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Remedial Investigation Data Quality Objectives Summary Report for the 200-LW-1 – 300 Area Chemical Laboratory Waste Group Operable Unit

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For External Review

Prepared for the U.S. Department of Energy, Richland Operations Office
Office of Environmental Restoration

Submitted by: Bechtel Hanford, Inc.

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Remedial Investigation Data Quality Objectives Summary Report for the 200-LW-1 – 300 Area Chemical Laboratory Waste Group Operable Unit

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For External Review

EXECUTIVE SUMMARY

This data quality objective (DQO) summary report supports site characterization decisions for remedial investigation (RI) at representative waste sites in the 200-LW-1 300 Area Chemical Laboratory Waste Group Operable Unit (OU). The 200-LW-1 OU consists of 10 *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice waste sites (consisting mostly of cribs and trenches) and is one of two OUs assigned to the laboratory waste category. In addition to the 200-LW-1 OU representative waste sites, two sites from the 200-LW-2 200 Area Chemical Laboratory Waste Group OU are considered in this DQO process to ensure that the characterization activities are representative of the entire laboratory waste category. The OU designation and waste site assignments are defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan [DOE-RL 1999]). Waste sites in the 200-LW-1 OU received effluent waste streams that originated from 300 Area chemical laboratories. Waste sites in the 200-LW-2 OU received effluent waste streams that originated in both the 200 and 300 Area laboratories. These effluents contained significant concentrations of radionuclides and nonradiological constituents. Data collected during the RI will be used to determine if the waste sites are contaminated above levels that will require remedial action, to support evaluation of remedial alternatives, and to verify or refine the conceptual contaminant distribution models.

This DQO effort follows the concepts developed in the Implementation Plan (DOE-RL 1999) for using analogous site contaminant data to reduce the amount of characterization required to support RI/feasibility study (FS) decisions. These concepts involve grouping sites with similar process histories, structures, and contaminants and then choosing one or more representative sites for comprehensive field investigation, including sampling of environmental media during RI activities. Findings from the RI at representative sites are then used to make remedial action decisions for all of the waste sites in the OU. Analogous sites for which field data have not been (or will not be) collected are assumed to have soil contamination characteristics similar to the representative sites that are characterized. A Record of Decision for the OU will be obtained

through the RI/FS process using the data collected during the RI. The analogous sites (i.e., those not sampled during the RI) will be addressed during the confirmatory sampling phase to ensure that the remedial action specified in the Record of Decision is appropriate and to provide design data as needed. Following remedial actions, verification samples will be collected to support site closeout.

For the 200-LW-1 OU, two representative waste sites have been identified. Two additional sites were identified that are representative of the 200-LW-2 OU. The goals of the RI are to provide the data needed to support remedial decisions and to refine the preliminary conceptual contaminant distribution and exposure models for these OUs. The data will be generated mainly through soil sampling and analysis.

Washington State Department of Ecology Toxics Cleanup Program Guidance on Sampling and Data Analysis Methods (Ecology 1995) was used to develop the sampling design for the RI. Because the data will not be used to demonstrate compliance with a cleanup level, focused (biased) soil sampling of areas selected with the highest contamination potential was selected over an area-wide (unbiased) sample design. The concentrations of all contaminants in each soil sample will be compared directly with the cleanup levels. A statistical analysis of the sampling data is not appropriate for focused sampling schemes and, therefore, is not used in this report. The locations of samples exceeding the cleanup level will be used to delineate the areas of soil contamination requiring a remediation decision.

The proposed sampling strategy is to intercept the areas of highest contamination and determine the vertical extent of contamination. The nature (e.g., contaminant type and concentration) and the vertical extent of the contamination are the major RI data needs. Boreholes will be drilled through each representative site to the groundwater table, and soil samples will be collected at discrete intervals from the entire length of the borehole. Geophysical logging of planned and existing nearby boreholes will also be performed. For the 216-B-58 and 216-Z-7 waste sites, additional locations within the sites will be geophysically logged through direct-push or cased holes to help identify the optimal placement of the boreholes at these sites.

The contaminants of potential concern were identified through process history information for the representative sites and from review of previous data collection efforts. Analytical performance criteria were based on *Model Toxics Control Act* chemical compliance criteria (*Washington Administrative Code* 173-340) and other applicable or relevant and appropriate requirements. In the absence of applicable or relevant and appropriate requirements, other preliminary action levels were identified to determine analytical performance criteria. These levels provide the basis for identifying the laboratory or field screening detection limits required to support remedial action decisions. A modified version of the U.S. Environmental Protection Agency's DQO guidance (EPA 1994) was used to identify project data quality needs, evaluate sampling and analysis options, and document project data quality decisions.

TABLE OF CONTENTS

1.0 STEP 1 – STATE THE PROBLEM 1-1

1.1 INTRODUCTION 1-1

1.2 PROJECT SCOPE 1-6

1.3 PROJECT OBJECTIVES 1-7

1.4 PROJECT ASSUMPTIONS 1-7

1.5 PROJECT ISSUES 1-11

1.5.1 Global Issues 1-11
1.5.2 Project Technical Issues 1-11

1.6 WASTE SITES AND OPERATING HISTORY 1-12

1.6.1 Plant History 1-12
1.6.2 Process Information 1-13

2.0 STEP 2 – IDENTIFY THE DECISION 2-1

3.0 STEP 3 – IDENTIFY THE INPUTS TO THE DECISION 3-1

3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS 3-1

3.2 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL 3-5

3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS 3-5

3.4 ANALYTICAL PERFORMANCE REQUIREMENTS 3-9

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY 4-1

4.1 OBJECTIVE 4-1

4.2 WORKSHEETS FOR STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY 4-1

4.3 SCALE OF DECISION MAKING 4-3

4.4 PRACTICAL CONSTRAINTS 4-4

5.0 STEP 5 – DEVELOP A DECISION RULE 5-1

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES 5-1

5.2 DECISION RULES 5-2

6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS 6-1

6.1 STATISTICAL VERSUS NON-STATISTICAL SAMPLING DESIGN 6-1

6.2 NON-STATISTICAL DESIGNS 6-1

7.0 STEP 7 – OPTIMIZE THE DESIGN 7-1

7.1 PURPOSE 7-1

7.2 WORKSHEETS FOR STEP 7 – OPTIMIZE THE DESIGN 7-1

7.3 SAMPLING OBJECTIVES 7-4

7.4 SAMPLING DESIGN 7-4

7.4.1 Summary of Sampling Activities 7-4

7.5 POTENTIAL SAMPLE DESIGN LIMITATIONS 7-9

8.0 REFERENCES 8-1

FIGURES

1-1. Index Map for Location of 200-LW-1 Operable Unit Waste Sites. 1-2
1-2. Location of the 200-LW-1 Operable Unit Waste Sites Adjacent to the 200 East Area. 1-3
1-3. Location of 200-LW-1 and 200-LW-2 Operable Unit Representative Waste Sites and Other 200-LW-1 Waste Sites Located Near T Plant and the Z Plant Complex in the 200 West Area 1-4
1-4. Location of the 216-S-20 Representative Waste Site Located Near REDOX in the 200 West Area 1-5
1-5. Waste Collection at the 340 Complex in the 300 Area 1-16
1-6. Conceptual Exposure Model for the 200-LW-1 Operable Unit 1-42
1-7. 216-T-28 Crib Conceptual Contaminant Distribution Model 1-45
1-8. 216-B-58 Trench Conceptual Contaminant Distribution Model. 1-46
1-9. 216-S-20 Crib Conceptual Contaminant Distribution Model. 1-47
1-10. 216-Z-7 Crib Conceptual Contaminant Distribution Model 1-48

TABLES

1-1. DQO Scoping Team Members 1-17
1-2. DQO Workshop Team Members 1-18
1-3. DQO Key Decision Makers 1-18
1-4. Existing Documents and Data Sources 1-18
1-5. Sources of Contamination, COPCs, and Affected Media 1-24
1-6. COPC Exclusions and Justifications 1-28
1-7. Final COC List 1-35
1-8. List of Preliminary ARARs and PRGs 1-39
1-9. General Exposure Scenarios 1-40
1-10. Regulatory Milestones. 1-41
1-11. Project Milestones 1-43
1-12. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem 1-43
2-1. Summary of DQO Step 2 Information 2-1
3-1. Required Information and Reference Sources 3-2
3-2. Basis for Setting Preliminary Action Level. 3-5
3-3. Information Required to Resolve the Decision Statements 3-5
3-4. Details on Identified Computational Methods. 3-6
3-5. Potentially Appropriate Survey and/or Analytical Methods 3-7
3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils 3-10
4-1. Characteristics that Define the Population of Interest. 4-1
4-2. Geographic Boundaries of the Investigation 4-1
4-3. Zones with Homogeneous Characteristics. 4-2
4-4. Temporal Boundaries of the Investigation 4-3
4-5. Scale of Decision Making. 4-3
4-6. Practical Constraints on Data Collection. 4-4
5-1. Decision Statements. 5-1
5-2. Inputs Needed to Develop Decision Rules. 5-2
5-3. Alternative Actions. 5-2
5-4. Decision Rules. 5-3
6-1. Statistical Versus Non-Statistical Sampling Design. 6-1
7-1. Determine Data Collection Design. 7-1
7-2. Determine Non-Statistical Sampling Design. 7-2
7-3. Methods for Collection of Data at Depth 7-2
7-4. Key Features of the 200-LW-1 Sampling Design 7-4

ACRONYMS

AA	alternative action
AEA	alpha energy analysis
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
CAS	Chemical Abstract Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CHI	CH2M Hill Hanford, Inc.
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* past-practice
CVAA	cold vapor atomic absorption
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GC	gas chromatograph
GCMS	gas chromatography/mass spectrometry
GEA	gamma energy analysis
GPC	gas proportional counter
GPR	ground-penetrating radar
HEIS	Hanford Environmental Information System
HPGe	high-purity germanium
IC	ion chromatography
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectrometer
IDW	investigation-derived waste
MCL	maximum contamination level
MTCA	*Model Toxics Control Act*
NaI	sodium iodide
OU	operable unit
PCB	polychlorinated biphenyl
PNNL	Pacific Northwest National Laboratory
PQL	practical quantitation limit
PRF	Plutonium Reclamation Facility
PRG	preliminary remediation goal

PSQ	principal study question
PUREX	plutonium-uranium extraction
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan
REDOX	reduction-oxidation
RESRAD	RESidual RADioactivity dose model
RFI	*Resource Conservation and Recovery Act* field investigation
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	Record of Decision
RPP	*Resource Conservation and Recovery Act of 1976* past-practice
RPS	retention process sewer
RRLWS	retired radioactive liquid waste sewer
SAP	sampling and analysis plan
SGL	spectral gamma logging
STOMP	subsurface transport over multiple phases
SVOC	semi-volatile organic compound
TBP	tributyl phosphate
TIC	tentatively identified compound
TOC	total organic carbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU (waste)	waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years
TSD	treatment, storage, and disposal
UCL	upper confidence limit
UPR	unplanned release
URP	uranium recovery process
VOA	volatile organic analysis
WAC	*Washington Administrative Code*
WDOH	Washington State Department of Health
WIDS	Waste Information Data System

METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	metric ton
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
metric ton	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

1.0 STEP 1 – STATE THE PROBLEM

The purpose of data quality objective (DQO) Step 1 is to clearly and concisely state the problem to ensure that the focus of the study will be unambiguous.

1.1 INTRODUCTION

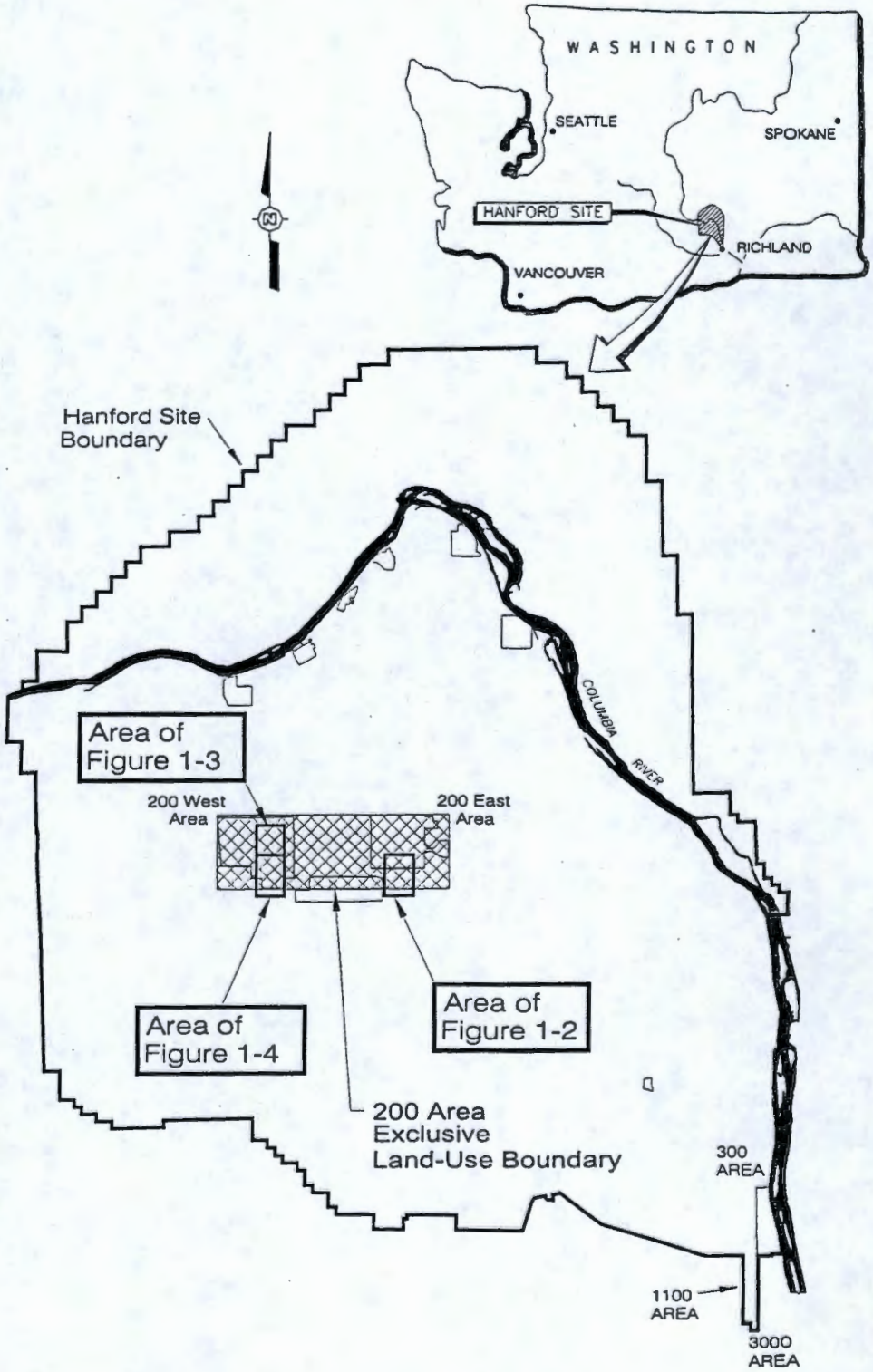
This summary report has been developed to support the remedial investigation/feasibility study (RI/FS) and remedial action decision-making processes for the 200-LW-1 300 Area Chemical Laboratory Waste Group Operable Unit (OU). The 200-LW-1 OU is being addressed under the *Resource Conservation and Recovery Act of 1976* (RCRA) for RCRA past-practice (RPP) sites, which follows the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) RI/FS decision process, as defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999). The 200-LW-1 OU consists of 10 waste sites (consisting mostly of cribs and trenches). Two representative sites have been identified for the 200-LW-1 OU in the *Waste Site Grouping for 200 Area Soil Investigations* report (DOE-RL 1997) and the Implementation Plan. As defined in the waste site grouping report, the 200-LW-1 OU is one of two OUs in the laboratory waste category. The other OU in this category, 200-LW-2 200 Area Chemical Laboratory Waste Group OU, consists of 17 waste sites (mostly cribs, french drains, and reverse wells) that received 200 and 300 Area laboratory waste. Two representative waste sites were preliminarily identified in the waste site grouping report and the Implementation Plan for the 200-LW-2 OU. In the streamlining process under the Implementation Plan (which reduces the number of OUs to be initially investigated), this DQO process considers the waste sites in both OUs to ensure that the representative waste sites selected for investigation are representative of the laboratory waste category.

This DQO summary report focuses on the development of sampling designs for the representative (typical and worst-case) sites identified in the waste site grouping report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999). Representative waste sites chosen for the 200-LW-1 OU include the 216-B-58 Trench and the 216-T-28 Crib.

The 216-B-58 Trench is a typical waste site for the 200-LW-1 OU. The 216-T-28 Crib is a worst-case waste site because of its high inventory and the amount of effluent received. Two representative sites were also identified in the 200-LW-2 OU. The 216-Z-7 and 216-S-20 Cribs received waste from the 200 and 300 Area laboratories. The waste site grouping report noted that these two sites could have been placed in either OU; therefore, these two sites are considered in this DQO summary report as potential representative waste sites that would be representative of the laboratory waste category.

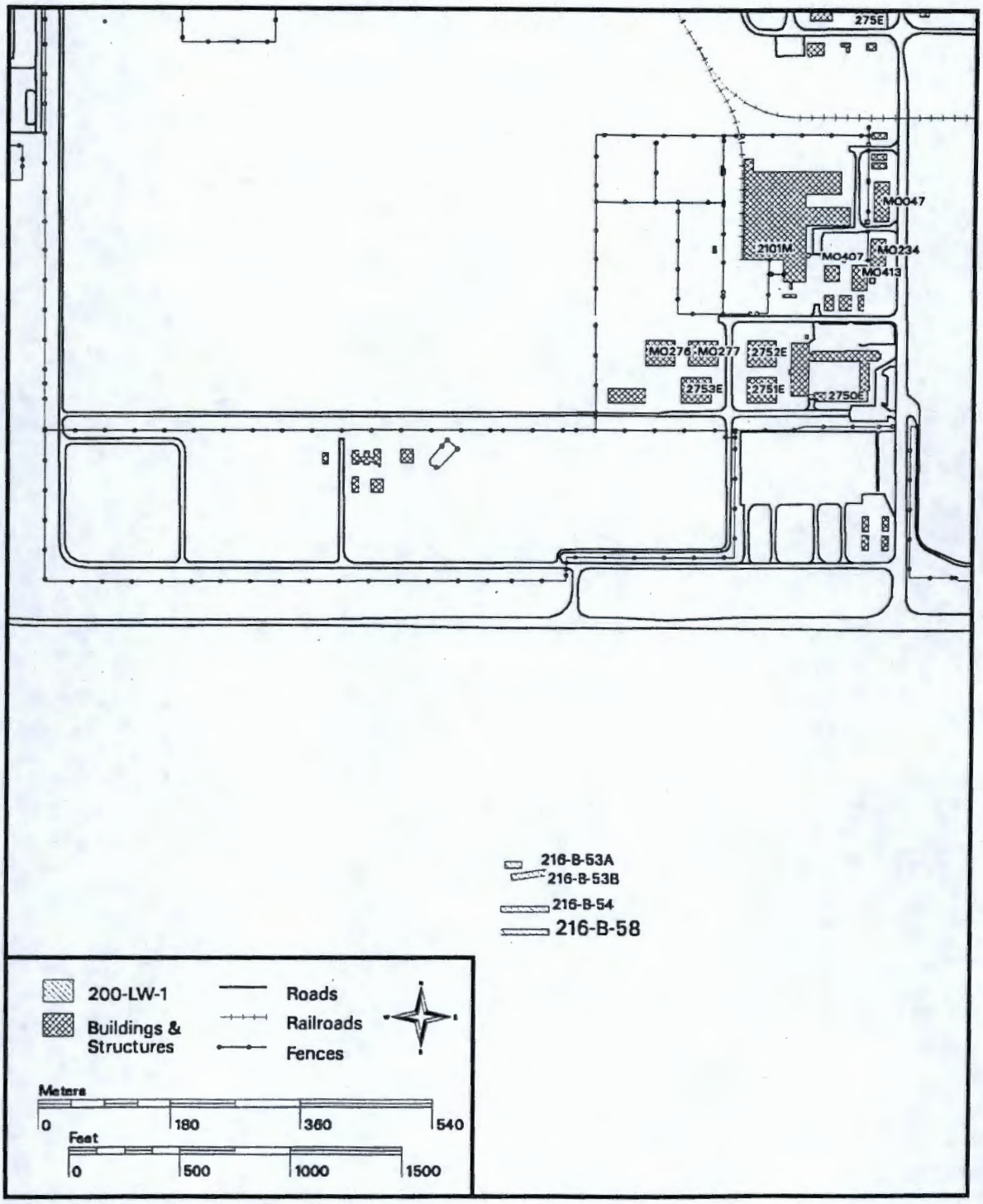
A map of the Hanford Site is provided in Figure 1-1 and depicts the 200 Areas and vicinity (i.e., the location of the 200-LW-1 OU). Figures 1-2 through 1-4 identify the locations of the waste sites and the associated source facilities.

Figure 1-1. Index Map for Location of 200-LW-1 Operable Unit Waste Sites.



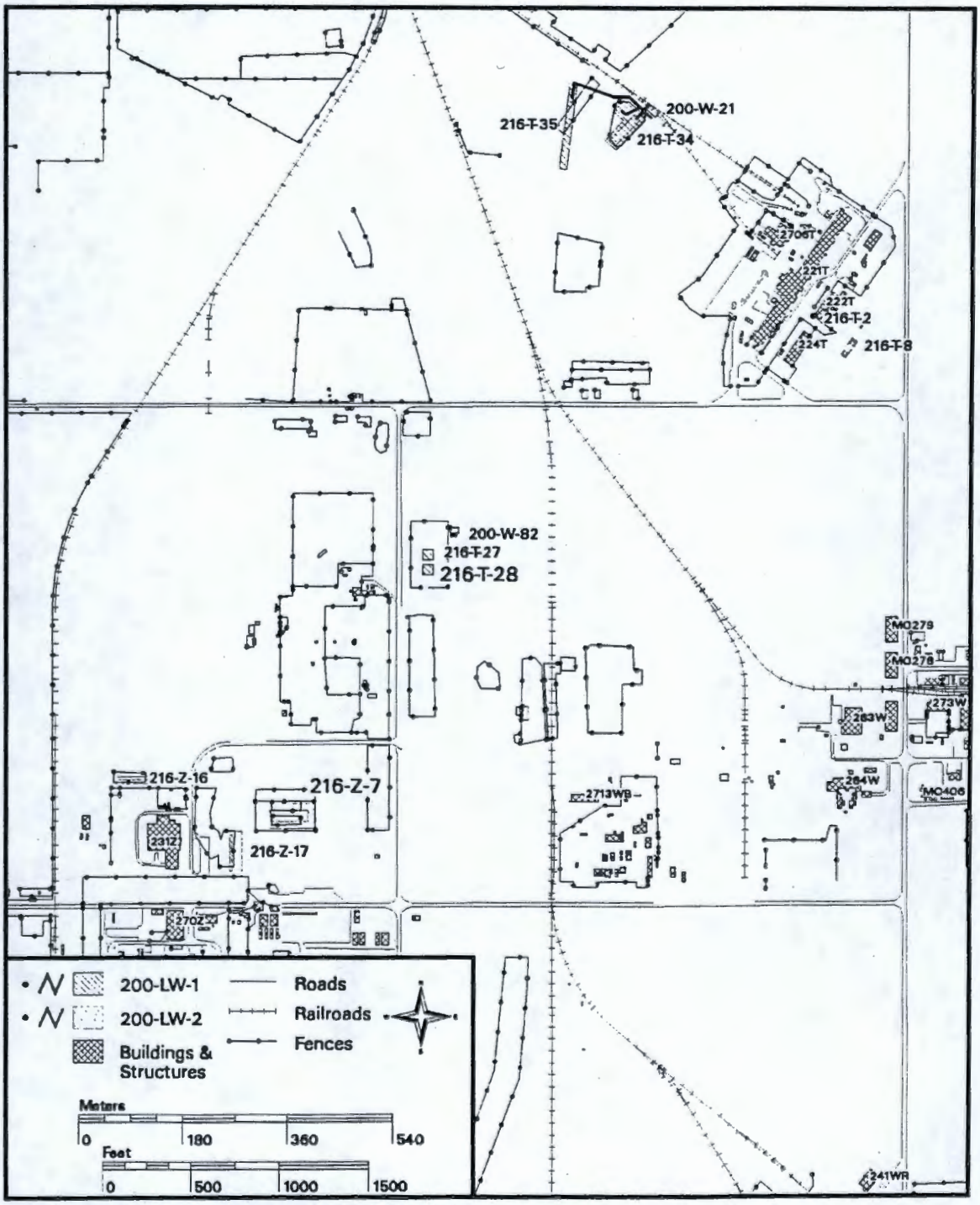
G:\Maps\110701C.DWG

Figure 1-2. Location of the 200-LW-1 Operable Unit Waste Sites Adjacent to the 200 East Area.



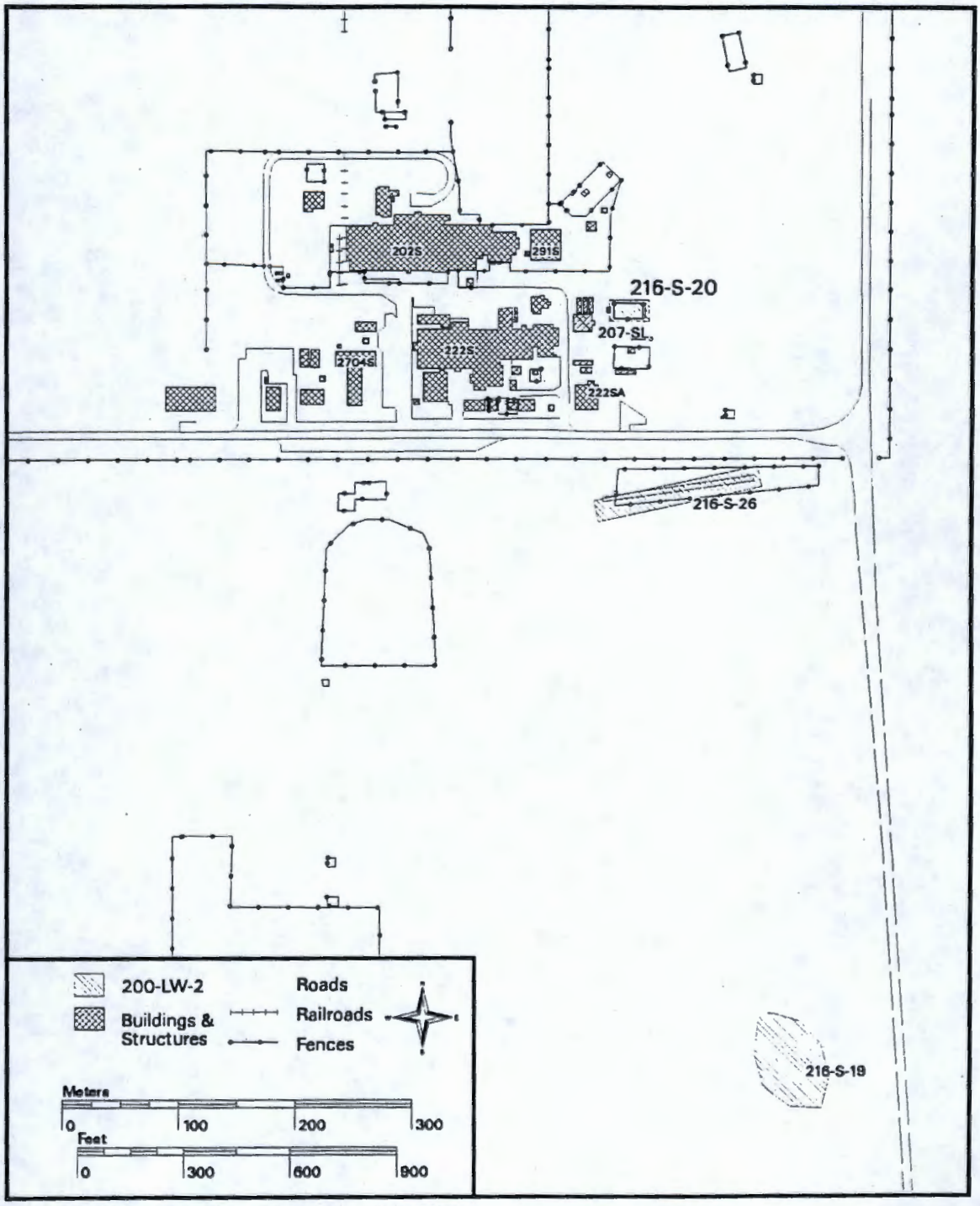
BHI:maa 10/18/01 /home/maa/amls/lw_easts3.aml Database: 19-NOV-2001

Figure 1-3. Location of 200-LW-1 and 200-LW-2 Operable Unit Representative Waste Sites and Other 200-LW-1 Waste Sites Located Near T Plant and the Z Plant Complex in the 200 West Area.



BHI:maa 10/18/01 /home/maa/amls/lw_wests1.aml Database: 20-NOV-2001

Figure 1-4. Location of the 216-S-20 Representative Waste Site Located Near REDOX in the 200 West Area.



BHI:maa 10/18/01 /home/maa/amls/lw_wests2.aml Database: 19-NOV-2001

The Washington State Department of Ecology's (Ecology's) guidance document on sampling and data analysis methods (Ecology 1995) was used during this DQO process to support the selection of an appropriate sampling approach. Table 1 of the Ecology guidance summarizes approaches for sampling and data analysis that are considered acceptable to Ecology. This guidance shows that a focused sampling approach may be used to investigate a site that is known to be contaminated and contaminated regions may be identified for sampling and analysis.

1.2 PROJECT SCOPE

This DQO summary report focuses on the representative waste sites associated with the 200-LW-1 300 Chemical Area Laboratory Waste Group OU. In addition, two waste sites in the 200-LW-2 OU are also considered. The scope of this project includes the DQO process and development of a sampling and analysis plan (SAP) for the representative sites. The DQO summary report and SAP will provide the basis for the RCRA facility investigation (RFI) for the 200-LW-1 sites. The process for integrating CERCLA and RCRA sites is defined in the Implementation Plan (DOE-RL 1999).

For the 200-LW-1 OU, a RFI/corrective measures study work plan will be prepared that satisfies the requirements for the RFI, as well as those of the Implementation Plan (DOE-RL 1999). The data acquired during the RFI will support the RFI/corrective measures study processes for this OU. For ease of preparation and readability (and as described in the Implementation Plan), the CERCLA RI/FS terminology will be used throughout the DQO summary report and work plan documents.

The Implementation Plan presents a consistent approach to data collection activities associated with 200 Area assessment and remediation activities. The activities include all phases of sampling required to support the completion of the integrated RCRA/CERCLA process as outlined in Section 2.3 and depicted in Figure 2-2 of the Implementation Plan (DOE-RL 1999). Specific activities include the following:

- Data collection at representative sites defined for the waste group-specific OU work plan, with an emphasis on verifying the conceptual model. This will support preparation of a focused FS and subsequent remedial action decision making.

- Data collection after the issuance of the Record of Decision (ROD) to confirm that all other sites in the specific waste group OU meet the conceptual model. In addition, data collection activities will be included as part of the remedy selected for the waste group and will provide site-specific information for preparation of the remedial design report/remedial action work plan (RDR/RAWP).

- Data collection, as defined in the RDR/RAWP, to verify that remedial actions associated with a remove, treat, and dispose remedy have met the required objectives.

- Data collection defined as part of the post-closure monitoring plan section in a closure plan for a RCRA treatment, storage, and disposal unit or RPP site. For CERCLA sites, remedies

where waste is left in place and a barrier cover is installed may include an operations and monitoring plan that requires specific monitoring activities to demonstrate adequacy of the design.

This DQO process supports the data collection at representative sites defined for the waste group-specific OU work plan and will support the evaluation of remedial alternatives and RI/FS decision making. Additional DQO processes will be conducted to define the sampling requirements for the other phases of data collection.

1.3 PROJECT OBJECTIVES

The objective of the DQO process for the 200-LW-1 300 Area Chemical Laboratory Waste Group OU is to determine the environmental measurements necessary to support the RI/FS process and remedial decision making, including refinement of the preliminary conceptual contaminant distribution model. Additionally, the DQO process supports development of a SAP for the RI, which will be included as an appendix to the RI/FS work plan for the OU.

Possible alternatives identified in the Implementation Plan (DOE-RL 1999) for the laboratory waste category include the following:

- No-action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- Excavation, ex situ treatment, and geologic disposal of transuranic soil
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

1.4 PROJECT ASSUMPTIONS

Project assumptions for the RI include the following

- The DQO process will follow BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2, "Data Quality Objectives," and Section 6.1 of the Implementation Plan (DOE-RL 1999).

- The 200-LW-1 waste group is a source waste group, and the investigations will focus on vadose zone soil contamination.

- The Implementation Plan (DOE-RL 1999) outlines the assessment and remediation approach to be followed for the OU:

  - Defines the regulatory framework

- Defines the integration of RPP and CERCLA past-practice (CPP) strategies
- Generally identifies the characterization approach
- Provides background information on 200 Area site conditions, operational history, and secondary plans (e.g., quality assurance [QA], health and safety, information management, and waste management)
- Provides governing assumptions, including preliminary applicable or relevant and appropriate requirements (ARARs), land-use considerations, remedial action objectives, and remedial action alternatives.

- The analogous site approach will be used. Characterization will be limited to representative waste sites and the characterization will be used to reach remedial decisions for all waste sites within the OU. The DQO effort will focus on representative waste sites within the OU. Preliminary representative waste sites have been selected in the waste site grouping report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999) that were considered to be representative of typical and worst-case conditions for the OU. The representative waste sites for the 200-LW-1 OU are as follows:

  - 216-B-58 Trench (typical site)
  - 216-T-28 Crib (worst-case site).

  In addition, two sites from the 200-LW-2 OU will be evaluated as potential representative sites for this investigation:

  - 216-Z-7 Crib (worst-case site)
  - 216-S-20 Crib (typical site).

  Specific waste sites within the OU are listed in Appendix G of the Implementation Plan (DOE-RL 1999). Sites identified in the 200-LW-1 OU, in addition to the representative sites, are listed below:

  - 216-B-53A Trench
  - 216-B-53B Trench
  - 216-B-54 Trench
  - 216-T-27 Crib
  - 216-T-34 Crib
  - 216-T-35 Crib
  - 200-W-21 pump station
  - 200-W-82 product piping.

While the 200-W-21 dump station and the 200-W-82 product piping differ in construction and contamination release from the cribs and trenches in the OU, they received the same waste stream as the cribs and trenches. Therefore, the conceptual contaminant distribution models developed as part of this DQO process will bound the contamination at these sites and support the development and selection of a remedial alternative through the FS/ROD process. Additional sampling to confirm the appropriateness of the remedial decision at these sites will be conducted following the issuance of the ROD during the confirmatory sampling phase, as needed.

Sampling to characterize the analogous waste sites is not included in the 200-LW-1 work plan scope.

- A review of the representative sites is a key component of the DQO process. The representative sites identified in the waste site grouping report (DOE-RL 1997) and the Implementation Plan (DOE-RL 1999) will be revisited with the DQO scoping team members and key decision makers to ensure that appropriate sites are selected. The final selection of representative waste sites is considered flexible (i.e., different waste sites may be selected as representative sites, or additional representative sites may be added) and will consider critical data needs of other Groundwater/Vadose Zone core projects (e.g., the River Protection Project or the Science and Technology Project). Integration of characterization efforts will promote more efficient and cost-effective use of resources while still obtaining the necessary data to support the objectives for the 200-LW-1 OU and for the laboratory waste category as a whole. Active participation by other Groundwater/Vadose Zone core projects will be solicited to provide input to the DQO process.

- Extensive characterization of a neighboring site (216-T-26 Crib) of the worst-case representative site, the 216-T-28 Crib, was conducted as part of the 200-TW-1 OU remedial investigation in the summer of 2001. The adequacy of the data to support the RI/FS process is evaluated in Section 3.0 of this DQO summary report.

- The potential for transuranic radionuclides at concentrations greater than 100 nCi/g (TRU) exists.

- Existing characterization data from waste sites within the OU and analogous data (i.e., borehole logging results from boreholes near the waste sites) will be used to support the DQO process and to prepare the work plan. Based on the historical uses of the waste sites and current contaminant of potential concern (COPC) information, it is expected that waste site contaminants of concern (COCs) will exceed action levels and that remediation will be required at most sites; however, it is possible that COC action levels will not be exceeded. In this instance, follow-up verification sampling during the confirmatory, design, and verification phases would be conducted to ensure that site closeouts without remediation are adequately supported. These activities would be conducted under separate DQO processes.

- The DQOs will be used to prepare a SAP to be included in the 200-LW-1 RI/FS work plan. The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement)

(Ecology et al. 1998) Milestone M-13-00L requires the submittal of three RI/FS work plans by December 31, 2001. The 200-LW-1 work plan will be used to satisfy the requirement for one of these work plans. The 200-MW-1 and 200-PW-1 OU work plans are assumed to satisfy the requirement for the two additional work plans.

- A preliminary conceptual contaminant distribution model for the 200-LW-1 waste group has been developed in *Waste Site Grouping for 200 Area Soil Investigations* (DOE-RL 1997). This preliminary conceptual contaminant distribution model provides an initial prediction of the nature and extent of the primary COCs. Models for individual representative sites will be developed as part of the DQO effort and work plan preparation.

- Remedial actions will likely be required at the waste sites to achieve ARARs, including soil cleanup standards of the *Model Toxics Control Act* (MTCA) (*Washington Administrative Code* [WAC] 173-340) for nonradiological contaminants and radiological dose limits to be determined in the future. For purposes of this DQO process, a dose limit of 100 mrem/yr above natural background for radionuclides in soil under an industrial exposure scenario is assumed as a reasonable representation of an acceptable dose limit. In accordance with 10 *Code of Federal Regulations* (CFR) 20 and 10 CFR 835, the total effective dose equivalent for members of the public entering a controlled area is 100 mrem/yr. Because most of the waste sites in this waste category are contained within the exclusive land-use boundary for the 200 Areas, an industrial land-use scenario is assumed. For waste sites outside the boundary, additional scenarios may be evaluated.

- Potential data uses that need to be considered when developing DQOs include conceptual contaminant distribution model refinement; evaluation of remedial action alternatives, remedial action decisions, and risk assessment; waste designation and disposal, and worker health and safety.

- The collected data will support investigation-derived waste (IDW) disposal. The data collected to solve the problem statement will satisfy the designation of the IDW. However, prior to the RI, a DQO effort will be conducted to support waste designation. Any additional sampling requirements needed for designation will be identified at that time.

- Characteristic wastes will be evaluated based on total analytical results. Toxicity characteristic leaching procedures may be conducted if total results exceed the regulatory standards identified in WAC 173-303-090.

- Process history associated with 200-LW-1 waste sites and the document, *Listed Waste History at Hanford Facility TSD Units* (Miskho 1996), will be reviewed and listed waste contaminants associated with the processes that discharged to these waste sites will be identified. An assessment of these contaminants as potential contaminants of concern will then be made. Should listed waste contaminants be determined to potentially be present in waste sites in quantities that may require an assessment of human health or ecological risk, then these contaminants will be added as potential contaminants of concern. If, however, they are not considered to be of concern (e.g., volatile and disposed of in small quantities),

then they will not be identified as such. Listed waste constituents, however, will be retained as analytes of interest because of issues associated with waste designation and compliance with land disposal restrictions.

- Groundwater has been impacted in the past by waste sites in this OU, and mobile contaminants were disposed at the sites within these waste groups. However, evaluations of groundwater contamination and remediation are not included in the scope of the work plan.

- The RI (i.e., initial OU characterization) will validate, or provide the basis to refine, the conceptual contaminant distribution models for the waste sites from the characterization of representative waste sites. The conceptual contaminant distribution models and the preliminary exposure model will be used to develop and evaluate remedial action alternatives applicable to the OU in a FS. The RI/FS will form the basis for selecting a preferred remedial action in a proposed plan for the RPP sites. The RPP sites will be incorporated into the RCRA Permit through the permit modification process.

1.5 PROJECT ISSUES

Project issues include both the global issues that transcend the specific DQO project and the technical issues that are unique to the project. Both global and project technical issues have the potential to impact the sampling design or the DQOs for the project.

1.5.1 Global Issues

The preliminary action level for exposure to radionuclides was identified as a global issue. Current activities to evaluate cleanup levels are underway for the 100 and 300 Areas, and similar activities will also be conducted for the 200 Areas. For the purpose of this DQO summary report, a preliminary action level of 100 mrem for annual dose exposure to radionuclides under an industrial exposure scenario will be used to evaluate appropriate analytical requirements. This level falls in the representative range of potential cleanup standards based on current land-use assumptions, regulatory requirements, and other requirements. The actual cleanup standards will be proposed in the FS and proposed plan and will be approved in the ROD for the OU. No other global issues were identified at the regulator interview meeting held on October 29, 2001.

1.5.2 Project Technical Issues

The project's technical issues include the following:

- Characterization of the 216-Z-7 Crib must consider radiological control requirements for possible transuranic-contaminated soils at levels above the U.S. Department of Energy (DOE) definition for TRU of 100 nCi/g.

- If contaminated soils are present above the TRU level in the representative waste sites, stringent health and safety restrictions will be imposed on workers and work practices. The presence of transuranic-contaminated soils may unfavorably impact analytical costs, detection limits, analyte lists, and sample media disposal.

- Because three of the representative waste sites (216-B-58, 216-S-20, and 216-Z-7) had wooden components to their respective constructions, subsidence may be an issue in developing investigation strategies.

1.6 WASTE SITES AND OPERATING HISTORY

The 200-LW-1 300 Area Chemical Laboratory Waste Group OU consists of 10 RPP waste sites located in the Hanford Site's 200 East and 200 West Areas and south of the 200 East Area. Figures 1-1 through 1-4 depict the location of the study areas in the 200 Areas.

1.6.1 Plant History

The 340 Complex and the radioactive liquid waste sewer (later renamed the 300 Area retired radioactive liquid waste sewer system [300 RRLWS]) were completed in 1953. The 307 Retention Basins, the 307 Trenches, and the retention process sewer (RPS) system were also completed in 1953 in an attempt to manage the radioactive effluents in a controlled manner. Effluents exceeding concentrations of 55,000 pCi/L were routed to the 340 Complex via the RRLWS system. Effluents with concentrations lower than this level were routed through the RPS to the 307 Retention Basin for possible disposal to the 307 Trenches, or to the process sewer for disposal to the 300 Area process ponds.

Facilities that discharged to the 300 RRLWS system from approximately 1953 through 1968 included the 308, 309, 324, 325, 326, 327, and 329 Buildings. The 300 RRLWS discharged into disposal tanks located in the 340 Complex.

The 200 Area laboratory wastes included wastes from each of the analytical laboratories supporting the major 200 Area chemical processing facilities. The analytical laboratories for the B, T, U, and S (Reduction-Oxidation [REDOX]) Plants were located in each of the respective 222 Buildings. The analytical laboratory for the Plutonium-Uranium Extraction (PUREX) Facility was located within the main processing canyon or the 202-A Building. The Z Plant complex was initially supported by analytical laboratories in the 231-Z Building; however, these laboratories were later moved to the 234-5Z Building. The laboratories generated wastes during experimental operations and daily activities. Generally, these operations and activities included QA/quality control (QC) sampling of process products in various operational stages, waste sampling to ensure proper routing to cribs or trenches, random soil and vegetation samples collected near process facilities and/or waste sites, residuals from analyses of tank waste samples, and process engineering bench-scale experiments.

Liquid waste generated in the 300 Area were collected within the 340 Complex and transferred by rail tanker car or truck to cribs and trenches in the 200 Areas. The wastes were off-loaded and disposed at the site using three different methods. The wastes from T Plant equipment decontamination and refurbishment operations and the various supporting analytical laboratories (i.e., Waste Encapsulation and Storage Facility/221-B; T, U, S [REDOX], and A [PUREX] Plants; and the 231-Z Building) were routed to collection sumps/pits through an underground transfer system. These wastes may have then been evaporated (concentrated) and were often neutralized before routing for disposal. The collection sumps/pits were used to settle the heavier constituents out of the liquid effluents, forming sludge. The liquid supernatants were ultimately discharged to the soil column via cribs and trenches.

Cribs and drains were designed to inject or percolate wastewater into the soil column. Cribs are shallow excavations that are either backfilled with permeable material or are voids created by wooden or concrete structures. Drains are small- to large-diameter metal or concrete pipes inserted at shallow depths into the ground. The drains may have been filled with gravel. Cribs and drains typically received low-level radioactive waste for disposal, and most were designed to receive liquid until a specific retention volume or radionuclide capacity was met (DOE-RL 1993a).

Trenches are shallow, long, narrow, unlined excavations and were often located adjacent to other trenches. Some of the trenches have been backfilled and marked as a single group (DOE-RL 1993a).

1.6.2 Process Information

The waste sites in the 200-LW-1 OU received waste from the 300 Area laboratories, and waste sites in the 200-LW-2 OU received waste from both 200 and 300 Area laboratory processes and/or 200 Area operations. The laboratories provided analytical services and supported research and development activities for the various 200 and 300 Area operations. This support was provided in the following ways:

- QA/QC for product processing in various operational stages and troubleshooting of process eruptions
- Preparation and characterization of radiochemical standards
- Liquid scintillation counting
- Preparation work for solvent extraction tests
- Waste sampling to ensure proper routing to cribs verses trenches

- Environmental analysis of soil and vegetation samples collected near process facilities and/or waste sites

- Analyses of tank waste samples.

Table 1-5 of this DQO summary report lists all of the chemicals and reagents known to have been used or stored in the laboratory areas. The exact quantities of the chemicals and reagents stored or used is not known. Three general types of liquid wastes were produced by the laboratories:

- Laboratory process wastes (including prepared sample solutions)
- Used or discarded analytical reagents and chemicals
- Wastewater from laboratory sinks and emergency showers.

Laboratory process wastes were characterized as slightly acidic, radioactive wastes with a low salt and organic content. These wastes were often routed through settling tanks or sumps to the cribs and trenches. The pH of these wastes may have been adjusted from slightly acidic to basic in the tanks/sumps prior to disposal.

Information on the disposition of used or discarded analytical reagents is not available. A large number of chemicals were used and/or stored in the laboratories, as listed in Table 1-5 of this DQO summary report.

Nonradiological laboratory sinks and emergency showers in the laboratory areas drained to sanitary and/or cooling water/chemical sewer wastewater systems. The contents of the wastewater have not been determined but likely contained intermittent releases from laboratory procedures, glassware cleaning, and chemical spills.

Most of the waste discharged to the soil column was generated between 1952 to 1972 at the major 300 Area laboratories (which supported several radiochemistry and metallurgical experiments), at the 200 Area laboratories (which supported the major chemical processing facilities), and from equipment decontamination at T Plant.

The 300 Area laboratory wastes included wastes from the 308, 309, 324, 325, 326, 327, and 329 Buildings. Wastes from these facilities that were too high in radiological content to be disposed in the 300 Area (activity levels greater than 55,000 pCi/L) were routed to the 340 Complex, where they were collected, sampled, and shipped to the 200 Areas via tanker truck or railcar. Wastes from these facilities were generated by experimental operations, including the following:

- Development of plutonium-based reactor fuels

- Plutonium Recycle Test Reactor

- Radiometallurgical and radiochemistry laboratories supporting the development of various 200 Area process operations, including bismuth-phosphate, lanthanum-fluoride, uranium recovery, REDOX, PUREX, and plutonium reclamation processes, as well as several experiments including tritium production, uranium, plutonium, and thorium studies

- Biophysics Laboratory.

The 200 Area laboratory wastes included wastes from several 200 Area processes generated by experimental operations including QA/QC sampling of process products in various operational stages, waste sampling to ensure proper routing to cribs or trenches, random soil and vegetation samples collected near process facilities and/or waste sites, and analysis of core samples from tank farms. These processes included the following:

- Bismuth-phosphate and lanthanum-fluoride

- Uranium recovery and scavenging operations

- REDOX

- PUREX

- Semi-works

- Strontium/cesium separations, recovery, and storage operations

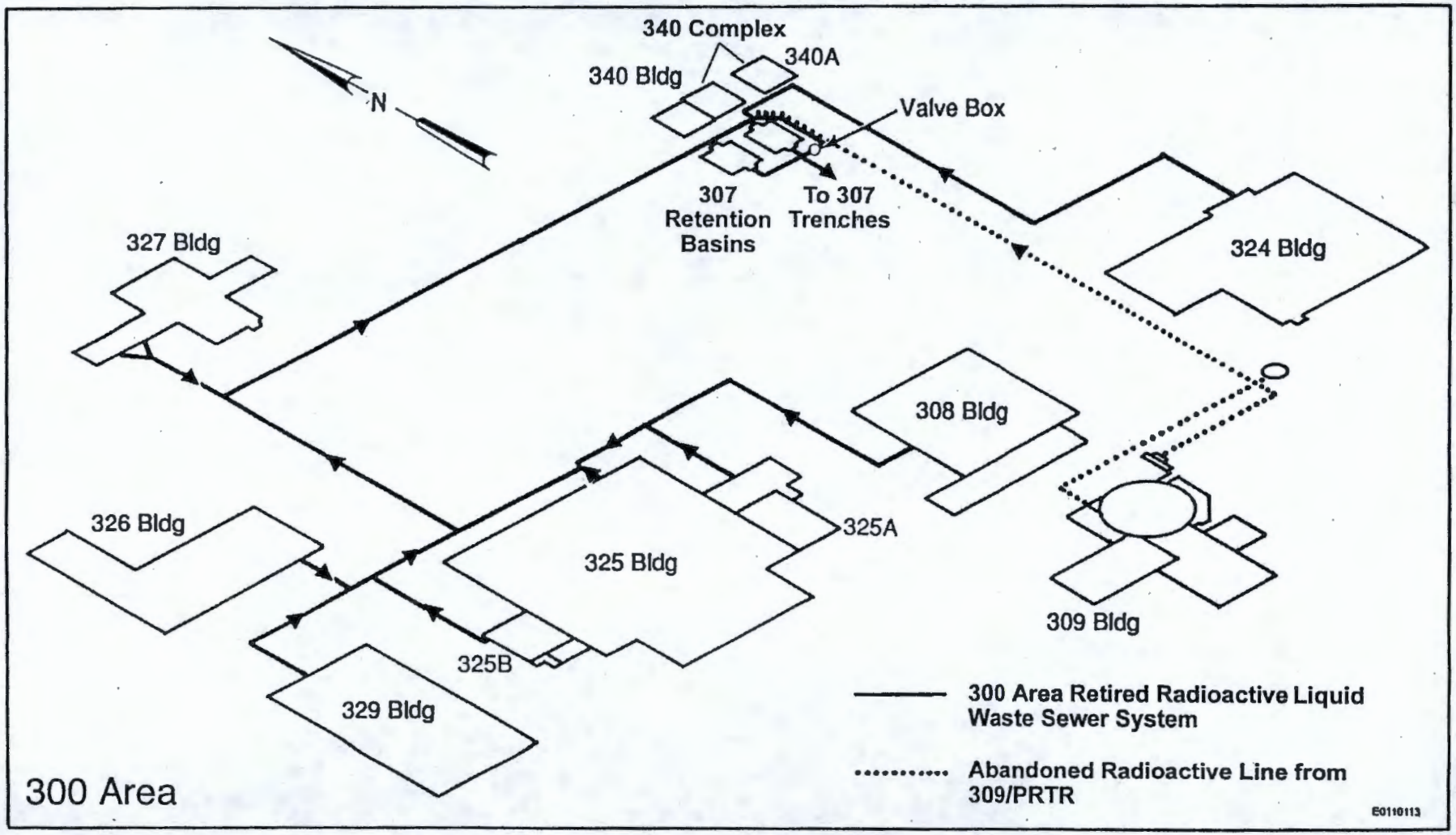
- Plutonium isolation processes (e.g., oxalate/fluoride precipitations, RG, and RMA/RMC operations)

- Plutonium/americium scrap recovery processes (e.g., RECUPLEX, Plutonium Reclamation Facility, and americium recovery), as well as several experiments including tritium production, uranium, plutonium, and thorium studies.

The 200 Area decontamination wastes included wastes from the T Plant complex after it was converted to a decontamination and equipment refurbishment facility in 1957. The 221-T Building used steam for heating the canyon area and for decontamination activities (e.g., steam cleaning with the addition of phosphate-based soaps and complexants). Heavy equipment and vehicles were steam-cleaned in the 2706-T Building.

Figure 1-5 shows graphical representations of waste collection in the 340 Complex from 300 Area facilities that was discharged to the 200-LW-1 OU waste sites.

Figure 1-5. Waste Collection at the 340 Complex in the 300 Area.



Tables 1-1, 1-2, and 1-3 identify the DQO scoping team members, DQO workshop team members, and key decision makers, respectively. The scoping team developed the checklist and binder prior to the internal seven-step process. The DQO workshop team members participated in the seven-step DQO process. The key decision makers provided external review of the results of the seven-step process.

Table 1-1. DQO Scoping Team Members.

Name	Organization	Area of Expertise (Role)
Roy Bauer	CHI Environmental Engineering	DQO Facilitator
Janet Badden	CHI Regulatory Support/ Environmental Science	Regulatory Support
Bruce Ford	BHI Site Assessments	BHI Task Lead
Chuck Hedel	CHI Environmental Engineering	200-LW-1 OU Lead
Jenifer Linville	CHI Regulatory Support/ Environmental Science	Biological/Ecological Issues
Michelle Yates Mandis	CHI Environmental Engineering	Technical Staff, Author, Process Engineering Lead
Dave St. John	CHI Sample/Data Management	Sampling Data Management/Site Sampling History
Jim Sharpe	CHI Regulatory Support/ Environmental Science	Cultural Issues
Kevin Singleton	CH2M Hill, Inc.	Technical Staff, Author, Geosciences Lead
Noe'l Smith-Jackson	CHI Regulatory Support/ Environmental Science	Technical Staff, Author
Wendy Thompson	BHI Environmental Technologies	Sampling/Field Analysis
Mary Todd	CHI Regulatory Support/ Environmental Science	DQO Summary Report, Author
Rich Weiss	CHI Sample/Data Management	Radiochemical and Analytical, Data Management
Curt Wittreich	CHI Environmental Engineering	CHI Project Lead

BHI = Bechtel Hanford, Inc.
CHI = CH2M Hill Hanford, Inc.

Table 1-2. DQO Workshop Team Members.

Name	Organization	Area of Expertise (Role)
Roy Bauer	CHI Environmental Engineering	DQO Facilitator
Bruce Ford	BHI Site Assessments	BHI Task Lead
Chuck Hedel	CHI Environmental Engineering	200-LW-1 OU Lead
Michelle Yates Mandis	CHI Environmental Engineering	Technical Staff/Author, Process Engineering Lead
Roger Ovink	CHI Regulatory Support	DQO Task Lead
Kevin Singleton	CH2M HILL, Inc.	Technical Staff/Author, Geosciences Lead
Wendy Thompson	BHI Environmental Technologies	Sampling/Field Analysis
Mary Todd	CHI Regulatory Support/ Environmental Science	DQO Workbook Author
Rich Weiss	CHI Sample/Data Management	Radiochemical and Analytical
Greg Gibbons	BHI Radiological Control Engineering	Radiological Control Engineering
Curt Wittreich	CHI Environmental Engineering	CHI Project Lead

Table 1-3. DQO Key Decision Makers.

Name	Organization	Area of Expertise (Role)
John Price	Ecology	Ecology Project Manager
Bryan Foley	RL	RL Project Manager

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

Table 1-4 lists the key sources of existing documents and data collected from previous investigations that were reviewed by the DQO team.

Table 1-4. Existing Documents and Data Sources. (6 Pages)

Reference	Summary
200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program, DOE/RL-98-28, Rev. 0 (DOE-RL 1999)	Provides information on background geography, process, waste site, and COC knowledge and strategy for the 200 Areas.
200 Areas Waste Sites Handbook, 3 vols., RHO-CD-673 (Maxfield 1979)	Provides waste site descriptions, releases, waste discharge information, and management reports.

Table 1-4. Existing Documents and Data Sources. (6 Pages)

Reference	Summary
Hanford Engineer Works Technical Manual (T/B Plants), Parts A, B, and C, HW-10475 (GE 1944)	Provides process information on B, T, and U Plant facilities, chemicals used or stored, and operation and maintenance information, including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the bismuth-phosphate campaign. Results in this reference include general designation of waste streams generated and conclusive evidence that the bismuth-phosphate separation and the lanthanum-fluoride purification processes were strictly inorganic in chemical nature.
Inventory of Chemicals Used at Hanford Site Production Plants and Support Operations (1944-1980), WHC-EP-0172, Rev. 1 (WHC 1990)	Includes list of chemicals used in processing plants and supporting facilities, including laboratories in 200 and 300 Areas.
Uranium Recovery Technical Manual, HW-19140 (GE 1951b)	Provides process information on U Plant facilities, chemicals used or stored, and operations and maintenance information, including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the URP campaign. Results include general designation of waste streams generated and conclusive evidence that the URP separation and the supplementary purification processes were strictly inorganic in chemical nature with the exception of TBP diluted in normal hydrocarbon paraffin.
Hanford Site Atlas, BHI-01119, Rev. 2 (BHI 2001)	Provides Hanford Site maps.
Pre-Operational Baseline and Site Characterization Report for the Environmental Restoration Disposal, Vols. 1 and 2, BHI-00270, Rev. 1 (BHI 1996)	Contains geological and groundwater information.
Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site, PNL-7336 (Bjornstad 1990)	Contains geological information.
Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells, ARH-ST-156 (Fecht et al. 1977)	Contains geophysical logs and contaminant distribution data.
Hanford Site Groundwater Monitoring for Fiscal Year 1999, PNNL-13230 (PNNL 2000)	Provides groundwater annual report information.
PNLATLAS/LG-ARCHV/200 East and West	Database for geophysical logging.
Hydrogeologic Model for the 200-East Groundwater Aggregate Area, WHC-SD-EN-TI-019, Rev. 0 (WHC 1992a)	Provides groundwater and geological information for 200 East Area waste sites.
Hydrogeologic Model for the 200-West Groundwater Aggregate Area, WHC-SD-EN-TI-014, Rev. 0 (WHC 1992b)	Provides groundwater and geological information for 200 West Area waste sites.

Table 1-4. Existing Documents and Data Sources. (6 Pages)

Reference	Summary
Geologic Setting of the Low-Level Burial Grounds, WHC-SD-EN-TI-290, Rev. 0 (WHC 1994)	Contains geological information.
Hanford Site Water Changes -- 1950 Through 1980, Data Observation and Evaluation, PNL-5506 (Zimmerman et al. 1986)	Contains groundwater maps of the Hanford Site.
History of Operations (1 January 1944 to 20 March 1945), OUT-1462 (HEW 1945)	Provides historical account of process operations information in the 100, 200, and 300 Areas. Includes information on trouble encountered, solutions implemented, chemical inventories, an overview of the daily activities for each process, building construction, functions, maintenance, and sampling, laboratory, and disposal activities.
Hanford Tank Chemical and Radionuclide Inventories: HDW Model, LA-UR-96-3860, Rev. 4 (Agnew et al. 1997)	Provides scavenged and URP process waste and COC comparisons.
U Plant Source Aggregate Area Management Study Report, DOE/RL-91-52, Rev. 0 (DOE-RL 1992b)	Contains process information on U Plant facilities, radionuclides. and nonradiological constituents used and discharged, known and suspected contaminants, and a list of COPCs.
T Plant Source Aggregate Area Management Study Report, DOE/RL-91-61, Rev. 0 (DOE-RL 1993e)	Provides waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in T Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of T Plant aggregate area, waste management operations history, chemical waste inventories estimates, and history of UPRs.
B Plant Source Aggregate Area Management Study Report, DOE/RL-92-05, Rev. 0 (DOE-RL 1993a)	Provides waste unit descriptions; maps with locations of waste units; preliminary conceptual site exposure model; summary of waste-producing processes in B Plant; known and suspected contaminants; affected media; results of soil, vadose zone, water, and biota sampling; plant buildings and waste discharge units (e.g., tanks, wells, vaults, ponds, ditches, trenches, septic systems, transfer lines and associated equipment, retention basins, and liquid effluent retention facilities); and site hazard rankings. Process history of B Plant aggregate area, waste management operations history, chemical waste inventories estimates, and history of UPRs.
Tank Waste Discharge Directly to Soil at the Hanford Site, WHC-MR-0227 (WHC 1991b)	Provides descriptions of waste units, site locations, and waste type summaries. Conclusions from previous studies, general model of contaminant distributions for cribs and trenches and process information overview.

Table 1-4. Existing Documents and Data Sources. (6 Pages)

Reference	Summary
200 Areas Disposal Sites for Radioactive Liquid Wastes, ARH-947 (Curren 1972)	Provides waste site and COC information.
Recovery of Cesium-137 from Uranium Recovery Process Wastes, HW-31442 (GE 1954)	Provides history of operations, process information of source facilities, and chemicals used or stored. Lists COC information.
Waste Site Grouping for 200 Areas Soil Investigations, DOE/RL-96-81, Rev. 0 (DOE-RL 1997)	Summarizes site name, location, type status, site and process descriptions, known and suspected contamination, preliminary contaminant distribution conceptual model, site conditions that may affect COC fate and transport, COC mobility in Hanford Site soils, COC distribution and transport to groundwater, and hazards associated with COCs. Soil porosity information for each waste site.
Phase I Remedial Investigation Report for 200-BP-1 Operable Unit, DOE/RL-92-70, Rev. 0 (DOE-RL 1993b)	Describes 200-BP-1 OU data collection, analysis, and results, including discussion of the nature and extent of contamination, a baseline risk assessment, and column leach and sorption testing.
WIDS database reports: 200-LW-1: 216-B-53A Trench, 216-B-53B Trench, 216-B-54 Trench, 216-B-58 Trench, 216-T-27 Crib, 216-T-28 Crib, 216-T-34 Crib, 216-T-35 Crib, 200-W-21 pump station, and 200-W-82 product piping 200-LW-2: 216-S-20 and 216-Z-7 Cribs	Summarizes site name, location, type, status, site and process descriptions, associated structures, clean-up activities, environmental monitoring description, access requirements, references, regulatory information, and waste information (e.g., type, category, physical state, description, and stabilizing activities).
Tank Characterization Database (http://twins.pnl.gov:8001/TCD/main.html) (LMHC 1999)	Allows inactive miscellaneous underground storage tank search for tanks pertaining to waste sites.
HEIS database	Contains borehole information and sampling data.
Decontamination of Nuclear Processing Equipment, HW-SA-2881 (GE 1963)	Provides historical information on decontamination processes and COCs.
Past-Practices Technical Characterization Study – 300 Area – Hanford Site, WHC-MR-0388 (Gerber 1992)	Provides historical information on 300 Area processes.
Decontamination, HW-63110 (Kingsley and Short 1960)	Provides historical information on decontamination processes and COCs.
200 Areas Fact Book, TRAC-0238 (RHO 1985)	Provides historical information on 200 Area processes, decontamination activities, tanks, and laboratories; COC information.
200-PW-1 Plutonium-Rich/Organic-Rich Process Waste Group Operable Unit RI/FS Work Plan, DOE/RL-2001-01, Draft A (DOE-RL 2001a)	Provides historical and contaminant information on PUREX processes and associated waste sites.

Table 1-4. Existing Documents and Data Sources. (6 Pages)

Reference	Summary
200-PW-2 Uranium-Rich Process Waste Group Operable Unit RI/FS Work Plan, DOE/RL-2000-60, Rev. 0 (DOE-RL 2001b)	Provides historical and contaminant information on REDOX processes and associated waste sites.
200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan, DOE-RL-2000-38, Rev. 0 (DOE-RL 2001c)	Provides historical and contaminant information on B, T, and U Plants and associated waste sites.
PUREX Technical Manual, WHC-SP-0479 (WHC 1989)	Contains process information on PUREX Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the PUREX process.
Chemical Information on Tank Supernatants, Cs Adsorption from Tank Liquids onto Hanford Sediments, and Field Observations of Cs Migration from Past Tank Leaks, PNNL-11495 (PNNL 1998a)	Includes information on distribution coefficients and contaminant movement in 200 Area soils; discussion of increased mobility of cesium associated with tank releases
"Buried Carbonate Paleosols Developed in Pliocene-Pleistocene Deposits of the Pasco Basin, South-Central Washington, U.S.A." *Quarternary International*, Vol. 34-36, pp. 191-196	Provides detailed information and description of the Plio-Pleistocene Unit.
REDOX Technical Manual, HW-18700-DEL (GE 1951a)	Provides process information on S Plant facilities, chemicals used or stored, and operations and maintenance information including process effluent sampling/analysis methods and theory behind the materials, chemicals, and equipment used during the REDOX process.
Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement, DOE/EIS-0222-F (DOE 1999)	Contains the land-use plan for the Hanford Site.
Hanford Tank Chemical and Radionuclide Inventories: HDW Model, LA-UR-96-3860, Rev. 4 (Agnew et al. 1997)	Provides scavenged and URP process waste and COC comparisons.
History and Stabilization of the Plutonium Finishing Plant (PFP) Complex, Hanford Site, HNF-EP-0924 (Gerber 1997)	Provides historical account of process operations information for Z Plant and ancillary facilities, and feed process modifications at REDOX, PUREX, and T and B Plants. Information on trouble encountered, solutions implemented, chemical used, an overview of each processes' daily activities, building construction, functions, maintenance, and sampling, laboratory, and disposal activities.
Radionuclide Inventories of Liquid Waste Disposal Sites on the Hanford Site, HNF-1744 (FDH 1999)	Provides waste site and COC information.

Table 1-4. Existing Documents and Data Sources. (6 Pages)

Reference	Summary
Z Plant Source Aggregate Area Management Study Report, DOE/RL-91-58, Rev. 0 (DOE-RL 1992c)	Includes soil and geological information, COPC information, process history, and geophysical logging.
B Plant Aggregate Area Management Study Technical Baseline Report, WHC-IP-0809 (WHC 1991a)	Provides waste unit descriptions including cribs, french drains, septic tanks, and drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
PUREX Source Aggregate Area Management Study Report, DOE/RL-92-04, Rev. 0 (DOE-RL 1993c)	Provides waste unit descriptions including cribs, french drains, septic tanks, and drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
REDOX Plant Source Aggregate Area Management Study Report, DOE/RL-91-60, Rev. 0 (DOE-RL 1992a)	Provides waste unit descriptions including cribs, french drains, septic tanks, and drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
Semiworks Plant Source Aggregate Area Management Study Report, DOE/RL-92-18, Rev. 0 (DOE-RL 1993d)	Provides waste unit descriptions including cribs, french drains, septic tanks, drain fields, trenches and ditches, ponds, catch tanks, settling tanks, diversion boxes, underground tank farms designed for high-level liquid wastes, and the lines and encasements that connect them. Waste sites are described separately.
Drawings: H-2-33144, Rev. 2, H-2-2735, Rev. 3, H-2-5229, Sheet 1, Rev. 6, H-2-44511, Sheet 102	Include construction and "as-built" drawings of individual waste sites.

HEIS = Hanford Environmental Information System
TBP = tributyl phosphate
UPR = unplanned release
URP = uranium recovery process
WIDS = Waste Information Data System

Table 1-5 represents the complete unconstrained set of COPCs that were (or could have been) discharged to the 200-LW-1 and 200 LW-2 waste sites. The master COPC list was evaluated against a set of exclusion rationale to determine a final list of project COCs. The COPCs that were excluded and the rationale for their exclusion are listed in Table 1-6.

Based on a review of process, operational, and waste discharge information from various sources (Table 1-4), the chemical behavior of the constituents was evaluated. Process knowledge indicates that the 200-LW-1 OU waste streams were predominantly liquid effluents from the analytical laboratories in the 300 Area that were too contaminated for disposal in the 300 Area.

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (3 Pages)

Known or Suspected Source of Contamination (Process)	Type of Contamination from Each Source (General Contamination)	Affected Media
Analytical laboratory waste discharged from various 200 and 300 Area facilities. 300 Area waste was routed to the 340 Building and then to the 200 Areas via railcar or tanker truck.	200 and 300 Area analytical laboratory wastes were similar and contained mixed fission products, activation products, transuranics, inorganics and were neutral to basic with low amounts of salts, semi-volatile and volatile organic chemicals.	Shallow soils (0 to 4.6 m [0 to 15 ft] bgs) and deep soils (>4.6 m [>15 ft] bgs) associated with the waste sites and potentially the groundwater beneath the waste sites.

Radioactive COPCs – 200 Area General (applies to all waste sites)			
Americium-241	Curium-245	Palladium-107	Technetium-99
Americium-242	Europium-152	Plutonium-238	Tellurium-129m
Americium-243	Europium-154	Plutonium-239/240	Tellurium-129
Antimony-123	Europium-155	Plutonium-241/242	Thorium-232
Antimony-125	Iodine-129	Praseodymium-143	Tin-113
Barium-137	Iodine-131	Praseodymium-144	Tin-123m
Barium-137m	Lanthanium-140	Promethium-147	Tin-123
Barium-140	Lead-212	Radium-224	Tin-125
Cadmium-113m	Lead-214	Radium-226	Tin-126
Carbon-14	Neodymium-147	Radium-228	Tritium
Cerium-141	Neptunium-237	Rhodium-106	Uranium-232
Cerium-144	Neptunium-239	Ruthenium-103	Uranium-233/234
Cesium-134	Nickel-59	Ruthenium-106	Uranium-235/236
Cesium-135	Nickel-63	Samarium-149	Uranium-238
Cesium-137	Niobium-93m	Samarium-151	Yttrium-90
Cobalt-60	Niobium-95	Selenium-79	Yttrium-91
Curium-242	Niobium-96	Strontium-89	Zirconium-93
Curium-243	Niobium-98	Strontium-90	Zirconium-95
Curium-244			

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (3 Pages)

Inorganic COPCs – 200 Area General (applies to all waste sites)			
Aluminum	Arsenic salts	Chromium	Iron sulfate
Aluminum fluoride	Barium nitrate	Chromium nitrate	Lanthanum
Aluminum nitrate	Beryllium	Citric fluoride	Lanthanum fluoride
Aluminum nitrate nonahydrate (ANN)	Bismuth	Copper	Lanthanum hydroxide
Aluminum nitrate (mono basic)	Bismuth subnitrate/oxynitrate	Cuppric sulfate	Lanthanum nitrate
Aluminum silicate	Bismuth orthophosphate	Cuppric nitrate	Lead
Aluminum sulfate	Borate(s)	Cyanide	Lead nitrate
Ammonia	Boric acid	Ferric ammonium sulfate	Lead oxide
Ammonium cerium nitrate	Cadmium nitrate	Ferric hydroxide	Lithium chloride
Ammonium fluoride/ ammonium nitrate (AFAN)	Calcium	Ferric nitrate	Magnesium
Ammonium fluoride	Calcium carbonate (lime)	Ferrous ammonium sulfate	Magnesium nitrate
Ammonium fluosilicate	Calcium fluoride	Ferro/ferric cyanide	Magnesium oxide
Ammonium hydroxide	Calcium iodide	Ferrous sulfamate	Magnesium silicate (Mistron)
Ammonium iron fluoride	Calcium nitrate	Fluoride	Manganese
Ammonium iron sulfate	Ceric iodate	Gallium oxide	Manganese oxide
Ammonium lanthanum nitrate	Ceric sulfate	Hydrobromic acid	Manganese nitrate
Ammonium oxalate	Cerium	Hydrochloric acid	Mercury
Ammonium sulfate	Cerium phosphate	Hydrofluoric acid	Mercuric nitrate
Anionic resins (sulfates)	Cesium nitrate	Hydroiodic acid	Mercuric thiocyanate
Antimony	Cesium phosphate	Hydrogen	Molybdenum
	Chloride	Hydrogen peroxide	Nickel
	Chromic acid	Hydroxide	Nickel nitrate
	Chromous sulfate	Iron	Nickel sulfate
Inorganic Chemical COPCs – 200 Area General (applies to all waste sites)			
Nitrous acid	Potassium fluoride	Sodium hydrogen sulfate	Sulfamic acid
Nitrate	Potassium nitrate	Sodium hydroxide	Sulfate
Nitrite	Potassium oxalate	Sodium metabismuthate	Sulfite
Nitric acid	Potassium permanganate	Sodium nitrate	Sulfuric acid
Periodic acid	Ruthenium oxide	Sodium nitrite	Tin
Peroxide	Selenium	Sodium oxalate	Titanium chloride
Phosphate	Silicon	Sodium persulfate	Tungsten
Phosphoric acid	Silver	Sodium silicate	Uranium
Phosphorous pentoxide	Silver nitrate	Sodium sulfate	Uranium dioxide
Phosphotungstic acid (PTA)	Sodium	Sodium thiosulfate	Uranium trioxide
Plutonium	Sodium aluminate	Sodium phosphate	Uranyl nitrate
Plutonium fluoride	Sodium bicarbonate	Disodium phosphate	Vanadium
Plutonium dioxide	Sodium bromate	Sodium pyrophosphate	Zinc
Plutonium nitrate	Sodium carbonate	Sodium uranyl carbonate	Zinc nitrate
Plutonium peroxide	Sodium chloride	Disodium uranyl oxide	Zinc phosphate
Potassium	Sodium dichromate	Strontium (metal)	Zirconium
Potassium carbonate	Sodium fluoride	Strontium carbonate	Zirconium carbonate gel
Potassium chloride	Sodium hexametaphosphate (calgon)	Strontium flouride	Zirconyl nitrate
Potassium dichromate		Strontium nitrate	Zirconyl phosphate
Potassium hydroxide			

Table 1-5. Sources of Contamination, COPCs, and Affected Media. (3 Pages)

Inorganic COPCs – 300 Area Laboratory (applies to all 200-LW-1 waste sites and 216-S-20 and 216-Z-7)			
Gold Hydrogen sulfide	Perchloric acid	Platinum	Tantalum
Inorganics COPCs – 200 Area Decontamination (applies to 216-T-27 and 216-T-28 in 200-LW-1, and 216-B-10A, 216-B-10B, 216-B-6, 216-S-19, 216-S-20, 216-T-2, 216-U-4, and 216-U-4A in 200-LW-2 OU)			
Clayton Kerful Cleaner Kleeno Bowl	Oakite LSD Sodium Bisulfate	Turco 4306 B, C, & D	Turco 4502 D Turco 4512 A
Organic Chemical COPCs – 200 Area General (applies to all waste sites)			
1,1-dichloroethane (DCA) 1,2-dichloroethane (DCA) 1,1,1-thrichloroethane (TCA) Acetic acid Acetone Alizarin yellow AMSCO Benzene Bromocresol purple Bromonaphthalene Butanol 2-butanone (methyl ethyl ketone-MEK) Benzyl alcohol Carbon tetrachloride Cis-1,2-dichloroethylene Citrate Chlorobenzene Chloroform Dibutyl butyl phosphonate (DBBP)	Dibutyl phosphate (DBP) Di(2-ethylhexyl) phosphoric acid Dodecane Ethanol Ethyl ether Ethylene diamine tetra-acetate (EDTA) Ethylene glycol Ethylbenzene Formaldehyde Hydraulic fluids (greases) Hydrazine Hydroxylamine (HN) Hydroxylamine hydrochloride Hydroxyacetic acid Hydroxyquinoline Isopropyl alcohol Kerosene Lard oil Methanol	Methylene chloride Methyl iso butyl ketone (MIBK hexone) Molybdate-citrate reagent Mono-2-ethylhexyl phosphoric acid Monobutyl phosphate Napthylamine n-butyl benzene Normal paraffins Oxalate Pentasodium diethylene triamine penta acetate (DTPA) Phenol Polychlorinated biphenyls (PCBs) S-diphenylcarbazide Sodium gluconate Sugar Sulfonic acid (Chloro) Super gel hyflo	Tartaric acid Tetrabromoethane Tetrahydrofuran Tetrachloroethylene (PCE) Tetraphenyl boron Thenoyltrifluoroacetone Thymolphthalein Trans-1,2-dichloroethylene Tri-iso-octylamine Tri-n-dodecylamine Tri-n-octylamine Tributyl phosphate (TBP) Trichloroethylene (TCE) Tris (hydroxymethyl) amino methane Trisodium nitrilo triacetate (NTA) Trisodium hydroxyethyl ethylene –diamine triacetate (HEDTA) Toluene Xylene
Organic Chemical COPCs - 300 Area Laboratory (applies to all 200-LW-1 waste sites and 216-S-20 and 216-Z-7)			
Glycerol Mandelic acid	Methyl lactic acid	Miscellaneous Turco products	Urea
Organic Chemical COPCs – 200 Area Decontamination (applies to 216-T-27 and 216-T-28 in 200-LW-1, and 216-B-10A, 216-B-10B, 216-B-6, 216-S-19, 216-S-20, 216-T-2, 216-U-4, and 216-U-4A in 200-LW-2 OU)			
Diversy Chemical 159 Immunol 1468-2 Jasco paint stripper Kelite 25E Keraff Oakite clear guard Oakite rust stripper Oakite swiff Orus K Pace-S-Teen	Penvert 192 Peroklean Saf-tee Solvent F.O. 128 Sani-Flush Spartan DC 13 Tide (detergenent) Turco EPO strip Turco EPO strip NP Turco (Fabrifilm) Turco 2822	Turco 2844 Turco 4358-4A Turco 4501 A Turco 4518 Turco 4521 Turco 4605-8 Turco 4669 Turco 4715 Turco 4738 (thin) Turco T-5561	Turco T-5589 Turco Alkaline (rust remover) Turco Deseal Zit 2 Turco Plaudit Versene(ethylenediamine tetraacetic acid) West Lode Degreaser Wyandotte Kelvar Wyandotte MF Wyandotte P1075 Wyandotte 1112

The first step in the evaluation process involved extracting known toxic materials from the master COPC list for placement in the final COC list. Inorganic salts and acids represent a large group of constituents in the waste sites being evaluated. Because laboratory analyses are generally not acid- or compound-specific, the acids and inorganic salts were excluded from further consideration. Instead, the readily detected cations and anions (e.g., metals, fluorides, and nitrates) associated with the acids and inorganic salts serve as the target constituents for those compounds. This logic recognizes the small volumes of radiological and nonradiological constituents released into large-volume aqueous discharges.

The analytical approach employed for this project generally targets the significant risk drivers that are representative of the waste constituents present. The general suite-type analytical techniques yield results on many metals and organic compounds, providing a cost-effective approach for the known toxic materials that could be present.

The COPCs in the following categories were excluded from further consideration:

- Short-lived radionuclides with half-lives less than 3 years
- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with atomic mass numbers equal to or greater than 242 that represent less than 1% of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that would be neutralized and/or decomposed by facility processes
- Chemicals in a gaseous state that cannot accumulate in soil media
- Chemicals used in minute quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals have no suspected introduction to waste streams except in incidental quantities
- Chemicals that are not persistent in the environment due to biological degradation or other natural mitigating features.

Table 1-6 includes the list of COPCs that were excluded and the specific rational of exclusions for each radionuclide/nonradionuclide.

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Radionuclides	
Americium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGEN2 modeling of Hanford reactor production).
Americium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGEN2 modeling of Hanford reactor production).
Antimony-123	Stable.
Antimony-125	Short-lived radionuclide (half-life <3 years).
Barium-137	Stable.
Barium-137m	Short-lived daughter of Cs-137 (which is a final COC).
Barium-140	Short-lived radionuclide (half-life <3 years).
Cadmium-113m	Less than 1% of Cs-137 activity.
Cerium-141	Short-lived radionuclide (half-life <3 years).
Cerium-144	Short-lived radionuclide (half-life <3 years).
Cesium-134	Short-lived radionuclide (half-life <3 years).
Cesium-135	Constituent generated at less than 5E-5 times the Cs-137 activity.
Curium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGEN2 modeling of Hanford reactor production).
Curium-243	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGEN2 modeling of Hanford reactor production).
Curium-244	Constituent with atomic mass number greater than or equal to 242 that represents less than 1% of the actinide activity. May be reported via americium isotopic analysis.
Curium-245	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGEN2 modeling of Hanford reactor production).
Iodine-129	Constituent generated at less than 5E-5 times the Cs-137 activity; historical tank sampling indicates nondetects at various process waste streams.
Iodine-131	Volatile gas emission; short-lived radionuclide (half-life <3 years).
Lanthanum-140	Short-lived radionuclide (half-life <3 years).
Lead-212	Short-lived radionuclide (half-life <3 years).
Lead-214	Short-lived radionuclide (half-life <3 years).
Neodymium-147	Short-lived radionuclide (half-life <3 years).
Neptunium-239	Short-lived radionuclide (half-life <3 years).
Nickel-59	Activity will be <5% of Ni-63 activity and may be estimated from that isotope.
Niobium-93m	Constituent generated at less than 5E-5 times the Cs-137 activity.
Niobium-95	Short-lived radionuclide (half-life <3 years).
Niobium-96	Short-lived radionuclide (half-life <3 years).

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Niobium-98	Short-lived radionuclide (half-life <3 years).
Palladium-107	Constituent generated at less than 5E-5 times the Cs-137 activity.
Plutonium-241	Not detected by normal plutonium analysis, can infer from americium/plutonium results.
Plutonium-242	Constituent with atomic mass number greater than or equal to 242 that represents << 1% of the actinide activity (based on ORIGEN2 modeling of Hanford reactor production).
Praseodymium-143	Short-lived radionuclide (half-life <3 years).
Praseodymium-144	Short-lived radionuclide (half-life <3 years).
Promethium-147	Short-lived radionuclide (half-life <3 years).
Protactinium-233	Even though Pa-233 was detected during spectral gamma logging performed at boreholes in the Z Plant complex area, as referenced by Price et al. (1979), it is a daughter product and can be calculated from Np-237 (which is a final COC).
Radium-224	Value can be calculated from Th-232, if present.
Radium-226	GEA will report if detectable quantities are present.
Radium-228	GEA will report if detectable quantities are present.
Rhodium-106	Short-lived radionuclide (half-life <3 years).
Ruthenium-103	Short-lived radionuclide (half-life <3 years).
Ruthenium-106	Short-lived radionuclide (half-life <3 years).
Samarium-149	Stable.
Samarium-151	Less than 1% of Cs-137 activity.
Selenium-79	Constituent generated at less than 5E-5 times the Cs-137 activity.
Strontium-89	Short-lived radionuclide (half-life <3 years).
Tellurium-129m	Short-lived radionuclide (half-life <3 years).
Tellurium-129	Short-lived radionuclide (half-life <3 years).
Tin-113	Short-lived radionuclide (half-life <3 years).
Tin-123m	Short-lived radionuclide (half-life <3 years).
Tin-123	Short-lived radionuclide (half-life <3 years).
Tin-125	Short-lived radionuclide (half-life <3 years).
Tin-126	Constituent generated at less than 5E-5 times the Cs-137 activity. (GEA will report if detected.)
Uranium-232	Less than 2x 10-3 times the U-238 activity.
Uranium-233	Measurement cannot resolve U-233 + U-234 isotopes, reported as U-234 or U-233/234.
Uranium-236	Measurement cannot resolve U-235 + U-236 isotopes, reported as U-235.
Yttrium-90	Short-lived daughter of Sr-90 (which is a final COC).

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Yttrium-91	Short-lived radionuclide (half-life <3 years).
Zirconium-93	Constituent generated at less than 5E-5 times the Cs-137 activity.
Zirconium-95	Short-lived radionuclide (half-life <3 years).
Inorganics	
Aluminum	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Bismuth	This inorganic substance is unlikely to be present in toxic concentrations.
Borate(s)	This inorganic substance is unlikely to be present in toxic concentrations.
Calcium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Carbonate(axb)	This inorganic substance is unlikely to be present in toxic concentrations. Screened for potential effect on pH.
Cerium	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Cesium	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Clayton Kerful Cleaner	Product name for sodium hydroxide, which are already listed as constituents.
Gallium	This inorganic substance is unlikely to be present in toxic concentrations.
Gold	Very expensive compounds would have been used in minimal quantities.
Hydrogen	Gas.
Hydroxide	Assessed via pH determination.
Iodine	This inorganic substance is unlikely to be present in toxic concentrations.
Iron	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Kleeno Bowl	Product name for ammonium chloride and hydrochloric acid, which are already listed as constituents.
Lanthanum	This inorganic substance is unlikely to be present in toxic concentrations.
Lithium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Magnesium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Manganese	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Molybdenum	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Oakite LSD	Product name for sodium hydroxide, which are already listed as constituents.
Oxides	Has degraded to oxygen, which is a gas.

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Perchlorate	Has degraded to chlorine and oxygen
Peroxide	Has degraded to hydrogen and oxygen.
Phosphotungstic acid (PTA)	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Platinum	Very expensive compounds would have been used in minimal quantities.
Plutonium	Will be identified via radionuclide analysis.
Potassium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Ruthenium	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Silicon	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Sodium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Strontium	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Sulfamates	Has degraded to sulfates.
Sulfite	Used in minimal quantities at Hanford. Reactive material with minimal lifetime in Hanford environment.
Tantalum	Very expensive compounds would have been used in minimal quantities.
Titanium	Very expensive compounds would have been used in minimal quantities.
Tin	This inorganic substance is unlikely to be present in toxic concentrations.
Tungsten	This inorganic substance is unlikely to be present in toxic or high concentrations due to minimal use in Hanford 200 Area processes.
Turco 4306 B, C, & D	Product name for sodium sulfate compounds, which are already listed as constituents.
Turco 4502 D	Product name for potassium hydroxide, dichromate, and permanganate compounds, which are already listed as constituents.
Turco 4512 A	Product name for phosphoric compounds, which are already listed as constituents.
Vanadium	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Zinc	This inorganic substance is unlikely to be present in toxic concentrations. Routine analyte reported by ICP analysis.
Zirconium	This inorganic substance is unlikely to be present in toxic concentrations.
Organics	
Acetate	Food-grade chemical (vinegar). The pH will be determined in the laboratory. No direct standard analytical technique available. Has dissolved into a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexing agents. Not a Washington State toxic or persistent waste.

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Alizarin yellow	Laboratory indicator. Typically used in drop quantities as <1% solutions. No analytical technology or toxicity issues identified.
Benzyl alcohol	Only limited use of this food-grade chemical was used.
Bromocresol purple	Laboratory indicator. Typically used in drop quantities as <1% solutions. No analytical technology or toxicity issues identified.
Citric acid	Very soluble. Available and used as food-grade material. Minimal potential for presence in toxic level quantities. No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Dibutyl butyl phosphonate (DBBP)	DBBP was widely used as a solvent during the PRF americium recovery operations. No direct standard analytical procedure available. Will degrade to phosphate and detected in those analytical measurements.
Dibutyl phosphate (DBP)	No direct standard analytical technique available. This compound is a degradation product of TBP and is unlikely to be present in toxic or high concentrations. This compound will be detected as TBP (TIC).
di(2-ethylhexyl) phosphoric acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Ethanol	Very soluble in water; likely to have migrated or vaporized if exposed; reasonably biodegradable. Available and used as food-grade material; and not likely to be present in toxic and/or flammable concentrations.
Ethylene-diamine tetra acetic acid (EDTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Formaldehyde	Very soluble in water; likely to have migrated or vaporized if exposed; reasonably biodegradable. Available and used as food-grade material; and not likely to be present in toxic and/or flammable concentrations.
Glycerol	This is a food-grade chemical with no applicable regulatory action levels.
Hydrazine	Extremely reactive, soluble, and very likely to have degraded and not be present within waste stream.
Hyrodroxylamine (HN)	No direct standard analytical technique available. Hydroxylamine was used during the PRF processes. Extremely reactive, very likely to have degraded and not be present within waste stream.
Hyrodroxylamine hydrochloride	No direct standard analytical technique available. Hydroxylamine was used during the PRF processes. Extremely reactive, very likely to have degraded and not be present within waste stream.
Hydroxyacetic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Hydroxyquinoline	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Isopropyl alcohol	Extremely reactive, soluble, and very likely to have degraded and not be present within waste stream.
Jasco paint stripper	Commercial chemical that most likely contains methanol, methylene chloride, and/or caustics such as sodium hydroxide due to time period used.
Lard oil	This is a food-grade chemical with no applicable regulatory action levels.
Mandelic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Methanol	Extremely reactive, soluble, and very likely to have degraded and not be present within waste stream.
Methyl lactic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Molybdate-citrate reagent	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Mono-2-ethylhexyl phosphoric acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Monobutyl phosphate	No direct standard analytical technique available. This compound is a degradation product of TBP and is unlikely to be present in toxic or high concentrations.
Oakite Swiff	This commercial chemical is trichloroethane, which is previously listed.
Oxalic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Pentasodium diethylene triamine penta acetate (DTPA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Sani-Flush	Commercial chemical. Constituents include chlorides, ammonium, and organic compounds, which are previously listed.
Sodium gluconate	Available as a food-grade material. Minimum potential for presence in toxic level quantities. No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Sugar	This is a food-grade chemical with no applicable regulatory action levels.
Sulfonic acid (Chloro)	This chemical has degraded to sulfate and chlorine, which are both constituents listed.
Super gel hyflo	A chromatography medium that was used in determining if samples collected from various steps of the bismuth-phosphate process had successfully reacted, separated, etc. This organic substance is unlikely to be present in toxic concentrations.

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Tartaric acid	Very soluble. Available and used as a food-grade material. Minimal potential for presence in toxic level quantities. No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Tetrahydrofuran	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. This compound is unlikely to be present in toxic or high concentrations.
Tetraphenyl boron	Boron and phenyl constituents of this chemical are previously listed.
Thymolphthalein	Laboratory indicator. Typically used in drop quantities as <1% solutions. No analytical or toxicity issues identified.
Thenoyltrifluoroacetone	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. This compound is unlikely to be present in toxic or high concentrations.
Tide (detergent)	This commercial chemical is sodium silicate and organic complexants.
Tris (hydroxymethyl) amino methane	Very soluble. Available and used as pharmaceutical-grade material. Minimal potential for presence in toxic level quantities. No direct standard analytical technique available.
Trisodium nitrilo triacetate (NTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents
Trisodium hydroxyethyl ethylene-diamine tri-aceatate (HEDTA)	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Turco (Fabrifilm)	Commercial chemical compound containing toluene, butanol, and isopropanol, which are previously listed.
Turco 2822	Commercial chemical compound containing methylene chloride and acetic acid, which are previously listed.
Turco 4518	Commercial chemical compound containing benzene, sulfonate and sodium, which are previously listed.
Turco 4521	Commercial chemical compound containing benzene, sulfonate and sodium, which are previously listed.
Turco T-5561	Commercial chemical compound containing ethanol, and mineral oil, which are previously listed.
Turco T-5589	Commercial chemical compound containing isopropanol and ammonium hydroxide, which are previously listed.
Turco alkaline (rust remover)	Commercial chemical compound containing sodium hydroxide and kerosene, which are previously listed.
Turco Deseal Zit 2	Commercial chemical compound containing methylene chloride and acetic acid, which are previously listed.

Table 1-6. COPC Exclusions and Justifications. (8 Pages)

COPCs	Rationale for Exclusion
Urea	This compound will degrade to nitrogen, nitrate, and ammonia. No standard analytical method in place for its analysis.
West Lode Degreaser	Commercial chemical compound containing aromatic compounds such as benzene and phenol, which are previously listed.
Versene(ethylenediamine tetraacetic acid	No direct standard analytical technique available. Has dissolved to a complexing agent that could have affected the mobility of certain COCs. Unexpected mobility of COCs will indicate the presence of complexents.
Miscellaneous Commercial Products	Unknown commercial chemicals that are most likely mixtures of inorganic salts (previously identified under metals/inorganics above), detergents (complexants/surfactants that cannot be analyzed for), and solvents (which are previously listed and will be analyzed under 8260/8270).

GEA = gamma energy analysis
ICP = inductively coupled plasma
PRF = Plutonium Reclamation Facility
TIC = tentatively identified compound

Table 1-7 includes the final lists of COCs with the rationale for inclusion for each of the COCs.

Table 1-7. Final COC List. (5 Pages)

Final COCs	Rationale for Inclusion
Radiological Constituents	
Americium-241	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Carbon-14	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Cesium-137	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Cobalt-60	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Europium-152	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Europium-154	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Europium-155	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Hydrogen-3 (tritium)	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Neptunium-237	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Nickel-63	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Plutonium-238	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Plutonium-239/240	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Strontium-90	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Technetium-99	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Thorium-232	Fuel components for several Hanford operations (Kupfer et al. 1997).
Uranium-233/234	Known constituent produced by various Hanford operations (Kupfer et al. 1997).

Table 1-7. Final COC List. (5 Pages)

Final COCs	Rationale for Inclusion
Uranium-235/236	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Uranium-238	Known constituent produced by various Hanford operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals	
Antimony	Metal byproduct from uranium fuel rod (GE 1951b).
Arsenic	Analytical results from sediment samples collected within the 241-Z-361 tank (FH 2000).
Barium	Metal byproduct from uranium fuel rod (GE 1951b).
Beryllium	Metal used in braze to seal end of fuel rod (GE 1951b).
Cadmium	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A).
Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Copper	Metal used in triple-dip process of cladding and cladding waste stream (1944 to 1952) (GE 1944, Section A).
Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A). Lead oxide was added as an oxidizing agent to the first- and second-cycle decontamination operations of bismuth-phosphate process (GE 1944, Section C).
Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses. Listed based on knowledge gained by interviews and via tank farm integration (Agnew et al. 1997).
Nickel	Experimental additions of nickel sulfate added during the bismuth-phosphate process to serve as a scavenging agent. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991) and extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes (GE 1951b).
Selenium	Several uses in bismuth phosphate campaign including filtering of gases generated in the 1950s and miscellaneous laboratory uses. Listed by the basis of knowledge gained by previous sampling efforts in the 200 Areas.
Silver	Several uses in bismuth-phosphate campaign including filtering of gases generated (1950s) and miscellaneous laboratory uses. Listed based on knowledge gained by interviews.
Nonradiological Constituents – General Inorganics	
Ammonia/ammonium	Several compounds contained ammonium. The most widely used included ammonium silica fluoride, which was used as a cleaning and decontamination compound based on the ability to dissolve metals and fission products (GE 1944 [Section C], GE 1951b, HEW 1945).
Chloride	Several compounds contained chloride. The most widely used included ferrous chloride, which was used as a carrier and potassium/sodium chloride used as salting agents during the bismuth-phosphate process (GE 1944 [Section C], GE 1951b, HEW 1945).

Table 1-7. Final COC List. (5 Pages)

Final COCs	Rationale for Inclusion
Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951b).
Fluoride	Several compounds contained fluoride. The most widely used included lanthanum fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], GE 1951b, HEW 1945).
Nitrate/nitrite	Several compounds contained nitrates/nitrites the most widely used included sodium nitrite, a salting agent during the cladding removal, nitric acid, used throughout the bismuth-phosphate process and URP, and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], GE 1951b, HEW 1945).
Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], GE 1951b, HEW 1945). Other sulfate complexes were used as carriers for various metals.
Sulfide	Hydrogen sulfide was used in the 329 Radiochemical Laboratory from 1952 to 1976 (WHC 1990).
Volatile Organics	
1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
1,1,1-trichloroethane (TCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Acetone	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Butanol	Degradation product of TBP used in various processes and experiments including URP and PUREX operations. (GE 1951b, WHC 1990).
Carbon tetrachloride	Carbon tetrachloride was widely used as a dilutant for TBP and DBBP in the RECUPLEX, PRF, and americium-241 recovery processes. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
Cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Chlorobenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).

Table 1-7. Final COC List. (5 Pages)

Final COCs	Rationale for Inclusion
Chloroform	Chloroform is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose (Rohay 1994).
Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Ethylene glycol	Antifreeze component used as a coolant for equipment.
2- butanone (methyl ethyl ketone, MEK)	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (Rohay 1994).
Methyl iso butyl ketone (MIBK, hexone)	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (Rohay 1994). Used as a solvent for solvent extraction of uranium and plutonium from fission products. Present in process drainage and possibly in process condensate. (GE 1951b).
Methylene chloride	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (Rohay 1994).
n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
Toluene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics	
AMSCO[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in the URP (GE 1951b).
Dodecane[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in the URP (GE 1951b).
Greases	Used for equipment in laboratory. Only an oil/grease separation analysis will be performed.
Normal paraffin hydrocarbons[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URP (GE 1951b).
Phenol	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).

Table 1-7. Final COC List. (5 Pages)

Final COCs	Rationale for Inclusion
Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions almost always contained PCBs (discussions/publications with David A. Dodd, PFP Chemist). Analytical results from sediment samples collected within the 241-Z-361 tank (FH 2000).
TBP and derivatives (mono, bi)	Extensive use (1953 to 1957) in solvent extraction operation as the bismuth-phosphate complexent in the URP (GE 1951b).

[a] Analyzed as kerosene by non-halogenated VOA via 8015 method, total petroleum hydrocarbons-diesel to oil range, or total petroleum hydrocarbons – gasoline range.
VOA = volatile organic analysis

Table 1-8 defines the ARARs and preliminary remediation goals (PRGs) for each of the COCs.

Table 1-8. List of Preliminary ARARs and PRGs. (2 Pages)

COCs	Preliminary ARARs	PRGs
Radionuclides Inside the 200 Area Industrial Exclusive Land-Use Boundary [a]		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	100 mrem/yr above background via industrial land-use scenario while under DOE control; 15 mrem/yr above background at the end of the exclusive-use period if DOE control is relinquished.	Contaminant-specific; RESRAD modeling[c]
Vadoze zone	4 mrem/yr above background to groundwater, or no additional groundwater degradation.[b]	MCLs, state and Federal ambient water quality control criteria; alternatively, site-specific modeling using STOMP model
Nonradiological Constituents Inside the 200 Area Industrial Exclusive Land-Use Boundary		
Shallow zone (0 to 4.6 m [0 to 15 ft] bgs)	MTCA Method C	Chemical-specific
Vadose zone	MTCA Method B groundwater protection criteria	Alternatively, site-specific modeling using STOMP model

Table 1-8. List of Preliminary ARARs and PRGs. (2 Pages)

COCs	Preliminary ARARs	PRGs
TRU Waste Definition		
Any depth zone	Radioactive waste containing more than 100 nCi of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years except for (1) high-level radioactive waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by the 40 CFR 191 disposal regulations; or (3) waste that the U.S. Nuclear Regulatory Commission has approved on a case-by-case basis in accordance with 10 CFR 61.[d]	Contaminant-specific
Greater than Class C Waste Definition		
Any depth zone	10 CFR 61.55	Contaminant-specific

[a] Based on *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE 1999) (see Figure 1-1). Sites outside the 200 Area industrial exclusive land-use boundary may require analysis of additional scenarios. See Table 1-12.
[b] Radionuclide standards are not final and will be agreed upon in the ROD.
[c] The RESidual RADioactivity dose model (RESRAD) use has been used for similar waste sites and will be used as a minimum for direct exposure. If models that are more appropriate are developed, they will be evaluated for use.
[d] Working definition of TRU waste as stated in DOE O 435.1.
EPA = U.S. Environmental Protection Agency
MCL = maximum contamination level
STOMP = subsurface transport over multiple phases (Nichols et al. 1997)

Table 1-9 lists the general exposure scenarios. Figure 1-6 shows the conceptual exposure model.

Table 1-9. General Exposure Scenarios. (2 Pages)

Scenario No.	General Exposure Scenario Description[a]
1	Industrial land-use scenario (inside the 200 Area industrial exclusive-use boundary)[b]: The source of contamination in the 200-LW-1 OU is the liquid effluent disposed at the waste sites. The release mechanism is direct radiation exposure to occupational workers near the waste sites (although shielded by stabilizing cover). Ingestion and inhalation of surface or subsurface soils in an occupational scenario does not represent a substantial exposure due to waste site surface stabilization and the limited soil ingestion and inhalation anticipated during excavation activities in an industrial setting (use of dust control measures limits exposures). Downward migration of mobile constituents into the groundwater would not affect occupational workers, as their drinking water source would not be the underlying aquifers. However, the protection of groundwater is a requirement and must be addressed by evaluating potential future impacts. An intruder scenario will be evaluated at 150 years from present for exposure to radionuclides.

Table 1-9. General Exposure Scenarios. (2 Pages)

Scenario No.	General Exposure Scenario Description [a]
	The exposure time is divided into time spent inside and outside an industrial facility: • Building occupancy: 8 hours/day x 0.6 (building occupancy factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime). • Outdoor exposure: 8 hours/day x 0.4 (outdoor exposure factor), 5 days/week, 50 weeks/yr, for 20 years (of a 75-year lifetime). In addition, the building occupancy exposure includes a factor of 0.4 to reduce the ingested dust component due to building ventilation system filtration. The inputs for an intruder scenario are being developed through the Central Plateau risk framework project. Biota that may be exposed to contaminants is this OU will be addressed through the 200 Area ecological evaluation. Remedial actions to address human health concerns can also serve to protect biota.

[a] Sites outside the 200 Area industrial exclusive land-use boundary may require analyses of additional scenarios (see Table 1-12).

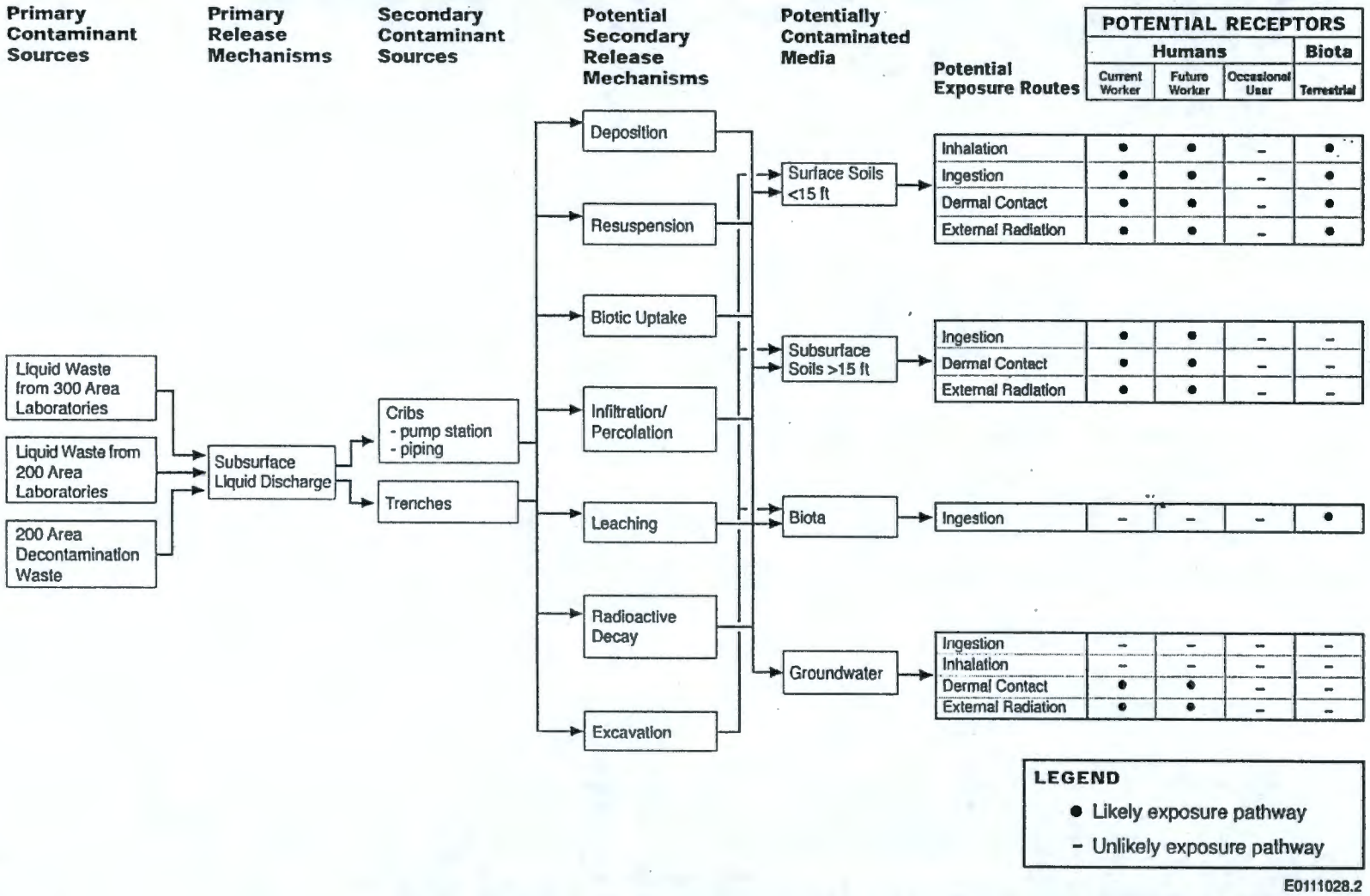
[b] The *Final Hanford Comprehensive Land Use Plan Environmental Impact Statement* (DOE 1999) (see Figure 1-1) identifies the actual land use within the 200 Area industrial exclusive land-use boundary as industrial (exclusive) and would center mainly around waste management activities.

Table 1-10 provides the regulatory milestones and regulatory drivers associated with this project.

Table 1-10. Regulatory Milestones.

Milestone	Due Date	Regulatory Driver
M-13-00L	December 31, 2001	Tri-Party Agreement milestone to submit three OU work plans. Draft A of the 200-LW-1 work plan would serve as one of the three required work plans.

Figure 1-6. Conceptual Exposure Model for the 200-LW-1 Operable Unit.



The project milestones and their drivers are listed in Table 1-11.

Table 1-11. Project Milestones.

Milestone	Due Date	Driver
Conduct decision maker interviews, global issues meeting	October 29, 2001	DQO schedule
Internal DQO workshop	November 8, 2001	DQO schedule
External DQO workshop	November 16, 2001	DQO schedule
Issue DQO summary report	February 28, 2002	DQO process documentation

Table 1-12 combines the relevant background information into a concise statement of the problem to be resolved.

Table 1-12. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem. (2 Pages)

Preliminary Conceptual Contaminant Distribution Models[a]:

Waste streams associated with analytical laboratories in the 200 and 300 Areas were discharged to the 200-LW-1 and 200-LW-2 OU waste sites. The streams contained radionuclides and nonradiological constituents associated with major 200 and 300 Area laboratory processes. Immobile contaminants accumulated in the soils over time, and the mobile contaminants may have reached the groundwater. Gamma logs from boreholes near the waste sites were reviewed. Data from these logs indicate a zone of higher contamination below the bottom of the cribs and trenches. Contamination continued below this zone but decreased with depth. Contaminants that were more mobile were then distributed throughout the soil column at residual concentrations.

Figures 1-7 through 1-10 graphically present the preliminary conceptual contaminant distribution models for each of the representative waste sites. Each of these waste sites is analogous to other sites in the OUs.

DQO Approach:

The DQO process for the 200-LW-1 OU is being performed to characterize representative sites in this waste category in support of remedial decision making.

The outcome of the characterization being developed in this DQO process for the representative sites will be applied to the other analogous sites. A SAP will be developed, after completion of the DQO process, which specifies the sampling and analyses to be performed for characterization of the representative sites.

All of the waste sites associated with the 200-LW-1 OU are located within the 200 Area land-use boundary line and will be evaluated on the basis of future industrial uses. Two waste sites associated with the 200-LW-2 OU are located outside the exclusive use boundary; additional exposure scenarios may need to be evaluated for these sites. An effort is underway between the Tri-Parties to establish exposure scenarios for sites outside the exclusive-use boundary. The results of this effort will be considered in this or future activities as they are available.

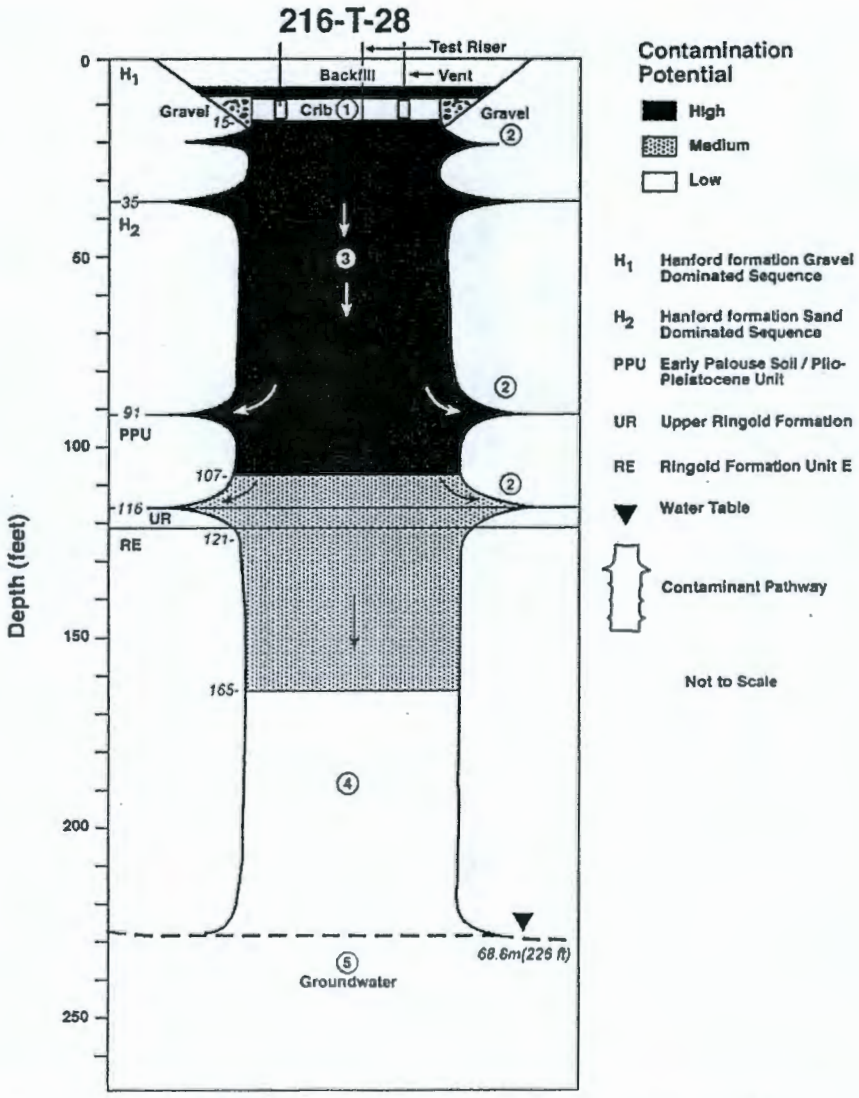
Table 1-12. Preliminary Conceptual Contaminant Distribution Model Discussion and Concise Statement of the Problem. (2 Pages)

Problem Statement:

The problem is that contaminants have been discharged to waste sites associated with the Laboratory Waste Category OUs. To support evaluation of remedial alternatives and remedial decision making in the FS and to verify or refine the conceptual contaminant distribution models, data regarding contaminant concentrations and physical parameters in the representative sites are needed.

[a] The preliminary conceptual contaminant distribution model will become the conceptual contaminant distribution model after acceptance of this DQO summary report and will then be applied to the project work plan.

Figure 1-7. 216-T-28 Crib Conceptual Contaminant Distribution Model.



(1) Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-T-28 crib between 1960 and 1966. The crib received a total volume of 42,300,000 L (11,167,200 gallons) of wastewater.

(2) Once discharged, wastewater and contaminants migrate vertically downward beneath the crib. Lateral spreading of wastewater occurs associated with the bottom of the crib, H2, the PPU, and UR. Contaminant impacts are significant in boreholes 299-W14-2, 299-W14-3, 299-W14-4 which are located in the crib. 125 ft southeast of the crib, low levels of contamination were detected in a borehole 299-W14-1 which monitors the crib. Concentrations near the crib may in part be associated with contamination from adjacent waste sites 216-T-26 and 216-T-27.

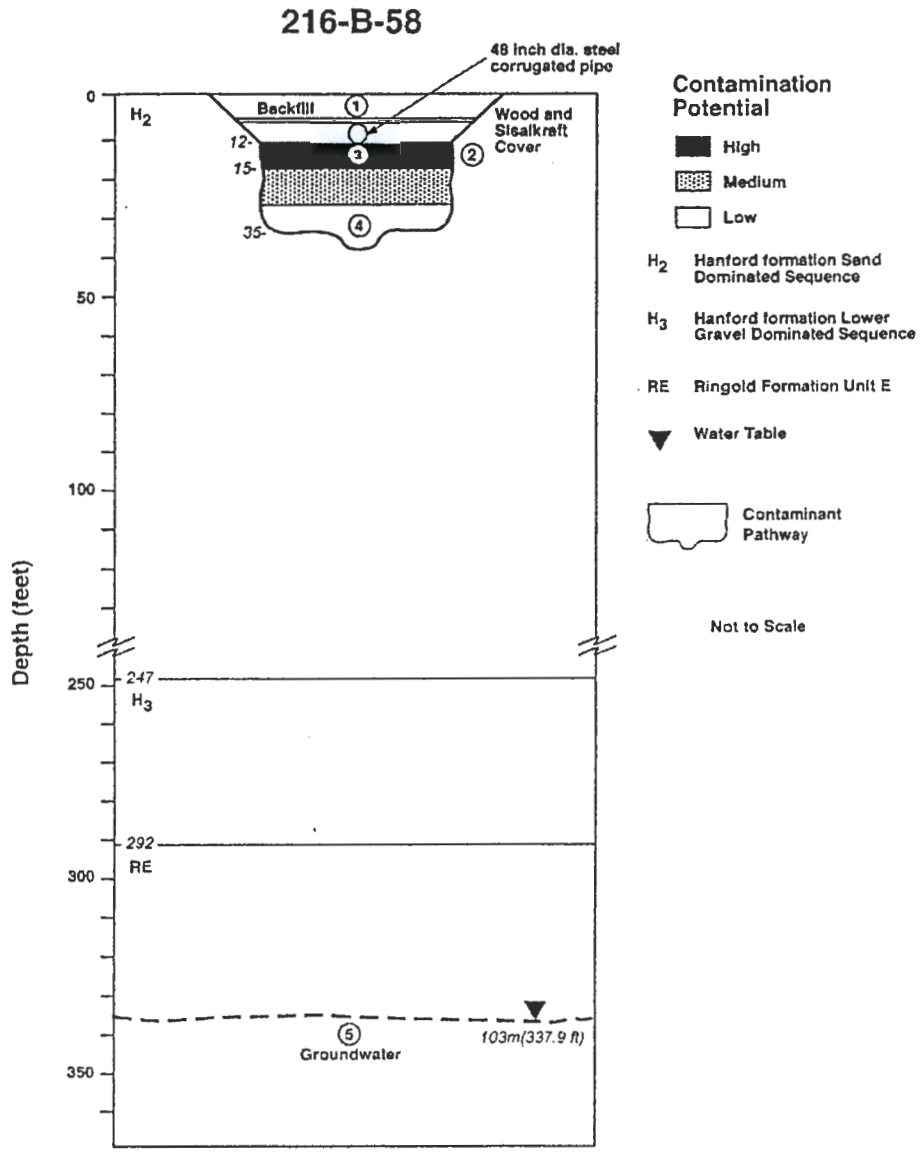
(3) Immobile contaminants such as cesium-137 normally sorb near the point of release of high concentrations. Beneath the crib, cesium-137 concentrations are >5000 pCi/g to a depth of 107 ft. based on spectral gamma data. Contaminant concentrations decrease to < 10 pCi/g at a depth of 165 ft. Enhanced mobility of contaminants may be due to the presence of a preferential pathway (i.e., lack of a well seal) prior to remediation of the borehole in 1983.

(4) Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to the water table.

(5) Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (42,300m^3) is greater than the soil column pore volume (680m^3). Nitrate, carbon tetrachloride, trichloroethylene, iodine-129, and tritium exceed groundwater protection standards near the crib.

E0111003.3

Figure 1-8. 216-B-58 Trench Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-B-58 trench between 1965 and 1967. The trench received a total volume of 413,000 L (109,032 gallons) of effluent. Very little data are available to evaluate the contaminant distribution at this site.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the trench within H2. Little or no lateral spreading occurs.

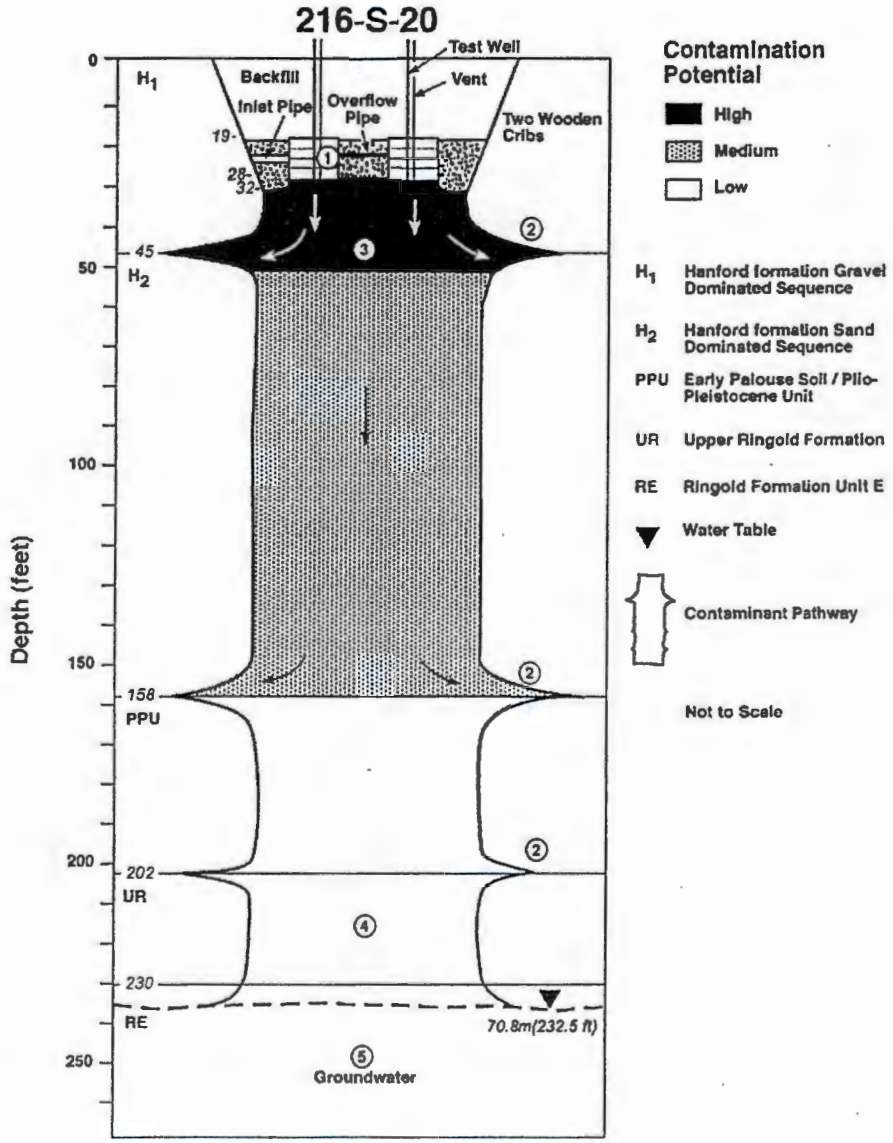
③ Immobile contaminants such as cesium-137 normally sorb near the point of release in high concentrations approximately 10 ft bgs. Concentrations decrease with depth.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to 35 ft±15ft. Concentrations may increase with depth. Based on the amount of effluent discharged, contamination is expected to a maximum depth of 35 ft±15 ft.

⑤ Wastewater and contaminants from the trench suggest no impact to groundwater since the effluent volume discharged to the soil column (423m³) is less than the soil column pore volume (5640m³). There are no groundwater plumes in the immediate area of the trench.

E0111003.4

Figure 1-9. 216-S-20 Crib Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-S-20 crib between 1952 and 1972. The crib received a total volume of 135,000,000 L (35,640,000 gallons) of wastewater. Very little data are available to evaluate the contaminant distribution at this site.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the crib. Minor lateral spreading of wastewater may occur associated with H2, the PPU, and UR. The available data suggest that lateral spreading is not significant beneath the crib.

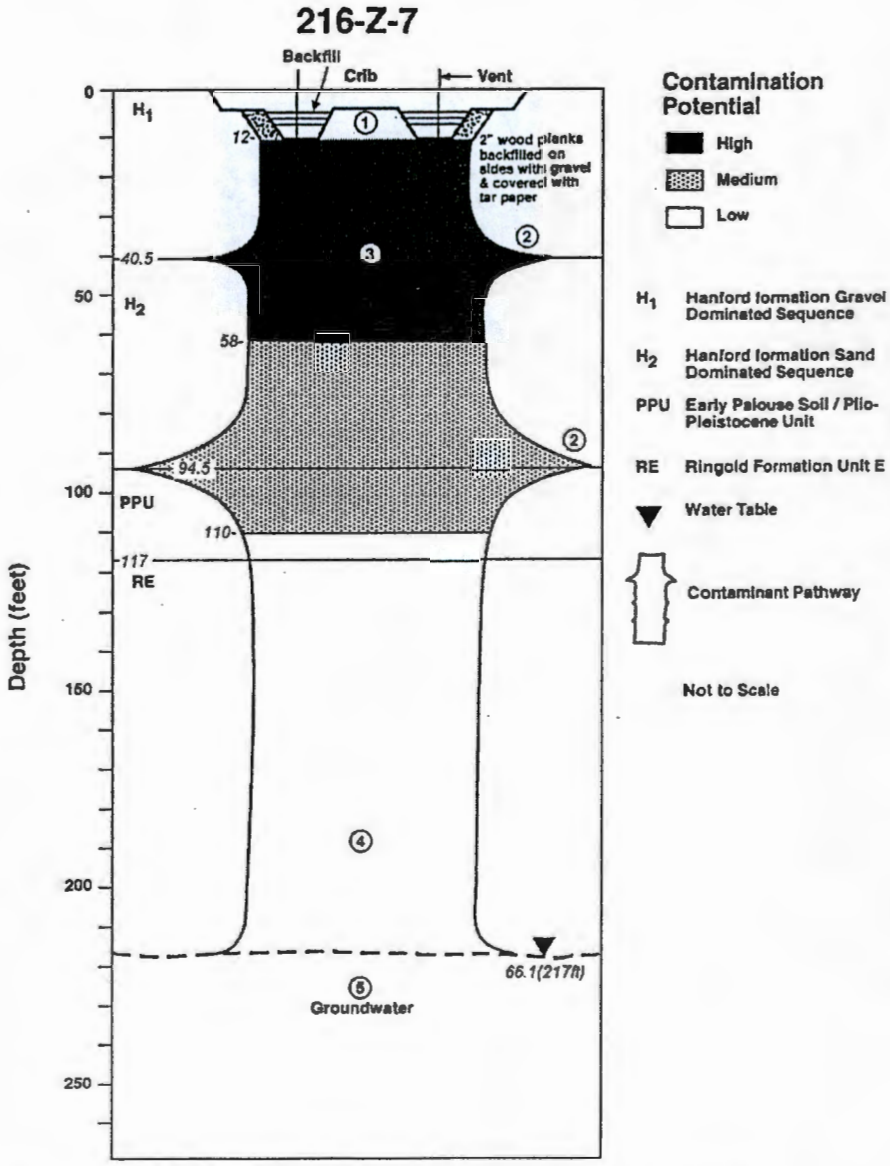
③ Immobile contaminants such as cesium-137 normally sorb near the point of release in high concentrations. Contaminant concentrations decreased with depth.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to the water table.

⑤ Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (135,300m^3) is greater than the soil column pore volume (6020m^3). Nitrate, carbon tetrachloride, iodine-129, and tritium exceed groundwater protection standards near the crib.

E0111003.1

Figure 1-10. 216-Z-7 Crib Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-Z-7 crib between 1947 and 1967. The crib received a total volume of 79,000,000 L (21,093,600 gallons) of wastewater. Very little data are available to evaluate the contaminant distribution at this site.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the crib. Minor lateral spreading of wastewater may occur associated with H2, and the PPU. The available data suggest that lateral spreading is not significant beneath the crib.

③ Immobile contaminants such as cesium-137 normally sorb near the point of release in high concentrations. Contaminant concentrations decreased with depth.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to the water table.

⑤ Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (79,000m^3) is greater than the soil column pore volume (30,000m^3). Nitrate, carbon tetrachloride, trichloroethylene, techetium-99, iodine-129, and tritium exceed groundwater protection standards near the crib.

E0111003.2

2.0 STEP 2 – IDENTIFY THE DECISION

The purpose of DQO Step 2 is to define the principal study questions (PSQs) that need to be resolved to address the problems identified in DQO Step 1 and the alternative actions (AAs) that would result from resolution of the PSQs. The PSQs and AAs are then combined into decision statements (DSs) that express a choice among AAs. Table 2-1 presents the task-specific PSQs, AAs, and resulting DSs. This table also provides a qualitative assessment of the severity of the consequences of taking an AA if it is incorrect. This assessment takes into consideration human health and the environment (flora/fauna) and political, economic, and legal ramifications. The severity of the consequences is expressed as low, moderate, or severe.

Table 2-1. Summary of DQO Step 2 Information. (2 Pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ #1 – Are the contaminant concentrations TRU or greater than Class C?			
1-1	Evaluate special remedial alternatives in a FS.	Special remedial alternatives for the waste sites will be unnecessarily developed during the FS. The remedial alternative will unnecessarily incorporate costly and difficult processes for handling TRU or greater than Class C contaminated soil.	Low
1-2	Evaluate conventional remedial alternatives in a FS.	The FS and associated remedial action will not plan for special remedial alternatives necessary for handling TRU or greater than Class C contaminated soils. These soils might be incorrectly managed and disposed. Workers could be exposed to unacceptable levels of radioactively contaminated soils during remediation.	Moderate (Additional samples will be collected during the confirmatory sampling phase to confirm waste profiles.)
DS #1 – Determine whether the contaminant concentrations are TRU or greater than Class C and evaluate special remedial alternatives in a FS, or evaluate conventional remedial alternatives in a FS.			
PSQ #2 – Is the soil radiologically contaminated?			
2-1	Evaluate remedial alternatives in a FS.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low
2-2	Evaluate the site for closure with no remedial action.	The site may inappropriately be closed without remedial action, increasing risks of potential exposure to workers and the environment.	Moderate (Additional samples will be collected during the confirmatory sampling phase to confirm waste profiles.)
DS #2 – Determine whether the soil is radiologically contaminated and evaluate remedial alternatives in a FS, or evaluate the site for closure with no remedial action.			

Table 2-1. Summary of DQO Step 2 Information. (2 Pages)

PSQ-AA #	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ #3 – Is the soil chemically contaminated?			
3-1	Evaluate remedial alternatives in a FS.	The site may be inappropriately remediated resulting in unnecessary expenditure of funds.	Low
3-2	Evaluate the site for closure with no remedial action.	The site may inappropriately be closed without remedial action, increasing risks of potential exposure to workers and the environment.	Moderate
DS #3 – Determine whether the soil is chemically contaminated and evaluate remedial alternatives in a FS, or evaluate the site for closure with no remedial action.			

3.0 STEP 3 – IDENTIFY THE INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the types of data needed to resolve each of the DSs identified in DQO Step 2. The data may already exist or may be derived from computational or surveying/sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limit [PQL], precision, and accuracy) are also provided in this step for any new data that need to be collected.

3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-1 specifies the information (data) required to resolve each of the DSs identified in Table 2-1 and identifies whether the data already exist. For the data that are identified as existing, the source references for the data have been provided with a qualitative assessment as to whether or not the data are of sufficient quality to resolve the corresponding DS.

Table 3-1. Required Information and Reference Sources. (3 Pages)

PSQ #	Required Information Category	Do Data Exist? (Y/N)	Source Reference	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)				Are Additional Data Required to Support RI/FS Process? (Y/N)			
				B-58	T-28	S-20	Z-7	B-58	T-28	S-20	Z-7
1 and 2	Soil radiological data	Y	*T Plant Source Aggregate Area Management Study Report*, DOE/RL-91-61, Rev. 0 (DOE-RL 1993e). Provides summary of existing data for sites associated with T Plant.	[a]	N	[a]	[a]	Y[b]	Y	Y[b]	Y[b]
			B Plant Source Aggregate Area Management Study Report, DOE/RL-92-05, Rev. 0 (DOE-RL 1993a). Provides summary of existing data for sites associated with B Plant.	N	[a]	[a]	[a]	Y	Y[b]	Y[b]	Y[b]
			PUREX Source Aggregate Area Management Study Report, DOE/RL-92-04 (DOE-RL 1993c).	[a]	[a]	[a]	N	Y[b]	Y[b]	Y[b]	Y
			Inventory of Chemicals Used at Hanford Site Production Plants and Support Operations (1944-1980), WHC-EP-0172, Rev. 1 (WHC 1990).	N	N	N	N	Y	Y	Y	Y
			Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells, ARH-ST-156 (Fecht et al. 1977). Provides scintillation logs with gross gamma readings for boreholes located near the waste sites.	N	N	N	N	Y	Y	Y	Y
			Duratek geophysical logging project files, which provide borehole geophysical logging data for gamma-emitting radionuclides.	N	N	N	N	Y	Y	Y	Y
			HEIS database (from 216-T-26 Crib characterization for 200-TW-1).	N	N	[a]	[a]	Y[b]	Y	Y[b]	Y[b]

Table 3-1. Required Information and Reference Sources. (3 Pages)

PSQ #	Required Information Category	Do Data Exist? (Y/N)	Source Reference	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)				Are Additional Data Required to Support RI/FS Process? (Y/N)			
				B-58	T-28	S-20	Z-7	B-58	T-28	S-20	Z-7
			Waste Site Grouping for 200 Areas Soil Investigations, DOE/RL-96-81, Rev. 0 (DOE-RL 1997). Provides existing information for the wastes sent to these OUs.	N	N	N	N	Y	Y	Y	Y
3	Soil nonradiological sample data	Y	*Waste Site Grouping for 200 Areas Soil Investigations*, DOE/RL-96-81, Rev. 0 (DOE-RL 1997). Provides existing information for the wastes sent to these OUs.	N	N	N	N	Y	Y	Y	Y
			HEIS database (from 216-T-26 Crib characterization for 200-TW-1).	N	N	[a]	[a]	Y	Y	Y[b]	Y[b]
N/A	Groundwater data	Y	See Section 1-4.	Groundwater data cannot be used to validate a vadose zone preliminary conceptual contaminant distribution model.							
1, 2, and 3	Physical properties moisture content, particle size distribution, and lithology	Y	*Hydrogeologic Model for the 200-East Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Rev. 0 (WHC 1992a). Presents site-specific data for 200 East Area that can be used to calculate soil density, hydraulic conductivity, and porosity.	N	[a]	[a]	[a]	Y	Y[b]	Y[b]	Y[b]
			Hydrogeologic Model for the 200-West Groundwater Aggregate Area, WHC-SD-EN-TI-290, Rev. 0 (WHC 1992b). Presents site-specific data for 200 West Area that can be used to calculate soil density, hydraulic conductivity, and porosity.	[a]	N	N	N	Y[b]	Y	Y	Y

Table 3-1. Required Information and Reference Sources. (3 Pages)

PSQ #	Required Information Category	Do Data Exist? (Y/N)	Source Reference	Are Available Data of Sufficient Quality and Quantity to Support RI/FS Process? (Y/N)				Are Additional Data Required to Support RI/FS Process? (Y/N)			
				B-58	T-28	S-20	Z-7	B-58	T-28	S-20	Z-7
1, 2, and 3	Distribution coefficients	Y	*Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, PNNL-11800 (PNNL 1998b). Provides 200 Area distribution coefficients for various waste stream types and Hanford soils.	Y	Y	Y	Y	N	N	N	N
			Geochemical Data Package for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment (ILAW PA), PNNL-13037, Rev. 1 (Kaplan and Serne 2000). Provides 200 Area distribution coefficients for various waste stream types and Hanford soils.	Y	Y	Y	Y	N	N	N	N
			Phase I Remedial Investigation Report for 200-BP-1 Operable Unit, DOE/RL-92-70 (DOE-RL 1993b). Provides 200 Area distribution coefficients for 200-BP-1 waste streams and Hanford soils.	Y	Y	Y	Y	N	N	N	N
1 and 2	RESRAD input data	Y	*Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0*, ANL-EAD-LD-2 (ANL 1993). Input parameters are defined in this manual that can be determined based on existing information or RESRAD defaults.	N/A	N/A	N/A	N/A	Y	Y	Y	Y

[a] Document does not pertain to this waste site; no site-specific information included for the site.
[b] Decision on additional data is irrelevant for the document, as no site-specific information is included for the site.
N/A = not applicable

3.2 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL

The preliminary action level is the threshold value that provides the criterion for choosing between AAs. Table 3-2 identifies the basis (i.e., regulatory threshold or risk-based) for establishing the preliminary action level for each of the COCs. The numerical value for the action level is defined in DQO Step 5.

Table 3-2. Basis for Setting Preliminary Action Level.

DS #	COCs	Basis for Setting Preliminary Action Level
1	TRU-contaminated soils	DOE's definition for TRU waste (DOE O 435.1)
	Greater than Class C contaminated soils	10 CFR 61.55
2	Radiological COCs	Radiological lookup values for shallow zone (i.e., less than 15 ft) soils based on RESRAD analyses for the applicable scenarios. Vadose zone values to support groundwater protection lookup values will be determined using RESRAD, STOMP, or another model.
3	Nonradiological COCs	MTCA Method C cleanup levels with contaminant-specific variations[a].

[a] If sites are located outside the 200 Area industrial exclusive-use boundary, additional scenarios and preliminary action levels may need to be evaluated. See Table 1-12.

3.3 COMPUTATIONAL AND SURVEY/ANALYTICAL METHODS

Table 3-3 identifies the DSs where existing data either do not exist or are of insufficient quality to resolve the DSs. For these DSs, Table 3-3 presents computational and/or surveying/sampling methods that could be used to obtain the required data.

Table 3-3. Information Required to Resolve the Decision Statements.[a] (2 Pages)

DS #	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1 and 2	Concentrations of radiological COCs in vadose zone soils	Alpha, beta, and gamma COC concentrations in soils for evaluation against ARARs and PRGs. Location data (vertical extent of COCs within waste site boundaries).	RESRAD – analytical modeling method for human health dose assessment. STOMP or other analytical code – analytical modeling through vadose zone to groundwater.	Field screening with radiological detection equipment. Geophysical borehole logging with downhole radiological detectors. Soil sampling and laboratory analysis.

Table 3-3. Information Required to Resolve the Decision Statements.[a] (2 Pages)

DS #	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
3	Concentrations of nonradiological COCs in vadose zone soils	Nonradiological (e.g., inorganic metals and anions, and SVOCs) COC concentrations in soils for evaluation against ARARs and PRGs. Location data (vertical extent of COCs within waste site boundaries).	MTCA risk assessment. STOMP or other analytical code – analytical modeling through vadose zone to groundwater.	Soil sampling and laboratory analysis.[b]
1, 2, and 3	Physical properties in vadose zone soils	Moisture content, bulk density, particle size distribution.	Direct comparison to existing models to determine conductivity.	Soil sampling, field measurements, and laboratory analysis.

[a] See Table 3-5 for additional information.
[b] Additional field screening data may be collected as vadose zone soil gas samples at the 216-Z-7 Crib and will be coordinated with other activities in the 200-PW-1 OU and with other 200 Area projects (i.e., groundwater).
SVOC = semi-volatile organic compound
TBD = to be determined

Table 3-4 presents details on the computational methods identified in Table 3-3. These details include the source and/or author of the computational method and information on how the method could be applied to this study.

Table 3-4. Details on Identified Computational Methods.

DS #	Computational Method	Source/ Author	Application to Study	Satisfy Input Req't?
1 and 2	RESRAD	Argonne National Laboratory	RESRAD will be used to estimate direct human radiation exposure to account for radioactive decay.	Yes
1, 2, and 3	STOMP code or other analytical codes	PNNL	Estimates the migration of all contaminants (radiological and nonradiological) through the vadose to groundwater. The model requires site-specific geohydrologic soil properties (e.g., hydraulic conductivity, and moisture). Other codes may be identified and used based on specific site conditions and requirements.	Yes

Table 3-5 identifies each of the survey and/or analytical methods that may be used to provide the required information needed to resolve each of the DSs. The possible limitations associated with each of these methods are also provided.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 Pages)

Media	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Possible Limitations
Field Screening			
Fine-grained materials, structures	Site location; underground structures or interferences	GPR	GPR is a radar-reflection surface geophysical survey technique that detects contrasts in di-electric constants in the below-grade environments from the surface. Requires subjective interpretation of the reflected signals. Lack of reflective below-grade surfaces or the presence of interfering matrices can complicate or invalidate the findings. The presence of nearby buildings and utilities can interfere with reflected signals. Fines (e.g., clay and heavy fly ash) can act as a reflector to the radar signal.
		EMI	EMI is a surface geophysical survey technique that measures electrical conductivity in below-grade soils based on detected changes in electrical fields. The results of EMI are generally used to support the interpretation of GPR surveys. Nearby buildings and utilities can cause interferences.
Vadose zone soils	Gross and isotopic gamma emissions	Cone penetrometer; NaI detector logging	A closed-end rod is pushed into the soil to the desired depth. A small-diameter NaI detector (or other suitable detector) is used to log the gross gamma response with depth. The cone penetrometer is not effective in cobbly or rocky soils.
	Gross and isotopic gamma emissions	Direct push; NaI detector logging	A small-diameter casing is pushed into the soil to the desired depth. A small-diameter NaI detector (or other suitable detector) is used to log the gamma response with depth. Direct-push methods (e.g., GeoProbe™) may be ineffective in cobbly or rocky soils.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 Pages)

Media	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Possible Limitations
	Gamma emissions from fission products, Am-241, Pu-239, and Np-237	Borehole SGL with HPGe detector	Gamma-ray logging provides the concentration profiles of gamma-emitting radionuclides such as Am-241, Pu-239, and many fission products in a borehole environment. It is considered by some to be more accurate than sampling and laboratory assay because the assay is performed in situ with less disturbance of the sample, there is higher vertical spatial resolution, and the sample size is much larger. This method may also be more economical than traditional sampling and analysis. This method does not assess radionuclides or daughter products that do not emit gamma rays. The gamma energies from these isotopes are at the low end of the spectrum, which results in high numerical minimum detectable activities and possible matrix effects from other isotopes. This technique requires the use of a single casing (installed by drilling or driving) in contact with the soil formation.
	Neutron emissions from plutonium	Borehole passive neutron logging	Passive neutron logging provides indication of the presence of neutron-emitting isotopes. Because of the very low incidence of spontaneous Pu fission and alpha-N reactions, the passive neutron profile is orders of magnitude lower than the gamma emissions.
	Active neutron emissions from transuranics	Borehole passive/active neutron-logging methods	This technique uses source materials or generators to release neutrons into the soil formation. Passive detectors measure the response to the neutron flux as a means of detecting specific transuranic constituents. Although neutron activation methods have been developed, they are not expected to be useful for this initial characterization effort. At present, these techniques are too expensive and time consuming, and logistical problems are associated with the handling of intense sources or generators.
	Vertical moisture profile	Borehole neutron-neutron moisture logging	Neutron-neutron moisture logs can be used to determine current moisture content profiles of the subsurface through new or existing boreholes. The moisture profiles are often directly correlated to contaminant concentrations, sediment grain size, composition, or subsurface structural features. For this project, the moisture profile may be useful for helping determine the location of contamination and/or the location of the ditch and establish geologic conditions to support contaminant fate and transport modeling. It may also be correlated to reflections identified in ground-probing radar surveys.

Table 3-5. Potentially Appropriate Survey and/or Analytical Methods. (3 Pages)

Media	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Possible Limitations
Laboratory Samples			
Vadose zone soils	All COCs and physical properties	Laboratory analysis	Highly contaminated samples require use of onsite laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, and long turnaround times). Lower contamination levels allow use of offsite laboratories, avoiding these limitations. Physical property analysis will include bulk density, moisture content, and particle size distribution.

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3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Table 3-6 defines the analytical performance requirements for the data that need to be collected to resolve each of the DSs. These performance requirements include the PQL and the precision and accuracy requirements for each of the COCs.

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology[1]	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		15 mrem/yr[b] (pCi/g)	500 mrem/yr[b] (pCi/g)	GW Protection[b] (pCi/g)		Water Low Activity (pCi/L)	Water High Activity (pCi/L)	Soil-Other Low Activity (pCi/g)	Soil-Other High Activity (pCi/g)				
Americium-241	14596-10-2	335	112,000	N/A	Americium isotopic – AEA	1	400	1	4,000	±20%	80-120%	±35%	65-135%
Carbon-14	14762-75-5	33,100	1,100,000	291	Carbon-14 – liquid scintillation	200	N/A	50	N/A	±20%	70-130%	±35%	70-130%
Cesium-137	10045-97-3	23.4	780	N/A	GEA	15	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Cobalt-60	10198-40-0	4.90	164	N/A	GEA	25	200	0.05	2,000	±20%	80-120%	±35%	65-135%
Europium-152	14683-23-9	11.4	388	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Europium-154	15585-10-1	10.3	345	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Europium-155	14391-16-3	426	14,200	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Neptunium-237	13994-20-2	59.2	1,980	N/A	Neptunium-237 – AEA	1	N/A	1	8,000	±20%	80-120%	±35%	65-135%
Nickel-63	13981-37-8	4,026	3,008,000	N/A	Nickel-63 – liquid scintillation	15	N/A	30	N/A	±20%	70-130%	±35%	70-130%
Plutonium-238	13981-16-3	470	15,700	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Plutonium-239/240	Pu-239/240	425	14,200	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Strontium-90	Rad-Sr	2,410	80,300	N/A	Total radioactive strontium – GPC	2	80	1	800	±20%	80-120%	±35%	65-135%
Technetium-99	14133-76-7	412,000	13,700,000	171	Technetium-99 – liquid scintillation	15	400	15	4,000	±20%	80-120%	±35%	65-135%
Thorium-232	TH-232	4.8	160	N/A	Thorium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Tritium (H-3)	10028-17-8	66,900	2,230,000	4,100	Tritium – liquid scintillation	400	400	400	400	±20%	80-120%	±35%	65-135%
Uranium-233/234	13966-29-5	2,660	88,800	39.5	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Uranium-235/236	15117-96-1	101	3,370	3.92	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Uranium-238	U-238	504	16,800	38.1	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Metals													
Antimony	7440-36-0	1,400	N/A	5	Metals – 6010 – ICP	0.06	0.2	6	20	g	g	g	g
Arsenic	7440-38-2	87.5	20[h]	20[h]	Metals – 6010 – ICP	0.1	0.2	10	20	g	g	g	g
					Metals – 6010[i] – ICP (trace)	0.01	N/A	1	N/A	g	g	g	g
Barium	7440-39-3	245,000	282[j]	132[h]	Metals – 6010 – ICP	0.2	0.2	20	40	g	g	g	g
Beryllium	7440-41-7	104[k]	N/A	10	Metals – 6010 – ICP	0.005	0.01	0.5	1	g	g	g	g
Cadmium	7440-43-9	139[k]	0.81[h]	4	Metals – 6010 – ICP	0.005	0.01	0.5	1	g	g	g	g
					Metals – 6010[i] – ICP (trace)	0.005	N/A	0.5	N/A	g	g	g	g
Chromium (total)	7440-47-3	Unlimited	2,000[j]	42	Metals – 6010 – ICP	0.01	0.01	1	2	g	g	g	g
					Metals – 6010 – ICP (trace)	0.01	N/A	1	N/A	g	g	g	g
Chromium VI	18540-29-9	21[k]	7.7[l]	42	Chromium (hex) – 7196 – colorimetric	0.01	4	0.5	200	g	g	g	g
Copper	7440-50-8	130,000	22[h]	50	Metals – 6010 – ICP	0.025	0.025	2.5	2.5	g	g	g	g
Lead	7439-92-1	1,000[m]	840[l]	50	Metals – 6010 – ICP	0.1	0.2	10	20	g	g	g	g
					Metals – 6010 – ICP(trace)	0.01	N/A	1	N/A	g	g	g	g
Mercury	7439-97-6	1,050	0.33[h]	0.33[h]	Mercury – 7470 – CVAA	0.0005	0.005	N/A	N/A	g	g	g	g
					Mercury – 7471 – CVAA	N/A	N/A	0.2	0.2	g	g	g	g
Nickel	7440-02-0	70,000[n]	130.4[j]	30	Metals – 6010 – ICP	0.04	0.04	4	4	g	g	g	g
Selenium	7782-49-2	17,500	1[l]	0.78[h]	Metals – 6010 – ICP	0.1	0.2	10	20	o	o	o	o
Silver	7440-22-4	17,500	9.4[l]	2	Metals – 6010 – ICP	0.02	0.02	2	2	g	g	g	g
					Metals – 6010 – ICP (trace)	0.005	N/A	0.5	N/A	g	g	g	g
Uranium (total)	7440-61-1	10,500[n]	115	5	Uranium total – kinetic phosphorescence analysis	0.0001	0.02	1	0.2	±20%	80-120%	±35%	65-135%

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Inorganics													
Ammonia/ ammonium	7664-41-7	Unlimited	Unlimited	N/A	Ammonia – 350.N[o]	0.05	800	0.5	8,000	[g]	[g]	[g]	[g]
Chloride	16887-00-6	N/A	N/A	N/A	Anions – 300.0 – IC	0.2	5	2	5	[g]	[g]	[g]	[g]
Cyanide	57-12-5	70,000	0.80[j]	N/A	Total cyanide – 9010 – colorimetric	0.005	0.005	0.5	0.5	[g]	[g]	[g]	[g]
Fluoride	16984-48-8	210,000	16[j]	N/A	Anions – 300.0 – IC	0.5	5	5	5	[g]	[g]	[g]	[g]
Nitrate	14797-55-8	Unlimited	40[j]	N/A	Anions – 300.0 – IC	0.25	10	2.5	40	[g]	[g]	[g]	[g]
Nitrite	14797-65-0	350,000	4[j]	N/A	Anions – 300.0 – IC	0.25	15	2.5	20	[g]	[g]	[g]	[g]
Phosphate	14265-44-2	N/A	N/A	N/A	Anions – 300.0 – IC	0.5	15	5	40	[g]	[g]	[g]	[g]
Sulfate	14808-79-8	N/A	1,000[j]	N/A	Anions – 300.0 – IC	0.5	15	5	40	[g]	[g]	[g]	[g]
Sulfide	18496-25-8	N/A	N/A	N/A	Sulfide 9030	0.5	15	5	40	[g]	[g]	[g]	[g]
Organics													
Acetone (2-propanone)	67-64-1	350,000	3.21	N/A	Volatile organics – 8260 – GCMS	0.02	0.02	0.02	0.02	[g]	[g]	[g]	[g]
Benzene	71-43-2	2,390	2.42	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Butanol; n-	71-36-3	350,000	6.62	N/A	GC organic – 8015	5	5	5	5	[g]	[g]	[g]	[g]
Butyl benzene; n	104-51-8	N/A	N/A	N/A	Volatile organics – 8260 – GCMS	0.005	N/A	0.005	N/A	N/A	N/A	N/A	N/A
Carbon tetrachloride	56-23-5	1,010	0.0031	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Chlorobenzene	108-90-7	70,000	1.4	40	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Chloroform	67-66-3	21,500	0.0382	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Dichloroethane; 1,1	75-34-3	350,000	4.37	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	[g]	[g]	[g]	[g]
Dichloroethane; 1,2	107-06-2	1,440	0.00232	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Dichloroethylene; 1,2- (mixed isomers)	540-59-0	31,500	0.4	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	[g]	[g]	[g]	[g]

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Ethylene glycol	107-21-1	Unlimited	N/A	N/A	GC organic 8015	5	5	5	5	[g]	[g]	[g]	[g]
Ethylbenzene	100-41-4	350,000	6.91	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Methyl ethyl ketone (MEK; 2-butanone)	78-93-3	Unlimited	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	[g]	[g]	[g]	[g]
Methyl isobutyl ketone (MIBK hexone)	108-10-1	280,000	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	[g]	[g]	[g]	[g]
Methylene chloride (dichloromethane)	75-09-2	17,500	0.0254	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Phenol	108-95-2	Unlimited	43.9	30	Semi-volatiles – 8270 – GCMS	0.01	0.1	0.33	3.3	[g]	[g]	[g]	[g]
PCBs	1336-36-3	10[m]	0.21[j]	0.65	PCBs – 8082 – GC	0.0005	0.005	0.0165	0.1	[g]	[g]	[g]	[g]
Tetrachloroethylene	127-18-4	2,570	0.0091	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Toluene	108-88-3	70,000	11.6	200	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Tributyl phosphate	126-73-8	N/A	N/A	N/A	Semi-volatiles – 8270 – GCMS	0.1	0.5	3.3	5	[g]	[g]	[g]	[g]
Trichlorethane; 1,1,1	71-55-6	Unlimited	57	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Trichloroethylene	79-01-6	11,900	0.0263	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Xylene (total)	1330-20-7	Unlimited	135	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Total petroleum hydrocarbons – diesel to oil range (kerosene)	68334-30-5	2,000[m]	2,000[m]	200	WTPH-D	0.5	0.5	5	5	[g]	[g]	[g]	[g]
Total petroleum hydrocarbons – gasoline range	8006-61-9	30[m]	30[m]	100	WTPH-G	0.5	0.5	5	5	[g]	[g]	[g]	[g]
Normal paraffin hydrocarbons	8008-20-6	2,000[m]	2,000[m]	200	Nonhalogenated VOA – 8015M – GC modified for hydrocarbons	0.5	0.5	5	5	[g]	[g]	[g]	[g]
Hydraulic fluids (grease; heavy oils)	8008-20-6	2,000[m]	2,000[m]	N/A	Oil and grease (total recoverable) – 413.N	2	N/A	200	N/A	[g]	[g]	[g]	[g]

Table 3-6. Analytical Performance Requirements – Shallow and Deep Zone Soils. (5 Pages)

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Field Screening Measurements													
pH	N/A	N/A	N/A	N/A	TBD	TBD		TBD		TBD	TBD	TBD	TBD
Soil Physical Properties													
Bulk density	N/A	N/A	N/A	N/A	D2937, or BHI-EE-05, Procedure 3.9	N/A		wt%		N/A	N/A	N/A	N/A
Lithology	N/A	N/A	N/A	N/A	BHI-EE-01, Procedure 7.0	N/A		Descriptive		N/A	N/A	N/A	N/A
Moisture content	N/A	N/A	N/A	N/A	D2216	N/A		wt%		N/A	N/A	N/A	N/A
Particle size distribution	N/A	N/A	N/A	N/A	D422	N/A		wt%		N/A	N/A	N/A	N/A

[a] The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the FS, will be finalized in the record of decision, and will drive remediation of the sites.
[b] 15 mrem/yr = nonradiological worker industrial exposure scenario; 2,000 hrs/yr onsite, 60% indoors, 40% outdoors. 500 mrem/yr = radiological worker industrial scenario; 2,000 hrs/yr onsite, 60% indoors, 40% outdoors. GW = groundwater protection radionuclide values based on RESRAD modeling of drinking water exposure with the entire vadose zone presumed to be contaminated.
[c] Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered). For both water and soil mediums, matrix affects may impact on specific sample basis.
[d] MTCA Method C industrial soil values for direct exposure from the CLARC Version 3.1 tables, updated November 2001 (Ecology 2001).
[e] MTCA Method B soil values for groundwater protection from the CLARC Version 3.1 tables, updated November 2001 (Ecology 2001), except as noted.
[f] Value is the lowest concentration for each analyte (adjusted for background) from Tables 749-2 and 749-3 of WAC 173-340-900, amended February 12, 2001.
[g] Precision and accuracy requirements as identified and defined in the referenced EPA procedures implemented by laboratory analysis and QA procedures.
[h] Cleanup value is less than Hanford Site soil background. Therefore, the soil background concentration is used as the preliminary action level.
[i] All four-digit numbers refer to *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA 1986).
[j] Calculated using MTCA Method B drinking water standards as inputs to the MTCA three-phase model for protection of drinking water (WAC 173-340-747[4], amended February 12, 2001), except as noted.
[k] Calculated using MTCA air cleanup standards from WAC 173-340-750(3)(a)(ii)(B), page 210, equation 750-2, with Washington State Department of Health mass loading of particulates in air of 10^{-4} g/m^3.
[l] Calculated using standards for surface water protection (40 CFR 131 and WAC 173-201A-040) as inputs to the MTCA three-phase model for protection of drinking water (WAC 173-340-747[4], February 12, 2001).
[m] Based upon MTCA Method A values from Tables 740-1 and 745-1 of WAC 173-340-900, amended February 12, 2001.
[n] Value based upon nickel or uranium soluble salts value.
[o] From *Methods of Analysis of Water and Waste* (EPA 1983).

AEA = alpha energy analysis
CAS = Chemical Abstract Service
CVAA = cold vapor atomic absorption
GC = gas chromatograph
GCMS = gas chromatograph/mass spectrometry
GPC = gas proportional counter
IC = ion chromatography
ICPMS = inductively coupled plasma mass spectrometer
N/A = not applicable
TBD = to be determined
TOC = total organic carbon

4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

4.1 OBJECTIVE

The primary objective of DQO Step 4 is for the DQO team to identify the spatial, temporal, and practical constraints on the sampling design and to consider the consequences. This objective (in terms of the spatial, temporal, and practical constraints) ensures that the sampling design results in the collection of data that accurately reflect the true condition of the site and/or populations being studied.

4.2 WORKSHEETS FOR STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

Table 4-1 defines the population of interest to clarify what the samples are intended to represent. The characteristics that define the population of interest are also identified.

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

DS #	Population of Interest	Characteristics
Cribs and Trenches		
All	Vadose zone soils	Concentrations of transuranic radionuclides, other radionuclides, metals, and limited organic constituents; physical properties including moisture content, bulk density, and grain size distribution.

Table 4-2 defines the spatial boundaries of the decision and the domain or geographic area (or volume) within which all decisions must apply (in some cases, this may be defined by the OU). The domain is a region distinctly marked by some physical features (i.e., volume, length, width, and boundary).

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
All	The geographic boundaries for the investigation are the boundaries of the individual representative waste sites.

When appropriate, the population is divided into strata that have relatively homogeneous characteristics. The DQO team must systematically evaluate process knowledge, historical data, and plant configurations to present evidence of a logic that supports alignment of the population into strata with homogeneous characteristics. Table 4-3 identifies the strata with homogeneous characteristics.

Table 4-3. Zones with Homogeneous Characteristics.

DS #	Population of Interest	Zone	Homogeneous Characteristic Logic
Cribs and Specific Retention Trenches			
1, 2 and 3	Vadose zone soils	Clean or very low concentration stabilizing fill over waste site	Not expected to be contaminated. Fill will be field-screened for contamination at all sites during characterization activities.
	Vadose zone soils	Highest contaminant concentration layer[a]	The particulates and high distribution coefficient contaminants were sorbed and/or filtered out of the liquid flow via the soils at the bottom of the excavated crib/trench. This zone is expected to contain the highest concentrations of contaminants and to have decreasing concentrations with depth. May also contain residual concentrations of mobile constituents.
	Vadose zone soils	Moderate to low contaminant concentration layer[a]	A moderate concentration layer was formed immediately beneath the expected high concentration layer. In this zone, finer particulates and moderate distribution coefficient contaminants from the liquid waste streams were filtered and sorbed. High volumes of disposed liquids may have carried some immobile constituents into this zone, and residual concentrations of mobile constituents may also be present. This zone is expected to have decreasing concentrations with depth as more immobile constituents filter and sorb out with the passing of the wetting front.[b]
	Vadose zone soils	Low contaminant concentration layer[a]	This zone is expected to contain low concentrations of mobile contaminants from the source to the groundwater table. Concentrations are expected to remain fairly constant through the impacted zone because the majority of the contaminants have been flushed through the system, leaving residual concentrations.

[a] The thickness is not specified.
[b] The wetted front may have reached groundwater for crib sites. It is not known if groundwater was impacted by the discharges in the trench sites.

The temporal boundaries of the decision are defined in Table 4-4.

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Timeframe	When to Collect Data
Field Screening		
1, 2, and 3	N/A	Avoid extreme hot/cold months due to impacts on worker efficiency and equipment effectiveness. Inclement weather may impact sample quality.
Laboratory Samples		
1, 2, and 3	N/A	Avoid extreme hot/cold months and inclement weather that have potential to impact sample integrity and soil sampling operations.

N/A = not applicable

4.3 SCALE OF DECISION MAKING

Table 4-5 defines the scale of decision making for each DS. The scale of decision making is defined as the smallest, most appropriate subsets of the population (sub-population) for which decisions will be made based on the spatial or temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making.

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Spatial Scale of Decision Making
			Timeframe	When to Collect Data	
All	Vadose zone soils	Boundaries of the individual representative waste sites: 216-B-58 Trench, 216-T-28 Crib, 216-S-20 Crib, and 216-Z-7 Crib	N/A	Avoid extreme hot/cold months and inclement weather that have potential to impact sample integrity and soil sampling operations.	Vadose soils

N/A = not applicable

The zones of homogeneous characteristics in Table 4-3 identify strata within the representative waste site. However, the spatial scale of decision making is the vadose zone soils from the ground surface to the water table. The data support remedial decision making that will consider the vertical distribution of contaminants throughout the entire vadose zone.

4.4 PRACTICAL CONSTRAINTS

Table 4-6 identifies all of the practical constraints that may impact the data collection effort. These constraints include physical barriers, difficult sample matrices, high radiation areas, or any other condition that will need to be taken into consideration in the design and scheduling of the sampling program.

Table 4-6. Practical Constraints on Data Collection.

Boreholes may not obtain sufficient volumes of sample media if the sampled zone is 0.6 m (2 ft) thick or less. Advancement of borehole casing may smear contamination downhole.
Other Constraints:
Laboratory constraints are expected when analyzing soil samples with high contaminant concentrations. Soil samples in this category would be analyzed in an onsite laboratory. Impacts are expected in cost, degradation of detection limits, and possible reduction in the analyte lists. Extreme weather conditions may also limit or shut down field screening operations.
Subsidence associated with subsurface wooden components of the waste sites (216-B-58, 216-S-20, and 216-Z-7) may require modifications to drilling strategies and will be evaluated prior to drilling activities.

5.0 STEP 5 – DEVELOP A DECISION RULE

The purpose of DQO Step 5 is initially to define the statistical parameter of interest (i.e., maximum, mean, or 95% upper confidence level [UCL]) that will be used for comparison against the action level. The statistical parameter of interest specifies the characteristic or attribute that a decision maker would like to know about the population. The preliminary action level for each of the COCs is also identified in DQO Step 5. When this is established, a decision rule (DR) is developed for each DS in the form of an "IF…THEN…" statement that incorporates the parameter of interest, the scale of decision making, the preliminary action level, and the AAs that would result from resolution of the decision. Note that the scale of decision making and AAs were identified earlier in DQO Steps 4 and 2, respectively.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 5-1, 5-2, and 5-3 present the information needed to formulate the DRs in Section 5.2. This information includes the DSs and AAs identified in DQO Step 2, the scale of decision making identified in DQO Step 4, and the statistical parameters of interest and preliminary action levels for each of the COCs.

Table 5-1. Decision Statements.

DS #	Decision Statement
1	Determine whether the contaminant concentrations are TRU or greater than Class C and evaluate special remedial alternatives in a FS, or evaluate conventional remedial alternatives in a FS.
2	Determine whether the soil is radiologically contaminated and evaluate remedial alternatives in a FS, or evaluate the site for closure with no remedial action.
3	Determine whether the soil is chemically contaminated and evaluate remedial alternatives in a FS, or evaluate the site for closure with no remedial action.

Table 5-2. Inputs Needed to Develop Decision Rules.

DS #	COCs	Parameter of Interest	Scale of Decision Making	Preliminary Action Levels
1	Transuranic radionuclides	Soil sampling; maximum detected values	Vadose zone soils	≥100 nCi/g
	Greater than Class C radionuclides			10 CFR 61.55
2	Radionuclides			RESRAD lookup values and TBD through other modeling; radionuclide concentrations equating to a dose limit of 100 mrem/yr above background
3	Nonradiological constituents			MTCA and other regulatory levels (identified in Table 3-6)
2 and 3	Soil and physical properties			N/A

N/A = not applicable
TBD = to be determined

The AAs identified in DQO Step 2 are summarized in Table 5-3.

Table 5-3. Alternative Actions.

PSQ #	AA #	Alternative Actions
1	1	Evaluate special remedial alternatives in a FS.
	2	Evaluate conventional remedial alternatives in a FS.
2	1	Evaluate remedial alternatives in a FS.
	2	Evaluate the site for closure with no remedial action.
3	1	Evaluate remedial alternatives in a FS.
	2	Evaluate the site for closure with no remedial action.

5.2 DECISION RULES

The output of DQO Step 5 and the previous DQO steps are combined into "IF...THEN" DRs that incorporate the parameter of interest, the scale of decision making, the action level, and the actions that would result from resolution of the decision. The DRs are listed in Table 5-4.

Table 5-4. Decision Rules.

DR #	Decision Rule
1	If the true maximum (as estimated by the maximum detected sample values) activity of radionuclides within the soil samples in each of the applicable strata[a] is greater than or equal to 100 nCi/g (transuranic) or the greater than Class C definition, evaluate special remedial alternatives in a FS; otherwise, evaluate conventional remedial alternatives in a FS.
2	If the true maximum (as estimated by the maximum detected sample values) activity of radionuclides within the soil samples in each of the applicable strata[a] results in a radiological dose greater than or equal to 15 to 100 mrem/yr above background, evaluate remedial alternatives in a FS; otherwise, evaluate the site for closure with no remedial action.
3	If the true maximum (as estimated by the maximum detected sample values) concentration of chemical constituents within the soil samples in each of the applicable strata[a] is greater than or equal to the preliminary action levels in Table 3-6, evaluate remedial alternatives in a FS; otherwise, evaluate the site for closure with no remedial action.

[a] The applicable strata include the highest contaminant concentration layers, the moderate-to-low contaminant concentration layers, and the low contaminant concentration layers.

6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data can only estimate the true condition of the site under investigation, decisions that are made based on measurement data could potentially be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which DSs (if any) requires a statistically based sample design. For those DSs requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error.

6.1 STATISTICAL VERSUS NON-STATISTICAL SAMPLING DESIGN

Table 6-1 provides a summary of the information used to support the selection between a statistical versus a non-statistical sampling design for each DS. The factors that were taken into consideration in making this selection included the timeframe over which each of the DSs applies, the qualitative consequences of an inadequate sampling design, and the accessibility of the site if resampling is required.

Table 6-1. Statistical Versus Non-Statistical Sampling Design.

DS #	Timeframe (Years)	Qualitative Consequences of Inadequate Sampling Design (Low/ Moderate/Severe)	Resampling Access After Remedial Investigation (Accessible/Inaccessible)	Proposed Sampling Design (Statistical/ Non-Statistical)
1, 2, and 3	N/A	Low to moderate	Accessible	Non-statistical

N/A = not applicable

6.2 NON-STATISTICAL DESIGNS

A biased (or focused) sampling approach, which targets the maximum potential contamination within a waste site, is considered appropriate for the waste sites in the 200-LW-1 OU. Contaminant distributions are expected to follow relatively predictable patterns based on process knowledge and existing environmental data.

For the DSs to be resolved using a non-statistical design, there is no need to define the "gray region" or the tolerable limits on decision error because these only apply to statistical designs. The nature of the waste sites to be investigated in the RI supports the use of focused sampling, as identified in *Washington State Department of Ecology Toxics Cleanup Program Guidance on Sampling and Data Analysis Methods* (Ecology 1995). This guidance document defines "focused sampling" as selective sampling of areas where potential or suspected soil contamination can reliably be expected to be found if a release of a hazardous substance has

occurred. The relatively small crib structures to be investigated released contaminants in a point-source manner. Contaminants released through a small crib would likely impact the soil immediately beneath the crib with minimal lateral spread; therefore, focusing the RI sampling through the crib will ensure collection of the area of greatest impact associated with the discharge. Even though the 216-B-58 Trench and 216-Z-7 Crib are larger than the other cribs identified for the RI, they are still relatively small sites. Additional efforts may be needed to determine the worst-case location for the borehole within these sites, which will provide additional data on gamma-emitting radionuclides to support the focused sampling regime.

7.0 STEP 7 – OPTIMIZE THE DESIGN

7.1 PURPOSE

The purpose of DQO Step 7 is to identify the most resource-effective design for generating data to support decisions while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed:

- Review the DQO outputs from the previous DQO steps and the existing environmental data.
- Develop general data collection design alternatives.
- Select the sampling design (e.g., techniques, locations, or numbers/volumes) that most cost effectively satisfies the project's goals.
- Document the operational details and theoretical assumptions of the selected design.

7.2 WORKSHEETS FOR STEP 7 – OPTIMIZE THE DESIGN

Table 7-1 identifies information in relation to determining the data collection design.

Table 7-1. Determine Data Collection Design.

Decision	Statistical	Non-Statistical	Rationale
All	N/A	Non-statistical sampling design	Judgmental data collection design is applicable to investigation as preliminary data suggest that the highest levels of contamination are located relative to release points or the bottom of waste sites. Relative size of waste sites present a point-source-type disposal, focusing the area of investigation to the distribution of contaminants with depth. Consequences of erroneous decisions are not severe. Characterization sampling results will be verified by confirmatory sampling of analogous sites during the confirmatory and remedial design phase.

N/A = not applicable

Table 7-2 is used to develop general data collection design alternatives. If the data collection design for a given decision will be non-statistical, determine what type of non-statistical design is appropriate (i.e., haphazard or judgmental).

Table 7-2. Determine Non-Statistical Sampling Design.

DR #	Haphazard	Judgmental
All	None	Professional judgmental sampling design is indicated.

The data collection design alternatives for this project are described in Table 7-3.

Table 7-3. Methods for Collection of Data at Depth. (2 Pages)

Method	Description
Trenching or test pit sampling	Excavation with backhoe or excavator. This technique provides grab samples taken directly from the soil column (approximate 0.3-m [1-ft] intervals) or from the excavator bucket. Because this technique creates a trench, direct inspection of the exposed soil column is possible. This method is not well suited for soils contaminated with alpha-emitting radionuclides because of direct exposure to personnel, equipment, wind, and weather.
Cone penetrometer or direct-push sampling	A closed-end rod is pushed into the soil to the desired depth, where a removable tip is displaced and a small volume of soil is retrieved. Due to the small volume of soil retrieved, multiple samples would be required to meet sample volume requirements for a large analyte list. The cone penetrometer and other direct-push methods are easily stopped by cobbles, rocks, or other features in the soil column. The resulting hole can be geophysically logged, providing information on gamma-emitting radionuclides and moisture content.
Auger drilling and sampling	Grab samples may be collected from the auger fitting during drilling, or split tube samples may be collected with the aid of hollow-stem auger "flights." To achieve laboratory analysis sample volume needs for large analytical lists, a 0.6-m (2-ft) core sample from a 13-cm (5-in.)-diameter sampler is typically needed. Running a sample tube down the hollow center of the flight retrieves split tube samples. This method is not well suited to drilling in soils contaminated with alpha-emitting radionuclides because of contamination control limitations. The auger split-spoon samples are typically 6 cm (2.5 in.) in diameter.
Cable tool drilling and sampling	This slow drilling method is particularly useful in highly contaminated areas because potential contamination releases can be more easily controlled. This drilling method allows collection of grab samples from the drive barrel or split-spoon. To achieve adequate laboratory analysis sample volumes for large analytical lists, a 0.6-m (2-ft)-long core sample from a 13-cm (5-in.)-diameter sampler is typically needed. DOE-owned, controlled cable tool rigs are available onsite for use in highly contaminated areas. In alpha-contaminated soils, significant contamination controls are required.
Diesel hammer drilling	The diesel hammer is a dual-string, reverse-air circulation drilling method. The potential impacts of this drilling method include degraded sample quality and increased contaminant release potential. Because of the introduction of air to the sample media, affects on analytical results for volatile organics and increased potential for dust result from this technique.

Table 7-3. Methods for Collection of Data at Depth. (2 Pages)

Method	Description
Sonic drilling and sampling	Sonic drilling can quickly advance either borehole casings or sample tubes. Samples are retrieved similar to split-spoon sample collection during a cable tool operation. To achieve adequate laboratory analysis sample volumes, a 0.6-m (2-ft)-long core sample is typically needed from a 13-cm (5-in.)-diameter sampler. Sonic drilling is much faster than cable tool drilling, but the technique generates a significant amount of heat, which can alter samples (e.g., liberate volatile organics from the sampled soils) and the surrounding formation. In alpha contaminated soils, significant contamination controls are required and may be difficult to implement because of the nature of the equipment and operations.
Air rotary drilling and sampling	Air rotary drilling is much faster than other drilling techniques. Grab samples and split-spoon samples may be taken using this method. In addition, most rotary drill rigs can be configured to collect core samples. To achieve adequate laboratory analysis sample volumes, a 0.6-m (2-ft)-long core sample is typically needed from a 13-cm (5-in.)-diameter sampler. This technique may introduce air into the soil, potentially altering the sample quality and formation moisture levels.

The design options are evaluated based on cost and ability to meet the DQO constraints. The results of the trade-off analyses should lead to one of two outcomes: (1) the selection of a design that most efficiently meets all of the DQO constraints, or (2) the modification of one or more outputs from DQO Steps 1 through 6 and the selection of a design that meets the new constraints.

The key features of the selected design are then documented, including (for example) the following:

- Maps outlining sample locations, strata, and inaccessible areas
- Directions for selecting sample locations, if the selection is not necessary or appropriate at this time
- Order in which samples should be collected (if important)
- Stopping rules
- Special sample collection methods
- Special analytical methods.

7.3 SAMPLING OBJECTIVES

The characterization objectives identified in Section 1.3 result in the following characterization goals:

- Determine the types and concentrations of radiological and nonradiological constituents with depth at worst-case locations in the 216-T-28 Crib, 216-B-58 Trench, 216-S-20 Crib, and 216-Z-7 Crib.
- Determine the presence and location of transuranic (above the TRU-waste and Class C definitions) materials associated with the worst-case locations at the 216-T-28 Crib, 216-B-58 Trench, 216-S-20 Crib, and 216-Z-7 Crib.
- Geophysically log planned boreholes.
- Analyze soils for physical properties to support modeling efforts.

7.4 SAMPLING DESIGN

7.4.1 Summary of Sampling Activities

A summary of the sampling activities is presented in Table 7-4.

Table 7-4. Key Features of the 200-LW-1 Sampling Design. (6 Pages)

Sample Collection Methodology	Key Features of Design[a]	Basis for Sampling Design
216-T-28 Crib		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of crib location.	Surface geophysical surveys used to locate crib and subsurface features. Geophysics techniques are expected to distinctly identify the crib location.
Borehole characterization	Install one vadose borehole within the crib boundaries at the location with the highest contamination potential, avoiding subsurface structures. Location will be based upon interpretation of the surface geophysical results. Borehole will be drilled to the water table.	Drill borehole to allow soil sampling with depth and to support geophysical logging with spectral gamma and neutron moisture tools.

Table 7-4. Key Features of the 200-LW-1 Sampling Design. (6 Pages)

Sample Collection Methodology	Key Features of Design[a]	Basis for Sampling Design
	Collect soil samples at the top of the crib (if soil is available), within the crib (if soil is available), at the bottom of the crib at the gravel/soil interface (approximately 4.6 m [15 ft] bgs), at 3.0 to 3.8 m, 3.8 to 4.6 m, 5.3 to 6.1 m, 6.8 to 7.6 m, 8.4 to 9.1 m, 9.9 to 10.7 m, 14.5 to 15.2 m, 20.6 to 21.3 m, 27.4 to 28.2 m, 48.0 to 48.8 m, and 60.2 to 70.0 m (10 to 12.5 ft, 12.5 to 15 ft, 17.5 to 20 ft, 22.5 to 25 ft, 27.5 to 30 ft, 32.5 to 35 ft, 47.5 to 50 ft, 67.5 to 70 ft, 90 to 92.5 ft, 157.5 to 160 ft, and 197.5 to 200 ft) bgs and at the water table (approximately 68.9 m [226 ft]). Collect bulk density and grain-size distribution samples at major changes in lithology. Moisture samples will be collected along with the other physical samples.	Soil samples will be used to determine type and concentration of COCs beneath the crib in the vadose zone. Sampling provides data for remedial action decision making, to confirm the preliminary conceptual contaminant distribution model, and to support numerical modeling efforts. Soil physical properties (e.g., moisture content, grain-size distribution, and bulk density) will be used to support numerical modeling.
	Perform borehole spectral logging from the surface to groundwater.	SGL logging will be performed to verify gamma-emitting contamination and to refine the preliminary conceptual contaminant distribution model. Cesium-137 will be the main target isotope for the SGL because of its prevalence and ease in identification; other gamma-emitting radionuclides may be detected if present.
	Perform neutron moisture logging from surface to groundwater.	Collect soil moisture data to support numerical modeling.
Borehole spectral logging in existing boreholes	Perform borehole spectral logging and neutron moisture logging in accessible boreholes and groundwater wells near the cribs. BHI well status records indicate that the following boreholes are accessible and will provide useful information on contaminant distribution: • 299-W14-1 • 299-W14-2 • 299-W14-3 • 299-W14-4.	These boreholes represent data collection points near the waste site. Logging of these boreholes will provide additional updated site-specific information on contaminant distribution, both laterally and vertically.
216-B-58 Trench		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of trench.	Surface geophysical surveys used to locate crib and subsurface features. Geophysics techniques should identify the location of the trench.

Table 7-4. Key Features of the 200-LW-1 Sampling Design. (6 Pages)

Sample Collection Methodology	Key Features of Design[a]	Basis for Sampling Design
Direct-push geophysical logging	Install up to eight direct-push holes using a direct-push method (e.g., cone penetrometer or drive casings) in each of the segments of the trench; geophysically log holes using spectral gamma and neutron moisture tools.	Logging will be used to verify location of trench, select the location of the borehole, and refine the sampling strategy. Data may also help identify the discharge method to the trench, which is not clear from historical information.
Borehole characterization	Drill one deep borehole to groundwater within the most contaminated/worst case segment in the 216-B-58 Trench. Selection of the borehole location will be based upon interpretation of the surface and direct-push geophysical results.	Drill borehole for borehole soil sampling and to support geophysical logging with a spectral gamma detector.
	Collect soil samples at the bottom of the trench (approximately 3.7 m [12 ft] bgs) at 3.8 to 4.6 m, 5.3 to 6.1 m, 6.8 to 7.6 m, 7.6 to 9.1 m, 10.7 to 11.4 m, 16.0 to 16.8 m, 29.7 to 30.5 m, 45.7 to 50.0 m, 60.2 to 60.9 m, 75.4 to 76.2 m, 89.2 to 89.9 m, and 102.2 to 103.0 m (12.5 to 15 ft, 17.5 to 20 ft, 22.5 to 25 ft, 27.5 to 30 ft, 35 to 37.5 ft, 52.5 to 55 ft, 97.5 to 100 ft, 147.5 to 150 ft, 197.5 to 200 ft, 247.5 to 250 ft, and 292.5 to 295 ft) bgs, and at the water table (approximately 102.7 m [338 ft]).	Soil samples will be used to determine COC concentrations beneath the trench and in the vadose zone. Sampling provides data for remedial action decision making and will be used to verify the preliminary conceptual contaminant distribution model.
	Collect bulk density and grain-size distribution samples at major changes in lithology. Collect moisture samples with other physical property samples.	Soil physical properties (e.g., moisture content, grain-size distribution, and lithology) will be used to support modeling.
	Perform SGL for the entire length of the deep borehole.	SGL logging will be performed to verify gamma-emitting contamination and to refine the preliminary conceptual contaminant distribution model. Cesium-137 will be the main target isotope for the SGL because of its prevalence and ease in identification; other gamma-emitting radionuclides may be detected if present.
	Perform neutron moisture logging for the entire length of the borehole.	Collect soil moisture data to expand the database and to support modeling.
Borehole spectral logging in existing boreholes	Perform borehole spectral logging and neutron moisture logging in accessible boreholes and groundwater wells near the cribs. BHI well status records indicate that the following boreholes are accessible and will provide useful information on contaminant distribution: 299-E13-16.	These boreholes represent data collection points near the waste site. Logging of these boreholes will provide additional updated site-specific information on contaminant distribution, both laterally and vertically.

Table 7-4. Key Features of the 200-LW-1 Sampling Design. (6 Pages)

Sample Collection Methodology	Key Features of Design[a]	Basis for Sampling Design
216-S-20 Crib		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of cribs.	Surface geophysical surveys used to locate crib and subsurface features. Geophysics techniques are expected to distinctly identify the crib locations.
Borehole characterization	Install one vadose borehole within the 216-S-20 Crib boundary at the location with the highest contamination potential (i.e., the first crib in the series of two cribs). Location will be based upon interpretation of the surface geophysical results. Borehole will be drilled to the water table.	Install borehole for borehole soil sampling and to support geophysical logging with spectral gamma and moisture tools.
	Collect soil samples at 3.8 to 4.6 m, 9.7 to 10.5 m, 10.6 to 11.4 m, 12.2 to 13.0 m, 14.5 to 15.2 m, 22.1 to 22.9 m, 29.7 to 30.5 m, 48.2 to 48.9 m, 61.6 to 62.3 m, and 70.1 to 70.9 m (12.5 to 15 ft, 32.0 to 34.5 ft, 35.0 to 37.5 ft, 40.0 to 42.5 ft, 47.5 to 50 ft, 72.5 to 75 ft, 97.5 to 100 ft, and 158 to 160.5 ft) bgs, and at the water table (approximately 70.7 m [232.5 ft]).	Soil samples will be used to determine COC concentrations beneath the crib and in the vadose zone. Sampling provides data for remedial action decision making and will be used to verify the preliminary conceptual contaminant distribution model.
	Collect bulk density and grain-size distribution samples at major changes in lithology. Collect moisture samples with the other physical property samples.	Soil physical properties (e.g., moisture content, grain-size distribution, and bulk density) will be used to support modeling.
	Perform spectral logging over the length of the borehole.	SGL will be performed to verify zones of gamma-emitting contamination and to refine preliminary conceptual contaminant distribution model.
	Perform neutron moisture logging over the entire length of borehole.	Collect soil moisture data to support numerical modeling efforts.
Borehole spectral logging in existing boreholes	Perform borehole spectral logging and neutron moisture logging in accessible boreholes and groundwater wells near the cribs. BHI well status records indicate that the following boreholes are accessible and will provide useful information on contaminant distribution: • 299-W22-20 • 299-W22-61 • 299-W22-63 • 299-W22-74.	These boreholes represent data collection points near the waste site. Logging of these boreholes will provide additional updated site-specific information on contaminant distribution, both laterally and vertically.

Table 7-4. Key Features of the 200-LW-1 Sampling Design. (6 Pages)

Sample Collection Methodology	Key Features of Design[a]	Basis for Sampling Design
216-Z-7 Crib		
Surface geophysical surveys (GPR and EMI)	Perform GPR and/or EMI over the general area of cribs.	Surface geophysical surveys used to locate crib and subsurface features Geophysics techniques should identify the location of the trench.
Direct-push geophysical logging	Install up to six direct-push holes using a direct-push method (e.g., cone penetrometer or drive casing); geophysically log holes using spectral gamma, passive neutron, and neutron moisture tools.	Logging will be used to verify location of trench, select the location of boreholes, and refine the sampling strategy. Data may also help identify the inlet area of the trench, which is not clear from historical information.
Borehole characterization	Drill one deep borehole to groundwater at the discharge point or within the most contaminated/worst case zone in the 216-Z-7 Crib. Selection of the borehole location will be based upon interpretation of the surface and direct-push geophysical results.	Drill borehole for borehole soil sampling and to support geophysical logging with a spectral gamma detector.
	Collect soil samples at the bottom of the crib at 3.8 to 4.6 m, 5.3 to 6.1 m, 6.8 to 7.6 m, 8.4 to 9.1 m, 12.2 to 12.9 m, 17.5 to 18.3 m, 29.0 to 29.7 m, 35.8 to 36.6 m, 60.2 to 61.0 m, and 65.5 to 66.3 m (12.5 to 15 ft, 17.5 to 20 ft, 22.5 to 25 ft, 27.5 to 30 ft, 40 to 42.5 ft, 57.5 to 60 ft, 95 to 97.5 ft, 117.5 to 120 ft, and 197.5 to 200 ft) bgs, and at the water table (approximately 66.2 m [217.5 ft]). Collect bulk density and grain-size distribution samples at major changes in lithology. Collect moisture samples with other physical property samples.	Soil samples will be used to determine COC concentrations beneath the trench and in the vadose zone. Sampling provides data for remedial action decision making and will be used to verify the preliminary conceptual contaminant distribution model. Soil physical properties (e.g., moisture content, grain-size distribution and lithology) will be used to support modeling.
	Perform SGL for the entire length of the borehole.	SGL will be performed to verify zones of gamma-emitting contamination and to refine preliminary conceptual contaminant distribution model.
	Perform passive neutron logging for the entire length of the borehole.	Passive neutron logging may help identify areas of alpha contamination.
	Perform neutron moisture logging for the entire length of the borehole.	Collect soil moisture data to expand the database and to support modeling.

Table 7-4. Key Features of the 200-LW-1 Sampling Design. (6 Pages)

Sample Collection Methodology	Key Features of Design[a]	Basis for Sampling Design
Borehole spectral logging in existing boreholes	Perform borehole spectral logging and neutron moisture logging in accessible boreholes and groundwater wells near the cribs. BHI well status records indicate that the following boreholes are accessible and will provide useful information on contaminant distribution: • 299-W15-7 • 299-W15-62 • 299-W15-63 • 299-W15-64 • 299-W15-76 • 299-W15-77 • 299-W15-78.	These boreholes represent data collection points near the waste site. Logging of these boreholes will provide additional updated site-specific information on contaminant distribution, both laterally and vertically.

[a] Additional samples may be collected and analyzed at the discretion of the field engineer/geologist, based on field conditions, measurements, or observations made during the conduct of remedial investigations.

7.5 POTENTIAL SAMPLE DESIGN LIMITATIONS

- Drilling impediments (e.g., boulders) may be encountered and/or insufficient sample volumes may be retrieved from the split-spoon samplers. The list of analytes will be prioritized in the SAP to account for insufficient sample volume.

- The 216-S-20 and 216-Z-7 Cribs may have the potential for cave-in. Safety considerations associated with borehole installation may require additional equipment (e.g., a bridge structure, or relocation of the borehole to a safer zone not directly through the crib structure), which may impact sampling location and quality.

- Because the potential exists for significant concentrations of radiological COCs, samples may need to be analyzed in an onsite laboratory. In this case, expected impacts include high analytical costs, degradation of detection limits, reduced analyte lists, and long turnaround times. The presence of transuranics at TRU concentrations would also significantly impact the handling and management of waste. Sample volumes may be reduced if the radiation levels are high for the samples.

- Geophysical logging of existing boreholes is dependent upon the accessibility and configuration of the boreholes. If the specified boreholes are not properly configured or available for logging, other boreholes may be considered or the logging program may be reduced.

8.0 REFERENCES

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