SGW-58692
Revision 0

Data Quality Objectives for the 200-CW-5, 200-PW-1, and 200-PW-6 Operable Units

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

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

**Approved for Public Release;
Further Dissemination Unlimited**

SGW-58692
Revision 0

Data Quality Objectives for the 200-CW-5, 200-PW-1, and 200-PW-6 Operable Units

Date Published
May 2015

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

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

APPROVED
By Ashley R Jenkins at 3:12 pm, May 27, 2015

Release Approval | Date

**Approved for Public Release;
Further Dissemination Unlimited**

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Contents

1 Step 1 – State the Problem 1-1
1.1 Introduction 1-1
1.2 Project Scope 1-1
1.3 Project Objective 1-2
1.4 Project Assumptions 1-3
1.4.1 Project-Specific Technical Considerations 1-4
1.5 Global Issues 1-4
1.6 Facility Description 1-4
1.6.1 200-CW-5 Operable Unit 1-5
1.6.2 200-PW-1 Operable Unit 1-5
1.6.3 200-PW-6 Operable Unit 1-7
1.7 Summary of Historical Data 1-7
1.8 Data Quality Objective Team Members and Key Decision Makers 1-10
1.9 Contaminants of Concern 1-11
1.10 Land Use 1-12
1.11 Action Levels 1-13
1.11.1 Direct Contact – Industrial Land Use 1-14
1.11.2 Direct Contact – Ecological Protection 1-14
1.11.3 Groundwater Protection 1-14
1.12 Expected Waste Streams 1-15
1.13 Statement of the Problem 1-15
2 Step 2 – Identify the Goal of the Study 2-1
3 Step 3 – Identify Information Inputs 3-1
3.1 Analytical Performance Requirements 3-3
3.2 Characterization Methods 3-9
3.2.1 Process Knowledge, Historical Data, and Calculations 3-9
3.2.2 In Situ Radiological Characterization Using the Dose-to-Curie Method 3-9
3.2.3 Nondestructive Assay 3-12
3.2.4 Sampling and Laboratory Analysis (Destructive Assay) 3-13
4 Step 4 – Define the Boundaries of the Study 4-1
5 Step 5 – Develop the Analytic Approach 5-1
5.1 Decision Rule Development 5-1
6 Step 6 – Specify Performance or Acceptance Criteria 6-1
6.1 Conceptual Site Model for Sample Designs 6-1
6.2 Developing Parameters for the Statistical Sample Design 6-1

6.2.1 Uncertainty and Decision Errors 6-1
6.2.2 Performance Goals for the Sample Design 6-3
6.2.3 Sample Cost 6-4
7 Step 7 – Develop the Design for Obtaining Data 7-1
7.1 Conceptual Site Model 7-1
7.2 Nonstatistical Design 7-2
7.2.1 Field Radiological Survey Methods 7-2
7.2.2 Field Nondestructive Assay Methods 7-4
7.2.3 Focused Sampling Methods 7-5
7.3 Statistical Design 7-6
7.3.1 Systematic Sampling for ROD (EPA et al., 2011) COCs 7-6
7.3.2 Gridded Radiological Surveys 7-7
7.4 Recommended Sample Approach 7-7
8 References 8-1

Figures

Figure 1-1. Conceptual Application of Cleanup Levels 1-4
Figure 1-2. Location of the 200-CW-5 OU Waste Sites 1-6
Figure 1-3. Location of the 200-PW-1 OU Waste Sites 1-8
Figure 1-4. Location of the 200-PW-6 OU Waste Sites 1-9
Figure 3-1. Field Detector Mounted on a Backhoe Bucket 3-10
Figure 3-2. Field Detector and GPS Mounted on a Cart 3-11
Figure 3-3. Radiological Field Screening Data Presentation 3-12
Figure 3-4. NDA Equipment 3-13
Figure 5-1. Decision-Making Process for DS 1a 5-5
Figure 5-2. Decision-Making Process for DSs 2a–2h 5-6
Figure 5-3. Decision-Making Process for DSs 3a, 3b, and 3c 5-9
Figure 6-1. CSM for DSs 3a, 3b, and 3c 6-2
Figure 7-1. Plutonium and Am-241 Soil Concentrations beneath the 216-Z-1A Tile Field (Long Axis) 7-2
Figure 7-2. Plutonium and Am-241 Soil Concentrations beneath the 216-Z-1A Tile Field (Width) 7-3

Tables

Table 1-1. 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU Waste Sites 1-2
Table 1-2. Technical Team Members 1-10
Table 1-3. Key Decision Makers 1-10
Table 1-4. 200-CW-5, 200-PW-1, and 200-PW-6 OUs Contaminants for Waste Management Decisions 1-11
Table 1-5. 200-CW-5 OU COCs for Final Cleanup Decisions 1-12
Table 1-6. 200-PW-1 and 200-PW-6 OU COCs for Final Cleanup Decisions 1-12
Table 1-7. Summary of Soil Cleanup Levels for Applicable 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU Waste Sites 1-13
Table 1-8. Expected Waste Streams for the 200-CW-5, 200-PW-1, and 200-PW-6 OU Remedial Actions 1-15
Table 2-1. Summary of DQO Information for Problem Statement 1 2-1
Table 2-2. Summary of DQO Information for Problem Statement 2 2-2
Table 2-3. Summary of DQO Information for Problem Statement 3 2-5
Table 3-1. Required Information and Reference Sources 3-1
Table 3-2. Information Required to Resolve DSs 1a, 1b, and 3c 3-3
Table 3-3. Analytical Performance Requirements for DSs 2a–2h 3-4
Table 3-4. Analytical Performance Requirements for DSs 3a and 3b 3-8
Table 4-1. Characteristics that Define the Population of Interest 4-1
Table 4-2. Consequences, Resampling Access, and Sampling Design Rigor Guidance 4-1
Table 4-3. Sampling Time Frame and Design Rigor Guidance 4-2
Table 4-4. List of Practical Constraints on Data Collection 4-3
Table 5-1. Statistical Parameters and Associated Statistics of Interest 5-1
Table 5-2. Scale for Decision Making 5-2
Table 5-3. DRs for DSs 1a and 1b 5-3
Table 5-4. DRs for DSs 2a–2h 5-7
Table 5-5. DRs for DSs 3a, 3b, and 3c 5-8
Table 6-1. Potential Consequences of Decision Error 6-2
Table 6-2. Tolerable Decision Errors 6-3
Table 6-3. Number of Samples Needed to Meet the Performance Goals 6-4
Table 7-1. Preliminary Waste Designations for the 200-CW-5, 200-PW-1, and 200-PW-6 OU Waste Sites 7-5
Table 7-2. Sampling Needs for the 200-CW-5 OU Waste Sites 7-9
Table 7-3. Sampling Needs for the 200-PW-1 OU Waste Sites 7-10
Table 7-4. Sampling Needs for the 200-PW-6 OU Waste Sites 7-11
Table 7-5. Recommended Sampling Approach to Resolve the DSs 7-11

This page intentionally left blank.

Terms

AA	alternative action
CAS	Chemical Abstracts Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
COC	contaminant of concern
COPC	contaminant of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
GEA	gamma energy analysis
HCP EIS	*Hanford Comprehensive Land-Use Plan Environmental Impact Statement*
HEIS	Hanford Environmental Information System
LDR	land disposal restriction
LLW	low-level waste
NCP	National Contingency Plan (40 CFR 300, “National Oil and Hazardous Substances Pollution Contingency Plan”)
NDA	nondestructive assay
OU	operable unit
PCB	polychlorinated biphenyl
PFP	Plutonium Finishing Plant
PSQ	principal study question
QC	quality control
RAG	remedial action goal
RAO	remedial action objective

RD/RAWP	remedial design/remedial action work plan
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
RME	reasonable maximum exposure
ROD	record of decision
SAP	sampling and analysis plan
SD	standard deviation
SVE	soil vapor extraction
SWOC	Solid Waste Operations Complex t
TCLP	toxicity characteristic leaching procedure
TRU	transuranic
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
UCL	upper confidence limit
UPR	unplanned release
VSP	Visual Sample Plan
WAC	*Washington Administrative Code*
WCH	Washington Closure Hanford
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant

1 Step 1 – State the Problem

The purpose of this data quality objectives (DQOs) report is to establish performance and acceptance criteria, which will serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the remedial actions planned for the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units (OUs). Use of the DQO process leads to efficient and effective expenditure of resources; consensus on the type, quality, and quantity of data needed to meet the project goal; and the full documentation of actions taken during the development of the project.

The purpose of DQO Step 1 is to document project objectives, assumptions, background information, and contaminants of concern (COCs) so problem statements that clearly and concisely state the problems can be developed. This ensures that the focus of the study and data collection activities will be unambiguous.

1.1 Introduction

As part of the approach to waste site cleanup, the U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Washington State Department of Ecology (Ecology), known as the Tri-Parties, agreed to consolidate the 23 process-based OUs in the 200 Area National Priorities List (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," hereinafter the National Contingency Plan [NCP], Appendix B, "National Priorities List,") site into 12 groups based on similarities in contaminant sources. This document addresses 2 of the 12 waste groups. The Z Ditches Waste Group includes waste sites in the 200-CW-5 OU. The Plutonium/Organic-Rich Waste Group includes waste sites in the 200-PW-1, 200-PW-3, and 200-PW-6 OUs. The 21 waste sites in these OUs are associated with subsurface liquid waste handling and disposal at sites that were engineered and constructed to receive liquid waste and discharge it into the soil beneath the sites. These facilities are primarily associated with the Plutonium Finishing Plant (PFP) and the Plutonium and Uranium Extraction Plant. The waste sites in these four OUs are located in the 200 East and 200 West Areas of the Hanford Site.

Final remedial actions were selected for the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 source OUs in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), Tri-Party Agreement (Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*), and NCP (40 CFR 300). The remedial actions are described in the record of decision (ROD) (EPA et al., 2011, *Record of Decision, Hanford 200 Area, Superfund Site, 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*). The purpose of the remedial actions is to address source contamination that poses threats to human health and the environment.

1.2 Project Scope

The selected remedy for the sites addresses soils and subsurface disposal structures, two settling tanks, and associated pipelines contaminated primarily with radioactive plutonium and cesium. Some of the waste materials are considered principal threat wastes. Principal threat wastes are defined as source materials that are considered highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health and the environment should exposure occur.
Also, structures and other debris that must be removed in order to conduct required remediation will be excavated. The remedy includes a combination of removal, treatment (as needed), and disposal; construction of evapotranspiration barriers; soil covers; and institutional controls. Table 1-1 lists the waste sites included in the ROD (EPA et al., 2011).

Table 1-1. 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU Waste Sites

Waste Site	OU	Waste Site Structure Type	Waste Site	OU	Waste Site Structure Type
216-Z-1D	200-CW-5	Ditch	216-A-7	200-PW-3	Crib
216-Z-11	200-CW-5	Ditch	216-A-8	200-PW-3	Crib
216-Z-19	200-CW-5	Ditch	216-A-24	200-PW-3	Crib
216-Z-20	200-CW-5	Tile field	216-A-31	200-PW-3	Crib
UPR-200-W-110	200-CW-5	Unplanned release	UPR-200-E-56	200-PW-3	Unplanned release
200-W-207-PL*	200-CW-5	Pipeline	216-Z-5	200-PW-6	Crib
216-Z-1A	200-PW-1	Tile field	200-W-208-PL	200-PW-6	Pipeline
216-Z-9	200-PW-1	Trench	200-W-210-PL	200-PW-6	Pipeline
216-Z-18	200-PW-1	Crib	241-Z-8	200-PW-6	Settling tank
200-W-174-PL*	200-PW-1	Pipeline	200-W-205-PL*	200-PW-6	Pipeline
200-W-206-PL*	200-PW-1	Pipeline	200-W-220-PL*	200-PW-6	Pipeline
216-Z-1&2	200-PW-1	Crib	216-Z-8	200-PW-6	French drain
216-Z-3	200-PW-1	Crib	216-Z-10	200-PW-6	Injection/reverse well
216-Z-12	200-PW-1	Crib			
241-Z-361	200-PW-1	Settling tank			

* Remedial action includes segments of the pipeline only, not the entire pipeline.
OU = operable unit

1.3 Project Objective

The overarching requirement in the site ROD is to meet the soil cleanup levels designated for industrial use. The following remedial action objectives (RAOs) are from the ROD (EPA et al., 2011):

RAO 1: Prevent unacceptable risk to human health and ecological receptors associated with radiological exposure to waste, soil, or debris contaminated above risk-based criteria, by removing the source or eliminating the pathway.

RAO 2: Prevent unacceptable risk to human and ecological receptors associated with nonradiological exposure to waste, soil, or debris contaminated above risk-based criteria by removing the source or eliminating the pathway.

RAO 3: Control the sources of potential groundwater contamination to support the Central Plateau groundwater goal of protecting the beneficial uses of groundwater, including protecting the Columbia River from adverse impacts.

Field measurements, media sampling, and analysis will be needed to characterize waste materials, guide the remediation, and determine that closeout requirements are achieved. This DQO provides the basis for the proposed sampling and analysis approach.

1.4 Project Assumptions

1. Due to the DOE acquisition process, the field implementation of remedial actions needed to implement the ROD (EPA et al., 2011) are anticipated to start several years in the future. Therefore, changes to sampling and analytical techniques may be needed resulting in changes to the sampling and analysis plan (SAP).

2. Historical characterization data on the waste sites have been gathered and will be used for the evaluations in this DQO. It is not anticipated that additional characterization data will be collected prior to the implementation of the remedial actions.

3. Waste management data gaps and data needs (e.g., for transportation, packaging, etc.) will be determined based on the current Waste Isolation Pilot Plant (WIPP) and Environmental Restoration Disposal Facility (ERDF) waste acceptance codes. A general sampling strategy will be developed. Specific analytical and sampling strategies for waste management decisions will be deferred until a later date when the remedial action is implemented.

4. Site endpoint data gaps and data needs will be determined based on the requirements of the ROD (EPA et al., 2011). A general sampling strategy will be developed. Specific analytical and sampling strategies for endpoint decisions will be deferred until a later date when the remedial action is implemented.

5. The remedial action for the five waste sites in 200-PW-3 OU involves enhancing and/or maintaining existing soil covers. These sites will not require excavation and sampling. Therefore, these sites will not be addressed in this DQO.

6. A site-specific treatment variance will be needed to facilitate effective disposal of the low-level wastes (LLWs) generated by this remedial action in ERDF. This is based on process knowledge and an evaluation of the historical data.

7. Cleaning out the sludge and removing the settling tanks is preferred over clean closure. After tank removal, the site will be excavated to 0.3 m (1 ft) below the original tank depth and sampled for the applicable constituents in the ROD (EPA et al., 2011). The data will be provided to DOE for discussion with EPA. It is recognized that a ROD amendment will be needed to change the remedy for the settling tanks.

8. The 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites will be excavated to the depths designated in the ROD (EPA et al., 2011) and sampled for the applicable constituents in the ROD. Sampling will also include nitrate and technetium-99 for some sites as requested by Ecology. The data will be provided to DOE for discussion with EPA.

9. The ROD (EPA et al., 2011) cleanup levels are based on an industrial exposure scenario and apply to soils at depths equal to or less than 4.6 m (15 ft) below ground surface (bgs). The ROD does not provide groundwater protection soil cleanup levels for soils greater than 4.6 m (15 ft) bgs. Concentrations of applicable contaminants (at depths >4.6 m [15 ft] bgs) will be collected for information and provided to DOE for discussion with EPA. Figure 1-1 shows a cross section of an excavation and how the cleanup level information applies.

10. The cleanup criteria for carbon tetrachloride and methylene chloride are applicable to the 200-PW-1 soil vapor extraction (SVE) system; the vapor standards are not applicable to soil sampling for cleanup decisions. Therefore, carbon tetrachloride and methylene chloride are not evaluated as COCs in this DQO.

11. Industrial health and radiological work place sampling will be addressed as part of the remedial design/remedial action work plan (RD/RAWP) and will not be explicitly addressed in the SAP.

12. CH2M HILL Plateau Remediation Company (CHPRC) will workwith DOE and EPA to develop the DQO, SAP, and RD/RAWP. DOE and EPA will keep Ecology apprised of the tasks as they determine appropriate.

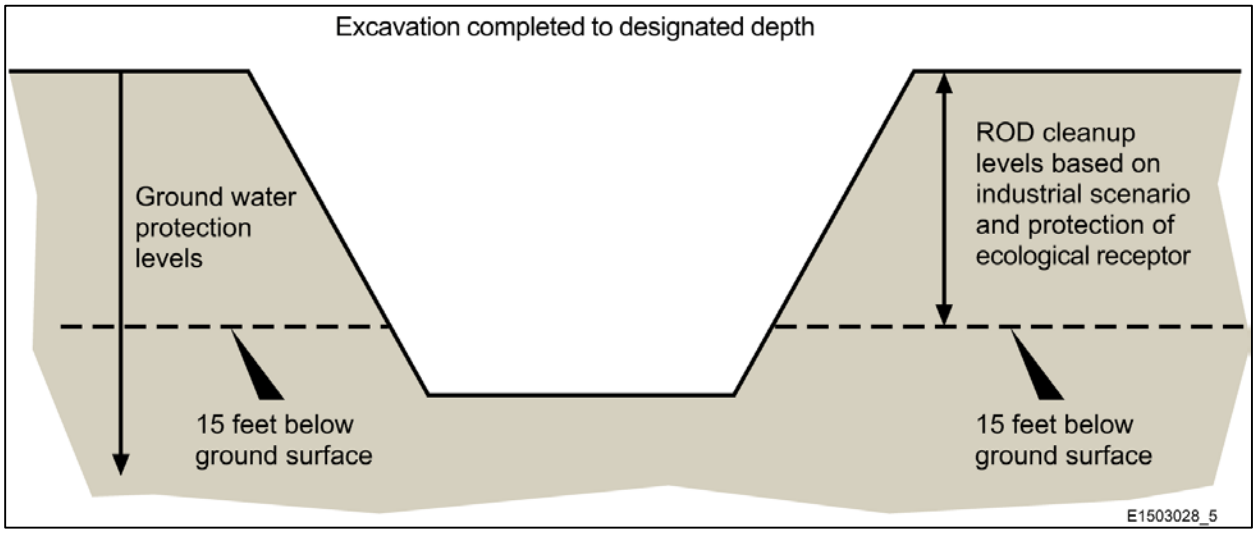


Figure 1-1. Conceptual Application of Cleanup Levels

1.4.1 Project-Specific Technical Considerations

1. Can field measurements of radiological constituents (principally americium-241) be used to make decisions during remediation and guide final cleanup sampling?

2. What characterization information will be required to support a site-specific treatment variance for waste disposal at ERDF?

3. Does historical data indicate the potential for greater than class C waste?

1.5 Global Issues

At the extent of excavation specified in the ROD (EPA et al., 2011) for the each of the waste sites, information on the nature and extent of residual contamination needs to be collected and documented.

At the extent of excavation specified in the ROD (EPA et al., 2011) for the high-salt waste sites (216-Z-9, 216-Z-1A, and 216-Z-18), DOE and EPA will use the nature and extent of residual contamination data to determine if further excavation should be performed to remove additional contamination.

1.6 Facility Description

The 200 Area of the Hanford Site encompasses about 190 km^2 (75 mi^2) and is the part of the Hanford Site with the highest in elevation. There are two main regions associated with the 200 Area (200 East Area and 200 West Area), which are separated by several miles.

The main function of the facilities in the 200 East and 200 West Areas was to remove plutonium from the uranium fuel rods after they had been subjected to a nuclear chain reaction in the 100 Area reactors. Five massive processing facilities called “canyons” were the site of these separation and removal activities.

They were called canyons because each of them is about three football fields long, with walls extending 18 m (60 ft) above the ground and dropping another 12 m (40 ft) below it.

Large volumes of liquid waste were generated from the separation of plutonium at the various processing plants in the 200 West and 200 East Areas. Billions of gallons of process wastewater were both intentionally and unintentionally put onto the ground in the 200 Area. The processes were intended to recover as much plutonium as possible prior to discharge of the waste liquids, but the waste streams still contained low levels of plutonium and other contaminants.

The waste sites in the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OUs are associated with subsurface liquid waste handling and disposal at sites that were engineered and constructed to receive liquid waste and discharge it into the soil beneath the sites. The 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU waste sites are all located within the Inner Area of the Central Plateau area, which has been designated as an industrial land use area.

The following subsections provide an overview of the waste sites addressed in this DQO.

1.6.1 200-CW-5 Operable Unit

The 200-CW-5 OU waste sites include the 216-Z-1D Ditch, 216-Z-11 Ditch, 216-Z-19 Ditch, 216-Z-20 Tile Field, and Unplanned Release (UPR)-200-W-110. Remediation of waste sites in this OU will also address the 200-W-207 Pipeline. This pipeline was used to transfer waste to the 216-Z-1D Ditch, 216-Z-11 Ditch, 216-Z-19 Ditch, and 216-Z-20 Tile Field. Figure 1-2 shows the location of the 200-CW-5 OU waste sites in the 200 West Area.

The 200-CW-5 OU is a process-based OU established to address waste sites that received cooling water and steam condensate liquid waste streams from plutonium processing facilities in the 200 West Area. The exception was UPR-200-W-110, which did not receive effluent but was a one-time-use disposal trench for spoils from the 216-Z-1D Ditch and contained the same waste stream contaminants.

The Z Ditches are a series of three parallel, shallow, unlined, and open-air ditches that operated in chronological sequence from 1944 to 1981. The ditches routed cooling water and other wastewaters from the 234-5Z Facility (Z Plant) to the 216-U-10 Pond for disposal. From 1944 to 1956, the ditch system was used to convey cooling water effluents from the 231-Z Plutonium Isolation Plant, where concentrated plutonium from the bismuth phosphate process at the 221-T Plant was processed from a wet nitrate form to a solid plutonium nitrate form for offsite shipment.

Initially, cooling water waste streams were not anticipated to be contaminated. The cooling water and steam condensate was designed to be entirely separate from contaminated process liquids. This was accomplished with physical barriers, which typically were the walls of a heating or cooling pipe coil. Steam and cooling water were circulated through coils inside process vessels to adjust the temperatures in the vessels. The spent steam was condensed with cooling water after exiting the process vessel. The condensed steam and cooling water were released to plant sewers or piping systems that discharged to ditches and ponds.

1.6.2 200-PW-1 Operable Unit

From the time the Z Plant complex came online in 1949, it generated large volumes of waste effluent. Until 1990, effluents such as cooling water that, under normal operating conditions, contained little or no radiological contamination were discharged to the Z Ditches, which drained to the U Pond.

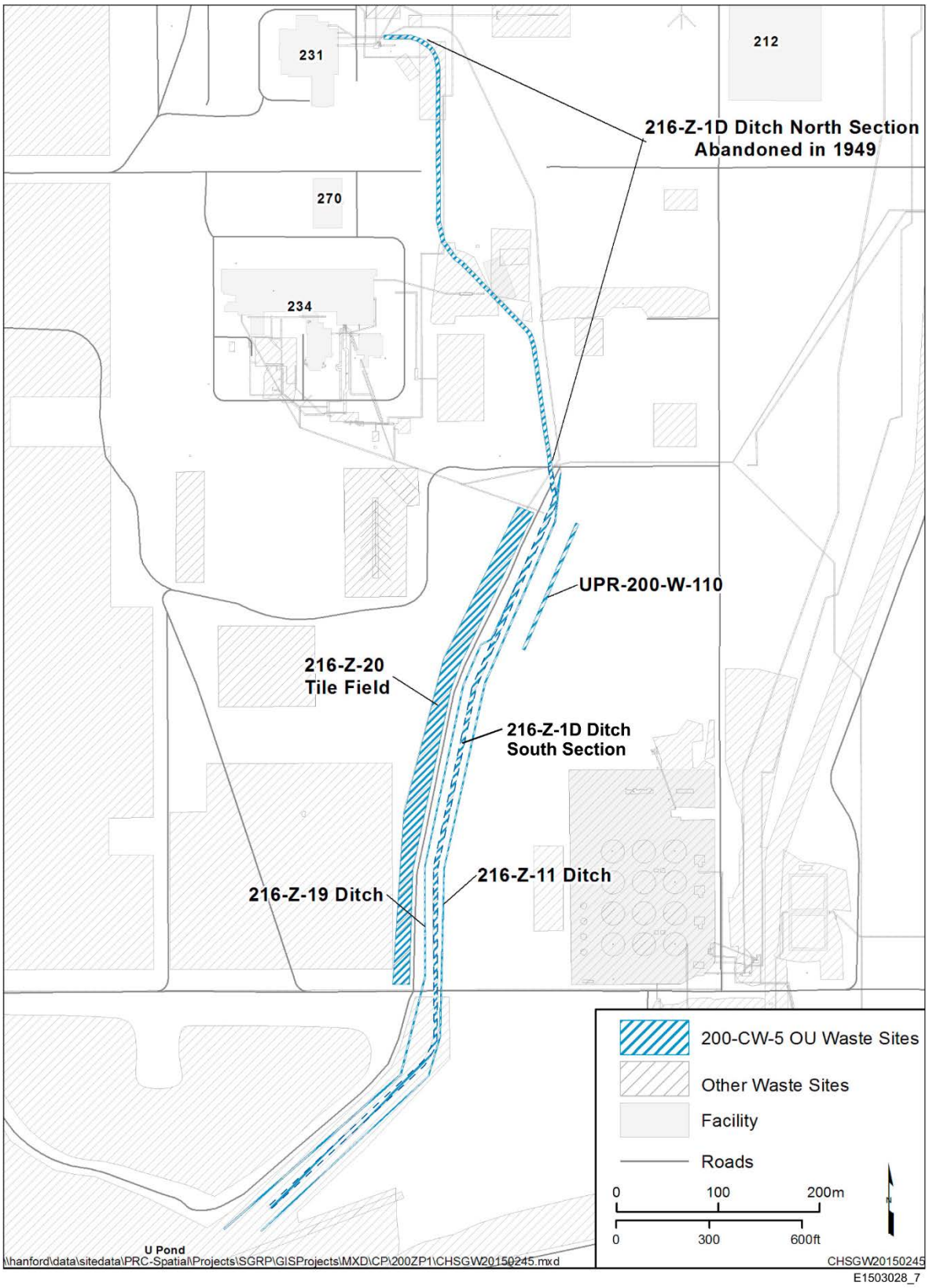


Figure 1-2. Location of the 200-CW-5 OU Waste Sites

From 1949 until May 1973, effluents from chemical processes and plutonium finishing activities that, under normal operating conditions, contained low levels of plutonium and other contaminants were discharged to the soil column at subsurface engineered waste sites. These engineered waste sites were designed to provide effective disposal of effluent to the soil column and were operated in a manner intended to limit adverse impacts to groundwater. Six subsurface engineered waste sites and an associated subsurface settling tank that received these contaminated process waste streams comprise the 200-PW-1 OU. Figure 1-3 shows the location of the 200-PW-1 OU waste sites in the 200 West Area.

The 216-Z-9 Trench primarily received waste streams from the Recovery of Uranium and Plutonium by Extraction (RECUPLEX), and the 216-Z-18 Crib primarily received waste streams from the Plutonium Reclamation Facility solvent extraction systems. These waste streams included acidic aqueous-phase process wastes containing plutonium and americium. This aqueous waste, referred to as high-salt waste, was a concentrated nitrate solution containing dissolved metal (aluminum, calcium, sodium, and magnesium) nitrates. The sites also received significant volumes of organic wastes (principally carbon tetrachloride, tributyl phosphate, and lard oil), both entrained in the aqueous-phase waste streams and as separate, nonaqueous-phase waste streams. The sites were operated sequentially, starting with the 216-Z-9 Trench and being replaced when conditions warranted.

Other 200-PW-1 OU waste sites (216-Z-1&2 Cribs, 216-Z-3 Crib, 216-Z-12 Crib, and 241-Z-361 Settling Tank) primarily received neutral-to-basic aqueous waste streams that contained plutonium and americium, with negligible amounts of organics and no nonaqueous-phase liquids. This aqueous waste, referred to as low-salt waste, was primarily a dilute sodium fluoride and sodium nitrate solution when discharged. These cribs were operated sequentially, being replaced when conditions warranted. The 241-Z-361 Settling Tank remained online for discharges to all four cribs, limiting pass-through of suspended solids with no design capability to discharge wastes directly to the soil column.

The 216-Z-1A Tile Field operated from 1949 through 1969 and received high-salt waste from the 234-5Z Facility (Z Plant) solvent extraction systems and low-salt waste via the 241-Z-361 Settling Tank.

1.6.3 200-PW-6 Operable Unit

The 200-PW-6 OU contains four waste sites located in the 200 West Area. These include the 216-Z-10 Injection/Reverse Well, 216-Z-5 Crib, 216-Z-8 French Drain, and 241-Z-8 Settling Tank. Figure 1-4 shows the location of the 200-PW-6 OU waste sites in the 200 West Area. These waste sites received wastes from the Plutonium Isolation Facility or the PFP Complex that contained plutonium but did not include organics. The 216-Z-10 Injection/Reverse Well and 216-Z-5 Crib received aqueous, neutral-to-basic process and laboratory wastes from the Plutonium Isolation Facility (231-Z Building). The 241-Z-8 Settling Tank received aqueous silica gel waste from back flushes of the feed filters at RECUPLEX. Overflow from the 241-Z-8 Settling Tank went to the 216-Z-8 French Drain.

1.7 Summary of Historical Data

Detailed information describing the 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU waste sites can be found in the following reports:

- DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units*
- DOE/RL-2004-24, *Feasibility Study for the 200-CW-5 Cooling Water Operable Unit*

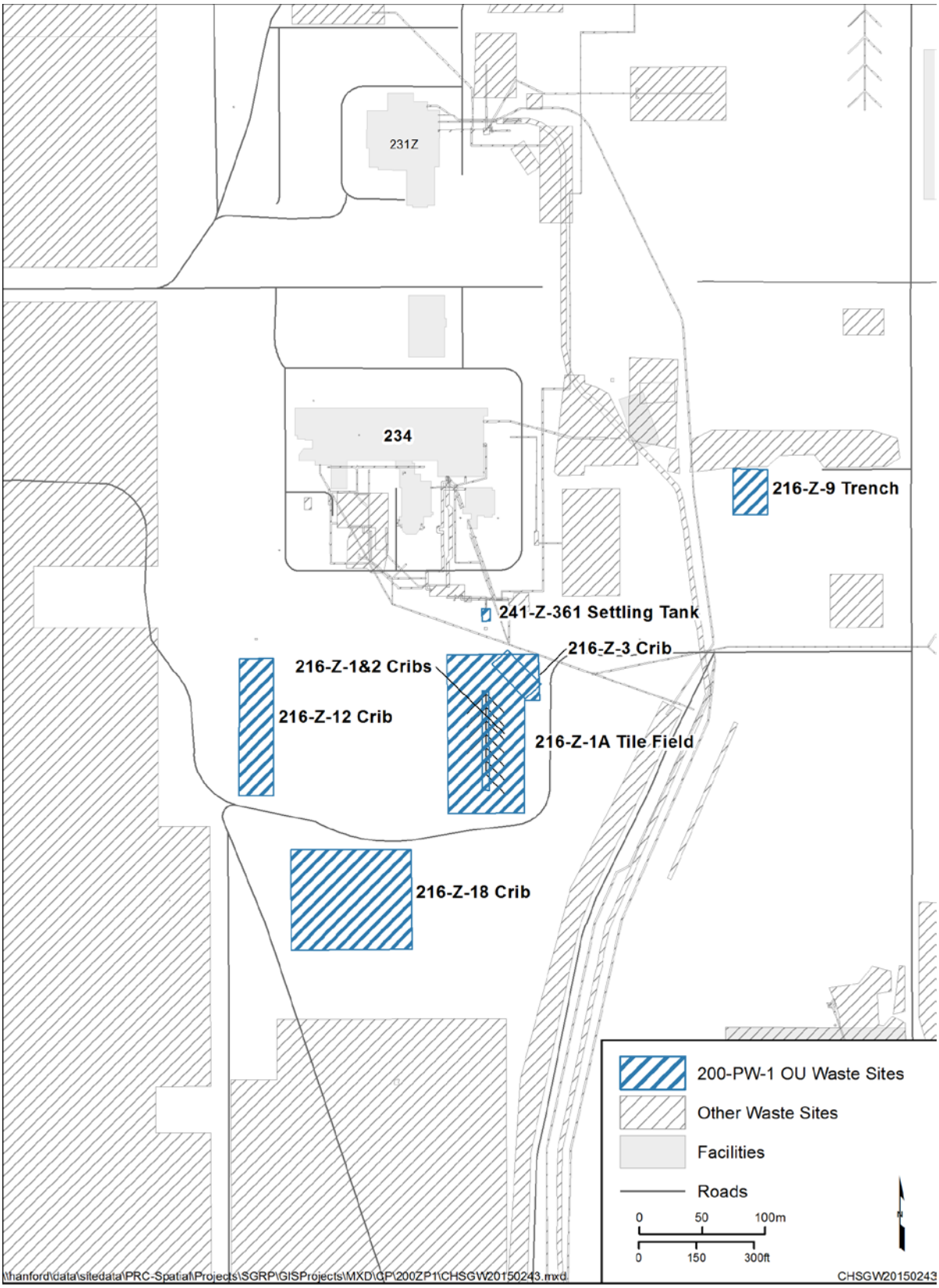


Figure 1-3. Location of the 200-PW-1 OU Waste Sites

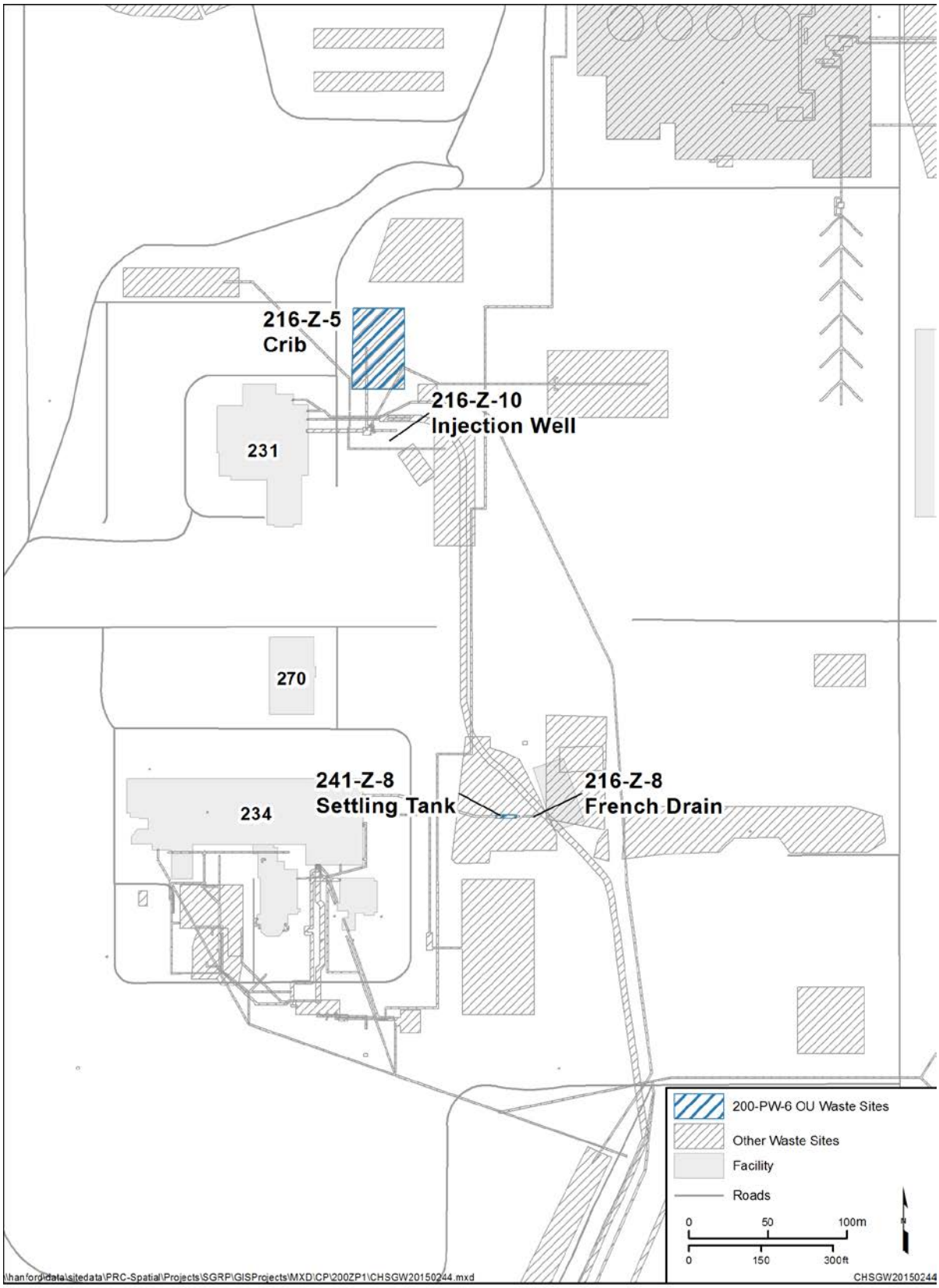


Figure 1-4. Location of the 200-PW-6 OU Waste Sites

- DOE/RL-2006-51, *Remedial Investigation Report for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*
- DOE/RL-2007-27, *Feasibility Study for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*

1.8 Data Quality Objective Team Members and Key Decision Makers

The DQO team staff was selected based on their technical backgrounds. The key decision makers include representatives from DOE and EPA. Tables 1-2 and 1-3 identify the DQO team members and key decision makers, respectively.

Table 1-2. Technical Team Members

Name	Organization	Area of Expertise
Patrick Baynes	CHPRC	Project Manager
Duane Jacques	CHPRC	Characterization/DQO Facilitator
Wendy Thompson	WCH	Characterization
Inna Berezovskiy	WCH	Characterization/SAP
Justin Bolles	CHPRC	Waste Management
Dean Nester	CHPRC	Waste Management
Steve Trent	CHPRC	Sample Management
John Stamper	CHPRC	Radiological Control
Curtis Stroup	CHPRC	Historical and Process Knowledge
Bruce Williams	CHPRC	Modeling and Historical Data
Fred Ruck	CHPRC	Regulatory

CHPRC = CH2M HILL Plateau Remediation Company
DQO = data quality objective
SAP = sampling and analysis plan
WCH = Washington Closure Hanford

Table 1-3. Key Decision Makers

Name	Organization	Area of Expertise
Emerald Laija	EPA	Project Manager
Julie Reddick	DOE-RL	Project Manager

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

1.9 Contaminants of Concern

A list of COCs was developed for the project by identifying the possible contaminants of potential concern (COPC), based primarily on historical process operation information for the former plutonium processing and finishing activities that discharged to the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites. Table 1-4 contains a list of contaminants for the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites that will be used for evaluating waste management decisions in this DQO.

Table 1-4. 200-CW-5, 200-PW-1, and 200-PW-6 OU Contaminants for Waste Management Decisions

Nonradioactive Contaminants		Radioactive Contaminants
Acetone	Arsenic	Potassium-40
Butyl Alcohol	Barium	Strontium-90
Carbon Tetrachloride	Beryllium	Technetium-99
Chlorobenzene	Boron	Cesium-137
Chloroform	Cadmium	Cerium-139
1, 1-Dichloroethane	Chromium	Radium-226
Methyl Ethyl Ketone	Copper	Radium-228
Methyl Isobutyl Ketone	Hexavalent Chromium	Thorium-228
Methylene Chloride	Lead	Thorium-230
Tetrachloroethene	Lithium	Thorium-232
Toluene	Manganese	Uranium-233/234
Trichloroethene	Mercury	Uranium-238
Tributyl Phosphate	Molybdenum	Plutonium-238
Aroclor 1248	Nickel	Plutonium-239
Aroclor 1254	Selenium	Plutonium-239/240
Aroclor 1260	Silver	Americium-241
Oil and Grease	Vanadium	
2-Butanone	Zinc	
2-Pentanone	Ammonium Ion	
	Fluoride	
	Sulfate	
	Nitrate	
	Nitrite	

OU = operable unit

Table 1-5 presents the list of COCs for the final cleanup of the 200-CW-5 OU waste sites as established in the ROD (EPA et al., 2011). Table 1-6 presents the list of COCs for the final cleanup of the 200-PW-1 and 200-PW-6 OU waste sites as established in the ROD (EPA et al., 2011).

Table 1-5. 200-CW-5 OU COCs for Final Cleanup Decisions

Nonradioactive COCs	Radioactive COCs
Aroclor 1254	Strontium-90
Aroclor 1260	Cesium-137
Boron	Radium-226
Mercury	Plutonium-239/240
Nitrate*	Americium-241

* Constituent requested by Ecology; data collected for information purposes.
COC = contaminant of concern
Ecology = Washington State Department of Ecology
OU = operable unit

Table 1-6. 200-PW-1 and 200-PW-6 OU COCs for Final Cleanup Decisions

Nonradioactive COCs	Radioactive COCs
Nitrate*	Technetium-99*
	Plutonium-239/240
	Americium-241

* Constituent requested by Ecology; data collected for information purposes for the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites only.
COC = contaminant of concern
Ecology = Washington State Department of Ecology
OU = operable unit

1.10 Land Use

All current land use activities associated with the Inner Area of the Central Plateau are industrial in nature. The facilities located in the Inner Area processed irradiated fuel from the plutonium production reactors in the 100 Area. Most of the facilities directly associated with fuel reprocessing are now inactive and awaiting final disposition.

The reasonably anticipated future land use for the Inner Area of the Central Plateau is industrial (DOE worker) for at least 50 years and industrial (DOE or non-DOE worker) thereafter. DOE issued DOE/EIS-0222-F, *Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (HCP EIS), and associated HCP EIS ROD (64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)") in 1999. The HCP EIS (DOE/EIS-0222-F) presents the potential environmental impacts of alternative land use plans for the Hanford Site and presents the land use implication of ongoing and proposed activities. Under the preferred land use alternative selected in the HCP EIS ROD (64 FR 61615), the Central Plateau was designated for industrial exclusive use,

defined as areas suitable and desirable for treatment, storage, and disposal of hazardous, dangerous, radioactive, and nonradioactive wastes, as well as related activities.

Groundwater below the Central Plateau is currently contaminated and not withdrawn from the aquifer for beneficial use (drinking water or industrial use). An alternative source of water derived from the Columbia River is provided to current industrial workers conducting activities on the Central Plateau. Groundwater located beneath the 200-CW-5, 200-PW-1, and 200-PW-6 OUs is part of the 200-ZP-1 Groundwater OU. The NCP (40 CFR 300.430(a)(1)(iii)(F), "Remedial Investigation/Feasibility Study and Selection of Remedy") establishes the expectation that EPA will return usable groundwaters to their beneficial uses wherever practicable and within a reasonable time frame, given the particulars of the site. EPA generally defers to state agency definitions of useable groundwater provided under the various comprehensive state groundwater protection programs administered by the states across the country. Based on physical yield and natural water quality, the State of Washington, through its groundwater protection program, has determined that the aquifer setting for the 200-ZP-1 OU meets the *Washington Administrative Code* (WAC) definition for potable groundwater and for beneficial use, and has been recognized by the state as a potential source of domestic drinking water. However, it is unlikely that the 200-ZP-1 OU groundwater will be used as a drinking water source in the future because drinking water is provided from a central water treatment facility.

1.11 Action Levels

Final cleanup levels for soil in 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OUs are defined in the ROD (EPA et al., 2011). Final cleanup levels for the applicable 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU waste sites are presented in Table 1-7. Not all of the constituents are COCs for all of the waste sites. Reducing contaminant concentrations to levels of the remedial action goals (RAGs) will protect all complete exposure pathways, including direct contact exposure based on industrial land use scenario, protection of ecological (terrestrial) receptors, and protection of groundwater beneath the OUs from future soil impacts. The basis for the cleanup level is listed as the exposure driver in Table 1-7.

Table 1-7. Summary of Soil Cleanup Levels for Applicable 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU Waste Sites

Contaminant	Hanford Site Background Concentration[a,b]	Cleanup Levels	Exposure Driver
Radionuclides (pCi/g)			
Americium-241	--	940	Direct contact industrial scenario
Cesium-137	1.1	17.7	Direct contact industrial scenario
Radium-226	0.82	4	Direct contact industrial scenario
Plutonium-239/240	0.025	765	Direct contact industrial scenario
Strontium-90	0.18	20	Ecological protection
Technetium-99	--	--[c]	--[c]
Chemicals (mg/kg)			
Aroclor 1254	--	0.65	Ecological protection
Aroclor 1260	--	0.65	Ecological protection

Table 1-7. Summary of Soil Cleanup Levels for Applicable 200-CW-5, 200-PW-1, 200-PW-3, and 200-PW-6 OU Waste Sites

Contaminant	Hanford Site Background Concentration[a,b]	Cleanup Levels	Exposure Driver
Boron	3.9	0.5	Hanford site background
Mercury	0.013	0.1	Ecological protection
Nitrate	52	--[c]	--[c]
Chemicals (ppm-v)			
Carbon Tetrachloride	--	100	Groundwater protection
Methylene Chloride	--	50	Groundwater protection

a. Hanford Site background values for nonradionuclides: DOE/RL-92-24, Vol. 1, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*; ECF-HANFORD-11-0038, *Soil Background for Interim Use at the Hanford Site*.

b. Hanford Site background values for radionuclides: DOE/RL-96-12, *Hanford Site Background: Part 2, Soil Background for Radionuclides*.

c. Identified by Ecology as a contaminant of interest in soil for further monitoring of potential groundwater impacts. A final cleanup level was not developed because it was determined that these contaminants do not pose an acceptable risk based on fate and transport modeling results.

Ecology = Washington State Department of Ecology
OU = operable unit

The following subsections describe the basis for each type of exposure driver listed in Table 1-7.

1.11.1 Direct Contact – Industrial Land Use

Soil RAGs to protect human health are developed by combining the direct contact and inhalation exposure pathways. As established by the NCP (40 CFR 300), CERCLA cleanup actions generally should achieve a level of risk within the 10^{-4} to 10^{-6} excess lifetime cancer risk based on the reasonable maximum exposure (RME) for an individual. RAGs represent a target risk level of 1×10^{-4} and are based on an RME industrial scenario.

1.11.2 Direct Contact – Ecological Protection

Soil RAGs for ecological protection are developed to protect terrestrial receptors (wildlife, plants, and biota). Soil RAGs for the protection of terrestrial receptors are based on a dose rate that would not exceed 0.1 rad/day for radionuclides and would not exceed an individual hazard quotient of 1 or a total hazard index of 1 for chemical contaminants.

1.11.3 Groundwater Protection

Soil RAGs for protection of groundwater are developed to prevent soil vapor from affecting groundwater beneath the 200 West Area. SVE is currently being used as an Expedited Response Action to minimize the migration of carbon tetrachloride and methylene chloride in the vadose zone. The RAGs were developed using a fate and transport model to develop a soil vapor concentration that would not impact groundwater above a target risk level of 1×10^{-5}.

1.12 Expected Waste Streams

Table 1-8 presents the expected waste streams generated during the remedial action, a brief description of the expected contaminants, and the anticipated disposal path.

Table 1-8. Expected Waste Streams for the 200-CW-5, 200-PW-1, and 200-PW-6 OU Remedial Actions

Waste Stream	Major Expected Contaminants	Anticipated Disposal Path
TRU soils	Pu-239/240, Am-241	SWOC storage for final shipment to WIPP
TRU debris	Pu-239/240, Am-241	SWOC storage for final shipment to WIPP
Mixed LLW soils	Pu-239/240, Am-241, nonradiological hazardous constituents	ERDF
Mixed LLW debris	Pu-239/240, Am-241, nonradiological hazardous constituents	ERDF

Am-241 = americium-241
ERDF = Environmental Restoration Disposal Facility
LLW = low-level waste
OU = operable unit
Pu-239/240 = plutonium-239/240
SWOC = Solid Waste Operations Complex
TRU = transuranic
WIPP = Waste Isolation Pilot Plant

1.13 Statement of the Problem

This DQO will address following problem statements:

Problem statement 1: Sufficient information on the nature and extent of contamination must be available in order to guide the remediation process and correctly segregate/manage waste.

Problem statement 2: Waste material (soil, debris, and sludge) resulting from remediation of the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites must be properly designated and packaged to meet the disposal facility requirements. No waste will be generated for the 200-PW-3 OU.

Problem statement 3: Sufficient information on the nature and extent of residual contamination in the remediated waste sites must be available for decision making and long-term stewardship documentation:

- Residual contamination levels at depths $\leq$4.6 m (15 ft) bgs in the remediated waste sites will be compared to the applicable final cleanup levels of the ROD (EPA et al., 2011).
- Residual contamination levels at depths >4.6 m (15 ft) bgs in the remediated 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites will be evaluated by EPA and DOE to determine if additional soil removal is warranted.

This page intentionally left blank.

2 Step 2 – Identify the Goal of the Study

Step 2 defines the principal study questions (PSQs) that need to be resolved to address the problem statements identified in Step 1. The alternative actions (AAs) that could result from the PSQ resolutions and their consequences also are evaluated in Step 2. Finally, the PSQs and AAs are combined into decision statements (DSs) that express a choice among AAs.

Table 2-1 presents the PSQs and the AA that will be taken when each PSQ is answered for problem statement 1. The table also shows a description and severity rating of the consequences of implementing the wrong AA. Each PSQ and the corresponding AAs are then combined into a DS.

Table 2-1. Summary of DQO Information for Problem Statement 1

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/Severe)
Problem Statement 1: Sufficient information on the nature and extent of contamination must be available in order to guide the remediation process and correctly segregate/manage waste.			
PSQ 1a – Are the waste materials properly segregated and managed as LLW as it is generated (segregate LLW from TRU)?			
1a-1	Determine that radiological contaminant levels are LLW and segregate and manage the waste as it is generated for ERDF disposal.	Improperly dispose of TRU waste at ERDF. Potential worker exposure and loss of control of contamination.	Moderate to Severe
1a-2	Determine that radiological contaminant levels are not LLW and segregate and manage the waste as it is generated for storage at the SWOC pending disposal at WIPP.	Erroneously package and send LLW for disposal at WIPP. Potential rework of waste packaging and treatment for waste rejected for storage at the SWOC pending disposal at WIPP.	Low
DS 1a – Determine that radiological contaminant levels are within the ERDF waste acceptance criteria and segregate and manage the waste as it is generated for disposal at ERDF; ***or*** segregate and manage the waste as it is generated for storage at the SWOC pending disposal at WIPP.			
PSQ 1b – Are the residual contaminant levels at depths <4.6 m (15 ft) bgs in the excavation less than the applicable cleanup levels of the ROD (EPA et al., 2011)?			
1b-1	Determine that residual contaminant levels at depths <4.6 m (5 ft) bgs in the excavation are less than the applicable cleanup levels of the ROD (EPA et al., 2011) and stop excavation.	Erroneously conclude the requirements of the ROD have been met during excavation. Remobilization of equipment. Additional excavation and resampling may be needed.	Moderate
1b-2	Determine that residual contaminant levels at depths <4.6 m (15 ft) bgs in the excavation are greater than the cleanup levels the ROD (EPA et al., 2011) and continue excavation or discuss with DOE and EPA.	Conduct unnecessary excavation. Collect additional data when it is not needed.	Low

Table 2-1. Summary of DQO Information for Problem Statement 1

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/Severe)
DS 1b – Determine that residual contaminant concentrations at depths ≤4.6 m (15 ft) bgs in the excavation are less than the cleanup levels of the ROD (EPA et al., 2011), and excavation may stop; ***or*** continue excavating; *or* discuss the need for additional excavation with DOE and EPA.			

Source: EPA et al., *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*

AA = alternative action
DOE = U.S. Department of Energy
DS = decision statement
DQO = data quality objective
EPA = U.S. Environmental Protection Agency
ERDF = Environmental Restoration Disposal Facility
LLW = low level waste
PSQ = principal study question
ROD = record of decision
SWOC = Solid Waste Operations Complex
TRU = transuranic
WIPP = Waste Isolation Pilot Plant

Table 2-2 presents the PSQs and AAs that will be taken when each PSQ is answered for problem statement 2. The table also shows a description and severity rating of the consequences of implementing the wrong AA. Each PSQ and the corresponding AAs are then combined into a DS.

Table 2-2. Summary of DQO Information for Problem Statement 2

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/Severe)
Problem statement 2: Waste material (e.g., soil, debris, and sludge) resulting from remediation of the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites must be properly designated and packaged to meet the disposal facility requirements.			
PSQ 2a – Is the material radiologically contaminated above ERDF disposal criteria?			
2a-1	Determine if the material is radiologically compliant with ERDF waste acceptance criteria, and evaluate material for treatment/disposal at ERDF.	Potential loss of control of radiological contamination. Environmental harm from improper disposal of radioactive waste.	Moderate to Severe
2a-2	Determine if the material is radiologically contaminated above levels compliant with ERDF waste acceptance criteria, and manage the waste for storage at the SWOC pending disposal at WIPP.	Unnecessary cost of storing waste that could have been disposed to ERDF.	Low
DS 2a – Determine if the material is radiologically compliant with ERDF waste acceptance criteria and will be evaluated for treatment/disposal at ERDF; ***or*** if it is radiologically contaminated above ERDF waste acceptance criteria levels and will be packaged and managed as TRU waste for storage at the SWOC pending disposal at WIPP.			

Table 2-2. Summary of DQO Information for Problem Statement 2

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/ Severe)
PSQ 2b – Is the material a listed dangerous waste?			
2b-1	Determine if the material is a listed dangerous waste and evaluate for treatment/disposal at ERDF, or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the SWOC.	Unnecessary cost of treating nonlisted dangerous material as if it were listed.	Low to Moderate
2b-2	Determine if the material is not a listed dangerous waste, and evaluate for disposal at ERDF.	Waste placed in ERDF would be misclassified.	Moderate
DS 2b – Determine if the material is a listed dangerous waste and will be evaluated for treatment/disposal at ERDF or treatment at an onsite or offsite facility prior to ERDF disposal or managed within the SWOC; ***or*** if the material is not a listed dangerous waste and will be evaluated for disposal at ERDF.			
PSQ 2c – Is the material a characteristic waste (e.g., ignitable, corrosive, reactive, or toxic)?			
2c-1	Determine if the material is a characteristic dangerous waste and evaluate for treatment/ disposal at ERDF, or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the SWOC.	Unnecessary cost of treating noncharacteristic dangerous material as if it were characteristic.	Low to Moderate
2c-2	Determine if the material is not a characteristic dangerous waste, and evaluate for disposal at ERDF.	Waste placed in ERDF would be misclassified.	Moderate
DS 2c – Determine if the material is a characteristic waste and will be evaluated for treatment/disposal at ERDF or treatment at an onsite or offsite facility prior to ERDF disposal or managed within the SWOC; ***or*** if the material is not a characteristic waste and will be evaluated for disposal at ERDF.			
PSQ 2d – Is the material a toxic dangerous waste as defined by Washington State criteria?			
2d-1	Determine if the material is a toxic dangerous waste, and evaluate for treatment/disposal at ERDF, or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the SWOC.	Unnecessary cost of treating nontoxic material as if it were toxic.	Low to Moderate
2d-2	Determine if the material is not a toxic dangerous waste, and evaluate for disposal at ERDF.	Waste placed in ERDF would be misclassified.	Moderate
DS 2d – Determine if the material is a toxic dangerous waste and will be evaluated for treatment/disposal at ERDF or treatment at an onsite or offsite facility prior to ERDF disposal or managed within the SWOC; ***or*** if the material is not a toxic dangerous waste and will be evaluated for disposal at ERDF.			

Table 2-2. Summary of DQO Information for Problem Statement 2

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/ Severe)
PSQ 2e – Is the material a persistent waste as defined by Washington State criteria?			
2e-1	Determine if the material is a persistent dangerous waste, and evaluate for treatment/ disposal at ERDF, or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the SWOC.	Unnecessary cost of treating nonpersistent material as if it were persistent.	Low to Moderate
2e-2	Determine if the material is not a persistent dangerous waste, and evaluate for disposal at ERDF.	Waste placed in ERDF would be misclassified.	Moderate
DS 2e – Determine if the material is a persistent waste and will be evaluated for treatment/disposal at ERDF or treatment at an onsite or offsite facility prior to ERDF disposal or managed within the SWOC; ***or*** if the material is not a persistent waste and will be evaluated for disposal at ERDF.			
PSQ 2f – Is the material a PCB waste?			
2f-1	Determine if the material is a PCB waste and evaluate for treatment/disposal at ERDF, or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within the SWOC.	Unnecessary cost of treating non-PCB waste as if it were PCB waste.	Low
2f-2	Determine if the material is not a PCB waste, and evaluate for disposal at the ERDF.	Waste placed in ERDF would be misclassified.	Low to Moderate
DS 2f – Determine if the material is a PCB waste and will be evaluated for treatment/disposal at ERDF or treatment at an onsite or offsite facility prior to ERDF disposal or managed within the SWOC; ***or*** if the material is not a PCB waste and will be evaluated for disposal at ERDF.			
PSQ 2g – Is the material an asbestos waste?			
2g-1	Determine if the material is an asbestos waste, and manage the material as such before disposal.	Unnecessary cost of treating clean material as if it were asbestos waste.	Low to Moderate
2g-2	Determine if the material is not an asbestos waste, and do not manage the material as such before disposal. Dispose of the material in an onsite facility without proper handling.	Workers may be exposed to asbestos material.	Moderate
DS 2g – Determine if the material is asbestos waste and requires proper handling; ***or*** if the material is not asbestos waste and may be disposed of in an onsite facility without additional handling.			
PSQ 2h – Is the material land disposal restricted?			
2h-1	Determine if the material is land disposal restricted, and treat material before disposal.	Unnecessary cost of treating clean material as if it were land disposal restricted.	Low to Moderate

Table 2-2. Summary of DQO Information for Problem Statement 2

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/ Severe)
2h-2	Determine if the material is not land disposal restricted, and do not treat the material before disposal. Dispose of the material in an onsite facility without treatment.	Improperly dispose of LDR waste at ERDF.	Moderate
DS 2h – Determine if the material is land disposal restricted and requires treatment before disposal; ***or*** if the material is not land disposal restricted and may be disposed of in an onsite facility without treatment.			

AA = alternative action
DQO = data quality objective
ERDF = Environmental Restoration Disposal Facility
LDR = land disposal restriction
OU = operable unit
PCB = polychlorinated biphenyl
PSQ = principal study question
SWOC = Solid Waste Operations Complex
TRU = transuranic
WIPP = Waste Isolation Pilot Plant

Table 2-3 presents the PSQs and AAs that will be taken when each PSQ is answered for problem statement 3. The table also shows a description and severity rating of the consequences of implementing the wrong AA. Each PSQ and the corresponding AAs are then combined into a DS.

Table 2-3. Summary of DQO Information for Problem Statement 3

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/ Severe)
Problem statement 3: Sufficient information on the nature and extent of residual contamination in the remediated waste sites must be available for decision making and long-term stewardship documentation.			
PSQ 3a – Are the residual soil concentrations of COCs at depths ≤4.6 m (15 ft) bgs in the remediated waste sites below the applicable cleanup levels of the ROD (EPA et al., 2011)?			
3a-1	Determine that residual concentrations of COCs at depths ≤4.6 m (15 ft) bgs in the remediated waste sites are below the applicable cleanup levels of the ROD (EPA et al., 2011).	Erroneously conclude that residual concentrations of the applicable contaminants meet the requirements of the ROD (EPA et al., 2011) when further action is needed. Increased risks of potential exposure to industrial workers and the environment.	Moderate

Table 2-3. Summary of DQO Information for Problem Statement 3

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/ Severe)
3a-2	Determine that residual concentrations of COCs at depths ≤4.6 m (15 ft) bgs in the remediated waste sites are above the applicable cleanup levels of the ROD (EPA et al., 2011), and discuss further actions with DOE and EPA.	Erroneously conclude that residual concentrations of the applicable contaminants do not meet the requirements of the ROD (EPA et al., 2011), and continue to excavate, resulting in unnecessary project expense.	Low
DS 3a – Determine if residual concentrations of COCs at depths ≤4.6 m (15 ft) bgs in the remediated waste sites are below the applicable requirements of the ROD (EPA et al., 2011), and the sites may be prepared for backfilling; ***or*** discuss further actions with DOE and EPA.			
PSQ 3b – What is the nature and extent of residual soil concentrations of the applicable contaminants of concern at depths >4.6 m (15 ft) bgs of the remediated waste sites?			
3b-1	Determine that the nature and extent of residual COCs at depths >4.6 m (15 ft) bgs in the remediated waste sites is adequately documented, and prepare to backfill the site.	Erroneously conclude that the nature and extent of residual COCs at depths >4.6 m (15 ft) bgs is adequately documented, and prepare to backfill site when further action is warranted.	Low
3b-2	Determine that the nature and extent of residual COCs at depths >4.6 m (15 ft) bgs in the remediated waste sites is not adequately documented, and discuss further actions with DOE and EPA.	Erroneously conclude that the nature and extent of residual COCs at depths >4.6 m (15 ft) bgs is not adequately documented, and continue to collect unnecessary data.	Low to Moderate
DS b – Determine if the nature and extent of residual COCs at depths >4.6 m (15 ft) bgs in the waste sites is adequately documented, and prepare to backfill the site; ***or*** discuss further actions with DOE and EPA.			
PSQ 3c– What are the residual soil concentrations of Pu-239/240 and Am-241 at the bottom of the remediated 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites?			
3c-1	Determine that residual concentrations of Pu-239/240 and Am-241 at the bottom of the remediated 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites are acceptable,* and excavation may stop.	Erroneously conclude that residual concentrations of Pu-239/240 and Am-241 are acceptable,* and stop excavation when further excavation is warranted.	Low to Moderate
3c-2	Determine that residual concentrations of Pu-239/240 and Am-241 at the bottom of the remediated 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites are not acceptable,* and continue excavation as directed by DOE and EPA.	Erroneously conclude that residual concentrations of transuranic contaminants (at depths >4.6 m (15 ft) bgs) are not acceptable,* and continue excavation. Unnecessary project expense and generation of additional waste.	Moderate

Table 2-3. Summary of DQO Information for Problem Statement 3

PSQ-AA	Description of AA	Description of Consequences of Implementing the Wrong AA	Severity of Consequences (Low/Moderate/ Severe)
DS 3c – Determine that residual concentrations of Pu-239/240 and Am-241 at the bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites are acceptable,* and stop excavating; ***or*** continue excavation as directed by DOE and EPA.			

Source: EPA et al., *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*

* Parameters for this decision need to be determined by DOE and EPA prior to implementation of the remedial action.

Am-241 = americium-241
AA = alternative action
COC = contaminant of concern
DOE = U.S. Department of Energy
DQO = data quality objective
DS = decision statement
EPA = U.S. Environmental Protection Agency
Pu-239/240 = plutonium-239/240
ROD = record of decision

This page intentionally left blank.

3 Step 3 – Identify Information Inputs

This chapter identifies the inputs needed to resolve each of the DSs identified in Chapter 2. Table 3-1 identifies the data needed to resolve each of the DSs and identifies whether the data already exist and are of sufficient quality to resolve the DSs.

Table 3-1. Required Information and Reference Sources

DS	Information	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Additional Information Required? (Y/N)
1a	Radiological TRU element levels	Total concentration of TRU radionuclides	Y	Data from remedial investigation (HEIS database)	N	Y
1b	Radiological and chemical cleanup COCs at depths ≤4.6 m (15 ft) bgs	Concentration of radiological COCs relative to cleanup levels	Y	Data from remedial investigation (HEIS database)	N	Y
2a	Radiological composition and concentration levels of waste	Requirements specified in ERDF waste acceptance criteria as listed in WCH-191	Y	Data from remedial investigation (HEIS database)	N	Y
2b	Listed dangerous waste codes that apply to the waste	Listed dangerous waste code status per WAC 173-303, WHC-MR-0517,	Y	Data from remedial investigation (HEIS database); 216-Z-9 waste designation (WMP-38831); WIDS Summary Reports	N	Y
2c	Characteristic waste codes that apply to the waste	Characteristic waste code status per WAC 173-303	Y	Data from remedial investigation (HEIS database); 216-Z-9 waste designation (WMP-38831); WIDS Summary Reports	N	Y
2d	Toxic waste codes that apply to the waste	Toxic waste code status per WAC 173-303, WHC-MR-0517	Y	Data from remedial investigation (HEIS database); 216-Z-9 waste designation (WMP-38831); WIDS Summary Reports	Y	N

Table 3-1. Required Information and Reference Sources

DS	Information	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Additional Information Required? (Y/N)
2e	Persistent waste codes that apply to the waste	Persistent waste code status per WAC 173-303	Y	Data from remedial investigation (HEIS database); 216-Z-9 waste designation (WMP-38831); WIDS Summary Reports	Y	N
2f	PCB concentrations	Process knowledge	Y	Data from remedial investigation (HEIS database)	N	Y
2g	Asbestos concentrations	Process knowledge	Y	Data from remedial investigation (HEIS database)	Y	N
2h	Land disposal restricted materials	Requirements specified in 40 CFR 268.40	Y	Data from remedial investigation (HEIS database)	N	Y
3a	Radiological and chemical COCs at depths $\leq$4.6 m (15 ft) bgs relative to applicable cleanup levels	Concentration of the applicable 200-CW-5, 200-PW-1, and 200-PW-6 OU COCs	Y	Data from remedial investigation (HEIS database)	N	Y
3b	Radiological and chemical COCs at depths >4.6 m (15 ft) bgs	Distribution of the applicable 200-CW-5, 200-PW-1, and 200-PW-6 OU COCs	Y	Data from remedial investigation (HEIS database)	N	Y
3c	Pu-239/240 and Am-241 levels at the bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 excavations	Concentration of Pu-239/240 and Am-241	Y	Data from remedial investigation (HEIS database)	N	Y

Table 3-1. Required Information and Reference Sources

DS	Information	Required Data	Do Data Exist? (Y/N)	Source Reference	Sufficient Quality? (Y/N)	Additional Information Required? (Y/N)

Note: Complete reference citations are provided in Chapter 8.

Am-241 = americium-241
DS = decision statement
COC = contaminant of concern
ERDF = Environmental Restoration Disposal Facility
HEIS = Hanford Environmental Information System
OU = operable unit
PCB = polychlorinated biphenyl
Pu-239/240 = plutonium-239/240
TRU = transuranic
WIDS = Waste Information Data System

3.1 Analytical Performance Requirements

Table 3-2 provides analytical requirements for the data that need to be collected to resolve DSs 1a, 1b, and 3c. These data will be collected at the waste excavation sites and used to guide the remediation.

Table 3-2. Information Required to Resolve DSs 1a, 1b, and 3c

DS	Variable	Required Data	Computational Methods*	Survey/Sampling Methods
1a	Transuranic isotopes	Pu-239/240, Am-241	Scaling factor to Am-241, Origen Run; dose-to-curie	Field survey, sampling and laboratory analysis, scaling factors, NDA, Origen runs
1b	Radiological and chemical COCs	Cs-137, Ra-226, Pu-239/240, Am-241	Scaling factor to Am-241, Origen Run; dose-to-curie modeling; correlations	Field survey, sampling and laboratory analysis, scaling factors, NDA, Origen runs
c	Transuranic isotopes	Pu-239/240, Am-241	Scaling factor to Am-241, Origen Run; dose-to-curie	Field survey, sampling and laboratory analysis, scaling factors, NDA, Origen runs

Table 3-2. Information Required to Resolve DSs 1a, 1b, and 3c

DS	Variable	Required Data	Computational Methods*	Survey/Sampling Methods

* Sources: ANL, 2002, RESRAD for Windows, Version 6.21.

PNNL-11217, *STOMP, Subsurface Transport Over Multiple Phases, theory guide.*

PNNL-12034, *STOMP: Subsurface Transport Over Multiple Phases Version 2.0: User's Guide*.

WAC 173-340, "Model Toxics Control Act—Cleanup."

Am-241 = americium-241
DS = decision statement
COC = contaminant of concern
Cs-137 = cesium-137
DS = decision statement
NDA = nondestructive assay
Pu-239/240 = plutonium-239/240
Ra-226 = radium-226

Table 3-3 provides the analytical performance requirements for the data that need to be collected to resolve the DSs for waste generated during the remedial action (2a–2h). COPCs for waste management and their associated target required quantitation limits, precision, and accuracy are included in the table.

Table 3-3. Analytical Performance Requirements for DSs 2a–2h

		Preliminary Action Level					
COPCs	CAS	TC Dangerous Waste Threshold[a]	Universal Treatment Standard[b]	Name/Analytical Technology[c]	Target Required Quantitation Limits Soil	Precision Soil	Accuracy Soil
Radionuclides (pCi/g)							
Potassium-40	13966-00-2	N/A	N/A	Isotopic potassium-gamma energy analysis	30	≤30%	70-130%
Strontium-90	10098-97-2	N/A	N/A	Total radioactive strontium-gross proportional counting	1	≤30%	70-130%
Cesium-137	10045-97-3	N/A	N/A	Isotopic cesium-gamma energy analysis	0.1	≤30%	70-130%
Radium-226	13982-63-3	N/A	N/A	Isotopic radium-alpha energy analysis	1	≤30%	70-130%
Radium-228	15262-20-1	N/A	N/A	Isotopic radium-gamma energy analysis	1.6	≤30%	70-130%
Thorium-228	14274-82-9	N/A	N/A	Isotopic thorium-alpha energy analysis	1	≤30%	70-130%
Thorium-230	14269-63-7	N/A	N/A	Isotopic thorium-alpha energy analysis	1	≤30%	70-130%

Table 3-3. Analytical Performance Requirements for DSs 2a–2h

COPCs	CAS	Preliminary Action Level		Name/Analytical Technology[c]	Target Required Quantitation Limits Soil	Precision Soil	Accuracy Soil
		TC Dangerous Waste Threshold[a]	Universal Treatment Standard[b]				
Thorium-232	Th-232	N/A	N/A	Isotopic thorium-alpha energy analysis	0.43	≤30%	70-130%
Uranium-233/234	U-233/234	N/A	N/A	Isotopic uranium-alpha energy analysis	1	≤30%	70-130%
Uranium-238	U-238	N/A	N/A	Isotopic uranium-alpha energy analysis	1	≤30%	70-130%
Plutonium-238	13981-16-3	N/A	N/A	Isotopic plutonium-alpha energy analysis	1	≤30%	70-130%
Plutonium-239/240	Pu-239/240	N/A	N/A	Isotopic plutonium-alpha energy analysis	1	≤30%	70-130%
Americium-241	14596-10-2	N/A	N/A	Isotopic americium-alpha energy analysis	1	≤30%	70-130%
Inorganics (mg/kg)							
Ammonium Ion	14798-03-9	N/A	N/A	EPA Method 350.1	0.5	≤30%[e]	70-130%[e]
Arsenic	7440-38-2	100	5[d]	EPA Method 6010	10	≤30%[e]	70-130%[e]
Barium	7440-39-3	2,000	21[d]	EPA Method 6010	2	≤30%[e]	70-130%[e]
Beryllium	7440-41-7	N/A	1.22[d]	EPA Method 6020	0.2	≤30%[e]	70-130%[e]
Boron	7440-42-8	N/A	N/A	EPA Method 6010	0.5	≤30%[e]	70-130%[e]
Cadmium	7440-43-9	20	0.11[d]	EPA Method 6020	0.2	≤30%[e]	70-130%[e]
Chromium 6+	18540-29-9	100	0.60[d]	EPA Method 7196	0.5	≤30%[e]	70-130%[e]
Chromium (Total)	7440-47-3	100	0.60[d]	EPA Method 6020	0.2	≤30%[e]	70-130%[e]
Copper	7440-50-8	N/A	N/A	EPA Method 6010	0.8	≤30%[e]	70-130%[e]
Lead	7439-92-1	100	0.75[d]	EPA Method 6020	0.2	≤30%[e]	70-130%[e]
Lithium	7439-93-2	N/A	N/A	EPA Method 6010	2.5	≤30%[e]	70-130%[e]
Fluoride	16984-48-8	N/A	N/A	EPA Method 300	25	≤30%[e]	70-130%[e]
Manganese	7439-96-5	N/A	N/A	EPA Method 6020	0.5	≤30%[e]	70-130%[e]
Mercury	7439-97-6	4	0.025[d]	EPA Method 7471	0.2	≤30%[e]	70-130%[e]
Molybdenum	7439-98-7	N/A	N/A	EPA Method 6010	2	≤30%[e]	70-130%[e]
Nickel	7440-02-0	N/A	11[d]	EPA Method 6020	4	≤30%[e]	70-130%[e]

Table 3-3. Analytical Performance Requirements for DSs 2a–2h

COPCs	CAS	Preliminary Action Level		Name/Analytical Technology[c]	Target Required Quantitation Limits Soil	Precision Soil	Accuracy Soil
		TC Dangerous Waste Threshold[a]	Universal Treatment Standard[b]				
Nitrate	14797-55-8	N/A	N/A	EPA Method 300	12.5	≤30%[e]	70-130%[e]
Nitrite	14797-65-0	N/A	N/A	EPA Method 300	12.5	≤30%[e]	70-130%[e]
Potassium	7440-09-7	N/A	N/A	EPA Method 6010	400	≤30%[e]	70-130%[e]
Selenium	7782-49-2	20	5.7[d]	EPA Method 6020	0.4	≤30%[e]	70-130%[e]
Silver	7440-22-4	100	0.14[d]	EPA Method 6020	0.2	≤30%[e]	70-130%[e]
Sulfate	14808-79-8	N/A	N/A	EPA Method 300	27.5	≤30%[e]	70-130%[e]
Vanadium	7440-62-2	N/A	1.6[d]	EPA Method 6020	1	≤30%[e]	70-130%[e]
Zinc	7440-66-6	N/A	4.3[d]	EPA Method 6020	1	≤30%[e]	70-130%[e]
Organics (mg/kg)							
2-Pentanone	107-87-9	N/A	N/A	EPA Method 8260	0.01	≤30%[e]	70-130%[e, f]
2-Butanone	78-93-3	4,000	36	EPA Method 8260	0.01	≤30%[e]	[f]
1,1-Dichloroethane	75-34-3	N/A	6	EPA Method 8260	0.01	≤30%[e]	[f]
4-Methyl-2-pentanone	108-10-1	N/A	33	EPA Method 8260	0.01	≤30%[e]	[f]
n-Butyl Alcohol (1-Butanol)	71-36-3	N/A	2.6	EPA Method 8260	0.1	≤30%[e]	[f]
Acetone	67-64-1	N/A	160	EPA Method 8260	0.02	≤30%[e]	[f]
Aroclor 1248	12672-29-6	N/A	10	EPA Method 8082	0.008	≤30%[e]	[f]
Aroclor 1254	11097-69-1	N/A	10	EPA Method 8082	0.008	≤30%[e]	[f]
Aroclor 1260	11096-82-5	N/A	10	EPA Method 8082	0.008	≤30%[e]	[f]
Carbon Tetrachloride	56-23-5	10	6	EPA Method 8260	0.005	≤30%[e]	[f]
Chlorobenzene	108-90-7	2,000	6	EPA Method 8260	0.005	≤30%[e]	[f]
Chloroform	67-66-3	120	6	EPA Method 8260	0.005	≤30%[e]	[f]
Dichloromethane (Methylene Chloride)	75-09-2	N/A	30	EPA Method 8260	0.005	≤30%[e]	[f]
Tetrachloroethylene	127-18-4	14	6	EPA Method 8260	0.005	≤30%[e]	[f]

Table 3-3. Analytical Performance Requirements for DSs 2a–2h

COPCs	CAS	Preliminary Action Level: TC Dangerous Waste Threshold[a]	Preliminary Action Level: Universal Treatment Standard[b]	Name/Analytical Technology[c]	Target Required Quantitation Limits Soil	Precision Soil	Accuracy Soil
Toluene	108-88-3	N/A	10	EPA Method 8260	0.005	≤30%[e]	[f]
Tributyl Phosphate	126-73-8	N/A	N/A	EPA Method 8270	3.3	≤30%[e]	[f]
Trichloroethylene	79-01-6	10	6	EPA Method 8260	0.005	≤30%[e]	[f]
Oil and Grease	N/A	N/A	N/A	EPA Method 1664	200	≤30%	[f]

a. Waste disposition for this project will comply with the Toxicity Characteristic (40 CFR 268.40, "Land Disposal Restrictions," "Applicability of Treatment Standards"). This value applies to the maximum concentration of contaminants for designation as a dangerous waste under the toxicity characteristic. This value is 20 times the TCLP value. EPA allows the use of 20 times the TCLP values to determine the total action levels because of the "20 times" dilution used in the TCLP process.

b. Value reflects the Universal Treatment Standard as an underlying hazardous constituent in accordance with 40 CFR 268.48, "Land Disposal Restrictions," "Universal Treatment Standards." The unit value is in mg/kg unless otherwise indicated.

c. For EPA Methods 300.0 and 350.1, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*. For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.* Technically equivalent analytical methods may be substituted for the listed methods.

d. Value reflects the Universal Treatment standard as an underlying hazardous constituent in accordance with 40 CFR 268.48. The unit value is in mg/L TCLP.

e. Precision and accuracy requirements are identified and defined in the referenced CHPRC-00189, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*, procedure.

f. Accuracy is statistically derived as a part of the method QC.

CAS = Chemical Abstracts Service
COPCs = contaminants of potential concern
DS = decision statement
EPA = U.S. Environmental Protection Agency
N/A = not applicable
QC = quality control
TC = toxicity characteristic
TCLP = toxicity characteristic leaching procedure

Table 3-4 provides analytical performance requirements for the data that need to be collected to resolve the DSs 3a and 3b. COC cleanup levels and their associated target required quantitation limits, precision, and accuracy are included in the table.

Table 3-4. Analytical Performance Requirements for DSs 3a and 3b

COCs	CAS	ROD[a] Cleanup Level	Name/Analytical Technology[b]	Target Required Quantitation Limits Soil	Precision Soil	Accuracy Soil
Radionuclides (pCi/g)						
Strontium-90	10098-97-2	20	Total radioactive strontium – gas proportional counting	1	≤30%	70-130%
Technetium-99[c]	14133-76-7	N/A	Technetium-99 – liquid scintillation	1.5	≤30%	70-130%
Cesium-137	10045-97-3	17.7	GEA	0.1	≤30%	70-130%
Radium-226	13982-63-3	4	GEA	1	≤30%	70-130%
Plutonium-239/240	PU-239/240	765	Isotopic plutonium – AEA	1	≤30%	70-130%
Americium-241	14596-10-2	940	AEA	1	≤30%	70-130%
Inorganics (mg/kg)						
Boron	7440-42-8	0.5	EPA 6010	0.5	≤30%	70-130%
Mercury	7439-97-6	0.1	EPA 7471	0.2	≤30%	70-130%
Nitrate[c]	14797-55-8	N/A	EPA 353.2[c]	12.5	≤30%	70-130%
Organics (mg/kg)						
PCB	Various[d]	0.65	EPA 8082	0.008	≤30%	[e]

Table 3-4. Analytical Performance Requirements for DSs 3a and 3b

COCs	CAS	ROD[a] Cleanup Level	Name/Analytical Technology[b]	Target Required Quantitation Limits Soil	Precision Soil	Accuracy Soil

a. EPA, Ecology, and DOE, 2011, Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.
b. Where method-based analysis is appropriate, additional analytes will be reported. Technically equivalent analytical methods may be substituted for the listed methods.
c. Constituents were requested by Ecology; data were collected for informational purposes.
d. CAS numbers for each PCB constituent (Aroclor 1260 [11096-82-5], Aroclor 1254 [11097-69-1], Aroclor 1221 [11104-28-2], Aroclor 1232 [11141-16-5], Aroclor 1248 [12672-29-6], Aroclor 1016 [12674-11-2], and Aroclor 1242 [53469-21-9]).
e. Accuracy is statistically derived as a part of the method QC.

AEA	=	alpha energy analysis
CAS	=	Chemical Abstracts Service
COC	=	contaminant of concern
DS	=	decision statement
Ecology	=	Washington State Department of Ecology
EPA	=	U.S. Environmental Protection
GEA	=	gamma energy analysis
N/A	=	not applicable
PCB	=	polychlorinated biphenyl
QC	=	quality control
ROD	=	record of decision

3.2 Characterization Methods

A combination of process knowledge, calculations, sampling, nondestructive assay (NDA), in situ radiological measurements, and destructive assay (laboratory sample analysis) are available for characterization. A balanced approach using these methods needs to be considered as part of the DQO process to determine if additional information is required in order to select AAs specified in the DSs. Available characterization methods and sources are discussed in the following subsections.

3.2.1 Process Knowledge, Historical Data, and Calculations

Historical data and knowledge of the waste streams discharged to the facilities (trenches, tanks, and cribs) are available. Historical information and process knowledge indicate that the predominant radionuclides of concern for these waste sites are isotopes of plutonium and americium-241. These data can be used to generate scaling factors, which can then be used to calculate the activity of the radionuclides of concern based on field radiological measurements and/or NDA. Field radiological survey instruments are available that can be used to detect americium-241. Scaling factors can be developed from the historical data and used to calculate the activity of radionuclides of concern based on the field radiological survey instrument measurement and/or NDA.

3.2.2 In Situ Radiological Characterization Using the Dose-to-Curie Method

The feasibility of in situ radiological characterization relies on the radionuclide-specific scaling factors developed from the process knowledge/historical data to convert the field measured dose rates into radionuclide-specific activities. The ability to analyze for americium-241 contamination in the field

simplifies the process for determining transuranic (TRU) contamination. It gives immediate results, eliminates the need and cost for grabbing highly contaminated soil samples and sending them to a laboratory for analysis, and provides input for applying scaling factors for determining the activity of other TRU/radionuclides. A technical basis is developed to support logic that the quantity of transuranic radionuclides is strongly correlated to the quantity of americium-241, and a field exposure rate instrument can be used for characterization. Radiological survey instructions for use of the field detector are prepared that specify requirements for measurements (e.g., scan rate, count time, minimum detectable activity, source checks, and background count). Limitations associated with using a field detector include the ability to detect the americium-241 60 keV gamma emission in soil.

Figure 3-1 shows a radiological field detector mounted to a backhoe bucket for remote screening of soil and debris. Figure 3-2 shows a sodium-iodide detector and GPS equipment mounted to a cart for remote radiological screening of surface soil and debris in an excavation. Figure 3-3 shows an example of the data presentation from radiological field screening of an excavation.

Figure 3-1. Field Detector Mounted on a Backhoe Bucket

Figure 3-2. Field Detector and GPS Mounted on a Cart

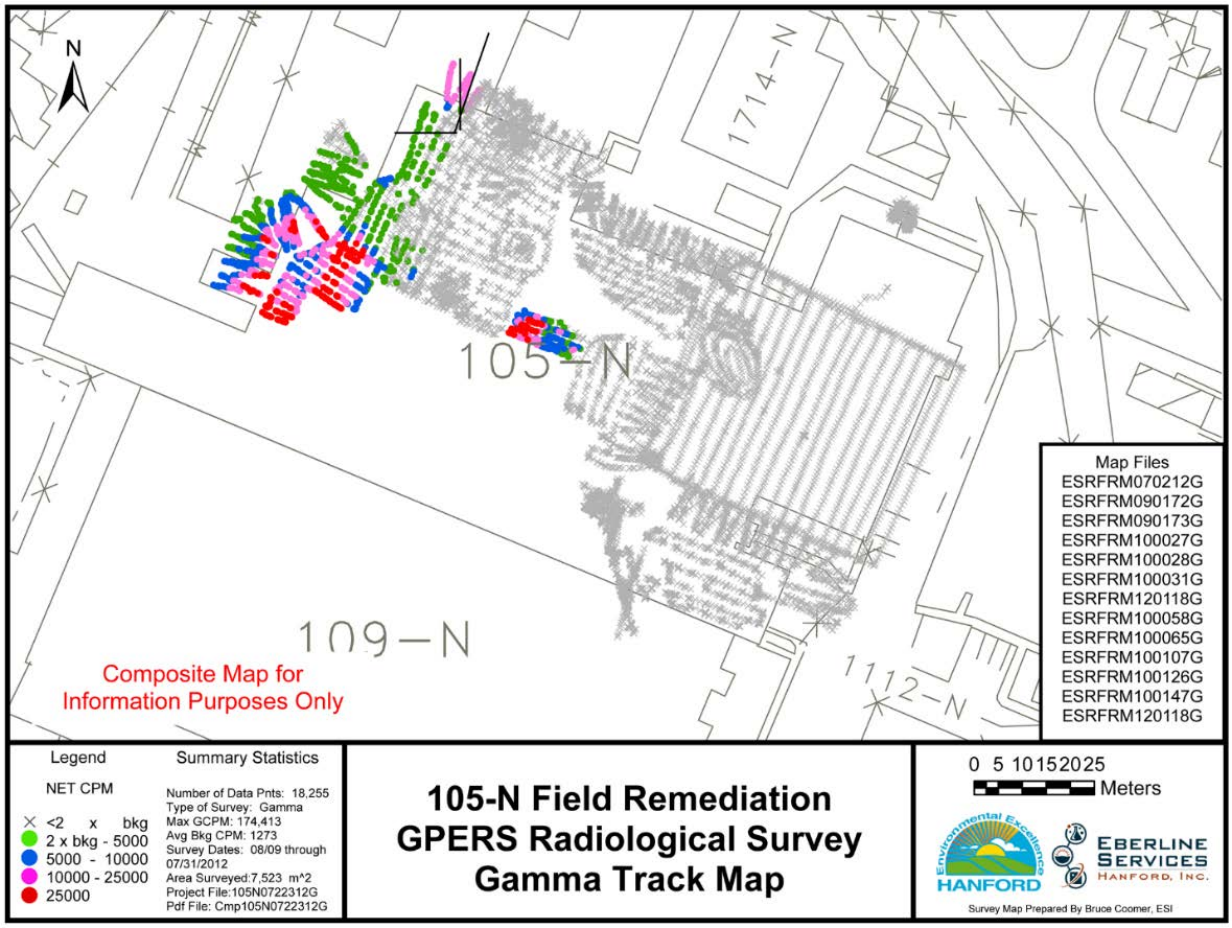


Figure 3-3. Radiological Field Screening Data Presentation

3.2.3 Nondestructive Assay

NDA is available for use in the field. NDA measures penetrating radiation emitted from containerized radioactive material. The detected radiation is related to the radionuclides present and their quantities. It is convenient and rapid, and in many cases, can provide an accurate measure of radioactivity packaged in containers from 3.8 to 11 L (1 to 3 gal) up to 114 to 208 L (30 to 55 gal) in size, including B-25 box-size containers. NDA is widely used because of its appeal in reducing sample collection of hazardous materials. Because NDA is a nonintrusive measurement, it eliminates the need for chemical separation of isotopes from one another, material processing to reduce radiation dose rates to levels manageable by the laboratory, and management of hazardous/radioactive waste generated by destructive analysis. As a result, exposure of personnel to radiation and hazardous substances is greatly reduced. For applications in which NDA is applicable, the sampling error that otherwise is associated with sampling heterogeneous materials is negligible. Because bulk measurement by NDA describes average radioactivity of the entire container, multiple NDA measurements of the same container are not required for improving the quality of the radioactivity measurement. However, there are restrictions in using NDA; it can suffer significantly from matrix effects in large containers. Under some field conditions, NDA cannot measure the isotopes present. Therefore, NDA results are often used in combination with destructive analysis and process knowledge. This allows scaling unmeasured isotopes to measured isotopes, to make better corrections for matrix and source effects, and to adjust parameters of the measurement system to achieve an optimized response. NDA is a three-step process: measure radiation, associate radiation with a specific radionuclide (or radionuclides), and determine the amount of each radionuclide. Figure 3-4 shows an example of a field NDA apparatus.

Figure 3-4. NDA Equipment

3.2.4 Sampling and Laboratory Analysis (Destructive Assay)

Collecting samples for laboratory analysis can provide an entire profile of a waste stream, including radiological and chemical constituents. However, a critical limitation of laboratory analysis is the adequacy of collecting a representative sample, particularly of a heterogeneous material. Sampling heterogeneous material will likely not result in a high level of representativeness; therefore, implementing highly rigorous quality control (QC) acceptance criteria on the laboratory analysis adds little value to the actual quality of the data. Obtaining representative samples of heterogeneous material is difficult and, in

the instance of debris, may be impossible without shredding and homogenizing to the extent practical prior to sampling. Often, this size reduction cannot be performed to provide a sample size that meets the minimal size (grams) which can be analyzed using laboratory instrumentation. The risk and cost of collecting samples of highly radioactive material for laboratory analysis should be factored into the sampling strategy. Of particular concern are prohibitive costs and as low as reasonably achievable concerns associated with unacceptable occupational exposure from collecting, packaging, shipping, and performing laboratory analysis on highly radioactive samples.

4 Step 4 – Define the Boundaries of the Study

Step 4 identifies the spatial, temporal, and practical constraints on the waste site sampling design. Table 4-1 specifies the characteristics that define the contaminant populations of interest for the waste sites under consideration.

Table 4-1. Characteristics that Define the Population of Interest

DS	Population of Interest	Unit Measurement Size
1a	Excavated soil and debris	Excavated waste volume (e.g., excavator bucket, screening tray)
1b	Excavation floor (Z Ditches and Settling Tanks) and side walls (at depth ≤4.6 m [15 ft] bgs for all waste sites)	Survey unit based on the size of the contamination control structure and weather enclosure
2a–2h	Excavated soil and debris	Waste container
3a	Soil at the excavation floor and side walls	Decision area (at depths ≤4.6 m [15 ft] bgs) based on the size of the contamination control structure and weather enclosure
3b	Excavation floor and sidewalls (at depths >4.6 m [15 ft] bgs) of waste sites	Bottom and sidewalls of waste site (at depths >4.6 m [15 ft] bgs) based on the size of the contamination control structure and weather enclosure
3c	Excavation floor of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites	Bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites based on the size of the contamination control structure and weather enclosure

DS = decision statement

The spatial scales for waste site decision making are based on the size of the contamination control structure and the weather enclosure that will be used to control potential spread of contaminants. The current design size of the contamination control structure is 45.7 m (150 ft) long by 36.6 m (120 ft) wide. The current design size of weather enclosure is 73 m (240 ft) long by 54.8 m (180 ft) wide. The enclosure will cover 5,013 m^2 (43,200 ft^2).

Table 4-2 presents the criteria for considering the recommended level of design rigor, based on the potential consequences of incorrect decisions and waste site access for resampling. Table 4-3 identifies the suggested rigor for the sampling designs. Practical constraints on data collection are summarized in Table 4-4.

Table 4-2. Consequences, Resampling Access, and Sampling Design Rigor Guidance

Consequences of Actions	Resampling Access	Sampling Design Rigor*
Severe	Inaccessible/accessible	Very robust/robust
Moderate	Inaccessible/accessible	Moderate/low
Low	Inaccessible/accessible	Low/low

* General guidance only; site-specific conditions must be considered for final site design needs.

Table 4-3. Sampling Time Frame and Design Rigor Guidance

DS	Time Frame	Qualitative Consequences of Inadequate Sampling Design (Severe/Moderate/Not Severe)	Resampling Access	Design Rigor*
1a	Real time	Moderate – risk of inappropriately packaging the waste	Inaccessible	Moderate
1b	Quick turnaround	Low – risk of erroneously deciding to stop excavation Risk of having rework	Accessible	Low
2a–2h	Radionuclides – real time NDA Chemicals – batch to set and/or adjust profiles	Moderate – risk of inappropriately shipping TRU waste to ERDF or shipping LDR soil and debris to ERDF without treatment	Inaccessible	Moderate for TRU Low for LDR due to process knowledge and historical data
3a	Post-excavation	Moderate – risk of leaving materials that present an unacceptable risk to industrial workers or ecological receptors (depths $\leq$4.6 m [15 ft] bgs)	Accessible	Moderate
3b	Post-excavation	Low – risk of leaving materials that are unacceptable at depths $\geq$4.6 m (15 ft) bgs	Inaccessible	Low
3c	Post-excavation (216-Z-9, 216-Z-1A, and 216-Z-18 only)	Low – risk of leaving materials that are unacceptable at depths $\geq$4.6 m (15 ft) bgs	Inaccessible	Low

* General guidance only; site-specific conditions must be considered for final site design needs.

DS = decision statement
ERDF = Environmental Restoration Disposal Facility
LDR = land disposal restriction
NDA = nondestructive assay
TRU = transuranic

1

Table 4-4. List of Practical Constraints on Data Collection

- Highly radioactive soil may not be accessible to workers during excavation.
- Waste will be loaded directly into waste containers, limiting access and ability to resample.
- Activity restraints for radiological samples that will be sent to analytical laboratories (lab licenses).
- Self-shielding of soils may present constraints for radiological survey instruments.
- Americium-241 low-energy gamma will not penetrate soil beyond the surface layer.
- Excavation may not be accessible for post-excavation sampling due to potential radiological exposure.
- The size of contamination control structures and enclosures may present constraints.
- The bottom of excavations may be inaccessible due to padding in soils.
- Waste management samples may be highly radiologically contaminated.
- Discrete samples from the excavation bottoms may be highly radiologically contaminated.

1

This page intentionally left blank

5 Step 5 – Develop the Analytic Approach

Step 5 of the DQO process involves developing an analytic approach that will guide how to analyze the study results and draw conclusions from the data. The purpose of Step 5 is to define decision making parameters and statistics of interest (e.g., maximum value, population mean, and 95 percent upper confidence level [UCL] on the mean).

5.1 Decision Rule Development

The parameters of interest and associated statistics of interest are identified in Table 5-1; the scale for decision making is presented in Table 5-2.

Table 5-1. Statistical Parameters and Associated Statistics of Interest

DS	DS Summary	Parameter of Interest	Statistic
1a	Determine TRU levels in order to properly segregate and manage waste as it is generated during remediation.	TRU activity in soil and debris	Field survey measurements – maximum value
1b	Determine if residual contaminant concentrations in the excavation at depths ≤4.6 m (15 ft) bgs are below the applicable cleanup levels of the ROD (EPA et al., 2011), and excavation may stop.	Radiological activity in soil	Field survey measurements – distribution of values
2a	Determine if the material is radiologically compliant with ERDF waste acceptance criteria and can be evaluated for treatment/disposal at ERDF.	Radiological activity in soil and debris	Field measurement (NDA) – average value
2b	Determine if the material is a listed dangerous waste and can be evaluated for treatment/disposal at ERDF or managed at the SWOC.	Soil concentration	Focused samples – maximum value
2c	Determine if the material is a characteristic waste and can be evaluated for treatment/disposal at ERDF or managed at the SWOC.	Soil concentration	Focused samples – maximum value
2d	Determine if the material is a toxic dangerous waste and can be evaluated for treatment/disposal at ERDF or managed at the SWOC.	Soil concentration	Focused samples – maximum value
2e	Determine if the material is a persistent waste and can be evaluated for treatment/disposal at ERDF or managed at the SWOC.	Soil concentration	Focused samples – maximum value
2f	Determine if the material is a PCB waste and can be evaluated for treatment/disposal at ERDF or managed at the SWOC.	Soil concentration	Focused samples – maximum value
2g	Determine if the material is asbestos waste and requires proper handling.	Soil concentration	Focused samples – maximum value
2h	Determine if the material is land disposal restricted and requires treatment before disposal.	Soil concentration	Focused samples – maximum value

Table 5-1. Statistical Parameters and Associated Statistics of Interest

DS	DS Summary	Parameter of Interest	Statistic
3a	Determine if residual concentrations of applicable COCs at depths ≤4.6 m (15 ft) bgs in the waste sites are less than the applicable cleanup levels of the ROD (EPA et al., 2011).	Soil concentration	Discrete samples – sampling design based on systematic radiological surveys
3b	Determine if the nature and extent of applicable COCs ≥4.6 m (15 ft) bgs in the waste sites is adequately documented.	Soil concentration and distribution of applicable COCs	Systematic radiological surveys supplemented with discrete samples as needed
3c	Determine if residual concentrations of Pu-239/240 and Am-241 in the bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites are acceptable.*	Soil concentration and distribution of Pu-239/240 and Am-241	Systematic radiological surveys supplemented with discrete samples as needed

Source: EPA et al., Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.

* Parameters for this decision need to be determined prior to implementation of the remedial action.

Am-241	=	americium-241
COC	=	contaminant of concern
DS	=	decision statement
ERDF	=	Environmental Restoration Disposal Facility
NDA	=	nondestructive assay
PCB	=	polychlorinated biphenyl
Pu-239/240	=	plutonium-239/240
ROD	=	record of decision
SWOC	=	Solid Waste Operations Complex
TRU	=	transuranic

Table 5-2. Scale for Decision Making

DS	Scale for Decision Making
1a	Excavated waste volume
1b	Waste site decision area (sidewall and/or bottom ≤4.6 m [15 ft] bgs) based on the size of the contamination control structure and weather enclosure
2a	Waste container
2b	Waste site
2c	Waste site
2d	Waste site

Table 5-2. Scale for Decision Making

DS	Scale for Decision Making
2e	Waste site
2f	Waste site
2g	Waste site
2h	Waste site
3a	Waste site decision area (sidewall and/or bottom ≤4.6 m [15 ft] bgs) based on the size of the contamination control structure and weather enclosure
3b	Waste site decision area (at depths >4.6 m [15 ft] bgs) based on the size of the contamination control structure and weather enclosure
3c	Bottom of 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Site excavations based on the size of the contamination control structure and weather enclosure

DS = decision statement

The next step develops decision rules (DRs) that provide the criteria for taking actions. The DRs state what action is to be taken when prescribed conditions are met. Figure 5-1 shows the decision-making process for segregating TRU waste from LLW (DS 1a). Table 5-3 presents the DRs that correspond to DSs 1a and 1b.

Table 5-3. DRs for DSs 1a and 1b

DS	DR	
1a	1a	Segregate LLW from TRU waste: If the maximum concentrations of TRU radionuclides in the wastes **exceed** the ERDF waste acceptance criteria, segregate the waste and manage it for storage at the SWOC. Otherwise, manage the waste for disposal at EDRF and proceed to DS 2a.
1b	1b	Guide the Excavation: If the radiological survey measurements at depths ≤4.6 m (15 ft) bgs indicate the COCs **do not exceed** the ROD (EPA et al., 2011) cleanup levels, then evaluate stopping the excavation. Otherwise, continue excavation or provide the data to DOE for discussion with EPA.

Table 5-3. DRs for DSs 1a and 1b

DS	DR

Source: EPA et al., Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.

COC	=	contaminant of concern
DOE	=	U.S. Department of Energy
DR	=	decision rule
DS	=	decision statement
EPA	=	U.S. Environmental Protection Agency
ERDF	=	Environmental Restoration Disposal Facility
LLW	=	low-level waste
ROD	=	record of decision
SWOC	=	Solid Waste Operations Complex
TRU	=	transuranic

Figure 5-2 presents a flowchart of the decision-making process for designating and managing waste materials (DSs 2a through 2h). Table 5-4 presents the DRs that correspond to DSs 2a through 2h.

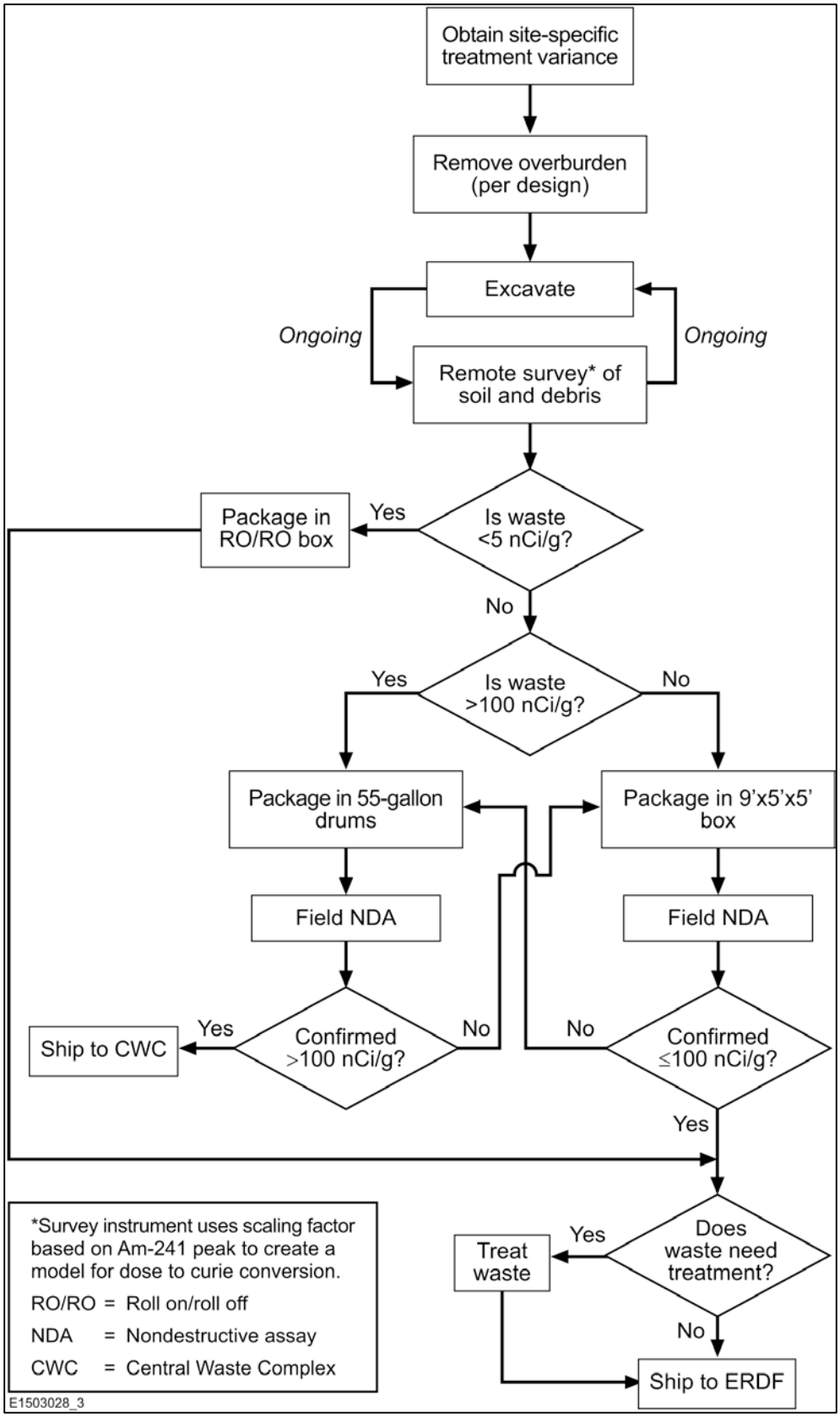


Figure 5-1. Decision-Making Process for DS 1a

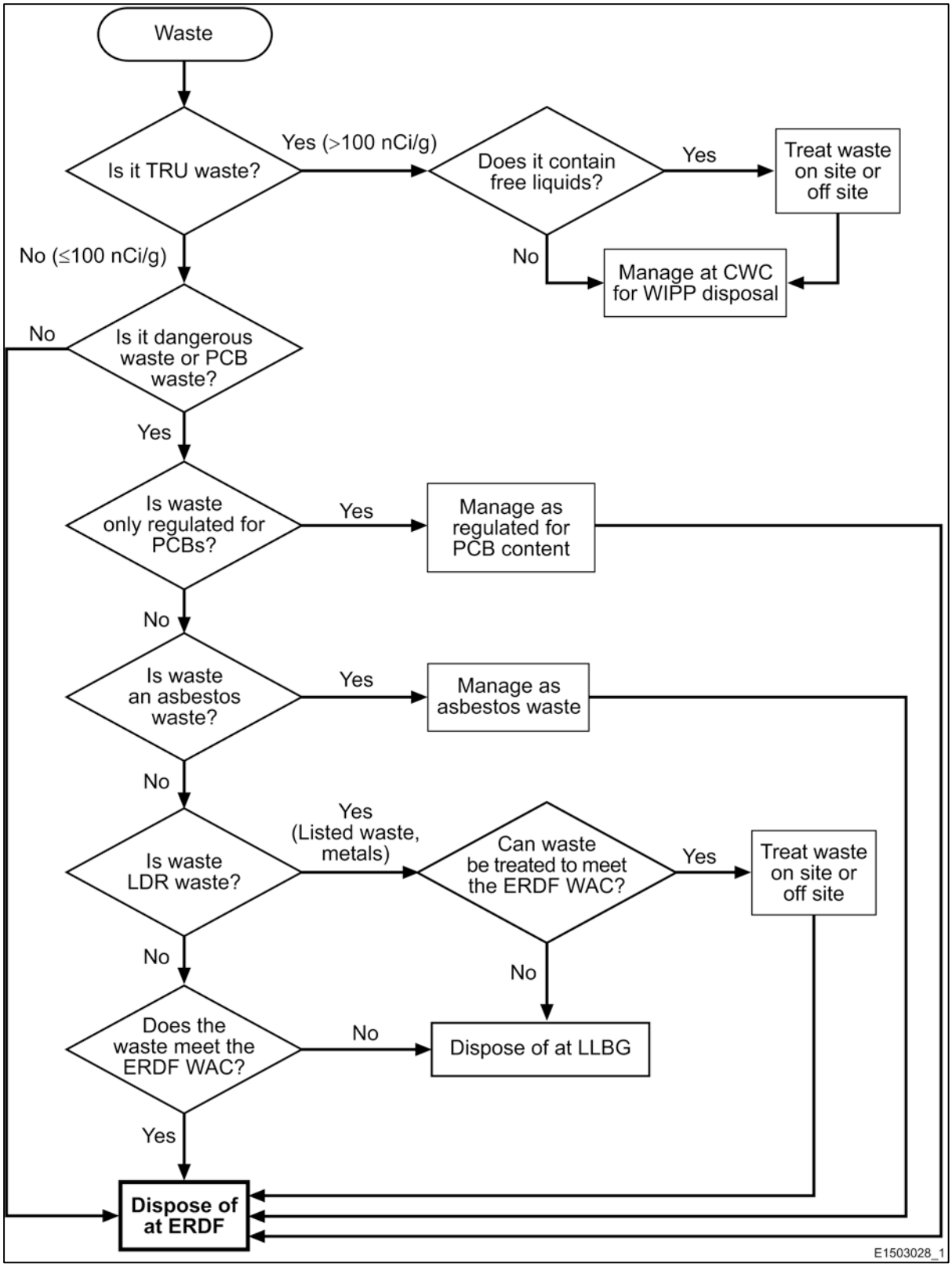


Figure 5-2. Decision-Making Process for DSs 2a–2h

Table 5-4. DRs for DSs 2a–2h

DS	DR	
2a	2a	Radiologically contaminated: If the maximum concentrations of radionuclides in the soil and debris **do exceed** the ERDF waste acceptance criteria, evaluate other storage and disposal options, including the SWOC. Proceed to DR 2b.
2b	2b	Listed dangerous waste: If the soil and debris **are** a listed dangerous waste, then evaluate for treatment/disposal at ERDF or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within SWOC. Otherwise, if the soil and debris **are not** a listed dangerous waste, then evaluate for treatment/disposal at ERDF. Proceed to DR 2c.
2c	2c	Characteristic dangerous waste: If the chemical concentrations in the soil and debris **do exceed** the criteria for being a characteristic dangerous waste, treat the material as a radiologically contaminated characteristic dangerous waste and evaluate for treatment/disposal at ERDF or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within SWOC. Otherwise, if the chemical concentrations in the soil and debris **do not exceed** the criteria for being a characteristic dangerous waste, do not treat the material as a characteristic dangerous waste and evaluate for treatment/disposal at ERDF. Proceed to DR 2d.
2d	2d	Toxic dangerous waste: If the chemical concentrations in the soil and debris **do exceed** the criteria for being a toxic dangerous waste, then treat the material as a radiologically contaminated toxic dangerous waste and evaluate for treatment/disposal at ERDF or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within SWOC. Otherwise, if the chemical concentrations in the soil and debris **do not exceed** the criteria for being a toxic dangerous waste, then do not treat the material as a toxic dangerous waste and evaluate for treatment/disposal at ERDF. Proceed to DR 2e.
2e	2e	Persistent dangerous waste: If the chemical concentrations in the soil and debris **do exceed** the criteria for being a persistent dangerous waste, then treat the material as a radiologically contaminated persistent dangerous waste and evaluate for treatment/disposal at ERDF or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within SWOC. Otherwise, if the chemical concentrations in the soil and debris **do not exceed** the criteria for being a persistent dangerous waste, then do not treat the material as a persistent dangerous waste and evaluate for treatment/disposal at ERDF. Proceed to DR 2f.
2f	2f	PCB waste: If the chemical concentrations in the soil and debris **do exceed** the criteria for being a PCB waste, treat the material as a radiologically contaminated PCB waste and evaluate for treatment/disposal at the ERDF or perform treatment at an onsite or offsite facility prior to ERDF disposal. If treatment options are not available, the waste may be managed within SWOC. Otherwise, if the chemical concentrations in the soil and debris **do not exceed** the criteria for being a PCB waste, do not treat the material as a PCB waste and evaluate for treatment/disposal at ERDF. Proceed to DR 2g.
2g	2g	Asbestos waste: If the asbestos concentrations **do exceed** the criteria for being an asbestos waste, treat the material as a radiologically contaminated asbestos waste and evaluate for treatment/disposal at ERDF. Otherwise, if the asbestos concentrations **do not exceed** the criteria for being an asbestos waste, do not treat the material as an asbestos waste and evaluate for treatment/disposal at ERDF. Proceed to DR 2h.

Table 5-4. DRs for DSs 2a–2h

DS	DR	
2h	2h	Land disposal restricted: If process knowledge or analytical results **do dictate** LDR-imposed treatment, the material shall be treated/disposed of at ERDF or treatment will be performed at an onsite or offsite facility prior to ERDF disposal. Otherwise, if treatment options are not available, the waste may be managed within SWOC.

DR = decision rule
DS = decision statement
ERDF = Environmental Restoration Disposal Facility
LDR = land disposal restriction
PCB = polychlorinated biphenyl
SWOC = Solid Waste Operations Complex

Figure 5-3 presents a flowchart of the decision-making process for collecting and evaluating final data from the waste sites following remediation (DSs 3a, 3b, and 3c). Table 5-5 presents the DRs that correspond to DSs 3a, 3b, and 3c.

Table 5-5. DRs for DSs 3a, 3b, and 3c

DS	DR	
3a	3a	Evaluate levels of residual COCs at depths ≤4.6 m (15 ft) bgs in the remediated waste site soils: If the residual concentrations of COCs at depths ≤4.6 m (15 ft) bgs in the remediated waste site soils **do not exceed** the applicable cleanup levels of the ROD (EPA et al., 2011), then provide the data to DOE and begin preparations to complete the remedial action. Otherwise, provide the data to DOE for discussion with EPA.
3b	3b	Evaluate the nature and extent of residual COCs at depths >4.6 m (15 ft) bgs in the remediated waste site soils: If the nature and extent of COCs at depths ≥4.6 m (15 ft) bgs in the waste site soils **is acceptable,*** then begin preparations to complete the remedial action. Otherwise, provide the data to DOE for discussion with EPA.
3c	3c	Evaluate residual concentrations of Pu-239/240 and Am-241 at the bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites: If the residual concentrations of Pu-239/240 and Am-241 at the bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites **are acceptable,*** then begin preparations to complete the remedial action. Otherwise, provide the data to DOE for discussion with EPA.

Source: EPA, et al., *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*

* Parameters for this decision need to be determined prior to implementation of the remedial action.

Am-241 = americium-241
COC = contaminant of concern
DOE = U.S. Department of Energy
EPA = U.S. Environmental Protection Agency
Pu-239/240 = plutonium-239/240
ROD = record of decision

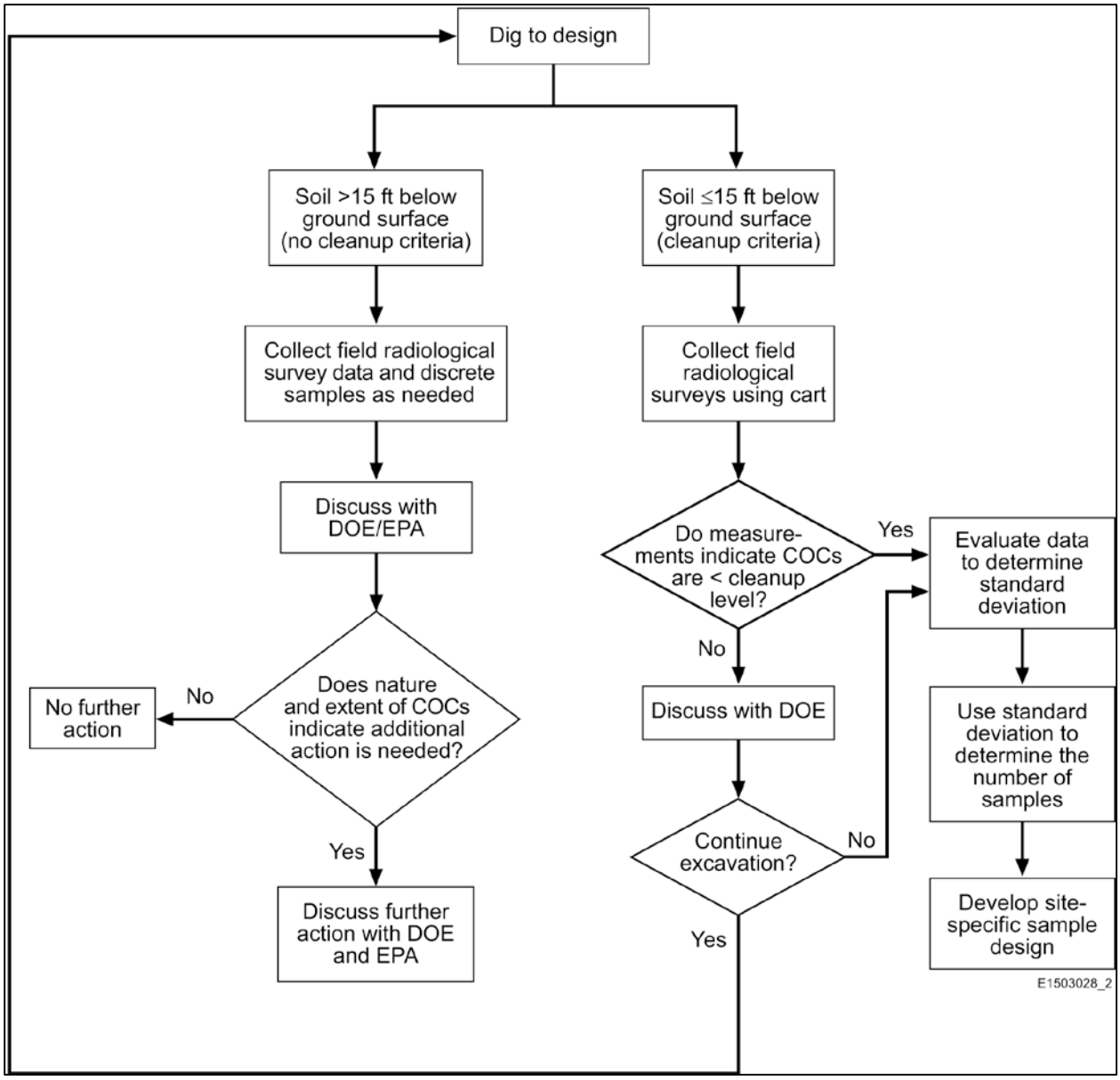


Figure 5-3. Decision-Making Process for DSs 3a, 3b, and 3c

This page intentionally left blank

6 Step 6 – Specify Performance or Acceptance Criteria

Step 6 of the DQO process derives the performance or acceptance criteria that the collected data will need to achieve in order to minimize the possibility of making erroneous conclusions. Step 6 is used to develop tolerable limits on decision errors. The established error limits are used to estimate the number of samples needed and to establish data performance goals.

6.1 Conceptual Site Model for Sample Designs

A combination of field radiological surveys and focused and/or statistical sampling methods are suitable to support the remedial action decisions for the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites:

- Field radiological measurements are recommended to support the decisions involving segregating waste (DS 1a) and guiding the excavation (DS 1b).
- NDA and focused sampling for laboratory analysis are recommended for designating waste (DSs 2a through 2h). Focused sampling uses professional judgment to determine the areas of interest. The sampling locations may be defined using historical/remediation process information, analogous site data, observations, and/or field surveys.
- For decisions involving comparison of residual concentrations of COCs at depths of $\leq$4.6 m (15 ft) bgs to cleanup levels (DS 3a), a statistical sampling approach is recommended using a systematic grid. The number of statistical samples needed for each decision unit may be adjusted using systematic radiological survey results to determine variance the applicable contaminants.
- For decisions involving determining the nature and extent of residual COCs at depths of >4.6 m (15 ft) bgs (DSs 3b and 3c), a gridded radiological survey approach supplemented with focused samples for laboratory analysis is recommended. Focused samples will be collected to evaluate chemical COCs and verify the radiological survey measurements.

Figure 6-1 shows the conceptual site model (CSM) for the recommendations to resolve DSs 3a, 3b, and 3c.

6.2 Developing Parameters for the Statistical Sample Design

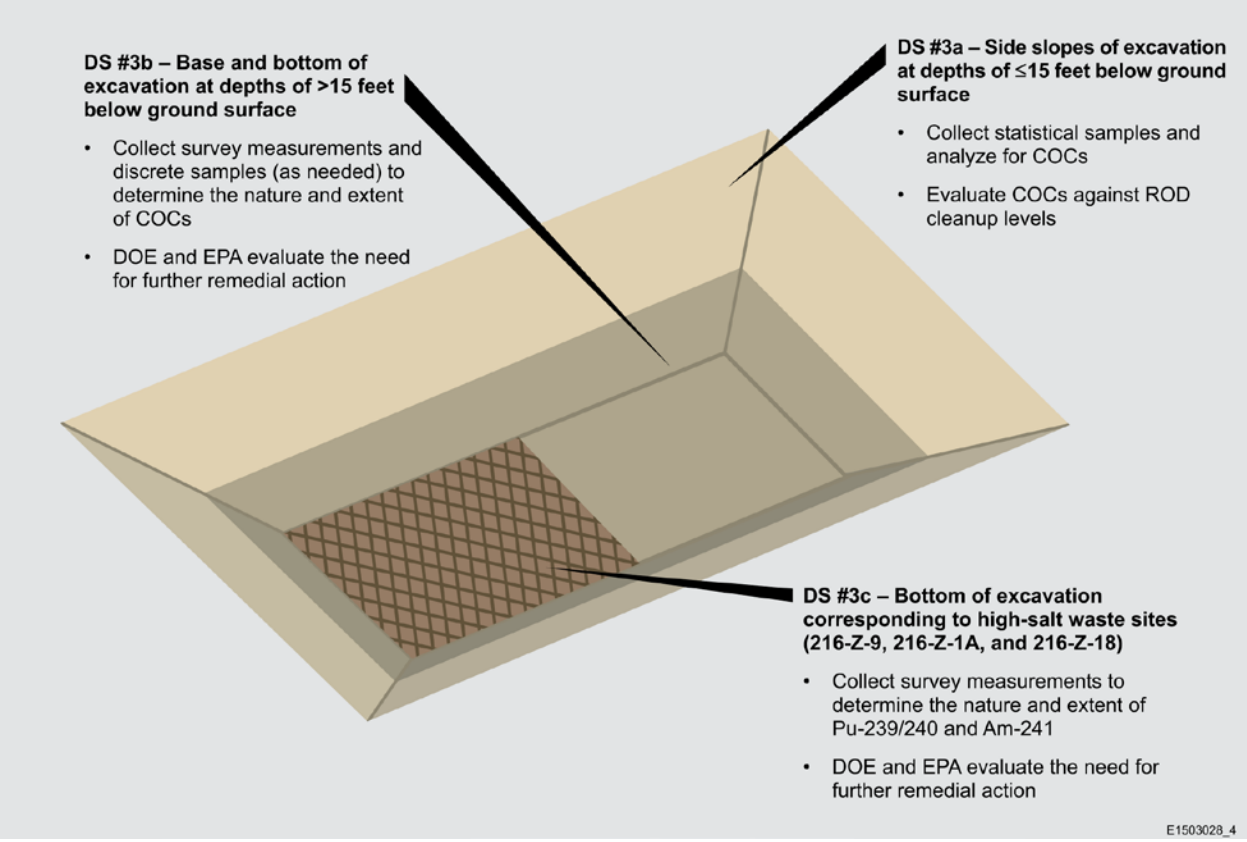
This section provides information on developing limits for decision errors for statistical sampling methods to resolve DS 3a. The gridded radiological surveys and supplemental focused samples for laboratory analysis (DSs 3b and 3c) are not statistically based. Therefore, statistical designs are not required.

The following subsections define limits on the probability of making a decision error to resolve DS 3a.

6.2.1 Uncertainty and Decision Errors

The statistical approach involves defining an acceptable level of uncertainty and computing the required number of samples based on that uncertainty and on the variability of contaminants at the site. The data collected using this approach would be of sufficient quantity to support calculation of the statistic of interest and subsequent hypothesis testing if site conditions are similar to those shown in historical or field screening data.

The null hypothesis assumes the site media are contaminated until they are shown to be clean. Table 6-1 shows the two types of decision errors that could be made based on the null hypothesis and the potential consequences of each type of error.



Reference: EPA et al., *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*

Figure 6-1. CSM for DSs 3a, 3b, and 3c

Table 6-1. Potential Consequences of Decision Error

Type of Decision Error	Impact	Potential Consequences
False positive: Mistakenly reject the null hypothesis (i.e., erroneously conclude that site contamination does not require remedial action).	The site would not be remediated when it should be remediated.	Unacceptable risk to industrial workers and environmental receptors
False negative: Mistakenly fail to reject the null hypothesis (i.e., erroneously conclude that site contamination requires remedial action).	The site would be remediated unnecessarily.	Expenditure of site resources to perform unnecessary remediation

Table 6-2 shows the tolerable decision error rates selected for decisions involving comparison of residual concentrations of radionuclides and chemicals at depths of ≤4.6 m (15 ft) bgs to the ROD (EPA et al., 2011) cleanup levels (DS 3a). The parameter of interest is the mean value of sample data. This value will be compared to applicable cleanup levels. The 95 percent UCL is the statistical parameter of interest for radionuclide and chemical COCs and establishes that there is a 95 percent certainty that the sample mean is not greater than the 95 percent UCL. This ensures that there is only a 5 percent probability of erroneously concluding the site does not need remedial action (false positive). Conversely, the probability of erroneously concluding that the site requires remedial action (false negative) is set at 20 percent.

Table 6-2. Tolerable Decision Errors

DS	Media	COCs	Parameter of Interest	Statistic of Interest	Tolerable Decision Error	
					False Positive (%)	False Negative (%)
3a	Soil	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, boron, mercury, Aroclor 1254, and Aroclor 1260	Mean	95% UCL	5	20

COC = contaminant of concern
DS = decision statement
UCL = upper confidence limit

6.2.2 Performance Goals for the Sample Design

The remedial investigation soil data from the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites were evaluated for use in developing preliminary performance goals for the sample design. Using historical information and process knowledge, it was decided that the americium-241 values were a representative constituent for establishing the number of samples needed to meet the performance goals.

As stated in the previous subsection, the parameter of interest is the population mean. The population of interest is the concentration of americium-241 in the excavation at depths less than or equal to 4.6 m (15 ft) bgs. The soil data from the remedial investigation of the 216-Z-11 Ditch were used to calculate the standard deviation (SD) of the data set.

Visual Sample Plan (VSP) was then used to determine the number of samples that would meet the performance goals using the americium-241 values from the remedial investigation data set. The following parameters were entered into the VSP tool:

- The radiological activity of americium-241 in 20 samples collected above 4.6 m (15 ft) depth for the 216-Z-11 Ditch range from 0.189 to 919 pCi/g.
- The SD of the historical americium-241 data is 260 pCi/g.
- The ROD (EPA et al., 2011) cleanup value of 940 pCi/g americium-241 is selected as the action level.

The evaluation of the false-negative decision error uses the lower bound of the gray region in conjunction with the sample mean and SD. The gray region is defined as a range of values for the parameter of interest (mean value of americium-241) where the consequences of making a decision error are considered acceptable. In this case, values in the gray region would inappropriately determine the site is contaminated (false negative) and require additional remediation. However, this consequence outweighs the alternative of determining that the site meets cleanup values when it does not. The gray region is bounded on one side by the action level and on the other side by that parameter value where the consequences of making a false acceptance decision error are considered significant.

In determining the number of samples needed to meet the performance goals, VSP can be used to see the effect of altering the gray region. Table 6-3 shows a summary of the effect of widening the width of the gray region (accepting a greater probability of a false negative) for the 216-Z-1 Ditch americium-241

data. In this case, it was determined that a width of the gray region of 400 was acceptable to the performance goals of the project, and a minimum number of 12 samples was selected as the default value for the sample in Step 7 of this DQO.

Table 6-3. Number of Samples Needed to Meet the Performance Goals

False Positive (%)	False Negative (%)	Width of the Gray Region	Lower Bound of the Gray Region	Upper Bound of the Gray Region	Number of Samples per Decision Area
5	20	200	740	940	24
5	20	250	690	940	18
5	20	300	640	940	14
5	20	400	590	940	12

As stated previously, this is a preliminary estimate of the sample statistics and resulting recommended number of samples. During implementation of the remedial actions, it is recommended that results of systematic radiological survey be used to determine the SD of the measured activity of americium-241. VSP, or a similar program, can then be used to determine the optimum number of samples that would meet the performance goals using the site-specific americium-241 data.

6.2.3 Sample Cost

The estimated cost for analyzing soil samples for the ROD (EPA et al., 2011) cleanup constituents at an offsite commercial laboratory is $1,000 per sample. Due to radiological limits on the offsite laboratories, it is estimated that samples containing greater than about 25 nCi/g activity would need to be analyzed at the 222-S Laboratory. Based on recent estimates to perform analytical work at the 222-S Laboratory, the cost for a comparable analysis is roughly 15 times the commercial cost, or $15,000 per sample.

7 Step 7 – Develop the Design for Obtaining Data

Performing Steps 1 through 6 of the DQO process results in a set of performance criteria that collected data will need to achieve. The goal of DQO Step 7 is to develop a resource-effective data collection design that is sufficient to fulfill the study objectives developed in DQO Steps 1 through 6 and achieve the performance criteria.

7.1 Conceptual Site Model

A CSM of contamination levels beneath the 216-Z-1A Waste Site was produced using the characterization data from the remedial investigation. The model of this high-salt waste site is useful for understanding the nature and extent of expected contamination and how the elements of the sample design will provide information to meet RAOs.

Evaluation of the historical data, including data collected from the remedial investigation, indicates that radiological contamination associated with the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites consists predominantly of americium-241 and isotopes of plutonium, with little contribution from mixed fission products or other gamma-emitting radionuclides.

Figure 7-1 presents a cross section of plutonium and americium-241 soil concentrations as modeled beneath the long axis of the 216-Z-1A Tile Field. The black-lined outline depicts the engineered structure of the waste site. The yellow line beneath the structure depicts a depth of 6.1 m (20 ft) bgs at the waste site. This is the design depth of excavation as provided in the ROD (EPA et al., 2011).

Furthermore, as indicated by Figure 7-1, the distribution of plutonium and americium-241 in the soil is very similar. Although the radiological activities of these two radionuclides differ, they appear to be consistently collocated. This supports the concept that americium-241, having a low-energy gamma emission that can be detected using field radiological survey instruments, could be used as a key radionuclide for determining the activity concentrations of the other difficult-to-measure radionuclides, particularly the isotopes of plutonium.

The figure also shows that even after remediation to the design depth, a large amount of radiological contamination will remain in the soil. These remaining levels of contamination, consisting predominantly of TRU contaminants, will pose difficulty in collecting soil samples for laboratory analysis for the purpose of characterizing the residual contamination levels. The analytical cost for these samples is likely to be high.

Figure 7-2 presents a similar cross section of plutonium and americium-241 soil concentrations modeled through the width of the 216-Z-1A Tile Field in the region of highest concentration. This figure indicates that the residual contamination will be most concentrated in the center portion of the waste site. Based on this model, characterization of the sidewalls of the excavation should encounter lower levels of TRU contaminants.

As can be seen from this representation of the CSM, the soil beneath the center portion of the 216-Z-1A Tile Field contains high-activity levels of plutonium and americium-241 that are collocated and appear to be consistent in relative concentrations. This information supports the use of field radiological survey methods with focused sampling, as needed, to confirm the field radiological measurements and concentrations of chemical constituents. Statistical sampling will be limited to sampling associated with closeout decisions where residual levels of COCs are directly compared to final cleanup levels specified in the ROD (EPA et al., 2011). The elements of the sample design are described in the following sections.

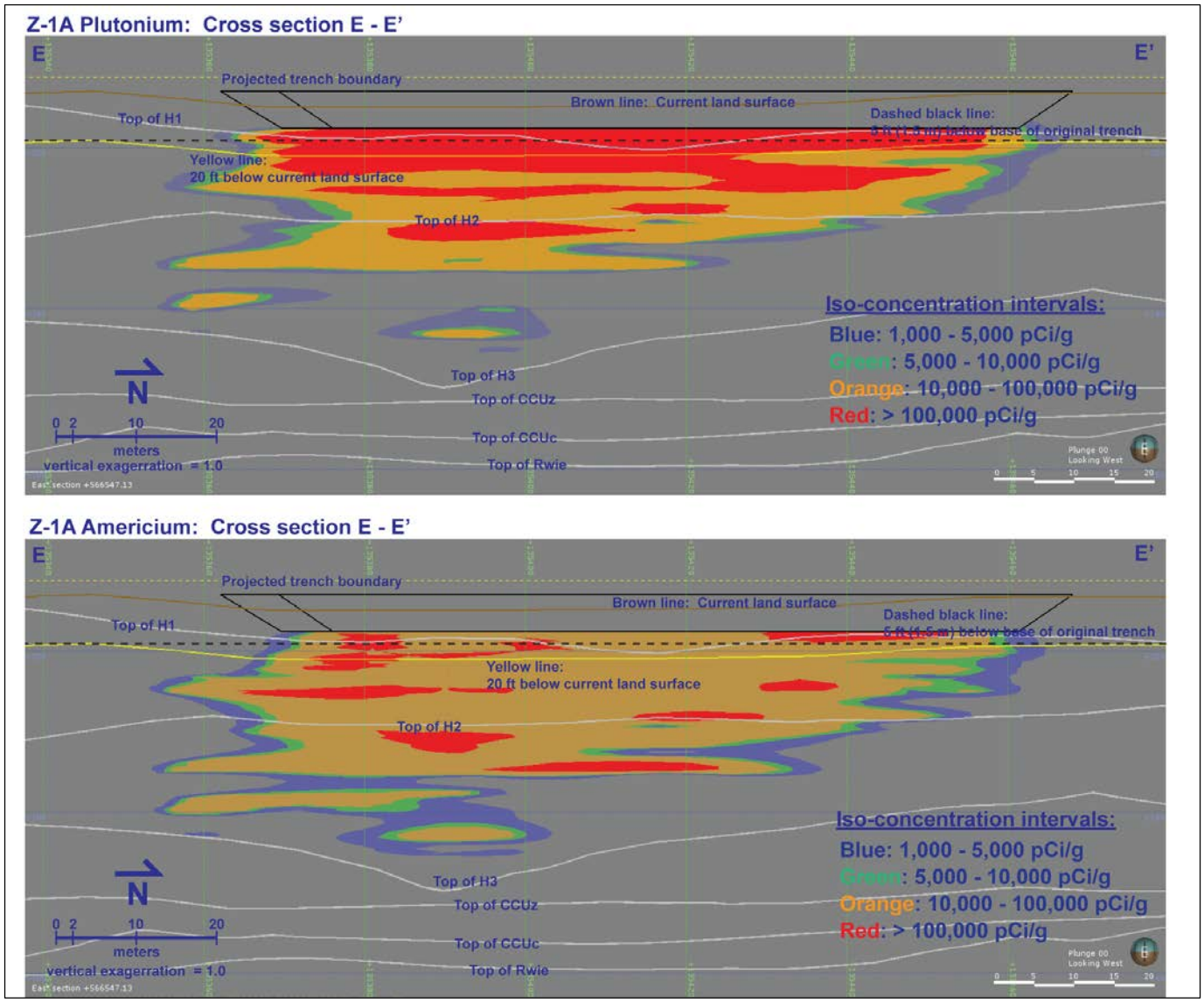


Figure notes:

CCUc	=	Cold Creek unit – calcic	H2	=	Hanford formation unit 2
CCUz	=	Cold Creek unit – silt dominated	H3	=	Hanford formation unit 2
H1	=	Hanford formation unit 1	Rwie	=	member of Wooded Island – unit E

Figure 7-1. Plutonium and Am-241 Soil Concentrations beneath the 216-Z-1A Tile Field (Long Axis)

7.2 Nonstatistical Design

This section describes the nonstatistical sample design methods that will be used to resolve DSs involved with segregating waste materials (DS 1a), guiding the excavation (DS 1b), and designating waste (DSs 2a through 2h).

7.2.1 Field Radiological Survey Methods

Historical information and process knowledge indicate the predominant radionuclides of concern for these waste sites are isotopes of plutonium and americium-241. Sodium iodide scintillation detectors can be used to detect the 60 keV gamma ray emitted by americium-241 that indicates the presence and relative concentrations of the radionuclides of concern. Although this is not a high-energy photon, and it is

emitted about 36 percent of the time, the high concentrations of americium-241 in the soil and the high action levels for the decisions contribute to effective use of americium-241 as a field indicator of the radionuclides of concern in surface soils.

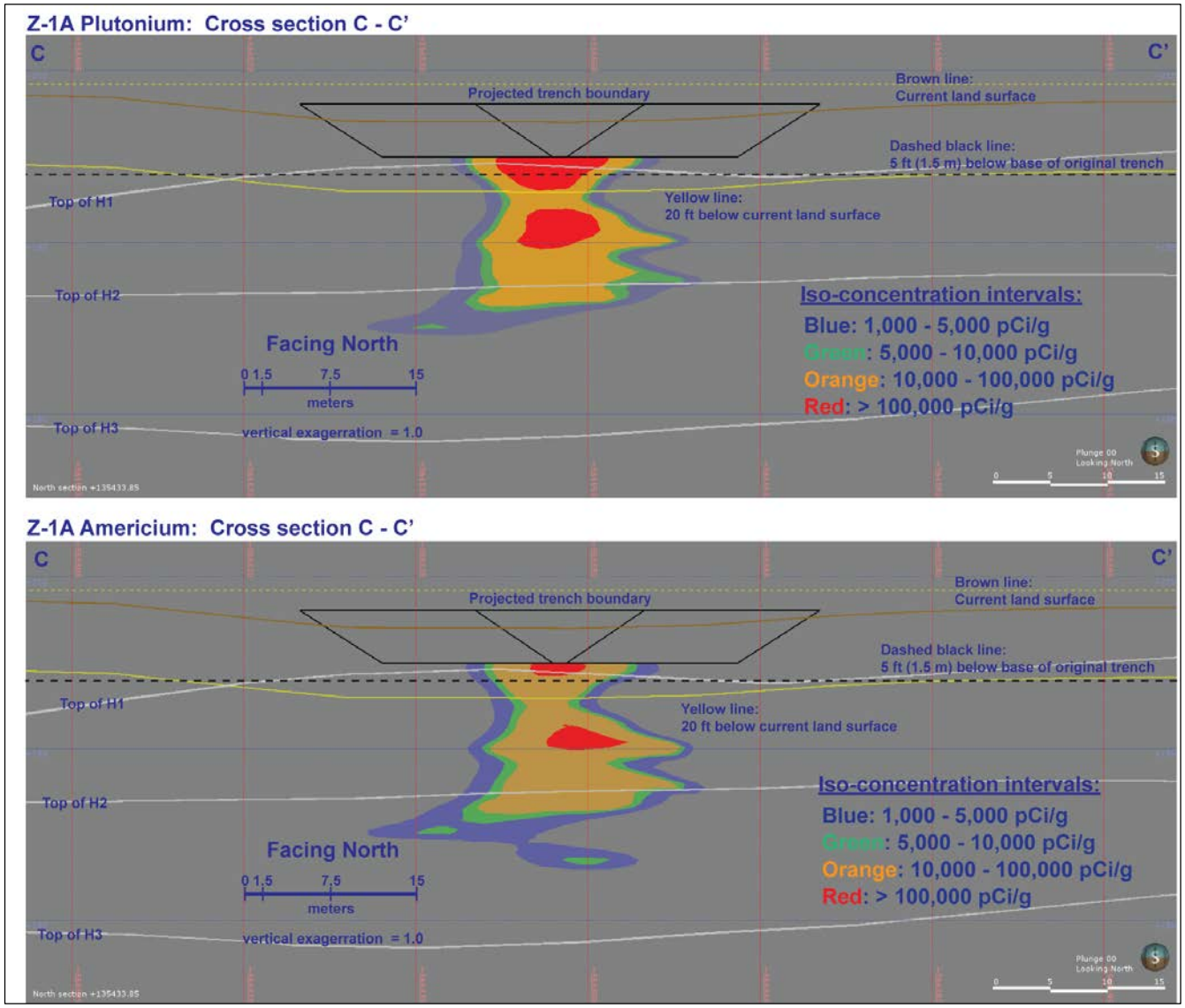


Figure notes:

H1	=	Hanford formation unit 1
H2	=	Hanford formation unit 2
H3	=	Hanford formation unit 2

Figure 7-2. Plutonium and Am-241 Soil Concentrations beneath the 216-Z-1A Tile Field (Width)

Onsite radiological measurements will be performed using a field-portable sodium iodide detector (or other suitable instrument) at the work site. Depending upon field conditions and instrument-specific detection limits, a field instrument for detection of low-energy radiation (FIDLER) may be used for the field radiological survey measurements. Standard operating procedures and a technical basis will be developed for the instruments and survey methods. Focused soil samples for laboratory analysis of the radionuclides of concern may be collected as needed to verify the field radiological survey measurements and to provide dose-to-curie conversion (cpm to pCi/g activity).

The purpose of the field radiological measurements is to support the excavation efforts during the remediation. To this end, the two types of information provided by the radiological survey measurements are gross-gamma count rates (cpm) and radionuclide-specific activities (pCi/g). Field measurements will be calibrated against known standards. Field radiological survey instrumentation will be used to provide gross count rate information to guide the excavation. Longer count times may be needed to detect activities near the soil cleanup levels, dependent on the ambient soil background.

The following subsections provide two applications of the field radiological survey instruments to resolve DSs 1a and 1b identified in this DQO.

7.2.1.1 Segregate and Manage Wastes

The feasibility of in situ radiological characterization relies on the radionuclide-specific scaling factors developed from the process knowledge/historical data to convert the field measurements (cpm) into radionuclide-specific activities (pCi/g). Scaling factors will be developed from the historical data and used to calculate the activity of radionuclides of concern based on the field radiological survey instrument measurement. A technical basis will be developed to support logic that the quantity of TRU radionuclides is strongly correlated to the quantity of americium-241, and a field instrument can be used for segregating wastes during excavation (DS 1a). A selected number of discrete samples will be collected and analyzed for the radiological COCs in order to verify the correlation of americium-241 activity to the other radiological COCs.

The instrumentation would be configured to obtain survey data from the excavation using remote reading methods. The survey data would primarily be used to segregate TRU waste from LLW during excavation.

7.2.1.2 Guide the Excavation

A technical basis also will be developed to support the logic that the quantity of radionuclides of concern is correlated to the quantity of americium-241. This correlation will be used to characterize residual levels of the radionuclides of concern in surface soil and guide the extent of excavation (DS 1b). Instrumentation would be configured to obtain survey data from the excavation using remote reading methods, mounted on a cart or other mobile device. The survey data would be used to guide the lateral extent of the excavation and determine that the cleanup levels have been obtained in the surface soils at depths less than or equal to 4.6 m (15 ft) bgs. If these systematic field radiological surveys indicate that the areas exceed cleanup levels, additional excavation may be required. If, however, the general area contamination levels are deemed acceptable, but discrete hot spots are noted, discrete samples may be collected from the hot spots for further analysis.

In lieu of a quantified discrete sampling and fixed laboratory analysis approach during excavation, the ongoing excavation guidance will rely primarily on onsite radiological measurement techniques and data, as described previously.

7.2.2 Field Nondestructive Assay Methods

Field NDA will be used for DS 2a to confirm if waste is LLW or TRU. The assays will determine the activities of gamma-emitting radionuclides and TRU nuclides. A gamma spectroscopy system and, if needed, a neutron measurement system will be used to provide isotopic ratios. Scaling factors will be developed to calculate the activity of alpha- and beta-emitting radionuclides not directly measured when using NDA to characterize waste. Samples for laboratory analysis will be collected, as needed, to verify the field NDA measurements and to support verification of chemical constituents. A QC program will be developed for use of field NDA.

Gamma detectors, such as the Canberra In Situ Object Counting System (ISOCS) high-purity germanium detector, will be used for measurements. Neutron detectors typically use a four-slab counting system. Sealed sources will be used for daily equipment checks and verification of measurements.

7.2.3 Focused Sampling Methods

Focused sampling is recommended for supplemented historical information and resolving the waste characterization DSs involving chemical constituents identified in this DQO (DSs 2b through 2h).

Based on a review of waste stream processes and the remedial investigation characterization data, two preliminary waste designations have been prepared that may be used for planning this project. Table 7-1 summarizes the preliminary waste designations based on the remedial investigation data for the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites. The upper-bounding waste designation was prepared using the maximum detected values for the constituents listed in Table 1-4. A lower-bounding waste designation was prepared using the minimum detected values for the constituents listed in Table 1-4. This is for preliminary information only; it is anticipated that additional information will be needed for the final waste designations developed for the remedial actions when they are implemented.

Table 7-1. Preliminary Waste Designations for the 200-CW-5, 200-PW-1, and 200-PW-6 OU Waste Sites

Preliminary Waste Designation	Applicable Waste Codes	Comments
Upper-bounding designation	Listed wastes (F001, F002, F003, and F005) Characteristic wastes (D006, D007, D008, and D039)	Treatment needed for some constituents and also to meet 40 CFR 268.48 UTS for UHCs
Lower-bounding designation	Listed wastes (F001, F002, F003, and F005)	F-listed constituents meet 40 CFR 268.40 UTS and do not require treatment

Source: 40 CFR 268.40, "Land Disposal Restrictions," "Applicability of Treatment Standards."
40 CFR 268.48, "Land Disposal Restrictions," "Universal Treatment Standards."
OU = operable unit
UHC = underlying hazardous constituent
UTS = universal treatment standard

It is anticipated that focused samples may need to be collected from the waste site excavations in order to finalize the waste designations. These would be collected at the discretion of waste management and used to confirm and adjust, as needed, the waste designation and shipping profile (DSs 2a through 2h). Radiological survey readings, obtained using the field radiological screening measurements discussed in Section 7.1, may be used to adjust the shipping profile.

Discrete sampling or a more quantified systematic sampling approach may be implemented if field conditions warrant such sampling. Examples of field conditions that may warrant a sampling effort are as follows:

- Health and safety action levels are approached—If action levels for health and safety are approached that require increased environment and worker protection, a sampling effort will be initiated. Action levels will be defined in applicable documents (e.g., radiation work permit, health and safety plan).
- Visual anomalies are encountered—If visual anomalies are encountered during the excavation, a sampling effort may be initiated. Visual anomalies include discoloration of soils, appearance of a

sheen on soil particles, obvious change in soil textural characteristics, unexpectedly uncovered structural materials, or other unexpected changes in site conditions.

- Waste profiles approach ERDF waste acceptance criteria—If the waste profile approaches the ERDF waste acceptance criteria, a sampling effort may be initiated.
- Not enough data are available to support development of a waste profile.

Other field conditions may be encountered in which additional sampling may be required. All sampling efforts will be evaluated by project and/or technical personnel to ensure that representative samples are taken and appropriate analyses are performed to specifically address the field condition in a cost-effective manner.

This preliminary review and designation of the available characterization results indicate that the project may wish to request and obtain a treatability variance for contaminated soil and debris prior to beginning the project. This should enable the LLWs to be accepted at ERDF and minimize handling and treatment of the wastes.

7.3 Statistical Design

This section describes the statistical sample design methods that will be used to resolve DSs involving characterizing the nature and extent of residual contamination in the waste sites at depths ≤4.6 m (15 ft) bgs (DS 3a) and >4.6 m (15 ft) bgs (DS 3b), and residual plutonium-239/240 and americium-241 contamination in the bottom of the 216-Z-9, 216-Z-1A, and 216-Z-18 Waste Sites (DS 3c).

7.3.1 Systematic Sampling for ROD (EPA et al., 2011) COCs

Site verification sampling starts once onsite radiological survey measurements and process knowledge provide reasonable confidence that the cleanup levels can be met. Project personnel decide when to initiate verification sampling. Based on the information discussed in Step 6 of this DQO, a statistical sampling design is recommended for portions of the excavations at depths of ≤4.6 m (15 ft) bgs. This corresponds to DS 3a. The statistical parameter of interest is the 95 percent UCL of the population mean. A default of 12 statistical soil samples was selected for each decision unit requiring statistical sampling.

The minimum number of samples needed for each decision unit was determined based on the minimum-detectable-difference approach presented in EPA 230/02-89-042, *Methods for Evaluating the Attainment of Cleanup Standards Volume 1: Soils and Solid Media*. The minimum-detectable-difference approach uses the desired tolerances of false-positive and false-negative errors, target cleanup levels, and an estimate the variability of the contaminants within the decision unit (SD). The size of the decision unit is not explicitly included in this approach.

When the site is ready for sampling, the location of analytical samples can be determined using VSP or other suitable planning tools. VSP is a site map-based user-interface program that may be downloaded at http://vsp.pnnl.gov/. Contaminant variability may be determined using radiological survey data obtained from the excavated waste site. Statistical parameters developed in Step 6 of this DQO can be used in the VSP to prepare the sampling design. It is recommended the statistical design use a triangular systematic grid to provide sufficient area coverage.

Site verification sampling will be completed in accordance with a site-specific work instruction. The following decision units will be considered during the site verification sampling process:

- Shallow zone of the excavated site, which is defined as residual soil 0 to 4.6 m (0 to 15 ft) below the surrounding grade.
- Overburden, which includes stockpiled soil that was segregated from contaminated materials during the excavation process with the intention of using it as backfill.

A general summary of the site verification sampling design and associated basis for each of the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites (or in some cases, groups of waste sites) is presented in Tables 7-2, 7-3, and 7-4. Where a statistical sampling design is identified (DS 3a), a default number of 12 statistical soil samples is proposed to be collected from locations identified within the decision unit using a systematic sampling grid with a random start. Results from the verification samples will be used in statistical and compliance calculations and site-specific modeling to demonstrate that cleanup objectives have been accomplished based on the requirements of the ROD (EPA et al., 2011).

7.3.1.1 Overburden

Overburden is defined as material previously placed on top of the waste site. The objective for sampling and analyses of overburden is to verify that the soil piles do not contain any COCs above the cleanup levels. This verification will be accomplished using onsite radiological measurements during removal of the overburden, with discrete sampling for laboratory analyses, as needed to confirm field radiological measurements. Verification sampling of overburden piles will be based on a statistical approach. Samples will be analyzed for all COCs by the standard fixed laboratory.

7.3.2 Gridded Radiological Surveys

Radiological survey data will be obtained from the bottom of the waste site excavations either as the excavation progresses or after excavation. These surveys correspond to DSs 3b and 3c.

The radiological surveys will be conducted, using the methodology and instrumentation previously discussed in Section 7.2, by means of an established correlation of americium-241 to the radionuclides of concern. These gridded radiological survey measurements will be mapped to show the distribution and relative concentration of residual contaminants in the bottom of the excavation. The gridded radiological surveys will provide information to resolve DSs 3b and 3c. The information will be provided to DOE and EPA for discussion.

In addition, the survey data will be used to determine the locations for collecting focused samples for laboratory analysis of applicable COCs. The number of focused samples required for each waste site and the applicable COCs is shown in Tables 7-2, 7-3, and 7-4 for DS 3b. A minimum of one focused sample is recommended for each decision unit at depths of >4.6 m (15 ft) bgs. The location of the focused sample will be selected using professional judgment and could correspond with a region of high radiological contamination or as directed by DOE and EPA.

7.4 Recommended Sample Approach

Table 7-5 summarizes the recommended sampling approach to support remedial actions at the 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites.

This page intentionally left blank

Table 7-2. Sampling Needs for the 200-CW-5 OU Waste Sites

Design Parameter		216-Z-1D (North Part)[a]	UPR-200-W-110	Composite of Z Ditches
DS 3a – Evaluate levels of COCs at depths of ≤ 4.6 m (15 ft) bgs.	COCs	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, Boron, Mercury, PCB, Nitrate	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, Boron, Mercury, PCB, Nitrate	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, Boron, Mercury, PCB, Nitrate
	No. of Decision Units	13 placements[b]	8 placements[b]	22 placements[b]
	Total Area (m^2 [ft^2])	11,500 (123,785)	18,690 (201,177)	35,818 (385,542)
	No. of Samples	156	96	264
DS 3b – Evaluate nature and extent of COCs at depths of >4.6 m (15 ft) bgs.	COCs	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, Boron, Mercury, PCB, Nitrate	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, Boron, Mercury, PCB, Nitrate	Sr-90, Cs-137, Ra-226, Pu-239/240, Am-241, Boron, Mercury, PCB, Nitrate
	No. of Decision Units	13	8	22
	Total Area (m^2 [ft^2])	Excavation is not anticipated to exceed 4.6 m (15 ft) bgs.	Excavation is not anticipated to exceed 4.6 m (15 ft) bgs.	Excavation is not anticipated to exceed 4.6 m (15 ft) bgs.
	No. of Samples	0	0	0

a. Includes pipelines.

b. Each decision unit is defined by the placement of a weather enclosure used to perform the work. The weather enclosure is approximately 73 m (240 ft) × 54.8 m (180 ft).

Am-241 = americium-241
COC = contaminant of concern
Cs-137 = cesium-137
DS = decision statement
OU = operable unit
PCB = polychlorinated biphenyl
Pu-239/240 = plutonium-239/240
Ra-226 = radium-226

Table 7-3. Sampling Needs for the 200-PW-1 OU Waste Sites

Design Parameter		216-Z-1A Cluster[a]	216-Z-9	216-Z-12	216-Z-18[b]	241-Z-361
DS 3a – Evaluate levels of COCs at depths of ≤4.6 m (15 ft) bgs.	COCs	Tc-99, Pu-239/240, Am-241, Nitrate	Tc-99, Pu-239/240, Am-241, Nitrate	Pu-239/240, Am-241	Tc-99, Pu-239/240, Am-241, Nitrate	Pu-239/240, Am-241
	No. of Decision Units	4 placements[c]	1 placement[c]	3 placements[c]	4 placements[c]	1 placement[c]
	Total Area (m^2 [ft^2])	4,089 (44,010)	1,552 (16,701)	2,658 (28,612)	2,748 (29,584)	476 (5,124)
	No. of Samples	48	12	36	48	1
DS 3b – Evaluate nature and extent of COCs at depths of >4.6 m (15 ft) bgs.	COCs	Tc-99, Pu-239/240, Am-241, Nitrate	Tc-99, Pu-239/240, Am-241, Nitrate	Pu-239/240, Am-241	Tc-99, Pu-239/240, Am-241, Nitrate	Pu-239/240, Am-241
	No. of Decision Units	4 (~6 to 10 m [20 to 33 ft] bgs)	1 (~7 m [23 ft] bgs)	3 (~7.3 m [24 ft] bgs)	4 (~6 m [20 ft] bgs)	1
	Total Area (m^2 [ft^2])	9,948 (107,083) (includes 216 Z-1A)	1,710 (18,403)	3,789 (40,785)	5,964 (64,200)	614 (6,609)
	No. of Samples	4	1	3	4	1
DS 3c – Evaluate residual Pu-239/240 and Am-241.	COCs	Pu-239/240, Am-241	Pu-239/240, Am-241	N/A	Tc-99, Pu-239/240	N/A
	No. of Decision Units	2 (~6 m [20 ft] bgs) for 216-Z-1A only	1 (~7 m [23 ft] bgs)	N/A	4 (~6 m [20 ft] bgs)	N/A
	Total Area (m^2 [ft^2])	6,316 (67,985) for 216-Z-1A only	1,710 (18,403)	N/A	5,964 (64,200)	N/A
	No. of Samples	0 (see DS 3b)	0 (see DS 3b)	N/A	0 (see DS 3b)	N/A

a. Includes 216-Z-1A, 216-Z-1&2, and 216-Z-3 OU waste sites.

b. Includes pipelines.

c. Each decision unit is defined by the placement of a weather enclosure used to perform the work. The weather enclosure is approximately 73 m (240 ft) × 54.8 m (180 ft).

Am-241 = americium-241
COC = contaminant of concern
DS = decision statement
N/A = not applicable
OU = operable unit
Pu-239/240 = plutonium-239/240
Tc-99 = technetium-99

Table 7-4. Sampling Needs for the 200-PW-6 OU Waste Sites

Design Parameter		216-Z-5[a]	241-Z-8
DS 3a – Evaluate levels of COCs at depths of ≤4.6 m (15 ft) bgs.	COCs	Pu-239/240, Am-241	Pu-239/240, Am-241
	No. of Decision Units	1 placement[b]	1 placement[b]
	Total Area (m^2 [ft^2])	1,349 (14,525)	689 m^2 (7,420)
	No. of Samples	12	12
DS 3b – Evaluate nature and extent of COCs at depths of >4.6 m (15 ft) bgs.	COCs	Pu-239/240, Am-241	Pu-239/240, Am-241
	No. of Decision Units	1 (~6.7 m [22 ft] bgs)	1
	Total Area (m^2 [ft^2])	1,164 (12,532)	191 (2,061)
	No. of Samples	1	1

a. Includes pipelines.

b. Each decision unit is defined by the placement of a weather enclosure used to perform the work. The weather enclosure is approximately 73 m (240 ft) × 54.8 m (180 ft).

Am-241 = americium-241
COC = contaminant of concern
DS = decision statement
OU = operable unit
Pu=239/240 = plutonium-239/240

Table 7-5. Recommended Sampling Approach to Resolve the DSs

DS	Available Information	COCs	Sample Medium	Data Needs	Recommended Approach
1a	Remedial investigation data for representative 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites	TRU radionuclides	Soil and Debris	TRU radionuclides at action levels of <5 and >100 nCi/G	In situ radiological characterization using dose-to-curie method
1b	Remedial investigation data for representative 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites	Pu-239/240 and Am-241	Soil	Pu-239/240 and Am-241 levels at the ROD (EPA et al., 2011) cleanup levels	In situ radiological characterization using dose-to-curie method
2a–2h	Remedial investigation data for representative 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites	Radiological and chemical constituents relative to waste management decisions	Soil and Debris	Set waste profile shipping levels. Supplement and confirm waste profile values as needed.	NDA for radionuclides Focused sampling as needed for chemicals
3a	Remedial investigation data for representative 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites	Applicable ROD (EPA et al., 2011) COCs	Soil	Residual levels of applicable ROD (EPA et al., 2011) COCs in soil at depths ≤ 15 ft bgs	Statistical sampling and laboratory analysis

Table 7-5. Recommended Sampling Approach to Resolve the DSs

DS	Available Information	COCs	Sample Medium	Data Needs	Recommended Approach
3b	Remedial investigation data for representative 200-CW-5, 200-PW-1, and 200-PW-6 OU waste sites	Applicable ROD (EPA et al., 2011) COCs	Soil	Residual levels of applicable ROD (EPA et al., 2011) COCs in soil at depths >4.6 m (15 ft) bgs	In situ radiological characterization using dose-to-curie method Focused sampling
3c	Remedial investigation data for representative 200-PW-1 OU waste sites	Pu-239/240 and Am-241	Soil	Residual levels of Pu-239/240 and Am-241 in the bottom of 216-Z-9, 216-Z-1A, and 216-Z-18	In situ radiological characterization using dose-to-curie method

Source: EPA et al., *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*

Am-241 = americium-241
COC = contaminant of concern
DS = decision statement
OU = operable unit
Pu=239/240 = plutonium-239/240
ROD = record of decision
TRU = transuranic

8 References

40 CFR 268.40, "Land Disposal Restrictions," "Applicability of Treatment Standards," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol26/xml/CFR-2010-title40-vol26-sec268-40.xml.

40 CFR 268.48, "Land Disposal Restrictions," "Universal Treatment Standards," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol26/xml/CFR-2010-title40-vol26-sec268-48.xml.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part300.xml.

300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy."

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," *Code of Federal Regulations*. Available at: http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol27/xml/CFR-2010-title40-vol27-part300-appB.xml.

64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," *Federal Register*, Vol. 64, No. 218, pp. 61615-61625, November 12, 1999. Available at: http://www.gpo.gov/fdsys/pkg/FR-1999-11-12/pdf/99-29325.pdf.

ANL, 2002, RESRAD for Windows, Version 6.21, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois. Available at: http://web.ead.anl.gov/resrad/home2/index.cfm.

CHPRC-00189, 2013, *CH2M HILL Plateau Remediation Company Environmental Quality Assurance Program Plan*, Rev. 10, CH2M HILL Plateau Remediation Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

D&D-27783, 2006, *200-UW-1 Field Summary Report for Fiscal Years 2004 and 2005*, Rev. 0, Fluor Hanford, Inc., Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA01917974.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158842.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158843.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158844.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158845.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158846.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D199158847.

DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at:
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096062.
http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0096061.

DOE/RL-96-12, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D1808987.

DOE/RL-2003-11, 2004, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=1111300811.

DOE/RL-2004-24, 2011, *Feasibility Study for the 200-CW-5 Cooling Water Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093826.

DOE/RL-2006-51, 2007, *Remedial Investigation Report for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA05807591. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=DA05807868. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0805130070. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0805130071.

DOE/RL-2007-27, 2011, *Feasibility Study for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093807. http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093806.

ECF-HANFORD-11-0038, 2012, *Soil Background for Interim Use at the Hanford Site*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0088381.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA, Ecology, and DOE, 2011, *Record of Decision Hanford 200 Area Superfund Site 200-CW-5 and 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093644.

EPA 230/02-89-042, 1989, *Methods for Evaluating the Attainment of Cleanup Standards Volume 1: Soils and Solid Media*, Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency, Washington, D.C.

EPA-600/4-79-020, 1983, *Methods for Chemical Analysis of Water and Wastes*, Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=D196019611.

PNNL-11217, 1996, *STOMP, Subsurface Transport Over Multiple Phases, theory guide*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/658243-GK2oSr/webviewable/658243.pdf.

PNNL-12034, 2000, *STOMP: Subsurface Transport Over Multiple Phases Version 2.0: User's Guide*, Pacific Northwest National Laboratory, Richland, Washington.

SW-846, 2007, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/epawaste/hazard/testmethods/sw846/online/index.htm.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-303.

WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340.

WCH-191, 2014, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 3, Washington Closure Hanford, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0085617.

WHC-MR-0517, 1996, *Listed Waste History at Hanford Facility TSD Units*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at: http://www.osti.gov/scitech/biblio/341253.

WMP-38831, 2008, *Acceptable Knowledge Summary Report for 216-Z-9 Crib Soil and Debris Waste*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

This page intentionally left blank.