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Revision 0

Sampling and Analysis Plan for the Uranium Sequestration Pilot Test

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Plateau Remediation Company
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Richland, Washington 99352

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Approval Page

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U.S. Department of Energy, Richland Operations Office

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U.S. Environmental Protection Agency

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Contents

1 Introduction 1-1

1.1 Project Scope and Objective 1-1
1.2 Background 1-1
1.3 Systematic Planning 1-4
1.4 Contaminants of Concern/Contaminants of Potential Concern/Target Analytes 1-9
1.5 Project Schedule 1-9

2 Quality Assurance Project Plan 2-11

2.1 Project Management 2-11
2.1.1 Project / Task Organization 2-11
2.1.2 Quality Assurance Objective and Criteria 2-15
2.1.3 Special Training/Certification 2-15
2.1.4 Documents and Records 2-19
2.2 Data Generation and Acquisition 2-22
2.2.1 Analytical Methods Requirements 2-22
2.2.2 Field Analytical Methods 2-26
2.2.3 Quality Control 2-27
2.2.4 Measurement Equipment 2-29
2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance 2-29
2.2.6 Instrument/Equipment Calibration and Frequency 2-30
2.2.7 Inspection/Acceptance of Supplies and Consumables 2-30
2.2.8 Nondirect Measurements 2-30
2.2.9 Data Management 2-30
2.3 Assessment and Oversight 2-31
2.3.1 Assessments and Response Actions 2-31
2.3.2 Reports to Management 2-31
2.4 Data Review and Usability 2-31
2.4.1 Data Review and Verification 2-31
2.4.2 Data Validation 2-32
2.4.3 Reconciliation with User Requirements 2-32

3 Field Sampling Plan 3-1

3.1 Sampling Design 3-1
3.2 Borehole Drilling 3-2
3.3 Sampling Methods 3-3
3.3.1 Decontamination of Sampling Equipment 3-10
3.3.2 Radiological Field Data 3-10
3.4 Documentation of Field Activities 3-11

3.4.1 Corrective Actions and Deviations for Sampling Activities 3-12
3.5 Calibration of Field Equipment 3-12
3.6 Sample Handling 3-13
3.6.1 Container Labeling 3-13
3.6.2 Sample Custody 3-14
3.6.3 Sample Transportation 3-15
4 Management of Waste 4-1
5 Health and Safety 5-1
6 References 6-1

Figures

Figure 1-1. Location of the 216-U-8 Crib Waste Site 1-3
Figure 1-2. Uranium Concentrations in the Sediments beneath the 216-U-8 Crib 1-4
Figure 2-1. Project Organization 2-12
Figure 3-1. Location of Boreholes 3-3
Figure 3-2. Split-Spoon Liner Samples 3-5

Tables

Table 1-1. Summary of Problem Statement 1 1-6
Table 1-2. Summary of Problem Statement 2 1-8
Table 1-3. Project Activity Durations 1-9
Table 2-1. DQIs 2-16
Table 2-2. Change Control for Sampling Projects 2-21
Table 2-3. Analytical Performance Requirements 2-22
Table 2-4. Specialized and Screening Analyses for Sediment Samples 2-24
Table 2-5. Field Instruments and Analyses 2-26
Table 2-6. Project QC Requirements 2-28
Table 3-1. Estimated Location Coordinates for Proposed Boreholes (NAD83 Washington State Plane South) 3-4
Table 3-2. Location, Depth, and Sample Design for Borehole 1 3-6
Table 3-3. Location, Depth, and Sample Design for Boreholes 2 and 3 3-7
Table 3-4. Location, Depth, and Sample Design for Post-treatment Boreholes 3-9
Table 3-5. Sample Preservation, Container, and Holding Time Guidelines for Sediment Samples 3-13

Terms

ALARA	as low as reasonably achievable
ASA	American Standards Association (currently American National Standards Institute)
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTR	Buyer's Technical Representative
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DOT	U.S. Department of Transportation
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DUP	field duplicate (sample)
EB	equipment blank
ECO	Environmental Compliance Officer
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERT	electrical resistivity tomography
FS	feasibility study
FSO	Field Sampling Operations
FWS	Field Work Supervisor
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Document* (DOE/RL-96-68)
HEIS	Hanford Environmental Information System
ICP	inductively coupled plasma
LSC	liquid scintillation counting

MS	mass spectrometry
N/A	not applicable
NCO	nuclear chemical operator
NPL	"National Priority List" (40 CFR 300, Appendix B)
OU	operable unit
PNNL	Pacific Northwest National Laboratory
POC	point-of-contact
ppm	parts per million
PSQ	principal study question
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	Radiological Control Technician
RI	remedial investigation
RPD	relative percent difference
SAP	sampling and analysis plan
SMR	Sample Management and Reporting
TBD	to be determined
TPA	Tri-Party Agreement
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
USPT	Uranium Sequestration Pilot Test
WE	water extraction

1 Introduction

This sampling and analysis plan (SAP) describes the field sampling activities and quality assurance processes for obtaining data of sufficient quality and quantity to support the Uranium Sequestration Pilot Test (USPT) as described by DOE/RL-2010-87, *Field Test Plan for the Uranium Sequestration Pilot Test*. The pilot or treatability test involves injection of a reactive gas (ammonia) into contaminated subsurface sediments in the vadose zone to induce geochemical changes that act to render contaminants, such as uranium, less mobile. Completion of the USPT will provide specific information that will be used to evaluate uranium sequestration via vadose zone ammonia injection as a treatment technology for reducing the mobility of contaminants that have the potential to adversely impact groundwater. It is anticipated the test will provide information that will enable uranium sequestration via ammonia injection to be considered as a remedy in *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) response actions.

1.1 Project Scope and Objective

The USPT test is being implemented to evaluate the effectiveness of injecting ammonia gas into the Hanford Site vadose zone to decrease the mobility of uranium, and other similar contaminants, in order to protect the underlying groundwater. Groundwater risk mitigation is derived from reducing the fraction of uranium contamination that is mobile. This process, uranium sequestration via ammonia injection, will be evaluated in a treatability test conducted at the 200-WA-1 Operable Unit (OU), located in the 200 West Area of the Hanford Site. The specific test site selected is adjacent to the 216-U-8 Crib in this OU. Figure 1-1 shows the location of the 216-U-8 Crib (lower center in figure) relative to the U Plant (Building 221-U) located within the 200 West Area of the Hanford Site.

The USPT will require drilling eight boreholes on the south side of the 216-U-8 Crib, one of which will serve as the ammonia injection well. Five surrounding boreholes will be equipped with instrumentation to monitor the ammonia/sediment pore water reaction process and collect data to evaluate ammonia injection as a potential remedy to protect groundwater from mobile contaminants. After the ammonia has been injected into the subsurface sediments, and the ammonia/pore water reaction has been completed, two boreholes will be drilled through the treatment zone to sample and characterize the treated sediments. The sediment results and the data collected during the test from in situ instruments and sensors will be used to evaluate the effectiveness of the treatment technology.

1.2 Background

The U.S. Department of Energy (DOE) Hanford Site is a 1,517 km^2 (586 mi^2) federal facility located in southeastern Washington State along the Columbia River. For administrative purposes, the Hanford Site was divided into four National Priority List (NPL) sites (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List") under CERCLA in 1989, one of which is the 200 Area. In anticipation of the NPL (40 CFR 300, Appendix B) listing, the Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency (EPA), and DOE entered into the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a), also known as the Tri-Party Agreement (TPA), in May 1989. This agreement established a procedural framework and schedule for developing, implementing, and monitoring CERCLA response actions and *Resource Conservation and Recovery Act of 1976* (RCRA) compliance and permitting, on the Hanford Site.

In March 2008, DOE/RL-2007-56, *Deep Vadose Treatability Test Plan for the Hanford Central Plateau*, was issued to meet Milestone M-015-50 of the TPA (Ecology et al., 1989a). The Deep Vadose

Treatability Test Plan identified two field treatability tests to be conducted under the treatability test program. One test was the desiccation field test, which has been completed. The second test was identified as a gas phase geochemical manipulation technology. The USPT fulfills this latter test.

The USPT is part of the remedial investigation/feasibility study (RI/FS) process initiated by the original RI/FS work plan for this site (DOE/RL-91-19, *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 200-UP-2 Operable Unit, Hanford Site, Richland, Washington*). The location of the test, the 216-U-8 Crib, is included in the 200-WA-1 OU. The 200-WA-1 OU, established in 2011, includes most waste sites located in the 200 West Area of the 200 Area NPL (40 CFR 300, Appendix B) site.

The 216-U-8 Crib was selected for the USPT because historic characterization data indicate the site contains a significant inventory of uranium that is likely to be in a mobile form. Previous characterization of the 216-U-8 Crib region indicates uranium, and other contaminants discharged to the crib, has spread laterally in the vadose zone soils surrounding the crib. Uranium contamination is present in two distinct regions at the 216-U-8 Crib (see Figure 1-2). One region is at a relatively shallow depth of approximately 10.6 m (35 ft) below ground surface (bgs) in the coarser-grained Hanford formation. The second, deeper region is at a depth of approximately 58 m (190 ft) bgs in the fine-grained Cold Creek unit (CCU). The treatability test will focus on contamination residing in a relatively shallow region of sediments in the Hanford formation. The sediments will be characterized prior to conducting the treatability test in order to confirm that site conditions are conducive to the treatment technology.

Field implementation of the ammonia treatment technology involves injection of an ammonia gas mixture into a subsurface target zone. The ammonia partitions into the pore water and approaches a pore water concentration dependent on the concentration of ammonia in the gas phase. A portion of the ammonia dissociates and causes the pore water pH to increase. Under these conditions, some aluminosilicate minerals in the soil matrix (including montmorillonite, muscovite, and kaolinite) partially dissolve into the pore water. When ammonia injection is stopped, and mineral dissolution has neutralized the alkaline pH, the pH of the pore water then declines to natural conditions (pH 8). As the pH declines, the ions in solution precipitate as various aluminosilicate minerals (including sodalite, cancrinite, and zeolite). These precipitates coat and bind much of the uranium contamination, rendering it less mobile. By reducing the fraction of uranium contamination that is mobile, its potential to contaminate groundwater is reduced.

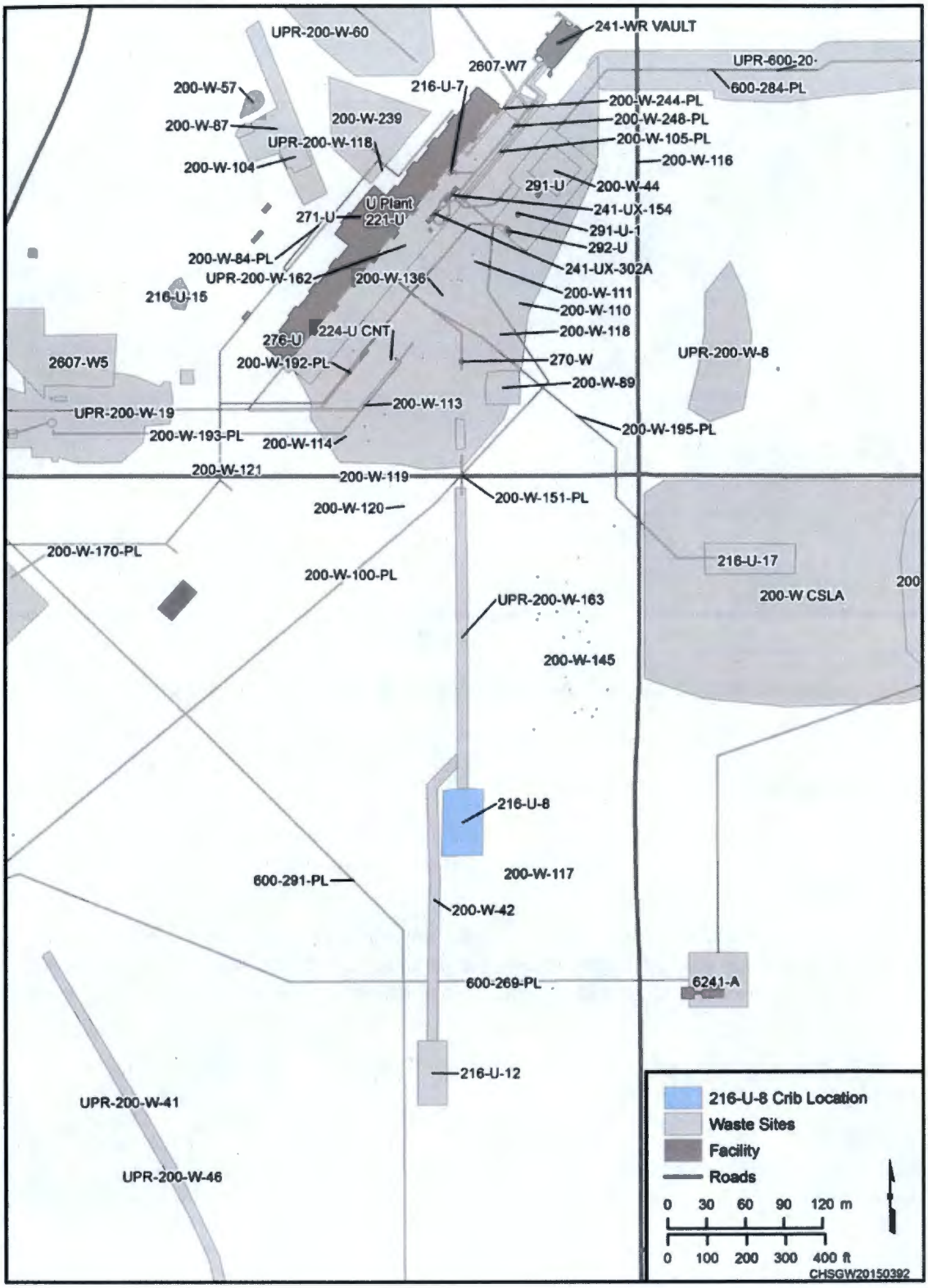


Figure 1-1. Location of the 216-U-8 Crib Waste Site

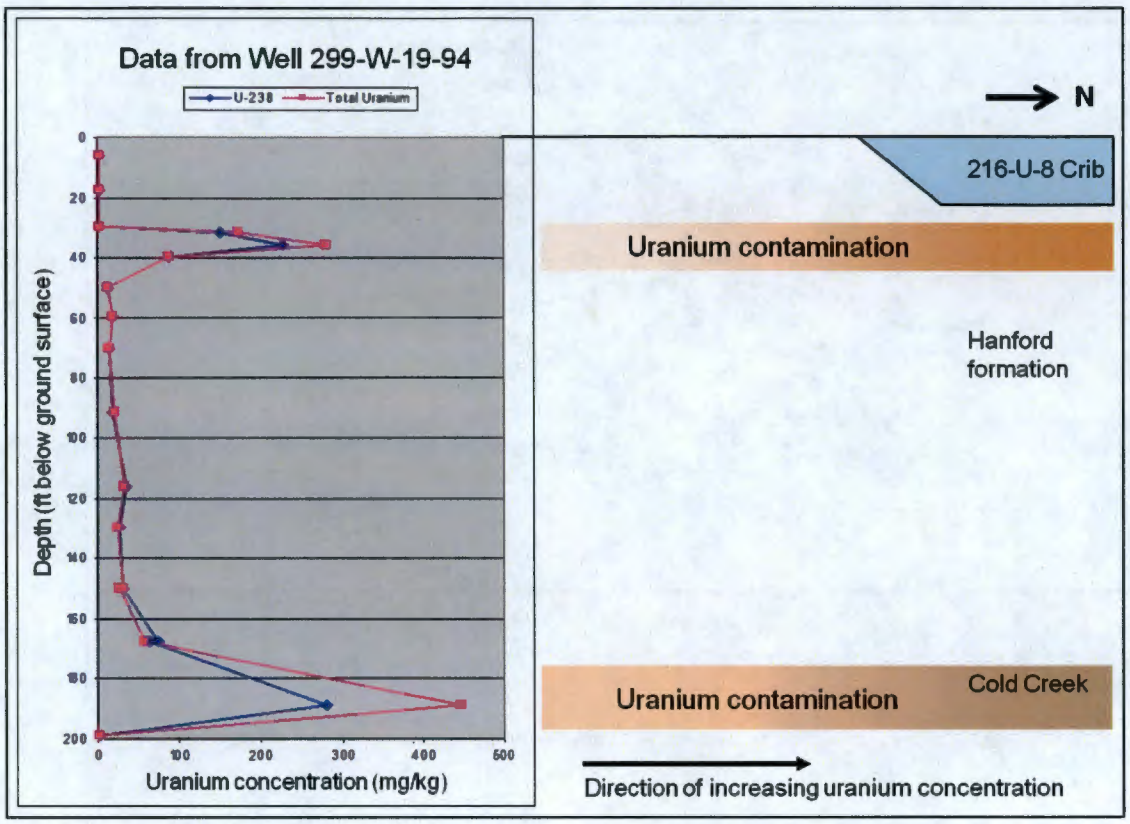


Figure 1-2. Uranium Concentrations in the Sediments beneath the 216-U-8 Crib

1.3 Systematic Planning

The overall objectives of the uranium sequestration treatability test are listed in DOE/RL-2007-56. The original objectives have been refined based on the selected reactive gas process (ammonia treatment). The refined test objectives include the following:

- Determine the design parameters for applying uranium sequestration via ammonia injection to the study area. This includes determining the operational parameters such as reactant flow rates and properties (e.g., gas composition) and identifying the target areas to achieve acceptable reduction of mobile uranium.
- Demonstrate field-scale treatment for targeted areas within the vadose zone by quantifying the following:
  - Reduction of uranium mobility in the field test treatment zone compared to the reduction of uranium mobility observed in laboratory-induced treatment of site sediments, with a goal of decreasing the mobile uranium fraction in the sediment by half. Extent is determined by a decrease in the amount of uranium that can be extracted using a sequential application of groundwater, an ion exchange solution, and a mild acetic acid solution as the extracting solutions.
  - Stability of sequestered uranium in terms of dissolution rate of uranium into the pore water.

- Demonstrate the ability to deploy operational equipment and instrumentation necessary to implement the treatment process on a large scale.
- Collect data to support consideration of uranium sequestration via ammonia injection as a remedy in the FS process.

A data quality objectives (DQOs) process, as described in EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G-4), was used to develop the sampling and analytical design to support the treatability test. The DQO process was documented in SGW-46487, *Data Quality Objectives Summary Report for the Uranium Sequestration Pilot Test*. Using the DQOs process, two problem statements were identified. The data collected during the USPT are targeted to resolve these problem statements.

- **Problem Statement 1** involves characterizing the sediments in the upper region of uranium contamination (Hanford formation) to determine if this location is suitable for the treatability test. As stated in the previous section, characterization data from nearby boreholes indicates two regions of higher uranium concentration are located in the vadose zone sediments near the 216-U-8 Crib. The upper region has been selected for the treatability test. Table 1-1 provides specific information on the principal study questions (PSQs) to be resolved, data needs, measurements, and data use for Problem Statement 1. Sampling to resolve PSQ 1 will provide vertical profile uranium soil characterization data in the Hanford formation portion of the vadose zone to confirm the location of higher concentrations of mobile uranium. Sampling to resolve PSQs 2 and 3 will provide data on the effectiveness of the treatment under laboratory conditions to reduce the mobility of uranium and technetium-99, respectively. Together, data collected to resolve these PSQs will be used to determine if the geochemical manipulation by ammonia injection technology should be applied to the field test location.

The following decision rules will be used to determine if sufficient information has been collected to resolve Problem Statement 1:

Decision Rule 1 – If the average (or other value as appropriate) concentration of mobile uranium in the 216-U-8 waste site sediment reaction zone is equivalent to or greater than the concentration of mobile uranium used in the lab test, then proceed with the field test. Otherwise, perform additional site characterization to find a suitable location.

Decision Rule 2 – If the average (or other value as appropriate) mobile uranium content of sediment samples taken from the 216-U-8 waste site sediment reaction zone was decreased during the treatability test, then proceed with the 216-U-8 field test for uranium reduction. Otherwise, determine why the mobile uranium content was not decreased.

Decision Rule 3 – If the average (or other value as appropriate) mobile technetium-99 content of sediment samples taken from the 216-U-8 waste site sediment reaction zone was decreased during the treatability test, then proceed with the 216-U-8 field test for technetium-99 reduction. Otherwise, determine why the mobile technetium-99 content was not decreased.

Table 1-1. Summary of Problem Statement 1

Problem Statement 1	The vadose zone sediments near the 216-U-8 Crib represent a region of subsurface uranium contamination that has been selected to demonstrate the effectiveness of uranium sequestration using treatment by injection of ammonia.	
Principal Study Question 1	Does the planned test interval contain sufficient mobile uranium and have characteristics suitable to evaluate potential treatment effectiveness?	
Discussion	Data obtained from nearby characterization boreholes indicates two regions of uranium-contaminated sediment that may be suitable to demonstrate uranium sequestration by ammonia injection. The upper region is in the Hanford formation at about 10.6 m (35 ft) bgs. The lower region is in the CCU silt zone at about 58 m (190 ft) bgs. The upper region is been proposed for the treatability test.	
Data Need	**Measurement/Observation and Location/Frequency**	**Data Use**
Vertical profile and distribution of uranium soil concentrations and lithology of the upper region of contaminated sediment (Hanford formation)	Collect continuous geophysical (neutron moisture and spectral gamma) measurements and lithology observations from three boreholes drilled through the upper region of contaminated sediment in the Hanford formation.	This information will be combined with existing data to refine the conceptual site model of uranium soil concentrations in the study area. The geophysical measurements will be used to select vertical profile interval samples for chemical and physical characterization.
Chemical and physical characteristics of contaminated sediment in the upper region of contamination (Hanford formation)	Conduct sequential extraction tests on vertical profile samples obtained from the three boreholes drilled through the upper region of contaminated sediment to determine the amount of labile uranium.	Confirm that sufficient labile uranium (>20%) is present to meet the test objectives. Confirm mobile uranium concentrations are present in concentration conducive for the treatability test (30 µg/L). Confirm that contaminant and sediment characteristics are conducive for the treatability test.
	Conduct grain-size, bulk conductivity, and chemistry analyses on samples selected for the leachability study.	Determine the physical characteristics of the sediments that may affect leachability and the treatability test.
Principal Study Question 2	Does laboratory testing of sediments obtained from the planned test interval show reduction in mobile uranium content due to ammonia treatment?	
Discussion	Vertical profile samples from PSQ 1 will be selected for laboratory exposure to ammonia to simulate the treatability test. Exposed samples will then be characterized in a similar manner as the samples characterized for PSQ 1 to determine the effectiveness of the treatment.	
Data Need	**Measurement/Observation and Location/Frequency**	**Data Use**

Table 1-1. Summary of Problem Statement 1

Leachability of uranium in contaminated sediments from the upper region of contamination (Hanford formation) following exposure to ammonia in the laboratory	Conduct tests on vertical profile samples characterized for PSQ 1 that have been exposed to ammonia in the laboratory to simulate treatment using the following laboratory methods: • Sequential extraction tests on sediments collected from each borehole to determine the change in labile uranium due to treatment • Soil column leach tests on selected untreated and treated sediments to quantify the effect of laboratory ammonia treatment on uranium leaching characteristics	Confirm that laboratory ammonia treatment of field site sediments reduces the amount of labile uranium by an amount that meets the test criteria (by 50% or greater). Determine the change in uranium leaching characteristics of the samples following exposure to ammonia in the laboratory.
Principal Study Question 3	Does laboratory testing of sediments obtained from the planned test interval show reduction in mobile technetium-99 content due to ammonia treatment?	
Discussion	Vertical profile samples from PSQ 1 will be selected for laboratory exposure to ammonia to simulate the treatability test. Exposed samples will then be characterized in a similar manner as the samples characterized for PSQ 1 to determine the effectiveness of the treatment.	
Data Need	**Measurement/Observation and Location/Frequency**	**Data Use**
Leachability of technetium-99 in contaminated sediments from the upper region of contamination (Hanford formation) following exposure to ammonia in the laboratory	Conduct tests on vertical profile samples characterized for PSQ 1 that have been exposed to ammonia in the laboratory to simulate treatment using the following laboratory methods: • Sequential extraction tests on sediments collected from each borehole to determine the change in labile technetium-99 due to treatment • Soil column leach tests on selected untreated and treated sediments to quantify the effect of laboratory ammonia treatment on technetium-99 leaching characteristics	Determine the extent to which laboratory ammonia treatment of field site sediments reduces the amount of labile technetium-99. Determine the change in technetium-99 leaching characteristics of the samples following exposure to ammonia in the laboratory.

Source: SGW-46487, *Data Quality Objectives Summary Report for the Uranium Sequestration Pilot Test.*

bgs = below ground surface
CCU = Cold Creek unit
PSQ = principal study question

- **Problem Statement 2** involves determining if geochemical manipulation using ammonia injection effectively reduces the mobility of uranium and technetium-99 during field application of the technology. Table 1-2 provides specific information on the PSQ to be resolved, data needs, measurements, and data use for Problem Statement 2. Sampling activities to resolve PSQ 4 will provide post-treatment vertical profile soil characterization data in the portion of the Hanford

formation vadose zone that was exposed to ammonia injection. The sampling approach and analytical methods will be the same as the pre-treatment data collected to resolve Problem Statement 1.

The following decision rule will be used to determine if sufficient information has been collected to resolve Problem Statement 2:

Decision Rule 4 – If the average (or other value as appropriate) mobile uranium and/or technetium-99 content in the sediment reaction zone was decreased during the treatability test, then evaluate potential future waste site treatment applications in the 200-WA-1 OU FS. Otherwise, do not evaluate potential future waste site treatment applications in the 200-WA-1 OU FS.

Table 1-2. Summary of Problem Statement 2

Problem Statement 2	Vadose zone geochemical manipulation via ammonia injection is a proposed treatment technology for inclusion in the 200-WA-1 OU FS.	
Principal Study Question 4	Will vadose zone geochemical manipulation via ammonia injection result in a reduction of uranium and/or technetium-99 mobility?	
Discussion	Ammonia will be injected into sediments in the upper region of the vadose zone (Hanford formation) near the 216-U-8 Crib that have been identified to contain elevated concentrations of uranium. Following injection of ammonia, vertical profile samples will be collected from two boreholes drilled through the treated sediments. The boreholes will be located adjacent to boreholes drilled for PSQ 1.	
Data Need	**Measurement/Observation and Location/Frequency**	**Data Use**
Leachability of uranium and technetium-99 in contaminated sediments from the upper region of contamination (Hanford formation) following exposure to ammonia under field conditions	Conduct tests on vertical profile samples characterized for PSQ 1 that have been exposed to ammonia in the field using the following laboratory methods: Sequential extraction tests on sediments collected from each borehole to determine the change in labile uranium and technetium-99 due to treatment Soil column leach tests on selected untreated and treated sediments to quantify the effect of field ammonia treatment on uranium and technetium-99 leaching characteristics	Determine the degree to which field ammonia treatment reduces the amount of labile uranium and technetium-99 for inclusion of this information in the 200-WA-1 FS. Determine the change in uranium and technetium-99 leaching characteristics of the samples following exposure to ammonia in the field for inclusion of this information in the 200-WA-1 FS.
Chemical and physical characteristics of contaminated sediment in the upper region of contamination (Hanford formation) following exposure to ammonia under field conditions	Conduct grain-size, bulk conductivity, and chemistry analyses on samples collected after the treatability test.	Determine the physical characteristics of the sediments that may affect leachability and the treatability test.

Source: SGW-46487, *Data Quality Objectives Summary Report for the Uranium Sequestration Pilot Test.*

FS = feasibility study

OU = operable unit

PSQ = principal study question

The current version of the USPT contains two minor changes to the scope of the treatability test, which are being incorporated into this SAP. The changes are summarized as follows.

- Along with uranium and technetium-99, two co-contaminants detected at the 216-U-8 Crib will be evaluated for mobility and geochemical manipulation using ammonia injection. The co-contaminants are cesium-137 and strontium-90.
- Based on the results of the uranium sequestration treatability test, this treatability technology will be evaluated as a potential remedy in all applicable OUs in the Central Plateau of the Hanford Site.

1.4 Contaminants of Concern/Contaminants of Potential Concern/Target Analytes

Multistep geochemical manipulation using gas phase reagents as a potential means for long-term control of technetium-99 and uranium migration in the vadose zone is identified in DOE/RL-2007-56.
The uranium sequestration component of the remedy seeks to sequester residual mobile uranium in the vadose zone. The target analytes for the USPT are technetium-99 and uranium. The test will also evaluate the impact on co-contaminants (cesium-137 and strontium-90).

1.5 Project Schedule

Table 1-3 provides the approximate durations of major project activities that follow approval of the USPT.

Table 1-3. Project Activity Durations

Activity	Comment	Approximate Duration
Planning: Includes subcontract preparation, preparation and issuance of statement(s) of work, and request(s) for proposal to drilling subcontractor(s) through award of contract(s).		110 days
Cultural and Ecological Review: Includes 140 days for preparation of cultural and ecological forms/reports/approval, plus 2 days for DOE-RL turnaround, plus 7 days for notification of Tribes.	Concurrent with planning activity	60 calendar days[a]
Roads and Pads: If needed.	Commences once planning and cultural and ecological review activities are completed	10 days
Mobilization: Includes submittals and subcontractor training and medical processes.	Concurrent with roads and pads activity	30 days
Drilling and Sampling: Drilling activity[b] includes drilling six boreholes.	Drilling and sampling commences upon completion of mobilization.	120 days
Demobilization	Commences with end of drilling and sampling	2 days
Analysis of Samples: Includes characterization samples and completion of laboratory tests. (Note that tests will be completed in phases with some tests, like soil-column leaching, requiring a long time.)		300 days

Closeout and Borehole Summary Preparation: Includes quality assurance inspection, final surveys, closeout of subcontractor reports, and preparation and approval of borehole summary.	Commences when demobilization is complete	40 days

a. Based on a full cultural review. The actual duration maybe shorter if information from previous cultural reviews can be used.

b. Borehole decommissioning may occur upon determination that the borehole will no longer be needed and with Project Manager approval. The decision to decommission boreholes is assumed to occur 2 months after the final test results are obtained.

DOE-RL = U.S. Department of Energy, Richland Operations Office

2 Quality Assurance Project Plan

A Quality Assurance Project Plan (QAPjP) establishes the quality requirements for environmental data collection. It includes planning, implementation, and assessment of sampling tasks, field measurements, laboratory analysis and data review. This chapter describes the applicable environmental data collection requirements and controls based on the QA elements found in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5)* and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document (HASQARD)*. Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement [TPA]) Action Plan (Ecology et al., 1989b) require the QA/quality control (QC) and sampling and analysis activities to specify the QA requirements for treatment, storage, and disposal units, as well as for past practice processes. This QAPjP also describes the applicable requirements and controls based on guidance found in Washington State Department of Ecology (Ecology) Publication No. 04-03-030, *Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies,* and EPA/240/R-02/009, *Guidance for Quality Assurance Project Plans (EPA QA/G-5)*. This QAPjP is intended to supplement the contractor's environmental QA program plan.

This QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to Hanford Site OU groundwater monitoring activities: Project Management, Data Generation and Acquisition, Assessment and Oversight, and Data Review and Usability.

2.1 Project Management

This section addresses the basic aspects of project management to ensure project roles and responsibilities are understood, and describes quality specifications, training, and management of project documents.

2.1.1 Project / Task Organization

CH2M HILL Plateau Remediation Company (CHPRC), or its approved subcontractor, is responsible for planning, coordinating, sampling, preparation, packaging, and shipping samples to the laboratory. CHPRC is responsible for managing all interfaces among subcontractors involved in executing the work described in this SAP. The project organization (in regard to sampling and characterization) is described in the following sections and is shown graphically in Figure 2-1.

2.1.1.1 Regulatory Lead

EPA is responsible for regulatory oversight of cleanup projects and activities. EPA, as lead regulatory agency for the 200-WA-1 OU, has approval authority for the work being performed under this SAP. The lead regulatory agency will work with the U.S. Department of Energy, Richland Operations Office (DOE-RL), to resolve concerns over the work described in this SAP in accordance with the TPA (Ecology et al. 1989a).

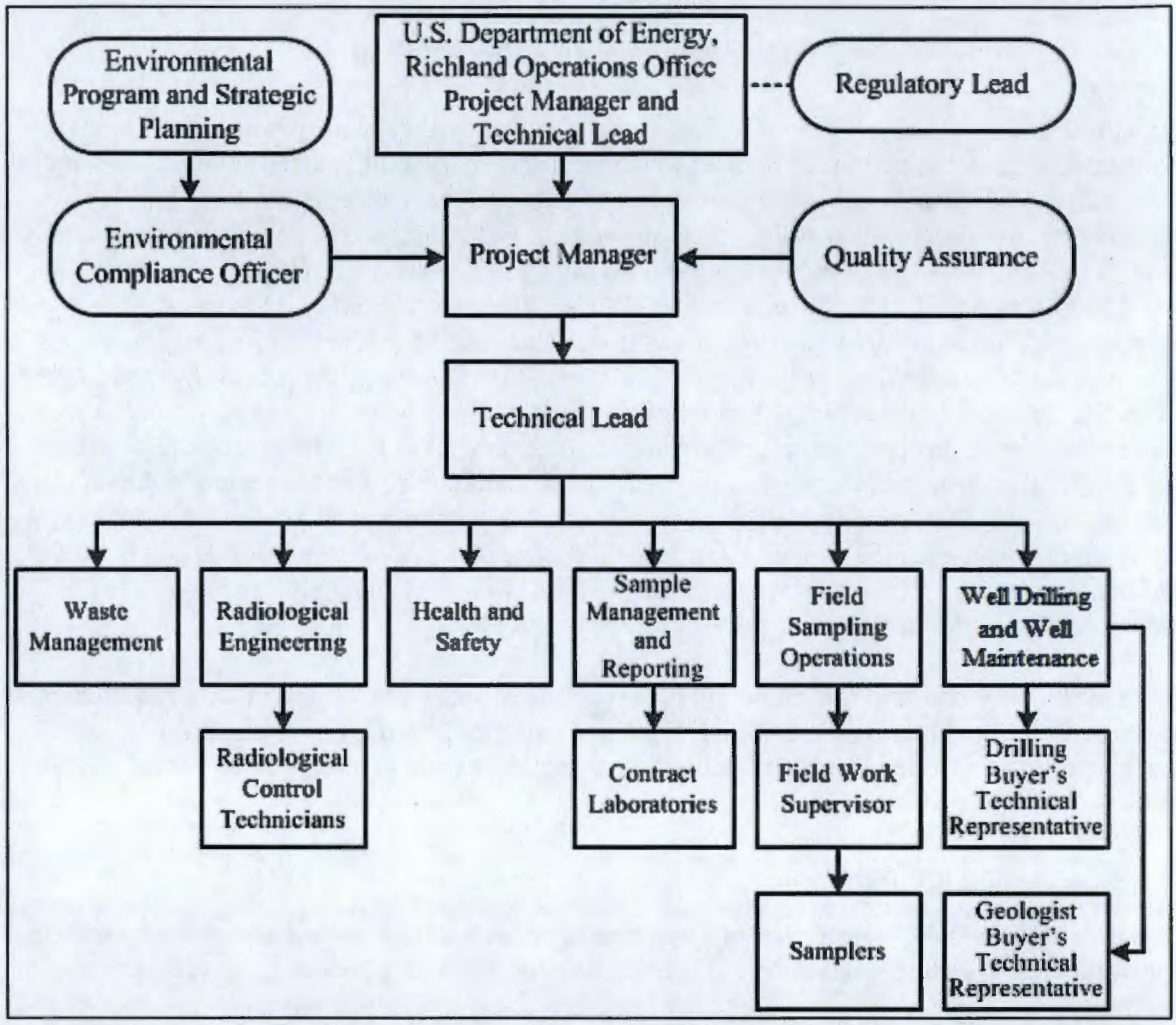


Figure 2-1. Project Organization

2.1.1.2 DOE-RL Project Manager

DOE is responsible for the Hanford Site cleanup. The DOE-RL Project Manager is responsible for monitoring the contractor's performance of activities for the Hanford Site under CERCLA, RCRA, the *Atomic Energy Act of 1954*, and the TPA (Ecology et al. 1989a). The DOE-RL Project Manager is also responsible for obtaining lead regulatory agency approval of the SAP authorizing the field sampling activities.

2.1.1.3 DOE-RL Technical Lead

The DOE-RL Technical Lead is responsible for providing day-to-day oversight of the contractor's work scope performance, for working with the contractor and the regulatory agencies to identify and resolve technical issues, and providing technical input to the DOE-RL Project Manager.

2.1.1.4 Project Manager

The Project Manager is responsible and accountable for project-related activities and coordinates with DOE-RL, regulators, and contactor management in support of sampling activities. In addition, support is provided to the Technical Lead to ensure work is performed safely and cost effectively. The Project

Manager (or designee) is responsible for managing sampling documents and requirements, field activities, and subcontracted tasks and for ensuring the project file is properly maintained. The Project Manager is responsible for ensuring that the project personnel are working to the current version of the SAP. The Project Manager ensures that the sampling design requirements are converted into field instructions providing specific direction for all field activities. The Project Manager works closely with the Environmental Compliance Officer (ECO), QA, Health and Safety, the Field Work Supervisor (FWS), and the Sample Management and Reporting organization to integrate these and other lead disciplines in planning and implementing the work scope. The Project Manager maintains a list of individuals or organizations filling each of the functional elements of the project organization.

2.1.1.5 Operable Unit Technical Lead

The Technical Lead is responsible for the development of specific sampling design, analytical requirements, and QC requirements, either independently or as defined through a systematic planning process. The Technical Lead ensures that sampling and analysis activities as delegated by Project Manager are carried out in accordance with the SAP.

2.1.1.6 Environmental Compliance Officer

The ECO, from the Environmental Program and Strategic Planning organization, provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and also develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The ECO also reviews plans, protocols, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues that affect operations and develops cost-effective solutions; and responds to environmental or regulatory issues or concerns raised by DOE-RL or regulatory agencies. The ECO also oversees project implementation for compliance with applicable internal and external environmental requirements.

2.1.1.7 Quality Assurance

The QA point-of-contact (POC) is matrixed from the Quality Assurance organization to the Project Manager and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements, reviewing project documents (including DQO summary report, QAPjP, and SAP), reviewing data validation reports from third-party data validation contractors, and participating in QA assessments on sample collection and analysis activities, as appropriate.

2.1.1.8 Health and Safety

The Health and Safety organization responsibilities include coordinating industrial safety and health support within the project in accordance with the health and safety program, job hazard analyses, and other pertinent federal regulation. In addition, the Health and Safety organization assists project personnel in complying with the applicable health and safety program. The Health and Safety organization coordinates with the Radiological Engineering organization to determine personal protective clothing requirements.

2.1.1.9 Radiological Engineering

The Radiological Engineering organization is responsible for radiological engineering and 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. In addition, radiological hazards are identified, and appropriate controls are implemented to maintain worker exposures to hazards at ALARA levels. The Radiological Engineering organization interfaces with the project Health and Safety representative and other appropriate personnel, as needed, to plan and direct Radiological Control Technician (RCT) support for activities.

2.1.1.10 Sample Management and Reporting

The Sample Management and Reporting (SMR) organization is responsible for interfacing between the project, Field Sampling Operations (FSO), the Drilling and Well Maintenance organization, and the analytical laboratories. The SMR organization generates field sampling documents, labels, and instructions for field sampling personnel; monitors the entire sample and data process; coordinates laboratory analytical work, and ensures that the laboratories conform to Hanford Site internal laboratory QA requirements (or their equivalent), as approved by DOE, EPA, and Ecology. SMR resolves sample documentation deficiencies or issues associated with FSO, laboratories, or other entities to ensure that project needs are met; receives the analytical data from the laboratories; performs the data entry into the Hanford Environmental Information System (HEIS); and arranges for and oversees data validation. The SMR organization is responsible for informing the Project Manager of any issues reported by the analytical laboratory. The SMR organization develops the Sample Authorization Form, which provides information and instruction to the analytical laboratories; oversees data validation; and works with the Project Manager to prepare a characterization report on the sampling and analysis results. The SMR organization also provides instructions to the FSO samplers on the collection of samples as specified in a sampling and analysis or monitoring plan.

2.1.1.11 Analytical Laboratories

Onsite analytical laboratories and offsite contract laboratories analyze samples in accordance with established methods, provide data packages containing analytical and QC results, and provide explanations in response to resolution of analytical issues. Pacific Northwest National Laboratory (PNNL) laboratories will be used for this work to maintain consistency with the data collected during technology development, and work will be conducted consistent with the QA requirements of the *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD) (DOE/RL-96-68).

2.1.1.12 Waste Management

The Waste Management organization communicates policies and protocols, and also ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Waste Management is also 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 confirming compliance with waste acceptance criteria.

2.1.1.13 Field Work Supervisor

The FSO FWS is responsible for planning and coordinating field sampling resources. The FWS ensures samplers are appropriately trained and available. Additional related responsibilities include ensuring the sampling design is understood and can be performed as specified, by directing training, performing mock-ups, and holding practice sessions with field personnel.

The FWS directs the samplers, who are nuclear chemical operators (NCOs). The NCO samplers collect groundwater, soil, vapor, and multimedia samples, including replicates/duplicates; collect field parameters; and prepare QC samples in accordance with the SAP, corresponding standard methods, and field and sample instructions. The samplers complete field logbook entries, chain-of-custody forms, and shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

The FWS acts as a technical interface between the Project Manager and the field crew supervisors (such as the Drilling Buyer's Technical Representative [BTR], and Geologist-BTR) and ensures technical aspects of the field work will be met. The FWS reviews the SAP for field sample collection concerns, analytical requirements, and special sampling requirements. The FWS, in consultation with the Project

Manager and the SMR organization, resolves issues arising from translation of technical requirements to field operations and coordinates resolution of sampling issues.

2.1.1.14 Well Drilling and Well Maintenance

The Well Drilling and Well Maintenance Manager has overall responsibility for planning, coordinating, and executing drilling construction and well maintenance activities. The Well Drilling and Well Maintenance Manager coordinates with the Project Manager to identify field constraints that could affect sampling design. The Well Activities Lead provides direction to the Geologist-BTR, who oversees the field geologist and the geophysical logging contractor, and to the Drilling BTR, who oversees field construction activities and is responsible for daily interface with drilling and remediation subcontractors.

2.1.2 Quality Assurance Objective and Criteria

The QA objective of this plan is to ensure the generation of analytical data of known and appropriate quality that are acceptable and useful for decision making. In support of this objective, statistics and data descriptors known as data quality indicators (DQIs) are used to determine the acceptability and utility of data to the user. The principal DQIs are precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These are defined for the purposes of this document in Table 2-1.

Data quality is defined by the degree of stringency in the acceptance criteria assigned to these parameters. Typically, the acceptance criteria are set by the analytical method itself; however, project-specific requirements as indicated by DQOs may result in more stringent acceptance criteria. The applicable QC guidelines, DQI acceptance criteria, and levels of effort for assessing data quality are dictated by the intended use of the data and the requirements of the analytical method. DQIs are evaluated during the data quality assessment (DQA) process (Section 2.4.3).

2.1.3 Special Training/Certification

A graded approach is used to ensure that workers receive a level of training commensurate with responsibilities and in compliance with applicable DOE orders and government regulations. The FWS, in coordination with line management, will ensure special training requirements for field personnel are met.

Training requirements or qualification programs have been instituted by the CHPRC management team to satisfy multiple training drivers imposed by the applicable *Code of Federal Regulations* and *Washington Administrative Code* requirements. The environmental, safety, and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. The following training for field personnel will be applied, as appropriate, for specific elements of work (details of training required for types of work and locations will be specified in the field site health and safety plan):

- 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

Table 2-1. DQIs

DQI	Definition[a]	Determination Methodologies	Corrective Actions
Precision	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples. The most commonly used estimates of precision are the relative standard deviation and, when only two samples are available, the RPD.	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. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	If duplicate data do not meet the objective: • Evaluate the apparent cause (e.g., sample heterogeneity). • Request reanalysis or re-measurement. • Qualify the data before use.
Accuracy	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.	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).	If recovery does not meet the objective: • Qualify the data before use. • Request reanalysis or re-measurement.
Representativeness	Sample representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. It is dependent on the proper design of the sampling program and will be satisfied by ensuring the approved plans were followed during sampling and analysis.	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.	If results are not representative of the system sampled: • Identify the reason for the results not being representative. • Reject the data, or if data are otherwise usable, qualify the data for limited use and define the portion of the system that the data represent. • Redefine sampling and measurement requirements and protocols. • Resample and reanalyze.

Table 2-1. DQIs

DQI	Definition[a]	Determination Methodologies	Corrective Actions
Comparability	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and QA protocols.	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.
Completeness	Completeness is a measure of the amount of valid data collected compared to the amount planned. Measurements are considered to be valid if they are unqualified or qualified as estimated data during validation. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (DQOs or performance/acceptance criteria).	If the data set does not meet the 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.
Bias	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: • Properly select and use sampling tools. • Institute correct sampling and subsampling procedures to limit preferential selection or loss of sample media. • Use random sampling designs. • Use sample handling procedures, including proper sample preservation, that limit the loss or gain of constituents to the sample media.

Table 2-1. DQIs

DQI	Definition[a]	Determination Methodologies	Corrective Actions
			Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other labs for analysis.
Sensitivity	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet the objective: • Request reanalysis or re-measurement using methods or analytical conditions that will meet required detection or limit of quantitation. • Qualify/reject the data before use.

Source: SW-846, Pending, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update V*, as amended.

DQO = data quality objective
QA = quality assurance
RPD = relative percent difference

In addition, pre-job briefings will be performed in accordance with work management and work release documents to evaluate an activity and associated hazards by considering various 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 protocols 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 employee in an electronic training record database. The contractor's training organization maintains the training records system. Line management will be used to confirm that an individual employee's training is appropriate and up-to-date prior to performing any field work.

2.1.4 Documents and Records

The Project Manager 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 document are handled consistent with HASQARD (DOE/RL-96-68) and the TPA Action Plan (Ecology et al., 1989b). Table 2-2 summarizes the changes that may be made and their documentation requirements.

The Project Manager is responsible for tracking all changes and obtaining appropriate reviews by contractor staff. The Project Manager will discuss the change with DOE-RL. DOE-RL will then discuss with the lead regulatory agency significant and fundamental changes, as described in Section 9.3 and Section 12.4 of the TPA Action Plan (Ecology et al., 1989b). Appropriate documentation will follow, in accordance with the requirements for the type of change.

The SMR organization, the FWS, and the appropriate BTR are responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the SAP. The SMR organization will ensure that any deviations from the SAP are reflected in revised paperwork, as applicable for the samplers and the analytical laboratory. The FWS or appropriate BTR 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 protocols.

The Project Manager, FWS, or designee, is responsible for communicating field corrective action requirements and ensuring immediate corrective actions are applied to field activities.

The Project Manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The project file will include the following, as appropriate:

- Operational records and logbooks
- Data forms
- Global positioning system data (a copy shall be provided to the SMR organization)
- Inspection or assessment reports and corrective action reports
- Borehole summary reports
- Geophysical logging 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

The following records are managed and maintained by SMR personnel:

- Field sampling logbooks
- Field sample reports
- Chain-of-custody forms
- Sample receipt records
- Laboratory data packages
- Analytical data verification and validation reports
- Analytical data "case file purges" (i.e., raw data purged from laboratory files) provided by the offsite analytical laboratories

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

Table 2-2. Change Control for Sampling Projects

Type of Change[a]	Type of Change (TPA Action Plan[b])	Action	Documentation
Minor Change. The change has no impact on the sample or field analytical result, and little or no impact on performance or cost. Furthermore, the change does not affect the DQOs specified in the SAP.	**Minor Field Change.** Changes that have no adverse effect on the technical adequacy of the job or the work schedule.	The field personnel recognizing the need for a field change will consult with the Project Manager prior to implementing the field change.	Minor field changes will be documented in the field logbook. The logbook entry shall include the field change, the reason for the field change, and the names and titles of those approving the field change.
Significant Change. The change has a considerable effect on performance or cost, but still allows for meeting the DQOs specified in the SAP.	**Minor Change.** Changes to approved plans that do not affect the overall intent of the plan or schedule.	The Project Manager will inform the DOE-RL Project Manager and the Regulatory Lead of the change and seek concurrence at a Unit Manager's Meeting or comparable forum. The lead regulatory agency determines there is no need to revise the document.	Documentation of this change approval would be in the Unit Manager's Meeting minutes or comparable record such as a change notice.[c]
Fundamental Change. The change has a significant effect on the sample or the field analytical result, performance, or cost, and the change does not meet the requirements specified in the DQOs in the sampling document.	**Revision Necessary.** The lead regulatory agency determines changes to approved plans require a revision to the document.	If it is anticipated that a fundamental change will require the approval of the Regulatory Lead, the applicable DOE-RL Project Manager will be notified by the Project Manager and will be involved in the decision prior to implementation of a fundamental change The lead regulatory agency determines the change requires a revision to the document.	Formal revision of the sampling document.

a. Consistent with DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD).

b. Consistent with Sections 9.3 and 12.4 of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan* (TPA Action Plan).

c. The TPA Action Plan (Ecology et al., 1989b), Section 9.3, defines the minimum elements of a change notice.

DOE-RL = U.S. Department of Energy, Richland Operations Office
DQO = data quality objective
OU = operable unit
SAP = sampling and analysis plan

Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the TPA (Ecology et al., 1989a) will be managed in accordance with the requirements of the agreement.

2.2 Data Generation and Acquisition

The following sections present the requirements for analytical methods, measurement and analysis, data collection or generation, data handling, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed. The sampling design is presented in the field sampling plan (Chapter 3) of this SAP.

2.2.1 Analytical Methods Requirements

Analytical methods performance requirements for samples collected from the boreholes are presented in Table 2-3. Deviations from the analytical methods noted in Table 2-3 must be approved in accordance with the change control requirements presented in Table 2-2. The SMR organization, in consultation with the Project Manager, shall take the lead in ensuring that deviations from the analytical methods noted in Table 2-3 are properly approved. Issues that may affect analytical results are to be resolved by the SMR organization in coordination with the Project Manager. Table 2-4 lists specialized and screening analyses that will be used for sediment samples.

Table 2-3. Analytical Performance Requirements

Analyte	Analytical Method	Practical Quantitation Limit		Precision (%)	Accuracy (%)
		Sediment (mg/kg)	Pore Water (mg/L)		
Mobile uranium concentration	WE per ASA, 1996 Kinetic phosphorescence or ICP/MS, EPA 6020 (sed.), EPA 200.8 (water)	0.005	0.005	≤20	80–120
Distribution of leachable uranium	Sequential extractions per Section 2.2.1.1 Kinetic phosphorescence or ICP/MS EPA 6020 (sed.), EPA 200.8 (water)	0.005	0.005	≤20	80–120
Total uranium	Microwave digestion and analysis for total uranium EPA Method 3052	1.0	1.0	≤30	70–130
Leaching characteristics of sequestered uranium	One-dimensional column experiments that include multiple stop/flow elements Kinetic phosphorescence or ICP/MS, EPA 6020 (sed.), EPA 200.8 (water)	N/A	0.005	≤20	80–120
Mobile technetium-99 concentration	WE per ASA, 1996 ICP/MS 6020 (sed.), EPA 200.8 (water), or wet chemical separation and LSC	15 pCi/g	15 pCi/L	≤20	80–120

Table 2-3. Analytical Performance Requirements

Analyte	Analytical Method	Practical Quantitation Limit		Precision (%)	Accuracy (%)
		Sediment (mg/kg)	Pore Water (mg/L)		
Distribution of leachable technetium-99	Sequential extractions per Section 2.2.1.1 ICP/MS, EPA 6020 (sed.), EPA 200.8 (water), or wet chemical separation and LSC	15 pCi/g	15 pCi/L	≤20	80–120
Gross sediment activity	Gamma energy analysis	10 pCi/g	10 pCi/L	≤20	N/A
	Total alpha/beta (WE)	100/5,000 dpm per 100 cm^2	100/5,000 dpm per 100 cm^2	≤50	N/A
	Total alpha/beta (Acid Extraction)	100/5,000 dpm per 100 cm^2	100/5,000 dpm per 100 cm^2	≤50	N/A
Strontium-90[a]	ASTM C1111-04 or SW-846	1.0	1.0	≤30	70–130
Cesium-137[a]	ASTM C1111-04 or SW-846	1.0	1.0	≤30	70–130
Cadmium[a]	EPA Method 6010B	1.0[c]	1.0[c]	≤30	70–130
Sodium[a]	EPA Method 6010B	1.0[c]	1.0[c]	≤30	70–130
Aluminum[a]	EPA Method 6010B	10.0[c]	10.0[c]	≤30	70–130
Silicon[a]	EPA Method 6010B	10.0[c]	10.0[c]	≤30	70–130
Magnesium[a]	EPA Method 6010B	1.0[c]	1.0[c]	≤30	70–130
Iron[a]	EPA Method 6010B	10.0[c]	10.0[c]	≤30	70–130
Potassium[a]	EPA Method 6010B	5.0[c]	5.0[c]	≤30	70–130
Barium[a]	EPA Method 6010B	5.0[c]	5.0[c]	≤30	70–130
Strontium[a]	EPA Method 6010B	3.0[c]	3.0[c]	≤30	70–130
Cesium[a]	EPA Method 6010B	0.4[c]	0.4[c]	≤30	70–130
Nitrate[b]	EPA Method 9056	20.0[c]	20.0[c]	≤30	70–130
Nitrite[b]	EPA Method 9056	10.0[c]	10.0[c]	≤30	70–130
Sulfide[b]	EPA Method 9056	5.0[c]	5.0[c]	≤30	70–130
Chloride[b]	EPA Method 9056	2.0[c]	2.0[c]	≤30	70–130
Bromide[b]	EPA Method 9056	2.0[c]	2.0[c]	≤30	70–130
Sediment pore water pH	EPA SW-846, Method 9045	N/A	0.05 pH units	≤30	70–130

Table 2-3. Analytical Performance Requirements

Analyte	Analytical Method	Practical Quantitation Limit		Precision (%)	Accuracy (%)
		Sediment (mg/kg)	Pore Water (mg/L)		
Sediment pore water electrical conductivity	ASTM D1125-14 or SW-846, EPA 9050A	N/A	10 µS/cm	≤20	80–120
Sediment moisture content	ASTM D2216-05	1 vol%	N/A	≤20	80–120
Particle size distribution	ASTM D422-63	N/A	N/A	N/A	N/A
Lithology	Sediment types and depths by ASTM D2488-06	1 vol%	N/A	≤20	80–120

Note: Complete reference citations are provided in Chapter 6.

a. Water and acid extraction per ASA, 1996.

b. WE per ASA, 1996.

c. Practical quantification limit values assume a maximum of 10 times dilution of samples for analysis.

ASA = American Standards Association (currently American National Standards Institute)
ASTM = American Society for Testing and Materials
EPA = U.S. Environmental Protection Agency
ICP = inductively coupled plasma
LSC = liquid scintillation counting
MS = mass spectrometry
N/A = not applicable
WE = water extraction

Table 2-4. Specialized and Screening Analyses for Sediment Samples

Analyte	Analytical Method
Air Permeability Screening	ASTM D6539
Sediment Electrical Conductivity	Ulrich and Slater, 2004
	ASTM G57-06
Uranium Mineralogy	Laser-induced cryogenic fluorescence (Wang et al., 2005)
Sediment Carbonate Content	Total carbon analyzer (e.g., Shimadzu TOC-5000A) with a solid sample module; inorganic carbon is measured by phosphoric acid digestion at 200°C, and total carbon (inorganic and organic) is measured at 900°C
Sediment Mineralogy	Whole sediment and clay fraction (<2µm) X-ray diffraction

Table 2-4. Specialized and Screening Analyses for Sediment Samples

Analyte	Analytical Method

Sources: ASTM D6539, *Standard Test Method for Measurement of the Permeability of Unsaturated Porous Materials by Flowing Air.*

ASTM G57-06, *Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method.*

Ulrich and Slater, 2004, "Induced polarization measurements on unsaturated, unconsolidated sands."

Wang et al., 2005, "Cryogenic Laser Induced U(VI) Fluorescence Studies of a U(VI) Substituted Natural Calcite: Implications to U(VI) Speciation in Contaminated Hanford Sediments."

ASTM = American Society for Testing and Materials

A laboratory using nonstandard methods, if any, must provide method validation data to confirm that 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. Approval of the SAP by a regulatory agency constitutes approval of the nonstandard method. The following sections describe the nonstandard methods that will be used for this project.

2.2.1.1 Sequential Extractions

As described in DOE/RL-2010-87 and by PNNL-18879, *Remediation of Uranium in the Hanford Vadose Zone Using Gas-Transported Reactants: Laboratory-Scale Experiments*, and PNNL-20004, *Remediation of Uranium in the Hanford Vadose Zone Using Ammonia Gas: FY 2010 Laboratory-Scale Experiments*, sequential extractions are a baseline measurement used to evaluate uranium mobility. The sequential extraction approach described in PNNL-18879 and PNNL-20004 will be modified to support the goals of this treatability test. These modifications are needed to address potential long-term release of uranium from sediments, eliminate the oxalate extraction because it did not provide significant value for interpreting the effectiveness of ammonia treatment, and provide a better comparison to methods used for evaluating sorbed uranium by others (e.g., PNNL-17031, *A Site-Wide Perspective on Uranium Geochemistry at the Hanford Site*). The revised sequential extraction solutions are as follows:

- Synthetic groundwater (1 hr) (PNNL-20004)
- 0.5 M magnesium nitrate solution for ion exchange (1 hr) (PNNL-20004)
- pH 5 sodium-acetate (1 hr) (PNNL-20004)
- pH 2.3 acetic acid (1 wk) (PNNL-20004)
- 8 M nitric acid at 95°C (2 hr) (PNNL-20004)

In addition, the following extraction will be completed on a separate subsample:

- Carbonate solution (0.0144 M $NaHCO_3$, 0.0028 M Na_2CO_3) for ion exchange (1,000 hr) (PNNL-17031)

Sequential extraction analysis will be performed on untreated samples collected during Phase 1, laboratory-treated samples collected during Phase 1, and samples exposed to ammonia treatment in the field during Phase 4. Replicates will be used to quantify variability in the analysis.

2.2.1.2 Leaching Tests

Sequential extractions evaluate uranium mobility based on an interpretation of how the extraction relates to uranium transfer into the pore water. Saturated soil column leaching tests provide a measure of

uranium mobility based on contact with water over time. Soil column leaching tests will be conducted on a subset of the samples analyzed by sequential extraction, ensuring that the samples have been held a suitable length of time for ammonia sequestration. These tests will provide uranium mobility information that can be analyzed both in terms of a comparison to the sequential extractions and an estimate of uranium transport parameters. For example, the data may support use of a combined surface complexation and kinetic dissolution model of uranium release into the water. While these experiments are conducted under saturated conditions, the kinetic parameters can be translated to unsaturated flow conditions. Leaching tests will be performed on untreated samples collected during Phase 1, laboratory-treated samples collected during Phase 1, and samples exposed to ammonia treatment in the field during Phase 4.

A laboratory test instruction will be prepared to guide the soil column tests. In summary and subject to update in the test instruction, sediment from the liners selected for leaching tests will be emptied and sieved to remove particles greater than 4 mm (0.16 in.). Sieved material will be packed into nominally 2.5 cm (1 in.) diameter by 15.2 cm (6 in.) long soil columns. High-performance liquid chromatography pumps will be used to inject simulated groundwater upward through the column with a residence time of about 4 to 10 hours. Effluent will be collected using a fraction collector, and selected time interval samples will be analyzed for uranium, bromide (tracer added to injected water), and pH. At selected times, flow will be stopped for 16 to 100s of hours to allow kinetically controlled processes and reactions to reach equilibrium. The difference in uranium concentrations before and after the stop flow events will be used to calculate a rate of uranium release from the sediment. The pH will be measured with a microelectrode (Accumet 13-602-292) with 3-point calibration before measurements and calibration check after measurements. The bromide tracer will be used to evaluate flow conditions in the column based on the breakthrough pattern of bromide concentrations in the column effluent. Bromide will be measured with an ion-specific electrode (Accumet 13-620-525), with 9-point calibration before each experiment and calibration check after measurements.

2.2.2 Field Analytical Methods

For sediment samples, radiological field screening data, visual observation of lithologies, or site geologist professional judgment, and borehole geophysical logs may be used to select sample locations in split-spoon liners, assist in determining sample shipping requirements, and support worker health and safety monitoring. Radiological field survey data used for site characteristics will be performed in accordance with approved methods and with HASQARD (DOE/RL-96-68), as applicable. Field analytical methods may also be performed in accordance with the instrument and equipment manufacturers' manuals. The RCT will record field measurements, noting the depth of the sample and the instrument reading. Measurements will be relayed to the site geologist for inclusion in the field logbook or operational records daily, as applicable. Chapter 3 provides the parameters identified for field analysis.

During the ammonia injection phase of the test, additional instrumentation and analyses will be conducted (Table 2-5). Field test instructions will guide details of data collection location and frequency.

Table 2-5. Field Instruments and Analyses

Analyte	Analytical Method	Range	Practical Quantitation Limit for Sediment (mg/kg)	Precision (%)	Accuracy (%)
Gas Tracers	Oxygen Sensor	0 to 21%	N/A	1	1
Ammonia Gas	Draeger Tube	0 to 10%	N/A	0.5	0.5

Table 2-5. Field Instruments and Analyses

Analyte	Analytical Method	Range	Practical Quantitation Limit for Sediment (mg/kg)	Precision (%)	Accuracy (%)
	Ammonia Sensor	0 to 1,000 ppm and 0 to 15%	N/A	0.1	0.3
Sediment Temperature	Thermistor	0 to 40°C	N/A	≤0.01°C	0.1°C
	Distributed Temperature Sensor	0 to 40°C	N/A	≤0.01°C	0.1°C
Electrical Resistivity Tomography	Johnson et al., 2010	N/A	N/A	N/A	N/A
Ground Penetrating Radar	Truex et al., 2013	N/A	N/A	N/A	N/A
Neutron Logging	Truex et al., 2013	N/A	N/A	N/A	N/A
Injected Gas Temperature	Field Instrument	-10 to 50°C	N/A	≤0.01°C	0.1°C
Injected Gas Flow Rate	Field Instrument	0 to 200 standard ft^3/min	N/A	N/A	5
Injected Gas Ammonia Concentration	Field Instrument Ammonia Sensor	0 to 1,000 ppm and 0 to 15%	N/A	0.1	0.3

Sources: Johnson et al., 2010, "Improved hydrogeophysical characterization and monitoring through parallel modeling and inversion of time-domain resistivity and induced-polarization data."

Truex et al., 2013, "Monitoring Vadose Zone Desiccation with Geophysical Methods."

N/A = not applicable

ppm = parts per million

2.2.3 Quality Control

The QC requirements specified in this SAP must be followed in the field and analytical laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Laboratory QC samples estimate the precision, bias, and matrix effects of the analytical data. Field and laboratory QC sample requirements are summarized in Table 2-6.

The impact of a failed QC measure will be determined and evaluated during data validation and DQA processes. Data will be qualified and flagged in HEIS, as appropriate.

Table 2-6. Project QC Requirements

Sample Type	Frequency	Characteristics Evaluated
	Field QC	
Field Duplicates (DUPs)	One for every 20 samples maximum of liquid or gas media sampled	Precision, including sampling and analytical variability
Equipment Blanks (EBs)	As needed. If only disposable equipment is used or equipment is dedicated to a particular well, then an EB is not required. Otherwise, 1 for every 20 samples for each media[a]	Adequacy of sampling equipment decontamination and contamination from nondedicated equipment
	Laboratory QC	
Method Blanks	b	Laboratory contamination
Laboratory Duplicates	b	Laboratory precision
Matrix Spikes	b	Matrix effect/laboratory accuracy
Matrix Spike Duplicates	b	Laboratory accuracy and precision
Surrogates	b	Recovery/yield
Tracers	b	Recovery/yield
Laboratory Control Samples	One for every batch	Evaluate laboratory accuracy

a. Vendor-provided borehole equipment is considered dedicated equipment, and EBs are not typically performed.

b. As defined in laboratory analysis methods.

DUP = field duplicate
EB = equipment blank
QA = quality assurance
QC = quality control

2.2.3.1 Field QC Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability and laboratory performance to help ensure that reliable data are obtained. Field QC samples include field duplicates (DUPs), split samples, and equipment blanks (EBs). The QC samples and the required frequency for collection are described in this section.

Field Duplicates. DUPs are independent samples collected as close as possible to the same time and same location, and are intended to be identical. DUPs are placed in separate sample containers and analyzed independently. The DUPs are collected at a frequency of 1 in 20 samples and should be collected generally from an area expected to have some contamination so valid comparisons between the samples can be made (i.e., some constituents that will likely be greater than their detection limit).

Collocated samples are two samples collected as close as possible to the same time and location, and are not homogenized. This sampling protocol is used when homogenizing samples for split or duplicate samples could impact the quality of data.

DUPs must agree within 30 percent, as measured by the relative percent difference (RPD), to be acceptable. Only those DUPs with at least one result greater than five times the appropriate detection limit are evaluated. Large RPDs can be an indication of potential laboratory performance problems, field sampling problems, or sample heterogeneity, and should be investigated. DUP results not satisfying evaluation criteria will be qualified and flagged in HEIS, as appropriate.

Equipment Blanks. EBs consist of reagent water or gas (as appropriate to the primary sample media) within the same sampling equipment, as identified on the project sampling authorization form. The EB sample bottles will be placed in the same storage containers with the samples from the associated sampling event. The EB samples will be analyzed for the same constituents as the samples from the associated sampling event.

EBs are collected from reusable sampling devices on a 1-in-20 basis and are not required for disposable sampling equipment. Results greater than two times the method detection limit are identified as containing 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 analytical data, blank results are flagged if they are greater than two times the total minimum detectable activity.

2.2.3.2 Laboratory QC Samples

The laboratory QC samples (e.g., method blanks, matrix spikes, and laboratory control samples) are defined for the three-digit EPA methods (EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*) and four-digit EPA methods (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*), and will be run at the frequency specified in the respective reference unless superseded by agreement. Laboratory QC requirements are also specified in HASQARD (DOE/RL-96-68).

The QC checks outside of control limits will be reflected in the narrative of the analytical report and during the DQA, if performed. For inorganic, metals, and radiochemical analyses, QC acceptance criteria for laboratory duplicate samples, matrix spike samples, matrix spike duplicate samples, surrogate recoveries, and laboratory control samples are given in HASQARD (DOE/RL-96-68).

2.2.4 Measurement Equipment

Each user of measuring equipment is responsible to ensure that the equipment is functioning as expected, properly handled, and properly calibrated at required frequencies in accordance with methods governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance shall be recorded in accordance with approved methods. Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved methods.

2.2.5 Instrument and Equipment Testing, Inspection, and Maintenance

Collection, measurement, and testing equipment should meet applicable standards (e.g., ASTM) or have been evaluated as acceptable and valid in accordance with the approved methods, requirements, and specifications. Software applications will be acceptance-tested prior to use in the field.

Measurement and testing equipment used in the field or in the laboratory and directly affecting 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 (e.g., documentation of routine maintenance) will be included in the individual laboratory and onsite organization's QA plan or operating protocols, as

appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with maintenance requirements specified in HASQARD (DOE/RL-96-68) and with applicable Hanford Site requirements.

2.2.6 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in Section 3.5. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan and in accordance with HASQARD (DOE/RL-96-68).

2.2.7 Inspection/Acceptance of Supplies and Consumables

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes. Responsibilities and interfaces necessary to ensure that items procured/acquired for the contractor meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

2.2.8 Nondirect Measurements

Nondirect measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. If evaluation includes use of such data, whenever possible, such data will be technically reviewed to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

2.2.9 Data Management

Environmental data will be managed to ensure the integrity and quality of the data are preserved. Data processing activities will be controlled to ensure that the introduction of errors is minimized while environmental data is being collected, transferred, stored, analyzed, and reviewed. The SMR organization, in coordination with the Project Manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management methods. Data processing practices will include some or all of the following controls to avoid errors during data handling and manipulation:

- Perform periodic checks/reviews to assure data is not lost or incorrectly transcribed when transferred from one format to another.
- Minimize the number of data transfer steps and the number of personnel handling the data.
- Institute access control and accountability measures to protect hardcopy and electronic database files.

Electronic data access, when appropriate, will be through a Hanford Site database (e.g., HEIS) or a project-specific database, whichever is applicable for the data being stored. Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the TPA Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to the SMR organization on a routine basis. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with applicable methods. This process is used to document analytical errors and to establish their resolution with the Project Manager. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

Further details on documentation of field activities are provided in Section 3.4 and shall be prepared, reviewed, approved, and maintained according to prescribed processes.

2.3 Assessment and Oversight

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

2.3.1 Assessments and Response Actions

Random surveillances and assessments verify compliance with the requirements outlined in this SAP, project field instructions, the project quality management plan, methods, and regulatory requirements. Assessments include but are not limited to surveillances, management systems reviews, readiness reviews, technical systems audits, performance evaluations, audits of data quality, and DQAs. Assessment processes, roles, and responsibilities will be in accordance with existing QA program methods and as directed jointly by the Project Manager and the QA POC. 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 resolutions in accordance with the QA program, the corrective action management program, and associated methods implementing these programs. When appropriate, corrective actions will be taken by the Project Manager (or designee).

The Project Manager will determine whether a DQA will be performed for the activities identified in this SAP. The DQA process, if performed, is discussed in Section 2.4.3. The results of the DQA will be provided to the Project Manager. No other planned assessments have been identified. If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments will be performed.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor oversees offsite analytical laboratories and verifies that the laboratories are qualified for performing Hanford Site analytical work.

2.3.2 Reports to Management

Management will be made aware of deficiencies identified by self-assessments, corrective actions from ECOs, and findings from QA assessments and surveillances. Issues reported by laboratories are communicated to the SMR organization, which then initiates a sample issue resolution form. This process is used to document analytical or sample issues and to establish resolution with the Project Manager.

2.4 Data Review and Usability

This section addresses the QA activities that occur after the data collection phase of the project is completed. Implementation of these activities determines whether or not the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review shall include linking sample numbers to specific sampling locations, reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times have been met, and reviewing QC data to determine whether analyses have met the data quality requirements specified in this SAP.

The criteria for verification include but are not limited to review for contractual compliance (samples were analyzed as requested), use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors.

Errors identified by the laboratories are reported to the SMR organization's project coordinator, who initiates a sample issue resolution form. This process is used to document analytical errors and to establish resolution with the Project Manager.

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

2.4.2 Data Validation

Data validation activities will be based on EPA functional guidelines. Data validation qualifiers must be compatible with the HEIS database.

Data validation is an independent assessment to ensure that the reliability of data is known. Analytical data validation provides a level of assurance that an analyte is present or absent. Validation might also include (1) verification of instrument calibrations; and (2) evaluation of analytical results based upon method blanks, recovery of various internal standards, correctness of uncertainty calculations, correctness of identification and quantification of analytes, and the effect of quality deficiencies on the reliability of the data. Data validation will be in accordance with internal methods. The criteria for data validation are based on a graded approach, using five levels of validation: Levels A through E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data, calculations of representative samples from the data set).

Level C data validation will be performed for a minimum of 5 percent of the laboratory-generated chemical and radiochemical data by matrix and analyte group. When outliers or questionable results are identified, additional data validation will be performed, which could involve up to 5 percent of the data. The additional validation will begin with Level C and may increase to Levels D and E, as needed to ensure that the data are usable (note that 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 data set.)

2.4.3 Reconciliation with User Requirements

In order to determine whether data collected conform to specified criteria and satisfy the objectives of the field investigation, data review and verification activities are performed. The data review and verification activities include a review for completeness (all samples were analyzed as requested, chain-of-custody documentation is complete, and scientific studies were conducted as requested); use of the correct analytical method/procedure; review for 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.

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 DQA is to determine whether quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met. The following information provides the steps that are considered in the DQA.

Step 1. Review Data Quality Objectives and Sampling Design
This step requires a comprehensive review of the sampling and analytical requirements outlined in the project-specific DQO summary report and this SAP.

- List any deviations from the planned sampling design
- Determine the potential effect of any deviations

Step 2. Conduct a Preliminary Data Review
Identify, locate, and compile all information related to the sampling and analysis data being assessed including sample summary sheets, logbooks, chain-of-custody forms, field measurement data, laboratory analysis, field and laboratory QC samples and analysis results, flagged data, laboratory standards results, data validation reports, and various discrepancy or data reviewer reports. Perform basic statistical calculations (e.g., percentage of flagged data, percent of various QC parameters not meeting acceptance criteria, and percent of nondetects).

Step 3. Conduct a Data Usability Assessment
Summarize the usability of the data set as a whole and the quality of individual results as appropriate. Describe the usability in terms of the following DQIs:

Precision – Primarily from field duplicate data but also from laboratory QC.

Accuracy/Bias – Discuss evidence of field contamination and laboratory QC.

Representativeness – Discuss the extent to which the sampling design was accomplished and the representativeness of the samples and the design as a whole. Identify any specific measurements that are not representative of the target condition, explain why they are nonrepresentative, and discuss the impact to the data set.

Comparability – If multiple laboratories were used, or if this data set is intended to be combined with others, discuss the nature of differences that may limit the comparability.

Completeness – Discuss the accomplishment of all SAP-required data-generating activities. This must include a comparison of samples actually collected versus those identified in the original sampling design. Comment on the impact to dataset usability of any planned samples that were not taken. Although the third-party data validation report typically includes a completeness metric that relates to the percent of data that is not rejected, the third-party data validation report generally relates only to the fraction of the dataset that was actually validated. Thus, it cannot be the only completeness evaluation of the dataset in total.

Sensitivity – Discuss any laboratory data that do not meet the SAP-required reporting limits and also compare the results to any applicable decision thresholds such as maximum contaminant levels, action levels, or other relevant levels.

In addition, for radiochemical determinations, discuss the magnitude of the total propagated uncertainty to the reported activity value and to applicable decision thresholds. Discuss uses of data where total propagated uncertainty calculations are warranted.

Describe the impacts of any deviations of the quality indicators as noted by data flags in terms of limitation of the use of the data set, or individual analytical results, for the specific question to be answered.

Step 4. Formulate Overall Conclusion as to Usability of Data Set

Based upon the usability assessments in Step 3, develop an overall conclusion as to the usability of the entire data set for its intended purpose.

3 Field Sampling Plan

The objective of the field sampling plan is to identify project sampling and analysis activities. The field sampling plan uses the sampling design identified during the systematic planning process, and includes defining the number of sample locations, sampling methods, field documentation, field equipment calibration requirements, and specific information on the various data collection technologies.

3.1 Sampling Design

The USPT will be conducted at the south end of the 216-U-8 Crib. The vadose zone near this site has been previously characterized, and data indicate the presence of significant levels of mobile uranium contamination. As shown earlier in Figure 1-2, two zones of uranium contamination have been previously identified: one relatively shallow in the Hanford formation and another much deeper in the CCU silt layer. This treatability test will focus on the shallow region of contamination in the Hanford formation.

The treatability test is designed to evaluate uranium sequestration via vadose zone ammonia gas injection as a potential remedy for groundwater protection. The test will consist of a single ammonia injection well screened within an interval of the vadose zone where sufficient mobile uranium contamination exists to test the technology. The target soils will be characterized prior to the test to ensure that uranium contamination is present, and the conditions are suitable for the test. Ammonia gas will then be injected into the vadose zone through the well to interact with the sediment moisture to increase its pH and render it sufficiently corrosive to dissolve a fraction of the aluminosilicate minerals that are present. Ammonia gas concentrations and soil parameters (e.g., temperature and electrical conductivity) will be monitored during the test to evaluate the distribution of ammonia in the subsurface. After ammonia injection is stopped, sediment pore water pH will return to near normal, resulting in precipitation of the aluminosilicate minerals and their entrainment of a significant portion of the mobile uranium. Post-treatment borehole geophysical logging and soil samples will be collected and analyzed to evaluate the effectiveness of the treatment.

The sampling strategy uses a phased approach to define the specific test site, evaluate the test site characteristics, and determine the effectiveness of the treatment. The phases of the field test, which are aspects of the treatability test, are described as follows:

- **Phase 1 – Site Characterization.** Three boreholes will be installed at the study site and sampled to characterize the vadose zone soils. The characterization data will be used to (1) validate the test site selection, (2) obtain baseline information for site characterization, (3) determine the effectiveness of ammonia on uranium present at the site, and (4) select a target treatment zone. The boreholes will be drilled in a manner to retain the representativeness of vadose zone soil samples.
  - Borehole 1 will be drilled to a depth of approximately 24.3 m (80 ft) bgs. Soil samples will be collected continuously, initiating at approximately 9.1 m (30 ft) bgs. Sampling will be performed using a 10.2 cm (4 in.) diameter, 0.76 m (2.5 ft) long split-spoon sampler equipped with four separate nonconductive plastic liners that are each 15.2 cm (6 in.) long which will be sealed and shipped to the laboratory for analysis. Once final depth is achieved, and all samples have been obtained, Borehole 1 will be geophysically logged using downhole neutron, spectral gamma, total gamma, and temperature technology.
  - Based on the data from Borehole 1 showing that the study site is suitable for the treatability test, two additional boreholes will be installed. Boreholes 2 and 3 will be drilled to a depth based on the characterization information determined from Borehole 1. Soil samples will be collected continuously, initiating at approximately 9.1 m (30 ft) bgs. Sampling will be performed using a

10.2 cm (4 in.) diameter, 0.76 m (2.5 ft) long split-spoon sampler equipped with four separate nonconductive plastic liners that are each 15.2 cm (6 in.) long which will be sealed and shipped to the laboratory for analysis. Once final depth is achieved, and all samples have been obtained, the boreholes will be geophysically logged using downhole neutron and spectral gamma technology.

- **Phase 2 – Field Site Test System.** Based on the data from Phase 1 confirming that the study site is suitable for the treatability test, Boreholes 4, 5, and 6 will be installed at the site. The boreholes will be drilled to depths based on the characterization information determined from Phase 1. Once final depth is achieved, the boreholes will be geophysically logged using downhole neutron and spectral gamma technology. Borehole 1 will be completed as the injection well, and Boreholes 2, 3, 4, 5, and 6 will be completed as monitoring locations. Post-completion, the well will be logged using downhole neutron, spectral gamma, total gamma, and temperature technology. These same logging processes will also be conducted after in situ instruments indicate that the borehole has reached a suitable equilibration with subsurface conditions. Monitoring will focus on obtaining and field-analyzing gas samples, monitoring temperature at multiple depth intervals, monitoring borehole and surface electrodes for electrical resistivity tomography (ERT) surveys, performing ground penetrating radar surveys, and collecting neutron moisture logging data.

- **Phase 3 – Conduct Field Test.** Pending successful site characterization and installation of the injection well and monitoring system, the field test will be conducted. Permeability and tracer gas testing will provide baseline information about injected gas flow in the treatment zone. Ammonia distribution during injection operations will be evaluated based on ammonia gas concentrations at the gas sampling locations, ERT, and in situ temperature data at discrete locations. Post-treatment sediment samples will be analyzed in the laboratory to evaluate treatment effectiveness.

- **Phase 4 – Post-Treatment Characterization.** In the final phase of the treatability test, post-treatment sediment samples will be collected from the treatment area and used to evaluate treatment effectiveness. Post-treatment sediment samples, obtained from two boreholes drilled after the treatment test, will be paired with pre-treatment sample locations. The two post-treatment boreholes will be drilled to a depth selected based the test system boreholes (Phase 1) and data from the field test (Phase 3). Soil samples will be collected continuously, initiating at approximately 9.1 m (30 ft) bgs. Sampling will be performed using a 10.2 cm (4 in.) diameter, 0.76 m (2.5 ft) long split-spoon sampler equipped with four separate nonconductive plastic liners that are each 15.2 cm (6 in.) long which will be sealed and shipped to the laboratory for analysis. Once final depth is achieved, and all samples have been obtained, the post-treatment boreholes will be geophysically logged using downhole neutron and spectral gamma technology.

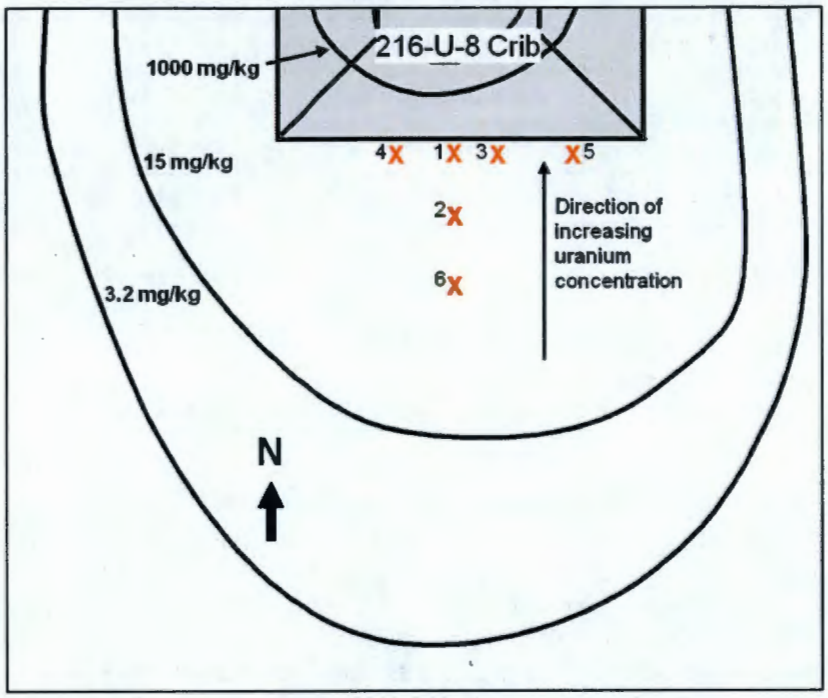
3.2 Borehole Drilling

The borehole drilling method will be approved by the OU project Technical Lead in consultation with the well maintenance and drilling manager. To avoid potential impact to the representativeness of vadose zone soil samples, all efforts must be made to drill without the use of drilling fluids or slurry makeup water. In the event that drilling slurry makeup water is needed, the situation must be discussed with project technical staff before proceeding.

Boreholes will be drilled to approximately 24.3 m (80 ft) bgs (depth does not include additional drilling pad thickness, if any). The final total depth of the boreholes will be determined by the Technical Lead and confirmed by the drilling BTR and site geologist and may change depending on subsurface conditions encountered. In the event that subsurface conditions prevent completion of the borehole to its intended depth, the Project Manager will be consulted to determine the path forward.

All boreholes will be geophysically logged using downhole neutron, temperature, spectral gamma, and total gamma technology, as described in Section 3.1. Sediment samples will be collected in Boreholes 1, 2, and 3 and in the post-treatment boreholes (see Section 3.3). Sediment samples will not be collected in Boreholes 4, 5, and 6.

Proposed borehole locations are shown on Figure 3-1, with the estimated NAD83, *North American Datum of 1983*, coordinates provided in Table 3-1.



Note: Uranium concentration data is from D&D-27783, *200-UW-1 Field Summary Report for Fiscal Years 2004 and 2005*. Contours are the estimated uranium sediment concentrations from previous characterization in the upper 25 m (82 ft) of the vadose zone (not to scale).

Figure 3-1. Location of Boreholes

3.3 Sampling Methods

To ensure sample and data usability, the sampling associated with this SAP will be performed in accordance with HASQARD (DOE/RL-96-68), pertaining to sample collection, collection equipment, and sample handling.

Soil samples will be collected throughout the length of the borehole, initiating at approximately 9.1 m (30 ft) bgs to the bottom of the borehole, which is estimated to be at approximately 24.3 m (80 ft) bgs. Sampling will be performed using a 10.2 cm (4 in.) diameter, 0.76 m (2.5 ft) long split-spoon sampler. The split-spoon samplers will be equipped with four separate nonconductive plastic liners that are each 15.2 cm (6 in.) long. If sufficient sample recovery is not achieved, soil from the split-spoon drive shoe may be used to supplement the sample mass of the split-spoon liners. Site personnel will not overdrive the sampling device.

Table 3-1. Estimated Location Coordinates for Proposed Boreholes (NAD83 Washington State Plane South)

Location	Borehole/Well Identification	Northing (m)	Easting (m)
1	C9516/299-W22-118	134669.01	567615.96
2	C9519/299-W22-121	134666.01	567615.96
3	C9517/299-W22-119	134669.01	567617.96
4	C9515/299-W22-117	134669.01	567612.96
5	C9518/299-W22-120	134669.01	567620.96
6	C9520/299-W22-122	134663.01	567615.96
Post-treatment 1	C9522*	TBD	TBD
Post-treatment 2	C9523*	TBD	TBD

Source: NAD83, North America Datum of 1983.
* Borehole only; boring will not be completed as a well.
TBD = to be determined (based on results of the ammonia injection phase of the test)

Upon retrieval of the split-spoon sampler, each split-spoon liner will be labeled at the top and bottom with the appropriate depths (e.g., 9.1 m [30 ft] and 9.2 m [30.5 ft]) and labeled according to borehole number (i.e., C9516). Each split-spoon liner will also be labeled regarding its position in the split-spoon (i.e., A, B, C, or D, with the bottom/deepest liner being "A" to the uppermost liner being "D"). A continuous line will be drawn the length of the split-spoon liner, with an arrow pointing to the shallowest end of the liner (i.e., with an "up" arrow indicating core orientation). Figure 3-2 shows the split-spoon liner samples and labeling. Once the split-spoon liners have been appropriately labeled, photos will be taken of the ends of each split-spoon liner to show the sediment.

Table 3-2 shows the borehole information and sample design for Borehole 1. Table 3-3 shows the borehole information and sample design for Boreholes 2 and 3. Table 3-4 shows the borehole information and sample design for the post-treatment boreholes.

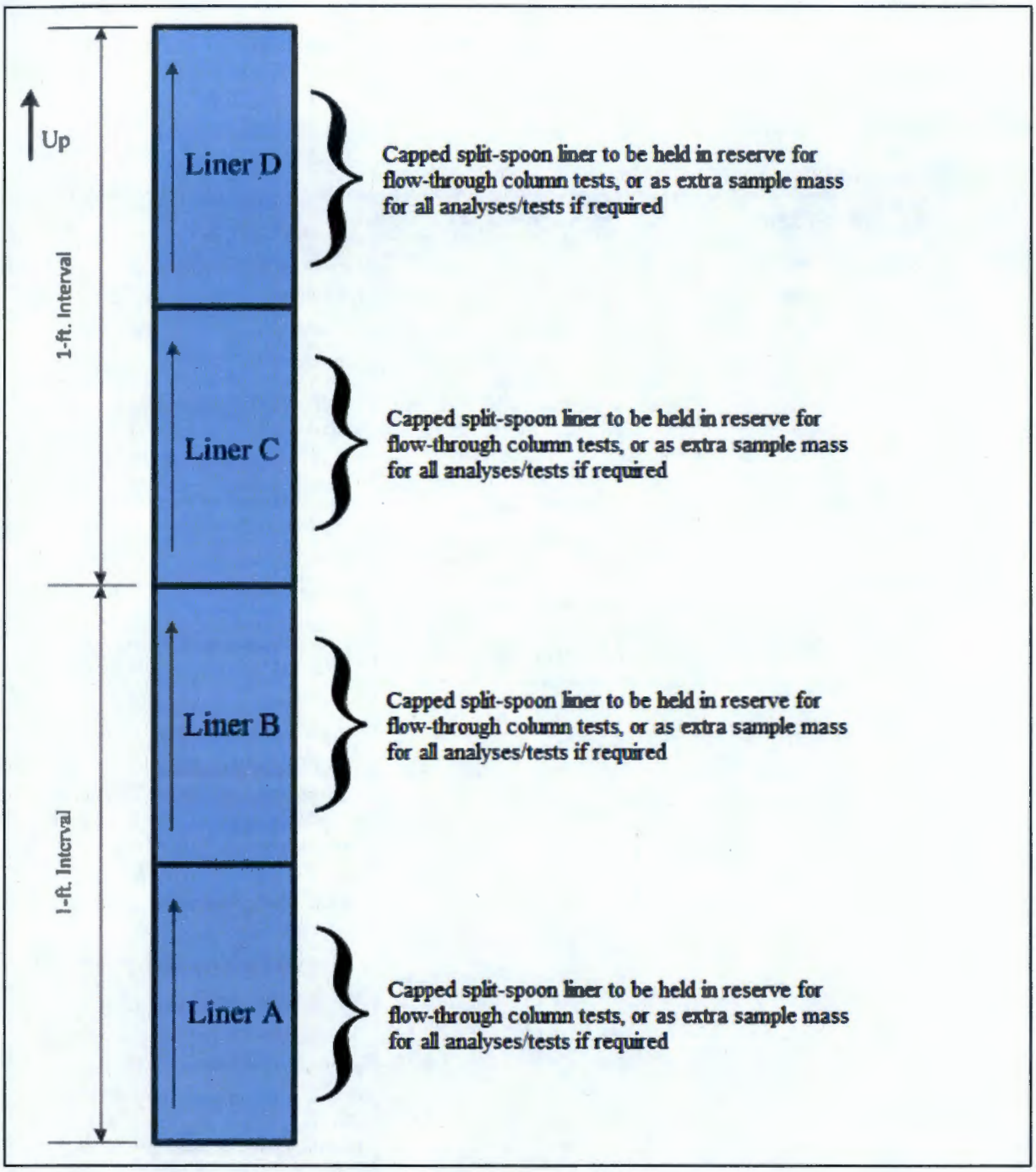


Figure 3-2. Split-Spoon Liner Samples

Table 3-2. Location, Depth, and Sample Design for Borehole 1

Sample Location		C9516	
Estimated Sample Depth		9.1 to 24.3 m (30 to 80 ft) bgs	
Projected Total Depth		Approximately 24.3 m (80 ft) bgs	
Media	**Sample Type[a]**	**Sample Location**	**Analytes**
Soil	All split-spoon liners	Continuous	Lithology description Core photographs Air permeability screening Gamma scan
	Obtain sample material from intact split-spoon liners in positions A, B, or C. Hold split-spoon liner D in reserve for additional sampling if needed.	Select five intervals for characterization. Select sample intervals (split-spoon liners A, B, or C) based on a combination of downhole neutron and spectral gamma geophysical measurements. Hold split-spoon liner D in reserve. For each interval, use one liner for sequential extraction, and use adjacent liners for other physical/ chemical analyses.	Uranium using sequential chemical extraction (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium
			Gamma energy analysis Total uranium (microwave digestion) Uranium mineralogy by fluorescence[b] Sediment mineralogy[b]
			Deionized WE (<4 mm grain-size fractions) pH Electrical conductivity Cations (calcium, sodium, aluminum, silicon, magnesium, iron, potassium, barium, uranium, technetium, strontium, and cesium) Anions (NO_3, NO_2, SO_4, chlorine, and bromine) Carbonate (by total inorganic carbon) Total alpha/beta
			Acid (8 M HNO_3) extraction (<4 mm grain-size fractions) Cations (calcium, sodium, aluminum, silicon, magnesium, iron, potassium, barium, uranium, technetium, strontium, and cesium) Total alpha/beta
			Moisture content Grain size (laboratory analysis) Soil resistivity

Table 3-2. Location, Depth, and Sample Design for Borehole 1

	Select an intact split-spoon liner from the five separate previously characterized intervals.	In the laboratory, expose sample material from the five split-spoon liners selected for sequential extraction to ammonia treatment. After ammonia treatment, conduct analyses.	Uranium using sequential extraction (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium
			Uranium leaching in the soil column with both untreated and treated sediments for these samples (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium in effluent analysis
			pH analysis Electrical conductivity

Note: Depths are approximate; field conditions need to be considered for actual collection depth.

a. Does not include samples for QA/QC.

b. Second-tier analysis may be conducted after review of other analyses at the discretion of the treatability test Project Manager.

bgs = below ground surface
QA = quality assurance
QC = quality control
WE = water extraction

Table 3-3. Location, Depth, and Sample Design for Boreholes 2 and 3

Sample Location		C9517, C9519	
Estimated Sample Depth		9.1 to 24.3 m (30 to 80 ft) bgs (determined by Technical Lead)	
Projected Total Depth		Approximately 24.3 m (80 ft) bgs (determined by Technical Lead)	
Media	**Sample Type[a]**	**Sample Location**	**Analytes**
Soil	All split-spoon liners	Continuous	Lithology description Core photographs Air permeability screening Gamma scan
	Obtain sample material from intact split-spoon liners in positions A, B, or C. Hold split-spoon liner D in reserve for additional sampling if needed.	Select three to five intervals for characterization. Select sample intervals (split-spoon liners A, B, or C) based on a combination of downhole neutron and spectral gamma geophysical measurements. Hold split-spoon liner D in reserve. For each interval, use one liner for sequential extraction, and use adjacent liners for other physical/chemical analyses.	Uranium using sequential chemical extraction (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium
			Gamma energy analysis Total uranium (microwave digestion) Uranium mineralogy by fluorescence[b] Sediment mineralogy[b]
			Deionized WE (<4 mm grain-size fractions) pH

Table 3-3. Location, Depth, and Sample Design for Boreholes 2 and 3

Sample Location		C9517, C9519	
Estimated Sample Depth		9.1 to 24.3 m (30 to 80 ft) bgs (determined by Technical Lead)	
Projected Total Depth		Approximately 24.3 m (80 ft) bgs (determined by Technical Lead)	
Media	**Sample Type[a]**	**Sample Location**	**Analytes**
			Electrical conductivity Cations (calcium, sodium, aluminum, silicon, magnesium, iron, potassium, barium, uranium, technetium, strontium, and cesium) Anions (NO_3, NO_2, SO_4, chlorine, and bromine) Carbonate (by total inorganic carbon) Total alpha/beta
			Acid (8 M HNO_3) extraction (<4 mm grain-size fractions) Cations (calcium, sodium, aluminum, silicon, magnesium, iron, potassium, barium, uranium, technetium, strontium, and cesium) Total alpha/beta
			Moisture content Grain size (laboratory analysis) Soil resistivity
	Select an intact split-spoon liner from the five separate previously characterized intervals.	In the laboratory, expose sample material from the three to five split-spoon liners selected for sequential extraction to ammonia treatment. After ammonia treatment, conduct analyses.	Uranium using sequential extraction (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium
			Uranium leaching in the soil column with both untreated and treated sediments for these samples (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium in effluent analysis
			pH analysis Electrical conductivity

Note: Depths are approximate; field conditions need to be considered for actual collection depth.

a. Does not include samples for QA/QC.

b. Second-tier analysis may be conducted after review of other analyses at the discretion of the treatability test Project Manager.

bgs = below ground surface
QA = quality assurance
QC = quality control
WE = water extraction

Table 3-4. Location, Depth, and Sample Design for Post-treatment Boreholes

Sample Location		To be determined (correlate with phase 1 boreholes)	
Estimated Sample Depth		9.1 to 24.3 m (30 to 80 ft) bgs (determined by Technical Lead)	
Projected Total Depth		Approximately 24.3 m (80 ft) bgs (determined by Technical Lead)	
Media	**Sample Type[a]**	**Sample Location**	**Analytes**
Soil	All split-spoon liners	Continuous	Lithology description Core photographs Air permeability screening Gamma scan
	Obtain sample material from intact split-spoon liners in positions A, B, or C. Hold split-spoon liner D in reserve for additional sampling if needed.	Select three to five intervals for characterization. Select sample intervals (split-spoon liners A, B, or C) based on a combination of downhole neutron and spectral gamma geophysical measurements. Hold split-spoon liner D in reserve. For each interval, use one liner for sequential extraction, and use adjacent liners for other physical/chemical analyses.	Uranium using sequential chemical extraction (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium
			Gamma energy analysis Total uranium (microwave digestion) Uranium mineralogy by fluorescence[b] Sediment mineralogy[b]
			Deionized WE (<4 mm grain-size fractions) pH Electrical conductivity Cations (calcium, sodium, aluminum, silicon, magnesium, iron, potassium, barium, uranium, technetium, strontium, and cesium) Anions (NO_3, NO_2, SO_4, chlorine, and bromine) Carbonate (by total inorganic carbon) Total alpha/beta
			Acid (8 M HNO_3) extraction (<4 mm grain-size fractions) Cations (calcium, sodium, aluminum, silicon, magnesium, iron, potassium, barium, uranium, technetium, strontium, and cesium) Total alpha/beta
			Moisture content Grain size (laboratory analysis) Soil resistivity

Table 3-4. Location, Depth, and Sample Design for Post-treatment Boreholes

Sample Location		To be determined (correlate with phase 1 boreholes)	
Estimated Sample Depth		9.1 to 24.3 m (30 to 80 ft) bgs (determined by Technical Lead)	
Projected Total Depth		Approximately 24.3 m (80 ft) bgs (determined by Technical Lead)	
Media	**Sample Type[a]**	**Sample Location**	**Analytes**
	Select an intact split-spoon liner from the five separate previously characterized intervals.	In the laboratory, expose sample material from the three to five split-spoon liners selected for sequential extraction to ammonia treatment. After ammonia treatment, conduct analyses.	Uranium using sequential extraction (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium
			Uranium leaching in the soil column with both untreated and treated sediments for these samples (<4 mm grain-size fractions) including uranium, technetium, cesium, and strontium in effluent analysis
			pH analysis Electrical conductivity

Note: Depths are approximate; field conditions need to be considered for actual collection depth.

a. Does not include samples for QA/QC.

b. Second-tier analysis may be conducted after review of other analyses at the discretion of the treatability test Project Manager.

bgs = below ground surface
QA = quality assurance
QC = quality control
WE = water extraction

3.3.1 Decontamination of Sampling Equipment

Sampling equipment shall be decontaminated in accordance with the sampling equipment decontamination methods. To prevent potential contamination of the samples, care should be taken to use decontaminated 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 bottles by setting the equipment/sample bottle 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

3.3.2 Radiological Field Data

Radiological screening will be performed by the RCT or other qualified personnel in accordance with approved methods and with HASQARD (DOE/RL-96-68), as applicable. The RCT will record field

measurements, noting the depth of the sample and the instrument reading. Measurements will be relayed to the site geologist for inclusion in the field logbook or operational records daily, as applicable.

The following information will be distributed to personnel performing work in support of this SAP:

- Instructions to RCTs on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the portable radiological field instrumentation, including 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 to obtain measurements of removable surface contamination measurements and direct measurements of total surface contamination.
- 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 radiological information.
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related information.
- The requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

3.4 Documentation of Field Activities

Logbooks or data forms are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and only authorized persons may make entries in logbooks. Logbooks entries will be reviewed by the FWS, cognizant scientist/engineer, or other responsible manager; the review will be documented with signature and date. 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 be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

Data forms may be used to collect field information; however, the information recorded on data forms must follow the same requirements as those for logbooks. The data forms must be referenced in the logbooks.

A summary of information to be recorded in logbooks is as follows:

- Purpose of activity
- Day, date, time, and weather conditions
- Names, titles, and organizations of personnel present
- Deviations from the QAPjP

- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (e.g., preparation, splits, duplicates, matrix spikes, and blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations testing, inspections, maintenance, and surveys, and equipment identification numbers, as applicable
- Equipment decontaminated, number of decontaminations, and variations to decontamination methods
- Equipment failures or breakdowns, and descriptions of any corrective actions
- Telephone calls relating to field activities

3.4.1 Corrective Actions and Deviations for Sampling Activities

The Project Manager, FWS, appropriate BTR (or designee), and SMR personnel must document deviations from protocols, problems pertaining to sample collection, chain-of-custody forms, target analytes, contaminants of potential concern, 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 methods. The Project Manager, FWS, appropriate BTR (or designee), or SMR personnel will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities.

The field team lead or designee (e.g., site geologist) will use the following criteria during borehole drilling to evaluate whether the planned sample depths and intervals are still accurate and to make adjustments as needed to the depths and quantities of samples to be obtained:

- Radiological field screening data
- Visual observation of lithology and moisture conditions, specifically noting the amount of gravel
- Visual observation of contamination
- Changes in drilling rate
- Site geologist professional judgment
- Changes in project requirement

3.5 Calibration of Field Equipment

Construction management, the appropriate BTR, or the FWS is responsible for ensuring that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with the manufacturer's operating instructions, internal work requirements and processes, and/or field

instructions that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in accordance with HASQARD (DOE/RL-96-68).

Field instrumentation, calibration, and QA checks will be performed as follows:

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

Calibration of radiological field instruments on the Hanford Site is performed by the Mission Support Alliance prime contractor, as specified by their calibration program. 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. Standards used for calibration will be traceable to a nationally or internationally recognized standard agency source or measurement system, if available.

3.6 Sample Handling

Collected split-spoon samples will be delivered from the field to the laboratory within 24 hours of collection. If necessary, samples stored prior to delivery will be stored in a controlled environment, as required. Sample handling and transfer shall be in accordance with established methods to preclude loss of identity, damage, deterioration, and loss of sample. Custody seals or custody tape shall be used to verify that sample integrity has been maintained during sample transport. The custody seal will be inscribed with the sampler's initials and date.

The Radiological Engineering organization will measure the contamination levels and the dose rates associated with the filled 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 radioactivity acceptance criteria. Suggested sample container, preservation, and holding time requirements for the sediment samples are provided in Table 3-5. There may be additional requirements associated with the analytical methods specified in Tables 2-3 and 2-4.

Table 3-5. Sample Preservation, Container, and Holding Time Guidelines for Sediment Samples

Bottle Size/Type	Minimum Sample Size	Preservation	Holding Time
Split-spoon liner	10.2 cm (4 in.) diameter by 15.2 cm (6 in.) long liner	N/A	6 months

N/A = not applicable

3.6.1 Container Labeling

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

- Sample authorization form number

- Sampler's name
- Sample collection date and time
- HEIS number
- Chain of custody number
- Liner letter (A, B, C, or D) and up arrow
- Laboratory performing the analyses
- Sample location and depth
- Preservation method (if applicable)

Sample records must include the following information:

- Analysis required
- Source of sample
- Matrix (e.g., water or soil)
- Field data (e.g., radiological readings)

3.6.2 Sample Custody

Sample custody will be maintained in accordance with existing protocols to ensure the maintenance of sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure 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 the SMR organization within 48 hours of shipping.

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

- Project name
- Printed name of sampler
- Unique sample number including liner letter
- Date and time of collection
- Signatures of individuals involved in sample transfer
- Matrix
- Preservative
- Requested analyses (or reference thereto)

- Date and time of transfer

3.6.3 Sample Transportation

All packaging and transportation instructions shall be in compliance with applicable transportation regulations and DOE requirements. Regulations for classifying, describing, packaging, marking, labeling, and transporting hazardous materials, hazardous substances, and hazardous wastes are enforced by the U.S. Department of Transportation (DOT) as described in 49 CFR 171, "Transportation," "General Information, Regulations, and Definitions," through 177, "Carriage by Public Highway." Carrier-specific requirements defined in the International Air Transportation Association Dangerous Goods Regulations should also be considered when preparing sample shipments conveyed by air freight providers.

Samples containing hazardous constituents shall be considered hazardous material in transportation and transported according to DOT 49 CFR, "Transportation," requirements. If the sample material is known or can be identified, then it shall be packaged, marked, labeled, and shipped according to the specific instructions for that material.

Materials are classified by DOT as radioactive when the isotope-specific activity concentration and the exempt consignment limits described in 49 CFR 173, "Transportation," "Shippers—General Requirements for Shipments and Packagings," are exceeded. Samples shall be screened, or relevant historical data shall be used, to determine if these values are exceeded. When screening or historical data indicate that samples are radioactive, they shall be properly classified, described, packaged, marked, labeled, and transported according to DOT requirements.

Prior to shipping radioactive samples to the laboratory, the organization responsible for shipping shall notify the laboratory of the approximate number and radiological levels of the samples. This notification is conducted through the SMR project coordinator. The laboratory is responsible for ensuring that the applicable license limits are not exceeded. The laboratory shall provide the SMR organization with written acceptance for samples with elevated radioactive contamination or dose.

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4 Management of Waste

Waste generated from sampling activities will be managed in accordance with an approved waste control plan. The waste control plan establishes the requirements for management and disposal of generated waste. Investigation-derived waste from these sampling activities will be handled as CERCLA waste. Unused samples will be archived for potential later analysis. Laboratory waste will be dispositioned in accordance with the laboratory contract and agreements concerning return to the Hanford Site. In accordance with 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," approval from the Project Manager is required before unused samples or wastes are returned from offsite laboratories.

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5 Health and Safety

The hazardous waste operations safety and health program is implemented for employees involved in hazardous waste site activities. The program was developed to comply with the requirements of 29 CFR 1910.120, "Occupational Safety and Health Standards," "Hazardous Waste Operations and Emergency Response," and 10 CFR 835 to ensure the safety and health of workers during hazardous waste operations.

The health and safety program was developed to define the chemical, radiological, and physical hazards, and to specify the controls and requirements for day-to-day work activities on the overall Hanford Site. The program incorporates applicable core functions and guiding principles outlined in the Integrated Safety Management System and governs minimal personal training; control of industrial safety and radiological hazards; personal protective equipment; site control; and general emergency response to spills, fire, accidents, injury, and incident reporting.

Project field staff will be required to comply with the health and safety program at all times. Site visitors must have read the health and safety plan and be escorted by project team personnel before entering the work area. Escorted visitors are briefed on health and safety concerns and must be escorted by the Project Manager (or designee) at all times when they are in the work area.

During operations, emergency response will be covered by the health and safety program. The health and safety program specifies primary emergency response actions for site personnel, area alarms, implementation of the emergency action plan and emergency equipment at the task site, emergency coordinators, emergency response, and spill containment.

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6 References

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49 CFR 174, "Carriage by Rail."

49 CFR 175, "Carriage by Aircraft."

49 CFR 176, "Carriage by Vessel."

49 CFR 177, "Carriage by Public Highway."

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