/70-130%
207-08-9	Benzo(k)fluoranthene	10	330	±20%/±30%	80-120%/70-130%
208-96-8	Acenaphthylene	10	330	±20%/±30%	80-120%/70-130%
218-01-9	Chrysene	10	330	±20%/±30%	80-120%/70-130%
50-32-8	Benzo(a)pyrene	10	330	±20%/±30%	80-120%/70-130%
51-28-5	2,4-Dinitrophenol	25	825	±20%/±30%	80-120%/70-130%
534-52-1	4,6-Dinitro-2-methylphenol	10	330	±20%/±30%	80-120%/70-130%
53-70-3	Dibenz[a,h]anthracene	10	330	±20%/±30%	80-120%/70-130%
541-73-1	1,3-Dichlorobenzene	10	330	±20%/±30%	80-120%/70-130%
56-55-3	Benzo(a)anthracene	10	330	±20%/±30%	80-120%/70-130%
59-50-7	4-Chloro-3-methylphenol	10	330	±20%/±30%	80-120%/70-130%
606-20-2	2,6-Dinitrotoluene	10	330	±20%/±30%	80-120%/70-130%
621-64-7	n-Nitrosodi-n-dipropylamine	10	330	±20%/±30%	80-120%/70-130%
65794-96-9	3+4 Methylphenol (cresol, m+p)*	10	330	±20%/±30%	80-120%/70-130%
67-72-1	Hexachloroethane	10	330	±20%/±30%	80-120%/70-130%
7005-72-3	4-Chlorophenylphenyl ether	10	330	±20%/±30%	80-120%/70-130%
77-47-4	Hexachlorocyclopentadiene	10	330	±20%/±30%	80-120%/70-130%
78-59-1	Isophorone	10	330	±20%/±30%	80-120%/70-130%
83-32-9	Acenaphthene	10	330	±20%/±30%	80-120%/70-130%
84-66-2	Diethylphthalate	10	330	±20%/±30%	80-120%/70-130%
84-74-2	Di-n-butylphthalate	10	330	±20%/±30%	80-120%/70-130%
85-01-8	Phenanthrene	10	330	±20%/±30%	80-120%/70-130%
85-68-7	Butylbenzylphthalate	10	330	±20%/±30%	80-120%/70-130%

Table A-7. U.S. Environmental Protection Agency (EPA) SW-846 Method 8270

CAS #	Constituent	Water RDL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
86-30-6	n-Nitrosodiphenylamine	10	330	±20%/±30%	80-120%/70-130%
86-73-7	Fluorene	10	330	±20%/±30%	80-120%/70-130%
86-74-8	Carbazole	10	330	±20%/±30%	80-120%/70-130%
87-68-3	Hexachlorobutadiene	10	330	±20%/±30%	80-120%/70-130%
87-86-5	Pentachlorophenol	10	330	±20%/±30%	80-120%/70-130%
88-06-2	2,4,6-Trichlorophenol	10	330	±20%/±30%	80-120%/70-130%
88-74-4	2-Nitroaniline	10	330	±20%/±30%	80-120%/70-130%
88-75-5	2-Nitrophenol	20	660	±20%/±30%	80-120%/70-130%
91-20-3	Naphthalene	10	330	±20%/±30%	80-120%/70-130%
91-57-6	2-Methylnaphthalene	10	330	±20%/±30%	80-120%/70-130%
91-58-7	2-Chloronaphthalene	10	330	±20%/±30%	80-120%/70-130%
91-94-1	3,3'-Dichlorobenzidine	10	330	±20%/±30%	80-120%/70-130%
95-48-7	2-Methylphenol (cresol, o-)	10	330	±20%/±30%	80-120%/70-130%
95-50-1	1,2-Dichlorobenzene	10	330	±20%/±30%	80-120%/70-130%
95-57-8	2-Chlorophenol	10	330	±20%/±30%	80-120%/70-130%
95-95-4	2,4,5-Trichlorophenol	10	330	±20%/±30%	80-120%/70-130%
98-95-3	Nitrobenzene	10	330	±20%/±30%	80-120%/70-130%
99-09-2	3-Nitroaniline	10	330	±20%/±30%	80-120%/70-130%

*May report as 3-Methylphenol (cresol, p-) and 4-Methylpheonl (cresol, m-) or a 3+4 Methylphenol (cresol, m+P) total.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

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Table A-8. U.S. Environmental Protection Agency SW-846 Method 8310.

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
90-12-0	1-Methylnaphthalene			±30%	70-130%
91-57-6	2-Methylnaphthalene			±30%	70-130%
83-32-9	Acenaphthene	20	100	±30%	70-130%

Table A-8. U.S. Environmental Protection Agency SW-846 Method 8310.

CAS #	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
208-96-8	Acenaphthylene	25	100	±30%	70-130%
79-06-1	Acrylamide			±30%	70-130%
120-12-7	Anthracene	10	50	±30%	70-130%
56-55-3	Benzo(a)anthracene	0.3	15	±30%	70-130%
50-32-8	Benzo(a)pyrene	0.5	15	±30%	70-130%
205-99-2	Benzo(b)fluoranthene	0.5	15	±30%	70-130%
191-24-2	Benzo(ghi)perylene	1	30	±30%	70-130%
207-08-9	Benzo(k)fluoranthene	0.5	15	±30%	70-130%
218-01-9	Chrysene	5	50	±30%	70-130%
53-70-3	Dibenz[a,h]anthracene	1	30	±30%	70-130%
206-44-0	Fluoranthene	5	50	±30%	70-130%
86-73-7	Fluorene	3	30	±30%	70-130%
193-39-5	Indeno(1,2,3-cd)pyrene	1	30	±30%	70-130%
91-20-3	Naphthalene	20	100	±30%	70-130%
85-01-8	Phenanthrene	10	50	±30%	70-130%
92-94-4	p-terphenyl			±30%	70-130%
129-00-0	Pyrene	5	50	±30%	70-130%

NOTE: Where EQL is not specified, current EQLs of laboratories contracted to the Hanford Site are applicable.

Table A-9. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

CAS #	Constituent	Water EQL (pCi/L)	Soil EQL (pCi/g)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
14331-83-0	Actinium-228			±30%	70-130%
14596-10-2	Americium-241	50	1	±30%	70-130%
13981-41-4	Barium-133		0.2	±30%	70-130%
13966-02-4	Beryllium-7	50	0.3	±30%	70-130%
14913-49-6	Bismuth-212			±30%	70-130%
14733-03-0	Bismuth-214			±30%	70-130%
CE/PR-144	Cerium/Praseodymium-144			±30%	70-130%

Table A-9. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

CAS #	Constituent	Water EQL (pCi/L)	Soil EQL (pCi/g)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
10045-97-3	Cesium-137	15	0.1	±30%	70-130%
10198-40-0	Cobalt-60	25	0.05	±30%	70-130%
14683-23-9	Europium-152	50	0.1	±30%	70-130%
15585-10-1	Europium-154	50	0.1	±30%	70-130%
14391-16-3	Europium-155	50	0.1	±30%	70-130%
15092-94-1	Lead-212			±30%	70-130%
15067-28-4	Lead-214			±30%	70-130%
14681-63-1	Niobium-94			±30%	70-130%
13966-00-2	Potassium-40			±30%	70-130%
13982-63-3	Radium-226		0.1	±30%	70-130%
15262-20-1	Radium-228		0.2	±30%	70-130%
14274-82-9	Thorium-228			±30%	70-130%
TH-232	Thorium-232			±30%	70-130%
15065-10-8	Thorium-234			±30%	70-130%
15832-50-5	Tin-126			±30%	70-130%
15117-96-1	Uranium-235	50	0.5	±30%	70-130%
U-238	Uranium-238	500	10	±30%	70-130%
14391-65-2	Silver-108m		0.2	±30%	70-130%

Where EQL is not specified, current EQLs of laboratories contracted to the Hanford Site are applicable.

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-10. Isotopic Uranium

CAS #	Constituent	Water EQL (pCi/L)	Soil EQL (pCi/g)	Precision Requirement Water/Soil	Accuracy Requirement Water/Soil
13966-29-5	Uranium-234	1	1	±30%	70-130%
15117-96-1	Uranium-235	1	0.5	±30%	70-130%
U-238	Uranium-238	1	1	±30%	70-130%

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

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